

WGEEL Country Reports 2014/2015

Report on the eel stock and fishery in Belgium 2014/2015

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Reporting Period: This report was completed in November 2015, and contains data up to 2015.

2 Introduction

This report is written in preparation of the Joint EIFAAC/ICES/GFCM Working Group on Eels (WGEEL), meeting in Antalya, Turkey, from 24 November to 2 December 2015. Extensive information on the eel stock and fishery in Belgium has been presented in the previous Belgian country reports (i.e. Belpaire *et al.*, 2006; 2007; 2008; 2009; 2010; 2011; 2012; 2013; 2014), in the Belgian Eel Management Plan (EMP), and in the first and second report submitted in line with Article 9 of the eel Regulation 1100/2007 (Vlietinck *et al.*, 2012; Vlietinck and Rollin, 2015). This report should thus be read in conjunction with those documents.

Four international RBDs are partly lying on Belgian territory: the Scheldt (Schelde/Escaut), the Meuse (Maas/Meuse), the Rhine (Rijn/Rhin) and the Seine. For description of the river basins in Belgium see the 2006 Country Report (Belpaire *et al.*, 2006). All RBDs are part of the NORTH SEA Ices ecoregion.

In response to the Council Regulation CE 1100/2007, Belgium has provided a single Eel Management Plan (EMP), encompassing the two major river basin districts (RBD) present on its territory: the Scheldt and the Meuse RBD.

Given the fact that the Belgian territory is mostly covered by two international RBDs, namely the Scheldt and Meuse, the Belgian Eel Management Plan was prepared jointly by the three Regional entities, each respectively providing the overview, data and measures focusing on its larger RBDs. The Belgian EMP thus focuses on the Flemish, Brussels and Walloon portions of the Schelde/Escaut RBD, and the Walloon and Flemish portions of the Meuse/Maas RBD.

The Belgian EMP has been approved by the European Commission on January 5th, 2010.

The three Belgian authorities (Flanders, Wallonia or Brussels Regions) are responsible for the implementation and evaluation of the proposed EMP measures on their respective territory.

In the next years, all eel-related measures proposed in the Belgian EMP will be fine-tuned according to the existing WFD management plans and implemented in such manner by the responsible regional authorities.

The Belgian EMP focuses on:

For the Flemish region

- the ban of fyke fishing on the lower Scheldt in 2009;
- making up an inventory of the bottle necks for upstream eel migration (priority and timing for solving migration barriers).

Specific action in 2014–2015: In Flanders, the network of watercourses allocated to first priority for the sanitation of fish migration barriers is about 800 km long, and includes 51 fish migration barriers, of which 90% (or 46 barriers) should be sanitized by December 31, 2015. These 46 barriers include 35 priority migratory barriers defined in the eel management plan. On December 31, 2014, a total of 18 of the 46 (39%) barriers of phase 1 were remediated. Of the 35 high priority barriers of the eel management plan, however, only eleven (31%) were sanitized (<https://www.inbo.be/nl/natuurindicator/>).

In 2013, a study was started at the sea sluices of Leopold Canal and Schipdonk Canal to optimize management of the sluices in order to allow glass eel migration.

- for downward migration:

Specific action in 2014–2015: A study is being conducted on the Albert Canal to estimate the damage and mortality causes by the combined pump/hydropower installations. Also downstream silvers eels will be equipped with transmitters in order to study their behaviour at the pump/hydropower installations and in order to determine to which amount they use the Albert Canal as downstream migration r

- controlling poaching.

Specific action in 2014–2015: Actions to control illegal fishing activities on eels were continued in 2014 and 2015, focusing mainly on the province of West-Vlaanderen. Illegal fishing equipment was seized.

- Glass eel restocking programme.

Specific action in 2014–2015: In Flanders 500 kg was stocked in 2014. In 2015, 335 kg was ordered but due to failure of the supplier in France, no glass eel could be stocked in Flanders in 2015.

- Achieving WFD goals for water quality.

Specific action in 2010–2015: Flanders continues to work to the development of water treatment infrastructure to achieve the good ecological status and ecological potential for the WFD. A pilot program to monitor eel and perch quality with respect to their levels of contaminants for reporting to the WFD has been finalised (De Jonghe *et al.*, 2014), and is now being implemented with new assessments (work in progress).

- Eel stock monitoring.

Specific action in 2014–2015:

Glass eel: the monitoring of the glass eel recruitment at Nieuwpoort (River IJzer) has been continued in 2015, and will be continued in upcoming years.

Yellow eel/silver eel: In 2015, Belpaire *et al.* (2015) calculated the escapement of silver eel for Flanders for the period 2011–2014, on the basis of data collected through fish stock assessments within the Flemish Monitoring Network Freshwater Fish. The method for calculating the level of escapement was modified in comparison to the method used in a previous report (Stevens and Coeck, 2013), taking into account previous recommendations (Stevens *et al.*, 2013).

- Eel quality monitoring.

Specific action in 2015: New information has been published about the presence of dyes (Belpaire *et al.*, 2015) and specific contaminants such as organophosphorus flame retardants and plasticizers (Malarvannan *et al.*, 2015), which contributes to the

scientific work about the status and effects of hazardous substances on the eel (see abstracts under subchapter 11.3). An international workshop has been organized to progress with the development of internationally harmonized methods for the evaluation of eel quality with respect to measuring and reporting on contaminants and diseases (ICES, 2015).

- Eel migration in river Scheldt.

A scientific survey of the silver eel migration on the River Scheldt is ongoing. For this, acoustic telemetry is used in combination with a permanent acoustic network in the Scheldt estuary and Belgian part of the North Sea, funded by the LifeWatch ESRI observatory (Verhelst, work in progress).

- Eel mortality at pumping stations.

Eel mortality was studied in a Belgian lowland canal after downstream passage through a large and small de Wit-adapted Archimedes screw pump over a 12-month period (2012–2013) (Buysse *et al.*, 2015a).

- General status

The European eel is categorized as ‘Critical Endangered’ on the new Red List of Fish in Flanders.

For the Walloon region

- avoiding mortality at hydropower stations;

For a complete report of the situation, see Vlietinckx and Rollin (2015).

- sanitation of migration barriers on main waterways (especially in the Meuse catchment);

For a complete report of the situation, see Vlietinckx and Rollin (2015).

- Eel stock monitoring.

Specific action in 2014–2015:

Yellow eel: the monitoring of the eel recruitment at Lixhe (River Meuse) has been continued in 2015, and will be continued in upcoming years.

Yellow eel/silver eel: In 2015, Belpaire *et al.* (2015) calculated the escapement of silver eel for Flanders for the period 2011–2014, on the basis of data collected through fish stock assessments within the Flemish Monitoring Network Freshwater Fish. The method for calculating the level of escapement was modified in comparison to the method used in a previous report (Stevens and Coeck, 2013), taking into account previous recommendations (Stevens *et al.*, 2013).

- Eel quality monitoring.

Specific action in 2015: New information has been published about the presence of dyes (Belpaire *et al.*, 2015) and specific contaminants such as organophosphorus flame retardants and plasticizers (Malarvannan *et al.*, 2015), which contributes to the scientific work about the status and effects of hazardous substances on the eel (see abstracts under subchapter 11.3). An international workshop has been organized to progress with the development of internationally harmonized methods for the evaluation of eel quality with respect to measuring and reporting on contaminants and diseases (ICES, 2015).

- Glass eel restocking programme.

Specific action in 2014–2015: In Wallonia 501 kg glass eel was ordered in 2014 with a 50% European Fishery Fund cofunding, but due to failure of the supplier in France, only 40 kg glass eel could be stocked and the delivery was reported in 2015. Due to a new failure of the same supplier in France, no glass eel could be stocked in Wallonia in 2015 and the contract had to be cancelled. A new public market will be done in 2016 but without EFP cofunding.

- controlling poaching.

Specific action in 2014–2015: Control actions have been focused specifically on the river Meuse, the river Sambre and in the canals during day and night. In 2015, the number of control actions was doubled (101 operations, 59 during the day and 42 during the night) compared to 2014 for a total of 2690 controlled fishermen. Numerous illegal fishing equipment was seized. Regarding Fisheries Act Violation, the rate was of 5.4% during the day in 2015, but of 20.1% during the night of the same year. Since 2010, the annual offence rate during the night decreased by about 5% per year and was highly correlated to control intensity. Only a small minority of violations concerned eel poaching, mostly illegal eel detention and utilisation for silurid fishing.

In the coming years, Belgium will pursue with its neighbouring countries the development and implementation of cross boundary eel management plans. These coordination activities will take place within the International Scheldt Commission (ISC) and the International Meuse Commission (IMC).

In June 2012 Belgium submitted the first report in line with Article 9 of the eel Regulation 1100/2007 (Vlietinck *et al.*, 2012). This report outline focuses on the monitoring, effectiveness and outcome of the Belgian Eel Management Plan. The second Belgian Progress Report in line with Article 9 of the eel Regulation 1100/2007, was submitted in June 2015 (Vlietinck and Rollin, 2015).

In comparison to the previous report (2012), the escape rate of silver eel dropped significantly (from 18% to 11% for Scheldt river basin district, and from 25% to 3% for the Meuse river basin district). However, one should be careful to draw firm conclusions from here considering the lack of eel density data in certain parts of the Meuse Basin as well as the modified way of calculating the figures compared to 2012 (hypotheses) and the limitations inherent in the methods used (Vlietinck and Rollin, 2015).

3 Time-series data

3.1 Recruitment

3.1.1 Glass eel recruitment

3.1.1.1 Commercial

There are no commercial glass eel fisheries.

3.1.1.2 Recreational

There are no recreational glass eel fisheries.

3.1.1.3 Fishery-independent

Glass eel recruitment at Nieuwpoort at the mouth of River Yser (Yser Basin)

In Belgium, both commercial and recreational glass eel fisheries are forbidden by law. Fisheries on glass eel are carried out by the Flemish government. Former years, when recruitment was high, glass eels were used exclusively for restocking in inland waters in Flanders. Nowadays, the glass eel caught during this monitoring are returned to the river.

Long-term time-series on glass eel recruitment are available for the Nieuwpoort station at the mouth of the river Yser. Recently new initiatives have been started to monitor glass eel recruitment in the Scheldt basin (see below).

For extensive description of the glass eel fisheries on the river Yser see Belpaire (2002; 2006).

Figure 1 and Table 1 give the time-series of the total annual catches of the dipnet fisheries in the Nieuwpoort ship lock and give the maximum day catch per season. Since the last report the figure has been updated with data for 2015.

Fishing effort in 2006 was half of normal, with 130 dipnet hauls during only 13 fishing nights between March 3rd, and June 6th. Catches of the year 2006 were extremely low and close to zero. In fact only 65 g (or 265 individuals) were caught. Maximum day catch was 14 g. These catches are the lowest record since the start of the monitoring (1964).

In 2007 fishing effort was again normal, with 262 dipnet hauls during 18 fishing nights between February 22nd, and May 28th. Catches were relatively good (compared to former years 2001–2006) and amounted 2214 g (or 6466 individuals). Maximum day catch was 485 g. However this 2007 catch represents only 0.4% of the mean catch in the period 1966–1979 (mean = 511 kg per annum, min. 252–max. 946 kg).

In 2008 fishing effort was normal with 240 dipnet hauls over 17 fishing nights. Fishing was carried out between February 16th and May 2nd. Total captured biomass of glass eel amounted 964.5 g (or 3129 individuals), which represents 50% of the catches of 2007. Maximum day catch was 262 g.

In 2009 fishing effort was normal with 260 dipnet hauls over 20 fishing nights. The fishing was carried out between and February 20th and May 6th. Total captured biomass of glass eel amounted 969 g (or 2534 individuals), which is similar to the catches of 2008). Maximum day catch was 274 g.

In 2010 fishing effort was normal with 265 dipnet hauls over 19 fishing nights. The fishing was carried out between and February 26th and May 26th. Total captured biomass of glass eel amounted 318 g (or 840 individuals). Maximum day catch was 100 g. Both total captured biomass, and maximal day catch is about at one third of the quantities recorded in 2008 and 2009. Hence, glass eel recruitment at the Yser in 2010 was at very low level. The 2010 catch represents only 0.06% of the mean catch in the period 1966–1979 (mean = 511 kg per annum, min. 252–max. 946 kg).

In 2011 fishing effort was normal with 300 dipnet hauls over 20 fishing nights. The fishing was carried out between and February 16th and April 30th. Compared to 2010, the number of hauls was ca. 15% higher, but the fishing period stopped earlier, due to extremely low catches during April. Total captured biomass of glass eel amounted 412.7 g (or 1067 individuals). Maximum day catch was 67 g. Total captured biomass is similar as the very low catches in 2010. Maximal day catch is even lower

than data for the four previous years (2007–2010). Overall, the quantity reported for the Yser station should be regarded as very low, comparable to the 2010 record. The 2011 catch represents only 0.08% of the mean catch in the period 1966–1979 (mean = 511 kg per annum, min. 252–max. 946 kg).

In 2012 fishing effort was higher than previous years with 425 dipnet hauls over 23 fishing nights. The fishing was carried out between and March 2nd and May 1st. Compared to 2010, the number of hauls was 42% higher. Total captured biomass of glass eel amounted 2407.7 g (or 7189 individuals). Maximum day catch was 350 g. Both, the total captured biomass and the maximum day catch are ca. six times higher than in 2010. Overall, the quantity reported in 2012 for the Yser station increased significantly compared to previous years and is similar to the 2007 catches. Still, the 2012 catch represents only 0.47% of the mean catch in the period 1966–1979 (mean = 511 kg per annum, min. 252–max. 946 kg).

In 2013 fishing effort included 410 dipnet hauls over 23 fishing nights. The fishing was carried out between 20 February and 6 May. Total captured biomass of glass eel amounted 2578.7 g (or 7368 individuals). Maximum day catch was 686 g. So compared to 2012, similar fishing effort (number of hauls), and similar year catches, but higher maximum day catch.

In 2014 fishing effort included 460 dipnet hauls over 23 fishing nights. The fishing was carried out between 24 February and 25 April. Total captured biomass of glass eel amounted 6717 g (or 17815 individuals). Maximum day catch was 770 g. So compared to 2013, same number of fishing nights, but 12% more hauls (increased fishing effort in number of hauls), and a 2.6 fold increase of the total year catches. Maximum day catch increased with 12% compared to the 2013 value.

In 2015 fishing effort was somewhat reduced compared to previous years, with 355 dipnet hauls over 19 fishing nights. The fishing was carried out between 16 February and 29 April. Total captured biomass of glass eel amounted 2489 g (or 6753 individuals). Maximum day catch was 487 g. So compared to 2014, 17% less fishing nights and 23% less hauls, and a decrease in total year catch of 63%. Compared to 2012 and 2013 total catch was similar in 2015, but considering the reduced fishing effort, the cpue (catch per haul) was between 11 and 23% higher. Maximum day catch was between the levels of 2012 and 2013 (Figures 1A–D, and Table 1).

See below under 7.1 for cpue data for the period 2002–2015.

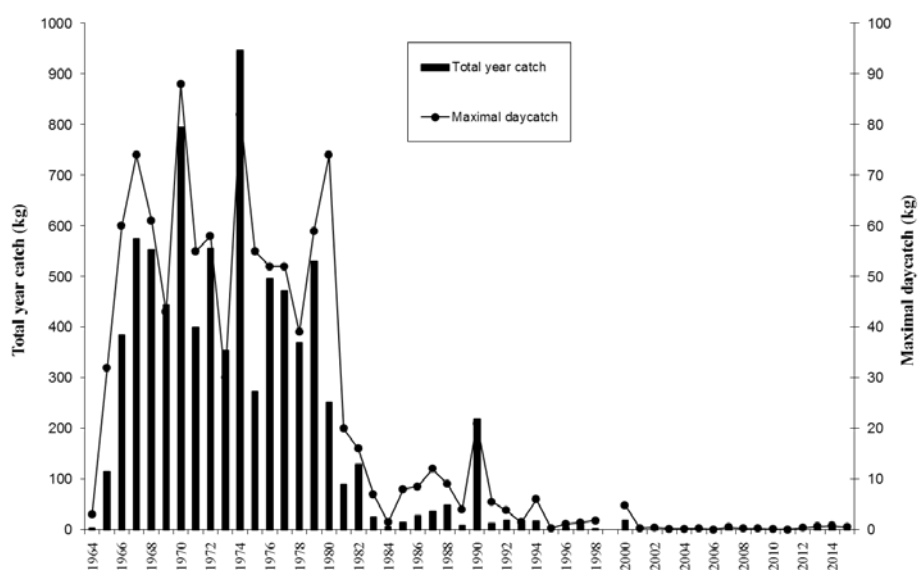


Figure 1A. Annual variation in glass eel catches at river Yser using the dipnet catches in the ship lock at Nieuwpoort (total year catches and maximum day catch per season), data for the period 1964–2015.

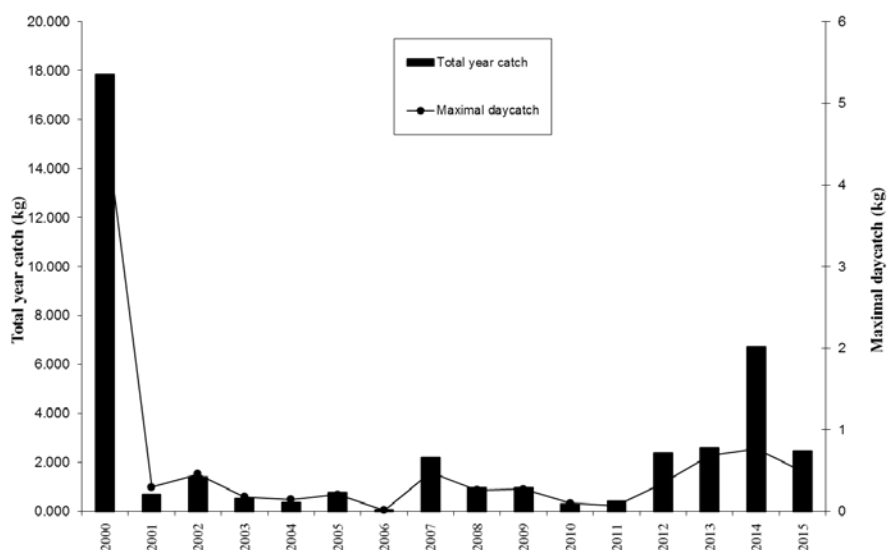


Figure 1B. Annual variation in glass eel catches at river Yser using the dipnet catches in the ship lock at Nieuwpoort (total year catches and maximum day catch per season), data for the period 2000–2015.

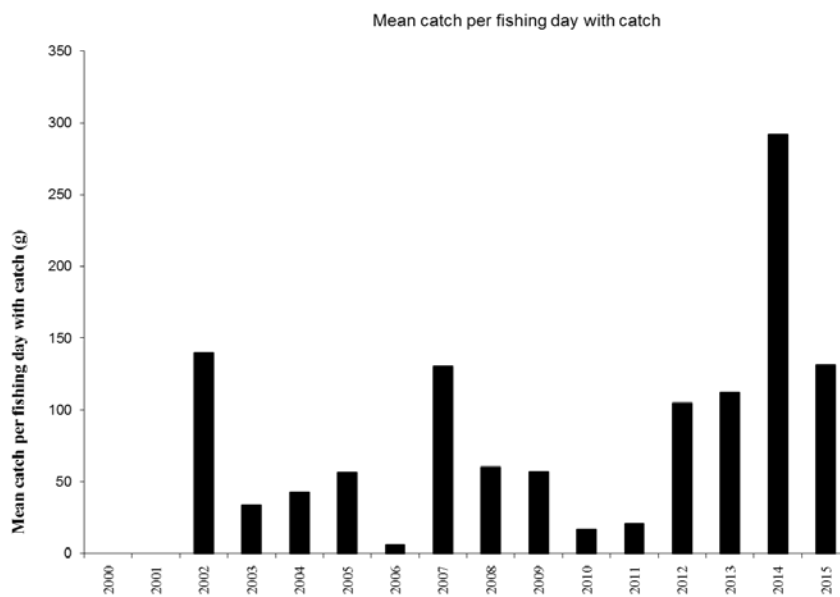


Figure 1C. Annual variation in glass eel catches at river Yser using the dipnet catches in the ship lock at Nieuwpoort) expressed as mean catches per fishing day with catch in g.

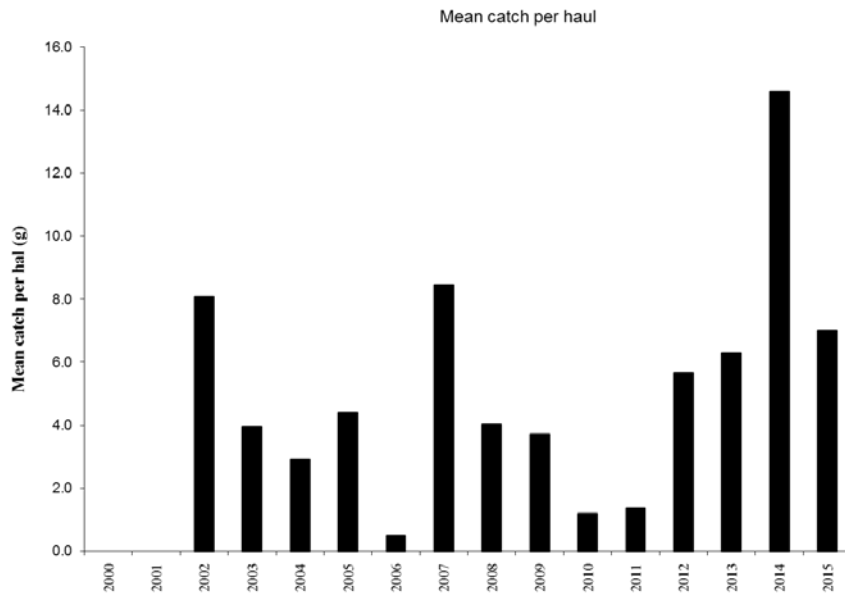


Figure 1D. Annual variation in glass eel catches at river Yser using the dipnet catches in the ship lock at Nieuwpoort), expressed as the mean catches per haul in g.

Table 1. Total year catches (kg) between 1964 and 2015. Data Provincial Fisheries Commission West-Vlaanderen.

DECADE						
YEAR	1960	1970	1980	1990	2000	2010
0		795	252	218.2	17.85	0.318
1		399	90	13	0.7	0.413
2		556.5	129	18.9	1.4	2.408
3		354	25	11.8	0.539	2.579
4	3.7	946	6	17.5	0.381	6.717
5	115	274	15	1.5	0.787	2.489
6	385	496	27.5	4.5	0.065	
7	575	472	36.5	9.8	2.214	
8	553.5	370	48.2	2.255	0.964	
9	445	530	9.1		0.969	

Other glass eel recruitment studies

The glass eel recruitment-series for the Schelde estuary which was reported in the 2011 Country Report (See Belpaire *et al.*, 2011) for the period 2004–2011 has been stopped.

3.1.2 Yellow eel recruitment

3.1.2.1 Commercial

There is no commercial fishery for yellow eel in inland waters in Belgium. Commercial fisheries for yellow eel in coastal waters or the sea are negligibly small.

3.1.2.2 Recreational

No data available.

3.1.2.3 Fishery-independent

On the Meuse, the University of Liège is monitoring the amount of ascending young eels in a fish-pass. From 1992 to 2015 upstream migrating eels were collected in a trap (0.5 cm mesh size) installed at the top of a small pool-type fish-pass at the Visé-Lixhe dam (built in 1980 for navigation purposes and hydropower generation; height: 8.2 m; not equipped with a ship-lock) on the international River Meuse near the Dutch-Belgium border (290 km from the North Sea; width: 200 m; mean annual discharge: 238 m³ s⁻¹; summer water temperature 21–26°C). The trap in the fish-pass is checked continuously (three times a week) over the migration period from March to September each year, except in 1994. A total number of 37 394 eels was caught (biomass 2459 kg) with a size from 14 cm (1992 and 2001) to 88 cm (2012) and an increasing median value of 28.5 cm (1992) to 41 cm (2015) corresponding to yellow eels. The study based on a constant year-to-year sampling effort revealed a regular decrease of the annual catch from a maximum of 5613 fish in 1992 to minimum values of 423–758 in 2004–2007 (Figure 2, Table 2). In 2008 2625 eels were caught. This sudden increase might be explained by the fact that a new fish pass was opened (20/12/2007) at the weir of Borgharen-Maastricht, which enabled passage of eels situated downward the weir in the uncanalized Grensmaas. Nevertheless the number of eels were very low again in 2009 (n=584), 2010 (n = 249) and 2011 (n=208). The figure for 2012 (n= 317) is a bit more than the two previous years. In 2013, 265 eels were caught (size range 19.6–76.5 cm, median 39.1 cm), the data for 2014 are similar to 255 individuals (size range 23.4–69.8 cm, median 40.1 cm). In 2015 92 eels were caught (size range 23.1–85 cm, median 41 cm) that is the smallest number of eels ever recorded since the start of the controls (1992, n = 5613). The decreasing trend in the recruitment of young eels in this part of the Meuse was particularly marked from 2004 onwards. The University of Liège (Nzau Matondo *et al.*, 2015a) is continuing a research programme financed by EFF-EU to follow the upstream migration of yellow eels at Lixhe and to analyse the historical trends. Since 2010, every individual yellow eel is pit-tagged and its upstream migration has been followed along detection stations placed at fish passes located upstream in the Meuse and in the lower course of the river Ourthe (main tributary of River Meuse). A preliminary report has been published (Nzau Matondo *et al.*, 2014). From 1273 eels (size range 21–88 cm) released 0.3 km upstream the Visé-Lixhe dam in 2010–2014, only 7.9% of these eels were detected beyond 31 km upstream the Visé-Lixhe dam moving upstream at night during spring and summer, which were deemed too insufficient to populate tributaries and subtributaries of the River Meuse basin. Note that some small changes have been made to the figure as presented in last years' reports.

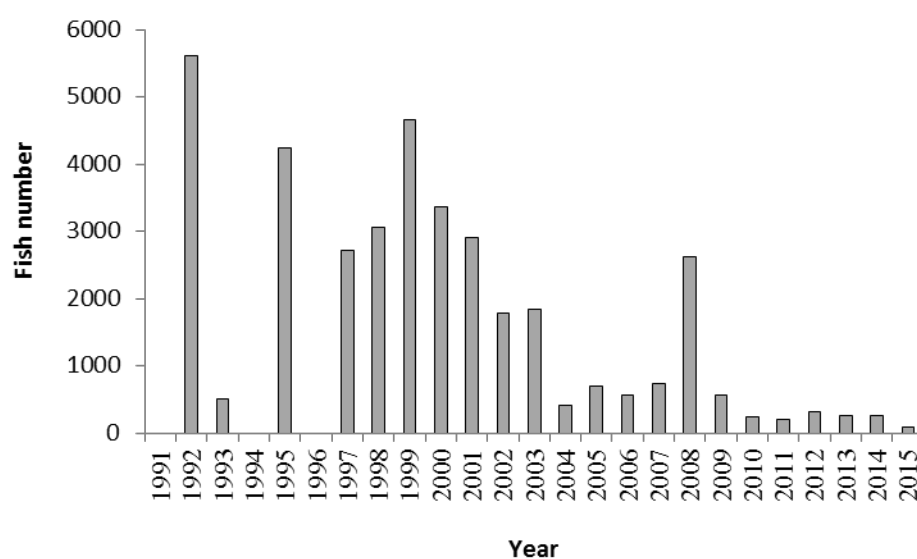


Figure 2. Variation in the number of ascending young yellow eels trapped at the fish trap of the Visé-Lixhe dam between 1992 and 2015. Data from University of Liège (Nzau Matondo *et al.*, 2015).

Table 2 Variation in the number of ascending young yellow eels trapped at the fish trap of the Visé-Lixhe dam between 1992 and 2013. Data from University of Liège (in Philippart and Rimbaud (2005); Philippart *et al.*, 2006; Nzau Matondo *et al.*, 2015).

YEAR	Decade		
	1990	2000	2010
0		3365	249
1		2915	208
2	5613	1790	324
3		1842	265
4		423	255*
5	4240	758	92
6		575	
7	2709	731	
8	3061	2625	
9	4664	584	

3.2 Yellow eel landings

3.2.1 Commercial

No time-series available. Currently there is no commercial yellow eel fisheries.

3.2.2 Recreational

No time-series available.

Flemish region

Based on an inquiry by the Agency for Nature and Forest in public waters in Flanders in 2008, recreational anglers harvest on a yearly basis 33,6 tons of eel (Vlietinck, 2010). In 2010 a small restriction of eel fishing was aimed by a new regulation (Besluit van de Vlaamse Regering 5/3/2010). Between April 16th and May 31th, and during the night, eels may not be taken home. This results in a roughly estimate of 10% reduction of eel harvest. Hence estimates for 2010 and later are an annual eel harvest of 30 tons (Vlietinck, pers. comm.). There is no distinction between the catch of yellow eel and silver eel, but due to the specific behaviour of silver eel, it is considered that these catches are mainly composed of yellow eel.

Soon, a new inquiry to anglers will be organized, to assess the eel yields by recreational fishermen in Flanders.

Only eels above the size limit of 30 cm are allowed to be taken home. In 2013 a new legislation on river fisheries went into force (Agentschap voor Natuur en Bos, 2013). The total number of fish (all species, including eel) which an angler is allowed to take with him on a fishing occasion is now limited to five. There is no indication to what extent this will have an impact on the total recreational biomass of eel retrieved by recreational fisheries.

Walloon region

Since 2006, captured eels may not be taken at home and have to return immediately into the river of origin. Therefore, yellow eel landing in Wallonia is zero.

3.3 Silver eel landings

3.3.1 Commercial

There is no commercial fishery for silver eel in inland waters in Belgium. Commercial fisheries for silver eel in coastal waters or the sea are negligibly small.

3.3.2 Recreational

No time-series available. Due to the specific behaviour of silver eel catches of silver eel by recreational anglers are considered low.

3.4 Aquaculture production

There is no aquaculture production of eel in Belgium.

3.4.1 Seed supply

3.4.2 Production

3.5 Stocking

3.5.1 Amount stocked

Stocking in Flanders

Glass eel and young yellow eels were used for restocking inland waters by governmental fish stock managers. The origin of the glass eel used for restocking from 1964 onwards was the glass eel catching station at Nieuwpoort on river Yser. However,

due to the low catches after 1980 and the shortage of glass eel from local origin, foreign glass eel was imported mostly from UK or France.

Also young yellow eels were restocked; the origin was mainly the Netherlands. Restocking with yellow eels was stopped after 2000 when it became evident that also yellow eels used for restocking contained high levels of contaminants (Belpaire and Coussement, 2000). So only glass eel is stocked from 2000 on (Figure 3). Glass eel restocking is proposed as a management measure in the EMP for Flanders.

In some years the glass eel restocking could not be done each year due to the high market prices. Only in 2003 and 2006 respectively 108 and 110 kg of glass eel was stocked in Flanders (Figure 3 and Table 3). In 2008 117 kg of glass eel from UK origin (rivers Parrett, Taw and Severn) was stocked in Flemish waterbodies. In 2009 152 kg of glass eel originating in France (Gironde) was stocked in Flanders. In 2010 (April 20th, 2010) 143 kg has been stocked in Flanders. The glass eel was originating in France (area 20–50 km south of Saint-Nazaire, small rivers nearby the villages of Pornic, Le Collet and Bouin). A certificate of veterinary control and a CITES certificate were delivered.

In 2011 (21 April 2011) 120 kg has been stocked in Flemish waters. The glass eel was originating in France (Bretagne and Honfleur). A certificate of veterinary control and a CITES certificate were delivered.

In 2012 156 kg has been stocked in Flemish waters. The glass eel was supplied from the Netherlands but was originating in France.

In 2013 140 kg has been stocked in Flemish waters. The glass eel was supplied via a French company (SAS Anguilla, Charron, France).

In 2014 the lower market price allowed a higher quantity of glass eel to be stocked. 500 kg has been stocked in Flemish waters. The glass eel was supplied via a French company (Aguirrebarrena, France).

In 2015, Flanders ordered 335 kg glass eel for stocking in Flemish waters (price 190 €/kg). However, the supplier was not able to supply the glass eel. Apparently, due to shortness of glass eel, suppliers prioritize fulfilment of their orders towards the more lucrative orders (e.g. by the aquaculture sector). As a result, no glass eel could be stocked in Flanders in 2015.

The cost of the glass eel per kg (including transport but without taxes) is presented in Table 4.

Glass eel restocking activities in Flanders are not taking account of the variation in eel quality of the restocking sites.

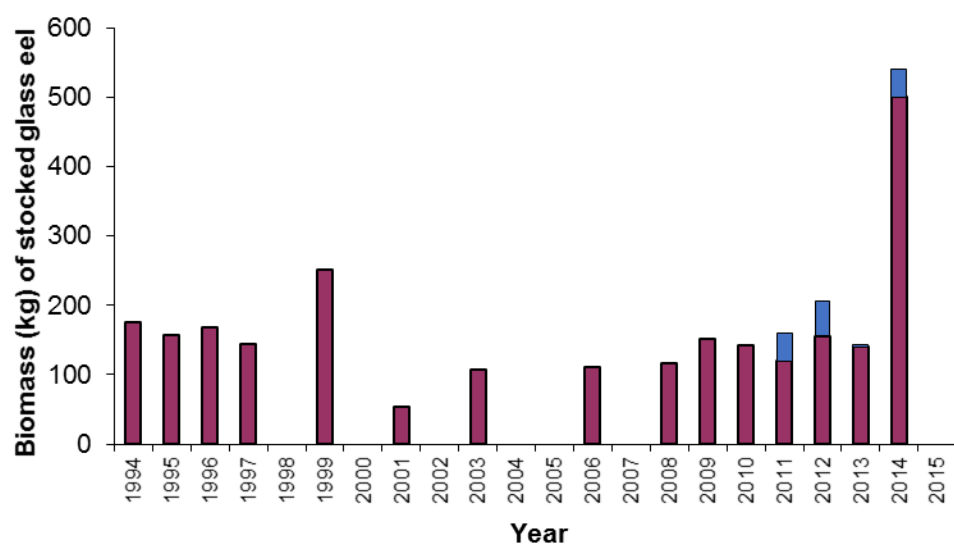


Figure 3 and Table 3. Restocking of glass eel in Belgium (Flanders and Wallonia) since 1994, in kg of glass eel. Flanders is represented in red and Wallonia in blue in the figure. * left Flanders/right Wallonia.

Decade				
Year	1980	1990	2000	2010
0			0	143
1			54	120/40*
2			0	156/50*
3			108	140/4*
4		175	0	500/40*
5		157,5	0	0/0*
6		169	110	
7		144	0	
8		0	117	
9		251,5	152	

Table 4. Prices of restocked glass eel in Belgium (2008–2015).

YEAR	COST (€/kg)
2008	510
2009	425
2010	453
2011	470 (Flanders) 520 (Wallonia)
2012	416 (Flanders) 399 (Wallonia)
2013	460 (Flanders) 400 (Wallonia)
2014	128 (Flanders) 128 (Wallonia)
2015	190 (Flanders)(not supplied) 128 (Wallonia) (not supplied)

Stocking in Wallonia

In Wallonia, glass eel restocking was initiated in 2011, in the framework of the Belgian EMP. In March 2011 40 kg of glass eel was restocked in Walloon rivers; in 2012 the amount stocked was 50 kg.

In 2013, for financial reasons no stocking was carried out in Wallonia, except for some restocking in 3 small rivers in the context of a research program led by the University of Liège. This research program is financed by EFF (project code 32-1102-002) to test the efficiency of glass eel restocking in waterbodies of diverse typology. In May 2013 in total 4 kg of glass eel was stocked (1,5 kg in La Burdinale, 1,5 kg in d'Oxhe and 1 kg in Mosbeux). (Price per kg was 400 Euros). The origin of these glass eels was UK glass eels Ltd, UK Survival, dispersion, habitat and growth were followed from September on, to assess to what extent glass eel stocking is a valuable management measure to restore Walloon eel stocks. One year after stocking, elvers were found up and downstream the unique point of the glass eels release and in the complete transversal section of these streams, with preference for the sheltered microhabitats located near the banks where water velocity and depth are low (Ovidio *et al.*, 2015). Higher recruitment success of glass eels was observed in the Mosbeux because of its high carrying capacity. Recently, the mark-recapture method using the Jolly-Seber model estimated the recruitment success at 658 young eels (density 11.1 eels/m², minimal survival 15.8%) two after stocking in Mosbeux. The young eels are monitored twice a month in Mosbeux and Vesdre using a mobile detection RFID station to study their space use and seasonal movement.

In 2014, 501 kg glass eel were ordered to a French company (Aguirrebarrena, France) with EFF 50% cofunding. Unhappily, the French supplier was unable to supply the ordered quantity and only 40 kg were restocked in 2014. Therefore, the Walloon region accepted to delay the delivery of the remaining 461 kg glass eel in 2015. However, the French supplier was again “unable” to supply the ordered glass eel. The higher prices for glass eel in 2015 probably explain this situation. The French supplier was excluded of the Walloon market for three years (between 2016 and 2018).

More information on stocking details for Wallonia is presented in Tables 4–6 (Cost of the glass eel, origin).

3.5.2 Catch of eel <12 cm and proportion retained for restocking

There are no glass eel fisheries in Belgium. As the glass eel caught for monitoring purposes by the Flemish authorities at the sluices at the mouth of River Yzer is so low, these glass eel are released directly above the sluices.

3.5.3 Reconstructed time-series on stocking

Stocking in Flanders

Table 5A. Source and size of eel restocked in Flanders between 1994 and 2015.

Year	LOCAL SOURCE				FOREIGN SOURCE			
	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured
1994					175		5394	
1995					157,5		4880	
1996					169		4168	
1997					144		5517	
1998					0		5953	
1999					251,5		5208	
2000					0		4283	
2001					54			
2002					0			
2003					108			
2004					0			
2005					0			
2006					110			
2007					0			
2008					117			
2009					152			
2010					143			
2011					120			
2012					156			
2013					140			
2014					500			
2015					0			

Stocking in Wallonia

Table 5B. Source and size of eel restocked in Wallonia between 1994 and 2015.

Year	LOCAL SOURCE				FOREIGN SOURCE			
	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured
1994								
1995								
1996								
1997								
1998								
1999								
2000								
2001								
2002								
2003								
2004								
2005								
2006								
2007								
2008								
2009								
2010								
2011					40			
2012					50			
2013					4			
2014*					40			
2015*					0			

* Despite an order of 501 kg, only 40 kg glass eel was supplied in 2014 and no supplies in 2015.

All glass eel used for the Flemish and Walloon restocking programs are purchased from foreign sources (usually UK or France). There are no quarantine procedures. Nowadays, no bootlace eels, nor ongrown cultured eels are restocked.

Table 6. Origin and amounts of glass eel restocked in Belgium (Flanders and Wallonia) between 2008 and 2015.

YEAR	REGION	ORIGIN	AMOUNT (KG)
2008	Flanders	UK	125
2009	Flanders	France	152
2010	Flanders	France	143
2011	Wallonia	UK	40
2011	Flanders	France	120
2012	Flanders	France	156
2012	Wallonia	France	50
2013	Flanders	France	140
2013	Wallonia	UK	4
2014	Flanders	France	500
2014	Wallonia*	France	40
2015	Flanders**	-	0
2015	Wallonia*	-	0

* Despite an order of 501 kg, only 40 kg glass eel was supplied in 2014 and no supplies in 2015.

** Despite an order of 335 kg, no glass eel was supplied.

3.6 Trade in eel

Information on the trade of the eel in Belgium is currently not available, but will be integrated in next year's report.

4 Fishing capacity

4.1 Glass eel

Commercial nor recreational fishery for glass eels is allowed in Belgium.

4.2 Yellow eel

Professional coastal and sea fisheries

Marine eel catches through professional and coastal fisheries are negligible.

Estuarine fisheries on the Scheldt

The trawl fisheries on the Scheldt was focused on eel, but since 2006 boat fishing has been prohibited, and only fyke fishing was permitted until 2009. Since 2009 no more licences are issued, which is as a measure of the Eel Management Plan of Flanders to reduce catches. In 2010 a Decree (Besluit van de Vlaamse Regering van 5 maart 2010) was issued to regulate the prohibition of fyke fishing in the lower Seascheldt.

For a figure of the time-series of the number of licensed semi-professional fishermen on the Scheldt from 1992 to 2009 (Data Agency for Nature and Forests) we refer to Belpaire *et al.*, 2011 (Belgian Eel Country Report, 2011).

Recreational fisheries in the Flemish region

The number of licensed anglers was 60 520 in 2004, 58 347 in 2005, 56 789 in 2006, 61 043 in 2007, 58 788 in 2008, 60 956 in 2009, 58 338 in 2010, 61 519 in 2011, 62 574 in

2012, 64 643 in 2013 and 67 554 in 2014. The time-series shows a general decreasing trend from 1983 (Figure 4). However in 2007 there was again an increase in the number of Flemish anglers (+7.5% compared to the minimum in 2006). In 2014 the number of anglers was 19% higher than in 2006. From an inquiry of the Agency for Nature and Forests in 2008 among 10 000 recreational anglers (36% feedback) it appeared that ca. 7% fish for eel.

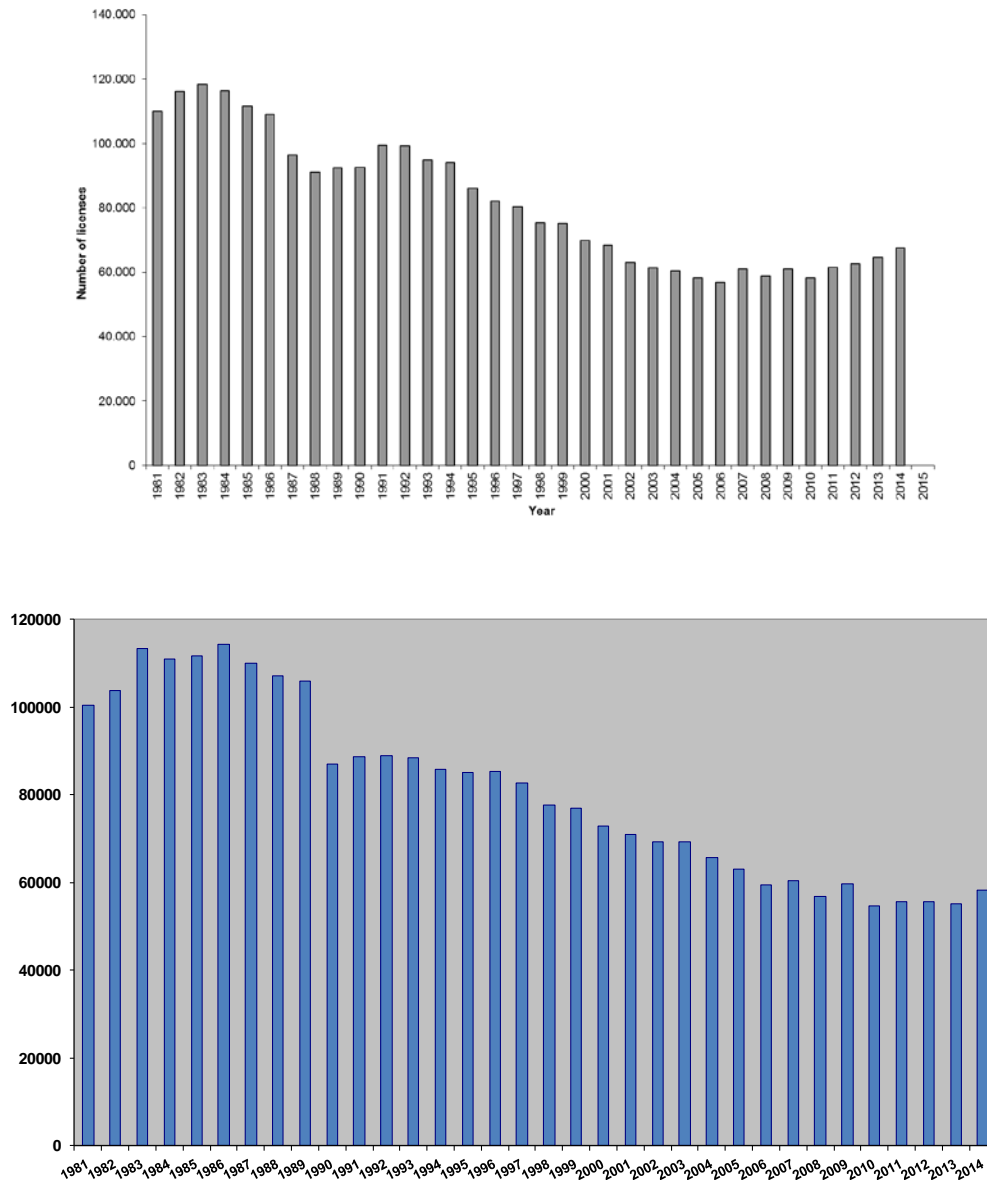


Figure 4. Time-series of the number of licensed anglers in Flanders (above) and Wallonia (below) since 1981 (Data Agency for Nature and Forests for Flanders and Nature and Fish Service of the Nature and Forests Department (DNF – DGARNE - SPW) for Wallonia).

Recreational fisheries in the Walloon Region

In Wallonia, the number of licensed anglers was 65 687 in 2004, 63 145 in 2005, 59 490 in 2006, 60 404 in 2007, 56 864 in 2008, 59 714 in 2009, 54 636 in 2010, 55 592 in 2011, 55 632 in 2012, 55 171 in 2013 and 58 379 in 2014 (Figure 4). The time-series shows a general decreasing trend from 1986. However in 2014 there was again an increase in the number of anglers in Wallonia (+6.9 % compared to the minimum in 2010). The

result of 2015 confirms this slight increase. The proportion of eel fishermen in Walonia is not documented, but is probably very small since it is forbidden to keep the caught eels.

Recreational fisheries in the Brussels capital

The number of licensed anglers is approximately 1400 (Data Brussels Institute for Management of the Environment).

4.3 Silver eel

See Sections 3.3.1 and 3.3.2.

4.4 Marine fishery

Marine eel catches through professional and coastal fisheries are negligible.

5 Fishing effort

5.1 Glass eel

There is no professional or recreational fisheries on glass eel.

5.2 Yellow eel

See Section 4.2 for the number of recreational fishermen and the proportion of eel fishermen.

5.3 Silver eel

There are no professional or recreational fisheries on silver eel.

5.4 Marine fishery

Marine fisheries on eel are not documented and are assumed to be negligible.

6 Catches and landings

6.1 Glass eel

Commercial nor recreational fishery for glass eels is allowed in Belgium.

6.2 Yellow eel

Catches and landings—estuarine fyke fisheries on river Scheldt

Fyke fishing for eel on the lower Scheldt estuary is prohibited now. Since 2009 no more licences for fyke fisheries on the river Scheldt are issued, which is as a measure of the Eel Management Plan of Flanders to reduce fishing capacity. Before 2009 annual catches of eel by semi-professional fyke fishermen was estimated between 2.8 and 12.4 tons. This is thus reduced to zero in 2009 and later.

Catches and landings—recreational fisheries in Flanders

Based on an inquiry by the Agency for Nature and Forest in public waters in Flanders in 2008, recreational anglers harvest on a yearly basis 33,6 tons of eel (Vlietinck, 2010). This figure holds for 2009 too (Vlietinck, pers. comm.). In 2010 a small restriction of eel fishing was aimed by a new regulation (Besluit van de Vlaamse Regering

5/3/2010). Between April 16th and May 31th, and during the night, eels may not be taken home. This results in a roughly estimate of 10% reduction of eel harvest. Hence estimate for 2010, 2011 and 2012 is an annual eel harvest of 30 tons (Vlietinck, pers. comm.). There is no distinction between the catch of yellow eel and silver eel, but due to the specific behaviour of silver eel, it is considered that these catches are mainly composed of yellow eel.

Other earlier estimates were 121 tonnes per annum and 43 tonnes per annum (Belpaire *et al.*, 2008).

In 2000 a catch and release obligation for the recreational fishing of eel was issued due to high contaminant concentrations, however this law was abolished in 2006. This resulted in an increase in yield of yellow eel by recreational fisheries from nihil to the actual 30 tons.

It is worth mentioning that based on the 2008 inquiry in a population of recreational anglers (Vlietinck, 2010), the majority (77%) of anglers are in favour of a restriction in the fishing or the harvest of eel (in the framework of the protection of the eel). 27% of the respondents are in favour of (among other options) the obligatory release of caught eel as management option (Figure 5).

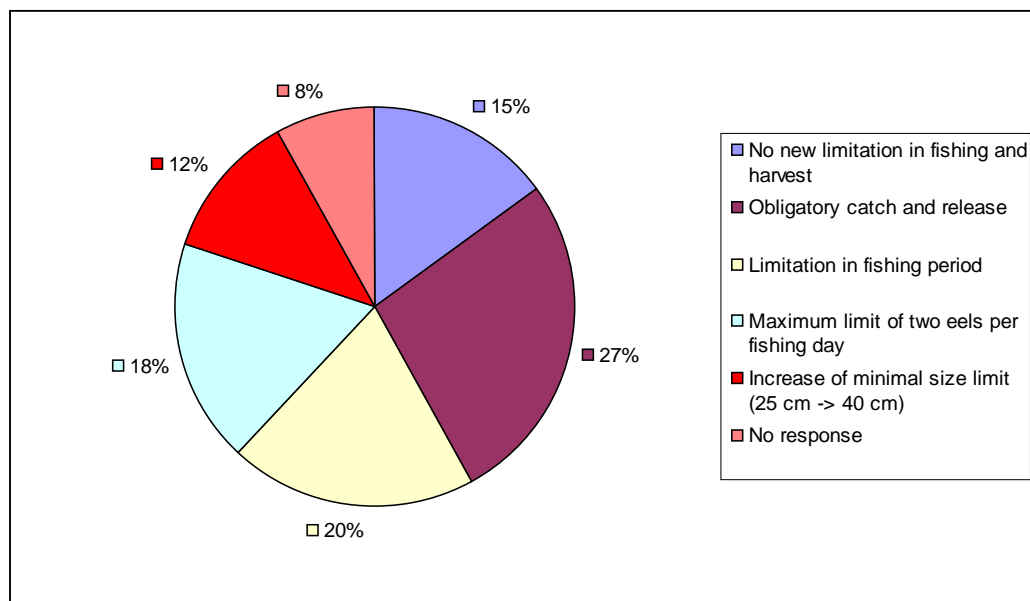


Figure 5. Results of a 2008 inquiry among 10 000 Flemish recreational anglers for their preference in management options for restoring the eel stock. 36% (N = 3627 anglers) responded (Vlietinck, 2010).

Only eel above the size limit of 30 cm are allowed to be taken home.

In 2013 a new legislation on river fisheries went into force (Agentschap voor Natuur en Bos, 2013). The total number of fish (all species, including eel) which an angler is allowed to take with him on a fishing occasion is now limited to five. There is no indication to what extent this will have an impact on the total recreational biomass of eel retrieved by recreational fisheries.

Currently (2014), in Flanders the eel is classified as “Critically Endangered” in the new Flemish Red List of Freshwater Fish and Lampreys (Verreycken *et al.*, 2014). It is

not known if in future this will have some implications on further restrictions on fishing and taking home eel by recreational fishermen.

Catches and landings by poaching

In the province of West-Vlaanderen, in the period 2012 to 2014 at least 14 actions were taken to search for illegal fishing equipment for eel. During these actions a total number of 41 illegal fykes were reported, indicating that some semi-professional poachers may cause very localized damage to the eel population (Vlietinck and Rollin, 2015). Van Thuyne and Belpaire (2015) estimated that in these waterbodies of West-Vlaanderen poaching with a fyke may result in a mean catch of 0.850 to 1.265 kg/fyke/24 hours (dependent of the season).

Catches and landings–recreational fisheries in Wallonia

In the Walloon region, fishing of eels is prohibited since 2006 (Walloon Government, 2006). By modification of the 1954 law on fishing activities, there is an obligation to release captured eels whatever their length. So from 2006 on, recreational catches of eel in Wallonia should be zero, except poaching of yellow and silver eels.

In Wallonia, fishery control actions have been focused specifically on the river Meuse, the river Sambre and in the canals during day and night. In 2014, 49 control operations were undertaken (20 during the day, 29 during the night) for a total of 1370 controlled recreational fishermen. In 2015, the number of control actions was doubled (101 operations, 59 during the day and 42 during the night) for a total of 2690 controlled fishermen. Numerous illegal fishing equipment was seized. Regarding Fisheries Act Violation, the rate was of 4.7% and 5.4% during the day in 2014 and 2015, respectively, but of 25.3% and 20.1% during the night of the same years. Since 2010, the annual offence rate during the night decreased by about 5% per year and was highly correlated to control intensity. Only a small minority of violations concerned eel poaching, mostly illegal eel detention and utilisation for *Silurus glanis* fishing.

Recreational fisheries in Brussels capital

No information on eel catches.

6.3 Silver eel

There are no professional or recreational fisheries on silver eel.

6.4 Marine fishery

Marine fisheries on eel are negligible and not documented.

6.5 Recreational Fishery

See under 6.2 and 7.2 for the information available on recreational fisheries.

No further data available.

Recreational Fisheries: Retained and Released Catches

Year	RETAINED				RELEASED			
	Inland		Marine		Inland		Marine	
	Angling	Passive Gears	Angling	Passive gears	Angling	Passive gears	Angling	Passive gears
2015 Flanders	30t							
2015 Wallonia	0							

Provide the catch and release mortality (%) used in your country for angling in marine and inland waters.

Recreational Fisheries: Catch and Release Mortality

Year	Released			
	Inland		Marine	
	Angling	Passive gears	Angling	Passive gears

6.6 Bycatch, underreporting, illegal activities

Bycatch through exploitation of marine fish stocks is not reported and is considered low.

From time to time illegal activities have been observed. Fishing using illegal gears, and illegal selling of catches might be the illegal activities with most impact on the eel stock. Quantitative information is not available.

7 Catch per unit of effort**7.1 Glass eel**

Commercial nor recreational fishery for glass eels is allowed in Belgium.

There is some information available on the cpue trend in the governmental glass eel monitoring at Nieuwpoort (River Yzer) (Table 7).

Table 7. Temporal trend in catch per unit of effort for the governmental glass eel monitoring by dipnet hauls at the sluices in Nieuwpoort (River Yzer, 2002–2015). Cpue values are expressed as Kg glass eel caught per fishing day with catch and as Kg glass eel per haul.

YEAR	TOTAL YEAR CATCH	MAX DAYCATCH	TOTAL YEAR CATCH/NUMBER OF FISHING DAYS WITH CATCH (KG/DAY)	TOTAL YEAR CATCH/NUMBER OF HAULS PER SEASON (KG/HAUL)
2002	1,4	0,46	0,140	0,0081
2003	0,539	0,179	0,034	0,0040
2004	0,381	0,144	0,042	0,0029
2005	0,787	0,209	0,056	0,0044
2006	0,065	0,014	0,006	0,0005
2007	2,214	0,485	0,130	0,0085
2008	0,964	0,262	0,060	0,0040
2009	0,969	0,274	0,057	0,0037
2010	0,318	0,1	0,017	0,0012
2011	0,412	0,067	0,021	0,0014
2012	2,407	0,35	0,105	0,0057
2013	2.578	0.686	0.112	0.0063
2014	6.717	0.770	0.292	0.0146
2015	2489	0.487	0.131	0.0070

7.2 Yellow eel

There are only rough estimates about the catches of eel by recreational fishing. These data are based on an inquiry (N=3627 responses) by the Agency for Nature and Forest in public waters in Flanders in 2008 (Vlietinck, 2010). At that time recreational anglers harvest on a yearly basis 33,6 tons of eel. 6.6% of the recreational fishermen (N=58 788) are eel fishermen. So 3880 eel fishermen are catching 33.6 tons, or an average eel fishermen is fishing 8.7 kg eel per year.

7.3 Silver eel

There are no professional or recreational fisheries on silver eel.

7.4 Marine fishery

Marine fisheries on eel are negligible and not documented.

8 Other anthropogenic and environmental impacts

In Belgium, the eel stock is considerably impacted by an overall poor water quality (especially for Flanders), and by a multitude of migration barriers (draining pumps, sea sluices, dams, weirs, impingement by power stations and hydropower units).

Water quality

Improvement of water quality by installing purification units is an ongoing process (within the objectives of the Water Framework Directive). As an example the installation of an important purification unit in 2007 on the River Senne (north of Brussels) purifying the wastewaters of the capital, has led to an impressive increase in the eel

population in river Senne and Rupel during 2008 and 2009. Due to a temporary closure of the water treatment plant (for technical reasons) at the end of 2009 all eels disappeared, subsequent monitoring showed that the eel population restored approximately six months after restart of the plant.

Wallonia

The implementation of the European Water Framework Directive (WFD), which was adopted in 2000, included the development of ecological and chemical monitoring programmes and the drafting and implementation of River Basin Management Plans (RBMP). In 2013, 145 out of the 354 inland surface waterbodies (41%) encountered in Wallonia reached a good or very good ecological status (Table 8.1). The chemical status except ubiquitous Persistent Bioaccumulative Toxic (PBT) chemicals and based on EQS from Directive 2008/105/EC is good in 280 out of 354 surface waterbodies (79%) in Wallonia (Table 8.2).

Water quality has improved during the last decade, due to investment in sewage systems to reduce pollution from urban wastewater treatment. Nevertheless, challenges remain. Many rivers are affected by diffuse pollution from agriculture, while some stay subject to point source pollution, for example from industrial facilities, sewage systems and wastewater treatment plants. The second RBMP (2016–2021), for which the public consultation process is ongoing, addresses these issues.

Table 8.1. Ecological status in 2013 of inland surface waterbodies for Wallonia by sub-basins.

Sub-basin	NUMBER OF WATER BODIES	ECOLOGICAL STATUS					
		Bad	Poor	Moderate	Good	High	Undetermined
Amblève	20	0	3	3	11	0	3
Lesse	30	1	0	7	21	1	0
Meuse amont	39	3	5	8	21	1	1
Meuse aval	35	8	7	14	3	3	0
Ourthe	35	2	0	5	24	2	2
Sambre	32	6	12	7	2	0	5
Semois-Chiers	42	0	5	5	27	4	1
Vesdre	24	3	3	6	7	3	2
Dendre	12	5	1	4	2	0	0
Dyle-Gette	13	7	4	2	0	0	0
Escaut-Lys	25	14	9	1	1	0	0
Haine	17	5	4	6	2	0	0
Senne	12	5	5	1	1	0	0
Moselle	16	0	0	9	7	0	0
Oise	2	0	0	0	2	0	0
Wallonia	354	59	58	78	131	14	14

Table 8.2. Chemical status except PBT in 2013 of inland surface water bodies for Wallonia by sub-basins (EQS from Directive 2008/105/EC).

Sub-basin	NUMBER OF WATER BODIES	CHEMICAL STATUS EXCEPT FOR UBIQUITOUS PBT		
		Poor	Good	Undetermined
Amblève	20	1	14	5
Lesse	30	2	28	0
Meuse amont	39	4	35	0
Meuse aval	35	9	26	0
Ourthe	35	0	24	11
Sambre	32	3	22	7
Semois-Chiers	42	0	42	0
Vesdre	24	1	23	0
Dendre	12	6	6	0
Dyle-Gette	13	2	11	0
Escaut-Lys	25	10	15	0
Haine	17	5	6	6
Senne	12	2	10	0
Moselle	16	0	16	0
Oise	2	0	2	0
Wallonia	354	45	280	29

Restoring migration possibilities

On April 26, 1996, the Benelux Decision about free fish migration was adopted. The Decision sets that the Member States should guarantee free fish migration in all hydrographic basins before January 1, 2010. Recently, the 1996 Benelux decision has been evaluated. The general conclusion is that a lot of barriers have been removed, but also that the timing is not achievable and that the focus should be on the most important watercourses. On June 16, 2009 a new Benelux Decision (Benelux, 2009) was approved. According to this new Decision, Member States commit themselves to draw up a map indicating the most important watercourses for fish migration. Here-to, the Research Institute for Nature and Forest (INBO) drew up a proposal for this prioritization map based on ecological criteria (Figure 6).

The proposal for the new prioritization map accounts for both the distribution of EU Habitat Directive species and the recommendations of the eel management plan. In addition, the Benelux Decision allows accounting for regionally important fish (i.e. rheophilic species for which Flanders has developed a restoration programme such as dace, chub and burbot).

The total length of the prioritization network of Flemish water courses is 3237 km (almost 15% of the total length of the watercourses in Flanders). Besides the barriers on the selected watercourses, also pumping stations and hydro turbines on unselected water courses should be taken into account. Depending on their location and functioning, pumping stations and hydro turbines may have a significant impact on the survival of downstream migrating fish and eel in particular. The results of a survey of pumping stations in Flanders will be used to draw up a list of the most harmful pumping stations. This list will then be added to the prioritization map.

The prioritization map gives an overview of the water courses that should be barrier-free in order to preserve the populations of the target species. Hereto a distinction is made between obstacles of first and second priority. Obstacles of first priority are those located on the main rivers of the major river basins (Scheldt and Meuse). 90% of these barriers should be eliminated by 2015, the remaining 10% by 2021. In Flanders, the highest priority is given to the obstacles on the River Scheldt and to the obstacles that should be removed first according to the eel management plan. The remaining obstacles on the water courses of the prioritization map are assigned to the second priority. These obstacles will be divided into three groups. 50% of these should be removed before December 31, 2015. 75% should be removed before December 31, 2021 and 100% by December 31, 2027.

Additionally, water courses of special attention were selected. These are water courses that have important fish habitat, but where the removal of migration barriers is not a priority. These water courses are important for the restoration of the eel stock, have an ecologically valuable structure or are located in a sub-basin where Habitat Directive species occur. They are not part of the prioritization map and have no timing for the removal of existing migration barriers. However, downstream migration should be guaranteed in these water courses and if an opportunity arises, the existing fish migration barriers should be removed.

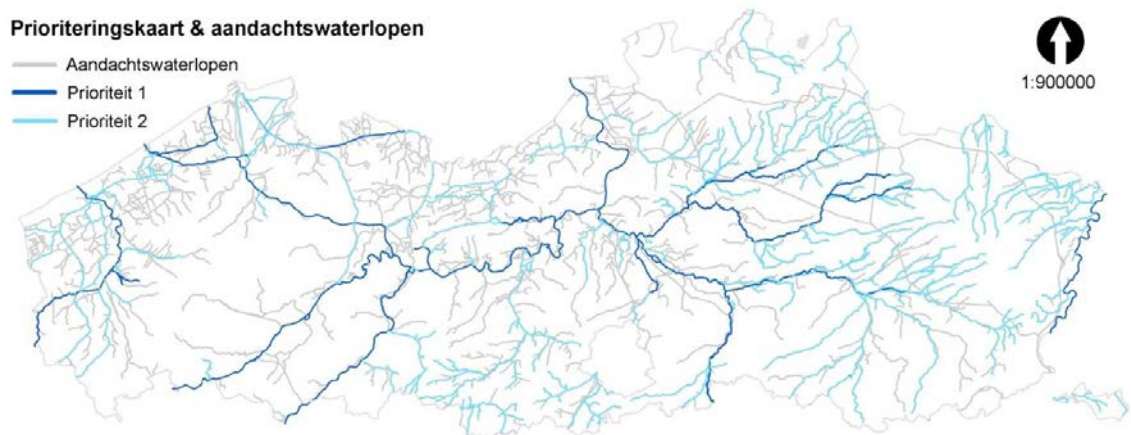


Figure 6. Fish migration prioritization network of Flemish water courses (blue) and water courses of special attention (grey) following the Benelux Decision “Free migration of fish” M(2009)1.

The indicator presented under Figure 7 shows the number of sanitized migration barriers on the watercourses of the strategic prioritization map for fish migration. The BENELUX decision on fish migration states that 90% of the fish migration barriers categorized as first priority on the strategic priority map must be eliminated before December 31, 2015 (phase 1 - MINA plan 4 indicator 1) and the obstacles of second priority before December 31, 2021 (phase 2 - MINA plan 4 Indicator 2).

On a significant part of the watercourses of second priority, fish migration barriers have not yet been fully inventoried. Therefore it is currently not possible to assess the second indicator (phase 2).

The network of watercourses allocated to first priority is about 800 km long, and includes 51 fish migration barriers, of which 90% (or 46 barriers) should be sanitized by December 31, 2015. These 46 barriers include 35 priority migratory barriers defined in the eel management plan. On December 31, 2014, a total of 18 of the 46 (39%) barriers of phase 1 were remediated. Of the 35 high priority barriers of the eel management

plan, however, only eleven (31%) were sanitized. Hence, by the end of 2015 still 24 barriers included in the eel management plan and four other bottlenecks in waterways of first priority need to be sanitized. The total number of bottlenecks may change as they sometimes naturally disappear or may turn out to be less problematic after in depth assessment.

Considering the current efforts in sanitizing barriers, phase 1 of the Benelux decision probably will not be achieved. Besides, the inventoried fish migration barriers of phase 2 will probably be sanitized only after 2021. The main bottlenecks remain available budgets, staff capacity and societal considerations.

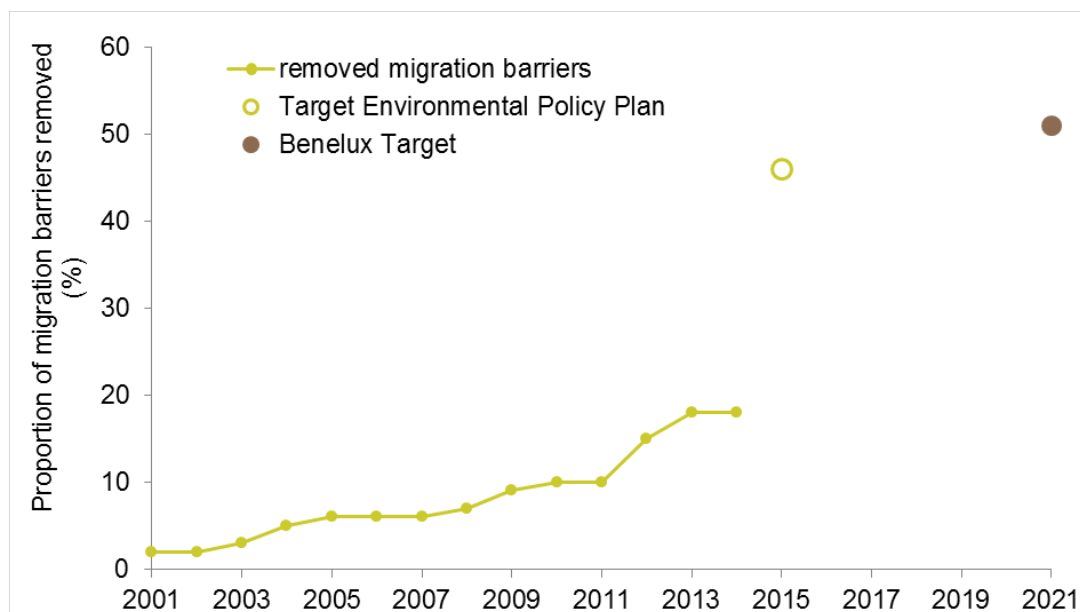


Figure 7. Number of sanitized fish migration barriers in Flanders (https://www.inbo.be/nl/natuurindicator/gesaneerde-vismigratieknelpunten-prioriteitsklasse-1?utm_source=INBO+Nieuwsbrief&utm_campaign=c30ade603d-Natuurindicatoren_201511_10_2015&utm_medium=e-mail&utm_term=0_402da5b35e-c30ade603d-205261121).

To enhance eel migration possibilities, a reverse drainage sluice management was conducted at two major salt–freshwater transition sites (sluices at river IJzer and the canal Ghent-Ostend). This was estimated to increase the glass eel passage at the sluices by about 200 fold. Research for the establishment of a similar reverse sluice management at two other major salt–freshwater transition sites at Zeebrügge is ongoing and will be implemented next year. For eel, the main migration bottleneck in Flanders is the access from the Lower Sea Scheldt to the Upper Scheldt. The Scheldt is the largest Flemish waterway and resolving this migration barrier can give access to a large eel habitat. Currently, some scenarios examine the feasibility to provide fish passage possibilities at the Merelbeke bottleneck to allow migration towards Upper Scheldt and river Leie. Further upstream on the Upper Scheldt two fish passages already exist (at Oudenaarde and Asper) but these need to be optimized. The third and most upstream fish migration bottleneck (Kerkhove) will be addressed in 2016–2017 (Vlietinck and Rollin, 2015).

An update of the anthropogenic impacts has recently been made in the framework of the report of the evaluation of the Belgian EMP (Vlietinck *et al.*, 2012). We refer to this document for a more complete description of the anthropogenic impacts on the stock.

In summary following management measures are foreseen:

Table 9. Status of measures of habitat restoration as reported in the evaluation of the Belgian EMP (Vlietinck *et al.*, 2012).

MEASURES	REGION	STATUS	TIMING
Resolving migration barriers for upstream migration	Flanders	In progress	2027
Resolving migration barriers for upstream migration	Wallonia	In progress	2027
Measures to protect eels from impingement (by industries using cooling water) during their downward migration.	Wallonia	In progress	To be defined
Measures to protect eels from hydropower installations during their downward migration.	Wallonia	In progress	To be defined
Measures to protect eels from hydroturbines and pumping stations during their downward migration.	Flanders	In progress	To be defined
Measures to attain good ecological status or good ecological potential of water bodies.	Belgium	In progress	2027
Measures for sanitation of polluted sediments	Flanders	To be started	To be defined
	Wallonia	In progress	To be defined

Although numerous pumping stations have been used by water managers for numerous applications on rivers, canals and other waterbodies, their impact on fish populations is poorly understood. Buysse *et al.* (2014) investigated European eel mortality after natural downstream passage through a propeller pump and two Archimedes screw pumps at two pumping stations on two lowland canals in Belgium. Fykenets were mounted permanently on the outflow of the pumps during the silver eel migration periods. Based on the condition and injuries, maximum eel mortality rates were assessed. Mortality rates ranged from $97 \pm 5\%$ for the propeller pump to $17 \pm 7\%$ for the large Archimedes screw pump and $19 \pm 11\%$ for the small Archimedes screw pump. Most injuries were caused by striking or grinding. The results demonstrate that pumping stations may significantly threaten escapement targets set in eel management plans (Buysse *et al.*, 2014).

In another study, eel mortality was studied in a Belgian lowland canal after downstream passage through a large and small de Wit-adapted Archimedes screw pump over a 12-month period (2012–2013) (Buysse *et al.*, 2015a). The hypothesis tested was the minimisation of fish injuries with the de Wit adaptation. Simultaneously, downstream migration through a Dutch pool and orifice fishway alongside the pumping station was monitored. Nets were mounted on the outflow of the pumps, and a cage was placed in the fishway. Based on the condition of the fish and injuries sustained, the assessed maximum mortality rates ranged from $19 \pm 4\%$ for the large de Wit Archimedes screw pump to $14 \pm 8\%$ for the small de Wit Archimedes screw pump. The

screw adaptations did not substantially minimise grinding injuries and overall mortality, and the fishway did not mitigate downstream eel migration. To achieve escapement targets set in the eel management plans, fish-friendly pump designs and effective pumping stations bypass solutions are needed.

The effect of a pumping station on eel behaviour in a wetland area in Boekhoute, Belgium was studied between July 2012 and December 2015. The study was conducted by means of acoustic telemetry: 88 eel were tagged and followed throughout the study area by acoustic listening stations. Buysse *et al.* (2015a) investigated the direct physical impact of the pumping station on passing eels. However, also behaviour might be impacted by the pumping station, due to disrupted flow conditions. In this study, various types of individual behaviour as a reaction on the altered flow conditions were observed and the relation between eel behaviour and environmental conditions like flow, precipitation, water temperature and light intensity were analysed.

Evaluation of reverse drain management to improve glass eel migration into the Diversion Canal of the Leie (DCL) and the Leopold Canal (LC) in Zeebrügge

During the last decades, European eel populations have declined dramatically. The limitation of upstream migration of glass eel is considered to be one of the critical factors endangering eel populations.

Previous research conducted by INBO (commissioned by W&Z and ANB) near the Ganzepoot in Nieuwpoort (Mouton *et al.*, 2011; 2014) and the Sas Slijkens in Ostend (Buysse *et al.*, 2015b) showed that reverse drain management significantly increases the upstream migration of glass eels from the sea to freshwater. Hence this study investigated the applicability of this reverse drain management on another freshwater/sea transition of the Diversion Canal of the Leie and that of the Leopold Canal in Zeebrügge. These two canals with a sharp salt–freshwater transition are two potentially important land inwards routes for glass eels in Flanders.

We looked at how many glass eels migrated upstream in the DCL by applying the reverse lock management. In this study the arriving glass eels were quantified when a door was 'slightly opened'. Quantification was done by sampling at one of the DCL sluice gates. Three large glass eel fykenets were used to evaluate the impact of limited sluice opening on glass eel migration.

Limited opening of a sluice gate (hinged at the top) during tidal rise appeared to be a cost-efficient and effective mitigation option to improve upstream glass eel migration, without significant inflow of seawater. Since the adjusted sluice gate management is easily implementable and could be applied on numerous tidal barriers, the presented results may contribute to restoration of eel populations worldwide and be of interest to a wide range of river managers and stakeholders.

The goal of this research was also to assess whether the measures taken are efficient, i.e. do the glass eels that enter via reversed drain management grow and spread in the LC?

During this study only very few glass eels (and eels in general) were caught so it has to be investigated in a later stage whether an efficient migration with low mortalities may or may not take place there. It will also be necessary to assess whether the current eel densities, which were calculated in four different sectors of the LC now, will increase by the adjusted management strategy.

9 Scientific surveys of the stock

9.1 Glass eel

See Section 3.1.1.3 Glass eel recruitment at Nieuwpoort at the mouth of River Yser (Yser basin).

Evaluation of the efficiency of the glass eel restocking and dispersal and habitat use of glass eel

The University of Liege has carried out a EFF cofounded research project on the efficiency of restocking glass eel in three small rivers of Wallonia, the affluent of rivers Méhaigne, Meuse and Vesdre, in order to increase our knowledge of the potential of restocking programmes in the framework of the international eel management. Results are in the final report (Matondo *et al.*, 2015). Shortly, the results indicated a good survival, growth and upstream as well as downstream dispersion of glass eel after restocking in the three tested small brooks of different typology. The authors concluded that this technique of direct restocking with glass eels seems appropriate to increase eel populations in continental hydrosystems. However, brooks containing suitable habitats have to be selected. Priority should be given to rivers with a high carrying-capacity containing diversified habitats, low bioenergetic losses for eels, rich in feeding resources and protections against predators. Most favourable habitats were sediments, tree roots and crevices between rocks and stones. The relative abundance of these habitats in these rivers would explain the differences of observed eel density and production between these brooks.

9.2 Yellow eel

Fish stock monitoring network in Flanders

Since 1994, INBO runs a freshwater fish monitoring network consisting of ca. 1500 stations in Flanders. These stations are subject to fish assemblage surveys on regular basis (on average every two to four years depending of the typology of the station). This network includes all water types, head streams as well as tributaries (stream width ranging from 0.5 m to 40 m), canals, disconnected river meanders, water retaining basins, ponds and lakes, in all of the three major basins in Flanders (Yser, Scheldt and Meuse). Techniques used for analysing fish stocks are standardized as much as possible, but can vary with water types. In general electrofishing was used, sometimes completed with additional techniques, mostly fyke fishing. All fish are identified, counted and at each station 200 specimens of each species were individually weighed and total length was measured. As much as possible biomass (kg/ha) and density (individuals/ha) is calculated. Other data available are number (and weight) of eels per 100 m electrofished river bank length or number (and weight) of eels per fyke per day. The data for this fish monitoring network are available via the website <http://vis.milieuinfo.be/>.

This fish monitoring network is now been further developed to cope with the guidelines of the Water Framework Directive.

A temporal trend analysis has been performed based on a dataset including fish stock assessments on locations assessed during the periods 1994–2000, 2001–2005 and 2006–2009. 334 locations were assessed in those three periods (30 on canals and 304 on rivers). These results have been reported in the 2011 Country Report; see Belpaire *et al.* (2011) for further details.

In 2012–2013 a new data analysis has been carried out for the most recent period, in the framework of updating the Red List status of Flanders' freshwater fish. In the

new Flemish Red List of Freshwater Fish and Lampreys (Verreycken *et al.*, 2014), eel was placed in the Critically Endangered category. The number of eel individuals, steeply decreased with 75% between the periods 1996–2003 and 2004–2011 and this despite the yearly restocking with glass eel.

Reporting for the Eel Regulation and the Fish stock monitoring network in Flanders

According to the EU Eel Regulation, each Member State has to report every three years on the progress of the implementation of the eel management plans. One of the things that need to be reported is the effective escapement of silver eels to sea. Both the calculations for the eel management plan and the first interim report are based on data on yellow eel abundances collected by the Flemish Fish Monitoring Network Freshwater. However, the current Monitoring Network for Freshwater Fish was evaluated and merged into a new monitoring network for the Water Framework Directive (Stevens *et al.*, 2013). This report discusses the methodology for calculating the escapement of silver eel in Flanders. The suitability of the new Monitoring Network Freshwater Fish for the European Eel Regulation reporting is discussed and recommendations are made to improve the methodology and validate the model results.

It was concluded that the new Monitoring Network Freshwater Fish covers satisfactorily the watercourses of the eel management plan and is suitable for reporting on the distribution of eel in Flanders. However, the number of sampling points in the new monitoring network is strongly reduced. As a result, the estimators for the calculation of the density of yellow eel will be based on a limited number of measurements, resulting in a lower reliability of these estimators. The new monitoring network can be used to calculate estimators per basin and per stratum (instead of current classification per basin and typology). This limits the number of combinations and avoids the double spatial component for the small streams in the ecological typology. Possibly a number of combinations can be grouped to increase the number of points per estimator. An analysis of the data from the Monitoring Network Freshwater Fish is necessary to determine which classification of watercourses is best suited to determine these estimators.

Large rivers, canals and estuaries represent a significant portion of the surface area of watercourses in the eel management plan. However, electric fishing is less efficient or impossible (brackish waters) in these watercourses, as a result of which the density estimators are less reliable. Therefore a method should be developed to improve the density estimators for these watercourses and for the Scheldt estuary in particular.

The methodology for calculating the escapement of silver eel is sufficiently suitable for reporting to Europe (see Stevens *et al.*, 2009). However, the method and model parameters need to be refined to reduce the uncertainty in the model output and the results of the model should be validated with real data on the escapement of silver eels.

The report suggests two approaches:

- First, desk studies can be used (1) to improve the calculations of eel mortality and (2) to refine the classification of the freshwater eel habitat (analysis of the habitat and fish data from the Monitoring Network Freshwater Fish). In addition, the habitat analysis is also important to underpin the conversion of eel cpue to eel density.
- - On the other hand, field studies are necessary to calibrate the conversion of eel cpue to eel density, to improve the model parameters and to validate the model results.

Finally, supporting research can be used to evaluate the effectiveness of measures in the management plan and to improve the model (e.g. research on the impact of eel quality and on the contribution of the Scheldt estuary in the production and migration of silver eels in Flanders) (Stevens *et al.*, 2013).

See 13.1 under “Stock assessment” for a description of the elaboration of the figures for Flanders in the framework of the second progress report 2015 (report by Belpaire *et al.*, 2015).

River Scheldt fish monitoring at the power station of Doel

Between 1991 and 2012, INBO has been following the numbers of impinged fish at the nuclear power station of Doel on the Lower Scheldt. We refer to the 2012 Country Report (Belpaire *et al.*, 2012) for a presentation of results and trends. Unfortunately, due to a shortness of means this monitoring series has been stopped in 2012.

Estuarine fish monitoring by fykes

A fish monitoring network by INBO has been put in place to monitor fish stock in the Scheldt estuary using paired fykenets (Figure 8 and below). Campaigns take place in spring and autumn, and also in summer from 2009 onwards. At each site, two paired fykes were positioned at low tide and emptied daily; they were placed for two successive days. Data from each survey per site were standardized as number of fish per fyke per day. Figures below show the time-trend of eel catches in six locations along the Scheldt (Zandvliet, Antwerpen, Steendorp, Kastel, Appels and Overbeke) (Data Jan Breine, INBO; Breine and Van Thuyne., 2015).

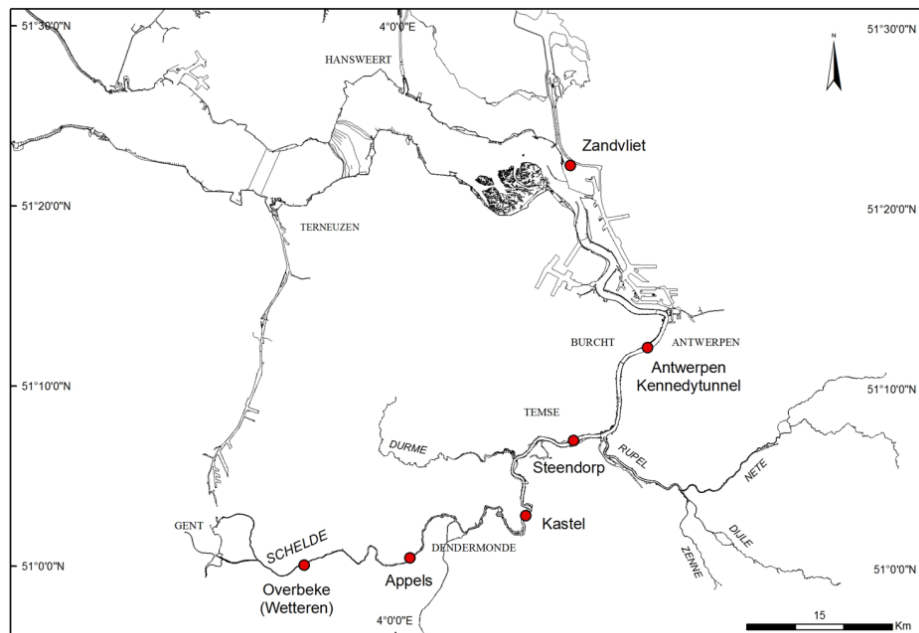


Figure 8. Locations sampled in the Zeeschelde estuary.

In the mesohaline zone (Zandvliet) catches are generally low. This could be due to the fact that eel moved since 2007 further upstream as since then the water quality improved in the oligohaline and freshwater parts of the estuary.

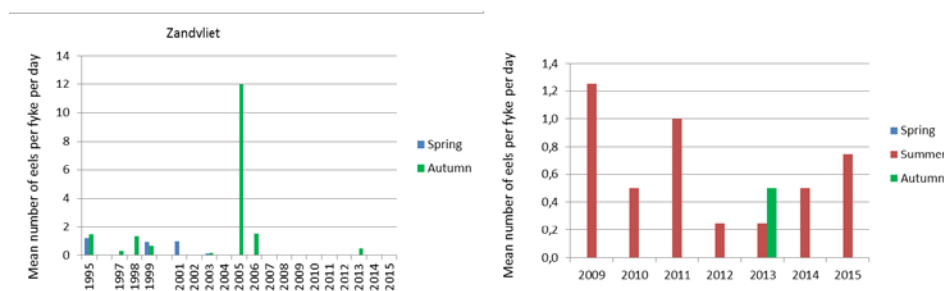


Figure 9. Time-trend of fyke catches of eel in Zandvliet. Numbers are expressed as mean number of eels per fyke per day. On the left, data are split up in spring catches and fall catches (1995–2015) while on the right, summer catches are added (2009–2015). Years without monitoring data are excluded from the X-axis.

Eel are rarely caught in spring (last catch in 2003). Since 2009 eel are caught in small numbers during summer and once in autumn. In 2015 more eel were caught in Zandvliet compared to previous campaign in 2014 (all data). Over the years a decline in numbers caught is observed.

In the oligohaline zone two locations are sampled (Antwerpen and Steendorp).

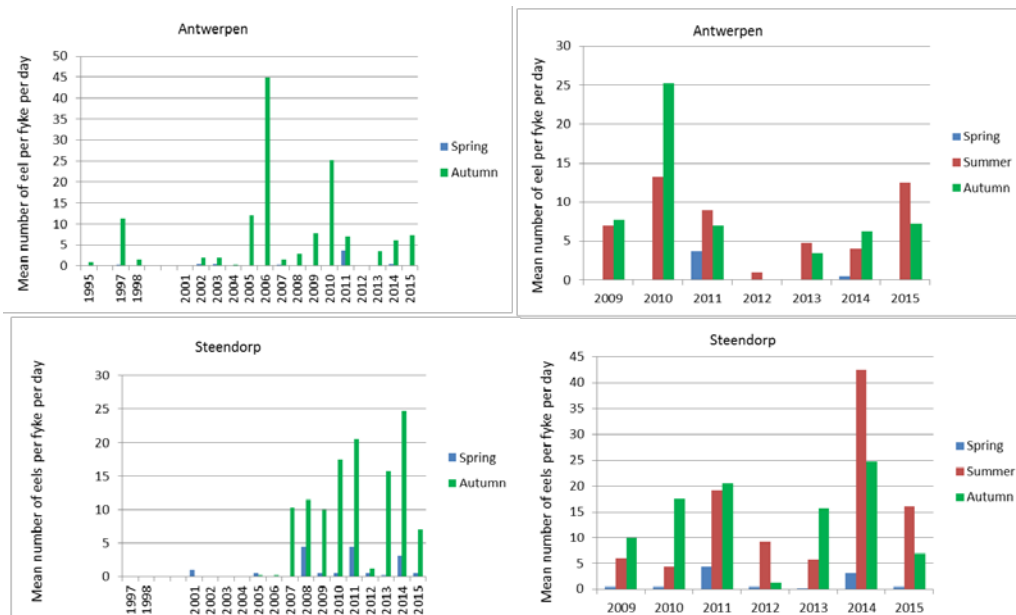


Figure 10. Time-trend of fyke catches of eel in Antwerpen and Steendorp. Numbers are expressed as mean number of eels per fyke per day. On the left, data are split up in spring catches and fall catches (1995–2015) while on the right, summer catches are added (2009–2015). Years without monitoring data are excluded from the X-axis.

Eel are rarely caught in spring in the oligohaline zone. In autumn peaks were observed in Antwerpen: 2006 and 2010. After a decline in 2011 an increase in autumn catches is observed. In Antwerpen a small increase in abundance is observed over the

years but only for the campaigns in autumn (1995–2015). If however data for the period 2009–2015 are taken then in all seasons a decline is observed. Further upstream in Steendorp the positive effect of the water purification station in Brussel Noord (active since March 2007) is clear. In 2014 more eel was caught in Steendorp compared to the other campaigns. In summer eel is caught regularly in the two locations. In Steendorp an increase in eel abundance is noted when considering the summer campaigns (2009–2015) while for autumn campaigns a *status quo* is recorded.

In the freshwater part of the estuary one location (Kastel) was sampled yearly since 2002. The two other sites (Appels and Overbeke) were sampled from 2008 onwards.

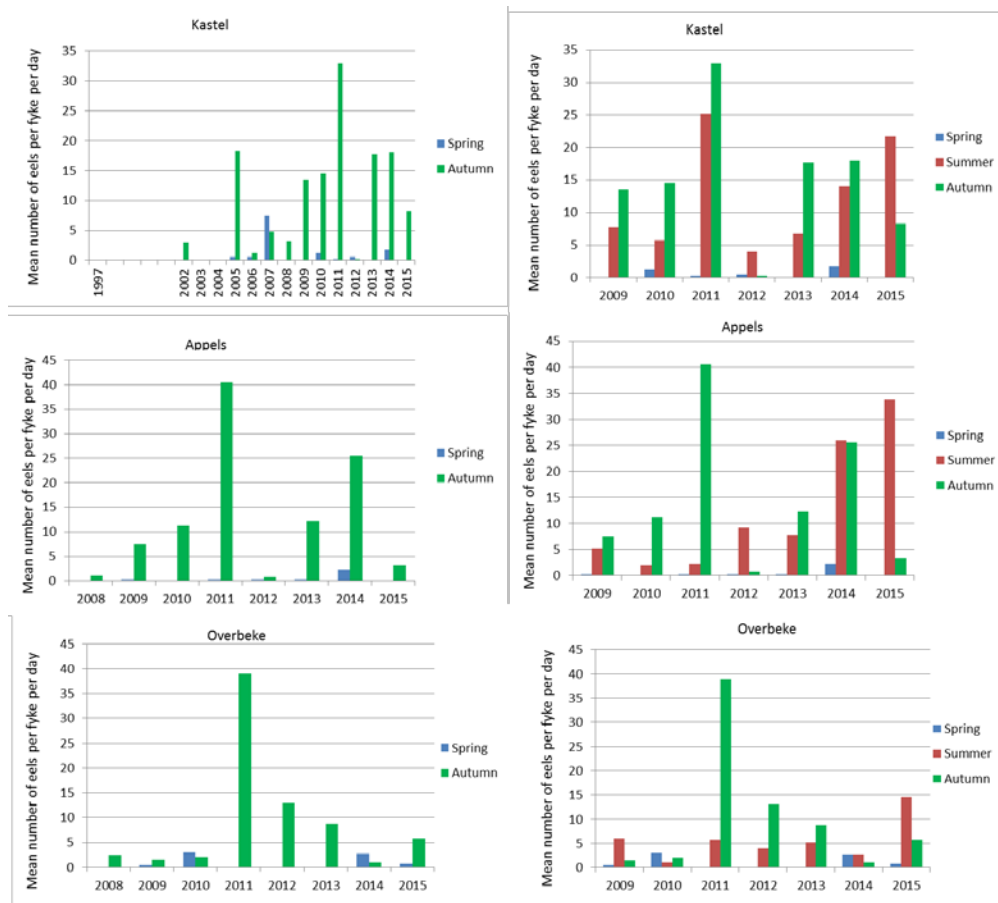


Figure 11. Time-trend of fyke catches of eel in Kastel, Appels and Overbeke. Numbers are expressed as mean number of eels per fyke per day. On the left, data are split up in spring catches and fall catches (1997 or 2008–2015) while on the right, summer catches are added (2009–2015). Years without monitoring data are excluded from the X-axis.

In all locations eel is rarely caught in spring. In autumn a peak is observed in all locations in 2011. In all locations an increase in eel caught during summer is noted. In later autumn campaigns catches in Kastel were extremely low in 2012 while in 2013–2014 more eel was caught. This is also the case in Appels while further upstream in Overbeke a decline in eel catches continued until 2014.

Conclusion

In summer eel was caught in all locations in all campaigns. In the mesohaline and oligohaline zone the average abundance of eel is highest in summer (2009–2015). In

the freshwater zone however, eel is more abundant in autumn. The lowest catch abundance is in Zandvliet.

Yellow eel telemetry study in the river Méhaigne (Meuse RBD)

In 2009, University of Liège started up a telemetry study on 50–80 cm yellow eels in the Méhaigne, tributary of the river Meuse. The objectives are the evaluation of home range, mobility, habitat choice, impact of alterations of water regime by hydropower stations and the assessment of up and downstream migration. This study aims to study habitat choice of eels in support of the management of river habitat in Walloon rivers.

The movements and habitat use of resident yellow eels were studied in a stream stretch having both natural and minimum flow zones. $N = 12$ individuals (total length 505–802 mm) were surgically tagged with radio transmitters and released at their capture sites. They were located using manual radio receivers during the daytime from two to five days/week over periods ranging from 200 to 329 days, for a total of 1098 positions. Eels showed home ranges ranging from 33 to 341 m (median value, 62 m), displayed strong fidelity to sites and demonstrated a great degree of plasticity in habitat use. Eels were slightly mobile throughout the year, but their movements were season- and temperature dependent, with a maximum during spring (mean water temperature, 12°C) and a minimum in winter (3°C). Stones and roots (utilization rate greater than 50% of eels for more than 30% of location days) were significantly the most frequently used habitats. Between the two flow zones, the natural flow was the most occupied, with a significantly larger proportion of resident eels (66.7% of radio-tagged yellow eels) and longer occupation (81% of location days) than the minimum flow zone with less suitable habitats (Ovidio *et al.*, 2013).

Upstream migration of yellow eel in the River Meuse basin

Migration flux at the Visé-Lixhe dam was estimated at 6152 eels (0.738 t, density: 1187 eels/ha, biomass 142 kg/ha) using the mark-recapture method (Nzau Matondo *et al.*, 2015a). This estimated value is much lower than the 445 000 eels (16.5 t) estimated by Baras *et al.* (1996) at Ampsin in the upper Meuse. At the Visé-Lixhe dam, eels moved upstream through the two fish passes but the old fishpass monitored since 1992 is their preferred migration route (Nzau Matondo *et al.*, 2015b).

Eel population study in the Lesse (Meuse RBD)

An ongoing research programme financed by the European Fishery Fund (FEP) and the Service Public de Wallonie (SPW), aims to estimate the resident stock of eels in the Lesse River, sub-basin of the River Meuse. The stock is estimated by the method of capture–recapture sampling and densities are calculated according to the Petersen method. On each sampling site, electrofishing is performed and fykenets are placed. The eels captured are individually tagged with passive integrated transponders. Morphometric measurements such as total length, weight, length of pectoral fins and eye diameters allowed to determine the stages of eels. As their migration can be compromised by their health state, eel blood samplings are also made on each fish in order to evaluate the physiological and immunological state of the stock. The results of thyroid hormones (T3 and T4), growth hormone (GH) and Insulin Like Growth Factor 1 (IGF1) measurements will be compared with the stages previously defined. Lysozyme and complement activities measurements will give us some indications on the health state of fish individuals. The detection of herpesvirus (HVA) is also done in each fish (Roland and Kestemont, 2014).

A : Anseremme ; ANL : Anloy ; BC : Aiguilles de Chaleux ; BD : Bande ; BEL : Belvaux ; BET : Beth ; BI : Rochefort (Biran) ; BLN : Neupont (Bras de Lesse) ; BU : Bure ; CHA : Chanly ; CHA2 : Chanly (station n°2) ; DAV : Daverdisse ; EP : Eprave ; F : Furfooz ; FE : Finffe ; FE2 : Finffe (station n°2) ; FMO : Ferme de Mohimont ; FOR : Forrières ; GHAN : Han-sur-Lesse (Grottes) ; GRU : Grupont ; HAR : Harsin ; HI : Houyet (Hileau) ; HOU : Houyet ; HK : Houyet (parking kayak) ; HSL : Han-sur-Lesse ; HUL : Hulsonniaux ; IW : Houyet (Iwène) ; J : Jemelle ; J2 : Jemelle (station n°2) ; J3 : Jemelle (station n°3) ; LES : Lesterny ; LSA : Lavaux Sainte-Anne ; MAI : Maissin ; MAS : Masbourg ; MF : Masbourg-Forrières ; MIR : Mirwart ; MO : Ferme de Mohimont ; NEU : Neupont ; OCH : Ochamps ; ON : On ; PAL : Pont-à-Lesse ; PAV : Pont d'Havène ; PAV2 : Pont d'Havène (station n°2) ; RA : Rau d'Avène ; RAV : Ri d'Ave ; RBE : Rau de Behotte ; RES : Resteigne ; RF : Ri des Forges ; RGO : Ruisseau du Godelet ; RO : Rochefort ; RO2 : Rochefort (station n°2) ; RPL : Rau de la Planche ; VA : Villers-sur-Lesse (Vachau) ; VIL : Villance ; VL : Villers-sur-Lesse ; Wi : Villers-sur-Lesse (Wimbe) ; WAN : Wanlin ; WB : Wanlin (Biran).

Among these 56 stations, ten contained a large number of eels and have been sampled twice, in order to study the growth of eels sampled at two occasions as well as the possible changes in developmental stage and physio-immunological status: Pont-à-Lesse, Aiguilles de Chaleux, Furfooz, Pont d'Avène, Wanlin, Han-sur-Lesse, Belvaux, Resteigne, Neupont et Maissin.

In total, 213 eel were captured and tagged during the sampling campaign (from autumn 2013 to autumn 2015), distributed on 21 stations only. Except for two eel, all fish were sampled in stations located on the Lesse River itself. Twelve eel were also sampled in Anseremme, close to the River Meuse, during the samplings aiming to investigate the downstream migration pattern of eels in the Lesse River. Thus, the grand total of captured and tagged eels is 225. The most abundant captures were done in the lower part of the Lesse, with 23 eels at the Aiguilles de Chaleux and 30 eel at Furfooz, in 2013. In 2014, 24 eels were also sampled at Belvaux (Higher section of the Lesse River). No eels were caught in the Lhomme River, the main tributary of the Lesse River, as well as in the tributaries of the Lhomme River.

The density, estimated by the Petersen method, varied between 28 and 800 eels/ha and the biomass ranged from 29.5 à 720.3 kg/ha (Table 10). However, in most cases, the Petersen method was not applicable, due to the lack of recapture.

As mentioned above, ten stations were sampled twice, with the same sampling methodology. For each station, the Schnabel method, adjusted by Chapman (1952), was used, as follows.

$$Nt = \sum (Ci * mi) / (R + 1)$$

where Nt is the number of fish in the population ; Ci, the number of fish of the i sampling; mi, the number of fish tagged just before the i sampling et R, the total number of tagged fish recaptured in the station after n successive samplings.

Based on this method, a density ranging from 31 to 298 eels/ha was calculated (Table 10).

Table 10. Number of eels captured and recaptured in each station and by each sampling method, estimated densities and estimated biomass per station.

CODE STATION	RIVER	YEAR	CAPTURE			RECAPTURE	TOTAL NUMBER OF FISH	ESTIMATED NUMBER OF FISH	DENSITY (N/HA)	BIOMASS (KG/HA)
			CAPTURE D0	CAPTURE D2						
			Electrofishing	Electrofishing	Fykenets					
PAL	Lesse	2013	0	0	3	0	3	n.a.	n.a.	n.a.
		2015	0	0	2	0	2	n.a.	n.a.	n.a.
BC	Lesse	2013	8	6	11	2	23	92	409	348,4
		2015	3	2	3	1	8	24	107	100,7
F	Lesse	2013	8	1	22	1	30	240	800	720,3
		2015	4	1	12	0	17	n.a.	n.a.	n.a.
HUL	Lesse	2015	0	0	11	0	11	n.a.	n.a.	n.a.
HOU	Lesse	2014	0	0	3	0	3	n.a.	n.a.	n.a.
HK	Lesse	2014	0	0	5	0	5	n.a.	n.a.	n.a.
HI	Hileau	2014	1	0	0	0	1	n.a.	n.a.	n.a.
VL	Lesse	2013	1	1	0	0	2	n.a.	n.a.	n.a.
PAV	Lesse	2014	0	0	5	0	5	n.a.	n.a.	n.a.
		2015	0	0	2	0	2	n.a.	n.a.	n.a.
WA	Lesse	2014	0	0	6	0	6	n.a.	n.a.	n.a.
		2015	0	0	2	0	2	n.a.	n.a.	n.a.
Wi	Wimbe	2013	0	0	1	0	1	n.a.	n.a.	n.a.
HSL	Lesse	2014	0	0	8	0	8	n.a.	n.a.	n.a.
		2013	0	0	6	0	6	n.a.	n.a.	n.a.
GHAN	Lesse	2014	0	0	2	0	2	n.a.	n.a.	n.a.

CODE STATION	RIVER	YEAR					TOTAL	ESTIMATED NUMBER OF FISH	DENSITY (N/HA)	BIOMASS (KG/HA)
			CAPTURE D0	CAPTURE D2		RECAPTURE	NUMBER OF FISH			
BEL	Lesse	2014	4	1	21	2	24	48	96	93,6
		2015	1	2	11	0	14	n.a.	n.a.	n.a.
RES	Lesse	2014	0	1	4	0	5	n.a.	n.a.	n.a.
		2015	0	0	6	0	6	n.a.	n.a.	n.a.
CHA	Lesse	2014	2	0	4	2	4	4	200	171,3
CHA (2)	Lesse	2015	7	0	5	5	7	10	98	90,3
NEU	Lesse	2014	5	0	4	3	6	10	28	29,5
		2015	0	0	8	0	8	n.a.	n.a.	n.a.
MO	Lesse	2015	0	0	2	0	2	n.a.	n.a.	n.a.
BLN	Lesse	2014	1	0	0	0	1	n.a.	n.a.	n.a.
MAI	Lesse	2014	2	1	0	0	3	n.a.	n.a.	n.a.
		2015	2	0	6	1	7	14	400	346,7

Table 11. Number of eels captured and recaptured in the ten stations sampled twice and by each sampling method, estimated densities and estimated biomass per station.

CODE STATION	CAPTURE YEAR 1		CAPTURE YEAR 2		TOTAL NUMBER OF RECAPTURE	TOTAL NUMBER OF FISH	ESTIMATED NUMBER	DENSITY (N/HA)
	Electrofishing	Fykenets	Electrofishing	Fykenets				
PAL	0	3	0	2	0	5	n.a.	n.a.
BC	12	11	4	3	4	29	67	298
F	9	21	5	12	8	40	83	277
PAV	0	5	0	2	0	7	n.a.	n.a.
WA	0	6	0	2	0	8	n.a.	n.a.
HSL	0	8	0	6	0	8	n.a.	n.a.
BEL	5	19	3	11	5	35	73	146
RES	1	4	0	6	4	7	6	31
NEU	5	1	0	8	4	13	14	39
MAI	3	0	2	5	3	8	10	286

9.3 Silver eel

Information on the migratory behaviour of silver eel in estuaries is scarce. Therefore, more insight is needed to efficiently restore and conserve the species. We tracked 47 eel with acoustic telemetry between July 2012 and December 2015 and analysed their behaviour from the Braakman creek into the Scheldt Estuary, separated by a tidal barrier. Eels arrived in the Braakman between midsummer and early winter and showed searching behaviour, resulting in significant delays before entering the Scheldt estuary. The long residence time in the Braakman was probably due to the discontinuous operation of the tidal barrier, resulting in an irregular flow condition, to control the water level in the upstream located wetland area. Eventually the majority of the eel did pass the sluice and reached the Scheldt Estuary. In the Scheldt Estuary, eels migrated towards the sea, however, a minority took the opposite direction. These eel might show estuarine retention behaviour. Moreover, the relation between the migratory behaviour of the tracked eels and environmental conditions like tidal currents, flow, water temperature, light intensity and precipitation were analysed. Preliminary results indicate that eel migration is obstructed by a tidal barrier and resulted in delayed eel migration. The information obtained by this study can be implemented in management plans such as environmental windows to open the sluice during eel migration if circumstances allow such measurements (Verhelst, work in progress).

The exact migration routes of European eel in estuaries and the marine environment are still unknown. To unravel these mysterious routes, 30 eels were tagged in 2015 with acoustic transmitters and in the three consecutive years, 30 eels will be tagged each year. The tagged fish can be detected by the permanent acoustic network in the Scheldt estuary and Belgian Part of the North Sea, funded by the LifeWatch ESRI observatory. By unravelling the migration routes and accompanied behaviour, a better estimation about the fate of the marine migrating silver eels from the Scheldt River can be made. The results of this study will be useful for management measures for the conservation and restoration of the eel stocks (Verhelst, work in progress).

See under 9.2 for information on an EFF research project assessing downstream migration of silver eel at the confluence of the Lesse and the Meuse.

De Canet *et al.* (2014) estimated the actual and historical eel stock and escapement to the sea estimated for French and Belgium Meuse by applying the EDA.2.0 model (Jouanin *et al.*, 2012, Eel Density Analysis). A total of 19 980 yellow eels and 1000 silver eels was estimated in 2013 in the Belgian part of the Meuse. This number is 5.8 times lower than the estimated number in 1980. Eel presence and abundance are decreasing linearly with the distance to the sea and the cumulative height of dams. As part of this work, a first attempt to estimate the anthropogenic mortality and biomass according to a pristine state has provided some results. However the lack of data and proper biological parameters limited the results to plots used to illustrate the possible outputs. The numbers estimated by the model are fairly lower than previous estimates for this area, and the reasons for this result are discussed.

10 Data collected for the DCF

Not applicable for Belgium as there are no commercial catches in inland waters. Commercial catches of eel in coastal waters or marine fisheries are not reported to DCF.

See Section 11.1 for data on length and weight gained from research sampling.

There are no routine surveys on age of eels. Some silver eels from Flanders have been aged in the framework of the Eeliad programme.

11 Life history and other biological information

11.1 Growth, silvering and mortality

von Bertalanffy parameters: L_{inf} , K , t_0

L_{50} = the length at which 50% of the population has silvered (my interpretation of 50% maturity)

Length and age at silvering

Fecundity

Weight-at-age

Length–weight relationship

Length and weight and growth (DCF)

Flemish Region

Length and weight data of individual eel collected through the freshwater fish monitoring network are available via the website <http://vis.milieuinfo.be/>.

An analysis of the length of yellow eels per catchment has been made for the EMP and is presented there.

A length–weight relationship ($W = aL^b$) in eel from 17 586 individual eels recorded has been published by Verreycken *et al.* (2011). See also the 2014 Belgian Eel Country Report (Belpaire *et al.*, 2014) for more details.

Results from a study on head dimorphism (Ide *et al.*, 2011) are presented in the 2011 Belgian Eel Country Report (See Belpaire *et al.*, 2011) for details).

Walloon Region

An analysis of the length of yellow eels in some rivers of the Meuse catchment has been made for the EMP and is presented there.

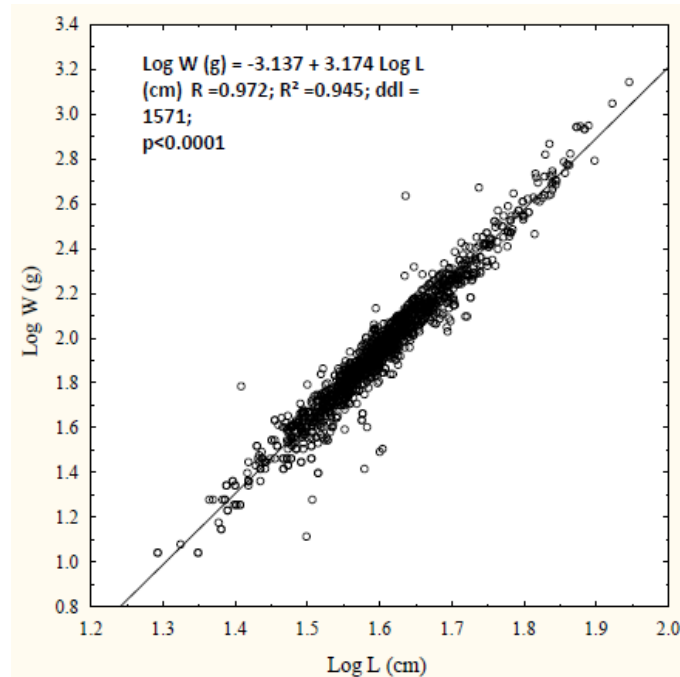


Figure 13. Length–weight relation of yellow eels (n = 1572, size range 19.6–88.5 cm) sampled at the Visé-Lixhe dam in the period 1992–2014.

Nzau Matondo *et al.* (2015a) describe the length–weight relationship of ascending yellow eels using the equation $W = aL^b$ and logarithmically transformed into $\log_{10}(W) = \log_{10}(a) + b \log_{10}(L)$ at the Visé-Lixhe in Wallonia. The equation was based on 1572 individual eels recorded for total length and weight is shown in Figure 10.

Lesse River sub-basin

Below are presented the main characteristics of the eels sampled from 2013 to 2015 in the Lesse River sub-basin.

Silvering stages

Among the 225 eels sampled in the Lesse River sub-basin, 44 (19.6%) were classified at the silvering stage FII, 159 (70.7%) at the stage FIII and ten (4.4%) at the stage FV, while ten eel could not be classified due to the abundance of damages. One eel was caught at the stage F1 in Chanly (CHA2) (Figure 14).

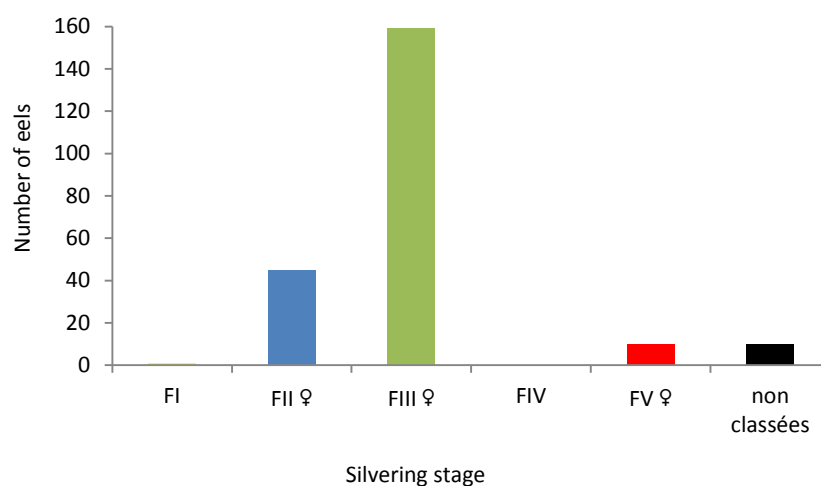


Figure 14. Number of eels at the different silvering stages (FI, FII, FIII, FV and “non-classes” (unclassified)), all stations combined (n = 226).

In the lower Lesse (i.e. between Belvaux and Han-sur-Lesse), 24.6% of the eels (35 fish) were at stage FII; 67.6% (96 fish) at stage FIII and five eels (3.5 %) at stage FV. In the Upper Lesse, most eels were at stage FIII (75.9%) or 63 fish; 12.0% at stage FII (ten fish); 6.0% (five fish) at stage FV and one fish (1.2%) at stage FI (Figure 15).

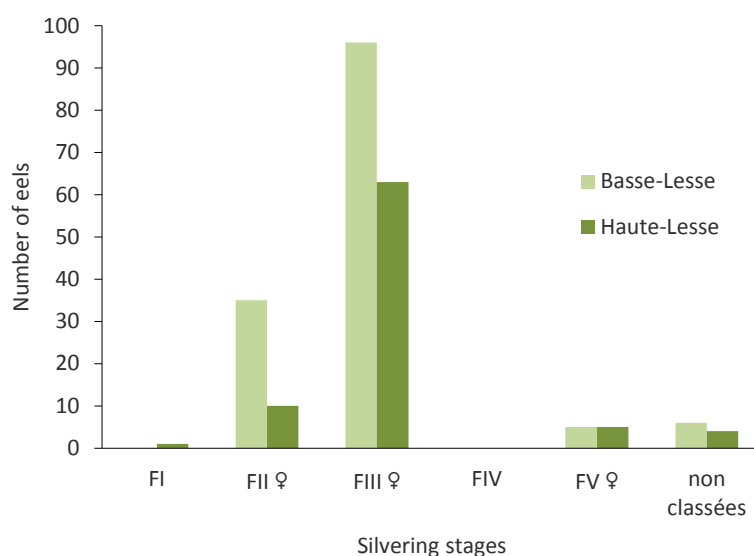


Figure 15. Number of eels of the different silvering stages (FI, FII, FIII and FV), in Lower Lesse (n = 142) and Upper Lesse (n = 83).

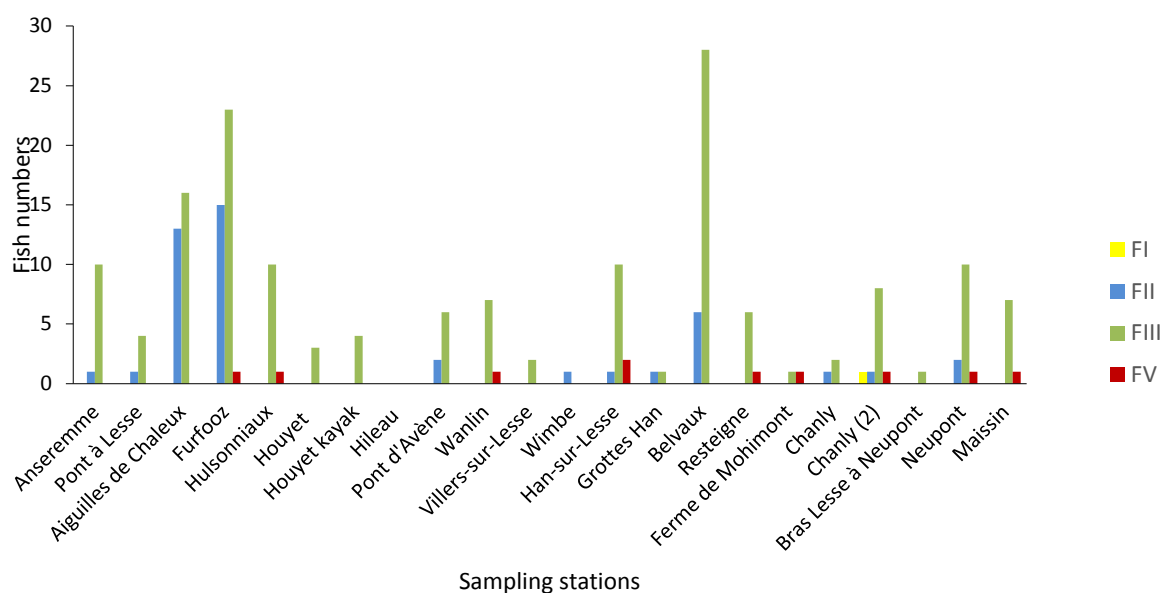


Figure 16.

Sex ratio

Sexual dimorphism is strongly marked in eel, and it is generally established that a body length of 46 cm is a female. The mean length of the captured eels was 79.8 ± 9.0 cm, with a minimum length of 44.5 cm (Chanly 2) and a maximum length of 105 cm (Han-sur-Lesse). At the exception of one eel with a body length below 46 cm, all sampled eels could be considered as females.

Length-frequency distribution

Among the 225 eels sampled in the Lesse River sub-basin, the dominant size class was the length interval 71–80 and 81–90, with 35.1% (79 fish) and 38.7% (87 fish) respectively. About 85% of the eels were considered as large fish, ranging from 71 to 110 cm. The length–frequency distribution was related to the silvering stage. About 50% of eels of stage FII belong to the size class 71–80 cm while fish of stage FIII were mainly present in the size class 81–90 cm, as well as the eels of stage FV.

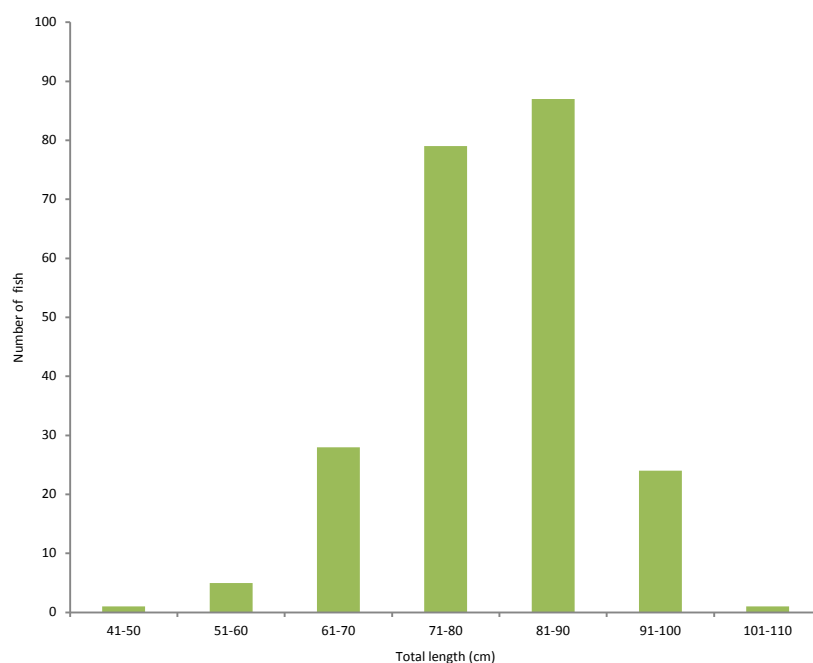


Figure 17. Number of eels of the Lesse river belonging to the different size classes (n=225).

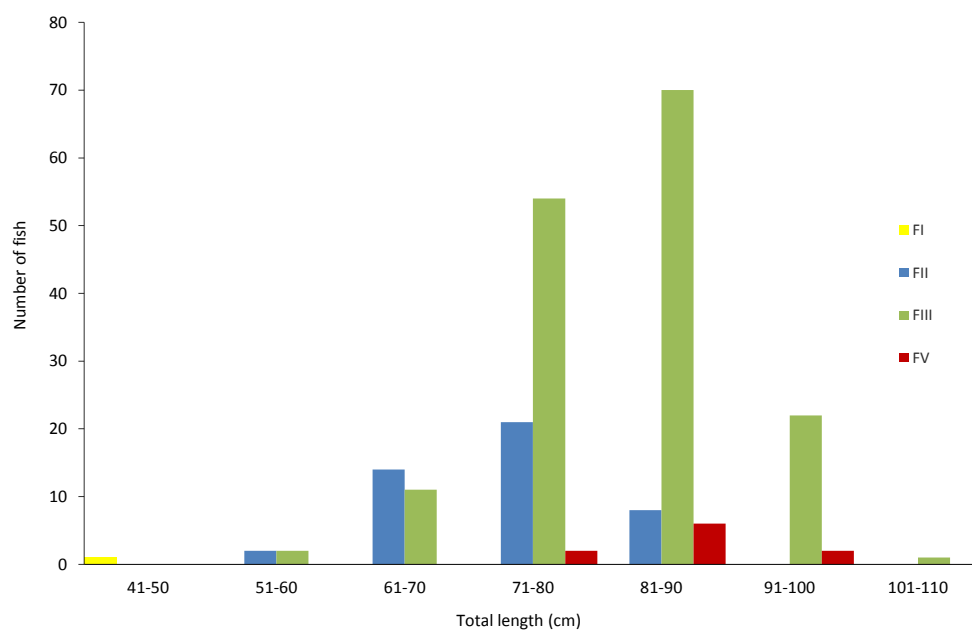


Figure 18. Number of eels of the Lesse river belonging to the different size classes, according to their silvering stage (n=225).

Growth

Among the 21 stations of the River Lesse sub-basin that were sampled from 2013 to 2015 and which contained eels, ten were sampled two times. This second sampling

campaign allowed recapturing 18 eels previously tagged. Table 12 shows the length, weight and silvering stage of the recaptured fish. Most fish grew of 144 to 170 g between 2014 and 2015, with a maximum of 230.3 ± 83.9 g in the Resteigne station. In 2015, most eels (13) at the same silvering stage as in 2014, while the silvering stage increased in three eels and decreased in two.

Table 12. Weight (g), length (cm) and silvering stage (FII, FIII, or FV) of eels recaptured in the River Lesse stations that were sampled twice between 2014 and 2015.

Station	Code individu	Code PitTag	2013			2014			2015		
			Poids	Taille	Stade	Poids	Taille	Stade	Poids	Taille	Stade
Furfooz	F2 = F31	00074EFB31	1192	87	FIII				1419	87	FV
	F13 = F32	00074EF78C	467	65	FII				634	69	FIII
	F26 = F35	00074DA74B	1182	87	FIII				1397	92	FIII
	F28 = F37	00074EEFBC	1207	87,1	FIII				1385	89,9	FIII
	F29 = F39	00074DB58F	677	73,7	FII				750	77,6	FII
	F30 = F40	00074D8801	666	71	FIII				850	73,9	FIII
	F20 = F44	00074F1B1E	797	76	FIII				927	79,5	FII
Aiguilles de Chaleux	BC20 = BC28	00074EFED3	921	79,4	FIII				824	81,5	FIII
Maissin	MA1 = MA6	00074F26E8				762	75	FIII	740	75	FIII
	MA2 = MA8	00074FB98D				816	75	FIII	892	77	FIII
Belvaux	BEL 15 = BEL 25	00075010FC	675	69	FIII				751	72	FIII
	BEL 21 = BEL 29	00074DE4EC	1535	87	FIII				1850	93,1	FIII
	BEL19 = BEL 31	00074D8A42	858	78	FIII				977	83,3	FIII
Resteigne	RES 2 = RES 7	00074F113E				1406	91	FIII	1608	97,5	FIII
	RES 1 = RES 8	00074F0969				1370	88	FIII	1725	93	FIII
	RES 4 = RES 9	00074F2D4D				910	76	FIII	1099	79	FV
	RES 5 = RES 10	00074ED7B0				663	72	FV	838	77	FIII
Neupont	NEU 1 = NEU 8	00074FCE31				1073	80	FIII	1285	83,5	FIII

Trophic plasticity in European eel

A recent study on the head shape of glass eels (*A. anguilla*) showed that there were already broad-headed and narrow-headed phenotypes present in this stage. However, there was still no unambiguous support for dimorphism, implying that head shape in glass eels is changing from a unimodal to a bimodal distribution (De Meyer *et al.*, 2015). Since glass eels are non-feeding, the presence of both phenotypes should be related to other trophic segregation.

However, to assess the importance of trophic segregation, De Meyer *et al.* (under review) divided glass eels in three groups that were fed different diets: one got hard prey, one got soft prey and one group got both. This allowed studying diet-induced morphological plasticity of the head in European eel. We found that glass eels feeding on hard prey develop a broader general head width and specifically, a broader postorbital region than soft feeders. The postorbital region is the region where the jaw-closing adductor mandibulae can be found. A broadening of this region is therefore most likely related to a larger volume of the adductor mandibulae muscles, increasing the bite force of these eels, which could allow them to cope with the harder prey. Specimens of the group with mixed diet developed a wide variation of head shapes, from broad-heads to narrow-heads. This implies that some eels prefer the hard prey, whereas other ones prefer the soft prey when the choice is given. This study thus indicates that, while head shape is not completely determined by it, trophic segregation still plays an important role. Next to this, trophic segregation was commonly studied in yellow eels larger than 30 cm. This study showed, however, that differences in head shape through differences in diet can already be induced shortly after eels start to feed in the rivers, with the eels still being smaller than 10 cm.

Musculoskeletal anatomy and feeding performance of pre-feeding larvae

Bouillart *et al.* (2015) studied the anatomy of the skull in leptocephali. Being part of the elopomorph group of fish, Anguillidae species show a *leptocephalus* larval stage. However, due to largely unknown spawning locations and habitats of their earliest life stages, as well as their transparency, these *Anguilla* larvae are rarely encountered in nature. Therefore, information regarding the early life history of these larvae, including their exogenous feeding strategy and feeding performance, is rather scarce. To better understand the structural basis and functional performance of larval feeding in captivity, the functional morphology of the cranial musculoskeletal system in pre- and first-feeding engyodontic leptocephali of the European eel (*Anguilla anguilla*) was studied. A 3D reconstruction of the feeding apparatus (head of the leptocephali <1 mm) was used to visualize and describe the musculoskeletal changes throughout these stages. To analyse the ontogenetic changes in the functionality of the feeding apparatus towards the active feeding phase, 3D data of joints, levers and muscles derived from the reconstructions were used to estimate bite and joint reaction forces (JRFs). Observing a maximum estimated bite force of about 65 μN (and corresponding JRFs of 260 μN), it can be hypothesized that *leptocephalus* larvae are functionally constrained to feed only on soft food particles. Additionally, potential prey items are size delimited, based on the theoretically estimated average gape of these larvae of about 100 μm . This hypothesis appears to be in line with recent observations of a diet consisting of small and/or gelatinous prey items (Hydrozoa, Thaliacea, Ctenophora, Polycystenia) found in the guts of euryodontic *leptocephalus* larvae.

11.2 Parasites and pathogens

Flemish Region

See for results on a pan European survey on the actual status of *Anguillicola* in silver eels (Faliex *et al.*, 2012), 2012 Country Report (Belpaire *et al.*, 2012).

Walloon Region

Pathological code

Within the framework of the European Decision n°1100/2007, ONEMA has set up a standardised protocol based on the sanitary guide proposed by Girard and Elie (2007). This protocol has been used to evaluate the health status of the eels sampled in the Lesse River sub-basin between 2013 and 2015. The macroscopic observations done in eels allowed one or several pathological codes to be given for each fish. All types of lesions and parasites are listed. The pathological code is attributed on the basis of the code grid, as described by Beaulaton and Penil (2009). The pathological code is composed of four characters: two characters for the lesion and parasitism, one character for the localisation and one numeric character indicating the importance of the lesion or parasitosis.

Among the 225 eels caught in the Lesse River sub-basin from 2013 to 2015, 184 (81.8%) displayed no lesions or parasites, and the code OOC0 was given. The remaining 41 eels displayed diverse lesions. No external parasites were found. Most eels sampled in the Lower Lesse were healthy, without any lesion, while a majority of fish sampled in the Upper Lesse displayed some lesions (Figure 19).

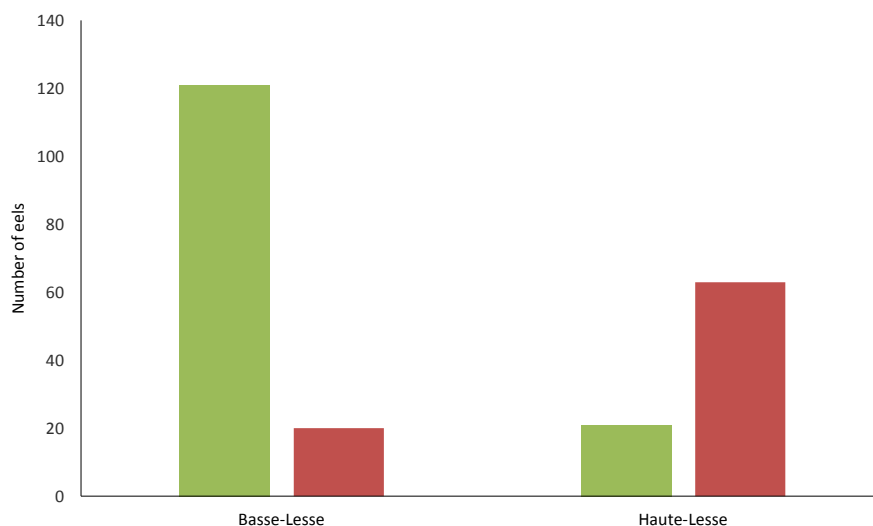


Figure 19. Number of eels without (green) and with (red) lesions in the Lower (Basse) and Upper (Haute) Lesse (n total = 225).

Immune markers

In order to obtain some complementary information on the health status of eels, some nonspecific immune markers (lysozyme, complement activity) as well as the presence of the eel herpes virus *Herpesvirus anguillidae* have been analysed in the plasma of eels sampled in different stations of the Lesse River sub-basin. Biomarker assays in plas-

ma were chosen as a non-invasive method to follow the health status without killing eel.

The lysozyme activity was measured in 222 eels, including 18 fish captured a second time during the second sampling campaign. The mean (\pm S.E.M.) lysozyme activity reached 11.19 ± 0.92 U/min for the eels of silvering stage FII ($n = 44$), 9.97 ± 0.43 U/min for those of stage FIII ($n = 158$) and 12.95 ± 2.62 U/min for stage FV ($n = 10$) without any statistical differences between silvering stages.

The lysozyme activity in eel plasma varied according to the station (Figure 20), with a statistical difference ($p < 0.05$) between the stations « Belvaux » and « Pont d'Avène ». The mean activity in fish without any damage was 10.1 ± 0.4 U/min ($n = 178$) while the activity reached 10.8 ± 1.1 U/min for eels with lesions ($n = 26$), with any difference between healthy and affected eels. Same statement has been observed between eels with and without herpes virus.

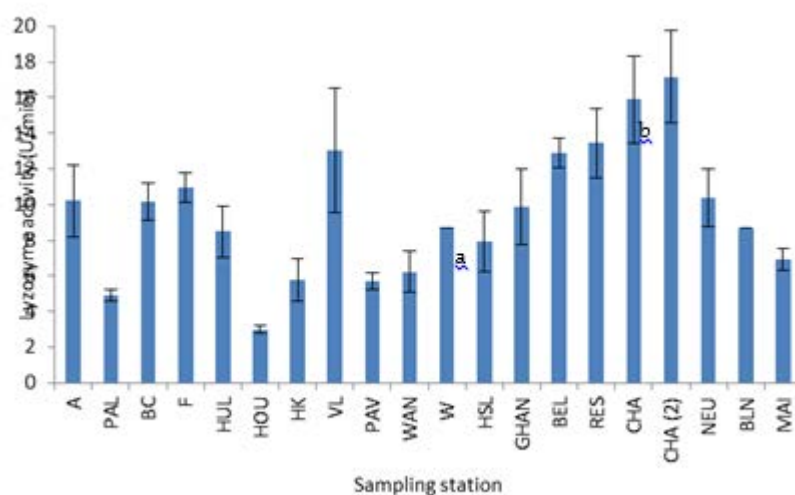


Figure 20. Mean lysozyme activity assayed in eel plasma sampled in different stations of the Lesse River sub-basin: A ($n = 12$), PAL ($n = 5$), BC ($n = 27$), F ($n = 37$), HUL ($n = 11$), HOU ($n = 3$), HK ($n = 5$), VL ($n = 2$), PAV ($n = 8$), WAN ($n = 8$), Wi ($n = 1$), HSL ($n = 13$), GHAN ($n = 2$), BEL ($n = 33$), RES ($n = 11$), CHA ($n = 7$), CHA 2 ($n = 6$), NEU ($n = 12$), BLN ($n = 1$) and MAI ($n = 8$). (See Table X for station names and locations).

The complement activity (ACH50) was assayed in 95 eels. The mean activity (\pm S.E.M.) reached 4429.7 ± 273.37 in eels of silvering stage FII ($n = 31$), 3784.5 ± 237.33 for those of stage FIII ($n = 62$) and 3788.1 ± 668.09 in fish of stage FV ($n = 2$), without significant differences between silvering stages. Based on the available data so far, ACH50 varied according to sampling stations, with a highly significant difference between the station « Belvaux » and those of « Anseremme » and « Aiguilles de Chaleux » (Figure XX). The mean complement activity did not differ between eels without and with lesions, nor between eels with and without the contamination by the herpesvirus.

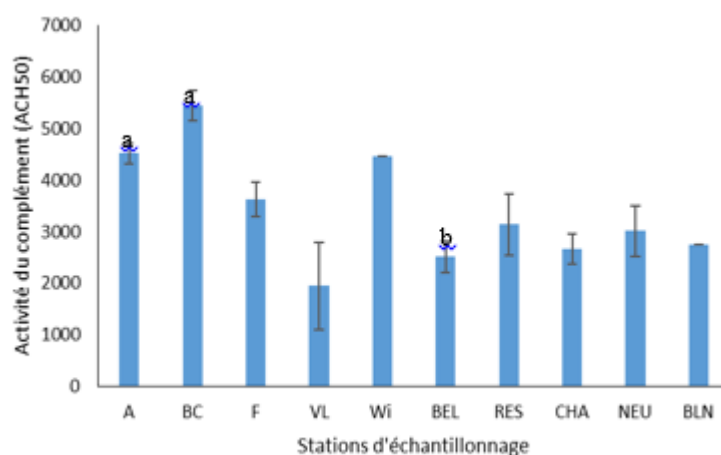


Figure 21. Mean complement activity (ACH50) assayed in eel plasma of eels sampled in ten stations of the Lesse River sub-basin : A (n = 5), BC (n = 25), F (n = 29), VL (n = 2), Wi (n = 1), BEL (n = 18), RES (n = 4), CHA (n = 3), NEU (n = 6) and BLN (n = 1). (See table X for station names and locations).

Presence of the herpesvirus (HVA)

Based on a PCR method (Table X), the detection of the eel herpesvirus (HVA) was performed in 225 eels sampled in the Lesse River sub-basin. Almost all eels (97%) are contaminated by the herpesvirus (Figure 22 A) while only six eels were considered as virus free, without any link a specific station. Among the 219 contaminated eels, 193 (86%) did not exhibit any specific lesion or clinical symptom of virus contamination, suggesting that the virus is present at a latent stage, without exhibiting its virulence (Figure 22 B).

Table 13. Sequences of the external probes used for the DNA amplification of *Herpesvirus anguillae* by PCR (according to Rijsewijk *et al.*, 2005).

EXTERNAL PROBE	SEQUENCE	LENGTH OF THE AMPLIFIED SEGMENT
ANGHV-1POLVPSD (forward)	5'-GTGTCGGGCCTTTGTGGTGA-3'	394 base pairs
ANGHV-1POLOOSN (reverse)	5'-CATGCCGGGAGTCTTTTGTAT-3'	

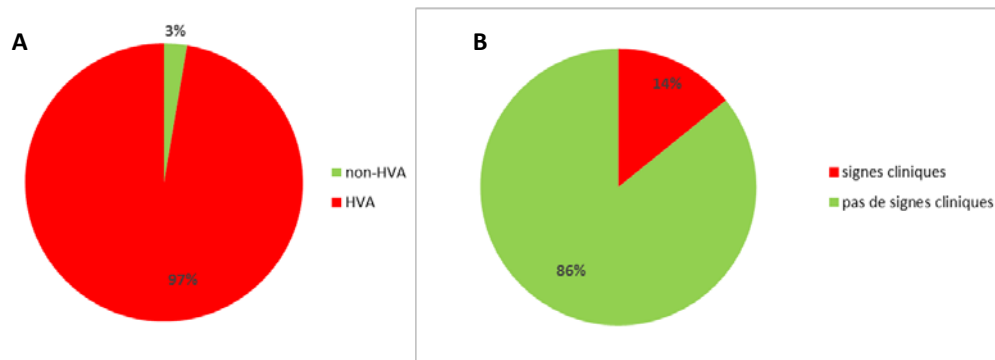


Figure 22. A) Proportion of eels contaminated by the herpes virus (HVA). In red: the percentage of contaminated eels. In green the percentage of eels free of herpes virus. B) In red, percentage of contaminated eels displaying some clinical signs. In green, absence of clinical symptoms in herpes virus contaminated eels.

All in one, it appears that most eels are contaminated by the eel herpesvirus. At this stage, this contamination does not seem to affect the health status as evaluated by nonspecific immune markers or clinical observation of HVA symptoms. Either the eels can cope in nature with the presence of such virus (reported to induce large mortalities in fish farms) or the virus is in a latent stage without expressing its virulence. In this latter case, the situation can be considered as of real concern because the herpesvirus are well known to stay in a latent stage during a relatively long period, and then become virulent (inducing diseases and mortalities) once the fish are under a stressful condition or physiologically weak. A more in-depth study of this situation, as well as a more complete database of eel status, including more biomarkers, are needed.

11.3 Contaminants

Some recent work (recently published papers and contributions to international meetings) is summarized below.

In order to meet the requirements of Water Framework Directive, De Jonghe *et al.* (2014) measured bioaccumulation of hydrophobic micropollutants in muscle tissue of eel (*Anguilla anguilla*) and perch (*Perca fluviatilis*) from Flemish waterbodies. Quantified pollutants included mercury (Hg), hexachlorobenzene (HCB), hexachlorobutadiene (HCBd), Polybrominated diphenyl ethers (PBDE), Hexabromocyclododecane (HBCDD), perfluorooctane sulfonate (PFOS) and its derivatives, dicofol, heptachlor and heptachlorepoxyde. Measured Hg and HCB concentrations were compared between species and in time, based on historical data of eel pollutant monitoring in Flanders. In addition two polycyclic aromatic hydrocarbons (PAH), fluoranthene and benzo(a)pyrene, were measured in zebra mussels (*Dreissena polymorpha*), which were caged for six weeks. At all sample sites eel could be captured, however this was not possible for perch. For perch only (too) small individuals could be captured. An exceeding of the biota environmental quality standard (EQS) was observed for HCB, HBCDD and PFOS at some sample sites. For Hg and PBDE, biota-EQS were exceeded at all sample sites. EQS evaluation for HCB depended on fish species, since more elevated HCB concentrations were measured in eel compared to roach. Measured Hg concentrations were dependent on fish size, and strong relations were observed between Hg accumulation in eel and perch. HCB concentrations in eel were found to decrease in time. In contrast, Hg concentrations seem to increase, although measured Hg bioaccumulation was comparable with levels found in other European studies.

Based on results from the present study and data from literature, biota EQS for both Hg and PBDE seem unrealistically low for Flemish and European watercourses. This study recommends eel as the most suitable species to monitor bioaccumulation of hydrophobic micropollutants in Flanders. The latter is based on both practical aspects (spatial distribution and amount of biomass) and species-specific aspects of the immature eel related to biomonitoring (sedentary, no gender issues, no reproduction). Furthermore, this study also highlights the need for intercalibration studies relating pollutant concentrations between different species (De Jonghe *et al.*, 2014).

This assessment was continued in 2015, with the aim to report on the status of contaminants in eel and perch at eleven sites in Flanders (work in progress, collaboration University Antwerp, INBO, VMM).

Malarvannan *et al.* (2015) investigated the levels, profiles and human health risk of organophosphorus flame retardants and plasticizers (PFRs) in wild European eels (*Anguilla anguilla*) from freshwater bodies in the highly populated and industrial Flanders region (Belgium). Yellow eels (n=170) were collected at 26 locations between 2000 and 2009 and for each site, muscle samples of 3–10 eels were pooled and analysed (n=26). Muscle lipid percentages varied widely between 2.4% and 21% with a median value of 10%. PFRs were detected in all pooled samples in the order of tris-2-chloroisopropylphosphate (TCIPP) >triphenylphosphate (TPHP) >2-ethylhexyldiphenylphosphate (EHDPHP) >tris-2-butoxyethyl phosphate (TBOEP) >tris-2-chloroethylphosphate(TCEP) >tris-1,3-dichloro-2-propylphosphate (TDCIPP). The median sum PFR concentration for all 26 sites was 44 ng/g lw (8.4 ng/g ww), and levels ranged between 7.0 and 330 ng/g lw(3.5 and 45ng/g ww). Levels and profiles of PFRs in eels showed that sampling locations and river basin catchments are possible drivers of spatial variation in the aquatic environment. Median PFR concentrations were lower than those of polybrominated diphenylethers (PBDEs) and hexabromocyclododecanes(HBCDs). No correlation was observed between the PFR concentrations and lipid contents, suggesting that the accumulation of PFRs is not primarily associated with lipids. Human exposure to PFRs, due to consumption of wild eels, seems to be of minor importance compared to other potential sources, such as inhalation and ingestion of indoor dust. Nevertheless, considering the very limited data available on PFRs in human dietary items and their expected increasing use after the phase out of PBDEs and HBCDs, further investigations on PFRs in biota and human food items are warranted.

Belpaire *et al.* (2015) published the results of a comprehensive survey of the presence of dyes in the muscle tissue of wild yellow eel over Flanders. Dyes are used to stain inks, paints, textile, paper, leather and household products. They are omnipresent, some are toxic and may threaten our environment, especially aquatic ecosystems. The presence of residues of sixteen dyes (triarylmethanes, xanthenes, phenothiazines and phenoxazines) and their metabolites was analysed in muscle tissue samples of individual yellow-phased European eels (*Anguilla anguilla*) from 91 locations in Belgian rivers, canals and lakes sampled between 2000 and 2009 using ultra performance liquid chromatography-tandem mass spectrometry. Eel was contaminated by dyes in 77% of the sites. Malachite Green, Crystal Violet and Brilliant Green were present in 25–58% of the samples. Dye occurrence was related to the distribution of textile and dye production industries. This field study is the first large-scale survey to document the occurrence of artificial dyes in wildlife. Considering the annual amounts of dyes produced worldwide and the unintentional spillage during their use, our observations warrant additional research in other parts of the world. The presence of these highly toxic dyes in the European eel may form an additional threat to this critically

endangered species. The contaminated eels should be considered as not suitable for consumption.

A workshop was organized by Belpaire (INBO, Belgium) and Haenen (CDI, The Netherlands) aiming to progress in the development of standardised and harmonised protocols for the estimation of eel quality. There were 31 participants (21 attendees and ten remote participants) representing 13 countries. The objective of WKPGMEQ (Workshop of a Planning Group on the Monitoring of Eel Quality) was to document standardised and harmonised protocols for the estimation of the quality of the European eel *Anguilla anguilla*, with regard to the bioaccumulation of contaminants and the presence of diseases, including parasites. The report (ICES, 2015) is available at <http://www.ices.dk/community/groups/Pages/WKPGMEQ.aspx>. The report starts with an overview of the current eel quality assessments in the Member States, and further discusses general issues on sampling of eel quality assessments. It includes a chapter on the assessment of eel condition in terms of fitness and lipid levels. In further chapters best practices to (sub)sample, analyse, report and visualize contaminants in the eel are described. The disease sections focus on parasitic diseases (including the swimbladder parasite *Anguillicoloides*), and on viral and bacterial diseases. Possible ways to integrate data and to implement them into eel quality indices have been suggested. The workshop also discussed the future perspectives of using biomarkers of effects to assess eel health. Finally the report concludes describing the international context and future perspectives in eel health assessments. Several recommendations were made to facilitate the further development of a framework to integrate eel quality assessments into the quantitative management of the eel stock.

11.4 Predators

Flemish Region

Information on the occurrence and distribution of the cormorant has been provided for Flanders in the Belgian EMP.

It was estimated that the yearly consumption of eels by cormorants amounts 5.6–5.8 tonnes for Flanders.

Walloon Region

For the Walloon region, no new data were available. See 2008 report and the Belgian Eel Management Plan.

12 Other sampling

Information on habitat, water quality, migration barriers, and turbines is available in the Belgian Eel Management Plan, and has been updated by the second EMP Progress Report (Vlietinck and Rollin, 2015).

13 Stock assessment

This section does not contain new information compared to the 2013 Country Report. Information from last year is copied here.

13.1 Method summary

Flemish Region

The EU Eel Regulation demands to report every three years on the effective migration of silver eels from the eel management units of the Meuse and the Scheldt. In a report by Belpaire *et al.* (2015) the scientific underpinning of Flanders' figures required for the second progress report 2015 was described.

Monitoring the actual numbers of emigrating silver eel leaving river catchments is technically complex and challenging. Instead, Flanders opted to determine the migration of silver eel based on model calculations. Within each stratum *River Basin * River Type*, the total number of yellow eels was estimated based on the recorded density of yellow eel, and adjusted for various factors of natural and anthropogenic mortality. The data are supplied by Flanders' Freshwater Fish Monitoring Network.

More recent and more complete GIS layers allowed us to make an accurate calculation of the surface of the waters of the eel management plan.

The modified calculation is based on data collected between 2011 and 2014. The Fish Monitoring Network was reorganized in 2013 in the context of the Water Framework Directive and the Habitats Directive. This resulted in a more limited set of available data compared to the previous report with smaller sample size and larger variability, with for certain strata less representative results. Moreover, for the estimates of tidal waters, no suitable methodology is available. Also ponds and lakes remain under-sampled.

The method for calculating the level of escapement was modified in comparison to the method used in a previous report (Stevens and Coeck, 2013), taking into account previous recommendations (Stevens *et al.*, 2013). The current model uses a more realistic estimate of the sex ratio. The model takes into account mortalities cormorant predation, fishing and effects of pumping stations and turbines. The impact of predation and sport fisheries was incorporated in the calculation model in a slightly different way compared to previous report.

The influence of different eel distribution patterns depending on river width was assessed through an exploratory analysis. The choice of the scenario for the correction of the river width in the calculation model seems to be of great influence on the end result, advocating the need for an empirical study.

A modelling study was performed to assess which habitat and water quality variables have the most impact on recorded yellow eel densities. Besides river type, oxygen and bank structure were found to be the most explanatory variables. If sufficient data became available this would allow more adequate estimations of eel densities in non-sampled waters.

The new figures clearly point to a reduction in stocks and silver eel escapement compared to the previous reporting period. With a B_{current} / B_0 of 11%, Flanders is further away from the targets than during the previous reporting period. The current low figures may have been the result of low recruitment about 5–10 years ago.

On the other hand, it may not be excluded that the results also were influenced by differences in measurement strategy, data quality and calculation method. The necessary field research recommended by Stevens *et al.* (2013) was not carried out, jeopardizing sound estimates also for the current figures. Moreover, due to the reorientation of the fish monitoring efforts in the context of the WFD, significantly less data were

available than for previous reporting, undermining the quality of the estimates. Additionally, the report formulates a number of recommendations.

Finally, during this project significant advancements were made to optimize future reports through the development of a custom module of database querying, and the programming of an R script to run the calculation model.

Walloon Region

See the EMP Progress Report 2015.

13.2 Summary data

13.2.1 Stock indicators and targets

Note that not all targets may be available, for example the Reg does not set a mortality rate target. The mortality rate target from WGEEL 2012 corresponds to $(0.92 \text{ if } 'B_{\text{current}}/B_0' > 40\%, \text{ or } 0.92 * B_{\text{current}}/(40\% * B_0) \text{ if } 'B_{\text{current}}/B_0' < 40\%)$.

EMUcode	Indicator	biomass (T)		Mortality (rate)			Target		
		B0	Bbest	Bcurr	ΣA	ΣF	ΣH	Source	ΣA (rate)
BE_Scheldt	169	45	33	0.3101	0.2879	0.02218	EMP		
	187	41	34	0,1872	0.1788	0.00841	EU Reg (Progress report 2012)		
	207	31	23	8	6	1	EU Reg (Progress report 2015)		11
BE_Meuse	53	41	16	0.9409	0.1520	0.78896	EMP		
	54	39	14	1.0245	0.11242	0.91209	EU Reg (progress Rep 2012)		
	32	16	1	16	0	15	EU Reg (Progress report 2015)		3

13.2.2 Habitat coverage

Area corresponds to the wetted area of eel-producing habitat. “A’d” asks whether or not eel are assessed in that habitat type.

EMU code	River		Lake		Estuary		Lagoon		Coastal	
	Area (ha)	A'd Y/N	Area (ha)	A'd Y/N	Area (ha)	A'd Y/N	Area (ha)	A'd Y/N	Area (ha)	A'd Y/N
BE_Scheldt	8978	Y	3505*	Y	4130**	Y	/	N	/	N
BE_Meuse	987	Y	452*	Y	0	/	/	N	/	N

* Lake = WFD waterbodies type ‘lake’, including the docks of the ports of Antwerp and Zeebrugge.

** Estuary = Scheldt estuary + IJzer estuary.

13.2.3 Impact

For each EMU, provide an overview of the assessed impacts per habitat type or for ‘All’ habitats where the assessment is applied across all relevant habitats. Barriers includes habitat loss. Indirect impacts are anthropogenic impacts on the ecosystem but only indirectly on eel (e.g. eutrophication).

EMU code	Habitat	Fish com	Fish rec	Hydro & pumps	Barriers	Restocking	Predators	Indirect impacts*
BE-Scheldt	Riv	AB	A	A	A	A	A	Nr/MA
	Lak	AB	A	Nr	Nr	A	A	Nr/MA
	Est	AB	A	Nr	A	A/Nr	A	Nr/MA
	Lag	Nr	Nr	Nr	Nr	Nr	Nr	Nr
	Coa	Nr	Nr	Nr	Nr	Nr	Nr	Nr
	All							
BE-Meuse	Riv	AB	A	A	A	A	A	Nr/MA
	Lak	AB	A	Nr	Nr	A	A	Nr/MA
	Est	Nr	Nr	Nr	Nr	Nr	Nr	Nr
	Lag	Nr	Nr	Nr	Nr	Nr	Nr	Nr
	Coa	Nr	Nr	Nr	Nr	Nr	Nr	Nr
	All							

A = assessed, MI = not assessed, minor, MA = not assessed major, AB = impact absent.

* indirect impacts were not assessed as such, but the calculated eel densities implicitly account for the current habitat conditions, i.e. the eel density in rivers is the result of water quality and habitat structures.

Express the loss in tonnes (t) for each impact per developmental stage or MI = not assessed, minor, MA = not assessed major, AB = impact absent. Where available, also report the total loss as silver eel equivalents, and explain the method used to calculate equivalents in Section 13.1.

EMU code	Stage	Fish com	Fish rec	Hydro & pumps	Barriers	Restocking	Predators**	Indirect impacts*
BE_Scheldt	Glass	AB	MI	AB	MA	MA ?	MI ?	
	Yellow	AB	27	MI ?	MA	MI	5.2	
	Silver	AB	6	1.27	MI	MI	1.51	
	Silver EQ	AB						
BE_Meuse	Glass	AB	MI	AB	MA	MA ?	MI ?	
	Yellow	AB	3	MI ?	MA	MI	0.58	
	Silver	AB	0.7	0.24	MI	MI	0.18	
	Silver EQ	AB						

* See previous table.

** Predation by cormorants. Scheldt = 90% of total silver eel biomass in Flanders → impact of predation calculated for Meuse and Scheldt together and then divided over both basins according to their contribution to overall biomass.

13.2.4 Precautionary diagram

13.2.5 Management measures

No new information compared to last year's report.

13.3 Summary data on glass eel

See chapters 3.1.1 and 3.5.1.

14 Sampling intensity and precision

No new data available.

15 Standardisation and harmonisation of methodology

No new data available.

15.1 Survey techniques**15.2 Sampling commercial catches****15.3 Sampling****15.4 Age analysis****15.5 Life stages****Wallonia**

Nzau Matondo *et al.* (2015a) report the absence of young eel stage in upstream migrant eels during the season 2013. From a sample of 50 ascending yellow eels (range size 31.6–77.5 cm, median 42.1 cm) at the Visé-Lixhe dam, eels showed a wide range of life stages, with a larger proportion of eels (80%, range size 31.6–74.6 cm) belonging to the yellow eel stage. A smaller proportion of eels (6%) had a larger size (range size 72.4–77.5 cm) and presented an advanced continental silvering process corresponding to the migrating stage before their transatlantic migration. Between these two ecophases, there are eels (14%, range size 37–69 cm) that were neither yellow, nor quite silvery, but probably in transition phase between yellow eels and silver eels.

15.6 Sex determinations**15.7 Data quality issues****16 Overview, conclusions and recommendations**

Recent (2011–2015) data from recruitment-series or other scientific stock indicators in Belgium indicate a further decrease of the stock, although the glass eel recruitment at Nieuwpoort (River Yzer) showed an increase within recent years (especially in 2012–2014). After significant higher glass eel recruitment in 2014, this year's (2015) data dropped back to similar values as 2012–2013. The monitoring series of ascending young yellow eels trapped at the fish trap of the Visé-Lixhe dam between 1992 and 2015, showed the lowest catches for 2015 since the start of the series.

Special fisheries management actions to restore the stocks in Flanders are confined to the prohibition of the semi-professional fyke fisheries in the Lower Scheldt. In the Walloon region eel fishing is prohibited to avoid human consumption of contaminated eels. In Flanders the eel has been listed as *Critically Endangered* on the Red List of Fish.

In Flanders, restocking practises with glass eel are going as in former years. Glass eel restocking activities are not taking account of the variation in eel quality (diseases/contamination) of the restocking sites. Due to failure of the supplier, no glass eel could be stocked in Flanders in 2015. In the Walloon Region restocking with glass eel has been initiated in 2011 and in 2012, but was temporarily stopped in 2013 for financial reasons. As in Flanders, the Walloon region was faced with failure of the supplier. As a result no glass eel was stocked in Belgium in 2015.

In Belgium, habitat and water quality restoration is a (slow) ongoing process within the framework of other regulations, especially the Water Framework Directive and the Benelux Decision for the Free Migration of Fish (which has been reformulated in 2009). Numerous migration barriers, pumps and hydropower stations still affect the free movement of eels and many rivers and brooks still have an insufficient water

quality to allow normal fish life. Measures have been taken to enhance the migration of glass eel at the seas sluices, by adapted sluice management.

Specific programmes for eel sampling and other biological sampling for stock assessment purposes of eel as required in the context of the Belgian EMP have been initiated and are ongoing in Wallonia under cofunding of EFF.

Some research programs focusing on habitat, migration and eel quality are being initiated or ongoing. Several scientific results have been published. A pilot project to monitor contamination in eel and perch for reporting about the chemical status of water bodies within the WFD has been reported in Flanders in 2014, and is currently implemented.

Recommendations

It is recommended that the sampling programmes as required in the Belgian EMP and the European restoration plan is initiated as soon as possible.

Considering further downward trend of most stock indicators, additional protection of the local stock is required. In the Walloon Region the harvest of eels by recreational fishermen is prohibited for human health considerations (as the eels are contaminated). Similarly Flanders could envisage the same management option. Eels from many places in Flanders are considerably contaminated and their consumption presents risks for human health. Furthermore apparently recreational fishermen are not reluctant for a limitation in eel fishing. Putting in place a catch and release obligation in Flanders would save 30 tons of eel on annual basis.

Issues regarding the difficulties to purchase glass eel for restocking should be considered on international scale.

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Report on the eel stock and fishery in Denmark 2014/2015

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Reporting Period: This report was completed in November 2015, and contains data up to 2014 and some provisional data for 2015.

2 Introduction

The Danish EMU belongs to the North Sea ecoregion.

From 1st July 2009 the eel is managed according to the EU regulation, aiming at 40% (relative to the pristine) silver eel escapement in freshwater and 50% effort reduction in the marine waters. The Danish territory is managed as one freshwater EMU excluding two small transboundary river basins named Kruså and Vidå shared with Germany. Intermediate and coastal waters are treated together with community waters constituting the entire marine area.

From 1st July 2009, professional fishing operations are based on licences. The professional fishermen in saline areas are given a licence permitting the use of a limited number of gear in order to meet the 50% reduction within five years following the EU eel regulation.

Recreational fishermen operating in the marine may use six fykenets or six hook lines but in a reduced period of the year. Fishing is closed from the 10th of May to 31th of July to reduce effort by 50%.

In freshwater a few professional fishermen have a licence permitting the use of a limited number of gears. For landowners and recreational fishermen the fishing season has been limited to a period of 2.5 month and fishing is closed from 16 October–31 July.

The escapement target of 40% in freshwater has been calculated to be achieved after ca. 85 years if a total ban on freshwater fisheries will commence. Licences are provisionally issued until 31st December 2015. The Ministry of Food, Agriculture and Fisheries may implement further reductions pending the development in the eel stock.

3 Time-series data

3.1 Recruitment series and associated effort

No data.

3.1.1 Glass eel

3.1.1.1 Commercial

No data; glass eel fishery is forbidden.

3.1.1.2 Recreational

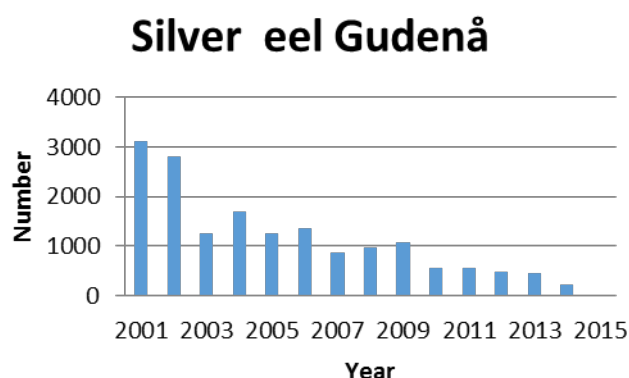
No data.

3.1.1.3 Fishery-independent

Silver eels

Data from a silver eel trap, active every year from ca. 1 September–15 December at Vestbirk Hydropower station in River Guden. Tag recapture experiments have shown that the trap takes $\frac{2}{3}$ of the eels migrating down the stream. This is likely to be constant every year! The stock is influenced by stocking activities.

Figure and Table 3.1.1.3. Silver eel trap catch since 2001.



YEAR	NUMBER	YEAR	NUMBER	YEAR	NUMBER
2001	3117	2006	1370	2011	562
2002	2802	2007	875	2012	490
2003	1248	2008	961	2013	451
2004	1697	2009	1076	2014	215
2005	1267	2010	549		

3.1.2 Yellow eel recruitment

The recruitment of young eels to Danish freshwater is currently monitored in pass traps at Harte Hydropower Station in river Kolding Å and at Tange Hydropower Station in river Guden Å. Both rivers empty into Kattegat on the east coast of Jutland. On the west coast of Jutland no passive trapping facilities are available. Here the recruitment is monitored in Vester Vedsted brook a small brook by the Wadden Sea. See also Section 9.1 for further information on glass eel monitoring by electrofishing.

In **Vester Vedsted brook** an annual population surveys is made by electrofishing four sections of the brook three times a year (further details in Pedersen, 2002).

At **Harte Hydropower Station** the condition for monitoring recruitment has changed. As part of a river restoration project in River Kolding Å, the water supply to Harte Hydropower station has been reduced by 60% since spring/summer 2008. The effect of lower water supply at the trapping site is a decrease in recruitment to the trapping site reflected in the data. This is the second time a major change to the eel monitoring in River Kolding Å has taken place since monitoring started in 1967. The first change was in 1991 where a trapping facility was terminated at the Stubdrup Weir. At that time a bypass stream was made at the Stubdrup Weir allowing eels to bypass the weir without being trapped. This is also reflected in the recruitment data (Table 3.1.2).

At **Tange Hydropower Station**. Eel ladder trap. The local staff at the station is responsible for the daily maintenance of the trap and registration of data.

Table 3.1.2. Recruitment data from Tange and Harte Hydropower Stations and Vester Vedsted brook. Mean density during the year and maximum density at any electrofishing occasion.

YEAR	TANGE	HARTE	VESTER VEDSTED BROOK		YEAR	TANGE	HARTE	VESTER VEDSTED BROOK		YEAR	TANGE	HARTE	VESTER VEDSTED BROOK	
			DENSITY EEL/M ²					DENSITY EEL/M ²					DENSITY EEL/M ²	
Year	Kg	Kg	Mean	Max (season)	Year	Kg	Kg	Mean	Max (season)	Year	Kg	Kg	Mean	Max (season)
1967		500	-	-	1984	84	172	-	-	2000	88	18	0.6	0.7
1968		200	-	-	1985	315	446	-	-	2001	239	11	0.6	0.8
1969		175	-	-	1986	676	260	-	-	2002	278	17	0.5	0.6
1970		235	-	-	1987	145	105	-	-	2003	260	9	0.6	0.7
1971		59	-	-	1988	252	253	-	-	2004	246	9	0.3	0.4
1973		117	-	-	1989	354	145	-	-	2005	88	7	0.5	0.5
1974		212	-	-	1990	367	101	-	-	2006	123	7	0.3	0.7
1975		325	-	-	1991	434	44	-	-	2007	62	7	0.4	0.5
1976		91	-	-	1992	53	40	-	-	2008	131	0.9	0.2	0.2
1977		386	-	-	1993	93	26	-	-	2009	20	1.3	0.2	0.2
1978		334	-	-	1994	312	35	-	-	2010	14	5	0.2	0.4
1979		291	2.8	6.5	1995	83	23	2.6	2.6	2011	84.6	3.6	0.3	0.3
1980	93	522	7	13	1996	56	6	4.6	6.8	2012	-	4.1	0.1	0.2
1981	187	279	7.8	13	1997	390	9	0.7	1	2013	47	1.4	0.1	0.2
1982	257	239	-	-	1998	29	18	0.3	0.4	2014	36	3.0	0.1	0.1
1983	146	164	-	-	1999	346	15	0.4	0.5	2015	NA	NA	0.2	0.2

3.1.2.1 Commercial

No data.

3.1.2.2 Recreational

No data.

3.1.2.3 Freshwater-independent

No data.

3.2 Yellow eel landings**3.2.1 Commercial**

The time-series on Yellow eel landing below (see 3.3.1).

3.2.2 Recreational

Available information is reported below (see 3.3.2 recreational).

3.3 Silver eel landings**3.3.1 Commercial**

Data on separate landings of yellow and silver eel in fresh and salt water are given below. Data origin is catch reports by commercial fishermen reported to the Ministry. From mid-2009 catches are only reported from those given a licence to fish for eel.

Table 3.3.1.1. Freshwater landings (ton) of yellow and silver eels.

YEAR	SILVER	YELLOW	TOTAL	YEAR	SILVER	YELLOW	TOTAL	YEAR	SILVER	YELLOW	TOTAL
1960	-	-	214	1979	-	-	78	1998	-	-	40
1961	-	-	235	1980	-	-	147	1999	-	-	30
1962	-	-	215	1981	-	-	140	2000	4	24	28
1963	-	-	238	1982	-	-	163	2001	2	34	36
1964	-	-	223	1983	-	-	116	2002	5	27	27
1965	-	-	205	1984	-	-	126	2003	2	21	24
1966	-	-	211	1985	-	-	111	2004	4	12	15
1967	-	-	243	1986	-	-	120	2005	3	10	14
1968	-	-	258	1987	-	-	90	2006	7	8	14
1969	-	-	254	1988	-	-	119	2007	5	6	11
1970	-	-	249	1989	-	-	114	2008	5	4	9
1971	-	-	183	1990	-	-	107	2009	8	5	13
1972	-	-	200	1991	-	-	99	2010	10	3	13
1973	-	-	201	1992	-	-	109	2011	11	4	15
1974	-	-	163	1993	-	-	57	2012	9	4	13
1975	-	-	260	1994	-	-	60	2013	10	3	13
1976	-	-	178	1995	-	-	52	2014	12	3	15
1977	-	-	179	1996	-	-	34	2015	NA	NA	NA
1978	-	-	157	1997	-	-	39				

Table 3.3.1.2. Marine landings (ton) of yellow and silver eels.

YEAR	SILVER	YELLOW	TOTAL	YEAR	SILVER	YELLOW	TOTAL	YEAR	SILVER	YELLOW	TOTAL
1960	2756	1967	4509	1979	887	939	1748	1998	306	251	517
1961	2098	1777	3640	1980	911	1230	1994	1999	380	307	657
1962	2132	1775	3692	1981	897	1190	1947	2000	382	218	572
1963	1837	2091	3690	1982	1003	1375	2215	2001	446	225	635
1964	1417	1865	3059	1983	884	1119	1887	2002	365	217	555
1965	1498	1699	2992	1984	830	915	1619	2003	437	188	601
1966	1829	1861	3479	1985	793	726	1408	2004	343	187	516
1967	1673	1763	3193	1986	818	734	1432	2005	372	149	506
1968	2063	2155	3960	1987	538	651	1099	2006	427	154	567
1969	1552	2072	3370	1988	799	960	1640	2007	411	115	515
1970	1470	1839	3060	1989	785	797	1468	2008	364	93	448
1971	1490	1705	3012	1990	834	734	1461	2009	367	87	454
1972	1662	1567	3029	1991	724	642	1267	2010	304	105	409
1973	1697	1758	3254	1992	687	655	1233	2011	271	84	355
1974	1378	1436	2651	1993	523	500	966	2012	226	78	304
1975	1534	1691	2965	1994	509	631	1080	2013	243	100	343
1976	1477	1399	2698	1995	408	432	788	2014	251	80	331
1977	1141	1182	2144	1996	381	336.5	684	2015	NA	NA	NA
1978	1187	1148	2178	1997	375	383	719				

3.3.2 Recreational

Marine

Recreational fishermen in the marine area are allowed to use a maximum of six fykenets. Catch data Table 3.3.2.1 is based on interview survey among recreational fishermen. A reduction in recreational fishery in marine waters is estimated at 100 tonne in 2009 and 55 tonne in 2014 (Table 3.3.2.1).

Freshwater

The reduction in recreational fishery in freshwater has been reduced from approximately 16 tonnes pre-2009 to 2 tonnes in 2014 (Table 3.3.2.1).

Table 3.3.2.1.

	FRESH	MARINE	TOTAL
2009	NA	100	100
2010	NA	117,5	117,5
2011	4,3	75,2	79,5
2012	0,4	51,9	52,3
2013	0,4	49,5	49,9
2014	2	55	57
2015	NA	NA	NA

3.4 Aquaculture production

3.4.1 Seed supply

Glass eels to Danish aquaculture are imported from France and England. The eel farmers have reported to the Danish AgriFish Agency that 2.3 ton of glass eel was imported during 2014. The glass eel are used as seed stock for the production presented in Table 3.4.1.

3.4.2 Production

Aquaculture production of eel in Denmark started in 1984. At present the production takes place at six indoor, heated aquaculture systems, Table 3.4.

Table 3.4. Annual aquaculture eel production.

YEAR	PRODUCTION UNITS	PRODUCTION [TON]	YEAR	PRODUCTION UNITS	PRODUCTION [TON]
1984	??	18	2000	25	2674
1985	30	40	2001	17	2000
1986	30	200	2002	16	1880
1987	30	240	2003	13	2050
1988	32	195	2004	9	1500
1989	40	430	2005	9	1700
1990	47	586	2006	9	1900
1991	43	866	2007	9	1617
1992	41	748	2008	9	1740
1993	35	782	2009	9	1707
1994	30	1034	2010	9	1537
1995	29	1324	2011	8	1156
1996	28	1568	2012	8	1093
1997	30	1913	2013	8	824
1998	28	2483	2014	6	842
1999	27	2718	2015		

Table 3.4.1. Usage of aquaculture production 2014 (Source: Danish AgriFish Agency).

	Number	Kg	Kg
Imported glass eel	6069,000	2,305	
Stocking exported (Weight ≤10)		32,630	
Stocking Denmark (3.5 g)		5,314	
Large eel exported (Weight ≥10 g)		187,000	
Large eel consumption			568,658
Dead biomass			48,793
Total			842,395

The import and export data (Table 3.4.1) are reported by the eel farmers to the Danish AgriFish Agency. The different categories (import, export, consumption, stocking) are reported in kg and partly in numbers. In Table 3.4.1 data are presented in kg. Life

mortality from the glass eel stage to the stocked eel stage or the consumption stage is the same level, approximately 15%. It should be noted that the number of glass eel imported to the farm is not necessarily comparable to the number of eel from the farm the same year. The retention time of eel in the farm differs by eel stage, e.g. eel for stocking is 3–12 months and eel for consumption is 18 months or more.

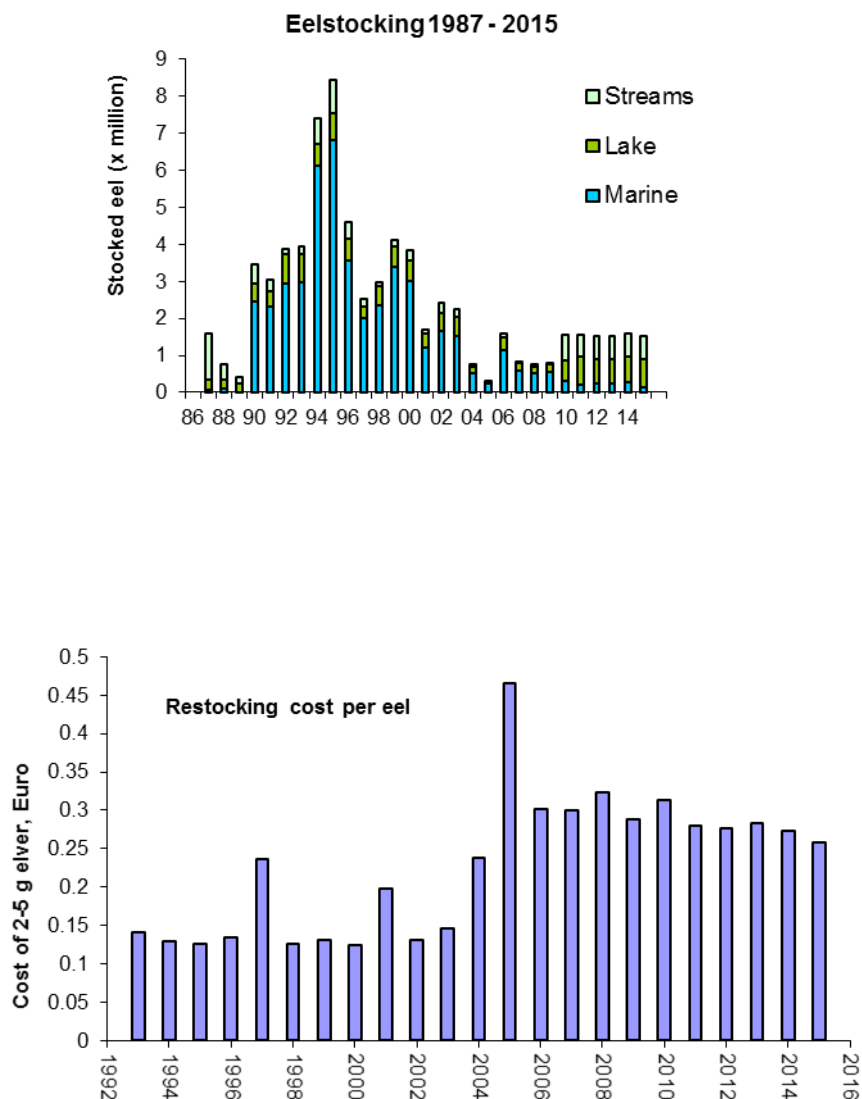
3.5 Stocking

3.5.1 Amount stocked

In 2015 a total of 1.53 million 2–5 gramme eels were stocked. In freshwater 1.4 million eel and in marine waters 0.13 million were stocked (Table 3.5.1 below).

The stocked eels are **foreign source** imported from France and England grown to a weight of 2–5 gramme in heated culture.

The price for SEC (sustainable eel certified) eels for stocking (0.28 €) were only slightly more expensive than for non-certified 2–5 gramme eel (0.26 €).



Figures 3.5.1. Restocking of elvers (2–5 g) in marine and freshwaters from 1987–2015 (numbers in millions) and cost per stocked eel.

Table 3.5.1. Restocking of elvers (2–5 g) in marine and freshwaters from 1987–2015. Numbers of eels stocked (in millions).

YEAR	MARINE	LAKE	RIVER	TOTAL	YEAR	MARINE	LAKE	RIVER	TOTAL
1987	0.07	0.26	1.26	1.58	2002	1.66	0.47	0.3	2.43
1988	0.11	0.24	0.4	0.75	2003	1.54	0.49	0.22	2.24
1989	0	0.24	0.17	0.42	2004	0.52	0.18	0.06	0.75
1990	2.46	0.49	0.51	3.47	2005	0.24	0.06	0	0.3
1991	2.3	0.44	0.32	3.06	2006	1.15	0.35	0.1	1.6
1992	2.94	0.81	0.11	3.86	2007	0.59	0.21	0.02	0.83
1993	2.97	0.76	0.23	3.96	2008	0.52	0.19	0.04	0.75
1994	6.12	0.61	0.67	7.4	2009	0.55	0.20	0.05	0.81
1995	6.83	0.72	0.9	8.44	2010	0.30	0.57	0.67	1.55
1996	3.58	0.58	0.44	4.6	2011	0.20	0.77	0.59	1.56
1997	2.02	0.29	0.22	2.53	2012	0.25	0.64	0.64	1.53
1998	2.35	0.53	0.1	2.98	2013	0.25	0.66	0.61	1.52
1999	3.38	0.56	0.18	4.12	2014	0.26	0.71	0.63	1.60
2000	3.02	0.55	0.25	3.83	2015	0.13	0.79	0.61	1.53
2001	1.2	0.38	0.12	1.7					

3.5.2 Catch of eel <12 cm and proportion retained for restocking

No data; catch of small eels is not allowed.

3.6 Trade in eel

Table 3.6.1. Value (Euro) of capture fisheries in Denmark.

Year	FRESHWATER		MARINE WATER	
	Yellow	Silver	Yellow	Silver
2013	34,133	100,267	961,867	2740,000
2014	33,333	121,066	701,466	2644,933
2015	NA			

4 Fishing capacity

4.1 Glass eel

No data; not allowed.

4.2 Yellow eel

No data.

4.3 Silver eel

No data.

4.4 Marine and freshwater fishery

From 1st July 2009, commercial eel fishing in marine and freshwaters are based on licences, and all gear must be registered with the Danish AgriFish Agency.

Commercial eel fishing effort and the reduction in fishing effort

Of the 783 commercial fishermen and entities with registered landings and pound-nets in the reference period 2004–2006, a total of 525 applied for licences. A total of 406 commercial licences were allocated in 2009. Since then 117 licences have been cancelled, reducing the number of active commercial fishing licences in 2014 to 289. (Danish AgriFish Agency).

Table 4.4 below illustrates the level of commercial fishing effort that catches eel each year specified into types of gear and the gradual reduction in fishing effort from the period 2004–2006. 2007. 2009. 2010 and 2011 (Danish AgriFish Agency).

Table 4.4. The level of commercial fishing effort by type of gear from 2004–2006 to 2014. From 2009, the number and types of gear represent the total allocated number and types of gear in all the individual fishing licenses (Danish AgriFish Agency).

	Fyke nets		Small pound nets		Large pound nets		Hook lines	
	Number	Reduction	Number	Reduction	Number	Reduction	Number	Reduction
Average 2004-2006	43.500 *		1.588		1.572		6.366	
2007	41.114	5,5%	1.578	0,6%	1.582	-0,6%	5.875	7,7%
2009	38.336	11,9%	1.292	18,6%	1.466	6,7%	1.932	69,7%
2010	33.661	22,6%	1.082	31,9%	1.322	15,9%	1.200	81,1%
2011	32.591	25,1%	1000	37,0%	1.273	19,0%	1.200	81,1%
2012	32.191	26,0%	963	39,4%	1.273	19,0%	1.200	81,1%
2013	29.004	33,3%	917	42,3%	1.198	23,8%	1.176	81,5%
2014	27.281	37,3%	915	42,4%	1.157	26,4%	1.136	82,2%

*The total number of 40,077 fyke nets registered by the fishermen, who applied for commercial eel licenses in 2009 and an estimate of 3,423 fyke nets used by the 258 fishermen, who reported landings of eel in the reference period 2004-2006, but who did not apply for eel licenses in 2009.]

5 Fishing effort

5.1 Glass eel

No data.

5.2 Yellow eel

No data.

5.3 Silver eel

No data.

5.4 Marine fishery

No data.

6 Catches and landings

6.1 Glass eel

Not allowed.

6.2 Freshwater landings

Best estimate of freshwater eel catches for 2014 are 17 tonnes. The official commercial landings reported to the ministry (Table 6.2) were 15 tonnes. Recreational landings, based on interview surveys, make up additional 2 tonnes.

Table 6.2. Freshwater landings (ton) from 2004–2013.

YEAR	SILVER	YELLOW	TOTAL
2004	4	12	15
2005	3	10	14
2006	7	8	14
2007	5	6	11
2008	5	4	9
2009	8	5	13
2010	10	3	13
2011	11	4	15
2012	9	4	13
2013	10	3	13
2014	12	3	15

6.3 Marine landings

The commercial marine fishery reported 394 tonnes of eel in 2014.

Table 6.3.1. Marine landings (ton) from 2004–2014.

YEAR	SILVER	YELLOW	TOTAL
2004	343	187	531
2005	372	149	520
2006	427	154	581
2007	404	115	519
2008	364	93	457
2009	367	87	454
2010	304	105	409
2011	271	84	355
2012	226	78	304
2013	243	100	343
2014	317	77	394

6.4 Recreational fishery

The recreational catch of eel in marine waters in 2014 was estimated at 57 tonnes. Recreational catch in freshwater was estimated at 2 tonnes.

Table 6.4. Interview survey of recreational fishermen.

Year	Fresh	Marine	Total
2008			
2009	8	100	108
2010	8	117,5	125,5
2011	4,3	75,2	79,5
2012	0,4	51,9	52,3
2013	0,4	49,5	49,9
2014	2	55	57

7 Catch per unit of effort

No data.

8 Other anthropogenic impacts

Some mortality has been documented due to hydropower turbines especially from Tange Hydropower plant but not from Vestbirk Hydropower plant (see below). An estimate of mortality from all hydropower plants may be ~5 tonne. At flow-through trout farms located at the bank of rivers the mortality is estimated at ~4 tonne (see below).

Predation from cormorants and mammals in freshwater is unknown and difficult to estimate. An estimate is ~10 tonne. Cormorants do eat eel from rivers and lakes, but they mainly forage in coastal waters, where results from Ringkøbing Fjord show a predation of 40% of stocked eel during the first year. Mortality outside the fishery adds up to ca. 20 tonne.

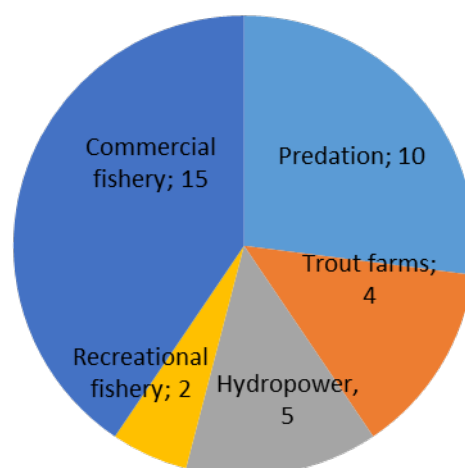


Figure 8.1. Best estimates of mortality (36 tonne) in freshwater. The number refers to tonne in each category.

8.1.1 Hydropower

In 2006 there were 43–61 hydroelectric power units in operation in Denmark. Since then several hydropower units have been closed down (e.g. Vilholt, Karlsgårdeværket, Harte).

Danish legislation stipulates that physical screens with a maximum bar distance of 10 mm must be installed in front of hydropower turbines. Bypasses guiding the eel around the power plant are established at some power plants, although at most power plants only fish ladders to guide salmonid are present. The knowledge of the efficiency of the different bypasses for the downstream migrating silver eel is limited and may differ from place to place. It is known that fish impinge on the turbine screens and die there.

Recent research at the biggest hydropower unit in Denmark, Tange Hydropower plant, suggests that up to 77% of the eels are lost bypassing the Hydropower plant. There is no exact knowledge of the proportion of eels that impinge on the screens or are lost for other reason e.g. predation and fisheries, but approximately 10% of the migrants overwinter upstream the power plant and resume migration in the next year. At Tange Hydropower plant there is a significant bypass problem for eels (Pedersen *et al.*, 2011).

At Vestbirk Hydro power station 25% of the water discharge is passed around the turbines in two bypass facilities. One bypass stream is the old river bed and the other is at the turbine screens guiding the fish around the turbines. The bypass facility seems appropriate and fish including eels do not impinge on the screens except at very low temperatures <5°C in combination with very high water discharge. These situations usually occur during winter outside the normal eel migration period.

Similar problems likely appear at other hydropower facilities in e.g. Holstebro Hydropower plant. This has not yet been investigated.

8.1.2 Aquaculture

Danish trout farms are often located on the banks of rivers depending on water intake from the rivers. To guide the river water into the trout farm a weir is built in the river. Less than 250 trout farms use “flow through” river water and approximately

ten have systems for recirculation of water. To prevent fish from entering the trout farms a screen with a maximum 6 mm bar distance is obligatory at the point of the water inflow and a maximum 10 mm bar distance at the point of outflow. Small eel can easily enter trout farms, and are possibly predated by the trout. However for the past years there has been an ongoing process in collaboration with municipal environmental authorities to improve measures for the unhindered migration of several different fish species.

Research in relation to weirs of trout farms have been conducted in connection with three trout farms in River Kongeåen and River Mattrup Å.

Mattrup Å. At Brejnholt trout farm in River Mattrup Å the National Institute of Aquatic Resources studied the behaviour of silver eels while bypassing the weir at the trout farm. The river water is guided into the farm by a weir and screens prevent the eels to enter the farm. Fish passage is through an overflow spillway at the weir and the water discharge in the spillway may be significantly reduced depending on the hydrological conditions. The study was conducted during two years. The first year the water discharge was low and only 56% of the eels bypassed the weir. The second year the river discharge was normal and several more eels succeeded to pass the weir (82%) during the same year as they were released. It was concluded that the weir had a significant effect in delaying migrating silver eels. The delay varied with water discharge in the migration period. It is therefore recommended that a constant amount of water in the fish pass should be available e.g. 25% of the river discharge to neutralize the effect of the weir (and screens are placed appropriate to guide the fish) (Pedersen, 2012).

In **River Kongeå** two trout farms are situated on the bank of the river at Vejen and Jedsted. In autumn 2011 forty fish were radio tagged and their downstream migration was monitored while passing the two trout farms. Both trout farms have 6 mm bar distance at the water intake. At Vejen fish farm several fish entered the fish farm despite the 6 mm bar screen which seems not correctly installed or damaged. At Jedsted no fish entered the fish farm and the screen was working well. If the screen at Vejen fish farm is fixed properly, eels would not be able to enter the fish farm. However it is quite difficult to see by eye if there is any such problem at other comparable fish farms unless the place where the screen is mounted is dried out.

9 Scientific surveys of the stock

9.1 Glass eel monitoring

Weirs in streams are being removed as a part of National river restoration projects e.g. to meet the requirements of the Water Frame Directive. Monitoring young eel recruitment the traditionally way, using eel pass traps has become more difficult. New methods and locations are urgently needed in order to monitor the effect of the EU regulation in terms of recruitment of young eel from the ocean.

Since 2008 three small brooks situated on the North Sea coast of Jutland were selected for monitoring. At each brook two stations of 10–20 m length (close to the shoreline <1000 m) are electrofished at three different times from May to August and the population of eels at each station is calculated using the removal method. The brooks have a water depth <50 cm and width of 1–4 m.

The aim is to have this type of monitoring replacing eel pass traps but data quality issues are not clear. E.g. is the number of times that we electrofish during the year

sufficient and is the number of stations large enough to reproduce a clear signal from the data?

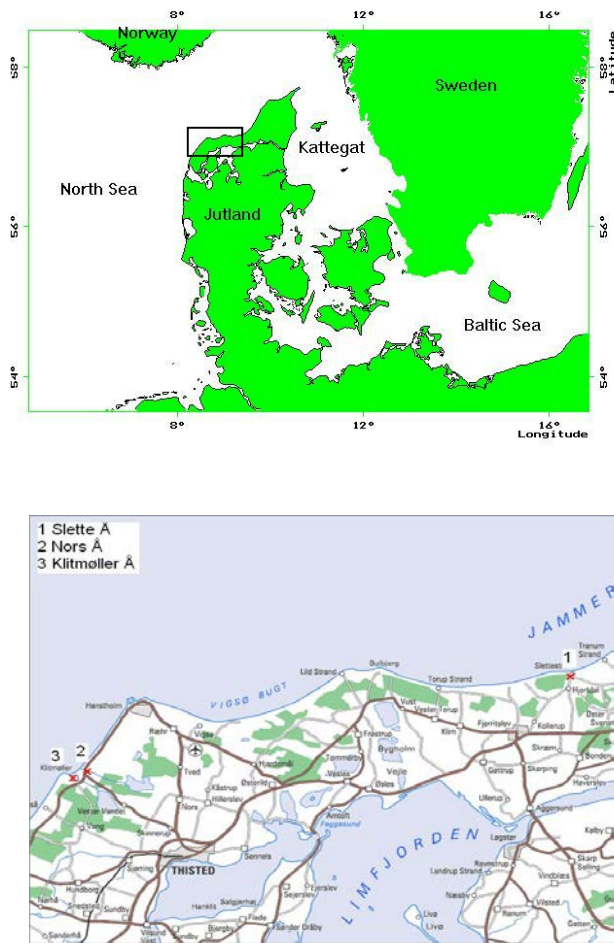


Figure 9.1. Map with new glass eel monitoring sites (1, 2 and 3) in the North Sea.

Table 9.1. Density of newly arrived glass eel pigmented glass eel (eel/m²) as a mean of three different times of electrofishing starting mid-May to mid-August. The maximum density during the season is given.

	SLETTE Å (1)		NORS Å (2)		KLITMØLLER Å (3)	
	Mean	Max.season	Mean	Max.season	Mean	Max.season
2008	1.2	1.2	11.8	11.8	2.8	2.8
2009	0.6	1.0	3.9	6.3	1.3	2.2
2010	1.0	1.4	0.3	0.8	0.2	0.2
2011	4.2	5.7	1.0	2.3	0.8	1.2
2012	1.1	1.8	0.8	2.1	0.2	0.2
2013	1.9	2.9	0.9	2.4	0.8	1.8
2014	19.0	29.6	36.8	75.5	13.0	21.4
2015	11.8	27.5	2.8	5.1	0.3	0.3



Picture. The author monitoring glass eel recruitment at Slette Å. Photo by Jan Skriver.

9.2 Silver eel escapement from freshwater

In River Gudenå trapped silver eels are tagged annually with PIT tags and released during autumn. Downstream movements are monitored by remote listening stations. These data are believed suitable for evaluating silver eel escapement from the river Guden Å, including anthropogenic mortality due to fishing and turbines. Monitoring silver eel escapement in other river basins is currently considered. River Ribe Å has been monitored in 2010 and again in 2014.

Production of silver eel in Lake Vester Vandet is monitored annually in an eeltrap.

9.3 Effect of stocking

Concerning stocking and the expected outcome in relation to the EU recovery plan of the eel, DTU Aqua has initiated a programme. The effect of stocking is made by tag recapture of cw-tagged eels in selected areas. Also short-time experiments in ponds have been initiated to evaluate fitness of stocked eel (2–5 gramme) compared to wild eels. Short-term experiments on the effect of glass eels as stocking material are ongoing.

10 Catch composition by age and length

Table 10.1. Summary of the DCF monitoring implementation per EMU.

DATA	RIVER	LAKES	ESTUARIES	LAGOONS	COASTAL & MARINE
No. of production / escapement surveys ¹	2	1			
No. of recruitment time-series surveys ²	6	0			
No. fished aged	0	0			
No. of fished sexed	351	0			194
No. of fish examined for parasites		0			194
No. of fish examined for contaminants	0				
No. of non-fishery mortality studies ³	1				
Socio-economic survey	0				

¹ Surveys to estimate B_{best} and/or $B_{current}$ [These should include WFD surveys where the data are being used to estimate production and/or escapement of eel].

² Fishery-independent surveys.

³ Studies to determine ΣH for non-fisheries anthropogenic impacts, such as hydropower, barriers, predation, etc.

11 Other biological sampling

11.1 Growth, silvering and mortality

Table 11.1. Von Bertalanffy parameters, from three different rivers.

LOCATION	L_{∞}	T_0	K	REFERENCE
Bjørnsholm å	60,10	-1,6	0,07	Bisgaard and Pedersen, 1990
Køge Lellinge å	59,83	-0,57	0.12	Rasmussen and Therkildsen, 1979
Giber å	90.3	-1.44	0.05	Bisgaard and Pedersen, 1991

11.2 Parasites and pathogens

The swimbladder parasite *Anguillicola crassus* is widely distributed throughout both brackish and freshwaters in Denmark. Monitoring of *Anguillicola* parasites takes place on a yearly basis at three locations; however for 2014 only one location were sampled. Monitoring has continued since 1987. The number of *Anguillicola* infected eel (prevalence) is relatively constant during 1987–2013 at all three locations.

Table 11.2. *Anguillicola* monitoring data for 2014.

LOCATION	SALINITY		COORDINATES	YEAR	TOTAL	INFECTED	PREVALENCE	INTENSITY
	PPT							
					N	N	%	n
Isefjord	18		55.50N;11.50E	2014	100	23	23	4.9
Ringk. Fjord	5–10		55.55N;08.20E	2014	NA	NA	NA	NA
Arresø	0		55.59N;11.57E	2014	NA	NA	NA	NA

11.3 Contaminants

No new data available.

11.4 Predators

Cormorants

Cormorants are possibly the only important predator of eel due to the large number of nesting birds; predation is expected to be largest in the vicinity of the colonies, but birds migrating through Denmark may have significant impact during autumn.

The number of cormorants nesting in Denmark during the last 10–15 years can be regarded as stable, but with downward trend. In the year 2000 42 481 nests were counted in colonies throughout Denmark. In 2014 the count was 30 558 nests.

In the Danish EMP it was suggested that in the period 2004–2006 approximately 80 tonne of yellow eel was eaten by cormorants. However recent work from Hirschholmene (57.29°N; 10.37°E) a cormorant colony in Kattegat analysing 350 regurgitated pellets showed that eel otoliths occurred with a frequency of 0.3% (Poul Hald, 2007). The frequency of occurrence of eel otoliths found in cormorant pellets in 2005 was 0.12% and Sonnesen (2007) suggesting that wild eels are not important as food in Ringkøbing Fjord (55.55°N;08.20°E). However despite this low occurrence, the estimated number of eels eaten in Ringkøbing Fjord by cormorants in 2004 was 38 000, more individuals than was caught in the fishery, and recovery of cw-tags from 20 000 tagged stocked eels showed a 40% predation from cormorants during the first season (Jepsen *et al.*, 2010). Thus cormorant predation can be a very significant factor in areas with a high cormorant density. The number of cormorants in Ringkøbing Fjord is not higher than most coastal areas in Denmark.

Recent analyses of data from ongoing studies of silver eel migration, using PIT tagging, showed that even relative large silver eels can be eaten by cormorants as PIT tags were recovered from nearby colonies and roosting sites. The recoveries may provide a basis for quantification of the predation in future studies.

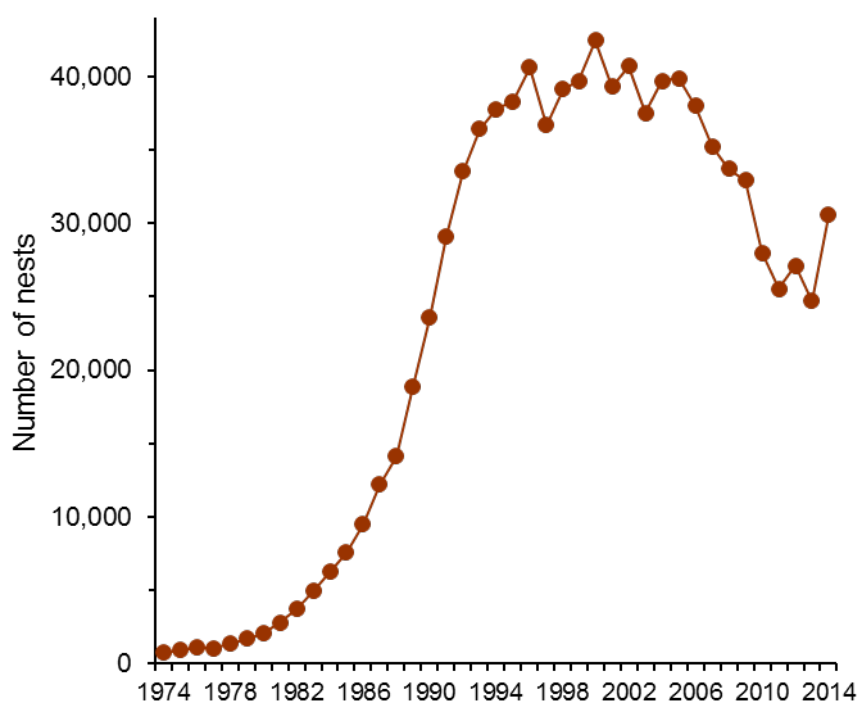


Figure 11.4. Number of cormorant nests in Denmark 1971–2014. Data from NERI. University of Århus.

12 Other sampling

No data.

13 Stock assessment

13.1 Method summary

The methods used to derive the stock indicators are as follows: B_0 for rivers is based on production models and mark–recapture studies. B_0 for lakes is estimated assuming that the production in lakes was twice the catch level of the lakes. B_{current} is estimated the same way but using recent surveys in rivers and lakes. B_{current} is derived by subtracting known anthropogenic and predation mortality from B_{best} .

See Anon, 2012 for further details.

13.2 Summary data

13.2.1 Stock indicators and targets

EMU: DK_Inla 2014

B_0 = 1110 tonne

B_{current} = 132 tonne

B_{best} = 168 tonne

EMU: DK_marin

50% effort or catch reduction

13.2.2 Habitat coverage

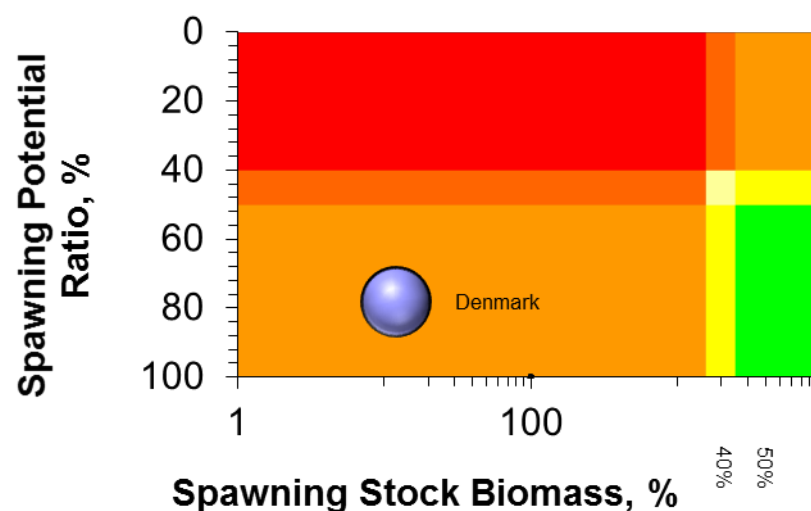
The present area of inland waters, where eel may be found, is approximately 15 000 ha. of running water and 45 000 ha. of lakes, in total 60 000 ha.

Table 13.2.2. Current escapement from inland waters. Mortality factors and Target level.

INLAND WATER	AREA (HA)	SILVER EEL PRODUCTION KG/HA (RANGE)	TOTAL PRODUCTION TONNE (RANGE)
Running water	15 000	6.7	100.5
Lakes	45 000	1.5	67.5
Total	60 000		168
Mortality (Fisheries, Hydropower, Predation)			36
Current escapement			132
Target level–40% prestine.			444

13.2.3 Impacts

Impacts from fisheries, hydropower and predation add up to an estimated 36 tonnes. See Table 13.2.2 and Chapter 8 Other anthropogenic impacts.

13.2.4 Precautionary diagram**13.2.5 Management measures**

All measures listed in Table 13.2.5 have been implemented in current management of the eel stock.

Table 13.2.5. Management measures planned to be implemented in 2009.

Legal size/ Season/ Selectivity/ Gear / Effort registration	Eel fisheries regulation in accordance with Danish Eel Management Plan EMU: DK_Inla	Eel regulation in accordance with the Danish Eel Management Plan EMU: DK_Marine
Legal size	45 cm minimum legal size for yellow eel	Minimum legal size for yellow eel will be stepwise increased from 35,3 cm in 2007 to 38 cm to 40 cm in year 2013)
Fishing season	<p>Only fykenets, poundnets, eel traps, longlines and fishing rods are allowed for eel fishing.</p> <p>Eel traps must be made unable to catch eel by 31st December 2013.</p> <p>For licensed commercial fishing activities the number and type of gear must be at 2007 level or lower.</p> <p>Minimum 100 m distance between fyke or poundnets.</p> <p>Type, size and position coordinates of all pile fixed fykenets, poundnets and eel traps must be registered with the Directorate of Fisheries prior to use.</p>	Only licensed commercial fishermen are allowed to use longlines, fykenets and poundnets designed to catch eel in the period from May 10th until July 31st.

Selectivity	<p>In lakes, only licensed commercial fishermen are allowed to use a limited number of fyke and poundnets designed to catch eel in the period between October 16th and July 31st.</p> <p>Eel traps allowed in operation only from sunset to sunrise, in the period August 1st until October 15th.</p> <p>All fishing activities with fixed nets in streams are restricted to the period August 1st until October 15th.</p> <p>All eel caught for recreational purposes in fixed gear, between October 16th and July 31st, must immediately be returned to the wild.</p> <p>Depending on stock developments all eel fishing activities may be phased out by 31st December 2013.</p>	<p>Minimum 32 mm mesh size (14 x 14 cm) window in rear fykebag.</p> <p>Longlines will be banned from May 1st until September 30th for recreational fishermen.</p> <p>All fykenets and poundnets used for non-licensed fishing activities, targeting species other than eel must be fitted with mesh windows or square openings throughout the fyke, hindering the catch of eel.</p>
Gear	<p>Minimum 32 mm mesh size (14 x 14 cm) window in rear fykebag.</p> <p>All fykenets and poundnets used in lakes, by non-licensed fishermen, outside the period allowed for eel fishing must be fitted with a mesh window, hindering the catch of eel.</p> <p>Gear must be presented for, registered with and approved by the Directorate of Fisheries.</p>	<p>The use of trawl, seinenets, eelpots, spear, torchlight and all other gear not explicitly described as legal, will be banned.</p> <p>Longlines will be banned from 1st May until 30th September for recreational fishermen.</p> <p>Only fykenets, poundnets, longlines¹ and fishing rods are allowed for eel fishing.</p> <p>Number of gear for all licensed commercial fishing activities must be equal to the level documented in 2007 or lower.</p> <p>Type, size and position coordinates of all pile fixed fykenets and poundnets must be registered with the Directorate of Fisheries prior to use.</p> <p>Recreational fishermen will be allowed to use only six fykenets or three nets during the fishing season. (The pile fixed fykenet will be banned)</p>

Effort registration	<p>All commercial catches and effort information must be reported frequently to the Directorate of Fisheries, according to specifications in licence.</p> <p>Historic catch data and effort must be reported to the Directorate of Fisheries in licence application.</p>	<p>All commercial catches and effort information must be frequently reported to the Directorate of Fisheries, according to specifications in licence conditions.</p> <p>Catch data and effort information (2004–2007) must be reported to the Directorate of Fisheries in license application.</p>
Stocking	Yes	No

14 Sampling intensity and precision

No data.

15 Standardisation and harmonisation of methodology

No data.

16 Overview, conclusions and recommendations

This report is an update of earlier reports on the eel stock and fishery in Denmark. Time-series data reported include commercial and recreational yellow and silver eel landings in marine and inland waters, production in the Danish eel culture and the number of eel stocked in fresh and salt water. Indices of Recruitment of glass eel and yellow eel in three river basins using eel pass traps and electrofishing.

Stock indicators are produced by scientific surveys and include estimates of silver eel escapement in the River Ribe Å and Lake Vester Vandet. These surveys are up scaled to represent the total Danish inland waters which consist of 887 river basins.

Eel fisheries are managed according to the EU regulation, aiming at 40% (relative to the pristine) silver eel escapement in freshwater and 50 % effort reduction in the marine waters.

All measures listed in the management plan have been implemented in current management of the eel stock.

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Report on the eel stock and fishery in Estonia 2015/2014

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Reporting Period: This report was completed in November 2015, and the data for 2015 are incomplete.

2 Introduction

2.1 General overview

Eel fisheries in Estonia occur in Lake Võrtsjärv (10–100 t) and in coastal waters (1–30 t). Annual catch from small lakes and rivers mostly in L. Peipsi basin is 2–5 t. Eel catches by recreational fishermen constitute about 0.1–0.5 t from brackish waters and about 1–1.5 t from inland waterbodies. At the turn of the century the overall annual landings from Estonian waters exceeded 65 tons. However it has diminished in the last fifteen years (from 67 tons in 2000 to 14.1 tons in 2015). Eel was very abundant in the first half of the 20th century and one of the most important commercial fish in the western coastal waters of Estonia. At that time annual eel landings exceeded hundreds of tons.

Natural eel stocks have never been very dense in Estonian large lakes. The annual landings of eel in 1939 were only 3.8 tons from L. Võrtsjärv and 9.2 tons from L. Peipsi. The construction of the Ivangorod hydropower station in the early 1950s blocked almost totally the natural upstream migration of young eel from the Baltic Sea to the basins of L. Peipsi and L. Võrtsjärv. As a result, eel almost disappeared from the fish fauna of Estonian large lakes. Today, thanks to the stocking of glass eels or farmed eels into L. Võrtsjärv, eel has become one of the most important commercial species in this lake. According to studies carried out in 2007 the downstream migration of silver eel through the hydropower station is possible.

Management of eel stock (stocking and fishery) is under governmental control. The Fishery Department of Ministry of Environment takes care of stocking and local services and Ministry of Agriculture gives out fishing licences. Gear and size restrictions apply in eel fisheries. Since 2011 Lake Võrtsjärv Fisheries Development Agency (FDA) is responsible for stocking.

There are three main eel fishing areas in Estonia:

- 1) L. Võrtsjärv is a large but very shallow and turbid lake with a surface area of about 270 km² and mean and maximum depths of 2.8 m and 6.0 m, respectively. Its drainage basin (Figure EE 2) (3104 km², incl. 103 km² in Latvia) is situated in the Central Estonia. Eel *Anguilla anguilla* (L.), pikeperch *Sander lucioperca* (L.), northern pike *Esox lucius* L. and bream *Abramis brama* (L.) are the main commercial fish in the lake. Professional fishing gears are fyke- and gillnets and longlines are used by recreational fishermen. Every fisherman has individual licences (number of fishing gear). The eel production of L. Võrtsjärv is entirely based on stocking with glass eels or farmed eels (2–20 g). During the period 1956–2015 over 50 million eels were stocked. According to the official statistics in 1988, the maximum annual

landings of eel exceeded 100 t. In the 1990s, the reported annual landings of eel were 22–49 t, in 2000s 10–37 tons. The reported landings are presumably much smaller than real catch. Professional fishermen get nearly half of their incomes from eel, despite the annual investments (>100 000 € annually). Since 2012 fishermen pay for $\frac{1}{3}$ of the stocking material and $\frac{2}{3}$ come from different foundations. The tax from fishing licences was invested through the state Foundation of Environmental Investments into stocking material. Due to the changes in the fishing law, the number of professional fishermen increased in the first decade of 2000s. During 1970–1998, the number of professional fishermen varied between 20–25, followed by an increase to 32 in 2003 and over 40 in 2004–2014. The total number of people involved in the fishery of L. Võrtsjärv is estimated to be two times higher.

- 2) In coastal waters - Gulf of Riga, Väinameri, Gulf of Finland and Baltic Proper, the landings of eel increased at the beginning of the century (from 3–10 t in 1991–95 to 20–28 t in 1999–2003), but from 2004 decreased again down to 4 t in 2010 and only to 0.8 tons in 2015 (as of 31.10.2015). Along the shore of the Baltics eels are caught with small fykenets set in line and fykenets; longlines are also used to a very marginal degree. Although there are hundreds of fishermen in that region, eel is not the first-rate fishing object due to declining catches in the last decade (Bernotas *et al.*, in press). That is mostly because eel is regarded as side catch in the large fykenets and thus not significant.
- 3) Small lakes in L. Peipsi basin, where eel has migrated from L. Võrtsjärv have been additionally stocked consistently during the last twelve years: in Vooremaa district, L. Saadjärv (707 ha), L. Kuremaa (497 ha) and L. Kaiavere (250 ha) and L. Vagula (519 ha) in Southern Estonia. Fykenets are mostly used for professional eel fishing in small lakes. Longlines and harpooning are used recreationally to some extent.

2.2 WDF and Eel Management Units

According to ordinance of government (RT I 2004, 48, 339) and WFD the territory of Estonia is divided into three basins and nine sub-basins. Basins and sub-basins are not directly connected to one river, as in European scale Estonian rivers are very small, except River Narva and its watershed area ($\frac{1}{3}$ of territory of Estonia and shared with Russia and Latvia). Other more important rivers are River Pärnu, River Kasari and River Gauja, last of which is shared with Latvia (not incl. to the EMP).

Estonian waterbodies were divided into two eel management units in connection with Eel Management Plan (EMP) on the basis of the formation of eel stock.

- 1) Narva River Basin District (East-Estonian basin); population of eel bases entirely on stocking;
- 2) West-Estonian Basin District (coastal waters and West-Estonian inland waterbodies); natural population of eel plus certain amount of eel emigrating from stocked waterbodies.

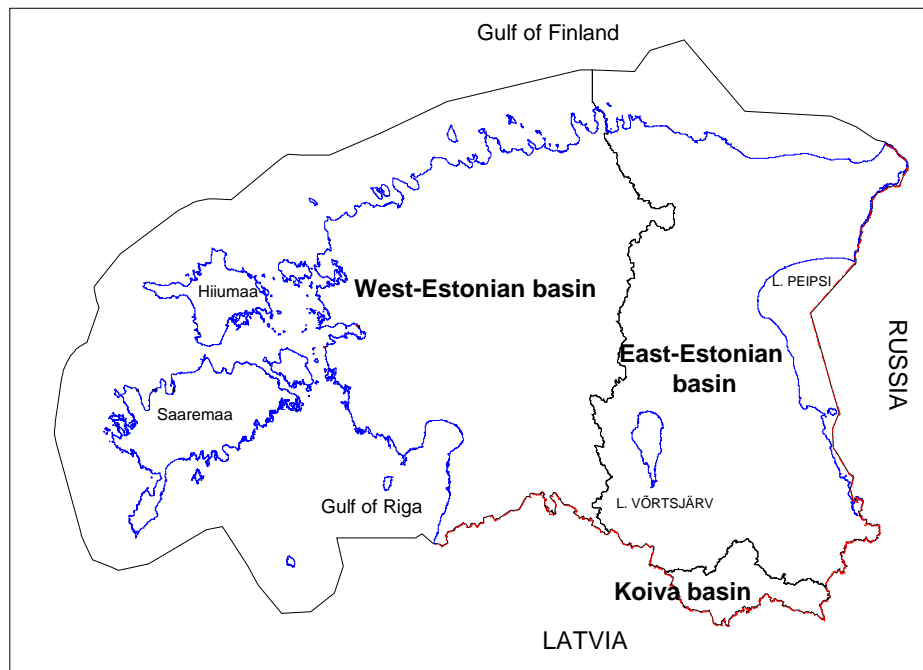


Figure 1. Map of basins.

3 Time-series data

3.1 Recruitment series and associated effort

3.1.1 Glass eel

3.1.1.1 *Commercial*

Glass eel does not occur in Estonian waters.

3.1.1.2 *Recreational*

Glass eel does not occur in Estonian waters.

3.1.1.3 *Fishery-independent*

Glass eel does not occur in Estonian waters.

3.1.2 Yellow Eel Recruitment

Natural recruitment of eel in Estonian waters takes place in the stage of young yellow eel. The length of eels migrating upstream to inland waterbodies of Estonia have been reported as TL=27–32 cm and age 4–7 years (Herm and Dementjeva, 1949).

No data.

3.1.2.1 *Commercial*

No time-series are available.

3.1.2.2 Recreational

No time-series are available.

3.1.2.3 Fishery-independent

No time-series are available.

3.1.2 Yellow eel landings

3.1.2.1 Commercial

No time-series are available as landings of yellow and silver eel are reported together.

3.1.2.2 Recreational

No time-series are available as landings of yellow and silver eel are reported together.

3.2 Silver eel landings

3.2.1 Commercial

No time-series are available as landings of yellow and silver eel are reported together.

3.2.2 Recreational

No time-series are available as landings of yellow and silver eel are reported together.

3.3 Aquaculture Production

At present there are two eel farms in Estonia. The first eel farm started in 2000, from where in 2001–2010 the stocking material (young yellow eel 2–40 g) for Estonian lakes was brought. This farm closed doors in 2015. Since 2011 a new eel farm started in Estonia (100 kg glass eels in 2011 and 300 kg in 2012) and in 2013 started a third eel farm (130 kg glass eels).

Table 1. Aquaculture production of eel in Estonia.

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
10	20	25	40	50	50	45	30	20	25	35	No data	80

In 2009 276 kg of glass eels was imported. During the first week in eel farm the total loss was 12 kg and during next three months 2 kg (recalculated in weight of glass eels). Total mortality was 14 kg or 5%. In 2004–2008 the mortality varied between was 2–3% from glass eel to 5 g young yellow eel. In 2010 180 kg of glass eels was imported, among them 60 kg for stocking into natural waterbodies after farming (5 g). In 2011 there were 100 kgs of glass eels imported for aquaculture and 206.5 kg for stocking directly into lakes. In 2011 Estonia bought in total 306.5 kg of glass eels from UK Glass Eels. In 2012 271 kg was bought for direct stocking and 387 kg for fish farms, in 2013 270 kg for stocking and 330 kg for fish farms accordingly.

3.4 Stocking

3.4.1 Amount stocked

Estonia had a state stocking programme for fish, including eel, for years 2002–2010.

In Soviet times, government using State money organized the stocking. At the beginning of 1990s 75–100% of the stocking was financed by fishermen although in the 2nd half of the 1990s and beginning of 2000s stocking of eel was financed fully by local fishermen (>100 000 € per annum). Finances for stocking were collected from licence tax of eel fishing gears (fykenets, longlines) on waterbodies where eel was stocked. Stocking quantities are listed in Tables 7 and 8. Estonia imported glass eel from France up to 1987, afterwards from England. Young yellow eel (5–20 g) was imported from Germany in 1988 and 1995 and from local fish farm in 2002–2010. Young eels were reared previously in a fish farm before stocking into lakes. During the period 2011–2014 the stocking of eel into L. Peipsi basin will supported by EFF up to €255 000 (co-financing up to $\frac{1}{3}$ of total annual financing). In 2011 680 000 glass eels were stocked (UK Glass Eels). Since 2012 fishermen pay $\frac{1}{3}$ of the stocking material and $\frac{2}{3}$ come from by Estonian Environmental Foundation. As the market price of glass eel in 2014 was extremely low, 3 million of glass eels and 193 000 on-grown cultured eels were stocked into Estonian lakes (Table 2).

In 1956 stocking of glass eels was started into L. Võrtsjärv. However, stocking has been irregular (Table 2). The stocking rate of glass eels in L. Võrtsjärv has been relatively low: annual average in 1956–2000 was about 37 ind.ha⁻¹yr⁻¹ with a maximum of 80 ind.ha⁻¹yr⁻¹ in 1976–1984. The peak of stocking with glass eels occurred in the early 1980s. As a result the landings of eel were the highest in the following 8–12 years, constituting 2.5 kg ha⁻¹ yr⁻¹. The maximum landings of eel in L. Võrtsjärv were recorded in 1988 (104 t or 3.7 kg ha⁻¹). From the end of 1980s the declared annual landings have decreased.

Table 2. Stocking of glass eel and young yellow eel in the Estonia (in millions).

	1950		1960		1970		1980		1990		2000		2010	2010
	young		young		young		young		young		young		young	young
	glass	yellow	glass	yellow	glass	yellow	glass	yellow	glass	yellow	glass	yellow	glass	yellow
Year	eel	eel	eel	eel	eel	eel	eel	eel	eel	eel	eel	eel	eel	eel
0			0,6		1		1,3				1,1			0,21
1							2,7		2			0,44	0,68	0,20
2			0,9		0,1		3		2,5			0,36	0,91	0,12
3							2,5					0,54	0,89	0,13
4			0,2		1,8		1,8		1,9			0,44	3,00	0,19
5			0,7				2,4			0,15		0,37	1,87	
6	0,2				2,6				1,4			0,38		
7					2,1		2,5		0,9			0,33		
8			1,4		2,7			0,18	0,5			0,19		
9									2,3			0,42		

Table 3. Number of young yellow eels (10³) stocked into the lakes of Narva River Basin and stocking density in 2002–2014 respectively.

AREA										
Lake	(ha)	2002	2003	2004	2005	2006	2007	2008	2009	2010
Võrtsjärv	27 000	285	408	483	330	330	290	175	370	178
Saadjärv	707	50	36	29,4	15	15	10	8,3	20,5	12,5
Kaiavere	250	20	25	22	10	10	10	4,5	12,1	7,5
Kuremaa	397	0	30	11,2	10	10	10	3	7,5	5,3
Vagula	519	6	20	19,6	10	10	8,1	2,6	8,4	5,7

STOCKING DENSITY							
Lake	2011	2012	2013	2014	Total	sp/ha	sp/ha/year
Võrtsjärv	154	87	111	164	3365	125	12
Saadjärv	11.6	6.5	7.8	11.8	234	331	33
Kaiavere	6.8	3.9	4.8	7.2	144	575	58
Kuremaa	5.5	3.2	3.6	5.3	105	263	26
Vagula	5.6	3.2	3.9	5.6	109	209	21

From 2011–2014 both glass eels and young yellow eels were stocked at the same year (Table 3, 4).

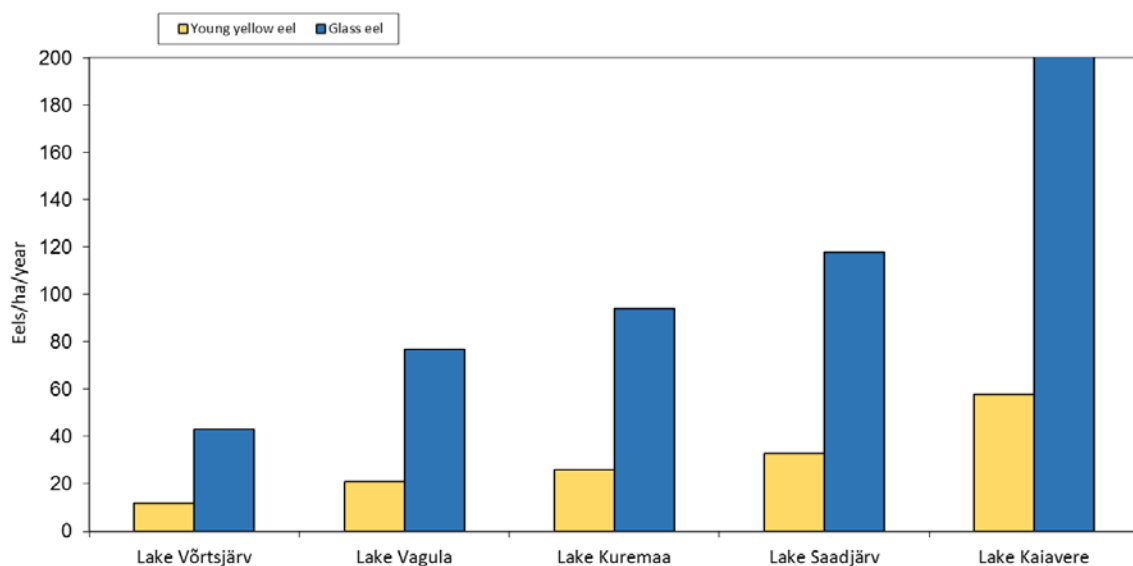


Figure 2. Mean stocking density of young yellow eel (2002–2014) and glass eel (2011–2014) in Estonian lakes.

Table 4. The amount of glass eels (10³) stocked into the lakes of Narva River Basin and stocking density in 2011–2014 respectively.

AREA		STOCKING DENSITY							
Lake	(ha)	2011	2012	2013	2014	2015	Total	sp/ha	sp/ha/year
Võrtsjärv	27 000	576	769	761	2536	1615	6257	232	58
Saadjärv	707	42	56	55	183	91	426	602	151
Kaiavere	250	25	34	34	112	60	265	1060	265
Kuremaa	397	19	25	25	82	54	204	513	128
Vagula	519	20	27	26	87	55	215	414	103

Table 5. Stocking of glass eels in 1956–2000, yield from 1964–2008 and recapture percentage in L. Võrtsjärv.

STOCKING RATE			YIELD		RECAPTURE	
Stocking	average 8–12 years later		Reported	Estimated		
period	sp/ha	sp/ha/year	kg/ha	kg/ha/year	%	%
1956–1960	29	5,7	0,8	0,2	4,9	6,1
1961–1970	156	15,6	11	2,2	12,9	16,1
1971–1980	392	39,2	19,1	1,9	7,0	11,1
1981–1990	585	58,5	14	1,4	4,5	7,4
1991–2000	489	48,9	8,5	0,9	4,2	6,0
Total	1611		53			
Mean		33		1,3	6	8,6

Percentage of re-capture was the highest in 1970s (16.7%) and lowest in 2000s (6.2%) in L. Võrtsjärv.

Table 6. Stocking of on-grown cultured eels in 2002–2006, yield from 2009–2013 and recapture percentage in L. Võrtsjärv.

STOCKING RATE			YIELD		RECAPTURE	
Stocking	average 7–11 years later		Reported	Estimated		
period	sp/ha	sp/ha/year	kg/ha	kg/ha/year	%	%
2002–2006	94	13.4	3,73	0,53	8,8	13,6

In 2013 94% and in 2014 96% of the eel catch composition in L. Võrtsjärv were eels stocked in on-grown cultured stage.

3.4.2 Catch of eel <12 cm and proportion retained for restocking

There is no catch of eel <12 cm in Estonia.

4 Fishing capacity

Potential eel fishing gear is dominated by fykenets in coastal waters and in the inland lakes. According to fishery law fykenets in coastal waters are divided into four groups: large fykes in deeper open waters, with the height of fykenet mouth over 3 m; fykenets with 1–3 m mouth opening; fykenets with the mouth opening height of up to 1 m and small fykes in line. Only small fykes in line are specially focused on eel.

Table 7. Number of gear licences (professional) allocated for coastal waters in West-Estonian Basin in 2008 (the year before the implementation of the EMP).

AREA (COUNTY)	IDA-	LÄÄNE-	HARJU-	HIIU-	LÄÄNE-	PÄRNU-	SAARE-	TYPE	CATCH
Type of gear	Virumaa	Virumaa	maa	maa	maa	maa	maa	Total	%
Large fykenets	30	30	80	250	30	487	130	1037	11
Fykenets (1–3 m)*	20	75	61	65	85	131	265	702	7
Fykenets up to 1 m*	12	29	101	1000	70	315	197	1724	18
Small fykenets in line	5	5	80	1026	1890	550	1300	4856	50
Longlines (100 hooks)	2	25	76	200	130	835	208	1476	15
Total	69	164	398	2541	2205	2318	2100	9795	

* Height of the mouth of fykenet.

**Total catch of fykes up to 1 m and 1–3 m mouth height.

Table 8. Decrease in number of small fykenet licences allocated for coastal waters in West-Estonian Basin in 2008–2013.

YEAR	2008	2009	2010	2011	2012	2013
Small fykenets in line	4830	4106	4390	2964	2520	2414
Percentage from average 2004–2006	100	85	72,3	61,4	52,2	50

Table 9. The total commercial landings of eel using different gear from coastal waters in 2014.

GEAR	TOTAL CATCH (KG)
Large fykenets	450
Fykenets (1–3 m)	404
Fykenets up to 1 m	58
Small fykenets in line	88
Gillnets	54
Longlines	2

Table 10. Number of fykenet and longline licences (professional) allocated for waterbodies in Narva River Basin in 2008 and 2012.

TYPE OF GEAR		L. PEIPSI	L. VÖRTSJÄRV	NARVA R.	SMALL LAKES	TOTAL
				and res.	and rivers	
Fykenet	2008	901	324	40	144	1409
	2012	906	324	40	168	1436
Longline (100 hooks)	2008	10			26	36
	2012	10			26	36

Fykenets are the most used eel fishing gear in L. Võrtsjärv and the small lakes of Narva RBD. However in L. Peipsi and Narva reservoir, fykenets are not used specially for the catch of eel (Table 10).

The number of fykenet licences in L. Võrtsjärv in 1970s and 1980s was 200–250, in 1990s 300 and from 1998 up to 2004 350. In 2005 the total number of fykenet licences was reduced to 324 (1.2 fykenets per km²) (Table 10).

Only longlines, harpoons and angling are used in recreational eel fisheries in Estonia.

Longlines are used only for recreational fishing in L. Võrtsjärv. In 2003–2007 fishing effort was 500 fishing nights of 100 hooks per year and mean annual landings were 400 kg. However the annual landings decreased to 190 kg in 2013. Licensed fishermen have 36 fykenets (2.6 fykenets per km²) and 3 eel boxes on the outflow of the small Narva RBD eel lakes. 20 licensed longlines (professional fishery) are not continuously in use. In 2007, 40 licences of longlines (100 hooks per line) were used in the small Narva RBD lakes, L. Saadjärv and L. Kuremaa respectively. Both are clear water lakes and therefore rather popular among underwater hunters. In 2007, 150 of harpooning licences were issued and the reported eel landings for harpoon fishing were 110 kg. In 2013, 213 kg of eel was caught by harpoon.

The proportion of recreational catches from total eel landings in inland waters in 2005–2007 was 3.9%. In 2013 the longline eel catches (488 kg) made up 3.1% of total (15.4 t) inland catch numbers. In 2014 even less.

Eel has a legal (minimum) size: TL=55 cm in L. Võrtsjärv and L. Peipsi, TL=50 cm in other Estonian inland waterbodies and TL=35 cm in coastal waters.

4.1 Glass eel

There is no glass eel fishery in Estonia.

4.2 Yellow eel

4.3 Silver eel

4.4 Marine fishery

5 Fishing effort

5.1 Glass eel

There is no glass eel fishery in Estonia.

5.2 Yellow eel

5.3 Silver eel

5.4 Marine fishery

6 Catches and landings

6.1 Glass eel

There is no glass eel fishery in Estonia.

6.2 Yellow eel

No distinction in catch statistics has been made between yellow and silver eels. The proportion of silver eel in commercial fykenet catches was estimated in some of the lakes where eel has been stocked in 2008.

Table 11. Mean length (TL cm), weight (TW g) and proportion (%) of silver eel in fykenet catches in "eel lakes" of Narva RBD in Autumn 2008.

Lake	TL cm	TW g	PROPORTION (%)	NUMBER OF
			of silver eel	measured eels
L. Võrtsjärv	58	412	41	199
L. Kuremaa	64	480	50	27
L. Saadjärv	70	608	94	69
L. Kaiavere	72	672	97	40

6.3 Silver eel

50–90% of the eel landed in Estonia have a stocked origin (Table 12).

Table 12. Eel landings (tons) in different water bodies of Estonia in 1993–2015* and proportion (%) of stocked eels in Narva RBD. * - 2015 data are presented as of 31/10/2015.

YEAR	BALTIC SEA	L. VÖRTSJÄRV	L. PEIPSI	OTHER WATERBODIES	TOTAL	PROPORTION (%) OF STOCKED EELS
1993	10	49	0.2		59.2	83
1994	10	36.9			46.9	79
1995	6	38.8		0.6	45.4	87
1996	19.7	34.1	0.1	1.2	55.1	64
1997	18.3	40.3	0.5		59.1	69
1998	22.2	21.8	0.2		44.2	50
1999	28.3	36.3	0.2		64.8	56
2000	26.7	38.9	0.2	1.2	67	60
2001	27.1	37.6	0.3	2	67	58
2002	27.3	20.4	0.2	2	49.9	46
2003	18.8	26.4	0.2	3.2	48.6	61
2004	15.6	20.1	0.3	3.2	39.2	60
2005	9.4	18.2	0.1	3	30.7	69
2006	9.2	20.3	0.1	3.8	33.4	73
2007	6.3	21.7	0.1	3	31.1	80
2008	5.3	20.5	0.1	4.7	30.6	83
2009	4.4	13.6	0.1	4	22.1	80
2010	3.6	10.3	0.1	4.9	18.9	81
2011	2.2	11.3	0.1	2.6	16.2	86
2012	1.9	12.6		3.2	17.7	89
2013	1.7	12.7		3	17.4	90
2014	1.1	13.3		2.3	16.7	93
2015	0.8	12.06	0	1.29	14.15	94

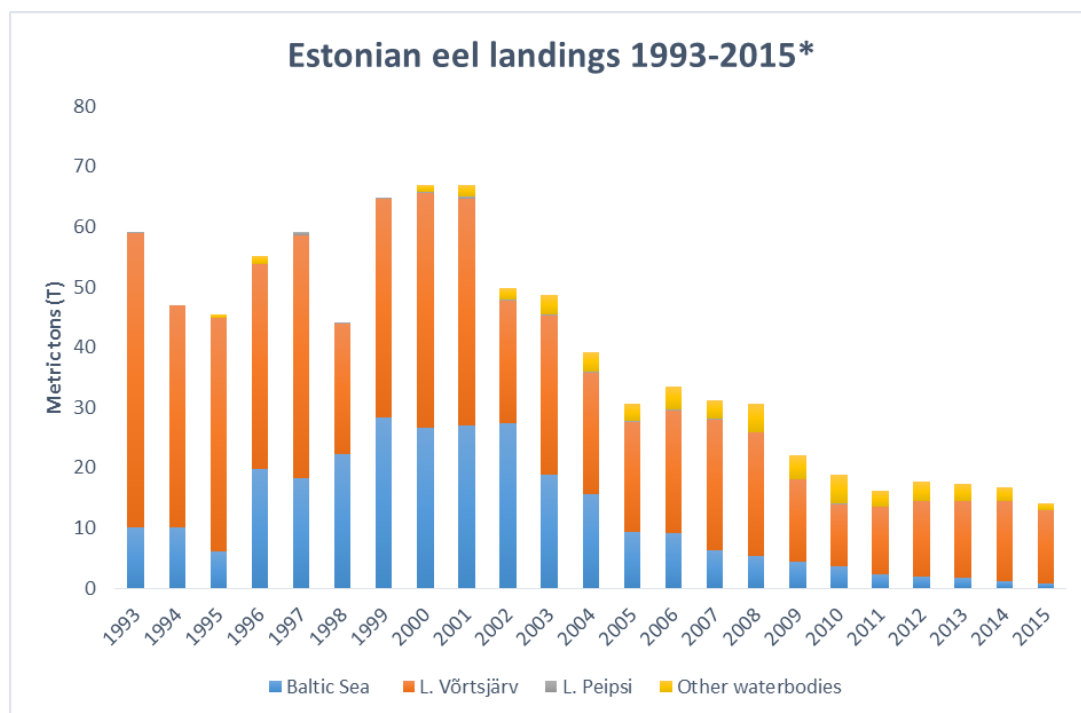


Figure 3. Official landings of eel in Estonian waters in 1993–2015. * - 2015 data are presented as of 31/10/2015.

Table 13. Annual landings (in tons) from Lake Võrtsjärv. * 2015 data are presented as of 31/10/15.

YEAR	1933–39	1960	1970	1980	1990	2000	2010
0	1,8	0	6,5	17,8	56,1	38,8	10,3
1	Mean	0	6,5	16,5	48,5	37,6	11,3
2		0	16,4	10,8	31	20,4	12,6
3		0	21,3	24,5	49	26,3	12,7
4		3	18,7	66,7	36,9	20,1	13,3
5		0,3	36,9	71,9	38,8	17,6	12.06*
6		1,9	49,6	55,6	34,1	19,9	
7		2,7	50	61,2	40,3	20,5	
8		2,9	44,5	103,8	21,8	19,9	
9		5	45	47,6	35,2	12,9	

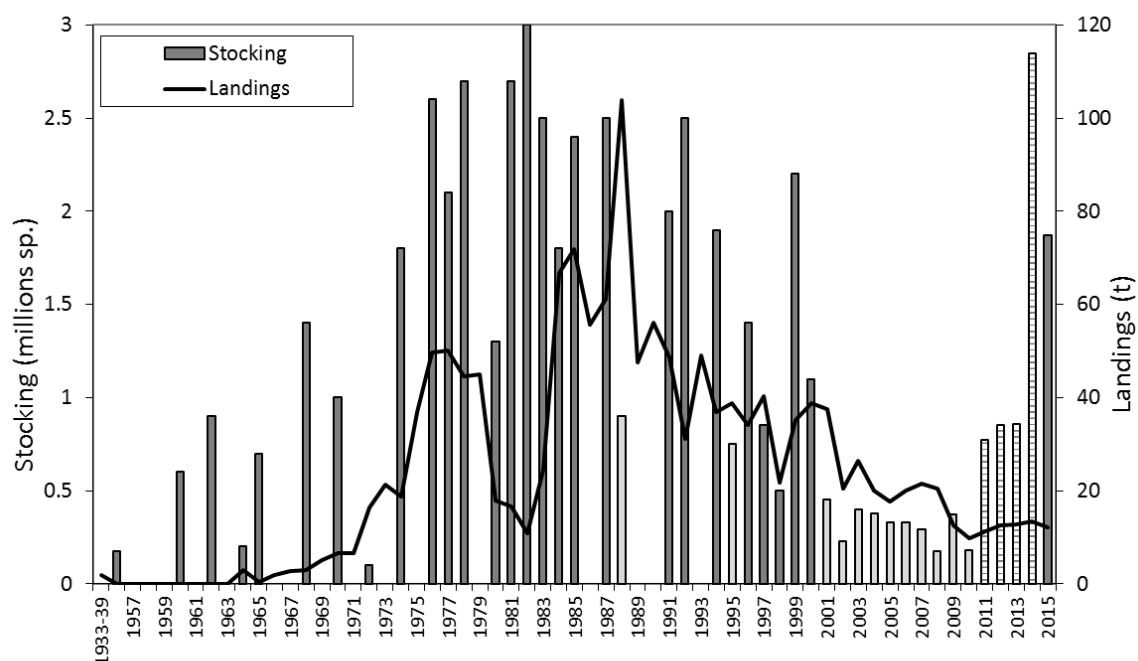


Figure 4. Stacking and landings of eel in L. Vörtsjärv (grey - glass eel; light grey - young yellow eel; striped - both at the same year).

6.4 Marine fishery

At the beginning of 2000s, eel catches by recreational fishermen, using longlines, constituted totally 0.1–0.5 t from brackish waters and about 0.7–1 t from inland waterbodies. The statistics of non-commercial catches are incomplete. Also the reporting of recreational data (especially from coastal areas) is marginal.

Table 14. Recreational catches (kg) of eel in ICES subdivisions in Estonian coastal waters in 2005–2012.

YEAR	28-5	32	28-2	29-2	TOTAL
2005	230	58	134	57	479
2006	120	24	52	33	229
2007	84	31	69	18	202
2008	73	14	91	21	199
2009	21	4	81	0	106
2010	60	20	51	6	137
2011	25	5	21	13	64
2012	5	3	7	0	15
Total	618	159	506	148	1431
%	43	11	35	10	

7 Catch per unit of effort

7.1 Glass eel

There is no glass eel fishery in Estonia.

7.2 Yellow eel

Data on cpue have only been available for combined commercial and recreational landings of yellow and silver eels.

7.3 Silver eel

Data on cpue have only been available for combined commercial and recreational landings of yellow and silver eels. In logbook every professional fisherman makes daily records, according to specific fishing gear (fykenets, longlines). According to the longline data the natural density of eel population in Estonian lakes outside L. Peipsi watershed area was 2–3 times lower. In 2000–2004 the mean annual catch of eel per fykenet in L. Võrtsjärv was 80 kg, in 2005–2008 60 kg and in 2009–2010 only 34 kg.

Table 15. Cpue (catch in grammes per 100 hooks per night during June–August) of longlines in inland waterbodies of different river basins (data from 2001–2008).

NUMBER OF					
River basin	cpue g	Longlines	Catch kg	Sub-basin	Origin
Amme R.	1758	541,5	952	Peipsi	Stocked
Emajõgi R.	1071	135	145	Peipsi	Stocked
Võhandu R.	368	223	82	Peipsi	Stocked
Väike Emajõgi R.	1218	352	429	Võrtsjärve	Stocked
L. Võrtsjärv	1096	1330	1457	Võrtsjärve	Stocked
Õhne R.	836	44	36,8	Võrtsjärve	Stocked
L. Ermistu	800	4	3,2	Pärnu	Natural/stocked
Pärnu R.	421	67,5	29	Pärnu	Natural
Koiva (Gauja) R.	544	9	5	Mustajõe	Natural
Daugava R.	390	122	48	Mustajõe	Stocked
Salaca R.	0	6	0	Mustajõe	Natural

7.4 Marine fishery

Data on cpue have only been available for combined commercial and recreational landings of yellow and silver eels.

Table 16. Cpue (catch in grammes per 100 hooks per night during June–August) of longlines in coastal waters of Estonia (data from 2001–2008).

AREA	CPUE G	NUMBER OF	
		longlines	CATCH KG
Väinameri	635	262	167
Baltic proper	612	489	299
Gulf of Riga	629	397	250

Mean/Total	623	1148	715
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8 Scientific surveys of the stock

The fish stock assessment programme of Fishery Department of Ministry of Environment that finances Environmental Investments Centre, has included special projects of eel stock investigations (length and weight composition, age structure, recapture calculations, tagging, application of limits) in L. Võrtsjärv and in other Narva RBD waterbodies.

9 Catch composition by age and length

There is a sampling programme including measuring of length, weight and age composition of eel in L. Võrtsjärv and small lakes of Narva RBD. Due to the legal catch size of eel (TL=55 cm) and minimum legal mesh size in the codend of fykenet (18 mm knot to knot) 30–60 % of eels in commercial catch in L. Võrtsjärv could be identified as silver eel. In the small lakes of Narva RBD this proportion could reach up to 80%.

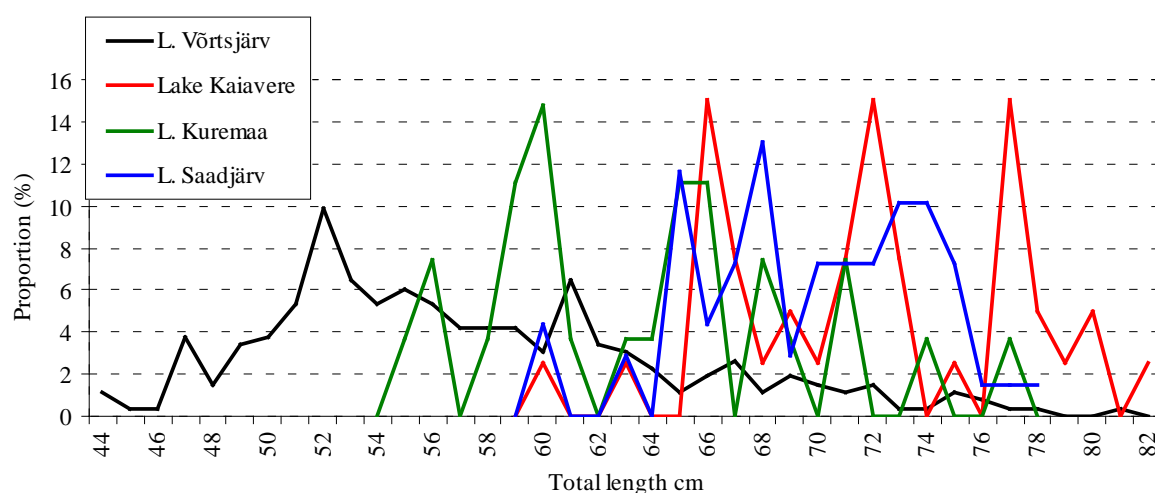


Figure 5. Length distribution of eel in fykenet catches in L. Võrtsjärv and in the small lakes of Narva RBD in autumn of 2008.

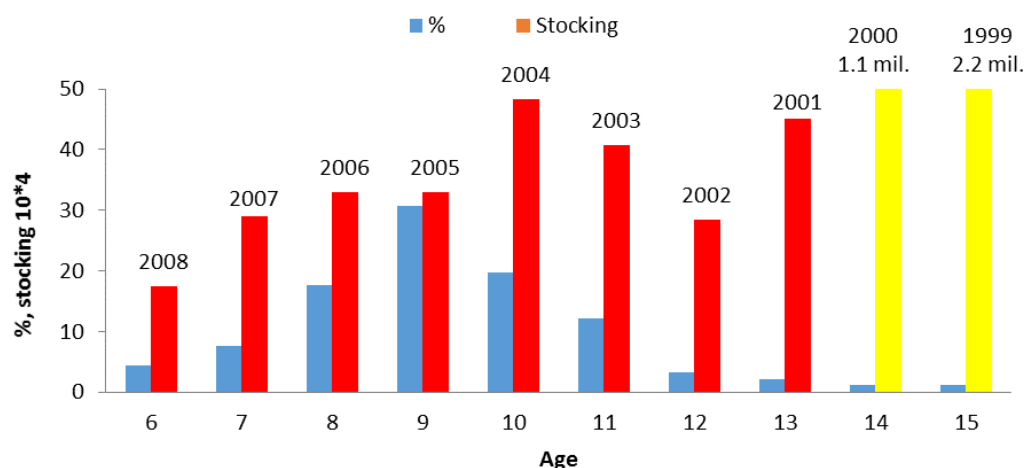


Figure 6. Proportion (%) of age groups in fykenet catches in 2014 and stocking amount in 1999–2008 (red columns - young yellow eel, yellow columns - glass eel) in L. Võrtsjärv.

10 Other biological sampling

Until the end of 1990s Estonian investigations, based on commercial catches, were focused on stocking and fishing return of eel in L. Võrtsjärv. Since 2001 the catches of yellow and silver eel are examined in many lakes and rivers all over Estonia. Main source of the information for the eel are the official catches and scientific longline, fykenet catches and electrofishing in rivers (multispecies survey in more than 300 stations every year, relative abundance).

10.1 Length & weight & growth (DCR)

There is a sampling programme that includes measuring of length, weight and age distribution of eel in L. Võrtsjärv and in small lakes of Narva RBD. The sampling programme from coastal waters has been conducted by Estonian Marine Institute of University of Tartu since 1998.

10.2 Parasites & pathogens

There are no routine programmes monitoring parasites and pathogens of eel in Estonia, except special investigations in the end of 1990s, 2002, 2008–2009 and 2014. Two articles were published during this period (see literature).

10.3 Contaminants

There is no sampling related to contaminants and effects on eel in Estonia.

10.4 Predators

In the period 1999–2003 food composition of cormorants was estimated in the coastal waters including the proportion of eel (Eschbaum *et al.*, 2003).

In the period 2002–2014 feeding of pike (*Esox lucius*) was studied in L. Võrtsjärv. This study concentrates on the diet of pike in winter and the proportion of eel in it. These data are yet to be published.

11 Other sampling

Estonia had the State programme for reproduction and re-stocking of fish (2002–2010) including European eel. In connection with this programme we have finished and ongoing scientific studies and monitoring projects concerning eel in Estonia financed by Ministry of Environment, ERDF and EFF:

- 1) Stocking results in small lakes;
- 2) Food resources of eel in waterbodies suitable for stocking;
- 3) The distribution of eel and long-term re-stocking results in L. Peipsi and L. Võrtsjärv basin.
- 4) Downstream migration of silver eel;
- 5) Mark–recapture estimation of yellow and silver eel;
- 6) The Estonian Marine Institute annual data collection from coastal waters using small fykenets in line;
- 7) Age and growth patterns of eel in L. Võrtsjärv and small lakes of Narva RBD;
- 8) Abundance of eel in L. Võrtsjärv using a 1 ha fykenet system (starting in 2016).

The studies have proven a positive effect of stocking it is therefore recommended to continue the existing stocking programme. There is an urgent need for monitoring the stocking results in more detail.

To measure the effectiveness of the stocking, growth rates and the migration of the eel, a mass-marking project was carried out in 2014 and continues in 2015. In spring 2014, 135 000 glass eels were marked with 0,15 g/L alizarin red (Sigma-aldrich A5533) at ~15°C water temperature. 34 of them were analysed for the successfulness of the marking. In summer 2014, 193 636 elvers (Tw 3.5 g–50 g) were marked with SrCl₂. 30 567 of them meant for stocking into smaller lakes were also marked with 0,15 g/L alizarin red. 36 specimens have been analysed for the Sr-marking effectiveness and 16 out of these also for alizarin marking effectiveness. Preliminary results from otoliths indicate efficiency of both methods (Silm *et al.*, in press). Silver eel investigations also continued in form of otolith and migration analysis from both freshwater and coastal areas.

12 Stock assessment

12.1 Local stock assessment

12.1.1 Habitat

12.1.2 Silver eel production

12.1.2.1 Historic production

Historically eel was one of the most important fish species in the coastal waters of Estonia. Before the Second World War (1938) the total annual catch of eel in Estonia exceeded 500 tons (Kint, 1940). Shallow coastal waters close to western islands (ICES Subdivision 28-2; 28-5) and Väinameri (29-4) were most productive areas at that time. Total catch decreased to one hundred tons in 1950s and continued to decline down to 20 t in the end of 1970s. In the coastal waters, the catches of eel increased for a period (from 3–10 t in 1991–1995 to 20–28 t in 1999–2003), but have decreased since 2004

down to 1.1 t in 2014 (Bernotas *et al.*, in press). According to A. Kangur (1998) the annual fishing return of eel in L. Võrtsjärv has considerably changed. The especially high values (8.4–8.7%) were noticed in the end of 1970s and in 1980s (5–6.6%). Since the beginning of 1990s until beginning of the 2000s fishing return of eel decreased (4%). During long-term glass eel stocking period (1965–2001) the effectiveness of stocking (the number of glass eels required to produce 1 kg of eel catch) was 32 (Kangur, 2002). As in this period the legal size of eel was 60 cm and mean weight in fykenet catches was 0,5 kg, there was recaptured one silver eel per 16 stocked glass eels or mean recapture percentage was 6,3%.

12.1.2.2 Current production

The size of the fishable eel stock in L. Võrtsjärv was determined by mark–recapture experiments. Lincoln-Petersen method (Seber, 1982) was used for the population size estimation:

$$N = \frac{n_1 n_2}{m_2}$$

where n_1 is the number of marked and released specimens, later a number of specimens is caught (n_2) of which m_2 is marked (Pollock *et al.*, 1990). N is the estimator of population size. An assumption that the amount of marked eels in the lake decreases by 20% a year was used. This was due to observations that the latest recapture was four years after tagging. After that period no marked eels were caught. This could be explained with the intensification of migration of fish aged 10 years and older (Järvalt *et al.*, 2015). The total number of caught specimens for a fishing season was calculated from the reported total catch and the average weight of eels in fykenet catch samples. In spring 2007, 95 Carlin-tagged eels with TL>55 cm were tagged for the first time in L. Võrtsjärv. On the course of the same year 12 eels (12,6%) were recaptured while annual catch of eel was 21.5 tons. In 2007 mean weight of eel in the professional fykenet catches was 430 g which makes around 50 000 specimens. According to the recapture percentage of 2007 there were approximately 395 800 eels with TL>55 cm in the lake that year (Table 17). On the basis of mark–recapture results approximately 85% of silver eels have possibility to emigrate from L. Võrtsjärv via Emajõgi R. to L. Peipsi and therefore via Narva R. to Gulf of Finland. As fishing gear is not allowed to be put closer than 200 m from both side of outflow in L. Võrtsjärv, entrance into river for migrating fish is free. There are 70 professional fishing licences (2015) for different types of fykenets in Emajõgi R. (100 km), but $\frac{2}{3}$ of riverbed including the main flow is not affected by them. According to official catch statistics the total catch of eel in Emajõgi R. was 30–150 kg yr⁻¹ in 1996–2014, in L. Peipsi 15–500 kg yr⁻¹.

Table 17. The number of tagged and recaptured eels, annual catch in kilos and numbers, total number of eel over mean length at first capture (TL>55 cm) in fykenet catches in Estonian eel lakes.

	MARKED	RECAPTURE	RECAPTURE	TOTAL CATCH	MEAN	TOTAL CATCH	ABUNDANCE IN LAKE
	in lake	sp.	%	kg	weight sp. g	sp.	(>55 cm)
Lake Võrtsjärv							
2007	95	12	12,63	21 500	430	50 000	395 833
2008	99	12	12,12	19 900	425	46 824	386 294
2009	155	10	6,45	12 580	500	25 160	389 980
2010	138	19	13,77	9 700	421	23 040	167 346
2011	157	20	12,74	11 300	448	25 223	198 002
2012	111	7	6,31	12 100	500	24 200	383 743
2013	99	7	7,07	12 700	562	22 598	319 598
2014	108	12	11,11	13 360	635	21 039	189 354
Mean			10,3			29 761	303 769
Lake Kuremaa							
2009	93	12	12,90	1 449	367	3 948	30 599
2010	95	14	14,74	1 993	445	4 479	30 391
2011	172	12	6,98	1 007	360	2 797	40 094
2012	229	10	4,37	824	404	2 040	46 707
2013	247	25	10,12	983	393	2 501	24 713
Mean			9,8			3 153	34 501
Lake Saadjärv							
2009	74	5	6,76	1 153	514	2 243	16 830
2010	86	5	5,81	1 319	601	2 195	24 522
2011	166	7	4,22	1 073	560	1 916	48 164
2012	226	8	2,68	1 367	524	2 609	97 350
2013	199	10	3,01	1 414	407	3 474	115 415
Mean			4,50			2 487	60 456
Lake Kaiavere							
2010	32	3	9,4	658	655	1004	10 709
2013	44	2	4,6	509	663	768	17 067
Lake Vagula							
2012	38	2	5,3	154	639	241	4 547

12.1.2.3 Current escapement

The construction of the hydropower station on the Narva River in the early 1950s blocked the natural path of eel to the waterbodies of L. Peipsi basin. As a result, eel almost disappeared from the fish fauna of Estonian large lakes.

To investigate the downstream migration of silver eels from L. Võrtsjärv and L. Peipsi and their possibility to pass through the turbines of the Narva hydropower station 146 eels were tagged. All specimens were tagged with Carlin-type of tags, among them seven specimens with radio telemetric tags. Release of label-tagged eels into Narva reservoir took place in November 2006 and in June 2007. Despite low intensity of fishing using suitable fishing gear for catching eel (fykenets, longlines) in Narva River, four label-tagged eels were occasionally recaptured downstream of the station

in 2007–2009. Two of the tagged eels were recaptured in Gulf of Finland. During 2007–2009 three large eels and one small eel (82 g) tagged with Carlin tags have been caught in Danish Straits. In November of 2007 survival and behaviour of seven eels equipped with radio transmitter tags were observed after passing through the turbines using manual registration of migration. A minimum of four radio-tagged eels came through the turbines alive and without any damage. Three of them were caught back in Narva R. after two months in winter and one in the next summer close to Saaremaa Island in the Baltic Sea.

It can be assumed on the basis of mark–recapture data that the migration route runs along the North Estonian coast up to the western top of Saaremaa Island. Next recaptures were recorded in Danish Straits already. According to Herm and Dementjeva (1949) eel is swimming from Saaremaa Island in the direction of Gotland Island and then to Danish Straits.

A tagging programme has been carried out in Narva RBD waterbodies since 2007. 93% of recaptures have taken place in the waterbodies where eels were stocked into, as most of the tagged eels (mean total length 57 cm) were not in silvering stage. Only thirteen tagged eels were caught outside the stocking lake (Table 18, Figure 7).

Table 18. Release of tagged eels in Estonian inland waterbodies, recapture and repeated recapture in the same lake or outside the water body of release in 2007–2013.

WATERBODY OF RELEASE	NUMBER OF TAGGED EELS	FIRST RECAPTURE	SECOND RECAPTURE	THIRD RECAPTURE	TOTAL RECAPTURE	PERCENTAGE OF RECAPTURE	RECAPTURE OUTSIDE WATERBODY OF RELEASE
Narva Reservoir	139	8	0	0	8	5,8	7
Ivangorod HPS	7	4	0	0	4	57,1	1
Lake Võrtsjärv	702	88	7	0	95	13,5	5
Lake Saadjärv	339	39	3	0	42	12,3	1
Lake Kuremaa	413	77	8	1	86	20,8	1
Lake Kaiavere	53	6	0	0	6	11,3	0
Lake Vagula	38	3	0	0	3	7,9	0
River Emajõgi	25	1	0	0	1	4,0	1
River Amme	7	1	0	0	1	14,2	1
Total	1723	227	18	1	164	13,6	13



Figure 7. Waterbodies of release (blue - L. Võrtsjärv; red – L. Kuremaa; yellow – Narva reservoir) and recapture of eel outside Narva RBD.

12.1.2.4 Production values e.g. kg/ha

No information available.

12.1.2.5 Impacts

No information available.

12.1.2.6 Stocking requirement eels <20 cm

In 1988, 1995, 2001–2010 only farmed eels were stocked with mean weight 1–10 g/sp. In 2011–2014 both glass and farmed eels (Table 2). According to the Estonian EMP, there is requirement to stock at least 0.6 million farmed or 2.5 million glass eels into Estonian lakes. This plan was first time completed in 2014. In 2015 only glass eels were stocked into the waterbodies of Narva RBD.

12.1.2.7 Data quality issues

No information available.

13 Sampling intensity and precision

No information available.

14 Standardisation and harmonisation of methodology

On the bases cpue of longlines catches in lakes and coastal waters were estimated relative abundance in different areas (Tables 15 and 16). Experimental fykenet monitoring data are used to compare the results with commercial data in L. Võrtsjärv.

14.1 Survey techniques

No surveys or samples are done.

14.2 Sampling commercial catches

Section 9.

14.3 Sampling

No surveys or samples are done.

14.4 Age analysis

Section 9.

14.5 Life stages

No surveys or samples are done.

14.6 Sex determinations

No surveys or samples are done.

15 Overview, conclusions and recommendations

The natural status of eel stock in Narva River Basin before the construction of hydro-power station was not very abundant (annual catch 1,8 tons L. Võrtsjärv and 3–6 tons L. Peipsi), therefore the contribution into recruitment was ten times lower than at present. Due to permanent stocking and rather fetterless downstream migration, the 40% escapement objective of silver eel in Narva River Basin is achieved. In Narva RBD on the basis of financing of local fishermen, state funding and EFF the present escapement capacity exceed the pristine escapement several times and there is no need of reduction in fishing effort at the moment. According to tagging and recapture results hydropower station dam and turbines are not obstacles for downstream migration of eel. Total amount of emigrating silver eels from Estonian side of Narva RBD is approximately 150 000–200 000 specimens per year. The evidence of successful downstream migration of silver eel was very important result for sustainable and reproductive management of European eel in Narva River Basin during the last 50 years. Without stocking into Narva RBD waterbodies a huge area with a high spawner production potential would be cut off.

According to tagging and recapture results more than 2% of silver eel escaped from Narva River Basin were caught in Danish Straits.

As in most of fykenets used in coastal waters eel is regarded as bycatch as it consists under 1% of total, there is no need to diminish the number of licences of this gear, except small fykenets that are focused on catch of eel. In 2013 the number of licences of small fykes in line has been diminished approximately 50% compared to 2008. At the same time all active licences were not in use because of the low catches. The number of professional and recreational fishermen specialized to eel fishing has also decreased (Bernotas *et al.*, in press).

The annual catch of eel in West Estonian RBD had to make up less than 50% of that it made in period 2004–2006 (Cm = 12 t) as required in the EMP implemented in 2008.

The requirement of reducing eel catches by 50% is achieved as the yield of eel in coastal waters was 4.8 tons in 2008 and only 0.8 tons in 2015.

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Report on the eel stock and fishery in Finland 2014/2015

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Reporting Period: This report was completed in November 2015, and contains data up to 2014 and some provisional data for 2015.

2 Introduction

In Finland eels are on their northeastern limits of natural geographical distribution. Natural eel populations have probably always been very sparse, and the overall importance of the species has been low. In freshwaters only in few areas in Southern parts of the country eel has been a target in the recreational fisheries. According to old fishermen the catch and the importance of eel to local fisheries were still high in 1940-1960 in some parts of the Gulf of Finland, mainly in the estuary of the river Kymijoki and east of the city of Kotka. Also in Finnish Archipelago eel was a common species at that time. Almost all rivers running to the Baltic are closed by hydroelectric power plants. Natural eel immigration is possible only in few freshwater systems near the coast and in the coastal areas of the Baltic. Eel populations and eel fisheries in Finnish inland waters depend almost completely on introductions and restockings. First introductions were conducted in 1893 but until now the most numerous introductions were made in the sixties and 1970s. During the years 1979–1988 it was not allowed to import eels because eel was detected to be a possible carrier of some viral fish diseases. For this reason it was decided in 1989 to carry on restockings only with glass eels reared in a careful quarantine. Since then glass eels originating in River Severn in the UK have been imported through a Swedish quarantine and re-stocked in almost one hundred lakes in Southern Finland and in the Baltic along the Southern coast of Finland.

Finnish EMP covers the whole Finnish national territory as one eel river basin. It is bounded to the ICES Ecoregion Baltic Sea.

3 Time-series data

3.1 Recruitment-series and associated effort

3.1.1 Glass eel

No glass eel recruitment at all.

3.1.1.1 Commercial

3.1.1.2 Recreational

3.1.1.3 Fishery-independent

3.1.2 Yellow eel recruitment

No precise data.

There is only occasional bycatch in lamprey fykenets and pots in rivers running to the Baltic Sea, but only few individuals a year.

On the west coast:

In 2001 35 small yellow eels were caught (during 15.8–31.10) in lamprey fykenets in the river Kokemäenjoki.

In 2014 one small yellow eel was caught (during 15.8–31.10) in same lamprey fykenets in the river Kokemäenjoki.

In 2015 not a single small yellow were caught (research during 1.6–31.10 and commercial catch during 15.8–31.10) in same lamprey nets in the river Kokemäenjoki.

3.1.2.1 Commercial

3.1.2.2 Recreational

3.1.2.3 Fishery-independent

3.2 Yellow eel landings

No data.

3.2.1 Commercial

3.2.2 Recreational

3.3 Silver eel landings

No data.

3.3.1 Commercial

3.3.2 Recreational

3.4 Aquaculture production

3.4.1 Seed supply

40 000 glass eels (ongrown ~1 g) through the Swedish quarantine in 2013.

50 000 glass eels through the Swedish quarantine both in 2014 and 2015 according to the fish farmer (Polar Fish).

3.4.2 Production

About 500 kg in 2014 and also in 2015. This is not official information but based on the discussions with the one and only eel farmer in the country.

3.5 Stocking

3.5.1 Amount stocked

Table 1. Eel stockings in Finland in 1961–2015 (source, type, quantity (number of individuals)).

	QUARANTINED/ON		ORIGIN
	GLASS EELS	GROWN GLASS EELS	
1961		53 000	Denmark, Germany
1962		143 000	Denmark, Germany

	GLASS EELS	QUARANTINED/ON GROWN GLASS EELS	BOOTLACE	ORIGIN
1963				
1964			83 000	Denmark, Germany
1965			114 000	Denmark, Germany
1966	1 077 000		53 000	France, Denmark, Germany
1967	3 935 000			France
1968	2 803 000		4 000	France, Denmark, Germany
1969			35 000	Denmark, Germany
1970			30 000	Denmark, Germany
1971– 1974	no	introductions	allowed	
1975			38 000	Denmark, Germany
1976			19 000	Denmark, Germany
1977			30 000	Denmark, Germany
1978	368 000		12 000	France, Denmark, Germany
1979			75 000	Denmark, Germany
1980– 1988	no	introductions	allowed	
1989		9 700		Swedish quarantine
1990		58 840		Swedish quarantine
1991		108 515		Swedish quarantine
1992		102 450		Swedish quarantine
1993		105 000		Swedish quarantine
1994		103 500		Swedish quarantine
1995		216 600		Swedish quarantine
1996		74 580		Swedish quarantine
1997		82 200		Swedish quarantine
1998		77 550		Swedish quarantine
1999		62 500		Swedish quarantine
2000		61 015		Swedish quarantine
2001		45 500		Swedish quarantine
2002		55 000		Swedish quarantine
2003		0		Swedish quarantine
2004		63 500		Swedish quarantine
2005		64 000		Swedish quarantine
2006		55 000		Swedish quarantine
2007		107 000		Swedish quarantine
2008		206 000		Swedish quarantine
2009		117 500		Swedish quarantine
2010		153 000		Swedish quarantine
2011		306 000		Swedish quarantine
2012		177 000		Swedish quarantine
2013		197 000		Swedish quarantine
2014		147 000		Swedish quarantine
2015		102 000		Swedish quarantine

Year	LOCAL SOURCE				FOREIGN SOURCE			
	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured
2005						64 000		
2006						55 000		
2007						107 000		
2008						206 000		
2009						117 500		
2010						153 000		
2011						306 000		
2012						177 000		
2013						197 000		
2014						147 000		
2015						102 000		

3.6 Trade in eel

No data.

In last decade some hundreds of kilograms of smoked eels were sold to tourists in every year and exported to Russia by them. After CITES 2010 and as a consequence of some international political events this export has nowadays stopped almost completely.

4 Fishing capacity

There are no exact data available but for the professional fisheries, eel is of no importance. Some semi-professional fishermen may have minor income from eels mainly as a bycatch. Therefore the recreational fisheries mainly catch the eels. The number of recreational fishermen in Finland is high (1,6 million in 2014) but only a very small portion of those catch eels as a main target (with fykenets, longlines, angling, spears, etc.). For most of the people eel is a surprising bycatch.

4.1 Glass eel

4.2 Yellow eel

4.3 Silver eel

4.4 Marine fishery

5 Fishing effort

No data.

5.1 Glass eel

Not pertinent.

5.2 Yellow eel

5.3 Silver eel

5.4 Marine fishery

6 Catches and landings

The re-stockings in the late sixties and in 1970s gave a catch of 60–80 tonnes a year at the end of 1970s and the beginning of 1980s (Pursiainen and Toivonen, 1984). Introductions and re-stockings ceased in 1979, which caused a radical reduction in the annual eel catch (Table 2). After the year 1986 the catch was so low that the eel was not detected as a species in the official statistics, but included mainly into the group “other species”. Pursiainen and Toivonen (1984) found out that 1000 stocked individuals/year in freshwaters in Southern Finland gave a catch of 90 kg/year about ten years later. Using the same figures the re-stockings after 1990 probably should give nowadays a catch between 5–10 tonnes/year.

Table 2. Official eel (yellow and silver altogether) catches in Finland 1976–2014 (x1000 kg). The statistical data are collected by the FGFRI. Figures in the professional fisheries columns are based in marine fisheries on annual logbook data and in freshwater fisheries on questionnaires made every second year. In recreational fisheries figures are based on data collected by questionnaires every second year.

Year	MARINE FISHERIES		FRESHWATER FISHERIES		Total catch
	Professional	Recreational	Professional	Recreational	
1976	4	15	2	7	28
1977	2	14	2	45	63
1978	1	14	2	60	77
1979	2	14	2	59	77
1980	2	14	3	60	79
1981	1	8	2	28	39
1982	1	8	1	28	38
1983	1	8	1	28	38
1984	1	4	1	22	28
1985	1	4	1	22	28
1986	1	4	2	49	56
1987	0,2	NC	0	NC	min 0,2
1988	0,4	NC	0	NC	min 0,4
1988–1995	ND	NC	0	NC	?
1996	ND	1	0	21	min 22
1997–2002	ND	NC	ND	NC	?
2003	0,4	NC	NC	NC	min 0,4
2004	1,1	ND	0	ND	min 1,1
2005	0,4	NC	NC	NC	min 0,4
2006	0,2	ND	0	ND	min 0,2
2007	0,5	NC	NC	NC	min 0,5
2008	1	13	0	4	17
2009	1,8	NC	NC	NC	min 1,8

Year	MARINE FISHERIES		FRESHWATER FISHERIES		Total catch
	Professional	Recreational	Professional	Recreational	
2010	2,2	1	0	9	12,2
2011	2	NC	NC	NC	min 2,0
2012	2	2	0	3	7
2013	1	NC	NC	NC	min 1,0
2014	1	9	0	11	21

6.1 Glass eel

Not pertinent.

6.2 Yellow eel

No data.

6.3 Silver eel

No data.

6.4 Marine fishery

See Table 2.

6.5 Recreational Fishery

See Table 2.

Recreational Fisheries: Retained and Released Catches

Year	Retained				Released			
	Inland		Marine		Inland		Marine	
	Angling	Passive Gears	Angling	Passive gears	Angling	Passive gears	Angling	Passive gears

Provide the catch and release mortality (%) used in your country for angling in marine and inland waters.

Recreational Fisheries: Catch and Release Mortality

Year	Released			
	Inland		Marine	
	Angling	Passive gears	Angling	Passive gears

6.6 Bycatch, underreporting, illegal activities

Most of the eel catch is bycatch. In year (2014) it was the first time ever when illegal fishing activities were discovered. A group of fishermen was caught in action catching eel with longlines without a licence in the Vanajavesi watercourse near Hämeenlinna. Their catch was estimated to have been about 100–150 eels in that summer. They were also suspected of catching eels illegally in previous years (2012–2013) as smoked eels were sold on Facebook by them also at that time. The fishermen were not Finns and the activity seemed to be rather well organized. As the total catch of eels in freshwaters in Finland is low (according to a questionnaire 3 t in 2012) the role of this single group might have been remarkable. Their catch in that particular year might have been about 4–5% of the total catch. Otherwise illegal fishing is not significant because there is enough chance to catch eels legally if you wish.

7 Catch per unit of effort

No data.

7.1 Glass eel

7.2 Yellow eel

7.3 Silver eel

7.4 Marine fishery

8 Other anthropogenic impacts

No data.

9 Scientific surveys of the stock

9.1 Recruitment surveys, glass eel (includes yellow eel in Scandinavia)

No data.

9.2 Stock surveys, yellow eel

No data.

9.3 Silver eel

DIDSON has been used in autumns in 2011 and 2012 and in spring in 2013 to monitor downstream migration of silver eels in Nokia in the upper reaches of the Kokemäenjoki watercourse above the uppermost dam. In autumn 2013 monitoring was done in Pämpinkoski downstream the same watercourse below the five electrical power plants. Observations are presented in the table below.

Date	Observed ind.	mean length, cm	Range, cm
Nokia			
12.9–11.10.2011	221	90,5	63–123
27.9–8.11.2012	314	85,6	51–111
17.4–13.5.2013	98	89,1	61–115
Pämpinkoski			

11.9–23.10.2013	122	81,8	47–112
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10 Data collected for the DCF

According to Finnish National Programme for data collection, no stock-related biological eel data (e.g. length–weight data or samples for ageing) are collected from the Finnish catches. There is no targeted professional or recreational eel fisheries in Finland, and catches are few and very scattered in time and space, so that sampling would consume too much time and resources. Data on eel catches in recreational fisheries are collected as part of the Finnish DCF every second year and reported to WGEEL. Eel catches in professional fisheries are negligible.

11 Life history and other biological information

During 1974–1994 over 2000 eels were collected in thirty lakes and in some lake outlets in Southern Finland. Length, weight, eye diameter, colour of the sides and belly, sex and weight of the gonads (not always) were determined and after 1986 also swimbladders were examined for *Anguillicola*. Age and growth were also determined. The aim of the study was to evaluate the biological outcome of eel stockings made in 1960s and 1970s and to estimate the yield to fishery and the proportions of eels escaping the lakes. The results were published mainly in 1980s (Pursiainen and Toivonen, 1984; Pursiainen and Tulonen, 1986; Tulonen, 1988; Tulonen, 1990; Tulonen and Pursiainen, 1992). The concentrations of radionuclides ^{134}Cs and ^{137}Cs and PCB in eels were also investigated (Tulonen and Saxen, 1996; Tulonen and Vuorinen, 1996).

There were no routine biological sampling programmes or eel research projects during 1994–2005. Some occasional samples were taken in few lakes on the author's personal interest. Also in some small water systems silver eel escapement has been monitored since 1974 (one place), 1980 (two places) and 1989 (two places) with eel boxes in the outlets. Eels in the lakes have been re-stocked there in 1967, 1978 and 1989 respectively. One sample of “natural” elvers has been collected in 2002 in Southwest Finland and on the coast of the Bothnian Bay. One third of the elvers were infected with *Anguillicola*. This was the first time *Anguillicola* ever found in Finland (Tulonen, 2002). Since then *Anguillicola* has spread to almost every eel population in the sea and after 2007 also to some freshwater populations where it is still spreading.

In 2006 a four year study on the biological and economical outcome of eel stockings made since 1989 and on the state of natural eel stocks was established in FGFR. The main goal was to compile the facts and other biological data on eels in Finland to the Eel Management Plan. In the study some sampling was also done in ten lakes in southern Finland and in eight areas in the Baltic along the coasts of Gulf of Finland and Bothnian Bay and in the rivers running into them. Due to sparse populations the sample sizes are only in few cases big enough (>100 ind.) to make any scientific evaluations. Since 2010 there has been sampling only in the most interesting locations.

11.1 Growth, silvering and mortality

Data not yet processed.

11.2 Parasites and pathogens

Data not yet processed.

11.3 Contaminants**11.4 Predators****12 Other sampling**

No data.

13 Stock assessment

No data. There is no routine assessment of local stocks. Neither there is any formal advice on fisheries management.

13.1 Method summary

No data.

13.2 Summary data**13.2.1 Stock indicators and targets**

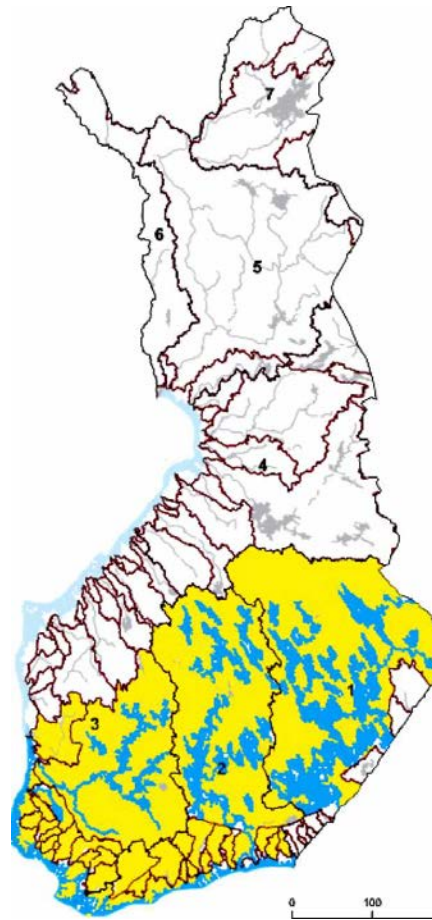
No data.

EMUcode	Indicator	biomass (T)	Mortality (rate)	Target					
		Bbest	Bcurr	ΣA	ΣF	ΣH	Source	Biomass (t)	ΣA (rate)
XY_abcd							EMP		
							EU Reg		
							WGEEL		
XY_abcd							EMP		
							EU Reg		
							WGEEL		

13.2.2 Habitat coverage

Terms used in the EMP to define natural habitats for the eel were:

- outlet of the river basin is in Finland's national territory;
- there has been natural immigration of elvers before the damming of the rivers;
- there have been considerable stockings lately;
- there has been regular eel fishery.



On the grounds of the terms two categories with few subcategories were defined:

A) Area of free migration includes all coastal waters of the Baltic and the inner archipelago to the depth of ten meters and the few small undammed river basins running to the Baltic. The area was subdivided into two categories:

a) Reserve area (the Bothnian Bay area) where eels exist but for climatically and geographical reasons have always been very rare. Light blue area in the map. Total area is 1783 km².

EMU code Aa.

b) Main management area for the eel (the Gulf of Finland and the small undammed river basins running to it). Deep blue coastal area in the map Total area is 4677 km² for the coastal area and 382 km² for the small river basins. According to EMP stockings in this area compensates in the long run the loss of silver eels in freshwaters.

EMU code Ab

B) Area where immigration of elvers is totally prevented because of the dams and the hydroelectric turbines in the dams have a severe negative effect on the escapement of silver eels. This area includes three major freshwater river basins; Vuoksi (number 1 in the map), Kymijoki (number 2) and Kokemäenjoki (number 3), and also some small water basins running to the Baltic. Yellow area in the map, main lakes in the area are coloured in deep blue. Total area is 20 509 km². No management actions take place in this area.

EMU code B

EMU CODE	RIVER		LAKE		ESTUARY		LAGOON		COASTAL	
	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)
Aa									178 300	N
Ab									467 400	N
Ab			38 200	N						
B			205 0900	N						

13.2.3 Impact

EMU code	Habitat	Fish com	Fish rec	Hydro & pumps	Barriers	Restocking	Predators	Indirect impacts
Aa	Coa	AB	AB	MI	MI	MI	MI	MI
Ab	Lak	AB	MI	AB	AB	MA	MI	MI
Ab	Coa	MI	MI	AB	AB	MA	MI	AB
B	Lak	AB	MI	MA	MA	MI	MI	MI
All								

No data.

EMU code	Stage	Fish com	Fish rec	Hydro & pumps	Barriers	Restocking	Predators	Indirect impacts
XY_abdc	Glass							
	Yellow							
	Silver							
	Silver EQ							

13.2.4 Precautionary diagram

No data.

13.2.5 Management measures

EMU code	Action Type	Action	Life Stage	Planned	Outcome
Aa	Com Fish	no			
	Rec Fish	no			
	Hydropower & Pumps	no			
	Restocking	no			
	Other	no			
Ab	Com Fish	catch statistics, logbook		yes	yes
	Rec Fish	catch statistics, questionnaires		yes	yes
	Hydropower & Pumps	no			
	Restocking	yes	quarantined glasseels	537 999/year	partly
	Other	no			
B	Com Fish	no			
	Rec Fish	no			
	Hydropower & Pumps	no			
	Restocking	no			
	Other	no			

13.3 Summary data on glass eel

No glass eels caught in Finland. All glass eels or on grown eels are imported and used mainly for stockings in Finland.

14 Sampling intensity and precision

No data available yet. Only a small fraction of the data has been analysed.

15 Standardisation and harmonisation of methodology**15.1 Survey techniques**

No data.

15.2 Sampling commercial catches

No data.

15.3 Sampling

Done by FGFRI since 1974 with longlines and fykenets in lakes and eel traps in the rivers. In 2006–2009 samples were collected in freshwaters with the help of local recreational fishermen and in the sea by few professional fishermen. Fish have been collected mainly alive from the fishermen but occasionally also as frozen. In few cases the fishermen have measured (weight and length) the fish and delivered the head

and the guts together with the length–weight data to FGFR1 where otoliths have been removed and swimbladder examined for *Anguillicola*.

For every fish following information has been collected:

- Catching date and killing date
- Catching site
- Fishing gear
- Length
- Weight
- Sex
- Colour (sides and belly)
- Diameter of the eye
- Weight of the gonad (only occasionally)
- *Anguillicola* (no/yes, how many, size)

15.4 Age analysis

So far when age analysis has been done grinding and polishing method has been used, Swedish style as described in ICES, WKAREA Report 2009 in Bordeaux. Lately also cutting slices with otolith saw and etching using EDTA and staining using neural red has been tried out.

15.5 Life stages

Silver eel: side silver or copper, glossy, belly white and glossy.

Yellow eel: sides brown, grey, green, not glossy, belly brown, green, grey, yellow, not glossy.

15.6 Sex determinations

From macroscopic examination of the gonads, confirmed by length and colour.

15.7 Data quality issues

16 Overview, conclusions and recommendations

In the EMP there are some recommendations for the research:

- 1) The natural distribution of eel in Finland and the state of this natural stock has to be examined and followed regularly.
- 2) Eel has to be taken as a species in the catch statistics both in recreational and professional fishery.
- 3) Research has to be carried out to find out the biological outcome of the stockings conducted according to the EMP. Natural and fishing mortality and especially recruitment of yellow eels to silver eels and the success of silver eel's migration have to be studied.
- 4) *Anguillicola* infection level should be investigated in the natural and introduced eel populations.

Only the recommendation number 2 has fulfilled and some aspects of recommendations 1, 3 and 4.

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Report on the eel stock and fishery in France 2014/2015

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Reporting Period: This report was completed in 2015, and contains data up to 2015 (for glass eels).

2 Introduction

2.1 Presentation of eel fisheries in France

The French eel fisheries occur mainly in inland waters (rivers, estuaries, ponds and lagoons) but also in coastal waters (see Figure FR 1 and Table FR 1). The glass eel fisheries are more important in the Bay of Biscay region but they are also found in the Channel region. The yellow eel fisheries occur in the same areas and concern also the upper parts of the rivers of the Atlantic coast, the Rhine and tributaries. The Mediterranean lagoons produce the most part of yellow eels and bootlace eels are targeted for exportation towards Italy. Silver eel fisheries are limited to some rivers, mostly in the Loire basin and in the Mediterranean lagoons.

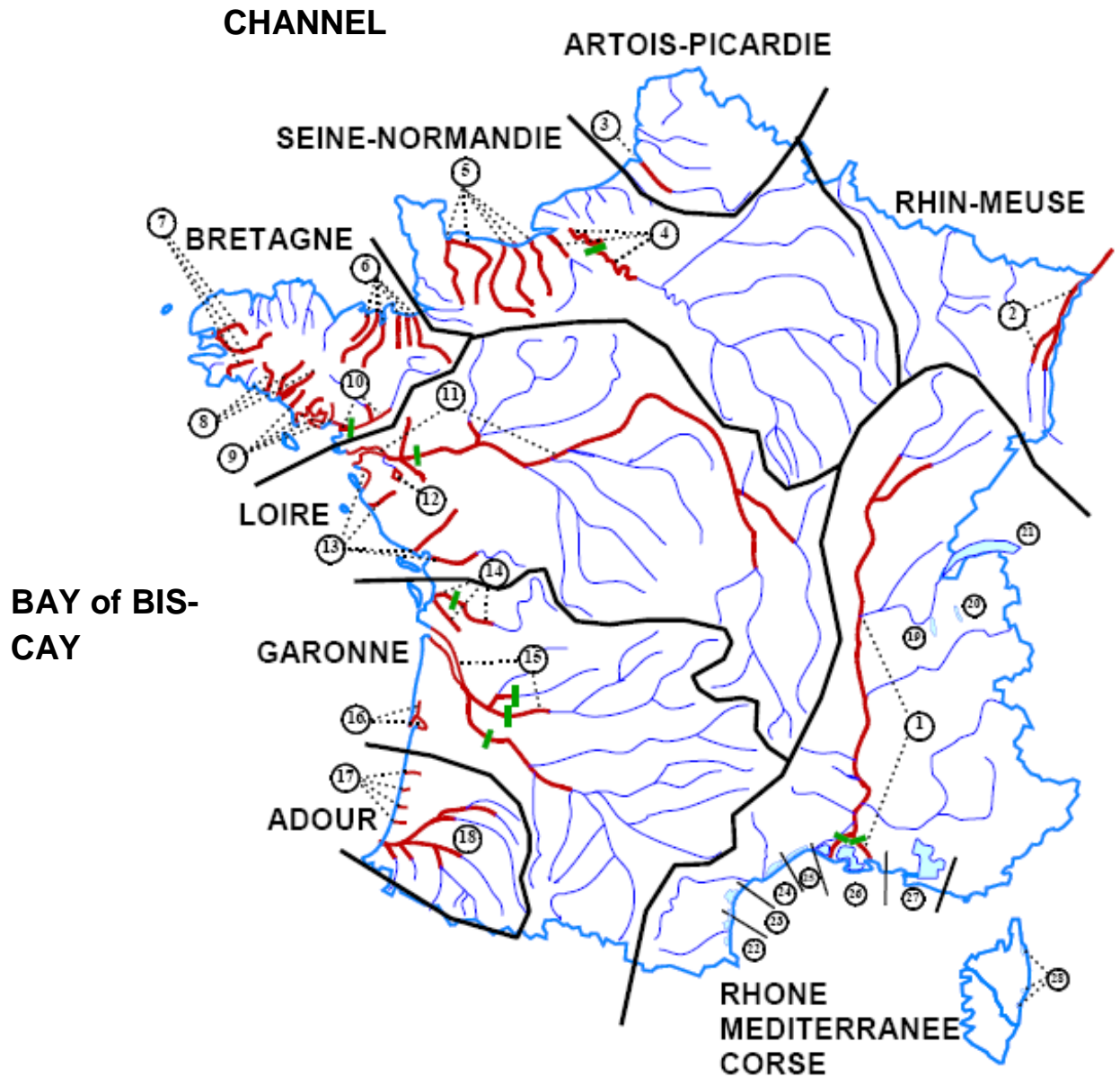


Figure FR 1. Inland waters in France (eel fisheries in red; tidal limits in green). The number correspond to the list of fishing zones in Table FR 1. The management unit names and limits are in black (redrawn from CASTELNAUD, 2000).

From 1999 to 2001, the total number of professional fishermen fishing eel, seeking one or several stages, was about 1800 with an estimated total catch of 200 tons of glass eels and 900 tons of yellow or silver eels (Castelnaud and Beaulaton, unpublished data).

Illegal fishermen are targeting glass eels in the tidal parts of rivers and other stages in whole France including sometimes for commercial purpose. Their number and the amount of their catches had never been clearly quantified.

Table FR 1. Fishing zones in French inland waters related to the eight management units (COGEPOMI) (modified from CASTELNAUD *et al.*, 2000, unpublished data).

(NUMBER FROM FIGURE FR) FISHING ZONE – SURFACE FOR LAGOONS	COGEPOMI
(1) Delta du Rhône	Rhône-Méditerranée Corse
(1) Fleuve Rhône aval et amont, Saône, Doubs	Rhône-Méditerranée Corse
(2) Fleuve Rhin, Ill	Rhin Meuse
(3) Estuaire Somme	Artois-Picardie
(4) Estuaire Seine, Fleuve Seine aval	Seine Normandie
(4) Fleuve Seine amont, Risle	Seine Normandie
(5) Estuaires Touques, Dives, Orne, Aure, Vire	Seine Normandie
(6) Estuaires Couesnon, Rance, Fremur, Arguenon, Gouessan, Gouet	Bretagne
(7) Estuaires Elorn, Aulne, Odet	Bretagne
(8) Estuaires Laïta, Scorff, Blavet	Bretagne
(9) Rivières d'Etel, d'Auray, de Penerf, Golfe du Morbihan	Bretagne
(10) Estuaire Vilaine aval	Bretagne
(10) Estuaire Vilaine amont, Fleuve Vilaine aval, Oust, Chère, Don	Bretagne
(11) Estuaire Loire, Loire aval, Erdre, Sèvre Nantaise	Loire
(11) Fleuve Loire amont, Maine, Mayenne, Allier	Loire
(12) Lac de Grand-Lieu	Loire
(13) Baie de Bourgneuf, Estuaires Vie, Lay, Sèvre Niortaise	Loire
(14) Estuaire Charente, Fleuve Charente aval, Estuaire Seudre	Garonne
(14) Fleuve Charente amont	Garonne
(15) Estuaire Garonne, Garonne aval, Dordogne aval, Isle	Garonne
(15) Fleuve Garonne amont, Dordogne amont	Garonne
(16) Canal de Lège	Garonne
(16) Delta d'Arcachon	Garonne
(17) Courants de Mimizan, Contis, Huchet, Vieux-Boucau	Adour
(18) Estuaire Adour, Fleuve Adour, Nive, Bidouze, Gaves de Pau et d'Oloron, Luy	Adour
(19) Lac du Bourget	Rhône-Méditerranée Corse
(20) Lac d'Annecy	Rhône-Méditerranée Corse
(21) Lac Léman	Rhône-Méditerranée Corse
(22) Canet lagoon - 480 ha	Rhône-Méditerranée Corse
(22) Salses Leucate lagoon - 5800 ha	Rhône-Méditerranée Corse
(23) La Palme lagoon - 600 ha	Rhône-Méditerranée Corse
(23) Bages-Sigean lagoon - 3700 ha	Rhône-Méditerranée Corse
(23) Campagnol lagoon – 115 ha	Rhône-Méditerranée Corse

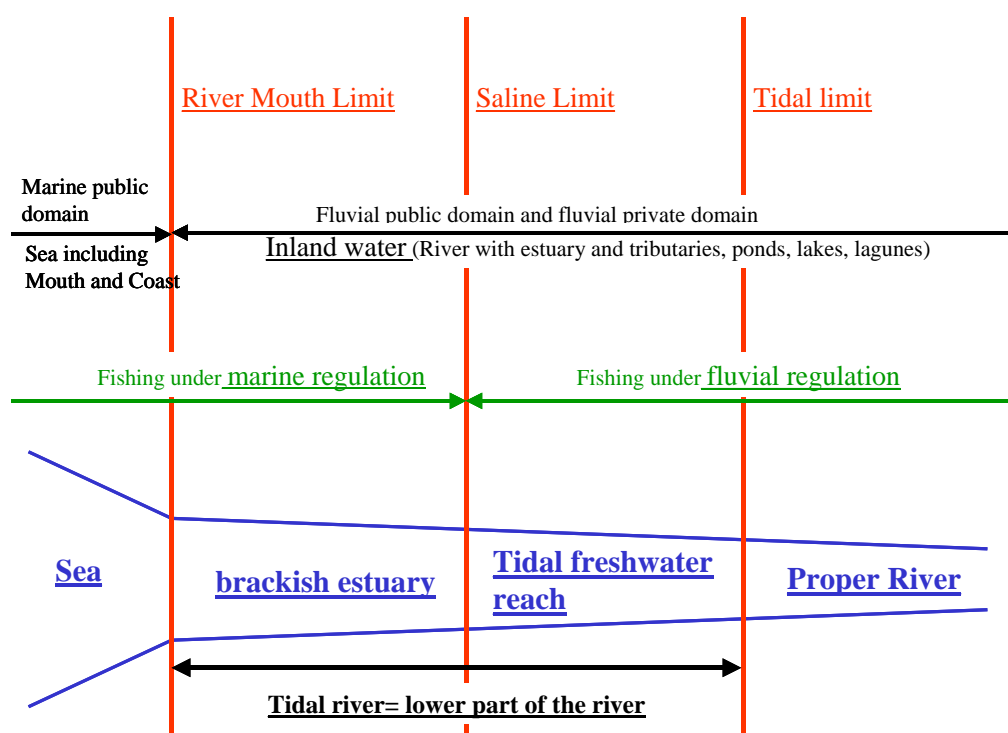
(NUMBER FROM FIGURE FR) FISHING ZONE – SURFACE FOR LAGOONS	COGEPOMI
(23) Ayrolle lagoon – 1320 ha	Rhône-Méditerranée Corse
(23) Gruissan lagoon – 145 ha	Rhône-Méditerranée Corse
(23) Grazel and Mateille lagoons – 142 ha	Rhône-Méditerranée Corse
(24) Vendres lagoon – 661 ha	Rhône-Méditerranée Corse
(24) Thau lagoon – 7500 ha	Rhône-Méditerranée Corse
(25) Ingril lagoon – 685	Rhône-Méditerranée Corse
(25) Vic lagoon – 12 55 ha	Rhône-Méditerranée Corse
(25) Pierre- Blanche lagoon – 371 ha	Rhône-Méditerranée Corse
(25) Prévost lagoon – 294 ha	Rhône-Méditerranée Corse
(25) Arnel lagoon – 580 ha	Rhône-Méditerranée Corse
(25) Grec lagoon – 270 ha	Rhône-Méditerranée Corse
(25) Latte-Méjean lagoon – 747 ha	Rhône-Méditerranée Corse
(25) Mauguio lagoon – 3200 ha	Rhône-Méditerranée Corse
(26) Ponant lagoon – 200 ha	Rhône-Méditerranée Corse
(26) Camargue gardoise lagoons – 1200 ha	Rhône-Méditerranée Corse
(26) Vacares and Impériaux lagoons – 12 000 ha	Rhône-Méditerranée Corse
(27) Berre lagoon – 15 500 ha	Rhône-Méditerranée Corse
(28) Biguglia lagoon – 1379 ha	Rhône-Méditerranée Corse
(28) Diana lagoon – 570 ha	Rhône-Méditerranée Corse
(28) Urbino lagoon – 790 ha	Rhône-Méditerranée Corse
(28) Palu lagoon – 210 ha	Rhône-Méditerranée Corse

2.2 Management and monitoring system

The administrative saline limit separates two different fishery regulations: marine and fluvial (freshwater) (Figure FR 2). The marine fisheries are located in coastal water, brackish estuaries and in the Mediterranean lagoons. The freshwater fisheries are located upstream from the saline limit and comprise rivers, lakes, ponds, ditches and canals. In large estuaries there is a special zone, called the “tidal freshwater reach”, located between the saline limit and the tidal limit, where some marine professional

fishermen can fish along with river fishermen while these are not allowed to go downstream the saline limit.

In brackish and coastal waters within EMU, amateur fishermen do not need licences to fish with authorized fishing gears. A system of licenses is set up for marine professional fishermen, for river professional and amateur fishermen in freshwaters. The glass eel fishery is limited with quotas of glass eel stamps and the silver eel fishery is limited by personal authorizations. Since EMP, professional and recreational fisher fishing with gears should have a special authorization to target eels. Anglers do not require any special authorization for eel fishing, just to have a general fishing licence. In the Mediterranean lagoons, where glass eel fishing is forbidden, there are also limitations in the number of marine professional fishermen and fishing capacities. Since the French EMP there is also a system of stamps one for yellow and one for silver eel fishing.



		Marine professional = MP
		River professional = FP
		River amateur with gears with or without boat in public domain = FA
		Angler = AN
		River amateur (being also angler) with gears in private domain = AG
Fisher category	Marine professional = MP Marine recreational with or without boat = MA	
Fishing rights	MP: quota of licence, eel specific stamps MA: no licence, gears limited by rules	MP & FP: quota of licence, eel specific stamps FA: quota of licence, eel specific stamps AN: general rod licence AG: AN licence + eel specific authorisation

Figure FR 2. Inland waters and fisheries limits, fishermen categories and fishing rights by zones (Castelnaud and Beaulaton, 2005, unpublished data).

Outside EMU, at sea, eel fishing is forbidden.

In the rivers under fluvial regulation, the fishing rights are delivered to fishermen by the local Fluvial Fisheries Administrations. The regulation systems in brackish estuaries and Mediterranean lagoons are the result of a negotiation between fishermen organizations (respectively “Commission des poissons migrateurs et des estuaires” and “Prud’homies”) and Marine Fisheries Administrations.

The marine professional fisheries in Atlantic coastal areas, estuaries and tidal part of rivers in France has been monitored by the “Direction des Pêches Maritimes et de l’Aquaculture” (DPMA) of the Ministry of Agriculture and fisheries through the Centre National de Traitement Statistiques (CNTS, ex-CRTS) from 1993 to 2008 and is now by France-Agrimer. This system is evolving and is supposed to include marine professional fishermen from Mediterranean lagoons. In this system, glass eels are distinguished from subadult eel, but yellow and silver eels cannot be separated until recently.

The river commercial and amateur fishermen in rivers above marine estuaries (and in lakes) have been monitored since 1999 by the ONEMA (Office National de l’Eau et des Milieux Aquatiques, ex-CSP) in the frame of the « Suivi National de la Pêche aux Engins et aux filets » (SNPE).

These two monitoring systems are based on mandatory reports of captures and effort (logbooks) using similar fishing forms collected monthly (or daily for glass eel) with the help of some local data collectors.

Beside these mandatory systems, for which reliability, accuracy and availability of data are variable, local scientific monitoring have been developed in the Gironde, the Adour and the Vilaine basin for instance. Data on annual captures were also provided for some sectors by the local fishery administrations: “Directions Départementales des Affaires Maritimes” (DDAM), “Directions Départementales du Territoire/du Territoire et de la Mer” (DDT/DDTM). At some occasions, some punctual studies made by scientific institute, local fishery administration or fishermen themselves are available.

Table FR 2. Official administrative monitoring systems in France.

SEA		INLAND WATERS	
Outside EMU	Salt water	Brackish water (including Med. Lagoons)	Freshwater
Professional	No data available	Quota of licences	Quota of licences
		Stage specific stamps	Stage specific stamps
		Compulsory logbook (DPMA/France-Agrimer)	Compulsory logbook (ONEMA)
Recreational with gears	Eel Fishing ban	No licence, no logbooks	Licences and specific yellow eel authorisation
			Compulsory logbook (public domain: ONEMA / private domain: not monitored)
Anglers			Licences (not eel specific), no logbooks

To manage the migratory species and their fisheries all along the watershed (under marine and fluvial regulation), special organizations, called “Comités de Gestion des Poissons Migrateurs” (COGEPOMI), have been created in 1994. There are 8 COGEPOMI (management units, grouping basins), one for each important group of basin: Rhine-Meuse, Artois-Picardie, Seine-Normandie, Bretagne, Loire, Garonne, Adour and Rhone-Méditerranée-Corse (see Figure FR 1 and Table FR 1). They gather representatives of fishermen organizations, administrations and research centers. Each COGEPOMI propose a management plan and funding every five years and has to monitor them. The plan determines conservation and management actions, restocking operations, proposes fishing regulations for both recreational and professional fisheries.

Until 2009, these management plans did not aim at achieving a particular escapement rate for eel, and the results of management actions have not really been evaluated. While this system allows for a global approach, and tries to solve environmental problems such as migration barriers or turbine mortality, it does not give for the moment, a consistent management basis for eel at the national level by lack of central regulation and designing of practical management rules.

Since 2009, French eel management unit (EMU) as defined by the European eel regulation are more or less COGEPOMI. One should notice that Corse is a separate management unit and that EMU are extended to coastal waters (Figure FR 3 and Table FR 3). A national EMP has been build that gives national instructions that can for some measures be adapted by EMU through COGEPOMI or other local institutions.

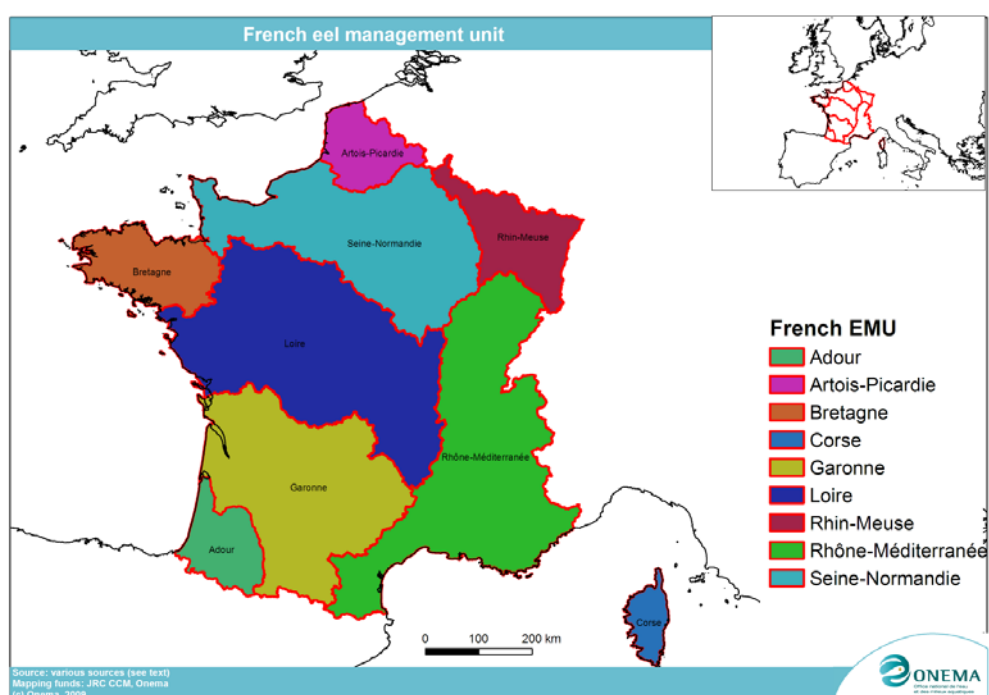


Figure FR 3. French eel management unit.

Table FR 3. French eel management unit and ICES ecoregion.

FRENCH EMU	FRENCH CODE	ICES ECOREGION
Rhin – Meuse	RMS	F – North Sea
Artois – Picardie	ARP	F – North Sea
Seine – Normandie	SEN	F – North Sea
Bretagne	BRE	E – Celtic Sea and G – South European Atlantic Shelf
Loire et côtiers vendéens	LCV	G – South European Atlantic Shelf
Garonne, Dordogne, Charente, Seudre, Leyre	GDC	G – South European Atlantic Shelf
Adour	ADR	G – South European Atlantic Shelf
Rhône – Méditerranée	RMD	H – Western Mediterranean Sea
Corse	COR	H – Western Mediterranean Sea

3 Time-series data

3.1 Recruitment

Time-series data are already included in the database, they are not detailed there.

Table FR 4. Recruitment series in France. 2012 means 2011–2012 migration season.

EMU	BRETAGNE	LOIRE	GARONNE–DORDOGNE–CHARENTE– SEUDRE–LEYRE			ADOUR – COURS D’EAU COTIERS		
Year	Vilaine Arzal trapping all	Loire Estuary com. catch	Sèvres Niortaise Estuary com. cpue	Gironde (catch) com. catch	Gironde pibalour (cpue) com. cpue	Gironde scient. Estim.	Adour Estuary (catch) com. ² catch	Adour Estuary (cpue) com. cpue
1923				46.0				
1924		65						
1925		70						
1926		90		18.7				
1927		65		34.1				
1928		102		22.4				5
1929				22.5				5.5
1930		1		28.2				6.7
1931				26.9				18.7
1932				31.1				
1933				13.5				
1934		90		13.4				
1935		150		19.7				
1936		30						
1937		7						
1938		15						
1939		17						
1940		27						
1941		21						
1944		10						
1945		66						
1946		43						
1947		178						
1948		197						
1949		193						
1950		86						
1951		166						
1952		121						
1953		91						
1954		86						
1955		181						
1956		187						
1957		168						
1958		230						
1959		174						

EMU	BRETAGNE	LOIRE	GARONNE-DORDOGNE-CHARENTE- SEUDRE-LEYRE			ADOUR – COURS D'EAU COTIERS		
Year	Vilaine Arzal trapping all	Loire Estuary com. catch	Sèvres Niortaise Estuary com. cpue	Gironde (catch) com. catch	Gironde pibalour (cpue) com. cpue	Gironde scient. Estim.	Adour Estuary (catch) com. ² catch	Adour Estuary (cpue) com. cpue
1960		411						
1961		334		32.2	10.47			
1962		185	30	218	30.64			
1963		116	72	363	33.15			
1964		142						
1965		134	17	353	62.74			
1966		253	13	27.6	10.02			5.1
1967		258	8	163	25.46			6.4
1968		712	15	284	38.23			10.1
1969		225	14	36.6	18.52			5
1970		453	15	204	24.98			7.5
1971	44	330	12	47.1	9.12			4.6
1972	38	311	11	69.0	13.73			4.4
1973	78	292	8.5	20.0	29.19			4.5
1974	107	557	9	54.6	21.44			7.4
1975	44	497	8.5	44.1	12.5			5
1976	106	770	17	121	34			11
1977	52	677	15	122	25.38			
1978	106	526	18	64.7	23.17			
1979	209	642	17.5	73.2	18.74			10
1980	95	526	12	125	35.05			5
1981	57	303	9	84.9	32.41			
1982	98	274	8.5	61.0	14.55			
1983	69	260	6	66.7	14.33			
1984	36	183	ND	45.0	13.87			
1985	41	154	ND	27.0	7.39			2.4
1986	52.6	123	ND	35.3	9.02		8	1.5
1987	41.2	145	ND	44.6	9		9.5	3.3
1988	46.6	177	ND	27.9	7.55		12	3.7
1989	36.7	87	ND	45.9	8.9		9	4.1
1990	35.9	96	ND	29.2	5.37		3.2	1.2
1991	15.35	36	ND	38.4	6.78		1.5	0.7
1992	29.57	39	ND	22.5	6.58	1.75	8	2.9
1993	31	91	ND	42.4	8.92	2.83	5.5	2.4
1994	24	103	ND	45.5	8.15	2.2	3	1.4
1995	29.7	133	ND	43.5	8.49	2.92	7.5	2.6
1996	23.29	81	ND	27.9	5.25	2.07	4.1	1.53
1997	22.85	71	ND	49.3	9.24	3.14	4.6	1.6
1998	18.9	66	ND	18.4	3.46		1.5	1.07

EMU	BRETAGNE	LOIRE	GARONNE-DORDOGNE-CHARENTE- SEUDRE-LEYRE			ADOUR – COURS D'EAU COTIERS		
Year	Vilaine Arzal trapping all	Loire Estuary com. catch	Sèvres Niortaise Estuary com. cpue	Gironde (catch) com. catch	Gironde pibalour (cpue) com. cpue	Gironde scient. Estim.	Adour Estuary (catch) com. ² catch	Adour Estuary (cpue) com. cpue
1999	16	87	ND	43.1	7.41	3.49	4.3	1.82
2000	14.45	80	ND	28.5	5.41	1	10	4.43
2001	8.46	33	ND	8.2	1.85	0.36	2	0.49
2002	15.9	42	ND	35.1	6.22	1.02	1.8	0.89
2003	9.37	53	ND	9.6	2.52	0.28	0.6	0.31
2004	7.49	27	ND	14.4	2.5	0.3	1.8	0.6
2005	7.36	17	ND	17.3	2.7	0.53	3.2	1.13
2006	6.6	15	ND	9.4	2.4	0.27	1.7	0.72
2007	7.7	21	ND	7.5	2.1	0.14	1.4	0.66
2008	5.1	ND	1.93	10	2.6	0.28	1.7	1.05
2009	2.2	ND	ND	3.5	1.4	0.44	ND	ND
2010	3.8	ND	ND	3.4	1.2	0.10	ND	ND
2011	3.7	ND	ND	ND	ND	0.16	ND	ND
2012	ND	ND	ND	ND	ND	0.07	ND	ND
2013	ND	ND	ND	ND	ND	0.19	ND	ND
2014	ND	ND	ND	ND	ND	0.39	ND	ND
2015	4.4	ND	ND	ND	ND	0.11	ND	ND

GEREM (Glass-Eel Recruitment Estimation Model) model has been developed to estimate glass eel recruitment at different nested spatial scales (Drouineau *et al.*, 2015). More specifically the model estimates annual recruitments both at the river catchment level and at the eel management unit scale, which are two relevant spatial scales for management. The model has been applied to France on dataseries lasting from 1970 to 2013 and provides trends that are consistent with current expert knowledge, and absolute recruitment estimates that are consistent with expert knowledge of exploitation rates (Figure FR 4). Provided enough data become available in future, it could be extended to the scale of the distribution area of any of the three temperate eel stocks, which would be consistent with the population scale.

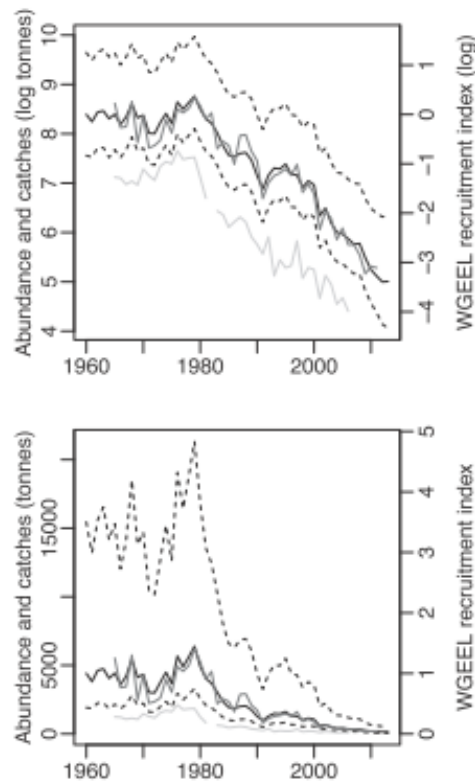


Figure FR 4. Estimated French glass-eel recruitment in tons by GEREM (Solid line indicates the median while dashed lines represent the corresponding 95% credibility interval. Grey lines represents French glass-eels catches estimates from Briand *et al.*, 2008b) (Drouineau *et al.*, 2015).

3.2 Yellow eel landings

The Gironde series has been collected by the IRSTEA (Girardin and Castelnaud, 2011) and details landings from professional fishermen in the lower part of the Garonne basin (comprising the brackish estuary and the tidal freshwater reach of the Garonne and Dordogne rivers). This series was extended in the past before 1978 by Beaulaton (2008). One should notice that 1946–1977 data are based on small numbers of fishermen that may explain high variability from these years (Figure FR 5). The fisheries also shifted from eelpot made of wood to plastic eelpots. Like for glass eel, the Gironde is one of the few estuaries where an estimation of recreational landings is available as a time-series. It has been extrapolated from professional landings and number of river amateur fishermen.

Yellow eel landings clearly decreased over the last twenty years from 158 t in average between 1978–1986 to less than 25 t between 2002 and 2009; after two years of fishery ban because of the contamination by PCB, the captures have remained low around less than 10 t (Table 5).

Table FR 5. Time-series for landings in the Gironde, * indicates fishery closed for PCB, only the latest years are reported in the table.

	COMMERCIAL FISHERMEN	NON COMMERCIAL FISHERMEN
2010*	1300	700
2011*	630	124
2012	5227	500
2013	9436	1290
2014	4249	366

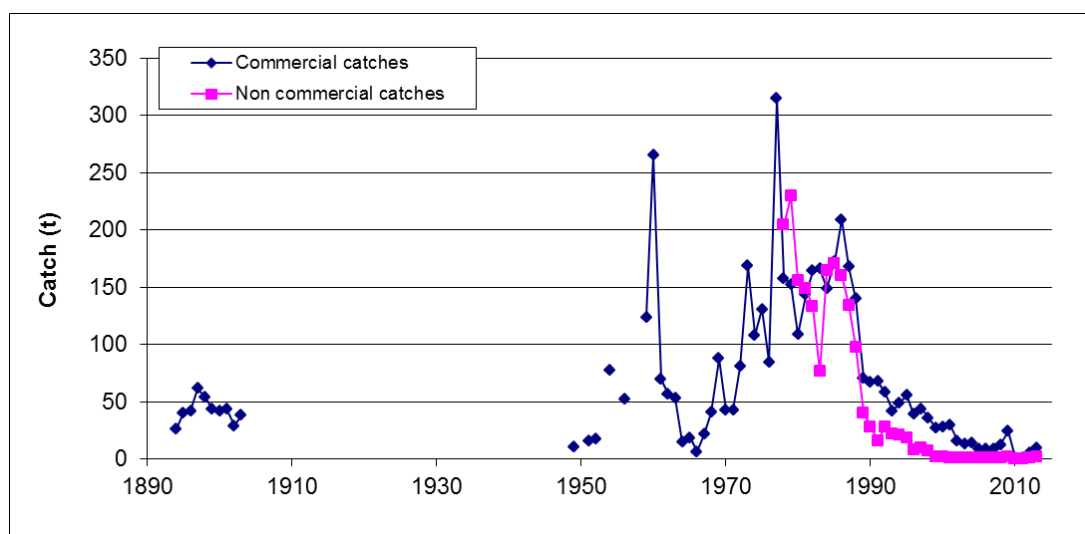


Figure FR 5. Marine and river commercial and river non-commercial yellow eel landings in the Gironde basin (brackish and freshwater estuary)

3.2.1 Recreational

No data available.

3.3 Silver eel landings

3.3.1 Commercial

3.3.1.1 Loire river (Loire EMU)

The Guideau fishery of the Loire is one of the French fishery targeting silver eels. Statistics on a sample of four fishers are available from 1987 and on the whole fishery from 2001 (Table FR 6). One should notice that since the entry into force of the French EMP (2008–2009 season) this fishery does not catch eel each week between Saturday 18:00 and Monday 06:00.

Table FR 6. Landings (in t) of silver eel “Guideau” fishery in the Loire River. In Brackets: number of fishers considered.

	ACOU ET AL., 2010	OFFICIAL STATISTICS	BODIN ET AL., 2011
1987–1988			27.8 (4)
1988–1989			31.8 (4)
1989–1990			23.2 (4)
1990–1991			29.4 (4)
1991–1992			23.5 (4)
1992–1993			18.1 (4)
1993–1994			15.6 (4)
1994–1995			22.2 (4)
1995–1996			24.3 (4)
1996–1997			18.9 (4)
1997–1998			26.0 (4)
1998–1999			18.5 (4)
1999–2000			19.9 (4)
2000–2001			17.4 (4)
2001–2002	45.3 (12)		25.6 (4)
2002–2003	38.1 (10)		20.1 (4)
2003–2004	36.4 (10)		24.8 (4)
2004–2005	16.1 (8)	22.7 (7)	7.3 (3)
2005–2006	25.9 (9)	19.6 (7)	14.9 (4)
2006–2007	26.4 (7)	29.4 (8)	15.3 (4)
2007–2008	33.2 (9)	24.8 (6)	19.7 (4)
2008–2009	18.2 (7)	12.2 (7)	12.9 (4)
2009–2010		19.5 (7)	14.3 (4)
2010–2011		11.4 (10)	5.7 (4)
2011–2012			7.0 (4)
2012–2013	29.4 (8)		18.5 (4)
2013–2014			13.1 (4)

Acou *et al.*, 2010 = Total landings from Acou *et al.* (2010) and Boisneau, com. pers. in Beaulaton *et al.*, 2009; 2012–2013 Acou *et al.*, 2014, provisional data.

Official statistics = Total landings as declared to SNPE from Onema.

Bodin *et al.*, 2011 = landings from a sample of four fishers from Bodin *et al.* (2011) and Boisneau and Boisneau (2014).

3.3.2 Recreational

No data available. No more relevant: the French EMP has banned silver eel recreational fishing.

3.4 Aquaculture production

3.4.1 Seed supply

No data available.

3.4.2 Production

No data available.

3.5 Stocking

A full report on the analysis of stocking in France is available. (Rigaud *et al.*, 2015).

http://www.onema.fr/Le-programme-francais-de-repeuplement-en-civelles?var_recherche=repeuplement

3.5.1 Amount stocked

A public tender of 2 million Euros for restocking (and restocking monitoring) has been made each year since 2010. In 2014 this public tender was made twice.

Glass eels are all caught in the EMU in which they are restocked. Thus there is no restocking in EMU where there isn't a glass eel fishery. Glass eels have been quarantined in fish sellers' tanks for the duration of sanitary analyses (e.g. EVEX). All restocking sites are monitored to assess the efficiency of restocking.

In 2010, two projects representing 150 k€ (including monitoring) for 200 kg restocked have been selected. Finally no glass eel have been restocked because of the end of the glass eel season. However 209 kg (glass eel mean weight 0.233 g and thus 900 000 glass eels) have been restocked in the Loire River in July 2010. Those Glass eel were collected from a CITES seizure.

In 2011, eleven projects have been selected for a total amount of 4024 kg. Finally only 747.5 kg were really restocked, partly because of late selection process and partly because of lack of supply.

In 2012, eleven projects have been selected for a total amount of 3475 kg. Finally 3086 kg were really restocked.

In 2013, eleven projects have been selected for a total amount of 3400 kg. Finally 2940 kg have really been restocked.

In 2014, eleven projects have been selected for a total amount of 6307 kg. Finally 5656 kg have really been restocked.

In 2015, twelve projects have been selected for a total amount of 3951 kg. Finally 1154 kg have really been restocked.

Apart from this national restocking program, some local restocking may have taken place but quantity, quality (glass eel or yellow eel, ...), origins and objectives are unknown. For example: they have been a long history of stocking in Lake Grand Lieu (Adam, 1997) to enhance fishery with a maximum of more than 2 t of glass eels in the 1960s and more than 1.5 t of elvers in the 1990s. Dekker and Beaulaton (submitted) make a review of XIXth century's French data.

Table FR 7. Quantity (in kg) of glass eels restocked in France per EMU between 2010 and 2015. * = glass eels from a CITES seizure. (in yellow updated value).

EMU	2010	2011	2012	2013	2014	2015
Artois-Picardie	0	45	37	34	35	
Seine-Normandie	0	134	111	53	130	
Britanny	0	200	333	306	650	225
Loire	209 *	323.5	1684	1667	3232	
Garonne	0	45	870	563	1259	929
Adour	0	0	51	302	350	
Total	209	747.5	3086	2925	5656	1154

3.5.2 Catch of eel <12 cm and proportion retained for restocking

See landings and restocking in Table FR 8.

3.5.3 Reconstructed time-series on stocking

Table FR 9 presents a summary of known quantity of stocked eel. At present only those from the national restocking program are fully known. Some local restocking may have taken place but quantity, quality (glass eel or yellow eel, ...), origins and objectives are unknown. Recent findings in historical grey literature show that restocking in France has begun as soon as the mid XIXth and that quantity can be important (Dekker and Beaulaton, submitted), this is not reported here.

Table FR 9. Reconstructed time-series on stocking. Quantity in kg. * = from a CITES seizure, unknown origin.

Year	LOCAL SOURCE				FOREIGN SOURCE			
	Glass Eel (kg)	Quarantined Glass Eel	Wild Bootlace	On-grown cultured	Glass Eel	Quarantined Glass Eel (kg)	Wild Bootlace	On-grown cultured
2010						209*		
2011	748.5							
2012	3086							
2013	2940							
2014	5656							
2015	1154							

3.6 Silver eel “restocking”

Glass eels have never been exploited on the French Mediterranean coast. Restocking measures were therefore not applicable on the Mediterranean coastline. Instead, a new approach was experienced in 2011: a part of the exploited silver eels was released to the sea. In the Rhône Méditerranée and Corsica EMUs, eel fishing activity is principally located in lagoons and both yellow and silver stages are targeted. Fishermen working in lagoons are small-scale fishers (boat <7 m, using passive gears: mostly assemblage of fykenets called capechades), relying mostly on eel species to sustain their livelihoods. This pilot study was closely followed by the scientists and the governmental authorities. A protocol was designed by a group of scientists (Amilhat *et*

al., 2012a) to ensure the respect of good practices. Eels were released at the mouth of the lagoons with direct access to the sea (no dams or fishing gears). They were released at dawn, their natural time to migrate, shortly after they have been captured (mostly the following night). In total 16 044 kg of silver eels have been released in 2011, 17 281 in 2012, 17 488 in 2013 and 25 606 in 2014 from ten locations (Figure FR 11 and Table FR 12) in the Languedoc Roussillon region (for details see Amilhat *et al.*, 2012b, 2013, 2014, 2015 in prep.).

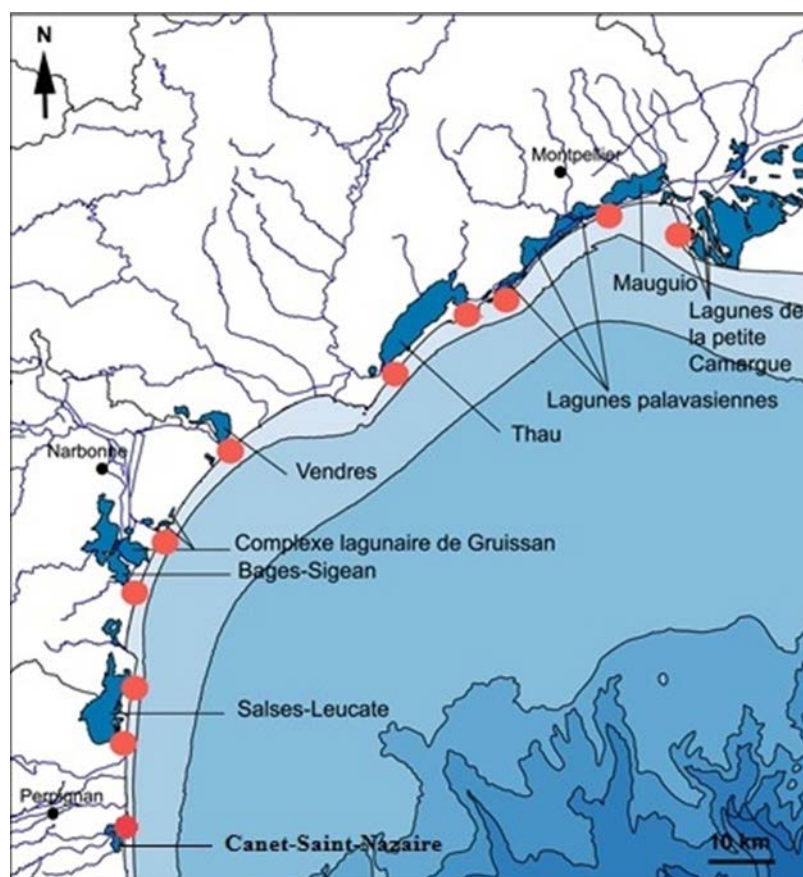


Figure FR 11. Locations (red dots) where silver eels were released (©S. Berné background map).

Table FR 12. Quantity of silver eels released.

Lagoon(s)	Code	released quantity (kg)			
		2011	2012	2013	2014
Canet-St-Nazaire	Canet	-	-	270	816
Salses-Leucate (Barcarès sector)	LeucateS	1452	2016	1620	2856
Salses-Leucate (Leucate sector)	LeucateN	983.5	683	810	948
Bages-Sigean (South)	BagesS	1452	1386	1485	1632
Bages-Sigean (North)	BagesN	1188	1260	1350	1632
Gruissan lagoons (Ayrolle, Campagnol, Gruissan)	Gruissan	1974.5	2006.5	1748	2627
Vendres	Vendres	528	378	350	408
Thau (Marseillan sector)	Thau1_M	924	1512	1215	2040
Thau (Bouzigues sector)	Thau2_B	924	756	675	956
Thau (Sète sector)	Thau3_S	3168	3756	3915	4967
Palavas lagoons(Ingril, Vic, Pierre Blanche, Arnel, Pérols, Moures)	Palavas	942	1134	1350	2244
Mauguio	Mauguio	1716	1638	1620	2848
Little Camargue lagoons (Ponant, Médard, Murette)	PetiteC	792	756	1080	1632
Total (kg)		16 044	17 282	17 488	25 606
Estimated number of eels released		97 913	111 409	111 695	161 866
Number of fishermen involved		125	138	130	127
Time period		24 November– 29 December	8 November– 14 December	7 November– 12 December	8 December– 19 January

4 Fishing capacity

Since the enforcement of the management plan, the number of fishermen licensed for eel is reported at the national level. Data are given separately for the Mediterranean lagoons which have different regulations.

Before the entry into force of the French EMP, there was no special licence for yellow (and silver) eels fluvial fishermen.

4.1 Glass eel

The eel fishery is regulated by a licence and a local basin “stamp” is necessary to go fishing for glass eel in a given location. These “stamps” are granting access to the whole EMU but to a more local level.

Before 2015, licences were delivered annually but the fishing season overlapped from one year to the next. From 2015, licences are delivered for the fishing season. The number of licences delivered for glass eel has been steadily diminishing from a total of 1224 in 2006 to 413 in 2015 (Table FR 11).

Table FR 12 gives the details by EMU. Fishing for glass eel is not authorized in the Rhône Mediterranean, nor in the Corsica EMU. Before 2014, a fisher could have a licence in more than one UGA. This explains why the total number of licences before that year does not correspond to the total given in Table FR 11.

Table FR 11. Glass eel fishers.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Marine commercial fishermen	853	862	814	754	643	573	500	475	457	412
Marine commercial hand net fishermen (Adour)	?	?	?	?	25	21	9	10	13	13
Fluvial Commercial fishermen	371	343	328	205	180	158	147	145	129	106
Total	>1 224	>1 205	>1 142	>959	848	752	656	630	599	531
Amateur	?	?	?	?						

□ Fishing f

The fishing licences comprise both fluvial and marine fishermen.

Table FR 12. Glass eel licences per EMU.

	ARTOIS PICARDIE	SEINE NORMANDIE	BRETAGNE	LOIRE ET CÔTIERS VENDÉENS	GARONNE- DORDOGNE- CHARENTE	ADOUR ET LANDES
2009	19	22	142	366	296	173
2010	15	18	121	311	252	154
2011	12	16	104	281	226	132
2012	12	14	99	233	209	105
2013	13	12	91	223	199	104
2014	12	12	81	210	180	104
2015	10	10	64	200	165	90

4.2 Yellow eel

In addition to the diminution in the number of licences for yellow eel, several sectors have been closed for PCB contamination reasons (Seine, Rhône, Saône, Gironde estuary...).

Table FR 13. Yellow eel licences.

	2009	2010	2011	2012	2013	2014	2015
Marine commercial fishermen	309	268	245	236	222	248	226
Mediterranean and Corsica (Yellow and Silver) commercial fishermen	.	295	2653	269	229	218	201
Fluvial commercial fishermen	169	171	170	169	175	146	145
Fluvial amateur with gears	.	.	.	5224			
Anglers ⁴	.	.	1 414 017	1 321 924			

Table FR 14. Yellow eel licences per EMU in 2015.

	MARINE COMMERCIAL FISHERMEN	FLUVIAL COMMERCIAL FISHERMEN	TOTAL
Rhin-Meuse	0	0	0
Artois-Picardie	1	0	1
Seine-Normandie	8	0	8
Bretagne	10	0	10
Loire ...	58	55	113
Garonne ...	130	53	183
Adour	20	24	44
Rhône-Méditerranée	190	13	203
Corse	11	-	11
Total	427	145	573

4.3 Silver eel

Since the adoption of the French eel management plan, fishing for silver eels is no longer allowed in marine waters except in the Mediterranean lagoons where a specific licence is required (Table FR 27). In fluvial areas, commercial fishermen are allowed to fish silver eels in some specific areas of the Loire EMU (mostly in the Loire river itself and in the Grand Lieu lake) and in the Rhône-Méditerranée EMU, in the downstream part of the Rhône river. However, due to PCB contamination, silver eel is only fished in the Loire EMU.

³ Interregional number fixed.

⁴ Not eel specific licence. Eel fishing report is mandatory but no statistics are available yet.

Table FR 15. Silver eel licences.

	2009	2010	2011	2012	2013	2014	2015
Marine fishermen	Not allowed (NR)						
Mediterranean and Corsica (Yellow and Silver)		295	265	269	229	219	193
Fluvial fishermen	44	41	37	34	34	34	33
Fluvial amateur with gears	Not allowed						
Anglers	Not allowed						

Table FR 16. Silver eel licences by EMU in 2015.

	MARINE COMMERCIAL FISHERMEN	FLUVIAL COMMERCIAL FISHERMEN	TOTAL
Bretagne	-	1	1
Loire ...	-	19	20
Rhône-Méditerranée	203	13	216
Corse	16	-	16
Total	219	33	252

5 Fishing effort

No data available.

6 Catches and landings

6.1 Glass eel

Since the 2009–2010 season a TAC and quota system has been set up. The TAC is split by EMU, sometimes by river or group of river and there are specific restocking quotas (also split according to the same geographical pattern. From 2011–2012 to 2013–2014, the quota system has limited the fishing effort and created long period without fishing. This was no longer the case in 2014/2015 where both a higher quota level along with a drop in recruitment resulted in an increase in the period of fishing.

Table FR 17. Trend in glass eel landings (kg), marine commercial fishermen, Source MEDDE-DPMA; WGEEL 2009; WGEEL 2010; WGEEL 2011; WGEEL 2012. Quota allowed is also given.

EMU	2007/ 2008	2009/ 2010	2010/ 2011 ⁵	2011/ 2012	2012/ 2013	2013/ 2014	2014/ 2015
Artois Picardie	1175	460	278	468 ⁶	384	499	288
Seine Normandie		860	400	369	694	975	427
Bretagne	5864	4095	3619	3322 ⁸	2000	4340	5307
Loire et Côtiers Vendéens	42 816	24 761	17 415	18 415 ⁸	15 281	14 924	17 389
Garonne- Dordogne- Charente	17 031	6423	5352	6928	9692	7562	7712
Adour et Landes	4 519	537	1 353	949	1126	2006	1060
France	71 405 ⁷	37 177 ⁸	28 417 ⁹	30 452 ¹⁰	29 179	30 306	32 183
Quota		53 540	38 860	32 190	29 580	36 975	62 250

Table FR 18. Trend in glass eel landings (kg), fluvial fishermen, Source ONEMA-MEDDE (DEB). Quota allowed is also given.

EMU	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015
Loire et Côtiers Vendéens	3316	1270	3114	1669	2 094	1727	1787	1624
Garonne- Dordogne- Charente	1727	143	26	236	646	1120	1218	812
Adour et Landes	2224	217	542	936	1 105	1592	2030	1475
France	7267	1630	3683	2840	3 845	4439	5035	3911
Quota			8000	5806	4 810	4420	5525	9751

yy.6/2013-2013 fisheries have been banned due to a PCB level above consumption limit.

⁵ Source FranceAgrimer (DPMA), WGEEL 2011.

⁶ In cases where the total amount of catch is lower than the “official quota report”, the official figure is used. The latter is then based on trade reports.

⁷ Extrapolated, see WGEEL 2009, 31 847 in the official database.

⁸ Probably quite inaccurate.

⁹ Note that this value is lower than official figure (32 291), see WGEEL 2011 for explanation.

¹⁰ Updated from national database in July 2011, this figure is slightly larger than official quota report 30 361.

6.2 Yellow eel

6.2.1 Marine fishery

6.2.1.1 Atlantic and channel

No data available.

6.2.1.2 Mediterranean lagoons

No data available.

6.2.2 River fishery

The declared landings of professional fluvial fishermen is given in Table FR 19.

Table FR 19. Declared landings of yellow eels caught by commercial fluvial fishermen per EMU.
Source: SNPE ONEMA (yellow highlighting indicates changes from previous table).

	2007	2008	2009	2010	2011	2012	2013	2014
Rhin	724			131	647	0	0	0
Seine	862	230	120	214	0	0	0	0
Loire	6447	11 755	13621	12 507	8372	9665	7283	5423
Garonne	7572	15 185	14535	697	1572	5495	8535	3668
Adour	706	515	458	552	498	245	50	577
Rhône	576	1	0	0	0	0	0	0
Total	16 887	27 686	28 734	14 101	11 089	15 405	15 868	9668

The declared landings of recreational fluvial fishermen with gears in public domain is given in Table FR 20.

Table FR 20. Declared landings of yellow eels caught by recreational fluvial fisher with gears in public domain split by EMU. Source: SNPE Onema

	2007	2008	2009	2010	2011	2012	2013	2014
Rhin	0	0	165	207	56	161	62	51
Bretagne			6035	3767	2224	3507	3283	1903
Loire			1980	380	384	610	482	509
Garonne			730	579	625	531	511	705
Adour			108	34	32	71	18	3
Rhône			165	107	56	161	62	51
Total			9018	4867	3321	4880	4356	3171

No estimation of catch from recreational fishermen is available at the EMU or national level.

6.3 Silver eel

No precise statistics are available for marine fishermen (see 6.2).

Silver eel fishing for fluvial fishermen is only allowed in Loire and Rhône EMU. Due to PCB contamination silver eel fishing only takes place in Loire EMU. The status of

Grand Lieu lake being particular, we only give here the statistics for Loire EMU excluding this lake (Table FR 21).

Table FR 21. Declared silver eel landings for professional fluvial fisher in Loire EMU (Grand lieu Lake excluded). Source: SNPE ONEMA.

	LOIRE
2009	12 539
2010	17 151
2011	11 222
2012	3531
2013	1396
2014	4018

6.4 Recreational fishery

Recreational fishers are only allowed to fish for yellow eel according to French EMP. Catch from gear fishers in river public domain are given in 6.2.2. There are no up to date national estimate for anglers even if local estimate exist in some places.

6.5 Bycatch, underreporting, illegal activities

Table 6-x. Estimation of underreported catches in Country, per EMU and Stage.

Year	EMU_code	GLASS EEL				YELLOW EEL				SILVER EEL				COMBINED (Y + S)			
		Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)
2013	EMU_a																
	EMU_b																
	EMU_c																
	EMU_d																
	EMU_e																
	EMU_f																
	Total/mean (%)																

Table FR 22 summarizes all data we have on illegal fisheries and quantity seized. Table FR 22. Existence of illegal activities, its causes and the seizures quantity they have caused in 2014. Seizure data should be considered as a minimum. However since many enforcement service can seized eels these data should be considered as a minimum.

Table FR 22. Existence of illegal activities, its causes and the seizures quantity they have caused in 2014. Seizure data should be considered as a minimum.

GLASS EEL				YELLOW EEL				SILVER EEL				COMBINED (Y +S)	
EMU	Y/N/?	Cause	Seizures (kg)	Y/N/?	Seizures (kg)	Cause	Y/N/?	Seizures (kg)	Cause	Y/N/?	Seizures (kg)	Cause	
RMS	N			?			?						
ARP	?			?			?						
SEN	?			?			?						
BRE	Y		477	Y			Y						
LCV	Y			Y			Y						
GDC	Y			Y	34.5		Y	80.5					
ADR	Y			?			Y						
RMD	?			Y			Y	701					
COR	?			Y			Y						
Total			647		65			892					

7 Catch per unit of effort

7.1 Glass eel

No new data at the national scale.

7.2 The Garonne (Garonne EMU)

The Gironde basin is the tidal part (Figure FR 1 and Figure FR 2) of the Garonne basin, comprising the brackish estuary and the tidal freshwater reach of the Garonne River, Dordogne River and of its tributary, the Isle River. The results are provided by the Irstea statistical monitoring system and have been studied by Beaulaton (2008).

One of the notable features of the glass eel fishery in the Gironde is the major shift from scoopnet catches in favour of large push net catches (Figure FR 7 and Table FR 23). The fishery is currently very largely a large pushnet fishery in the estuary, whereas formerly it was a scoopnet fishery in freshwater estuary.

After a large decrease of the glass eel abundance (cpue) in the Gironde basin between 1981 and 1985, the cpue slightly decreased to reach its lowest level in the last recorded year between 2003 and 2012 (Figure FR 7 and Table FR 23). The legal catches remain at the same level the last three years while the cpue increased in 2013, due to a lower fishing effort (less professional fishermen) (Figure FR 12 and Table FR 26).

Table FR 23. Catches of glass eel for professional large push net (LPN), small pushnet (SPN) and scoopnet (SN) and non-professional scoopnet fishermen, cpue on the Gironde basin for 1961–2008 (Source: Irstea). “-” : gears not used that year ; “?” unevaluated.

YEAR	TOTAL CATCH (T)			CPUE (KG/DAY)	
	Pro. LPN	Pro. SN	Pro. SPN	NonPro. SN	Pro. LPN
1960-1961	-	32.2	-	?	
1961-1962	-	217.8	-	?	
1962-1963	-	363	-	?	
1963-1964	-	?	-	?	
1964-1965	-	352.5	-	?	
1965-1966	-	27.6	-	?	
1966-1967	-	162.8	-	?	
1967-1968	-	284.2	-	?	
1968-1969	-	36.6	-	?	
1969-1970	-	203.8	-	?	
1970-1971	-	47.1	-	?	
1971-1972	-	69	-	?	
1972-1973	-	20	-	?	
1973-1974	1.9	52.7	-	?	7.8
1974-1975	6.6	37.5	-	?	6.7
1975-1976	25.2	95.7	-	?	13.2
1976-1977	39	82.6	-	?	11.7
1977-1978	26.7	83.3	-	107.8	12.8
1978-1979	28	89.7	-	116.2	14
1979-1980	45.8	167.3	-	217.1	25.4
1980-1981	45.5	78.3	-	150.6	14.9
1981-1982	49.6	36.6	-	36.5	10.9
1982-1983	49.5	25.8	-	26.9	12.7
1983-1984	30.5	26	-	26	17.6
1984-1985	16.3	11.7	-	11.8	8.1
1985-1986	26.3	13.6	-	14.4	8.8
1986-1987	31.9	25	-	28.6	13.5
1987-1988	25.4	6.7	-	6.7	9.3
1988-1989	37.5	15.6	-	17.3	7.1
1989-1990	28.6	8.6	-	9	5.6
1990-1991	36	9.6	-	14.5	8.5
1991-1992	17	8	-	12.8	4.5
1992-1993	29.6	11.6	-	21.7	8.9
1993-1994	34.6	6.5	-	12.4	9.2
1994-1995	47.5	9.6	-	18.9	7.9
1995-1996	21.4	1.5	2.2	4.2	4.7
1996-1997	33	3.6	7.9	6.4	6.3
1997-1998	14.1	0.4	1.7	1	3.8
1998-1999	40.6	0.8	7.5	2.7	8.9
1999-2000	21.2	0.1	3.4	0.3	6.6

YEAR	TOTAL CATCH (t)			CPUE (KG/DAY)	
	Pro. LPN	Pro. SN	Pro. SPN	NonPro. SN	Pro. LPN
2000-2001	8.8	0	0.2	0.1	1.9
2001-2002	28.3	3.8	4.7	6.2	4.9
2002-2003	9.5	0.1	0.8	0.1	2.7
2003-2004	13.3	0.1	1	0.1	2.5
2004-2005	12.9	0.8	3.6	0.5	2.7
2005-2006	8.1	0	1.2	0	2.4
2006-2007	6.2	0.1	1.1	0.1	2.1
2007-2008	8.2	0.4	1.3	0.2	2.6
2008-2009	3.5	0	0	0	1.4
2009-2010	3.4	0	0	-	1.2
2010-2011	4.5	0.3	0.2	-	1.8
2011-2012	4.5	0.1	0.3	-	2.9
2012-2013	4.6	0.1	1.0	-	4.9
2013-2014	3.9	0.05		-	6.3

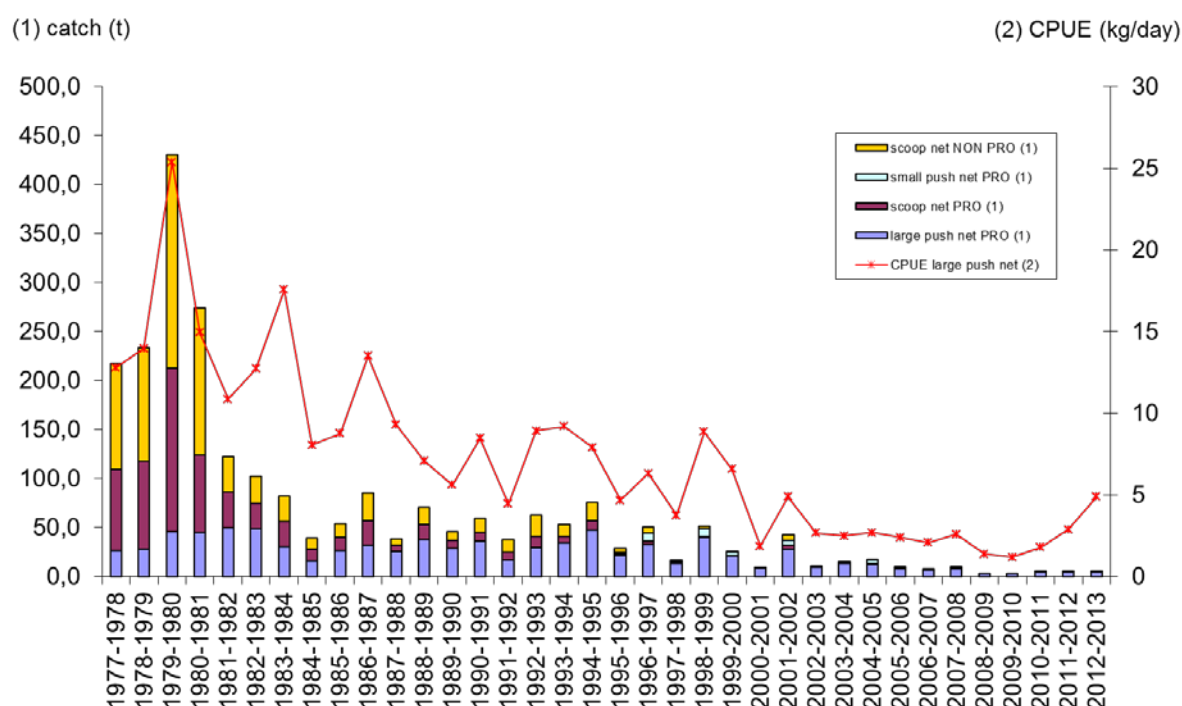


Figure FR 7. Cumulated capture of glass eel for non-commercial and commercial fishermen for 1978–2008, cpue of large pushnet professional fishermen on the Gironde basin for 1978–2011 (Source: Irstea).

7.3 Yellow eel

7.3.1 The Garonne (Garonne EMU)

Yellow eel cpue for the Gironde basin have been extended by Beaulaton (2008). The eelpot cpue increase in the 1970s, mainly because of change of eelpot (from wooden to plastic). Then the eelpot cpue for yellow eel has fallen since the middle of the

1980s, slightly increased until 1998 before decreasing again until 2007 (Table FR 24 and Figure FR 8). The total catches have decreased while the number of fishermen has also decreased. But changes in the fishing power and in the tactics have increased the real effort and our effort unit does not reflect these changes. Consequently, this cpue is not fully representative of the real current tendency of the abundance which presents certainly a more marked decrease. After a ban of the fishery in 2010 and 2011 because of the contamination by PCB, the cpue reach a high level but in connection with a limited period of fishing and a few number of fishermen.

Table FR 24. Catches of yellow eel for professional and non-professional (from 1978 onwards only) yellow eel fishermen, cpue on the Gironde basin for 1894–2010 (Source: Irstea). * major fisheries have been banned due to PCB level.

YEAR	TOTAL CATCH (T)		CPUE (KG/EELPOT/MONTH)
	Pro.	Non Pro.	Pro.
1894	26.2		
1895	40.5		
1896	42.1		
1897	61.6		
1898	53.7		
1899	43.5		
1900	41.8		
1901	43.9		
1902	29.1		
1903	38.1		
1949	10.7		
1950			
1951	15.4		0.5
1952	17.6		0.5
1953			
1954	77.5		1
1955			
1956	51.9		0.7
1957			
1958			
1959	123.8		1.4
1960	265.3		2.5
1961	69.4		0.9
1962	56.8		0.8
1963	53.1		0.9
1964	14.5		0.6
1965	18.4		0.5
1966	6.3		0.7
1967	21.5		0.9
1968	40.8		0.8
1969	87.8		3.3

YEAR	TOTAL CATCH (t)		CPUE (KG/EELPOT/MONTH)
	Pro.	Non Pro.	Pro.
1970	42.4		1.4
1971	43.1		1.7
1972	80.6		1.9
1973	168.6		1.2
1974	108.2		2.7
1975	130.8		2.3
1976	84.8		1.8
1977	314.8		2.8
1978	157.9	204.1	2.6
1979	152.5	229.5	3.7
1980	108.4	155.7	2.5
1981	143.5	148.8	1.6
1982	164.3	133.1	3.3
1983	166	76.2	2.6
1984	148.8	164.1	2.8
1985	172.4	170.3	3.4
1986	208.8	160.5	3.3
1987	167.7	134.3	1.3
1988	140	97.7	1.9
1989	70.4	40.2	1
1990	67	28.3	1
1991	67.5	15.8	1.1
1992	58.5	27.7	1.1
1993	42.2	21.4	1.5
1994	48.7	21.1	1.5
1995	55.8	18.4	1.4
1996	38.8	7.7	1.3
1997	43.7	9.7	1.3
1998	36.1	7.3	1.3
1999	27.3	1.5	1.2
2000	27.9	1.4	1
2001	29.4	0.6	1.1
2002	15.8	1.1	0.9
2003	12.8	0.5	0.8
2004	14.4	1.3	1.3
2005	8.6	0.6	0.8
2006	8.4	0.6	0.9
2007	8.8	0.8	1
2008	12.4	1.3	2.3
2009	24.2	1.6	2.1
2010	1.3	0	_*
2011	0.6	0	_*
2012	5.2	0.5	1.2
2013	9.4	1.4	1.8

YEAR	TOTAL CATCH (t)		CPUE (KG/EELPOT/MONTH)
	Pro.	Non Pro.	Pro.
2014	4.3	0.4	1.3

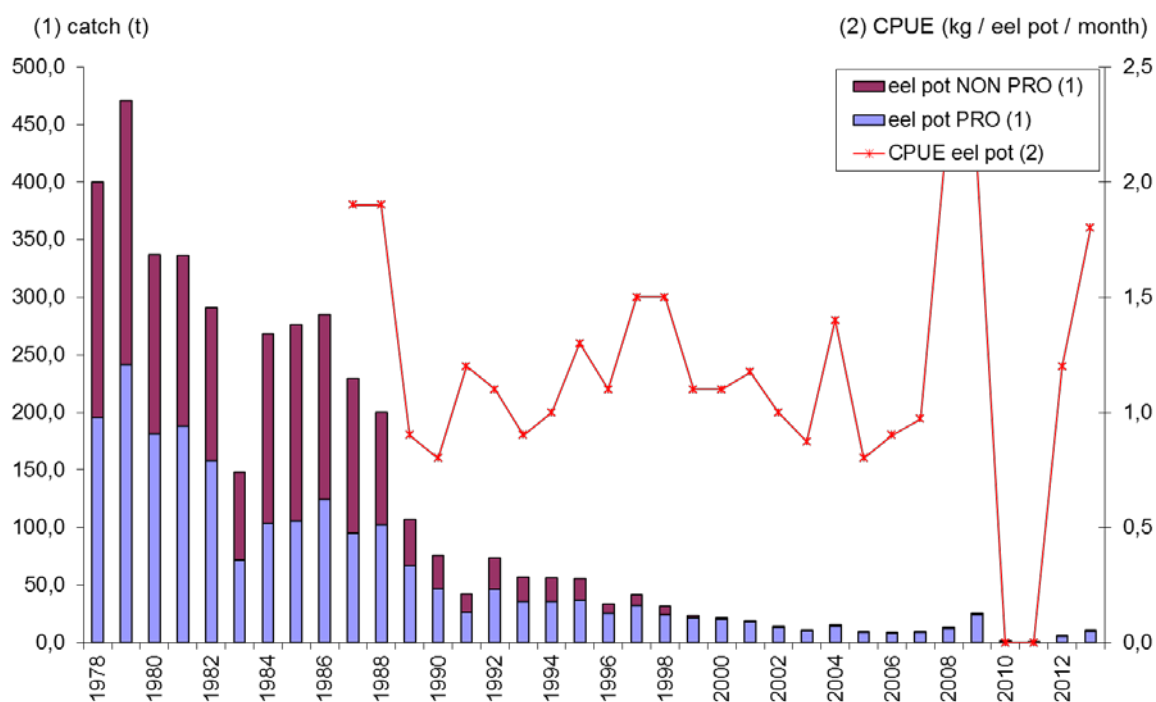


Figure FR 8. Cumulated catch of yellow eel for commercial and non-commercial fishermen, cpue on the Gironde basin for 1978–2013 (Source: Irstea).

7.4 Silver eel

Cpue have been extracted from data of a sample of four (three in between 2004 and 2007) fishers of the Guideau fishery (Boisneau and Boisneau 2014; Figure FR 9). They show a significant decreasing trend over the 26 years.

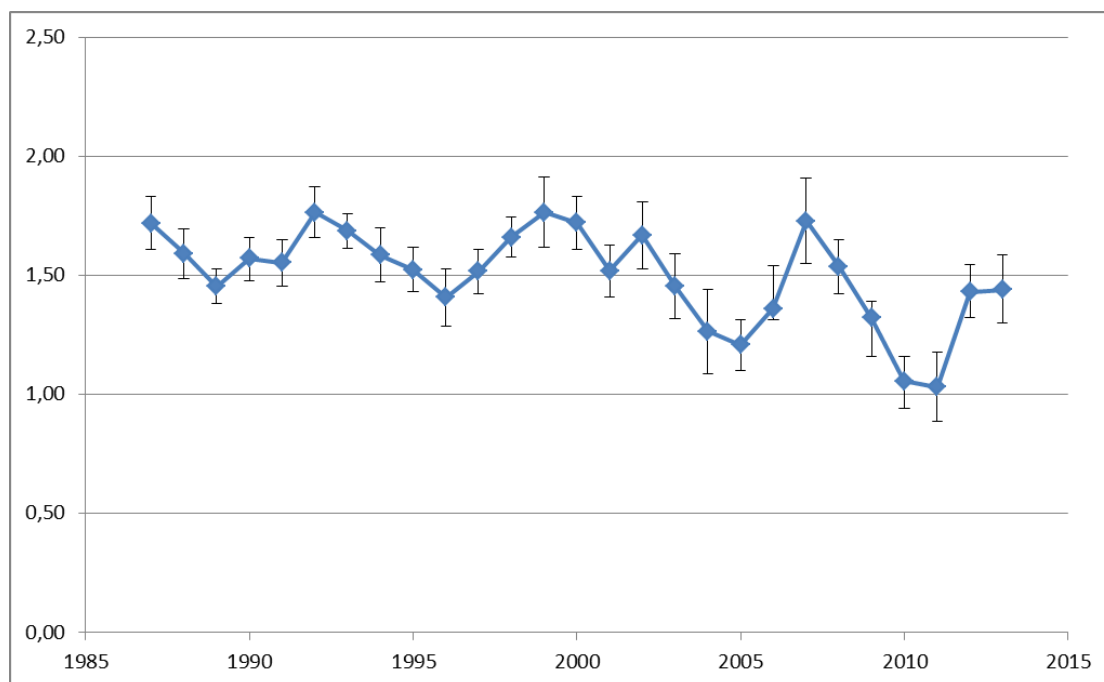


Figure FR 9. Cpue from four* Guideau fisheries (silver eel) in the Loire river (Boisneau and Boisneau, 2014). (*three fisheries between 2004 and 2007).

8 Other anthropogenic and environmental impacts

The Figure FR 10 highlighted contrasted evolution of the discharge in the estuary. Since 1960 the Gironde discharge has been highly decreasing, lightly in Loire while the discharge remained stable in Seine. Moreover the summer temperature in the Gironde estuary has increased by 2.5°C in 30 years. In France the concentration in nitrate has increased until the 1990s and has been stabilized since. Metallic and organic pollution is not well known and evolutions are site-specific (Le Treut (Ed.), 2013)

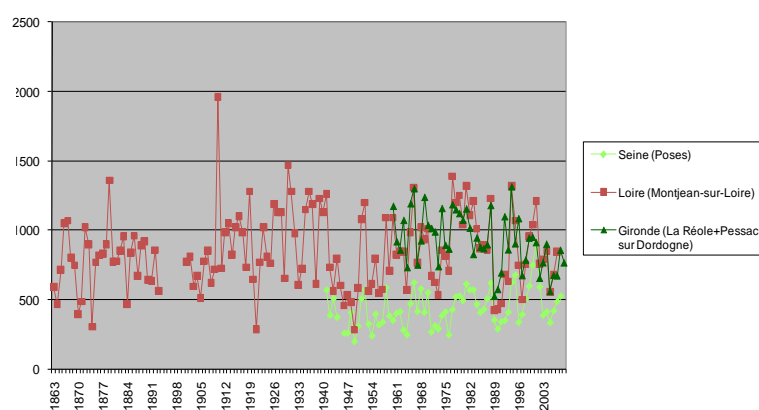


Figure FR 10. Evolution of discharge of Seine, Loire and Gironde Rivers at the river mouth (data sources Seine: GIP seine aval, MEEDAT, banque Hydro, Loire: GIP Loire Estuaire, Banque Hydro, CMB, Gironde: PAB).

9 Scientific surveys of the stock

9.1 Recruitment survey, glass eel

9.1.1 The Gironde (Garonne EMU)

The Gironde survey consists in a monthly sampling of 24 stations (surface + deep) distributed along four transects. This monitoring uses an estuarine research vessel (Figure FR 11) and aims at evaluating the abundance variations of the juveniles of fish and crustacean and the adults of small species.



Figure FR 11. “L’Esturial” boat used for scientific survey in the Gironde (Source: Irstea).

The results (annual average from September to August) for glass eels highlight a sharp decrease for season 1999–2000 and a steady low decrease afterwards. An increase is recorded for the two seasons 2012–2013 and 2013–2014 and a new decrease for the last season (2014–2015). In the main, this analysis confirms results coming from fishery data (Table FR 25) even if some little differences remain to analyse.

Table FR 25. Time-series for the Gironde glass eel recruitment data by migratory season= year (n-1)- (n). (Girardin and Castelnaud, 2015).

SEASON (N-1,N)	1990	2000	2010
0		1.00	0.10
1		0.36	0.16
2	1.75	1.02	0.07
3	2.83	0.28	0.19
4	2.20	0.30	0.39
5	2.92	0.53	0.10
6	2.07	0.27	
7	3.14	0.14	
8		0.28	
9	3.49	0.44	

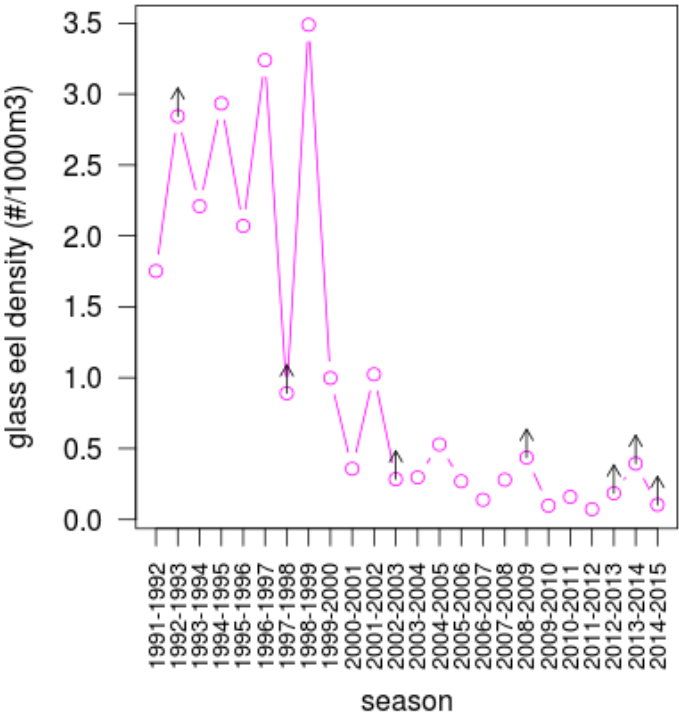


Figure FR 12. Results of the glass eel recruitment survey in the Gironde (↑ indicates a possible underestimates from missing sampling during the main part of the migration).

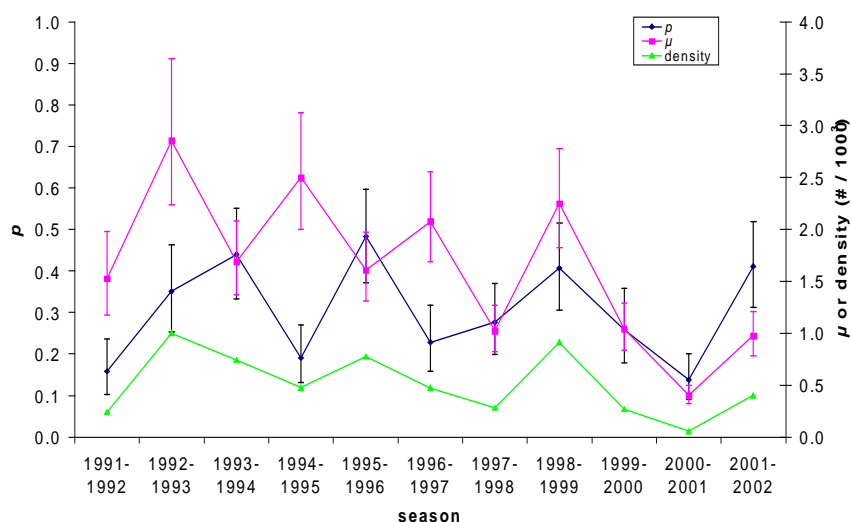


Figure FR 13. Results for glass eel of a delta-gamma analysis for season effect (p =probability of positive capture, μ =mean capture for only positive capture, density= $p \cdot \mu$) (extracted from Lambert, 2005).

These data were from seasons 1991–1992 to 2001–2002 were analysed by Lambert (2005) using a delta-gamma approach (Stefánsson, 1996). This method allows separate analyses of the presence probability (p) and positive capture (μ) and joint analyse through overall density. The delta and gamma approaches were performed thanks to generalized linear models (GLM; McCullagh and Nelder, 1989) with both spatial and temporal effects. Results on season effect (Figure FR 13) show some peculiar seasons like 2000–2001 for which glass eels were rarely caught (low p) and when caught, in small number (low μ), resulting in a very low density.

9.1.1 Index river system

In the framework of the French management plan, a network of index rivers (at least one for each EMU) are setting up in order to monitor ascending recruitment (glass eels or elvers) and migrating silver eels (Table FR 26).

Table FR 26. Selected river for a river index network.

EMU	SELECTED RIVER	UPSTREAM	DOWNSTREAM	STOCK IN PLACE
Adour	Courant de Soustons (fluvial basin with big lakes < 1000 km ²)	X	X	X
Gironde	Dronne (fluvial basin >1000 km ²)		X	
Loire	Sèvre Niortaise (marshes)	X	X	X
Bretagne	Frémur (fluvial basin <1000 km ²) and Vilaine (fluvial basin >1000 km ²)	X	X	X
Seine-Normandie	Bresle (fluvial basin <1000 km ²)	X	X	X
Artois-Picardie	Somme (fluvial basin >1000 km ²)	X	X	X
Rhône-Méditerranée	Rhône (fluvial basin >1000 km ²) and Vaccarès lagoon	X		X
Corse	Not yet selected			
Rhin-Meuse	Rhine (fluvial basin >1000 km ²)	X		

The Frémur and the Bresle River are part of this system and results for recruitment survey are given above.

9.2 Stock surveys, yellow eel

9.2.1 WFD survey

Water Framework Directive (WFD) survey is operated by Onema for fish compartment in rivers. The survey consists of electrofishing in 1500 sites in France every two years.

An example of results has been presented in previous report (Briand *et al.*, 2008a). Poulet *et al.* (2011) used these data to study time-trends in fish population (including eel) over a 20 year period (1990–2009) and 590 sites in France. They show that eel is one of the most declining fish both in terms of presence and abundance. Figure FR 14 shows the extraction per site from their results of the trend in eel population. Most sites show a decreasing trend.

Furthermore WFD survey is the raw data used by EDA model to assess the biomass (Jouanin *et al.*, 2012).

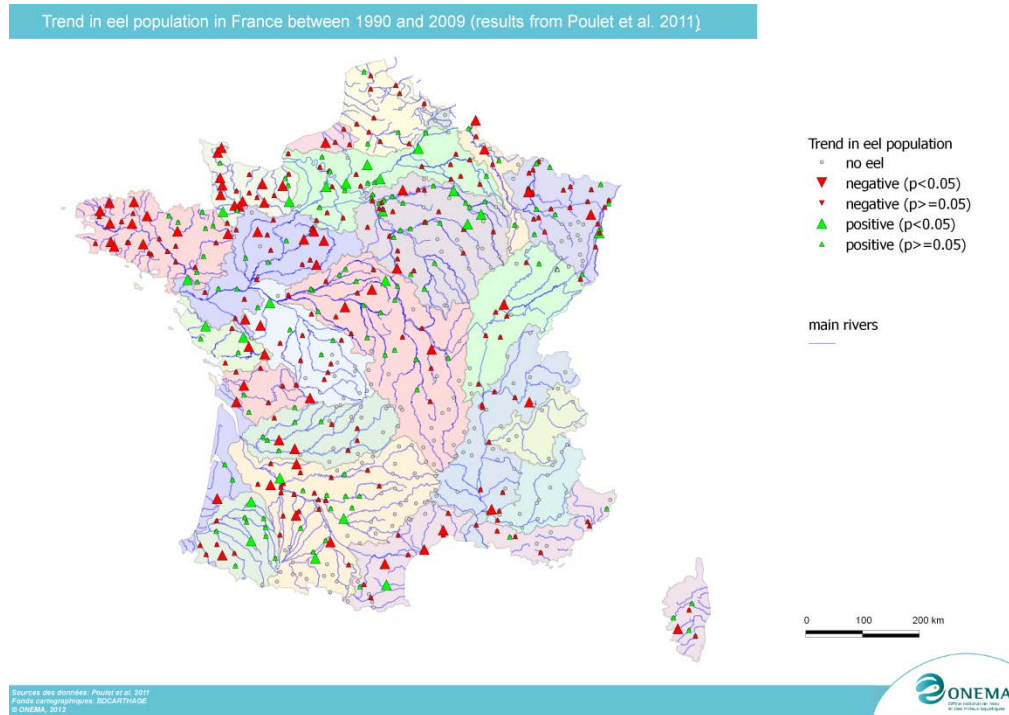


Figure FR 14. Trend in eel population in France between 1990 and 2009 according to Poulet *et al.* (2011) results.

9.2.2 Specific eel survey

To complete the WFD survey network, the French EMP established eel specific networks consisting of electrofishing network of sites close from the sea (<200 km) not covered by WFD network. There are about 300 sites that are fished in the following EMU: Artois-Picardie (62), Seine-Normandie (30), Brittany (49), Loire (27), Garonne (65), Adour (61). Some of them are localized on index river (Table FR 26).

Results need to be analysed.

9.3 Silver eel

9.3.1 Index river system

The index river system describe above (1.1.1) also provide data on silver run. Bresle River and Frémur River results are described above.

10 Data collected for the DCF

Provide summary information on the monitoring of eel by EMU in the current year.

Table 10-1. Summary of the DCF monitoring implementation per EMU.

DATA	RIVER	LAKES	ESTUARIES	LAGOONS	COASTAL & MARINE
No. of production / escapement surveys ¹					
No. of recruitment time-series surveys ²					
No. fished aged					
No. of fished sexed					
No. of fish examined for parasites					
No. of fish examined for contaminants					
No. of non-fishery mortality studies ³					
Socio-economic survey					

¹ Surveys to estimate B_{best} and/or $B_{current}$ [These should include WFD surveys where the data are being used to estimate production and/or escapement of eel].

² Fishery-independent surveys.

³ Studies to determine ΣH for non-fisheries anthropogenic impacts, such as hydropower, barriers, predation, etc.

DCF data from 2010 have been analysed in Beaulaton *et al.* (2011). Data from 2011 have been analysed by Mahé and Sévin (2012) and are summarised here.

In 2011, 140 eels have been sampled between July and October: 60 in the Loire River, 39 in the Garonne River and 41 in the Dordogne River. The overall length–weight relationship is $W_t = 5.10^{-7} L_t^{3.2047}$ (Figure FR 15).

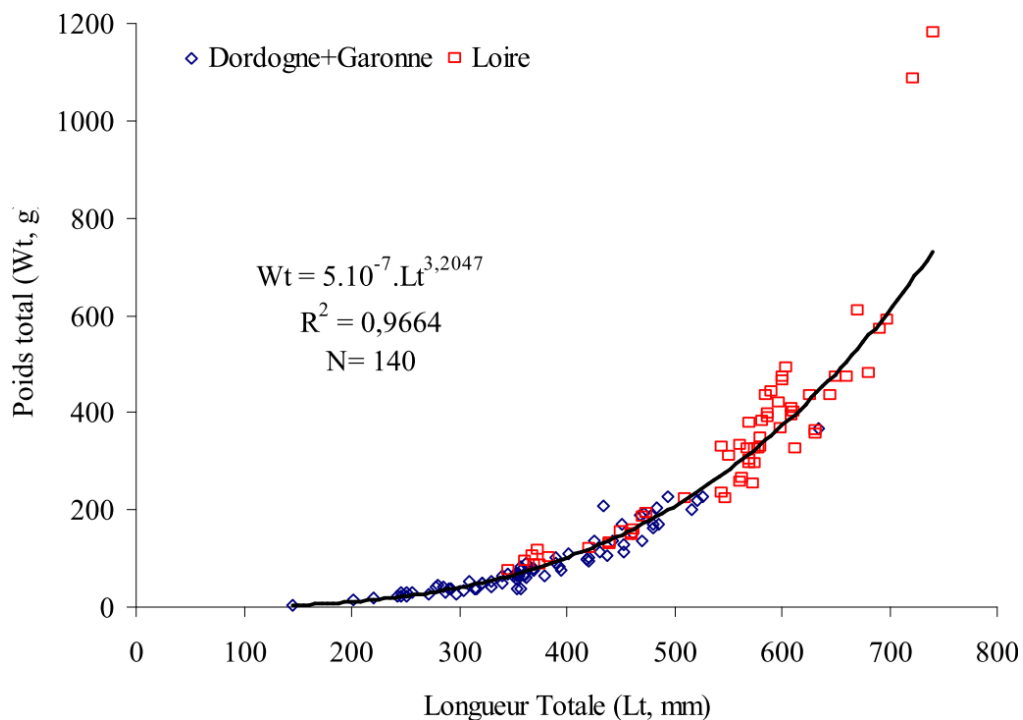


Figure FR 15. Length–weight relationship from 2011 DCF samples (from Mahé and Sévin, 2012).

From these 140 eels, 130 have been successfully aged (Figure FR 16). The age range from 2 to 16 years in the Dordogne and Garonne (mean = 7 years) and from 5 to 15 years in the Loire (mean = 11 years).

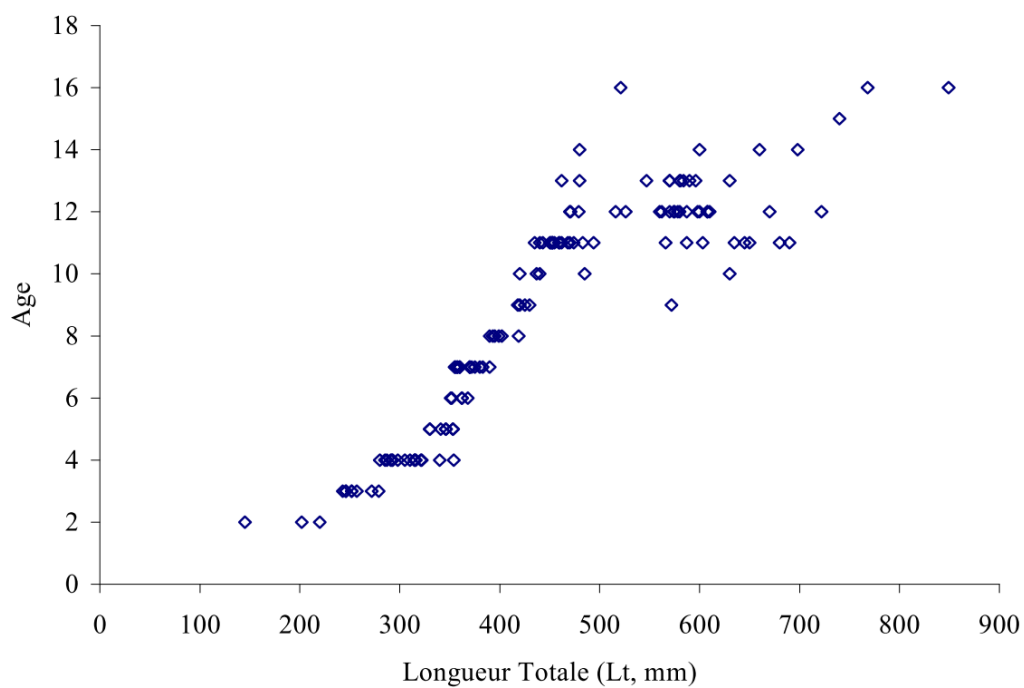


Figure FR 16. Length–age relationship from 2011 DCF samples (from Mahé and Sévin, 2012).

11 Life history and other biological information

11.1 Growth, silvering and mortality

von Bertalanffy parameters: L_{∞} , K , t_0

L_{50} = the length at which 50% of the population has silvered (my interpretation of 50% maturity)

Length and age at silvering

Fecundity

Weight-at-age

Length–weight relationship

11.1.1 Garonne EMU

In the study of Lamaison (2005) age was estimated in 19% among the 865 otoliths, Based on a generalized estimating equation regression model (Horton and Lipsitz, 1999), this author found different mean linear growth rates according to sectors in the Garonne catchment (Table FR 27).

Table FR 27. Mean linear growth rate in the Garonne basin for year 2004 (Lamaison, 2005)

SECTOR IN THE CATCHMENT		LINEAR GROWTH RATE (MM/YEAR)
ESTUARY		67,53
GARONNE	Tidal freshwater zone (zone mixte)	53,49
	Tributaries of tidal freshwater zone	50,54
	Mainstream river	46,84
	Tributaries of mainstream river	44,70
	First obstacle of the mainstream river	43,65
DORDOGNE	Tidal freshwater zone (zone mixte)	50,33
	Tributaries of tidal freshwater zone	46,77
	Tributaries of mainstream river	41,86
	First obstacle of the mainstream river	41,86

The length–weight relationship leads to the equation:

And explains 97% of the variance.

The condition factor (Blackwell *et al.*, 2000) shows differences between the estuary and the two main rivers Garonne and Dorgone (Table FR 28). On each river the worse condition factor are recorded for fish climbing the first obstacle (Lamaison, 2005)

Table FR 28. Condition factor in the Garonne basin for year 2004 (Lamaison, 2005).

SECTOR IN THE CATCHMENT		KN (%)
ESTUARY		118
GARONNE	Tidal freshwater zone (zone mixte)	114
	Tributaries of tidal freshwater zone	110
	Mainstream river	113
	Tributaries of mainstream river	108
	First obstacle of the mainstream river	101
DORDOGNE	Tidal freshwater zone (zone mixte)	112
	Tributaries of tidal freshwater zone	94
	Tributaries of mainstream river	96
	First obstacle of the mainstream river	88

11.1.2 France

Using the BDMAP database of ONEMA's electrofishing (Poulet *et al.*, 2011), we can determined the relationship between length and weight of 91 153 eels caught throughout France from 1978 to 2012 (Figure FR 17). This relationship can be summarised by a quantile regression between the log of length and the log of weight. For the quantile 25%, 50% (median) and 75% the intercept are respectively -14.52011, -14.15382, -13.73644 and the coefficient is 3.19175, 3.14903 and 3.09744. Table FR 29 summarizes statistics by length class. Those statistics however hide geographical and temporal differences that need to be analysed.

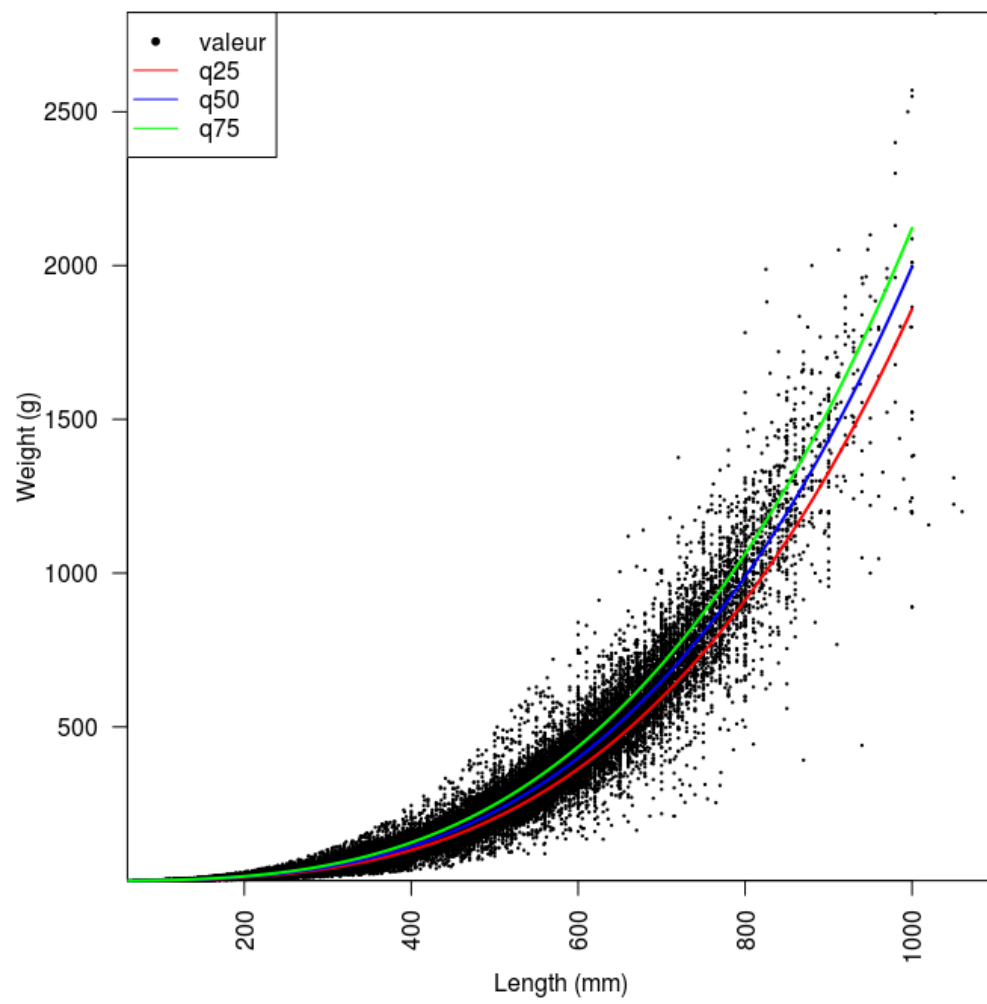


Figure FR 17. Length–weight relationship on French Eel (n = 91153) represented by quantile regression (25%, 50%, 75%).

Table FR 29. Weight by 20 mm length class. N = number of data used; q50, q05 and q95 = quantile statistic and Ws = predicted weight according to quantile 75% regression.

LENGTH	N	q50	[q05-q95]	Ws
100	378	2	[1 - 3]	1.7
150	1318	5	[2 - 8]	6
200	2501	12	[8 - 18]	14.5
250	3904	25	[18 - 35]	29
300	4746	45	[32 - 60]	50.9
350	4961	74	[53 - 100]	82.1
400	3206	110	[81 - 142]	124.2
450	2681	159	[119 - 204]	178.9
500	2313	226	[171 - 290]	247.9
550	1750	302	[231 - 387.5]	333
600	1163	400	[300 - 514.5]	436
650	812	514.5	[378 - 664.2]	558.7
700	596	663.5	[506 - 830.5]	702.8
750	312	810	[606.6 - 1074]	870.3
800	221	987	[672 - 1240]	1062.9
850	103	1200	[900.8 - 1498.7]	1282.4
900	47	1400	[1018.1 - 1670]	1530.8
950	12	1839	[1121 - 2073.6]	1809.9
1000	22	1523.5	[905.2 - 2547.5]	2121.5

11.2 Parasites and pathogens

11.3 Contaminants

11.4 Predators

No data available.

12 Other sampling

12.1 Silver eel transfer in Mediterranean lagoons

Since 2011, operations of transport to the sea of silver eels have been done yearly in autumn (3.7). A random sample of about 60 migrant silver eels (IO ≥ 6.5) was taken from each transport operation in order to characterize silver eels "population" in each lagoon. Figure FR 23 to FR29 present the results for length, Fulton's condition factor, percentage of lipids in muscle and sex-ratio. Males and females were distinguished according to their size, ≤ 45 cm for males and >45 cm for females.

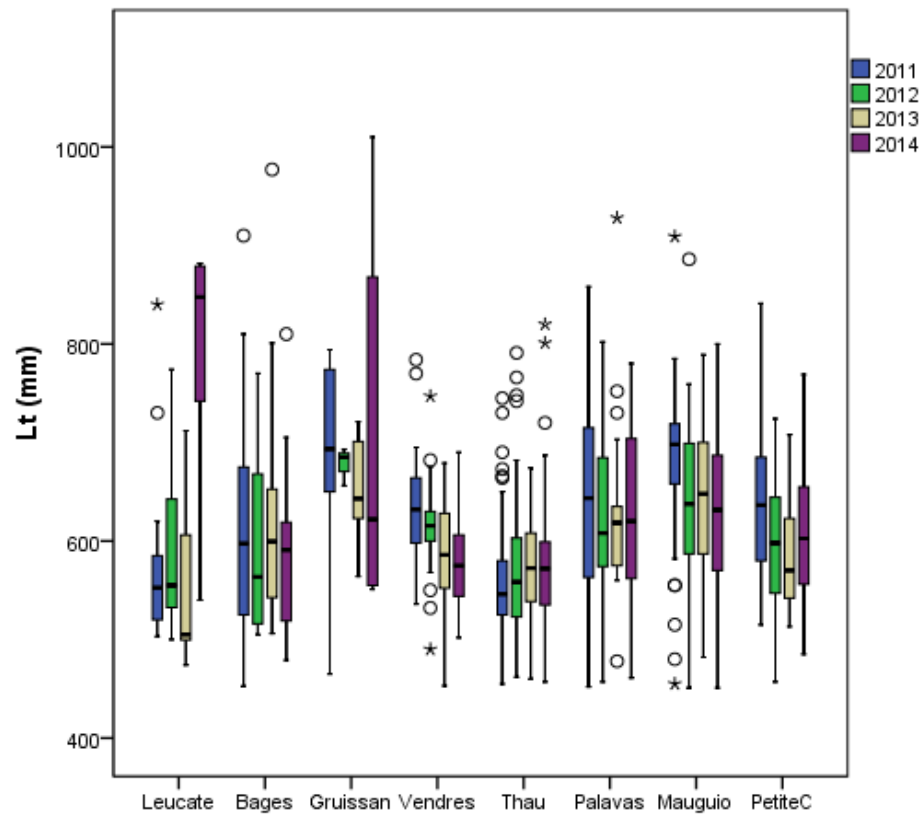


Figure FR 23. Total length (in mm) of silver eels females sampled during the transport operations from 2011 to 2014 (see Figure FR 11 for locations). N<10 in Gruissan in 2011, 2012 and 2014; Leucate in 2012, 2013 and 2014.

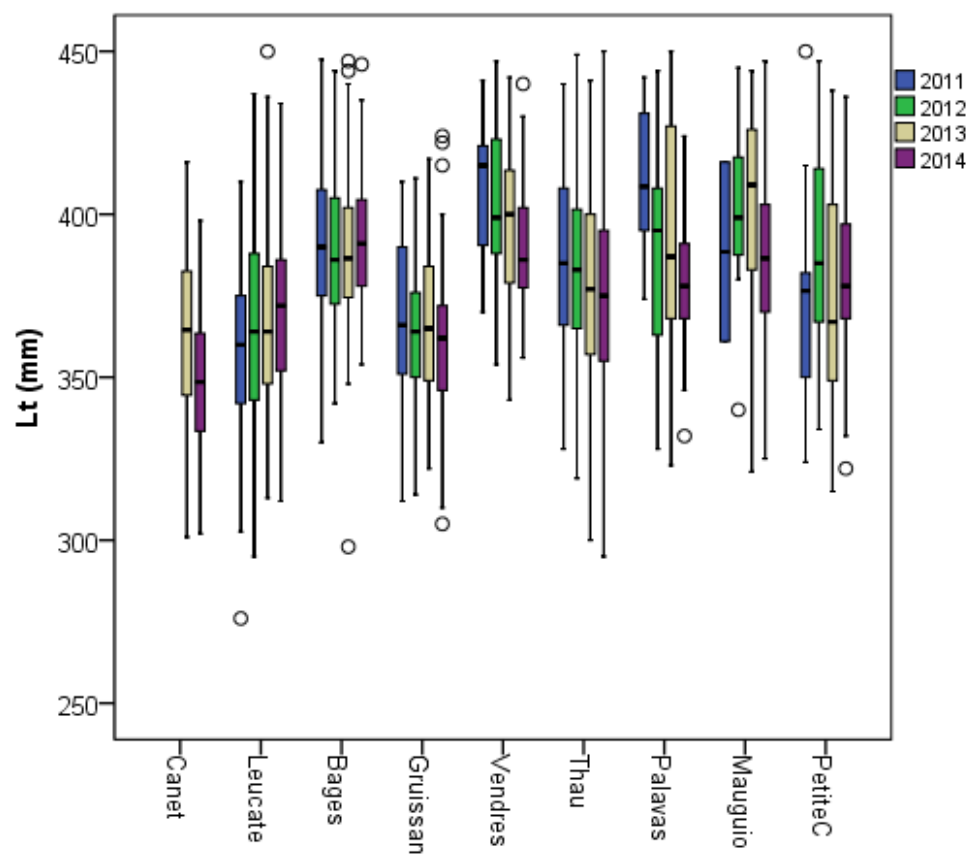


Figure FR 24. Total length (in mm) of silver eels males sampled during the transport operations from 2011 to 2014 (see Figure FR 11 for locations). N<10 in 2011 in Mauguio and Vendres.

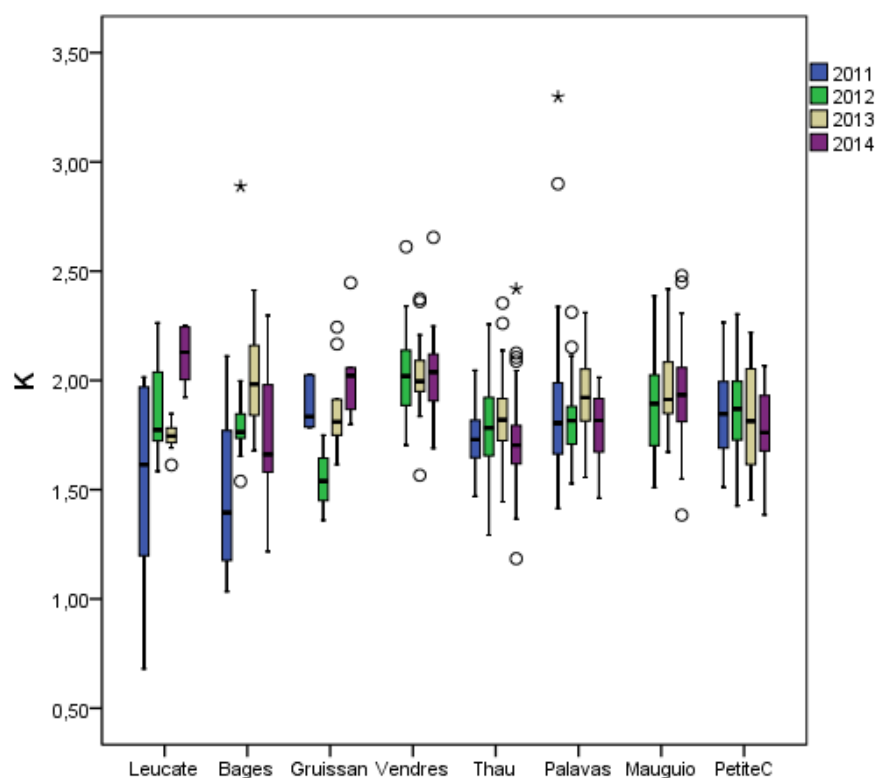


Figure FR 25. Fulton's condition index of silver eels females sampled during the transport operations from 2011 to 2014 (see Figure FR 11 for locations). N<10 in Gruissan in 2011, 2012 and 2014; Leucate in 2012, 2013 and 2014.

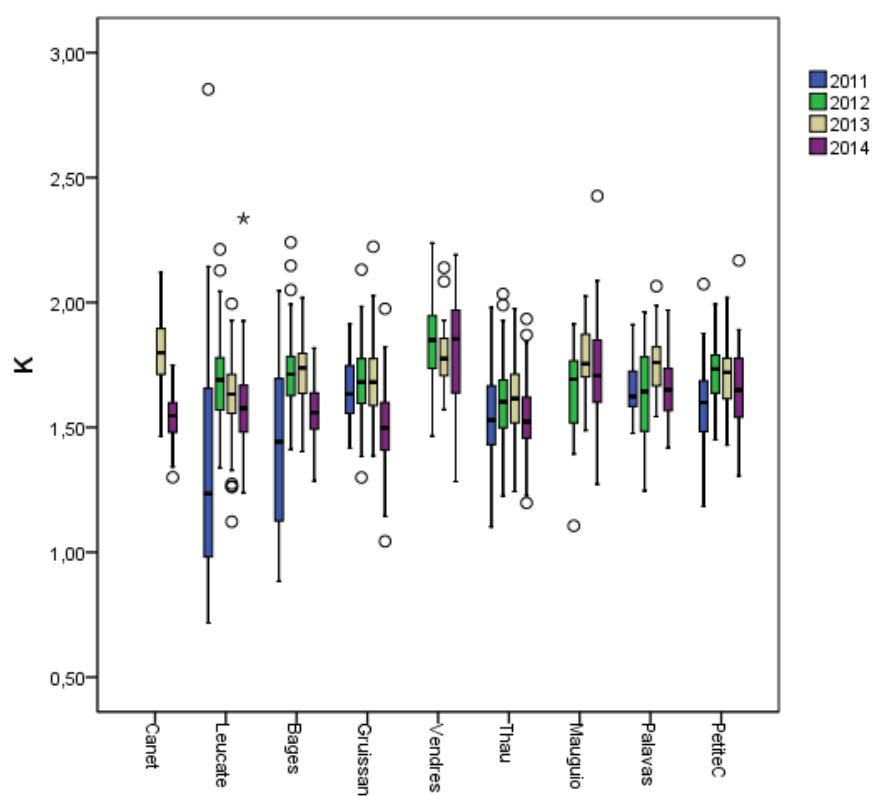


Figure FR 26. Fulton's condition index of silver eels males sampled during the transport operations from 2011 to 2014 (see Figure FR 11 for locations).

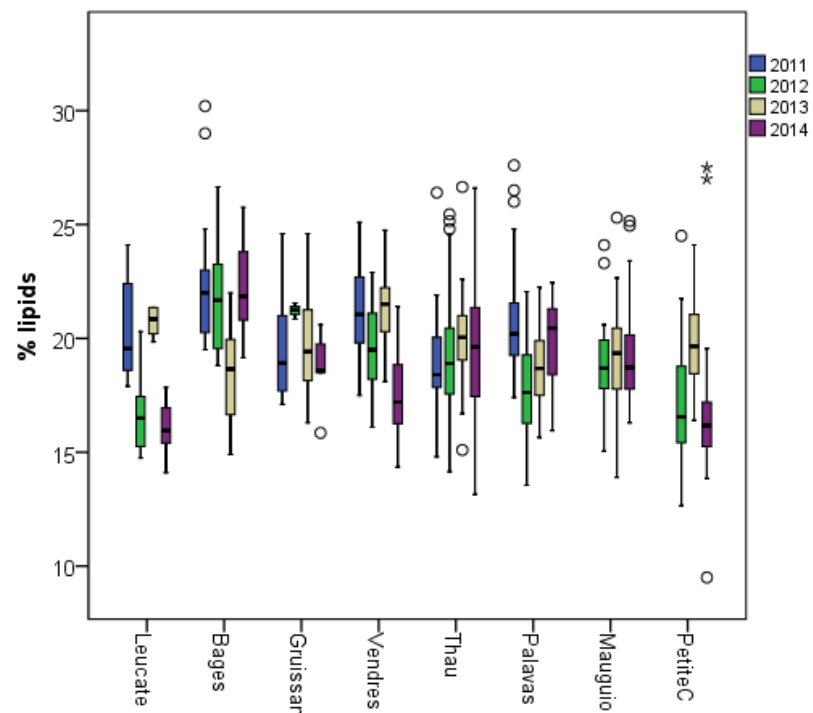


Figure FR 27. Lipids content (measured with a Distell© fatmeter) of silver eels females sampled during the transport operations from 2011 to 2014 (see Figure FR 11 for locations). N<10 in Gruissan in 2011, 2012 and 2014; Leucate in 2012, 2013 and 2014; Bages in 2014.

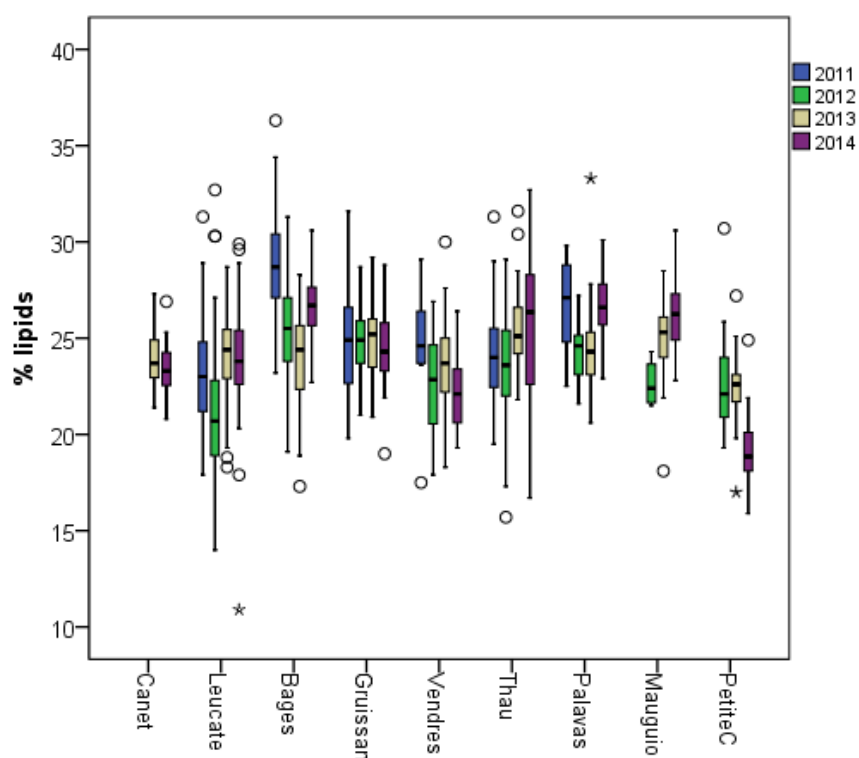


Figure FR 28. Lipids content (measured with a Distell© fatmeter) of silver eels males sampled during the transport operations from 2011 to 2014 (see Figure FR 11 for locations). N<10 in Vendres in 2011 and in Mauguio in 2012.

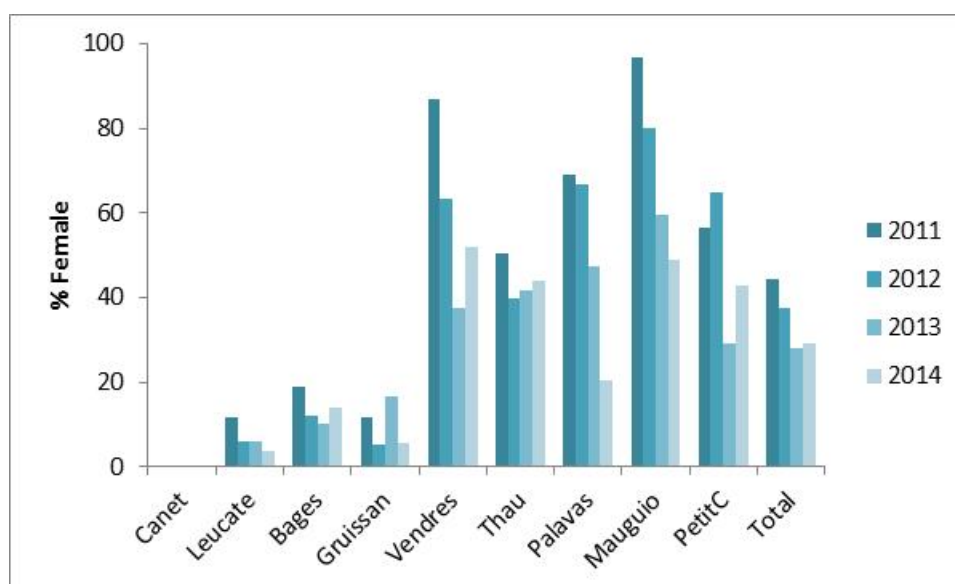


Figure FR 29. Percentage of females silver eels (> 45 cm) sampled during the transport events from 2011 to 2014. No transport events were organised in Canet in 2011 and 2012.

12.2 Monitoring of glass eel stocking operations

See (Rigaud *et al.*, 2015).

13 Stock assessment

The silver eel production in rivers has been modelled by the 2.2 version of EDA model (Briand *et al.*, 2015).

Figure FR 22. Colonization front (modelled probability of presence > 50%) and density (eel / 100 m²) estimated for 2012 by the EDA2.2 model (Briand *et al.*, 2015).

The estimation is relying on a more robust estimation of silvering. The model is also structured per size class. It includes electrofishing in the downstream part of the river, giving a much more robust output than simply extrapolating the density found with two pass electrofishing in shallower areas. The model estimates a silver eel production of 616 t, 1. 829 +1.379,2.338 million of silver eels in 2012 (Figure FR28).

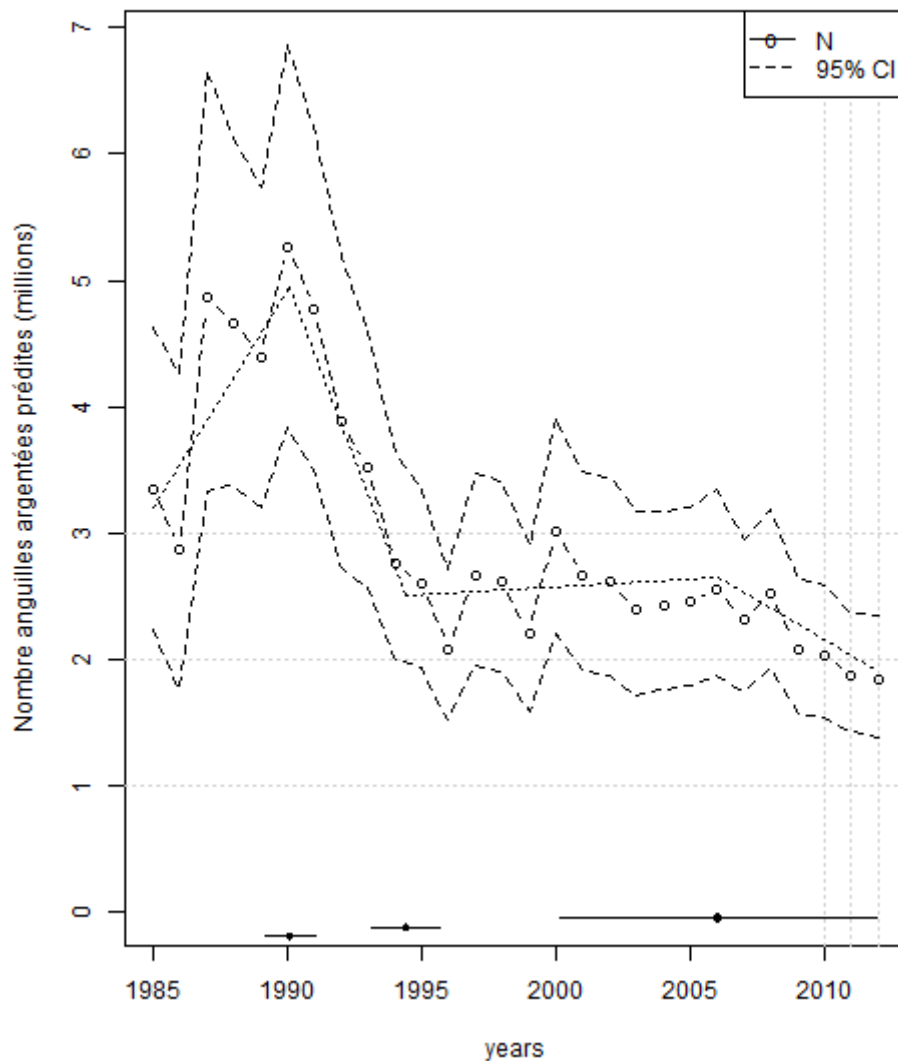


Figure FR 23. Estimated trend in silver eel production for French rivers estimated for 2012 by the EDA2.2 model (Briand *et al.*, 2015). The confidence interval is shown by dashed lines. A segmented regression is applied to the trend.

The results seem also to be supported by field assessments of silver eel production, although those show that the GIS of river habitats used in the assessment, is not including lakes and canals, and as such, may be underestimating the production in some areas. Other habitats, such as marshes or the Mediterranean lagoons are not accounted for by the model though an expert opinion show that they represent a large proportion of the potential output, with only 13% of the potential silver eel production in France covered by EDA (Table FR 34).

Table FR 30. Estimation of silver eel production per type of habitat in France (source French management plan).

SILVER EEL PRODUCTION								
Habitat type		Water surface (km²)	kg/ha	tonnes	nb/ha	nb	Mean weight (g)	
Habitat not covered by EDA2.2	Wetlands for Biscay and Channel areas							
	Marshes	Freshwater marsh	254	5,8	148	40,8	1 035 723	143
		Saltmarshes	185	8,8	161	61,3	1 130 154	143
		Total march	439	7,1	309	49,4	2 165 877	143
	Brackish habitats	Bays	1 171	0,3	29	1,5	175 691	167
		Gironde estuary	389	0,3	10	1,5	58 290	167
		Atlantic lagoons	243	0,7	17	4,3	104 066	163
		Total salt water habitat	1 803	0,3	56	1,9	338 047	166
	Lakes	Lakes	401	2,0	80	10,0	401 300	200
	Total wetlands of Biscay and Channel		2 643	1,7	450	11,0	2 900 000	153
	Mediterranean lagoons							
	Mediterranean lagoons		575	17,5	1 000	143,8	8 300 000	122
	Total habitats not covered by EDA2.2		3 217	4,5	1 450	34,7	11 000 000	130
Habitats covered by EDA 2.2	River and estuaries (Gironde excluded)		2 114	2,9	613	8,7	1 828 000	335
Grand Total			5 331	7	2 063	43	13 000 000	159

14 Sampling intensity and precision

No new data.

15 Standardisation and harmonisation of methodology

No data available.

15.1 Survey techniques**15.2 Sampling commercial catches****15.3 Sampling****15.4 Age analysis****15.5 Life stages****15.6 Sex determinations****15.7 Data quality issues****16 Overview, conclusions and recommendations****17 Literature references**

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Report on the eel stock and fishery in Germany 2014

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2 Introduction

This report provides the most recent information about eel stocks, eel fishery and eel surveys in Germany. The recent years were characterised by the implementation of the Eel Management Plans for nine German River Basin Districts. During that period, the revision of legal frameworks continued, structures for documentation of catch, efforts and re-stocking had to be established and, of course, many direct management measures had to be conducted. At the end of June 2015, the second report about the implementation of the German Eel Management Plans and the recent development of the eel stocks was submitted to the European Commission (Fladung and Brämick, 2015). It covers the period 2011 to 2013 and hence, many data here in this Country Report also refer to this period. During the recent years, an updated version of the German Eel Model was developed (GEM III), which has been used in all nine RBD's to calculate the eel population parameters.

If new data for 2014 had become available, they were included in the report. For practical reasons, the relevant authorities and institutions in the States mainly focus on the requirements of the reports to the EU Commission and not on providing detailed data on an annual basis. This is mainly caused by limited resources and capacities of the regional fisheries authorities, which are confronted with an increasing effort for European and national regulations. Therefore, there is no permanent new calculation of escapement, production and other population parameters for each year. These data are now provided for the period 2011–2013.

The relevant German river systems belong to the ICES Ecoregions North Sea (Rhine, Elbe, Weser, Ems, Eider) and Baltic Sea (Oder, Warnow/Peene, Schlei/Trave). The Danube, which drains into the Black Sea, is not considered to constitute natural eel habitats at a relevant level and hence, no stock indicators have been calculated for the Danube and no EMP has been established for this system.

Eel data collection under the DCF

Sampling of European Eel data in freshwaters is mandatory under the DCF. In Germany, sampling has started in spring 2009. The results of the biological sampling of eels in the freshwaters are regularly included as an Annex to the Country Report and this report contains the DCF data on eel for 2014. The recent years of sampling have been considered as a “pilot” phase. So far, sampling is focused on biological parameters of eel in commercial catches of the inland fishery. From each river basin district (according to WFD), about 200 eels (100 yellow and silver eels, respectively) have been sampled and investigated. Since 2011 the sampling scheme has slightly changed, but is still focused on biological parameters. Analyses include length, weight, age, sex. Some additional parameters are and will be also be analysed, such as *Anguillicola crassus* infestation and also concentration of some contaminants. However, these additional investigations are not mandatory under the DCF.

At present, no data on the fishery itself are sampled within the DCF. This was decided, because a lot of these data have to be obtained in the frame of the Eel Management Plans and the formal and administrative requirements of the EU Council Regulation 1100/2007. Yet, at present the future strategy of the DCF-sampling is under discussion and possibly may change (e. g. inclusion of detailed data on fishing effort in direct relation to catches).



Figure 1. River Basin Districts (RBD) in the Federal Republic of Germany: Eider, Schlei/Trave, Elbe, Warnow/Peene, Oder, Weser, Ems, Rhine, Meuse and Danube.

3 Time-series data

3.1 Recruitment series and associated effort

3.1.1 Glass eel

3.1.1.1 Commercial

There is no glass eel fishery in Germany.

3.1.1.2 Recreational

There is no recreational fishery for glass eel in Germany.

3.1.1.3 Fishery-independent

There is no regular and long-term glass eel monitoring in Germany. A monitoring for immigrating elvers/young yellow eels is performed in Mecklenburg-Pomerania (see 3.1.2.3).

3.1.2 Yellow eel recruitment

3.1.2.1 Commercial

There is no time-series on yellow eel recruitment available based on commercial catches.

3.1.2.2 Recreational

There is no time-series on yellow eel recruitment available based on recreational catches.

3.1.2.3 Fishery-independent

Immigration and upstream migration of young eels have been monitored on some locations in Mecklenburg-Pomerania, Lower Saxony and North Rhine Westphalia, the latter starting in 2014. The monitoring stations were established in waters of the RBD's Warnow/Peene (both Baltic Sea), Elbe, Ems, and Rhine (North Sea). The Results from Mecklenburg-Pomerania indicate that recruitment to the rivers of the Baltic Sea is considerably lower than in the rivers draining into the North Sea (Ubl and Dorow, 2010; Dorow and Ubl, 2011). The few data available indicate that the numbers of glass eels arriving are very low if compared to former data but there was no clear trend in the recent years (Lemcke, 2003; Schaarschmidt, 2005; Schaarschmidt *et al.*, 2007; Ubl *et al.*, 2007; Ubl and Dorow, 2010; Dorow and Ubl, 2011; Table 3.1).

Ems results of the investigation of upstream migration of glass eels/pigmented young-of-the-year eels on two locations (Herbrum, Bollingerfähr) are summarized by Salva *et al.* (2014, see also 9.1). A report containing the first results for Rhine and Ems from North Rhine Westphalia is being processed (Camara *et al.*, in prep).

Table 3.1. Comparison of standardised catches of upstream migrating eels (2003–2011) in several rivers in Mecklenburg-Pomerania (number of eels per fishing gear between May and October; Ubl and Dorow, 2010; Dorow and Ubl, 2011; data for 2011 to 2013 Dorow, pers. comm.). In 2013 only total catches are given for the two stations in Dömitz, because sampling was disturbed for six weeks due to a flood event. Data for 2014 from Malte Dorow (pers. comm.).

RIVER	STATION	DISTANCE TO COAST	GEAR/RELATION	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Baltic Sea															
Wallenstein-graben	Wismar (Mühlenteich)	2 km	per eel ladder	not sampled	173	153	123	296	509	238	614	113	39	39	8 *
Mühlengrube	Wismar (Ziegenmarkt)	0.1 km	per eel ladder	not sampled	not sampled	not sampled	17	19	81	4	0	0	2	0	10
Uecker	Torgelow (Wehr)	52 km (Oder estuary) or 83 km (Peene estuary)	per eel ladder	33	---	---	53	32	25	37	37	52	62	39	Not sampled
Plastbach (or Farpener Bach)	Alt Farpfen (Stausee/Speicher)	4.8	per eel ladder	not sampled	not sampled	not sampled	---	101	67	25	29	84	37	16	401 **
North Sea															
Müritz-Elde-Wasserstraße	Dömitz (Fischpass)	224 km	per fykenet	2365	3145	2861	3124	2440	1395	Not sampled	2659	3236	4686	(630)	344
Dove Elbe	Dömitz (Wehr)	224 km	per eel ladder	1981	676	721	1035	890	542	Not sampled	62	2024	1523	(350)	49 ***
			per eel collector	not sampled	not sampled	not sampled	11	---	Not sampled	Not sampled	Not sampled	Not sampled	Not sampled		

* Due to a newly built fish pass, the trap/eel ladder was not fully efficient. Comparisons with previous years are difficult. In 2015 the system was adapted.

** The increase may have been influenced by glass eel stocking in coastal waters.

*** The values are likely influenced by the flow management at this location. There was no attracting current in the area of the harbour Dömitz (due to strongly regulated flow). The Situation changed in 2015 and better data might be expected then.

3.2 Yellow eel landings

3.2.1 Commercial

There are no time-series on commercial catches of yellow eels available, which could serve as an index. Therefore, data on total landings of yellow eels are presented in chapter 6.

3.2.2 Recreational

There are no time-series on recreational catches of yellow eel available.

3.3 Silver eel landings

3.3.1 Commercial

There are no time-series on commercial catches of silver eels available, which could serve as an index. Therefore, data on total landings of yellow eels represented in chapter 6.

3.3.2 Recreational

There are no time-series on recreational catches of silver eel available.

3.4 Aquaculture production

3.4.1 Seed supply

According to data of the German Federal Statistical Office (Statistisches Bundesamt) **4.610 tons** of glass eel were brought to German eel aquaculture companies in 2014. However, information about the sources of the glass eels was not provided. In general, the legal situation regarding the availability of the data (sources) appears to be a bit unclear (data protection, etc.)

3.4.2 Production

Table 3.2. Production of eel in recirculation systems.

YEAR	PRODUCTION (T)
2004	328
2005	329
2006	567
2007	740 (440 t for human consumption and 300 t stocking size eel)
2008	749 (447 t for human consumption and 302 t stocking size eel)
2009	667 (385 t for human consumption and 282 t stocking size eel)
2010	681 (398 t for human consumption and 283 t stocking size eel)
2011	660 (Data not available separately for consumption / stocking)
2012	706 (Data not available separately for consumption / stocking)
2013	757 (471 t for human consumption and 286 t for stocking)
2014	926 (642 t for human consumption, 284 t for stocking)

3.5 Stocking

3.5.1 Amount stocked

Data on re-stocking in the period 2011–2013 are given in Table 3.3. The general level of re-stocking remained rather stable, but due to the higher availability of glass eels on the market, the use of glass eels for re-stocking increased in the recent years. The bootlace eels originate in local sources and should be considered as a “zero-balance” or “assisted migration”.

Table 3.3. Eel re-stocking in German inland waters from 2011–2013 (numbers) (Fladung and Brämick, 2015). Bootlace eel are wild-caught eels with lengths of roughly 20–30 cm.

YEAR	GLASS EEL	ONGROWN EEL	BOOTLACE EEL
2011	4,823,772	5,473,830	458,421
2012	4,009,562	6,102,490	134,987
2013	4,659,466	6,607,587	121,412
Total 2011–2013	13,492,800	18,183,907	714,820

3.5.2 Catch of eel <12 cm and proportion retained for restocking

There is no glass eel fishery in Germany.

3.5.3 Reconstructed time-series on stocking

A document with detailed information about re-stocking with different types (age groups) of eel during the period 1990–2010 had been provided to the working group during the 2014 meeting. The table is too complex to be included in the report but it can be provided again, if necessary.

3.6 Trade in eel

Such data are not available.

4 Fishing capacity

4.1 Glass eel

There is no glass eel fishery in Germany.

4.2 Yellow eel

Fisheries in Germany are usually mixed fisheries, which catch different species and also both stages of eel, yellow and silver eel (although some gears are more specialized for one of the stages). Therefore, fishing capacity is given combined for yellow and silver eels. The data were taken from the EMP's (for 2007, commercial fishery) and from the 2015 report (Fladung and Brämick, 2015) to the European Commission about the implementation of the EMP's (anglers). Yet, the data have probably not changed very strongly since 2007 for the commercial fisheries. It should also be noted that more recent data are available for fishing effort (Chapter 5), which are even more relevant to assess the intensity of the fishery.

RBD Eider

- 69 full-time (68 coastal, 1 inland water), 146 part-time, 300 hobby fishermen (1200 fykenets allowed)
- about 20 000 anglers (in 2013, Fladung and Brämick, 2015)

RBD Elbe

- 413 full- and part-time fishermen / fishing enterprises, (11 102 fykenets, 31 stownets, 24 electrofishing gears, 38 stationary eel traps allowed in 2007)
- 349 245 anglers (in 2013, Fladung and Brämick, 2015)

RBD Ems

- four full-time and five part-time fishermen (using fykenets and stownets)
- 52 248 anglers (in 2013, Fladung and Brämick, 2015)

RBD Maas

- 6237 anglers (in 2013, Fladung and Brämick, 2015)

RBD Oder

- 89 full- and part-time fishermen / fishing enterprises (using 2116 fykenets, seven stownets, 23 electrofishing gears, five stationary eel traps)
- 34 807 anglers (in 2013, Fladung and Brämick, 2015)

RBD Rhein

- approximately 288 (full-) and part-time fishermen (fykenets and a few stownets)
- 176 983 anglers (in 2013, Fladung and Brämick, 2015)

RBD Schlei/Trave

- coastal fishery: 142 cutters (124 full-time, 18 part-time), 107 boats (full-time) and 379 boats (part-time fishermen); in total 628 fishing vessels of different sizes; 808 hobby fishermen (allowed to use 3232 fykenets and 80 800 hooks on longlines)
- inland fishery: 16 fishing enterprises
- about 20 000 anglers (in 2013, Fladung and Brämick, 2015)

RBD Warnow/Peene

- coastal fishery: 345 full-time fishermen, 138 part-time fishermen, 261 hobby fishermen (in total 846 fishing vessels <12 m and 34 vessels >12 m)
- inland fishery: 41 fishing enterprises with 125 vessels (using ca. 1800 fykenets or eel trap chains, ten seines, seven electrofishing gears, four stationary eel traps, longlines with 25 000 hooks)
- 127 833 anglers (in 2013, Fladung and Brämick, 2015)

RBD Weser

- 17 full-time fishermen, four cooperatives, 99 part-time fishermen (using stownets, fykenets, traps)
- 113 926 anglers (in 2013, Fladung and Brämick, 2015)

In 2013, the total number of valid fishing licences in the RBD's relevant to eel was **901 279**. This is an increase of 3% compared to 2008 (the first year of the implementation of the EMP's). Yet, it is not known, how many anglers actually fish for eel.

Fladung *et al.* (2012a) found that only about 58% of all anglers in the river Havel system fished for eel and of these, only about one third was successful. There was a considerable variability of angling activity and angling success between the anglers. In relation to the total number of valid fishing licenses, the annual yield was 0.6 eels or 288 g eel per angler in this system. Similar results had been found for the State Mecklenburg-Pomerania in an earlier study (Dorow and Arlinghaus, 2008; 2009).

4.3 Silver eel

See 4.2.

4.4 Marine fishery

These data are included in the previous section (4.2).

5 Fishing effort

In the frame of the implementation of the EMP's, data on fishing effort became available due to documentation requirements in the Regulation 1100/2007. The data are taken from the second report to the EU Commission on the implementation of the EMP's in Germany (Fladung and Brämick, 2015) and refer to the period 2011–2013.

5.1 Glass eel

There is no glass eel fishery in Germany.

5.2 Yellow eel

Fisheries in Germany usually are mixed fisheries, which catch different species and also both stages of eel, yellow and silver eel (although some gears are more specialized for one of the stages). Therefore, fishing effort cannot be presented separately for yellow and silver eel. Hence, Table 5.1 gives the data on total fishing effort on both stages.

The main fishing gear for eel in Germany are fykenets (different types), which account for more than 90% of all "gear days". Among the fykenets, the "small fykes" are the most important group and it is important to note that for this most important gear in the eel fishery in Germany, a reduction of 21% in effort was documented between 2008 and 2013.

Table 5.1. Fishing effort with the most relevant eel fishing gears of commercial and semi-commercial fisheries in German waters in 2013 and change (%) in relation to the 2008 data. Data are presented as *gear * days used*.

RBD	SMALL FYKES	LARGE FYKES	LONGLINES (EEL LINE 100 AT HOOKS)	AALPUDDEN ("HOOK BUOY"?)	STOWNETS	STATIONARY EEL TRAPS	ELECTRO FISHING
Eider	13,091	---	0	0	434	0	0
Elbe*	350,922	297,947	245	15,750	2,967	675	47
Ems	2,212	13,257	0	0	4,341	0	0
Maas	0	0	0	0	0	0	0
Oder	229,415	29,851	6,000	12,320	1,236	3	20
Rhein	121,007	5,163	64	0	311	0	342
Schlei/Trave	180,580	0	1,439	0	0	0	0
Warnow/Peene	3,495,530	51,758	289,411	2,450	0	740	255
Weser	176,843	3,030	0	0	910	25	0
Total	4,569,600	401,006	297,159	30,520	10,199	1,443	664
Change from 2008 to 2013 (%)*, **	-21	+3	-40	-71	-30	-11	+23

* Without Hamburg, because no data delivered for 2010–2013.

** Without the State of Brandenburg, because no data from this State were available for 2008.

5.3 Silver eel

See 5.2.

5.4 Marine fishery

The data for the marine coastal fishery, which are conducted in the frame of the EMP's, are included in Table 6.2.

6 Catches and landings

At present, it is not possible to provide temporally structured information (e.g. on a monthly basis or so). Although the fishermen (will) have to deliver the information at least on a monthly basis to the authorities (at least in some States), it is not clear, if the authorities will have the capacities to analyse or summarise the data, at least in a regular scheme. However, the new documentation requirements have been established and most States document catches separately for yellow and silver eel, respectively.

6.1 Glass eel

There is no glass eel fishery in Germany.

6.2 Yellow eel

According to the report on the German inland fishery and aquaculture for the year 2014 (Brämick, in prep.), the eel yields of the commercial fishery amounted to **155.7 t**. The data are not given separately for yellow and silver eels. This figure is clearly lower than in the previous years. However, the change results basically from missing

data of one important State and from a change in the data collection procedure in another important State. Hence, the real yields have probably been higher and it can be assumed that the order of magnitude has remained stable.

6.3 Silver eel

Silver eels are included in Section 6.2.

6.4 Marine fishery

Table 6.2. Eel landings from the coastal fishery in North and Baltic Sea by quantities and value.

Year	NORTH SEA				BALTIC SEA				
	Lower Saxony (incl. stocking size eel)	Schleswig- Holstein		Schleswig- Holstein		Schleswig- Holstein		Mecklenburg- Pomerania	
		Stocking size eel							
	t	€	t	€	t	€	t	€	t
1961	47.8	76,854							
1962	66.8	108,019							
1963	55.3	111,128							
1964	56.1	124,742							
1965	56.3	135,596							
1966	67.8	143,672							
1967	92.3	199,788							
1968	102.5	245,202							
1969	85.3	194,871	97.4	313,213			204.5	909.189	
1970	130.3	324,193	94.1	349,148			143.8	682.162	
1971	113.9	375,358	130.6	550,216			124.5	679.720	
1972	77.2	71,785	92.3	453,610			146.8	749.918	
1973	77.5	393,541	105.5	510,202			151.2	825.524	
1974	85.9	392,953	113.8	661,990			109.8	679.307	
1975	94.7	509,196	102.6	592,191			123.7	762.290	
1976	104.5	540,277	102.4	599,191			102.6	660.139	
1977	99.3	540,192	135.9	793,559			77.6	546.213	
1978	69.0	432,263	100.7	682,567			62.6	465.377	
1979	81.4	486,924	76.1	569,022			81.6	596.672	
1980	108.9	658,220	73.5	548,177			66.0	474.395	
1981	119.4	787,696	55.4	405,403			75.1	575.250	
1982	107.3	766,437	67.3	502,455			98.3	746.875	
1983	102.9	684,057	72.6	531,814			82.6	636.962	
1984	95.4	617,621	62.2	483,898			51.3	420.048	
1985	65.4	449,844	57.1	442,299			50.4	411.762	
1986	91.7	662,076	39.6	324,351			65.6	564.750	
1987	69.0	485,298	21.0	171,292			57.1	478.490	
1988	45.6	349,384	42.2	363,694			70.1	590.345	
1989	29.3	220,463	31.4	265,244			86.9	751.143	
1990	35.9	283,640	14.7	125,732			82.4	741.405	
1991	24.5	202,558	11.8	94,525			83.5	773.621	

Year	NORTH SEA					BALTIC SEA			
	Lower Saxony (incl. stocking size eel)		Schleswig- Holstein	Schleswig- Holstein		Schleswig- Holstein	Mecklenburg- Pomerania		
				Stocking size eel					
1992	25.7	223,031	6.1	57,957		78.7	701.902		
1993	30.1	227,157	12.8	115,980	1.9	9,690	66.5	624.781	
1994	64.5	492,489	13.3	68,891	10.4	44,146	63.7	567.412	
1995	42.5	322,316	7.7	60,244	3.6	18,496	60.2	542.434	
1996	15.7	135,320	6.3	43,984	3.5	17,850	27.7	267.152	
1997	30.0	238,911	12.0	84,278	3.7	22,452	44.5	417.479	
1998	13.8	114,715	8.5	62,714	3.7	22,289	19.1	186.149	
1999	19.9	161,782	10.5	75,144	6.1	33,233	27.0	254.386	
2000	16.3	141,990	5.7	39,266	5.0	27,756	30.1	284.963	
2001	21.1	186,200	4.7	37,764	4.7	26,266	28.6	278.228	108
2002	35.3	292,198	4.4	38,850	4.0	21,547	28.0	218.217	98
2003	29.8	233,986	4.8	36,067	3.4	19,548	27.4	251.862	93
2004	31.7	246,038	5.4	39,745	4.1		17.3	136.337	94
2005	22.2	198,872	5.0	38,400			17.0	130.560	86
2006	19.1	165,340	4.1	29,247			21.1	141.178	91
2007	23.6	191,278	0.05	388			11.3	67.806	76
2008	14.3*		0.1				13.2		71
2009	13.2*		0.1				8.5		64
2010	13.5*		0				13.4	87,529	61
2011	14.8*		0				9.5	59,987	42
2012	9.2*		0.1	310			6.8	46,561	35
2013	20.0*		4.0*				11.5*		37.9
2014	15.3		0				7.4	55,169	39.2

* These catches do not reflect real “marine” fishery. Instead, they represent also catches from the lower reaches and estuaries of rivers draining into the North Sea and the Baltic Sea. They come from transitional waters according to the WFD, but in the fisheries legislation they are counted as “coastal fishery”.

6.5 Recreational fishery

Detailed data on recreational fishery are basically missing, except for some estimates of yields (see chapter 6.2). Data on retained and released catches and on catch and release mortality are so far not available.

Table 6.3. Recreational Fisheries: Retained and Released Catches.

Year	Retained				Released			
	Inland		Marine		Inland		Marine	
	Angling	Passive Gears	Angling	Passive gears	Angling	Passive gears	Angling	Passive gears
2013	ND	ND	ND	ND	ND	ND	ND	ND

Table 6.4. Recreational Fisheries: Catch and Release Mortality.

Year	Released			
	Inland		Marine	
	Angling	Passive gears	Angling	Passive gears
2013	ND	ND	ND	ND

6.6 Bycatch, underreporting, illegal activities

Data on bycatch, underreporting or illegal activities are not available. With very few exceptions, inland and coastal fisheries in Germany usually are mixed fisheries, targeting a broader range of species. In that sense there is no bycatch.

The author is not aware of scientific studies on underreporting in relation to eel.

Illegal activities, such as “Fishing out of the season”, “Fishing without licence”, “Fishing using illegal gears”, “Retention of eel below or above any size limit”, “Illegal selling of catches” likely occur in Germany, but there is no database where relevant information is collected. Hence, detailed information about these aspects is not available.

Table 6.4. Estimation of underreported catches in Country, per EMU and Stage.

Year	EMU_code	Glass eel				Yellow eel				Silver Eel				Combined (Y + S)			
		Rep orte	Und erre	Und erre	Total catc	Rep orte	Und erre	Und erre	Total catc	Rep orte	Und erre	Und erre	Total catc	Rep orte	Und erre	Und erre	Total catc
2013	DE_Eide		ND	ND	ND		ND	ND	ND		ND	ND	ND		ND	ND	ND
	DE_Elbe		ND	ND	ND		ND	ND	ND		ND	ND	ND		ND	ND	ND
	DE_Ems		ND	ND	ND		ND	ND	ND		ND	ND	ND		ND	ND	ND
	DE_Maas		ND	ND	ND		ND	ND	ND		ND	ND	ND		ND	ND	ND
	DE_Oder		ND	ND	ND		ND	ND	ND		ND	ND	ND		ND	ND	ND
	DE_Rhei		ND	ND	ND		ND	ND	ND		ND	ND	ND		ND	ND	ND
	DE_Schl		ND	ND	ND		ND	ND	ND		ND	ND	ND		ND	ND	ND
	DE_Warn		ND	ND	ND		ND	ND	ND		ND	ND	ND		ND	ND	ND
	DE_Wese		ND	ND	ND		ND	ND	ND		ND	ND	ND		ND	ND	ND
	Total/mean (%)		ND	ND	ND		ND	ND	ND		ND	ND	ND		ND	ND	ND

Table 6.5. Existence of illegal activities, its causes and the seizures quantity they have caused.

[illegible]

7 Catch per unit of effort

According to the EU Regulation 1100/2007, catches as well as effort have to be reported by the fishermen. In the frame of the implementation of the EMP's, the documentation of the catches has been improved and that of effort has been established. (See relevant sections in this report.). However, so far the catches are not directly related to the efforts, because this analysis would mean a substantial and additional effort for the responsible authorities. In the moment it is not clear, if, when or how such analyses will become available in future.

7.1 Glass eel

There exists no glass eel fishery in Germany.

7.2 Yellow eel

There are no data on cpue available.

7.3 Silver eel

There are no data on cpue available.

7.4 Marine fishery

There are no data on cpue available.

8 Other anthropogenic and environmental impacts

Estimates for mortalities due to other anthropogenic impacts are given in chapter 13.2.3 (stock indicators). These estimates for the RBD's are based on knowledge of numbers of turbines, etc. and the areas affected by them. This information has been included in the modelling of the eel stock and silver eel escapement.

There may be local information about development of trophic state or mean water temperatures. However, there is likely no uniform picture for whole Germany and a general effect of such factors on the population development of eel in German waters cannot be assessed in a simplified and generalized way.

9 Scientific surveys of the stock

9.1 Recruitment surveys, glass eel (includes yellow eel in Scandinavia)

See information / data on elver monitoring in Mecklenburg-Pomerania in Chapter 3.1.2.3.

Another monitoring of glass eel and pigmented young-of-the-year was established at the weir Bollingerfähr at the river Ems (Salva, 2013). The weir is located 6.4 km upstream of the weir Herbrum, where a glass eel monitoring had existed for many years. Due to heavy water works on the River Ems with the consequence of strong currents, which did not exist before, this station has not been in operation for a longer time. During the recent starting period of the monitoring the general suitability of the location and of the fish ladder as monitoring gear were assessed. In summary it was concluded that the location is suitable for a glass eel monitoring and that the eel ladder worked well. A few suggestions for technical improvements were made. First results were given in last year's report.

This monitoring was continued in 2014 (Salva *et al.*, 2014). As a consequence of some technical adaptations, the efficiency of the monitoring could be improved. A total number of 43 371 glass eels and elvers with lengths between 5 and 23 cm were caught. Of these, 42 707 individuals were in the size class up to 10 cm. Within this group, the authors noted two peaks in the length distribution (6 and 8 cm). Within the group below 10 cm length, only 95 individuals (0.22%) were unpigmented glass eels. The upstream migration mainly occurs at night. However, in periods of high migration activity (July and August) the eels also migrated during daytime.

In addition to the monitoring at Bollingerfähr, in 2014 the monitoring at Herbrum was re-initiated on the basis of standardized catches with a small dipnet (Salva *et al.*, 2014). At the station Herbrum, the upstream migration peaked in April and May. A comparison to an earlier study in 2008 revealed that the maximum occurred on nearly exactly the same day (2008: 25/26 April, 2014: 26/27 April). The timing of the migration peak in April and May has also been described in historic literature. The size of the eels varied between 6 and 11 cm. In total, 1759 individuals were caught with the dipnet. All but one were in the size group ≤ 10 cm, the majority had a length of 7 cm. Only 22 individuals (1.25%) were pigmented elvers.

9.2 Stock surveys, yellow eel

Information on stock assessment (yellow eel monitoring) in coastal waters of the Baltic Sea has been provided in Chapter 12 (methodological aspects) of last year's report. There are no new results available.

9.3 Silver eel

No new information available.

10 Data collected for the DCF

Data obtained during the DCF-sampling are reported in a separate annex to this report.

Table 10.1. Summary of the DCF monitoring implementation per EMU.

Data	River	Lakes	Estuaries	Lagoons	Coastal & Marine
No. of production / escapement surveys ¹	0	0	0	0	0
No. of recruitment time-series surveys ²	See annex	See annex	0	0	0
No. fished aged	See annex	See annex	0	0	0
No. of fished sexed	See annex	See annex	0	0	0
No. of fish examined for parasites	See annex	See annex	0	0	0
No. of fish examined for contaminants	See annex	See annex	0	0	0
No. of non-fishery mortality studies ³	See annex	See annex	0	0	0
Socio-economic survey	See annex	See annex	0	0	0

¹ Surveys to estimate B_{best} and/or $B_{current}$ [These should include WFD surveys where the data are being used to estimate production and/or escapement of eel].

² Fishery-independent surveys.

³ Studies to determine ΣH for non-fisheries anthropogenic impacts, such as hydropower, barriers, predation, etc.

11 Life history and other biological information

11.1 Growth, silvering and mortality

Results of the sampling in the frame of the DCF are presented in a separate annex.

Simon (2015) investigated age and growth of eels and the variation of these parameters in the river Elbe. For this purpose, he collected 160 European silver eels grouped by 100 mm size classes at capture from the lower part of the Elbe River in Germany during fall 2011. Length of collected eels ranged from 360 mm to 957 mm and age from seven years to 23 years. Mean age and growth, estimated by otolith increments, were higher for females (14 years, growth 52 mm year⁻¹) than for males (13 years, 35 mm year⁻¹). Larger females were older and grew faster as compared to smaller females. Across all size classes at capture, the weighted mean age and annual length increment based on the percentage of eels per size class of the migrating silver eels were 13 years and 50 mm year⁻¹, respectively. To account for the differences in growth parameters between the size classes, the author also calculated weighted growth curves in relation to the number of individuals in the respective size groups. The results are summarized in Table 11.1.

Table 11.1. Growth parameters of eels from the Elbe River system (Simon, 2015).

Group analysed	n	L_{∞} (cm)	k	t0	Mean growth per year (mm)
Overall, pooled	160	863	0.098	-1.072	48±13
Males, weighted		501	0.129	-1.289	37
Females, weighted		1009	0.089	-0.959	53
Overall, weighted		931	0.096	-1.009	50

11.2 Parasites and pathogens

Within an EFF (European Fisheries Fund) project monitoring restocking (2012–2015) in North Rhine Westphalia (Germany), many data on eel diseases and parasites have been collected. The project contributed to a 2015 workshop aiming to progress in the development of standardised and harmonised protocols for the estimation of eel quality (WKPGMEQ, Workshop of a Planning Group on the Monitoring of Eel Quality) focusing on parasitic diseases (including the swimbladder parasite *Anguillicoloides*), and on viral and bacterial diseases. First steps of the development of an Eel Patho-Index as a simple and quick tool to visualize and interpret an abundance of eel health data were described (ICES, 2015)

11.3 Contaminants

Sührling *et al.* (2015) analysed the concentrations of in total 53 polybrominated diphenyl ethers (PBDEs) and their halogenated substitutes in muscle, gonads and eggs of artificially matured European eels and in muscle and gonads of untreated European eels that were used for comparison. The authors found evidence that persistent organic pollutants such as PBDEs, as well as their brominated and chlorinated substitutes are redistributed from muscle tissue to gonads and eggs. Concentrations ranged from 0.001 ng g⁻¹ ww for sum Dechlorane metabolites (DPMA, aCL10DP, aCL11DP) to 2.1 ng g⁻¹ ww for TBA in eggs, 0.001 ng g⁻¹ ww for Dechlorane metabolites to 9.4 ng g⁻¹ ww for TBA in gonads and 0.002 ng g⁻¹ ww for Dechlorane metabolites to 54 ng g⁻¹ ww for TBA in muscle tissue. Average egg muscle ratios (EMRs) for compounds detectable in artificially matured eels from both Schlei Fjord and Ems River ranged from 0.01 for Dechlorane 602 (DDC-DBF) to 10.4 for PBEB. Strong correlations were found between flame retardant concentrations and lipid content in the analysed tissue types, as well as transfer rates and octanol-water partitioning coefficient, indicating that these parameters were the driving factors for the observed maternal transfer. Furthermore, indications were found, that TBP-DBPE, TBP-AE, BATE and TBA have a significant uptake from the surrounding water, rather than just food and might additionally be formed by metabolism or biotransformation processes. Dechloranes seem to be of increasing relevance as contaminants in eels and are transferred to eggs. A change of the isomer pattern in comparison to the technical product of Dechlorane Plus (DP) was observed indicating a redistribution of DP from muscle tissue to gonads during silvering with a preference of the synisomer. The highly bio-accumulative DDC-DBF was the most abundant Dechlorane in all fish of the comparison group although it is not produced or imported in the EU. The aldrin related “experimental flame retardant” dibromoaldrin (DBALD) was detected for the first time in the environment in similar or higher concentrations than DP.

To deepen the understanding of the processes leading to the accumulation of lipophilic organic contaminants in yellow eels (i.e. the feeding, continental growth stage),

Brinkmann *et al.* (2015) developed a physiologically based toxicokinetic model using own data and values from the literature. Such models can predict the uptake and distribution of water-borne organic chemicals in the whole fish and in different tissues at any time during exposure. The predictive power of the model was tested against experimental data for six chemicals with octanol-water partitioning coefficient (log Kow) values ranging from 2.13–4.29. Model performance was excellent, with a root mean squared error of 0.28 log units. The authors conclude that this model has the potential to help identify suitable habitats for restocking under eel management plans.

In a study of Freese *et al.* (2015), muscle tissue samples of 192 European eels of all continental life stages from six different waterbodies and 13 sampling sites were analysed for contamination with lipophilic dl-PCBs to investigate the potential relevance of the respective habitat in light of eel stock management. Results of this study reveal habitat-dependent and life-history stage-related accumulation of targeted PCBs. Sum concentrations of targeted PCBs differed significantly between life stages and inter-habitat variability of dl-PCB levels and -profiles was observed. Among all investigated life stages, migrant silver eels were found to be the most suitable life-history stage to represent their particular water system due to habitat dwell-time and their terminal contamination status. With reference to a possible negative impact of dl-PCBs on health and the reproductive capability of eels, the authors hypothesized that those growing up in less polluted habitats have a better chance to produce healthy offspring than those growing up in highly polluted habitats. They suggest that the contamination status of water systems is fundamental for the life cycle of eels and needs to be considered in stock management and restocking programmes.

11.4 Predators

Estimates for predation by cormorants are included in chapter 13.2.3.

12 Other sampling

Aspects of migration

Stein *et al.* (2015) conducted a four year (2007–2011) telemetry study to understand the migratory behaviour and potential impact of environmental factors on the eel during this critical life stage. Out of 399 female eels tagged with acoustic transmitters, only 28% demonstrated clear downstream migratory behaviour. Fifty-five percent were detected exhibiting no downstream migration behaviour and 17% were not detected at any monitoring station. Movement patterns of downstream-migrating (silver) eels were characterized by nocturnal activity and seasonal migration, with distinct peaks in autumn and spring. Migration was often discontinuous and exhibited phases of active locomotion and expanded stopovers. The most important determinants of movement activity were water temperature, cumulative precipitation and moonlight, although the significance varied by season and location in the river basin. The results of the study corroborated a discontinuous, stepwise migration over an extended period. Furthermore, the findings indicate that migration success depends on holding duration prior to tagging and environmental predictors with varying importance depending on the season, as well as the locations of capture, tagging and release.

Stock assessment and modelling

Brämick *et al.* (2015) used various methodical approaches to study population parameters of eel in a large lowland river (Havel, a large tributary to the river Elbe) under

the application of a multi-annual intense stocking programme. The approaches were used to further enhance modelling of stock dynamics and silver eel escapement, in particular. Parameterizing the German Eel Model III (GEM III) with values and functions obtained for recruitment, growth, and mortality resulted in an annual escapement estimate of roughly 32 000–64 000 silver eels from 2010 to 2012. Escapement estimates based on a mark-recapture study conducted in parallel revealed somewhat lower values (11 000–25 000) for the same years. The authors concluded that, in view of the small number of natural recruits, such values are only contingent if stocking had a profound effect on silver eel production. The results from modelling annual silver eel escapement values indicate that escapement targets set in the EMP for this tributary cannot be reached without stocking. This constellation is likely to apply to other Eel Management Units with low current natural immigration values as well, and might be considered a key dilemma in eel management in such catchments due to the current confusion whether translocation of recruits yields a net benefit to the panmictic stock of the European eel.

13 Stock assessment

13.1 Method summary

As already stated before, there is no continuous calculation of the stock indicators on an annual basis. For the calculation of the stock indicators for the second implementation / progress report on the Eel Management Plans (Fladung and Brämick, 2015), an upgraded version of the German Eel Model has been developed (GEM III). It now includes the option to calculate the cohort development separately for males and females and also the possibility to calculate the so far missing mortality rates. The model has already been used for management considerations (Brämick *et al.*, 2015) in the river Havel system, the largest tributary to the river Elbe. A description of the previous version (GEM II) had been given by Oeberst and Fladung, 2012). For the 2015 implementation report, this model was used for all nine German RBD's.

The model incorporates the weight and sex of eel as well as the mean water temperature to estimate the natural mortality. Natural mortality was estimated based on Bevaqua *et al.* (2011). In addition, the three density levels of the eel stock are taken into account. The areas given in the EMP's and in the reports include all habitats, which would be potential eel habitats under undisturbed conditions; only some habitats e.g. in the trout region, far away from the coast may have been excluded, because these areas don't really form a typical eel habitat. Areas above impassable anthropogenic barriers are also included in the calculation of escapement. In agreement with the eel regulation, coastal waters have been included in some cases but not in others. When they were not included, fisheries should be decreased by 50% outside the areas covered by the EMP.

The estimates were done for the whole RBD without assuming any differences. It is clear that there will be differences between the different habitat types, but there were not sufficient data to calculate everything separately. As a consequence, the values represent a mean value for the whole RBD. This is not really correct but under pragmatic aspects it was chosen as the best way to do it. Meanwhile the model predictions have been compared to real values by tagging experiments. In these experiments the model has been proven to give rather correct estimates of escapement, at least in the order of magnitude (Fladung *et al.*, 2012b; Prigge *et al.*, 2013).

Restocking applies in all German RBD's except for the River Eider. In the calculation of B_0 and B_{best} , re-stocking is not included. $B_{current}$ includes the effect of re-stocking in

all RBD's, where re-stocking applies. The values of ΣA represent real mortalities and are not lowered by re-stocking.

For further detail see the documents and tables of previous WGEEL-meetings ("big nice table" and of WKEPEMP (ICES, 2013).

13.1.1 Estimate of B_0

Table 13.1. Reference period for B_0 .

EMU_code	B_0 (kg/ha)	Reference time period	Whether or not changed from value reported last year (Y/N)
DE_Eide	6.5	Pre-1980's	Y (new basis for calculation)
DE_Elbe	7.0	Pre-1980's	Y (adapted model)
DE_Ems	15.0	Pre-1980's	Y (adapted model)
DE_Maas	4.7	Pre-1980's	N (adapted model but no change in results)
DE_Oder	1.9	Pre-1980's	Y (adapted model)
DE_Rhei	4.7	Pre-1980's	N (adapted model but no change in results)
DE_Schl	4.1	Pre-1980's	Y (new basis for calculation)
DE_Warn	4.1	Pre-1980's	Y (adapted model)
DE_Wese	10.9	Pre-1980's	N (adapted model but no change in results)

13.2 Summary data

13.2.1 Stock indicators and targets

Table 13.2. Stock indicator and targets for individual RBD's.

EMUCODE	INDICATOR	BIOMASS (T)	MORTALITY (RATE)	TARGET					
	B_0	B_{best}	B_{curr}	ΣA	ΣF	ΣH	Source	Biomass (t)	ΣA (rate)
DE_Eide	3,031	933	884	0.05	0.01	0.05	Progress report 2015	1,213	ND
DE_Elbe	1,397	64	102	1.51	1.24	0.27	Progress report 2015	559	ND
DE_Ems	663	175	327	0.10	0.09	0.01	Progress report 2015	265	ND
DE_Maas	4	<1	<1	0.66	0.55	0.11	Progress report 2015	2	ND
DE_Oder	151	6	9	1.05	1.05	0.00	Progress report 2015	61	ND
DE_Rhei	288	4	149	0.95	0.33	0.62	Progress report 2015	115	ND
DE_Schl	1,355	1,670	1,669	0.05	0.05	0.00	Progress report 2015	542	ND
DE_Warn	1,499	1,019	990	0.10	0.10	0.00	Progress report 2015	600	ND
DE_Wese	605	91	301	0.43	0.23	0.19	Progress report 2015	242	ND

13.2.2 Habitat coverage

Table 13.3. Habitat coverage of EMP's and calculations for individual RBD's.

EMU CODE	RIVER		LAKE		TRANSITIONAL & LAGOON	COASTAL		
	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)
DE_Eide	2,899	Y	4,978	Y	1,662	Y (but no lagoons present)	459,244	Y
DE_Elbe	18,097	Y	136,662	Y	46,260	Y (but no lagoons present)	Not included	N
DE_Ems	6,730	Y	1,194	Y	36,164	Y (but no lagoons present)	Not included	N
DE_Maas	892	Y	0	Y	Not included	N	Not included	N
DE_Oder	2,654	Y	49,205	Y	28,507	Y (but no lagoons present)	Not included	N
DE_Rhei	46,665	Y	14,400	Y	Not included	N	Not included	N
DE_Schl	2,483	Y	20,546	Y	0	Y (but no lagoons present)	310,761	Y
DE_Warn	3,379	Y	27,130	Y	0	Y (but no lagoons present)	337,800	Y
DE_Wese	15,860	Y	4,962	Y	34,650	Y (but no lagoons present)	Not included	N

13.2.3 Impact

Table 13.4. Overview about assessment of several possible impacts in individual RBD's.

A = assessed, MI = not assessed, minor, MA = not assessed major, AB = impact absent.

EMU code	Habitat	Fish com	Fish rec	Hydro & pumps	Barriers	Restocking	Predators	Indirect impacts
DE_Eide	Overall	A	A	A	A	A	A*	MI
DE_Elbe	Overall	A	A	A	A	A	A*	MI
DE_Ems	Overall	A	A	A	A	A	A*	MI
DE_Maas	Overall	A	A	A	A	A	A*	MI
DE_Oder	Overall	A	A	A	A	A	A*	MI
DE_Rhei	Overall	A	A	A	A	A	A*	MI
DE_Schl	Overall	A	A	A	A	A	A*	MI
DE_Warn	Overall	A	A	A	A	A	A*	MI
DE_Wese	Overall	A	A	A	A	A	A*	MI

* In the previous reports, predation by cormorants had been calculated and given separately. However, in the present implementation report (Fladung and Brämick, 2015), it has been considered as part of the natural mortality and has not been provided separately, even if it had still been included in the model.

Table 13.5.

EMU code	Stage	Fish com	Fish rec	Hydro & pumps	Barriers	Restocking	Predators	Indirect impacts
XY_abdc	Glass							
	Yellow							
	Silver							
	Silver EQ							

It was requested to quantify the effect of each single impact on single life stages in a table. ("Express the loss in tonnes (t) for each impact per developmental stage or MI = not assessed, minor, MA = not assessed major, AB = impact absent. Where available, also report the total loss as silver eel equivalents, and explain the method used to calculate equivalents in Section 13.1.).

These data, however, are not available for Germany. Instead, in this section the overall losses due to the most important impacts as estimated in the second progress report on the implementation of the EMP's (Fladung and Brämick, 2015) are provided in the following table. A more detailed analysis is not available so far.

Table 13.6. Impacts on the eel stocks per RBD (2013). Data taken from the 2015 report to the European Commission on the implementation of the German EMP's (Fladung and Brämick, 2015).

RBD	IMPACT (MORTALITY IN TONS)		
	Commercial and recreational fishery (inland and coastal)	Mortality at technical constructions (turbines)	Predation by cormorants
Eider	5	37	ND*
Elbe	227	28	ND*
Ems	17	4	ND*
Maas	0.1	<1	ND*
Oder	20	<1	ND*
Rhein	63	127	ND*
Schlei/Trave	34	3	ND*
Warnow/Peene	86	<1	ND*
Weser	58	63	ND*
Total	511	262	ND*

* : Predation by cormorants is not given separately in the Implementation Report anymore.

13.2.4 Precautionary diagram

In this section the most recent precautionary diagrams for the RBD's of the North Sea and Baltic Sea catchments, respectively, are given. The graphs show the development of the years 2009 to 2013 and are based on the data provided for the 2015 Implementation Report (Fladung and Brämick, 2015). No graph is presented for the RBD Schlei/Trave, since the results for this RBD (e.g. $B_{curr} = 122\%$ of B_0) appear a bit uncertain and do not fit into the standard form of the diagram.

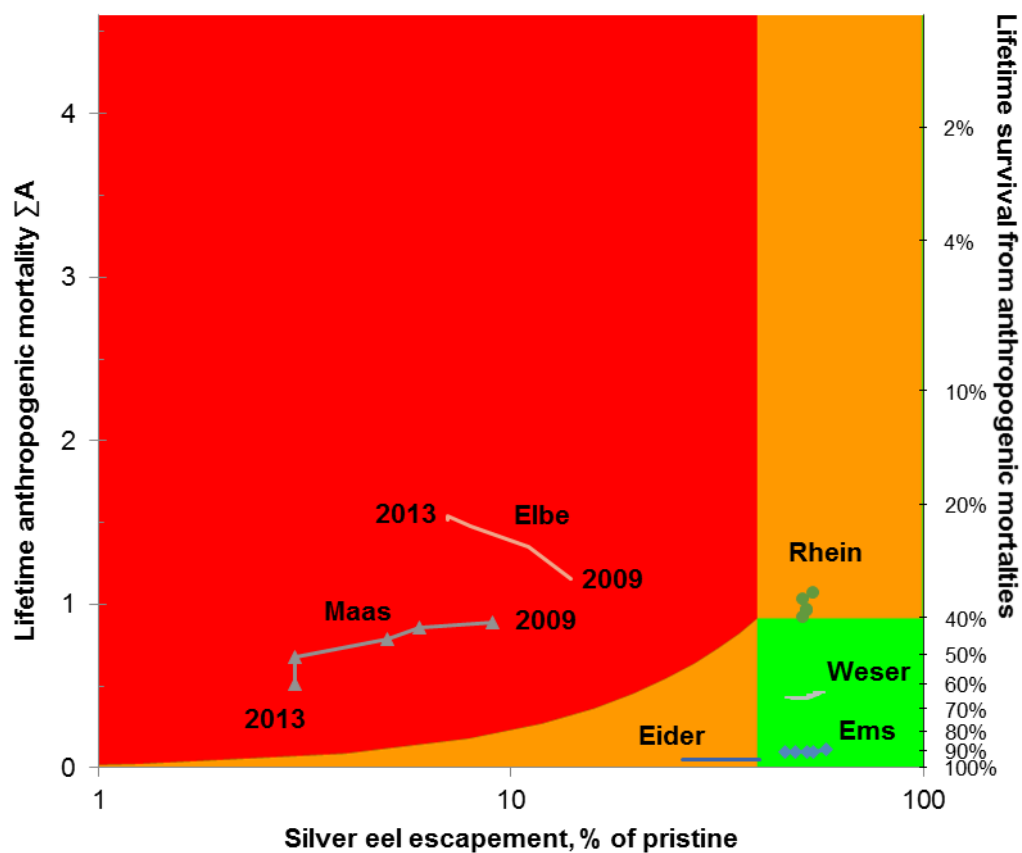


Figure 2. Precautionary diagram for the German RBD's draining into the North Sea. For reasons of clarity, start (2009) and endpoint (2013) are only indicated for the RBD's Maas and Elbe. In all other RBD's biomass also decreased during the reporting period, whereas mortalities remained rather stable or decreased slightly for the Rhine.

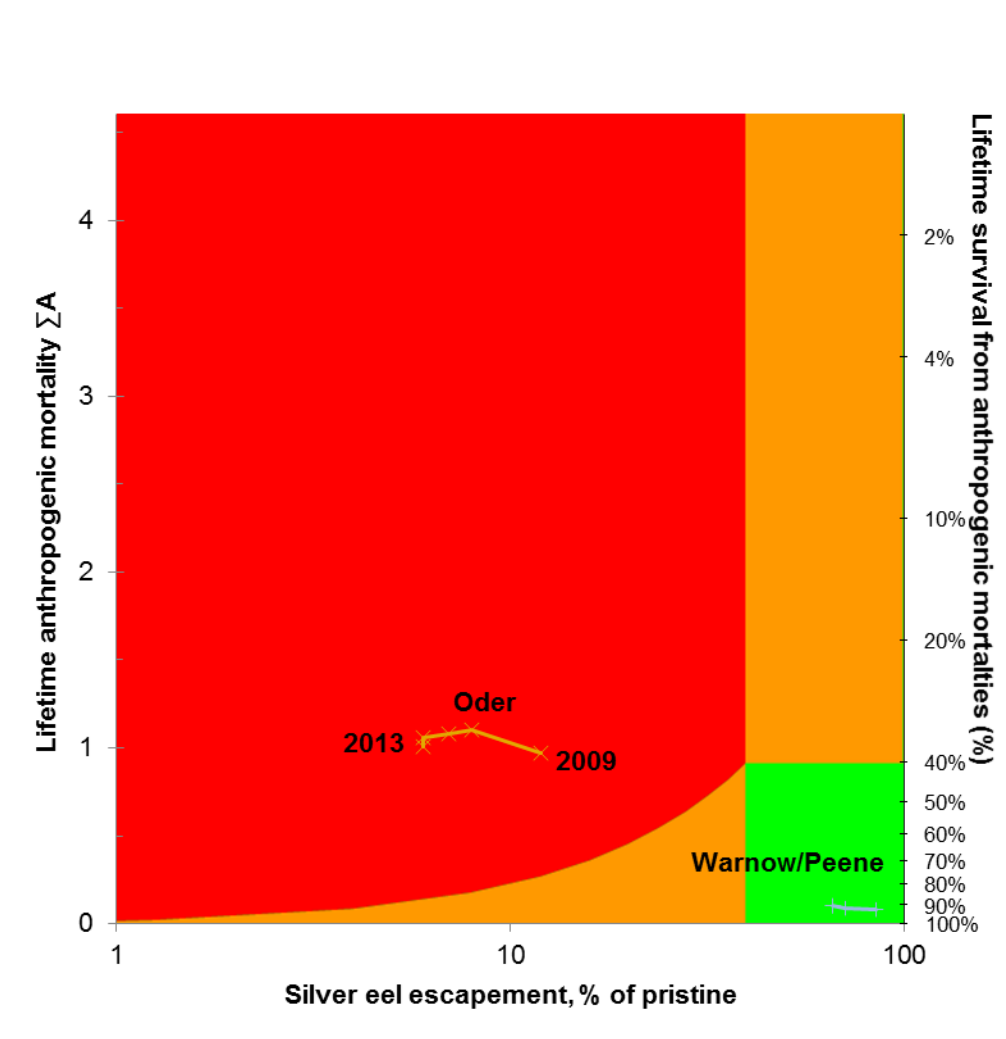


Figure 3. Precautionary diagram for the German RBD's draining into the Baltic Sea. For reasons of clarity, start (2009) and endpoint (2013) is only indicated for the RBD Oder. In the RBD Warnow/Peene, biomass also decreased during the reporting period, whereas mortality remained rather stable.

13.2.5 Management measures

Table 13.7. Implementation of management measures in the RBD Eider.

EMU code	Action Type	Action	Life Stage	Planned	Outcome
DE_Eide	Com Fish	Increase minimum size limit	Yellow	EMP	Implemented
		Close stationary eel traps	Mixed	Other	Partially implemented
	Rec Fish	Increase minimum size limit	Yellow	EMP	Implemented
	Hydropower & Pumps	Trap & Transport	Silver	EMP	Implemented
	Restocking	no	---	---	---
	Other	Predator control	Mixed	EMP	Implemented
		Improve longitudinal connectivity	Mixed	EMP/Other	Partially implemented
		Scientific studies and monitoring and data collection	Mixed	EMP	Implemented
		Legal framework	Mixed	EMP	Implemented
		Improve means of fishery control	Mixed	Other	Implemented

Table 13.8. Implementation of management measures in the RBD Elbe.

EMU code	Action Type	Action	Life Stage	Planned	Outcome
DE_Elbe	Com Fish	Increase minimum size limit	Yellow	EMP	Partially implemented
		Close stationary eel traps	Silver	EMP	Partially implemented
			Mixed	EMP	
		Reduction of fisheries intensity in coastal waters	Mixed	Other	Partially implemented
		Introduction of regional fishing limitations			Implemented
	Rec Fish	Increase minimum size limit	Yellow	EMP	Partially implemented
		Introduction of bag size limit for eel anglers	(Yellow)/Mixed	Other	Implemented
			(Yellow)/Mixed	Other	Implemented
		Closing fishery at night for anglers			
	Hydropower & Pumps				
	Restocking	Stabilize/increase amount stocked	Glass	EMP	Implemented
	Other	Improve longitudinal connectivity	Mixed	EMP/Other	(Partially) implemented
		Scientific studies and monitoring and data collection	Mixed	EMP	(Partially) implemented
				EMP	Partially implemented
		Legal framework	Mixed		

Table 13.9. Implementation of management measures in the RBD Ems.

EMU code	Action Type	Action	Life Stage	Planned	Outcome
DE_Ems	Com Fish	Increase minimum size limit	Yellow	EMP	Partially implemented
		Reduction of fisheries intensity in coastal waters	Mixed	EMP	Not implemented
	Rec Fish	Increase minimum size limit	Yellow	EMP	Partially implemented
	Hydropower & Pumps	Hydropower mortality is of subordinate importance in the RBD Ems. There is no urgent need for measures.			
	Restocking	Stabilize/increase amount stocked	Glass	EMP	Partially implemented
		Supply financial support for stocking	Glass	Other	Implemented
	Other	Improve longitudinal connectivity	Mixed	Other	Partially implemented
			Mixed	EMP	
		Scientific studies and monitoring and data collection			Implemented
		Legal framework	Mixed	EMP	Partially implemented

Table 13.10. Implementation of management measures in the RBD Maas.

EMU code	Action Type	Action	Life Stage	Planned	Outcome
DE_Maas	Com Fish	Increase minimum size limit	Yellow	EMP	Implemented
	Rec Fish	Increase minimum size limit	Yellow	EMP	Implemented
	Hydropower & Pumps	No permission for new hydropower facilities	Silver/Mixed	EMP	No action needed.
	Restocking	Stabilize/increase amount stocked (30,000 glass eels and 30,000 ongrown eels)	Glass	EMP	Implemented
		Supply financial support for stocking	Glass	Other	Implemented
	Other	Improve longitudinal connectivity	Mixed	Other	Partially implemented
		Scientific studies and monitoring and data collection	Mixed	Other	Implemented
			Mixed	Other	Implemented
			Mixed	EMP	Implemented
		Legal framework			

Table 13.11. Implementation of management measures in the RBD Oder.

EMU code	Action Type	Action	Life Stage	Planned	Outcome
DE_Oder	Com Fish	Increase minimum size limit	Yellow	EMP	Implemented
		Close stationary eel traps (but no concrete targets)	Silver	EMP	Not implemented
	Rec Fish	Increase minimum size limit	Yellow	EMP	Implemented
		Introduction of bag size limit	Mixed	Other	Implemented
	Hydropower & Pumps	Hydropower mortality is no issue in the German part of the RBD Oder. There is no need for measures.			
	Restocking	Stabilize/increase amount stocked	Glass	EMP	Implemented
	Other	Improve longitudinal connectivity	Mixed	Other	Partially implemented
		Scientific studies, monitoring and data collection	Mixed	EMP	Partially implemented
		Legal framework	Mixed	EMP	
					Implemented

Table 13.12. Implementation of management measures in the RBD Rhine.

EMU code	Action Type	Action	Life Stage	Planned	Outcome
DE_Rhei	Com Fish	Increase minimum size limit	Yellow	EMP	Implemented
		Introduce closed season	Mixed	EMP	Implemented
		Establish prolonged closed season	Mixed	Other	Implemented
	Rec Fish	Increase minimum size limit	Yellow	EMP	Implemented
		Introduce closed season	Mixed	EMP	Implemented
		Establish a prolonged closed season	Mixed	Other	Implemented
	Hydropower & Pumps	Trap & Transport	Silver	EMP/Other	Implemented
	Restocking	Stabilize/increase amount stocked	Glass	EMP	Implemented
		Supply financial support for restocking	Glass	Other	Implemented
	Other	Improve longitudinal connectivity	Mixed	Other	Implemented
		Predator control	Mixed	EMP	Partially implemented
		Scientific studies, monitoring and data collection	Mixed	Other	(Partially) Implemented
		Legal framework	Mixed	EMP	Partially implemented
		Include eel in existing species protection programmes	Mixed	Other	Implemented

Table 13.13. Implementation of management measures in the RBD Schlei/Trave.

EMU code	Action Type	Action	Life Stage	Planned	Outcome
DE_Schl	Com Fish	Increase minimum size limit	Yellow	EMP	Implemented
		Reduction of fisheries intensity in coastal waters	Mixed	EMP	Implemented
		Close stationary eel traps	Mixed	Other	Partially implemented
	Rec Fish	Increase minimum size limit	Yellow	EMP	Implemented
		Introduction of a bag size limit	Mixed	Other	Implemented
	Hydropower & Pumps	Trap & Transport	Silver	EMP	Partially implemented
	Restocking	Stabilize/increase amount stocked	Glass	EMP	Partially implemented
	Other	Improve longitudinal connectivity	Mixed	EMP/Other	Partially implemented
		Predator control	Mixed	EMP	Implemented
		Scientific studies and monitoring and data collection	Mixed	EMP/Other	Partially implemented
		Legal framework	Mixed	EMP	Implemented
		Improve means of fishery control	Mixed	Other	Implemented

Table 13.14. Implementation of management measures in the RBD Warnow/Peene.

EMU code	Action Type	Action	Life Stage	Planned	Outcome
DE_Warn	Com Fish	Increase minimum size limit	Yellow	EMP	Implemented
		Reduction of fisheries intensity in coastal waters	Mixed	EMP	Implemented
		Close stationary eel traps	Mixed	Other	Partially implemented
		Introduce a closed season	Mixed	EMP	Implemented
	Rec Fish	Increase minimum size limit	Yellow	EMP	Implemented
		Introduce a closed season	Mixed	EMP	Implemented
	Hydropower & Pumps				
	Restocking	Stabilize/increase amount stocked	Glass	EMP	Partially implemented
	Other	Improve longitudinal connectivity	Mixed	Other	Partially implemented
			Mixed	EMP	Partially implemented
		Predator control	Mixed	EMP/other	Implemented
		Scientific studies and monitoring and data collection	Mixed	EMP	Implemented
		Legal framework			

Table 13.15. Implementation of management measures in the RBD Weser.

EMU code	Action Type	Action	Life Stage	Planned	Outcome
DE_Wese	Com Fish	Increase minimum size limit	Yellow	EMP	Partially implemented
		Reduction of fisheries intensity in coastal waters	Mixed	EMP	Not implemented
		Establish or prolong closed season for eel fishery	Mixed	Other	Partially implemented
	Rec Fish	Increase minimum size limit	Yellow	EMP	Partially implemented
		Establish or prolong closed season for eel fishery	Mixed	Other	Partially implemented
	Hydropower & Pumps	Introduce trap and transport programme and/or turbine management	Silver	Other	Partially implemented
	Restocking	Stabilize/increase amount stocked	Glass	EMP	Partially implemented
		Supply financial support for stocking	Glass	Other	Implemented
	Other	Improve longitudinal connectivity	Mixed	Other	Partially implemented
		Scientific studies and monitoring and data collection	Mixed	Other	Implemented
		Legal framework	Mixed	EMP	Partially implemented

13.3 Summary data on glass eel

Quantities:

caught in the commercial fishery: no glass eel fishery
 exported to Asia: no export
 used in stocking: 2011: 4 823 772 glass eels and 5 473 830 ongrown eels
 2012: 4 009 562 glass eels and 6 102 490 ongrown eels
 2013: 4 659 466 glass eels and 6 607 587 ongrown eels
 used in aquaculture: (see comment below)*
 consumed direct: no fishery, potential import unknown
 mortalities: no data (but no fishery on glass eel)

* According to data of the German Federal Statistical Office (Statistisches Bundesamt) **4.610 tons** of glass eel were brought to German eel aquaculture companies in 2014. However, information about the sources of the glass eels was not provided. In gen-

eral, the legal situation regarding the availability of the data (sources) appears to be a bit unclear (data protection, etc.). Glass eels, which are brought to aquaculture, are partly used for re-stocking as ongrown eels (see chapter on aquaculture production).

14 Sampling intensity and precision

A regular sampling is conducted in the frame of the Data Collection Framework (DCF). Information on the sampling design is provided in a special Annex to this report.

There are no data available from other studies, except for the information provided in the chapters 11 and 12.

15 Standardisation and harmonisation of methodology

15.1 Survey techniques

So far, there is no standardized survey technique for eel monitoring. However, at least for the Baltic coastal waters, a monitoring system has been developed, which could allow a standardized monitoring in these waters in future and which potentially could be used in other Baltic countries as well. For details see Chapter 13.1. of the 2012 Country Report (for 2011) and Ubl and Dorow (2014).

15.2 Sampling commercial catches

Commercial catches are sampled in the frame of the DCF. Details are given in a special annex to this report.

15.3 Sampling

Commercial catches are sampled in the frame of the DCF. Details are given in a special annex to this report.

15.4 Age analysis

Commercial catches are sampled in the frame of the DCF. Details are given in a special annex to this report.

15.5 Life stages

Commercial catches are sampled in the frame of the DCF. Details are given in a special annex to this report.

15.6 Sex determinations

Commercial catches are sampled in the frame of the DCF. Details are given in a special annex to this report.

15.7 Data quality issues

The quality of the available data is not easy to assess. There is no long history of eel stock assessment in Germany and hence the results are based on catch statistics, estimates and model calculations. The reliability of the catch statistics has not been evaluated so far. The model used to calculate the different population parameters of eel in German waters (Oeberst and Fladung, 2012), has been further developed (GEM III) and has also been tested in the frame of the POSE project. Meanwhile, the model assumptions have been compared to data obtained by tagging studies and proved to be

acceptable (Fladung *et al.*, 2012b; Prigge *et al.*, 2013). Yet, the studies also indicated that the quality of the results strongly depends on the quality of the input data. Hence, the data basis for the modelling of the stock will have to be improved continuously in future. The reliability of the results will also be enhanced by increasingly using river-specific growth data obtained in the frame of the DCF sampling.

16 Overview, conclusions and recommendations

In Germany, the relevant authorities and institutions have prepared eel management plans as required by the EU Regulation 1100/2007. The plans were submitted in December 2008 and have been approved by the European Commission in April 2010. For most of the measures planned in the EMP's the implementation has been started or already achieved. However, some targets could not be achieved completely and some of the measures are still in some delay.

In 2015, the second report to the European Commission about the implementation of the EMP'S and the recent development of the eel stocks was submitted. This report formed another milestone in the development of eel management in Germany.

During the implementation process of the EMP's, the authorities in the States ("Bundesländer") in Germany established a dedicated (permanent) working group. However, the group mainly focuses on the requirements of the implementation reports, but not on an annual calculation of the stock parameters in the "in-between-periods". However, this is done backwards for each new implementation report. At present, estimates for all stock indicators are available until the year 2013.

It can be assumed that the general situation regarding the eel stocks and the eel fishery in Germany has not changed very strong, as can be concluded from data on catches, stocking etc. However, a noticeable decrease in fishing effort was documented during the recent years.

In Germany, in the last years, several projects and studies have been conducted, which improved the availability of data on important population parameters (and will continue to do so in future). German research institutes are also active in studying the marine stages of eel, in particular larval stages in the spawning area. In some restocking projects, eel quality issues, such as diseases and contamination, are addressed. The results of the biological sampling in the frame of the DCF will also help to improve the data basis for the population model used for the calculation of escapement.

The eel is still an important species for the German fisheries sector, especially for inland and coastal fishery, although the importance of this sector itself is rather small. After a clear decrease during the last decades, due to considerable efforts spent on restocking, the eel catches now appear to be on a low but rather stable level.

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German National Data Collection of European eel (*Anguilla anguilla*) 2014

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Introduction

Following the „pilot“ project in 2009/2010 (EIFAC/ICES WGEEL Report 2010), sampling of the European eel (*Anguilla Anguilla*) in German River Basin Districts (RBD) was continued in 2014 as part of the DCF. Data will be collected and reports will be provided on an annual basis ((EC) No 199/2008), starting in 2011.

In this pilot phase, sampling focused on gathering biological parameters of eel in commercial catches of inland fisheries. During the ongoing sampling period from 2011 to 2013 the proposal for the German national programme intended the gathering of 600 eels from the Baltic sea and 300 eels from the North Sea, including the respec-

tive discharging river basin districts (RBD; according to WFD, see Figure 1). However, recent sampling aimed at 600 eels from North Sea -and 300 eels from the Baltic Sea-related RBDs, which has proven to be a more reasonable approach.

If possible, 100 silver and 100 yellow eels per RBD were sampled, according to Council Decision (EC) No 949/2008. In some RBD's (e.g. Warnow/Peene) the collection of eels was difficult due to low catches and availability. Thus sample sizes were not fully achieved. Concerning the aims of the DCF to provide end-user oriented data, one of the main objectives for samplings done in 2014 was to purchase individuals of certain length classes, to fill gaps in already gathered data and to be able to provide datasets for RBD-specific growth functions, to be used by the federal German states in line with the states' related eel-management plans.

No samplings were made for the RBD Meuse (where no commercial fishery exists in its German part) and the RBD Danube (which is not considered a natural habitat of the European eel according to Council Regulation (EC) 1100/2007). Consequently, sampling was not required based on DCF standards. Due to low catches of commercial fishermen in the RBD Oder, no samples were available in Germany. As already performed in 2013, samples from the river Oder in 2014 were gathered in a bilateral agreement between Poland and Germany, with Poland being responsible for reporting DCF data for the Oder RBD to the EU, allowing Germany access to the respective data. However, samples gathered under this agreement are also mentioned in this report. A similar approach will be used for future sampling. In total, 807 (+ 200 for the river Oder sampled by Poland) eels were sampled in 2014 (see Table 1).

Yellow eels were mostly collected in spring/summer and silver eels in autumn/winter 2014 (for detailed information see Table 1 and Figure 2). Analyses include length, weight, age, sex and maturity (detailed information in the list of biological variables). Although not mandatory under DCF regulations, additional parameters such as infestation with the invasive swimbladder nematode *Anguillicola crassus* and other parasites as well as lipid content of eel tissue have been analysed, partly in cooperation with other institutions (e.g. Helmholtz Zentrum Geesthacht (HZG), RWTH Aachen, University of Duisburg-Essen, Karlsruhe Institute of Technology (KIT)).

Material and methods

Sampling in 2014 started in spring and ended in late winter 2014. Sampling locations are given in Figure 1, sample sizes, fishing gear and time of sampling are summarized in Table 1.

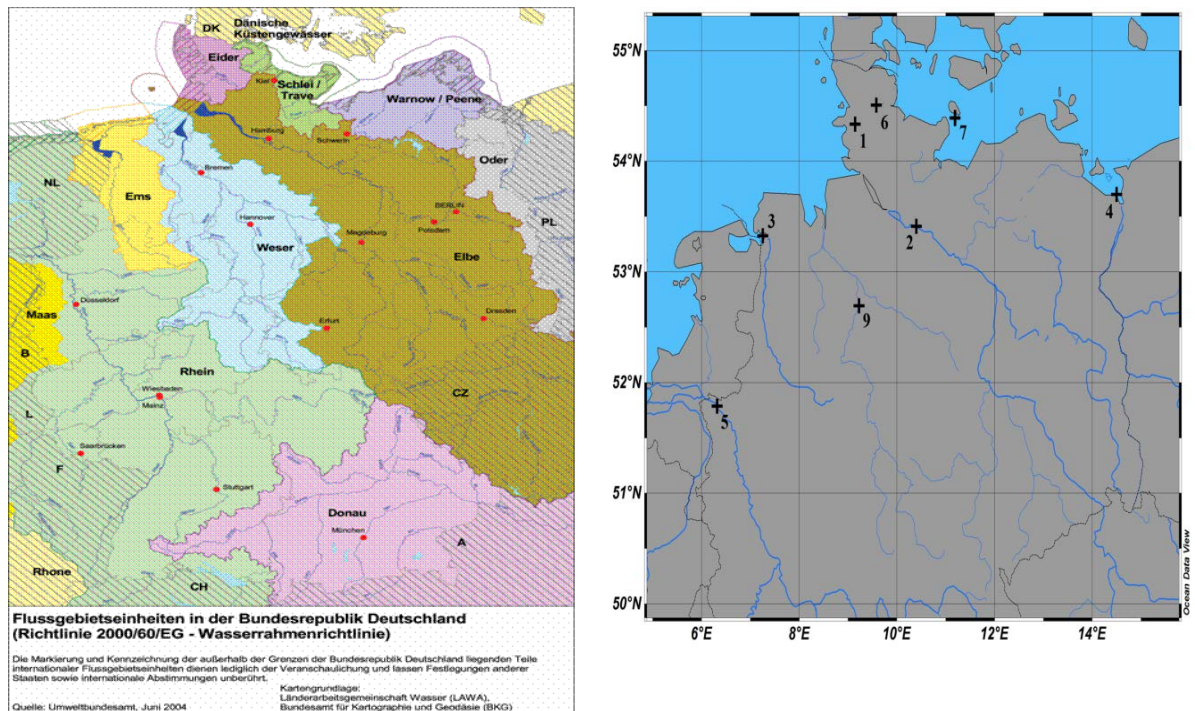


Figure 1. Left: German River Basin Districts; Right: Numbers indicate sampling locations within the RBD's: 1: Eider, 2: Elbe, 3: Ems, 4: Oder, 5: Rhine, 6: Schlei/Trave, 7: Baltic Sea (Fehmarn), 8: Warnow/Peene, 9: Weser.

Mandatory biological parameters of eel in commercial catches of inland fisheries were:

length a, weight b, sex c, maturity d, age e

a: total length was determined either immediately after catch (to the nearest 0.5 cm) or after thawing. In the second case the values were corrected by assuming a reduction of 2.5% according to Wickström *et al.*, 1986.

b: total weight was determined either immediately after catch or after thawing. In the second case the values were corrected by assuming a reduction of 2.8% according to Wickström *et al.*, 1986.

c: sex determination via macroscopic assessment of gonadal development.

d: determination of silvering index according to Durif *et al.*, 2005 and divided into yellow eels (stages 1–3) and silver eels (stages 4–6).

Table 1. Sampling scheme per RBD in the year 2014.

No.	RBD	SAMPLING TIME	SAMPLE SIZE (N)*			GEAR
			Y	S	Total	
1	Eider	May 2014	53	0	53	fykenet
1	Eider	Oktober/November 2014	2	51	53	fykenet
2	Elbe	May 2014	58	0	58	fykenet
2	Elbe	November 2014	0	15	15	traw
3	Ems	May/July 2014	86	29	115	fykenet
3	Ems	Oktober 2014	0	15	15	fykenet
4	Oder	Data will be reported by Poland (following bilateral agreement)				
5	Rhine	June 2014	146	12	158	stownet
5	Rhine	Oktober 2014	1	35	36	stownet
6	Schlei/Trave	June 2014	40	8	48	fykenet
7	Schlei/Trave	September 2014	16	14	30	fykenet
7	Baltic sea (Fehmarn)	November 2014	6	15	21	fykenet
8	Warnow/Peene	August/September 2014	5	39	44	stownet
8	Warnow/Peene	October 2014	29	21	50	stownet
9	Weser	June 2014	73	3	76	fykenet
9	Weser	October 2014	5	30	35	stownet

*:S=Silver Eel; Y=Yellow Eel

Results

A total of 807 eels (+200 in bilateral agreement with Poland for River Oder) were sampled from 7 (+1) different RBD's in 2014. All graphs in the following show pooled data from 2009 to the latest data collected in November 2015 (n=5775). Note, that the sum of all displayed data points might be less than 5775 since not all of the displayed parameters were available for every sample.

Length distributions for female (black fill) and male (black border, no fill) eels by RBD (pooled Y&S) are given in Figures 2a–h. Note that length distributions are biased by e.g. the selectivity of the respective fishing gear or differences in minimum landing size between locations.

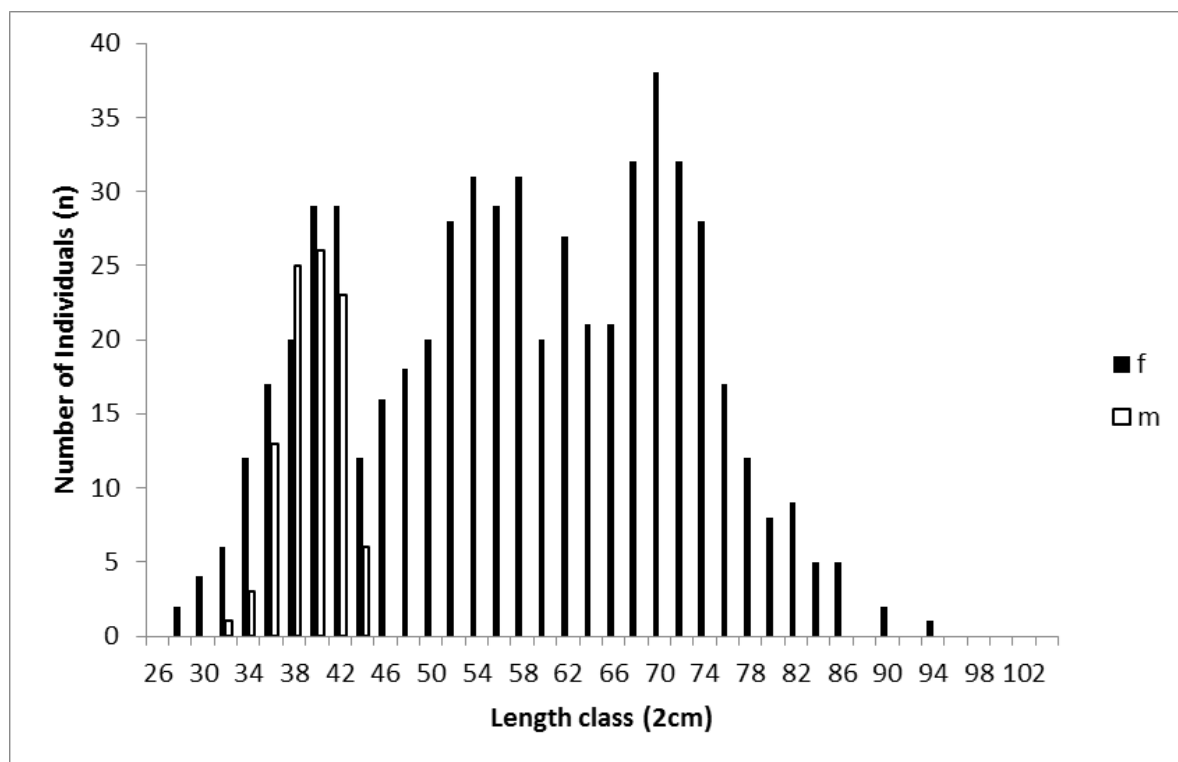


Figure 2a. Length distribution of eel samples from the RBD Eider (female: n=582, male: n=97).

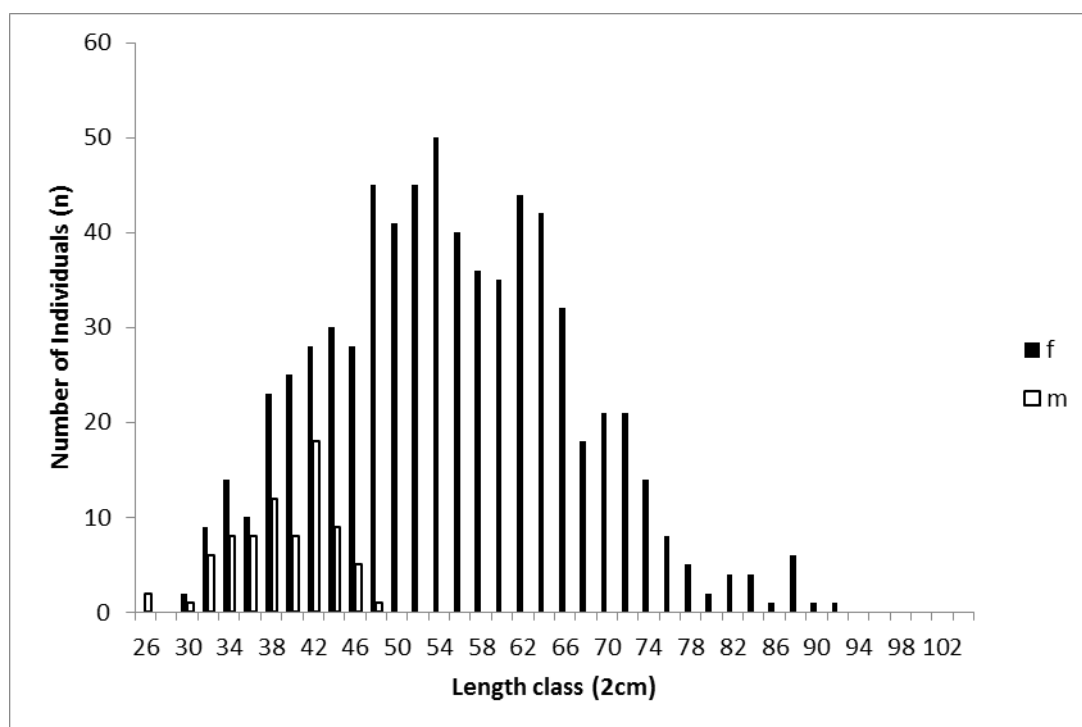


Figure 2b. Length distribution of eel samples from the RBD Elbe (female: n=685, male: n=78).

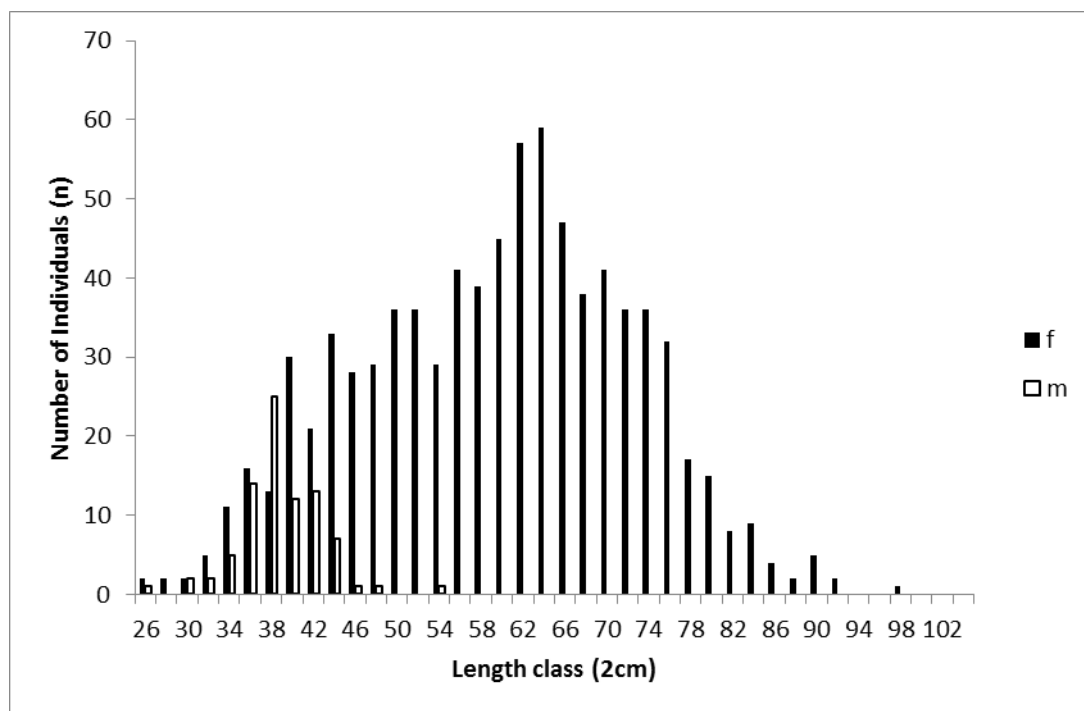


Figure 2c. Length distribution of eel samples from the RBD Ems (female: n=827, male: n=84).

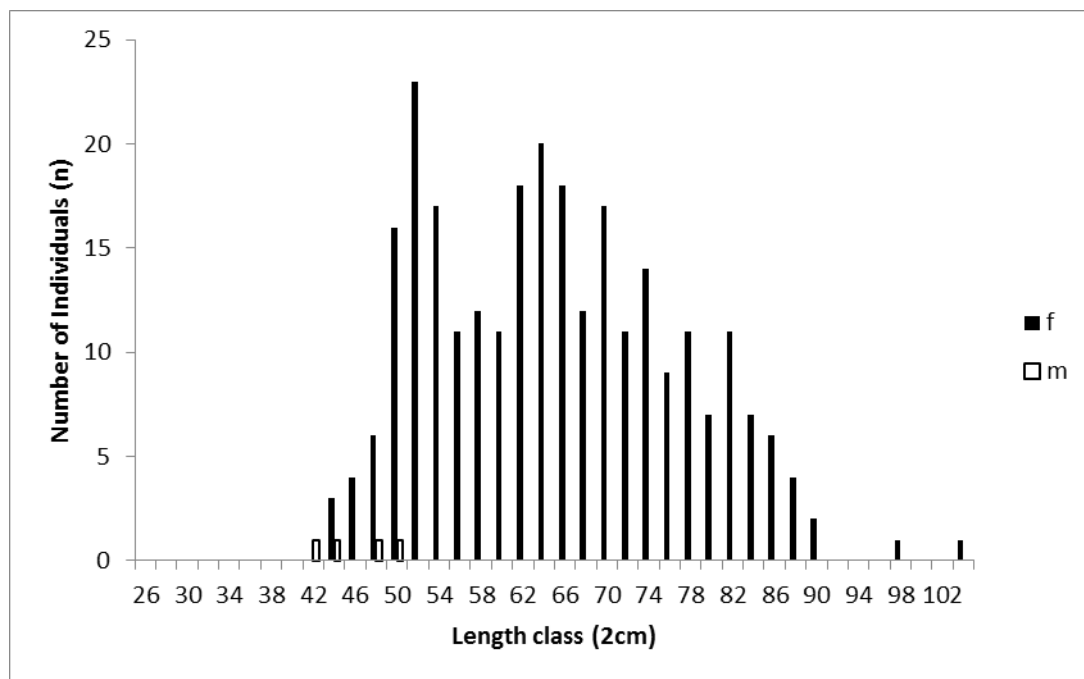


Figure 2d. Length distribution of eel samples from the RBD Oder (female: n=272, male: n=4).

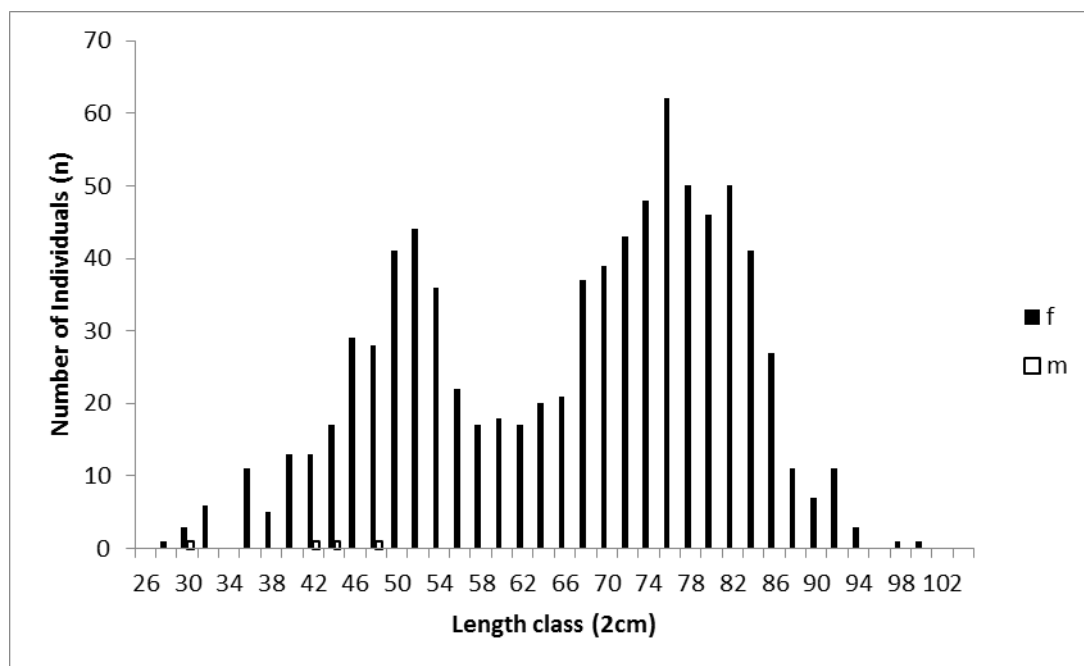


Figure 2e. Length distribution of eel samples from the RBD Rhine (female: n=839, male: n=4).

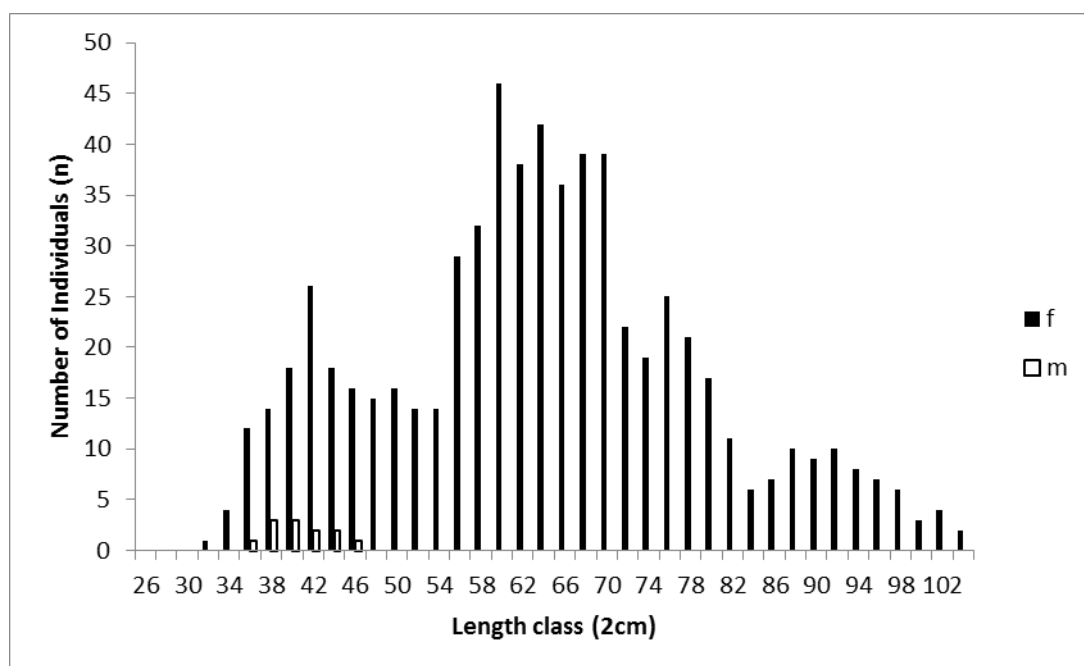


Figure 2f. Length distribution of eel samples from the RBD Schlei/Trave (female: n=656, male: n=12).

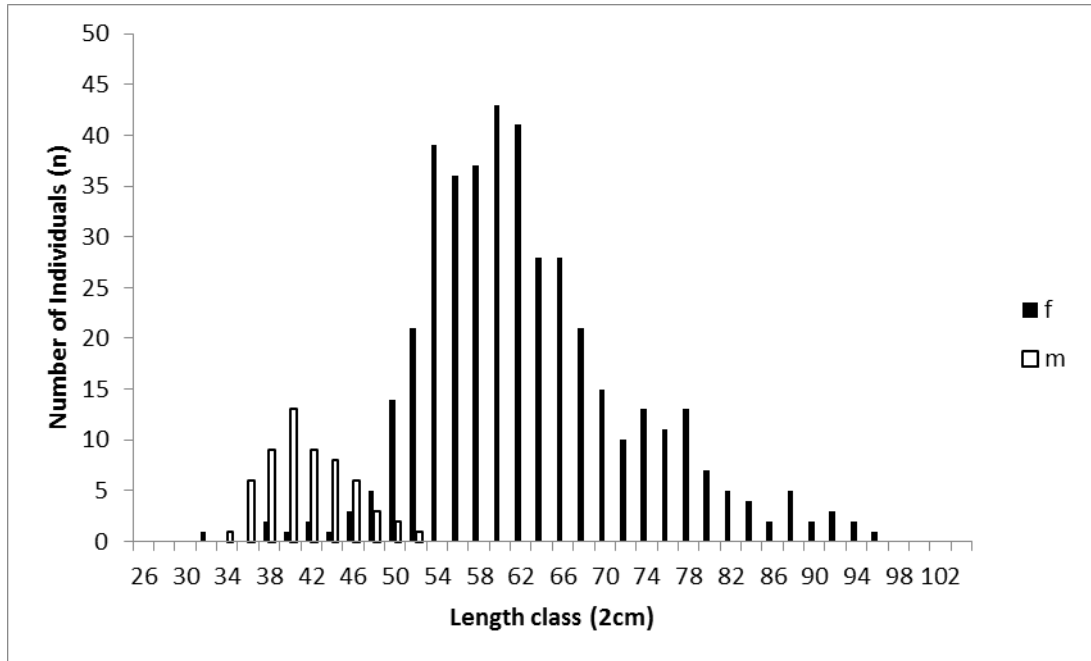


Figure 2g. Length distribution of eel samples from the RBD Warnow/Peene (female: n=416, male: n=58).

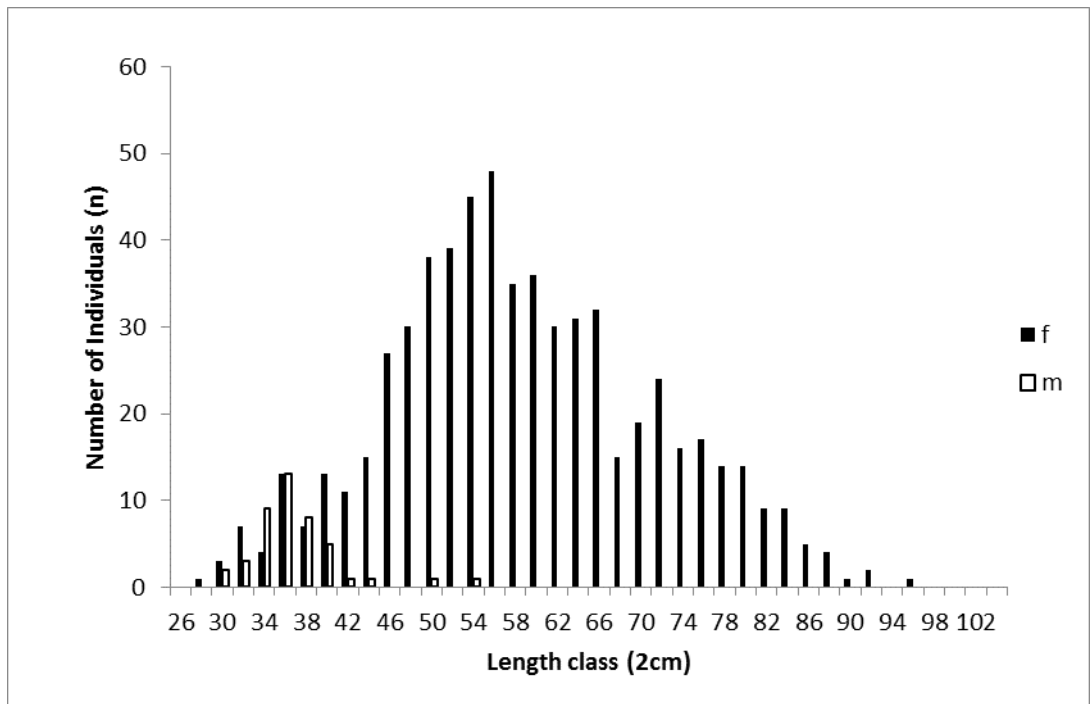


Figure 2h. Length distribution of eel samples from the RBD Weser (female: n=615, male: n=44).

Length–weight relationship for female (diamond, black) and male (cross, red) eels by RBD (pooled Y&S) are given in Figures 3a–h. The relationship is described by a power function ($L = aW^b$). Males are not displayed if $n < 40$.

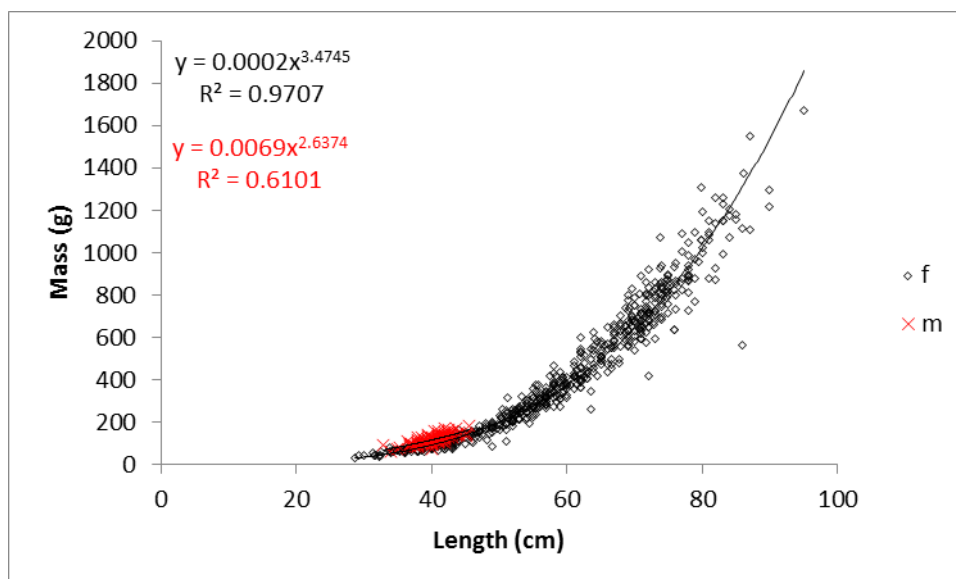


Figure 3a. Length–weight relationship of eel samples from the RBD Eider (female: n=582, male: n=97).

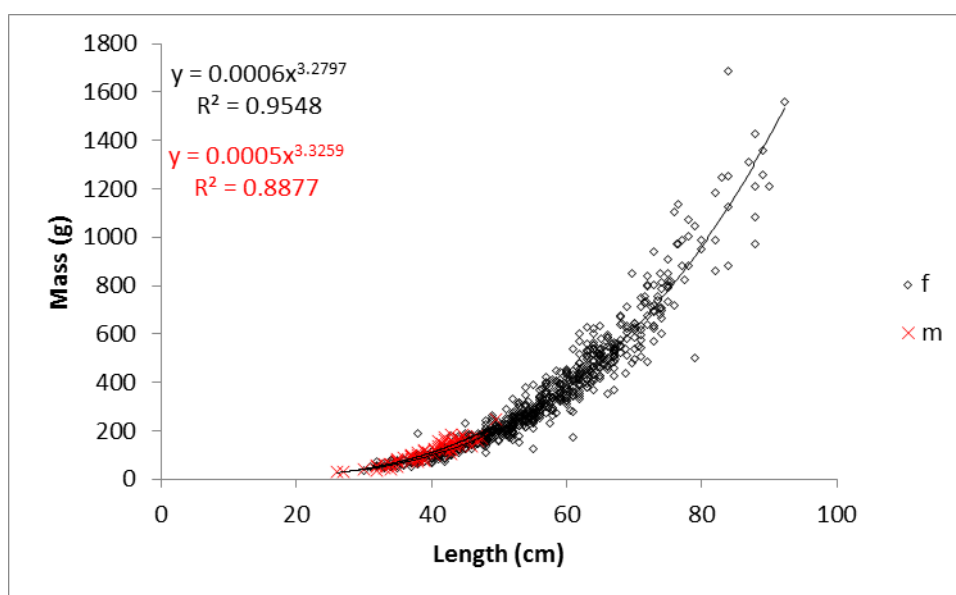


Figure 3b. Length–weight relationship of eel samples from the RBD Elbe (female: n=685, male: n=78).

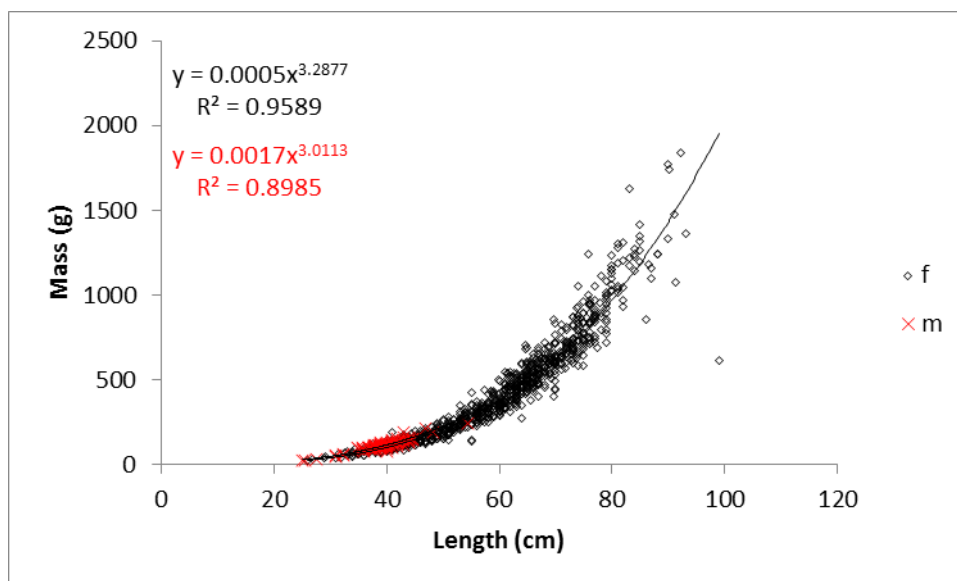


Figure 3c. Length–weight relationship of eel samples from the RBD Ems (female: n=827, male: n=86).

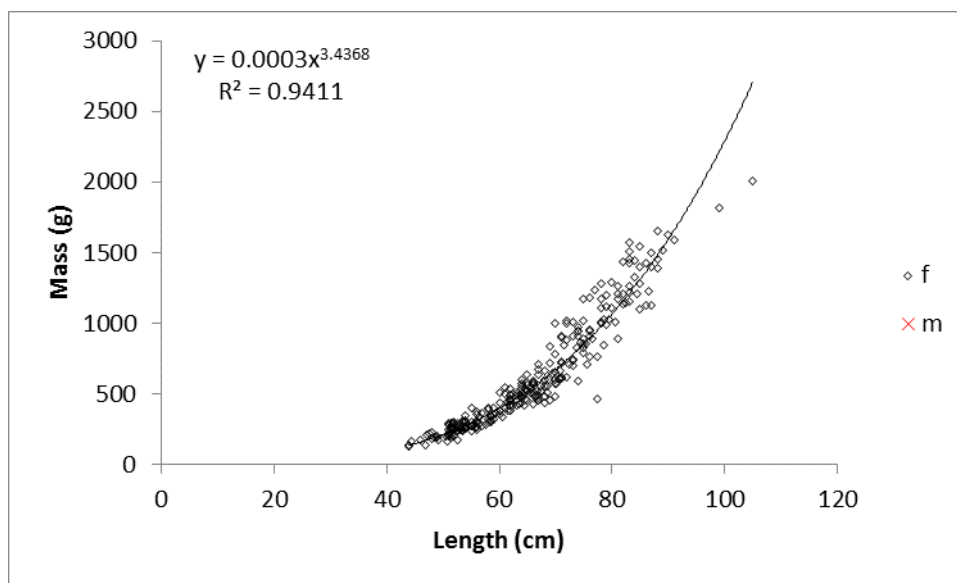


Figure 3d. Length–weight relationship of eel samples from the RBD Oder (female: n=272, male: n=4).

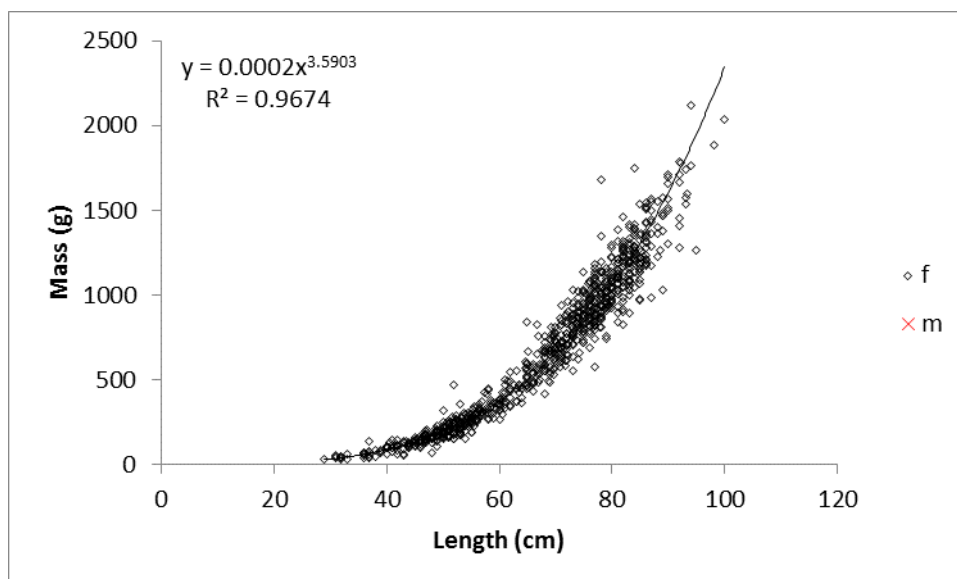


Figure 3e. Length-weight relationship of eel samples from the RBD Rhine (female: n=839, male: n=4).

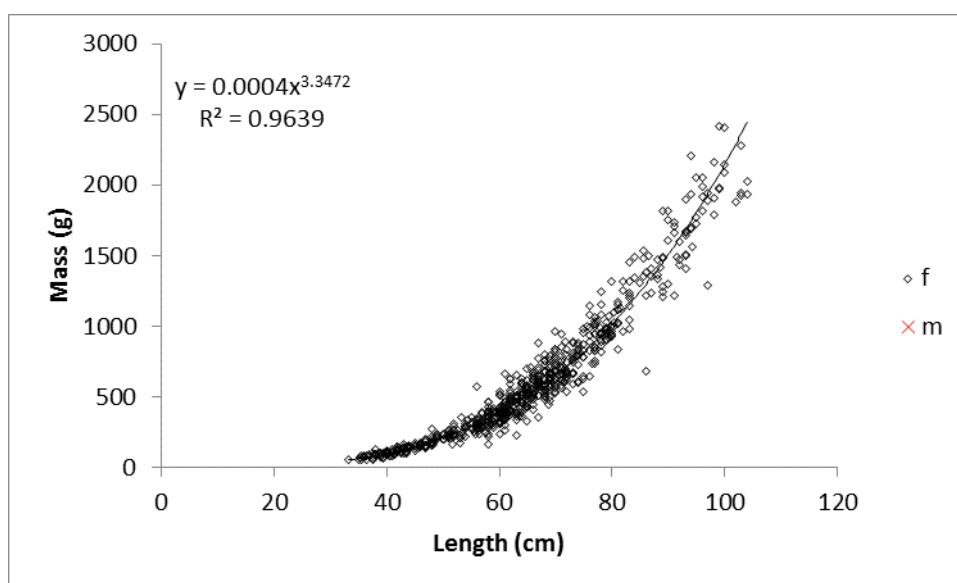


Figure 3f. Length-weight relationship of eel samples from the RBD Schlei/Trave (female: n=656, male: n=12).

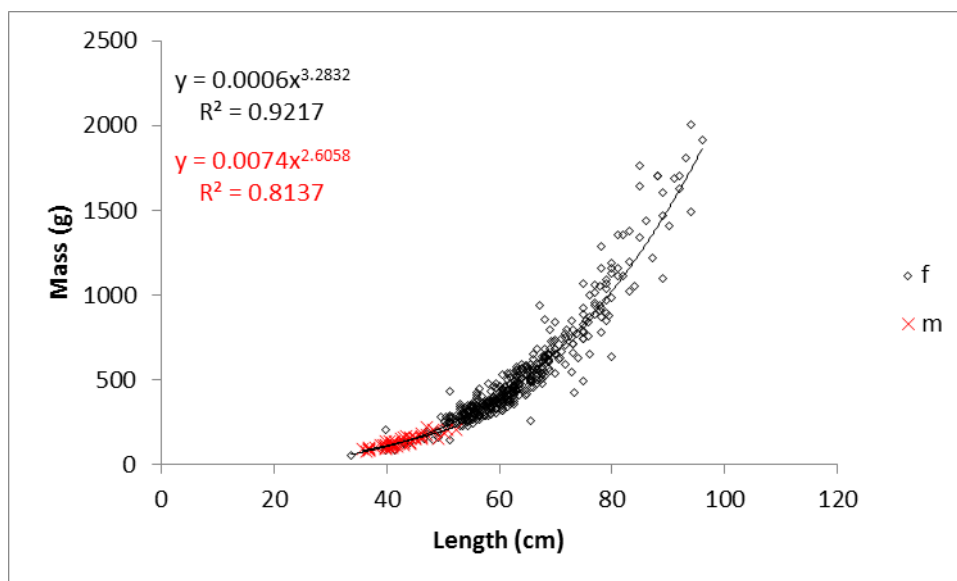


Figure 3g. Length–weight relationship of eel samples from the RBD Warnow/Peene (female: n=416, male: n=58).

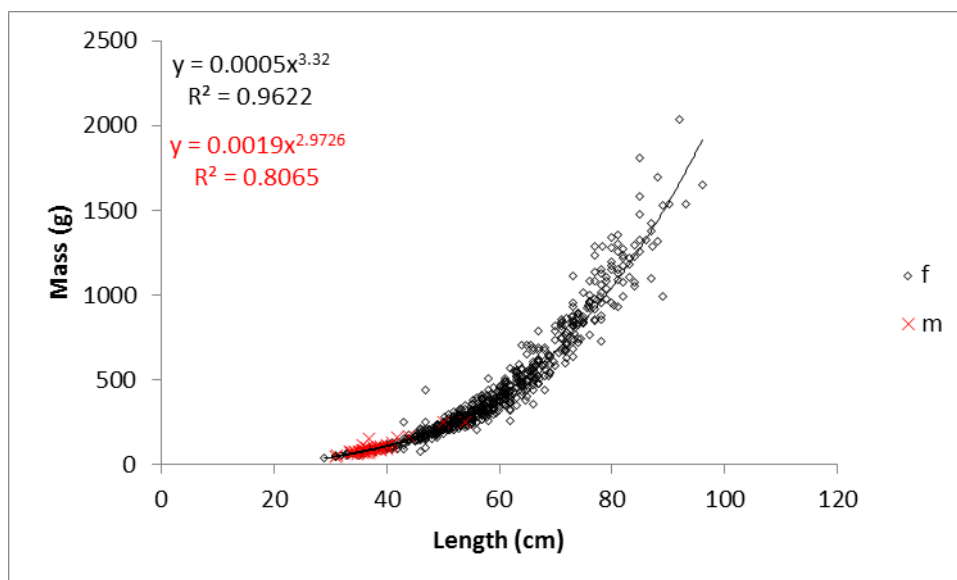


Figure 3h. Length–weight relationship of eel samples from the RBD Weser (female: n=615, male: n=44).

Age–length data for female (diamond, black) and male (cross, red) eels by RBD (pooled Y&S) are given in Figures 4a–h. Males are not displayed if n<40.

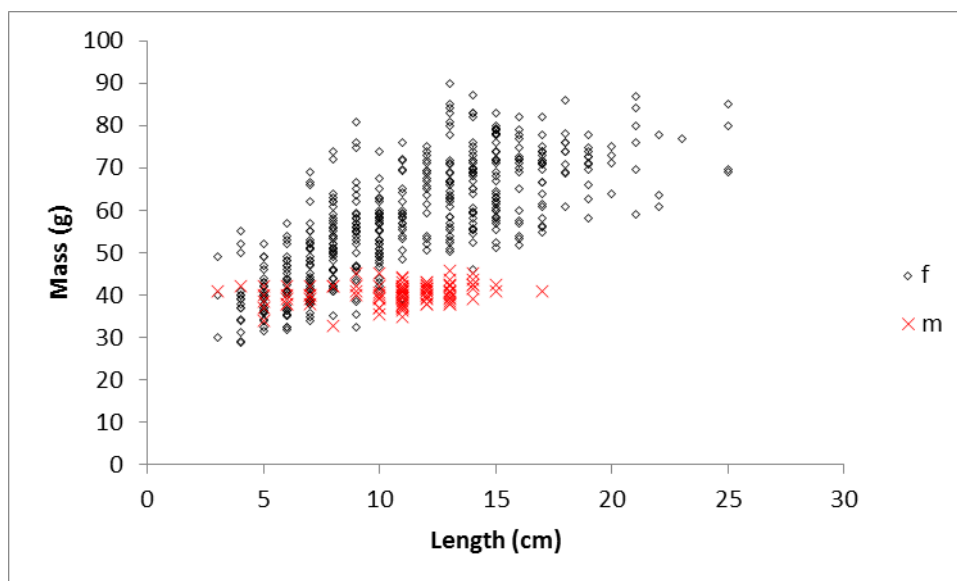


Figure 4a. Length–age relationship of eel samples from the RBD Eider (female: n=582, male: n=97).

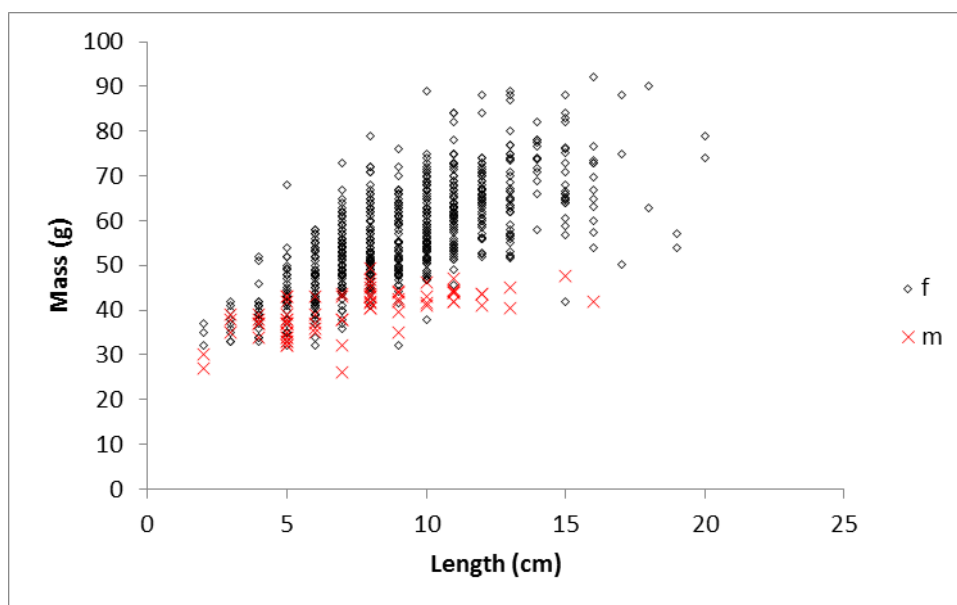


Figure 4b. Length–age relationship of eel samples from the RBD Elbe (female: n=685, male: n=78).

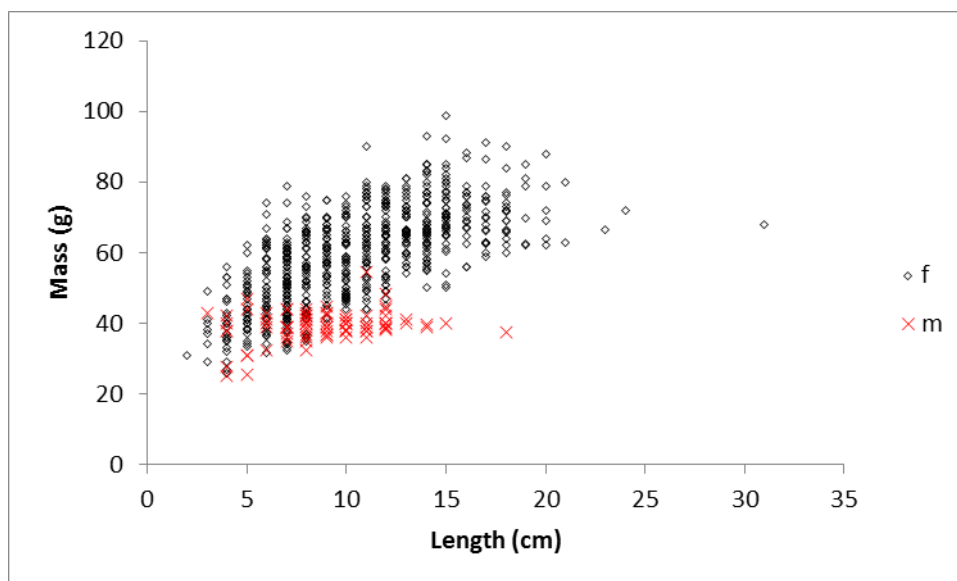


Figure 4c. Length–age relationship of eel samples from the RBD Ems (female: n=827, male: n=86).

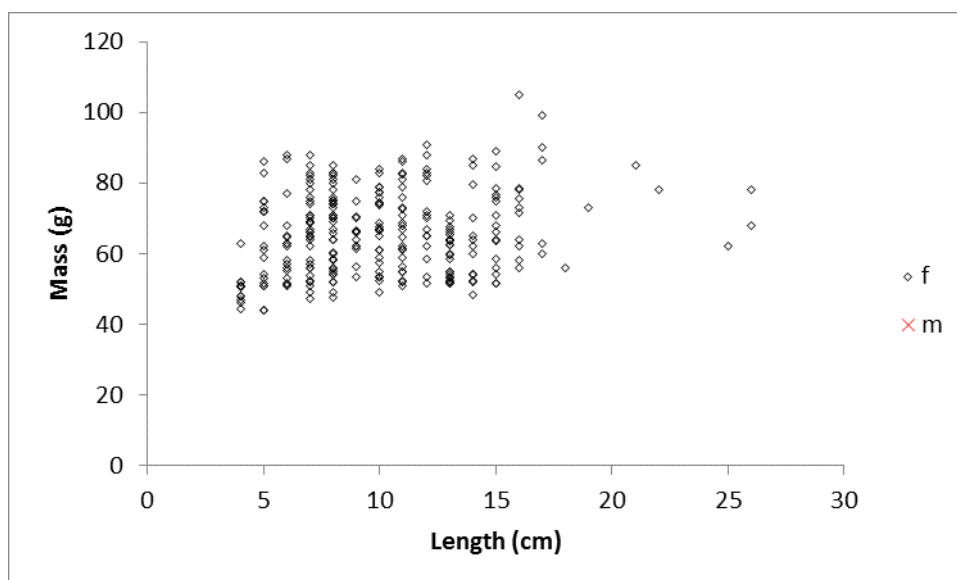


Figure 4h. Length–age relationship of eel samples from the RBD Oder (female: n=272, male: n=4).

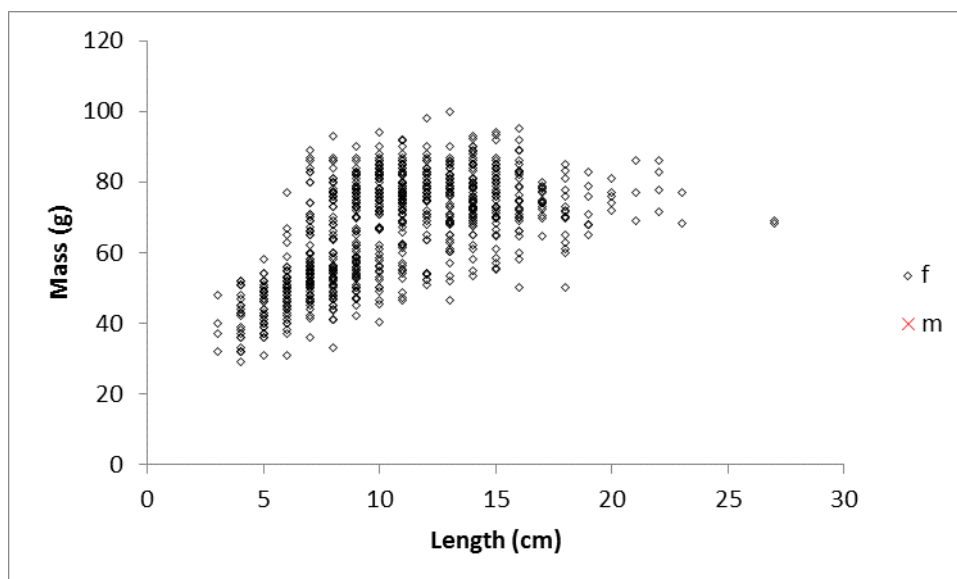


Figure 4d. Length–age relationship of eel samples from the RBD Rhine (female: n=839, male: n=4).

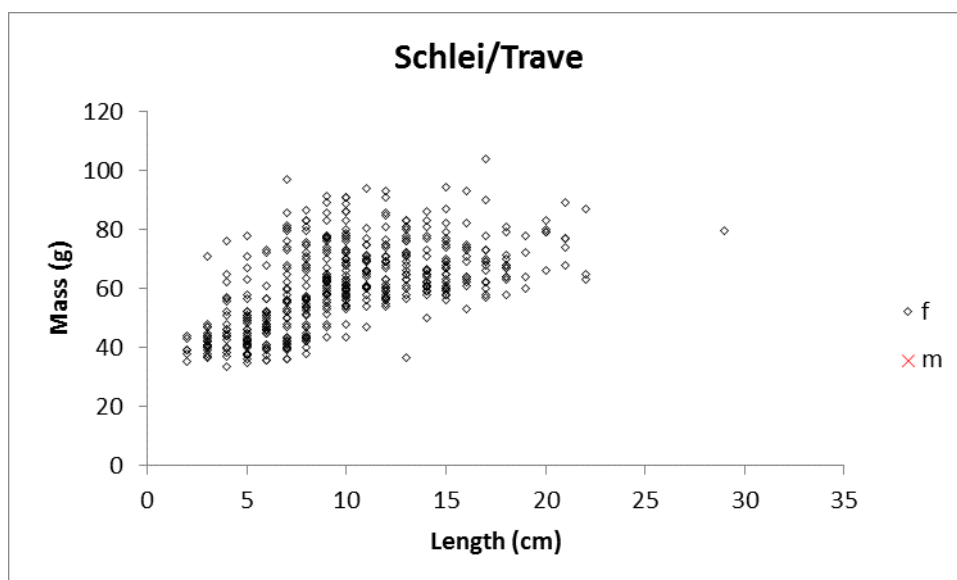


Figure 4e. Length–age relationship of eel samples from the RBD Schlei/Trave (female: n=656, male: n=12).

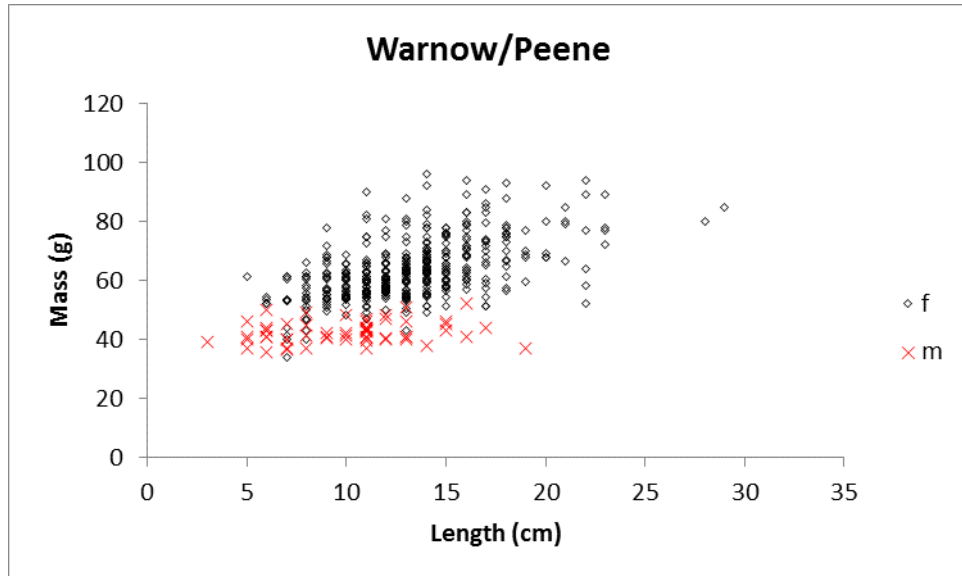


Figure 4f. Length–age relationship of eel samples from the RBD Warnow/Peene (female: n=416, male: n=58).

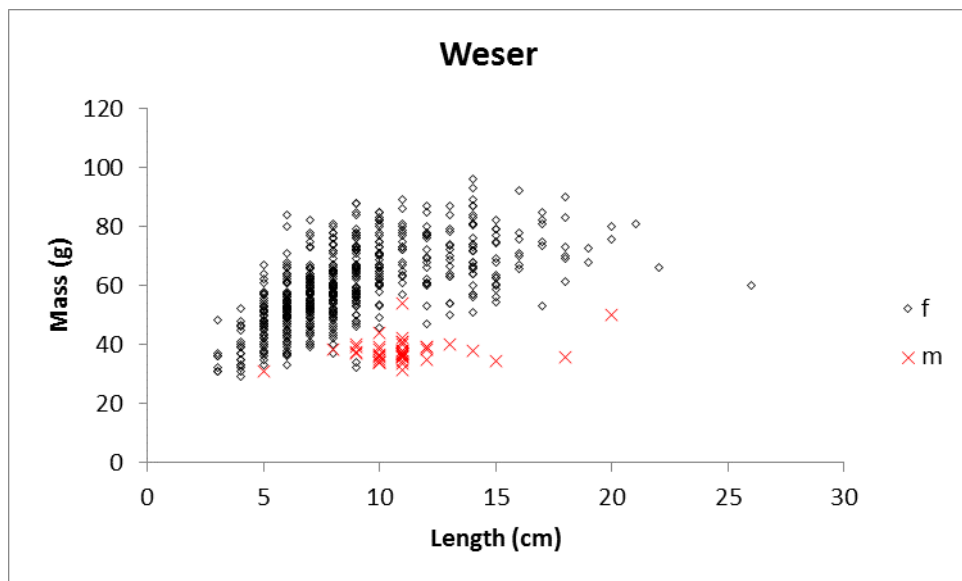


Figure 4g. Length–age relationship of eel samples from the RBD Weser (female: n=615, male: n=44).

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- Hartmann, F. 1994. Untersuchungen zur Biologie, Epidemiologie und Schadwirkung von *Anguillicola crassus* Kuwahara, Niimi & Itagaki 1974 (Nematoda), einem blutsaugenden Parasiten in der Schwimmblase des Europäischen Aals (*Anguilla anguilla*). 1st Edn. Shaker, Aachen.

Report on the eel stock and fishery in Greece 2014/2015

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Reporting Period: Report was completed in November 2015, and contains data up to 2014.

2 Introduction

The fishery for European eel in Greece is limited to the capture of adults during their migration to the Atlantic for reproduction. In Western Greece there is limited fishery of yellow eels, as part of the local tradition (influences from Italy) of consuming younger eels, a practice that is not found elsewhere in Greece.

The majority of eels are caught in the lagoons. Most of the lagoons are found in North Greece (estuarine systems of Evros, Nestos and Lake Vistonis - EMU3) and in Western Greece (Messolonghi and Amvrakikos lagoons – EMU1). In the region of Western Peloponnese (EMU-2) there are only two eel producing lagoons, but they exhibit the highest eel production per surface unit.

The regional authorities are responsible for the management of the lagoons, while some belong to the Ministries of Development and Economics and some belong to local municipalities. In any case, the economic exploitation of the lagoons is performed for a certain period of time by fishing cooperatives, which lease the lagoons (in most cases for ten years). The local fishing cooperatives have the exclusive right to exploit the fish of the lagoons (Koutrakis *et al.*, 2007).

By Ministerial Decision 643/39462/01-04-13 (in the implementation of Regulation (EU) number 1100/07) banned fishing for eels with fykenets in all the lagoons of the territory, including eel fishing carried from amateur fishermen. In lagoons fishing eel permitted (permanent establishments, according to Ministerial Decision), but it is mandatory to release 30% of the annual eel production of the lagoons and the tenants of the lagoons are obliged to promptly inform the fisheries service for the upcoming fishing eels, so that there is applicability of the proposed procedure.

Fishing in river estuaries is practised mainly by professional fishermen who use fykenets. Fishermen caught small quantities of eels also, by using longlines. These eels are placed on the internal market and in any case these quantities are not recorded.

In the past, eel fishing in lakes was also carried out off the migration period using fykenets. Fykenet is a fish trap, consisted by cylindrical or cone-shaped netting bags mounted on rings or other rigid structures. It has wings or leaders which guide the fish towards the entrance of the bags. The fykenets are fixed on the bottom by anchors, ballast or stakes. (FAO) (Figure 1.2.2).

3 Time-series data

After the approval of the Hellenic Eel Management plan (HEMP) (2011), the 2012 was the first year that the landings of silver eels and their biological characteristics were recorded. Due to the ban of the fykenets in all the lagoons, proposed in HEMP, yellow eels are not fished at all in the Greek lagoons. Moreover, there are no data for landings of eels of any stage from the freshwater fisheries. Glass eels landings are not recorded, there are sparse data derived by scientific research (Daoulas *et al.*, 2000; Cladas *et al.*, 1999; Zompola *et al.*, 2008).

2.1 Recruitment Series and associated effort

2.1.1 Glass eel

No data.

2.1.2 Yellow Eel Recruitment

No data.

2.2 Yellow eel landings

2.2.1 Commercial

No data.

2.2.2 Recreational

No data.

2.3 Silver eel landings

2.3.1 Commercial

It is estimated that, more than 80% of the landings are provided by lagoon fisheries. Table 3.1 presents the lagoon landings from the late 1960s until today. EMU-1 (Western Greece) provided the majority of the landings until mid-1990. The decreasing trends are obvious on the annual lagoon landings of the EMU-01 and EMU-03 (East Makedonia and Thrace) are obvious after 1990, while the annual lagoon eel landings of the EMU-02 (Western Peloponnese) showed a noticeable increase. The mean eel annual production of lagoons of the EMU-01 and EMU-03 decreased from 10 kg/ha during the period before 1980 to 2.4 kg/ha in recent years. On the other hand, the eel annual production of lagoons of the EMU-02 increased from 10 kg/ha during the period before 1985 to 20–25 kg/ha during the period after 1990. The origin of this inverse pattern of the EMU-2 is not identified. However, since the rise of production in the 1990s production has stabilized and shows signs of slight bending to all EMU (1 to 3). In any case the total landings decreased considerably despite the fact that the fishing effort was maintained stable at least since the installation of “modern fishing traps” in the 1980s.

In several areas of the EMU-01, individually operating fishermen who do not belong to a particular fishing cooperative, (often from the coast) target eels with catches varying from 200 kg to 1000 kg per period (Koutsikopoulos *et al.*, 2001). The number of those fishermen remains unknown along with their spatial distribution and their gears. The same information exists for EMU-03 and finally the few elements for EMU-04 (Rest of Greece) suggest that the intense eel fishing activities in some rivers

stopped in the late 1970s, as a result of the severe degradation of the corresponding ecosystems.

Table. 2.1. Annual silver eel catches (tons) per EMU of Greece.

Year	EMU1	EMU2	EMU3	EMU4
1966	14.9			
1967	19			
1968	4.905			
1969	2.93			
1972		4.31		
1973	7.47	8.03		
1974	121.33	8.44		
1975	76.16	5.04	52.58	
1976	94.75	2.23	61.77	
1977	62.18	2.25	24.79	
1978	104.17	3.99	117.11	
1979	107.59	6.44	71.46	
1980	157.02	3.63	66.28	
1981	193.67	9.07	47.91	
1982	199.75	5.23	50.26	
1983	116.48	10.33	73.95	
1984	167.89	10.50	107.04	
1985	166.35	9.46	13.76	
1986	120.86	11.91	18.79	
1987	210.74	12.39	43.18	
1988	227.14	13.16	27.79	
1989	137.95	8.37	9.29	
1990	142.98	12.69	38.55	
1991	181.33	12.42	15.65	
1992	117.01	45.79	21.68	0.37
1992	117.01	45.79	21.68	0.37
1993	132.64	42.92	6.05	0.30
1994	125.21	51.21	24.06	0.02
1995	145.18	26.02	30.14	0.05
1996	96.31	28.01	26.92	0.11
1997	76.26	46.36	13.79	0.0
1998	43.04	34.15	10.4	0
1999	45.45	26.69	8.37	0.22
2000	55.59	23.16	9.31	0
2001	50.31	36.55	6.48	0.09
2002	74.64	57.47	4.22	0
2003	23.61	44.79	8.08	0.02
2004	34.76	15.95	7.25	0.10
2005	63.71	41.95	10.17	0.30
2006	39.12	31.53	6.28	0.16
2007	50.83	33.00	5.69	0.13
2008	23.79	39.55	7.73	

Year	EMU1	EMU2	EMU3	EMU4
2009	41.10	26.75	10.61	
2010	34.56	15.86	8.21	
2011	51.07	29.51	2.65	
2012	31.27	21.27	2.67	
2013	25.33	18.25	1.33	

2.3.2 Recreational

The so-called independent fishermen that fish inside the Greek lagoons are allowed only in 8.3% of them (mainly in Messologi Lagoon) using nets and longlines, irrespective of the species caught. The lagoons with legal independent fishing activity are all recorded in EMU-01 and EMU-04, and belong mainly to the most important deltas of Acheloos and Arachthos systems. The independent eel fishery is carried out using eel traps, fykenets, lights, spears, longlines and other localized traditional fishing gears. The Hellenic Eel Management Plan proposed the prohibition of fykenet fishing in the lagoons and also and temporal closures prohibition in the rivers, in these delta and in these lakes. Measure that was implemented at the level of regions of the country after the 31-05-2011 relative circular of Management.

2.4 Aquaculture production

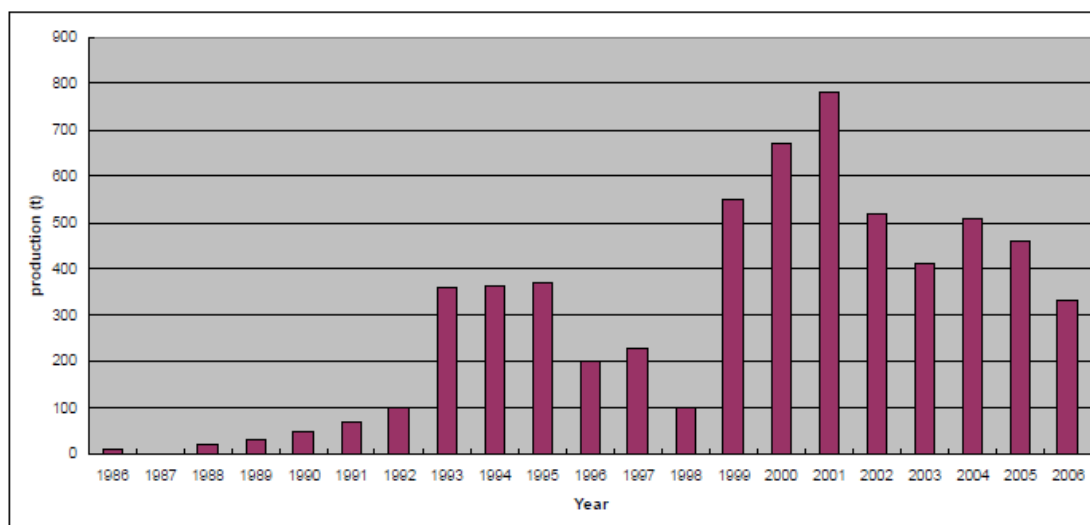


Figure 2.1. Productions of Greek eel aquaculture.

There were twelve licences issued for eel exportation from Greece in 2014, according to the data gathered from the CITES Administration office. The total quantities of live and frozen eels exported, were 247.13kg. Eight out of twelve permits were for exporting eels to Italy, the rests were exported to Bulgaria, Spain and Germany.

The total landings from the aquaculture units in region of Arta (most important region concerning eel aquacultures in Greece) for the period 2000–2013 was up to 4.091t with a maximum annual landings of 433 t (2000) and with a minimum annual landings of 168,5 t (2008).

2.5 Stocking

2.5.1 Amount stocked

In 2013 an eel enrichment at River Acheron (EMU 1) had been done, with eels coming from a private company in Epirus. The competence release fry from fish farms in 2013 was transferred to Fisheries Services Decentralized Administration Epirus-Western Macedonia. According to a decision (Internet Post Number: BΛ10OP1Γ-N02) the department proceeded to the release 10% of the imported amount of glass eels in 2013 to be used for farming in Epirus. The biomass of eels released was 127 kg at the region of Louros and 15 kg at River Acheron.

In 2014 44 kg were released at the area of Louros and 25 kg at River Acheron according to the framework of the EU Regulation 1100/07 implementation for the establishment of measures for the recovery of the stock of the European eel (*Anguilla anguilla*).

2.5.2 Catch of Elvers <12 cm and proportion retained for restocking

According to RD/142/1971, it is prohibited in Greece to catch eels <30 cm, but after the implementation of the EU Regulation 1100/07, which harmonized the Greek legislation by way of 643/39462/01-04-2013 (Official Gazette /883/B'/2013) Order of Ministry of Agricultural Development, it is now permitted glass eels that are trapped at swamps that are excised by any brackish or freshwater systems or in front of pump stations to be fished but only for purposes of restocking both of natural habitats of eel and aquacultures and always under the supervision of the competent service that will also issue the appropriate license that will follow the eels anywhere in EU and during all the stages of eel marketing.

3 Fishing capacity

No data.

4 Fishing effort

4.1 Glass eel

Glass eel fishing is prohibited according to RD/142/1971, yet 643/39462/01-04-2013 (Official Gazette /883/B'/2013) Order of Ministry of Agricultural Development foresees that glass eels can be fished in some specific occasions (see 2.5.2). Although it is not yet possible to measure the effort cause the local competent services do not record the tool and its mesh size.

4.2 Elvers and yellow eel

RD/142/1971 clearly mentions that both fishing and the commercial exploitation of eels smaller than 30 cm (elvers), is entirely prohibited. Concerning yellow eel effort, after the implementation of HEMP and according to 643/39462/01-04-2013 (Official Gazette /883/B'/2013) Order of Ministry of Agricultural Development it is prohibited to use fykenets in the lagoons all year round and during the period November 1–January 31 in rivers and their deltas. These regulations can be interpreted in zero effort for yellow eels in lagoons. Concerning the fishing effort of yellow eels in rivers and their deltas it cannot yet be estimated because of the absolute lack of catches.

4.3 Silver eel–marine fishery

Most of the eels are caught in the lagoons using fixed barrier fish traps. The lagoons are leased and operated by co-operatives of fishermen. Individual fishermen operating around the lagoons and in lakes also catch eels (fishing in rivers and river Deltas is prohibited). Small catches have also been recorded in coastal areas, mainly through the use of static fishing equipment used in coastal fisheries, but some quantities are also fished by trawls and purse-seines. Experts (HEMP, 2009) estimate that 90% of the eel catches come from fishing in the lagoons.

The number of the fishing traps in the lagoons remained unchanged in the last 2–3 decades. Therefore the main fishing dynamics and effort can be considered stable.

It is characteristic that fishing dynamics and effort in the Messolonghi-Aitoliko lagoons during 2012 remained stable despite an increase of the mesh size in fishing traps. This took place in an attempt to decrease the discards of this type of fishing. Smaller eels are expected to escape these traps, but there are no quantitative data available.

5 Catches and landings

5.1 Glass eel

See Section 5.1.

5.2 Yellow eel

See Section 5.2.

5.3 Silver eel

Landings recorded in 2014 for Western Greece (EMU-1) (Messolonghi-Aitolikou, Amvrakikos, Preveza and Lefkada) were cumulatively 23.7 t.

Landings recorded in 2014 for the western Peloponnese (EMU-2) from the lagoons in Ilia and Achaia were cumulatively 21.3 t.

Finally Landings recorded in 2014 for Eastern Macedonia and Thrace were 1.76 t (Vistonida and Evros).

The total landings in 2013 for Greece (EMU-1, EMU-2 and EMU-3) was 46.76 t.

6 Catch per unit of effort

6.1 Glass eel

See Section 5.1.

6.2 Yellow eel

See Section 5.2.

6.3 Silver eel

See Section 5.3.

6.4 Marine fishery

See Section 5.3.

7 Other Anthropogenic Impacts

There are no studies determining the mortality ratio of eels during their catadromous migration for any Greek dam. Table 7.1 exhibits the wetted areas above the insurmountable dam of the main rivers in Greece, while Figure 7.1 presents the distribution of barriers (dams, weirs, pumping stations) based on their height.

Table 7.1. Wetted areas above the first insurmountable dam of the main rivers in Greece.

RIVERS (DISCHARGE > 10 M ³ /S) WITH AT LEAST ONE DAM	WETTED AREA (HA) ABOVE 1 ST INSURMOUNTABLE DAM
Alfios	156,41
Axios-Vardar	512,23
Evros-Maritza	2.154,79
Arachthos	523,64
Acheloos	1.378,19
Aliakmonas	1.153,64
Nestos-Mesta	605,80
Strymonas-Strumna	587,26
Evinos	191,63
Luros	69,26
Kalamas	215,42

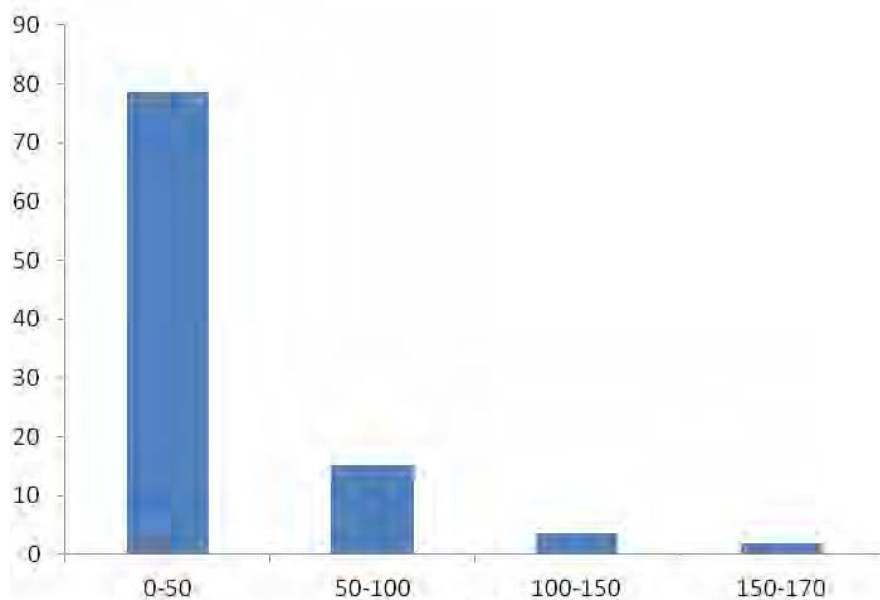


Figure 7.1. Distribution of Greek river barriers based on their height (= the maximum height of the dam from the foundation to the coronation). Number of barriers: 164.

8 Scientific surveys of the stock

There are no scientific surveys of the eel stock in Greece, apart from the collection of data, from the National Fisheries Data Collection Project, running from 2012.

9 Catch composition by age and length

9.1 West Greece (EMU-1): Messolonghi – Etoliko lagoons

The cumulative length distribution of the eel samples from all Messolonghi-Etoliko lagoons is presented in the following graph (Figure 9.1). Total number of specimens measured for length and weight from Messolonghi-Etoliko lagoons is 942.

The length classes that dominate the sample are 50–60 cm, while 40–50 cm classes are underrepresented in the sample. The distribution is almost comparable to the distribution of the year 2013.

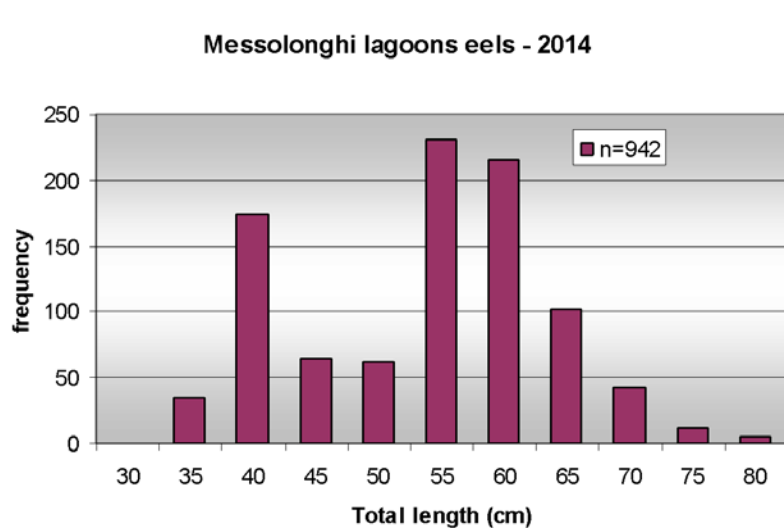
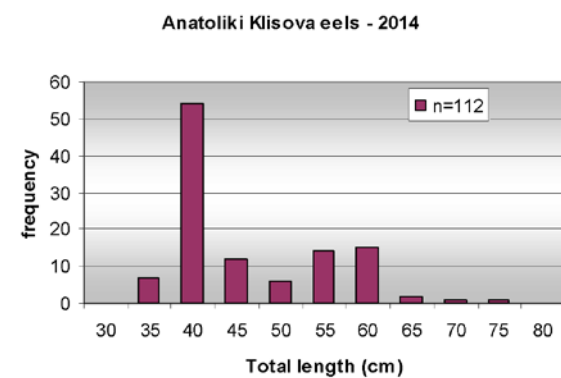
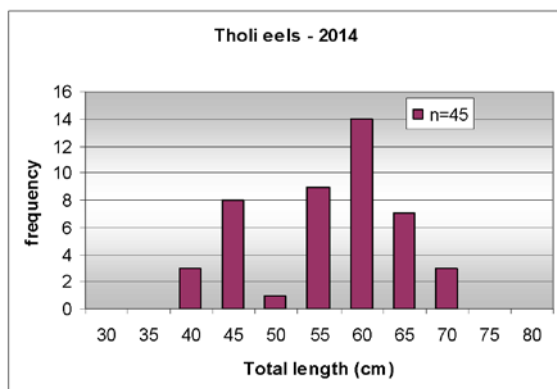
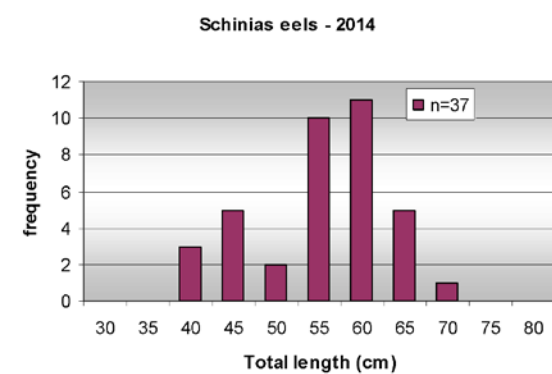
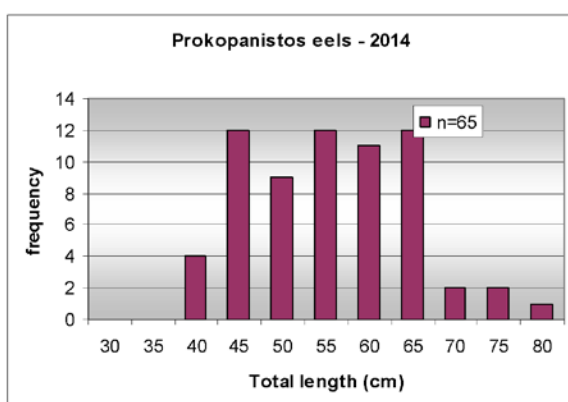
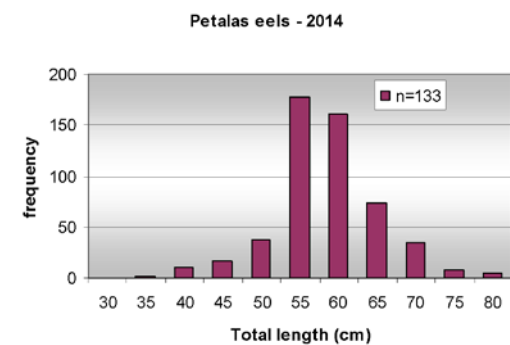
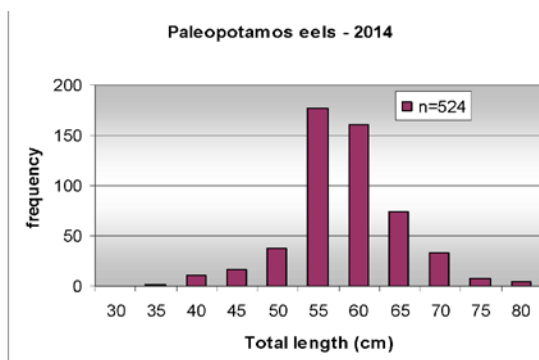


Figure 9.1. Length–frequency composition of eel samples from Messolonghi-Etoliko lagoons 2014.

The comparison (Figure 9.2) among the different length distributions of Messolonghi-Aitoliko complex lagoons distinguished East Kleisova and Vasiladi, lagoons that seem to be dominated by smaller eels. While Petalas lagoon, known to have the lowest salinity among the complexes' lagoons and well-known among local fishermen that produces smaller eels, do not exhibit different length classes distribution.



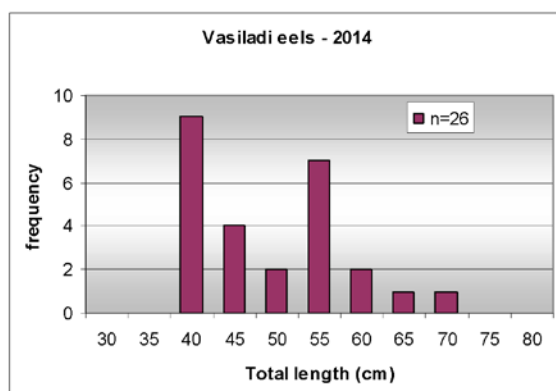


Figure 9.2. Length composition of each Messolonghi-Etoliko lagoon 2014 eel sample.

The age composition of eel catches at Messolonghi- Aitoliko lagoons are given in Figure 9.3. The average age of the total sample is 5.18 years with a standard deviation ($SD = 2.58$) and is derived from a sample of 483 individuals. These values are very close to the estimates of 2013 that gave an average age 5.86 ($SD = 1.76$). The relatively large SD values, are due to the sample, the age measurement uncertainty, but also the environmental heterogeneity of the lagoons of Messolonghi-Aitoliko complex (including freshwater ecosystems associated with them). The average age is much lower comparing to the northern countries and in line with the forecasts presented in the Greek eel management plan.

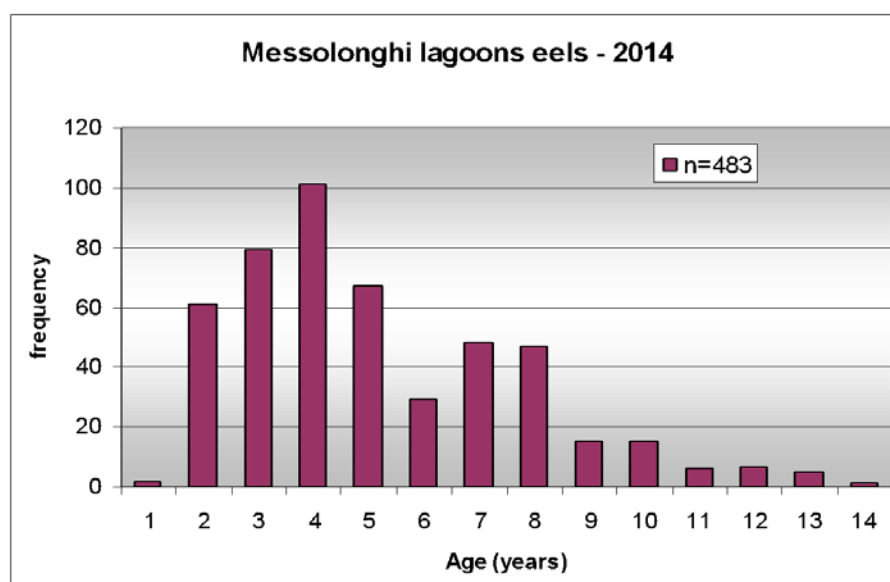


Figure 9.3. Age composition of Mesolonghi-Etoliko lagoons 2014 eel samples.

9.2 West Greece (EMU-1): Arta – Preveza – Lefkada lagoons

The comparison among the eel length distributions of Arta region (Amvrakikos Gulf), Preveza region (Amvrakikos Gulf) and Lefkada Island (Figures 9.4–9.6) highlights the difference of Lefkada eels to those of Epirus (Preveza, Arta). Lefkada lagoons length

distribution exhibits higher minimum and maximum values than the two other regions (Table. 9.1), on the same table the size of each sample is also presented.

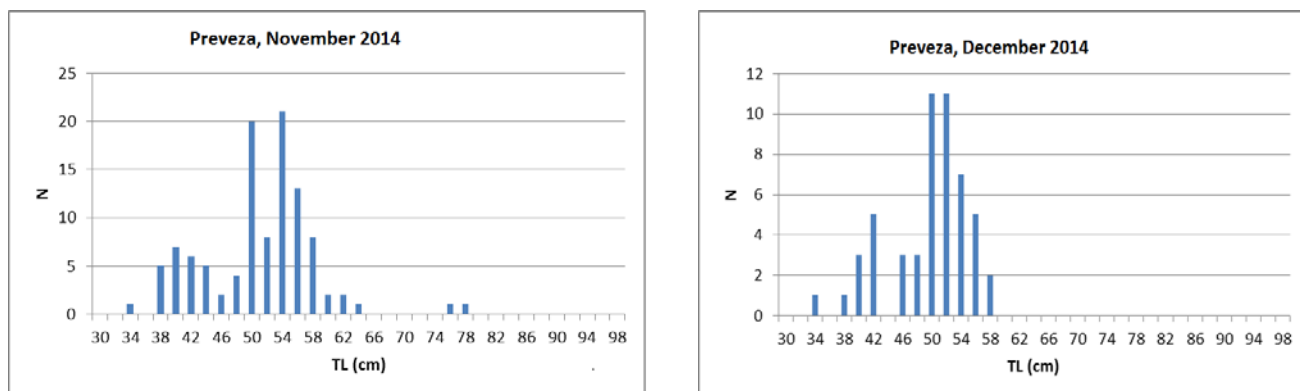


Figure 9.4. Length–frequency compositions of eel samples from Preveza lagoons for November and December 2014.

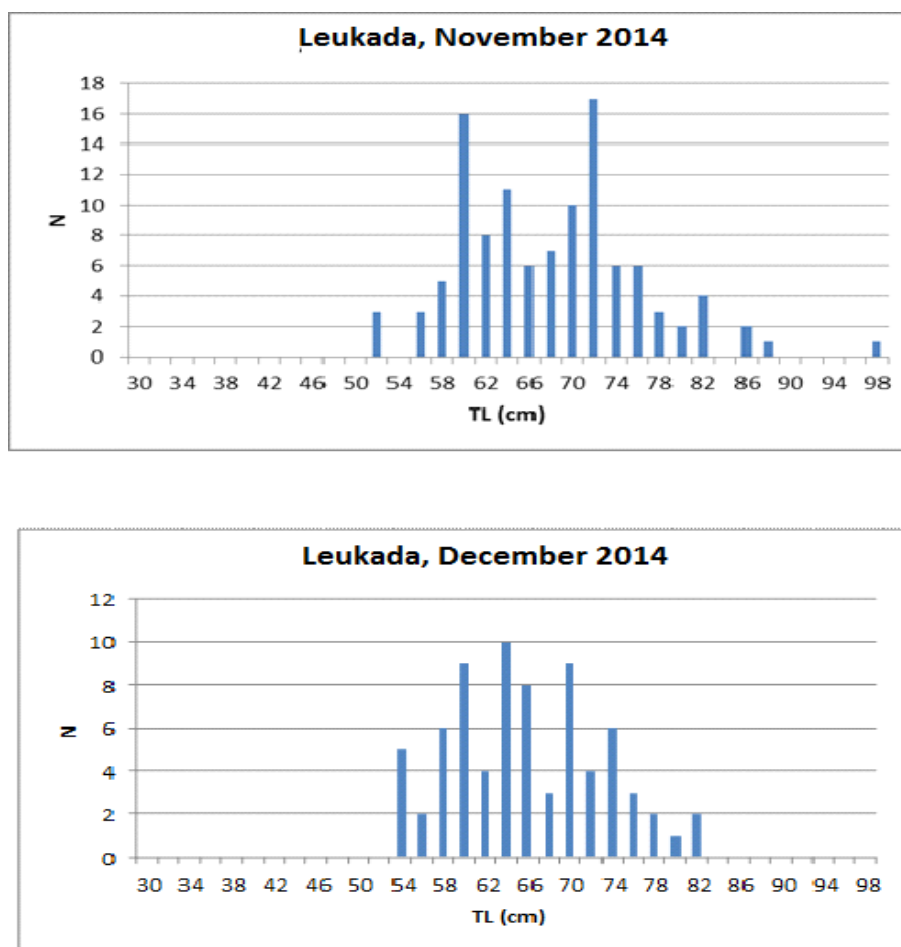


Figure 9.5. Length–frequency composition of eels samples from Preveza lagoons for November and December 2014.

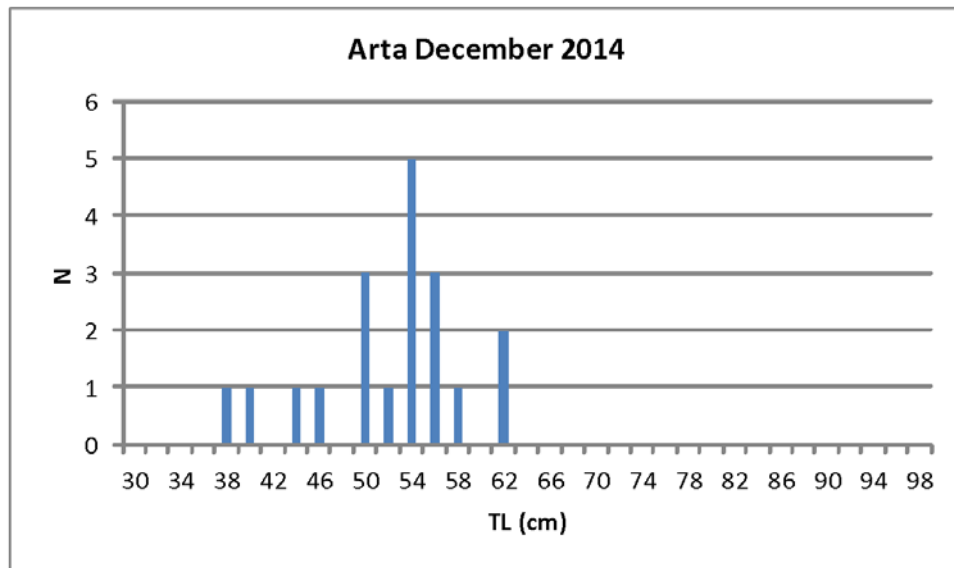


Figure 9.6. Length–frequency distribution of eel-samples collected in Arta region (Tsoukalio lagoon) December 2014.

Table 9.1. Number of eel specimen studied (N), average, maximum and minimum values and STDev of total length (TL) and total weight (TW) per each region (Papadopoulou, 2015).

AREA	N	MEAN TL(CM)	MAX TL(CM)	MIN TL(CM)	STDDEV TL(CM)	MEAN TW (G)	MAX TW (G)	MIN TW (G)	STDDEV TW (G)
Arta	20	52.83	63.70	39.40	6.29	286.40	521.60	93.90	93.22
Lefkada	185	67.79	99.00	52.60	7.85	557.8	1779.66	178.00	203.04
Preveza	159	51.06	78.00	34.00	6.78	273.80	842.00	69.00	108.00

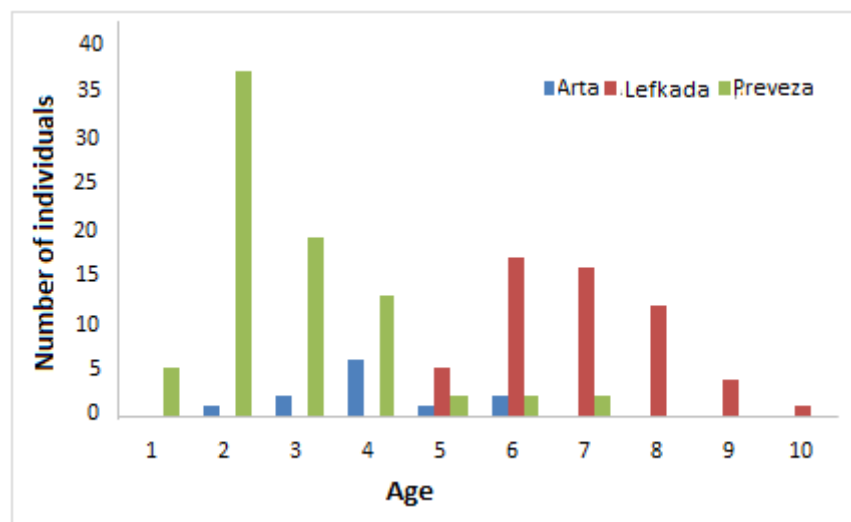


Figure 9.7. Age distribution of eel-samples collected from lagoons of Arta, Lefkada and Preveza regions in December 2014 (Papadopoulou, 2015).

9.3 EMU-2 (West Peloponnese)

The length distribution of eel landings from Prokopos lagoon is presented below (Figure 9.8). The length classes that dominate the sample are 50–60 cm. The only difference to the distribution of 2013 from the same area is the greater presence of eel length class 35–40 cm. The same distribution is also followed by Papas lagoon, which the second lagoon of EMU-2. The distribution is almost the same with this of Messo-longhi lagoon complex.

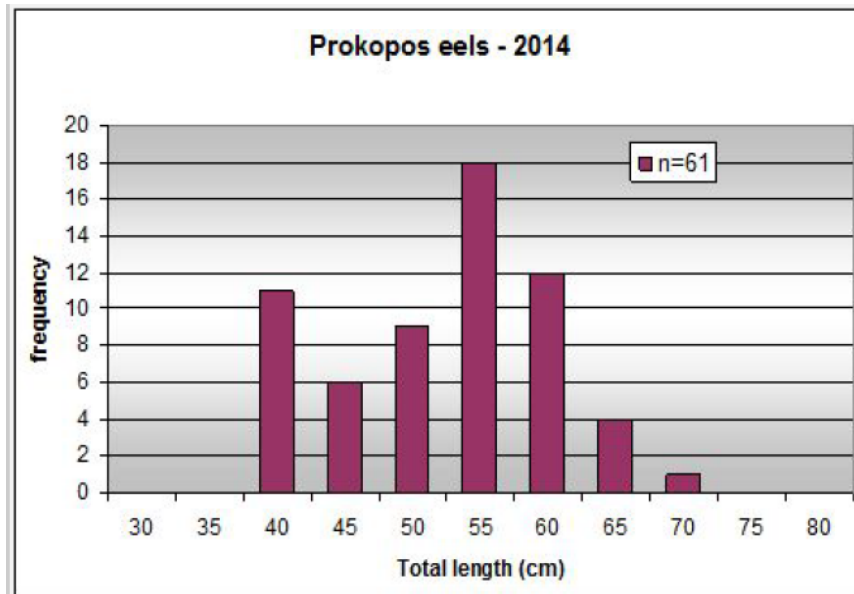


Figure 9.8. Length–frequency distribution of 2014 eel sample collected in Prokopos lagoon.

9.4 EMU-3 (East Macedonia and Thrace)

9.4.1 Vistonida lake

The length distribution of Vistonida (Figure 9.9), was calculated from just one sample (70 individuals) which was taken in January 2014 and that was because a mass mortality event occurred at Vistonida on August of 2014, killing almost all fish of the lagoon. Minimum, maximum and mean length of the sample was 625, 932 and 821 mm respectively, while minimum, maximum and mean weight was 483, 2300 and 1490 g respectively.

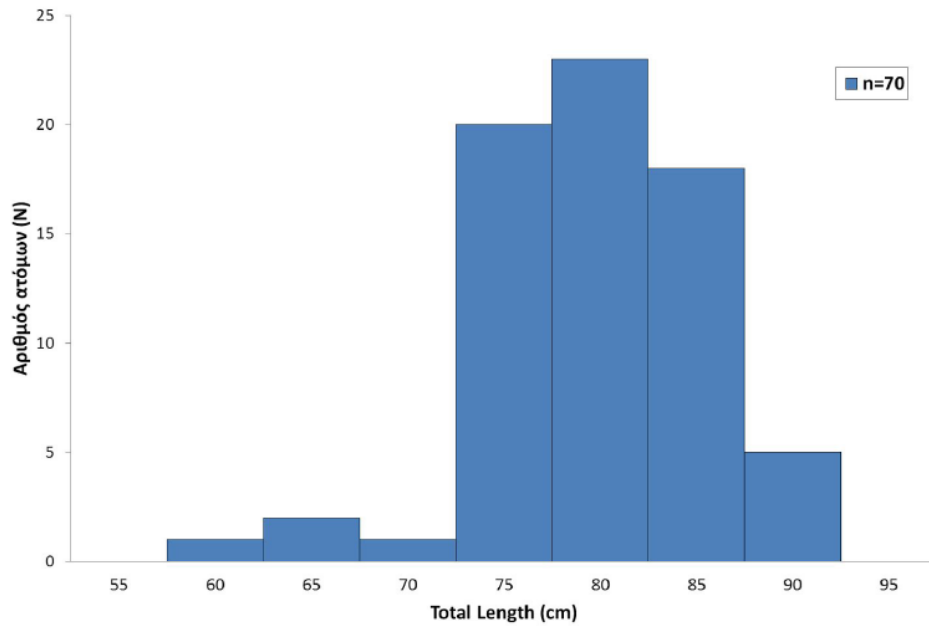


Figure 9.9. Length–frequency distribution of 2014 eel samples collected in Vistonida lagoon on January 2014.

9.4.2 River Evros Delta

Figure 9.10 presents the cumulative length composition (405 specimen) that were caught from the deltaic part of Evros in May 2014 (205 individuals) and October 2014 (200 individuals) of the same year.

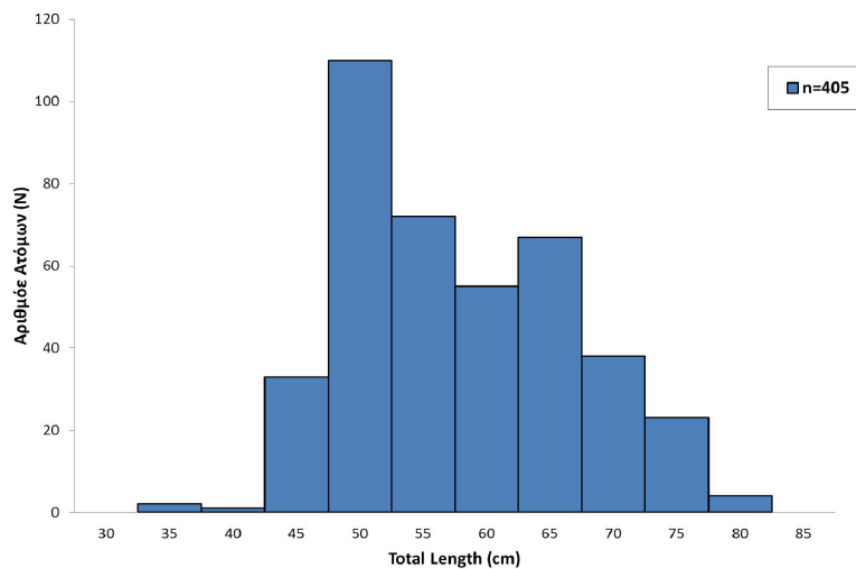


Figure 9.10. Cumulative Length distribution of May and October 2014 eel samples collected from deltaic part of river Evros.

Minimum, maximum and average length of May sample was 380, 807 and 576 mm respectively, while minimum, maximum and average weight was 208, 1290 and 468 g. The sample of October of the year 2014 had minimum, maximum and mean length 384, 825 and 626 mm, while had minimum, maximum and mean weight 191, 1357 and 572 g.

10 Other biological sampling

10.1 Length-Weight & Growth (DCF)

10.1.1 West Greece (EMU-1): Messolonghi – Etoliko lagoons

The length–weight relationship of the total sample of Messolonghi-Aitoliko eels presented in the following graph (Figure 10.1). The exponent of the length–weight correlation indicates isometric growth. The correlation covers a wide range of sizes (30–85 cm). Concerning the large specimen (>55 cm), they distinguished a relatively large dispersion of the weights of individuals for a given length. This observation may be the result of strong environmental heterogeneity that characterizes the complex of Messolonghi-Aitoliko lagoons. Nevertheless, the length–weight correlation has no differences from that of 2013.

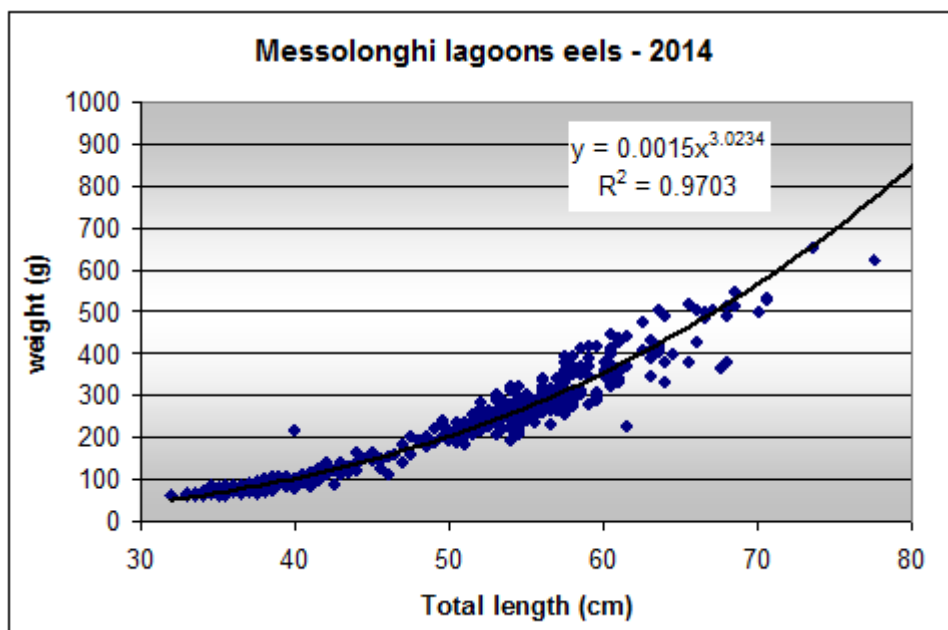


Figure 10.1. Length–weight relationship based on 2014 samples collected from all Messolonghi-Aitoliko lagoons.

10.1.2 West Greece (EMU-1) : Arta – Preveza – Lefkada lagoons

The analysis of the length–weight relationship of eels in the three regions of Epirus indicated that populations of Lefkada, Preveza and Arta exhibits negative allometric growth. The length–weight relationship for the eel sample of Preveza is presented in Figure 10.2, of Lefkada in Figure 10.3 and of Arta in Figure 10.4.1.

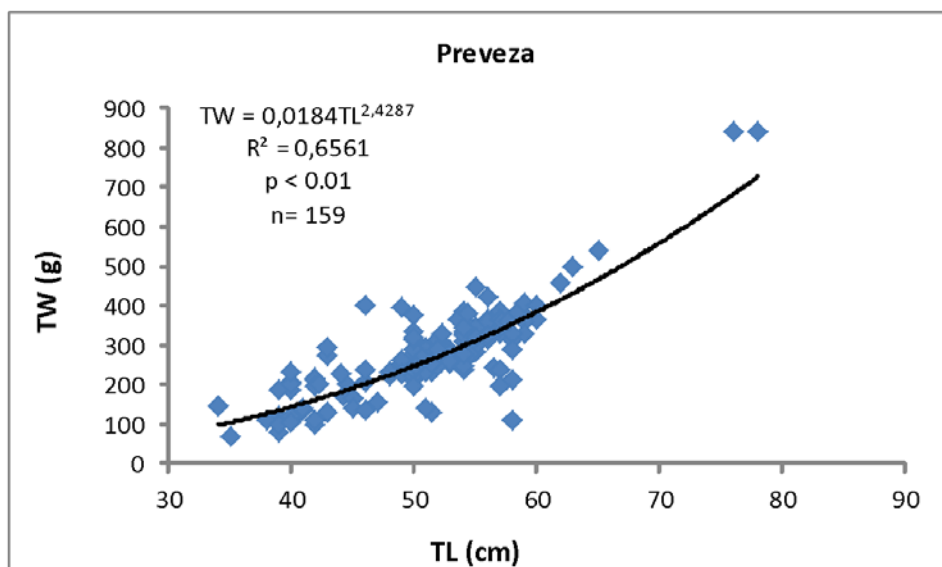


Figure 10.2. Length–weight relationship of the 2014 eel samples from the lagoons of the region of Preveza.

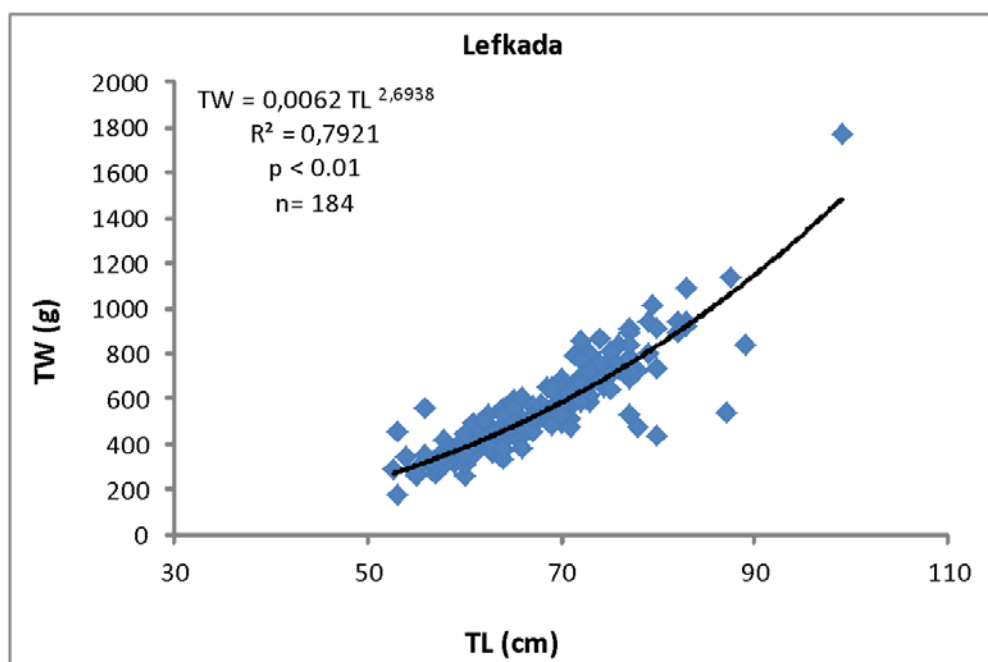


Figure 10.3. Length–weight relationship of the 2014 eel samples from the lagoons of the region of Lefkada.

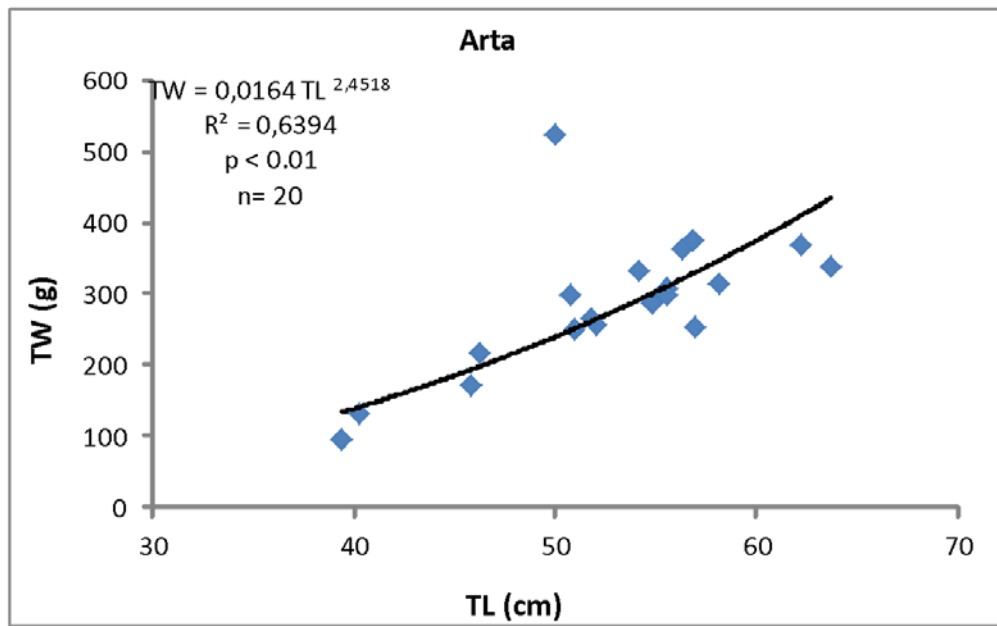


Figure 10.4. Length–weight relationship of the 2014 eel samples from the lagoons of the region of Preveza.

10.1.3 West Peloponnese (EMU-2)

The length–weight relationship of eels in Prokopos lagoon is presented in figure below (Figure 10.5). The length–weight relationship had no differences for that of 2013 of the same area. The same pattern is also followed by Papas lagoon, which is the second lagoon of EMU-2.

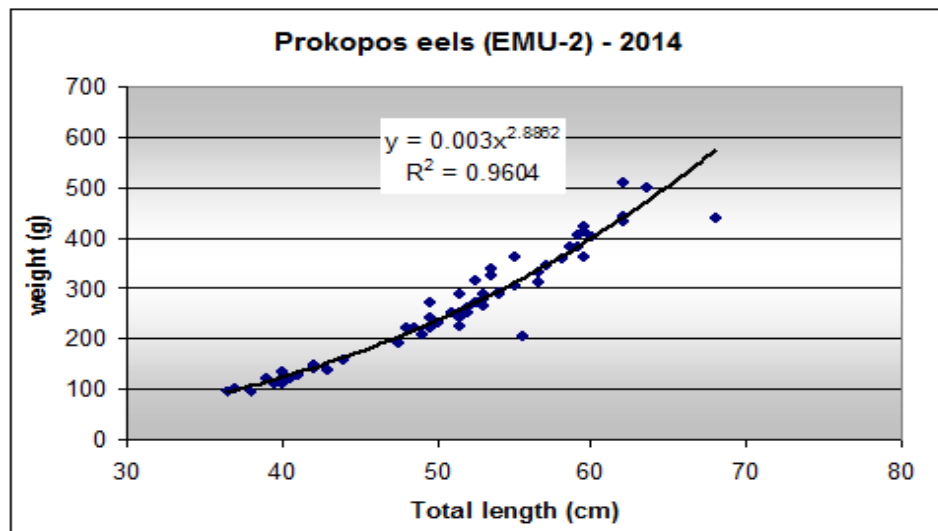


Figure 10.5. Length–weight relationship of the 2014 eel samples from the lagoons of the region of Preveza.

10.1.4 East Macedonia & Thrace (EMU-3): Vistonida lagoon

For the length–weight relationship of Vistonida lake sample (66 individuals) t-test analysis ($t = 0.2323$ $p > 0.0005$) indicated that the b coefficient of the length–weight correlation is not statistically different from the value 3 and therefore Vistonidas's eels exhibit isometric growth (Figure 10.6).

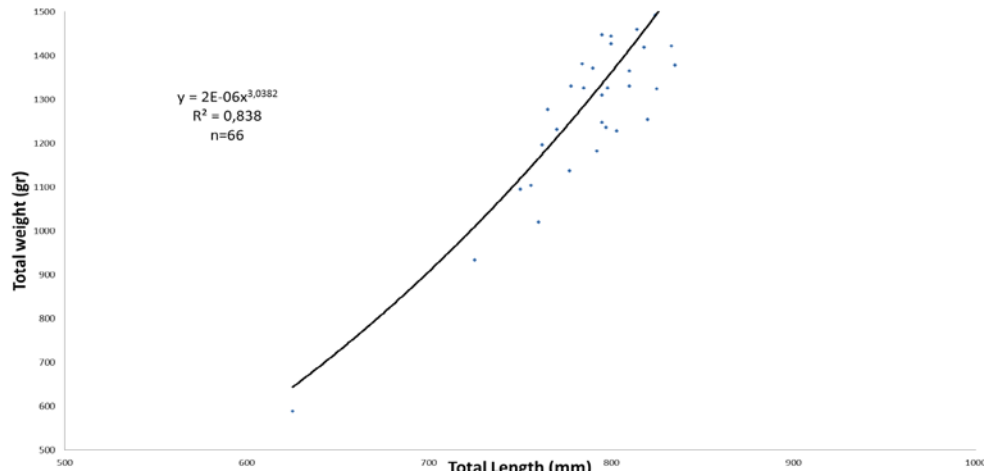


Figure 10.6. Length–weight relationship of the 2014 eel samples from Vistonida lagoon.

10.1.5 East Macedonia & Thrace (EMU-3): River Evros Delta

For the length–weight relationship of Evros samples (385 individuals) t-test analysis ($t = 2.699$ $p > 0.05$) indicated that the b coefficient of the length–weight correlation is not statistically different from the value 3 and therefore Evros eels exhibit isometric growth (Figure 10.7).

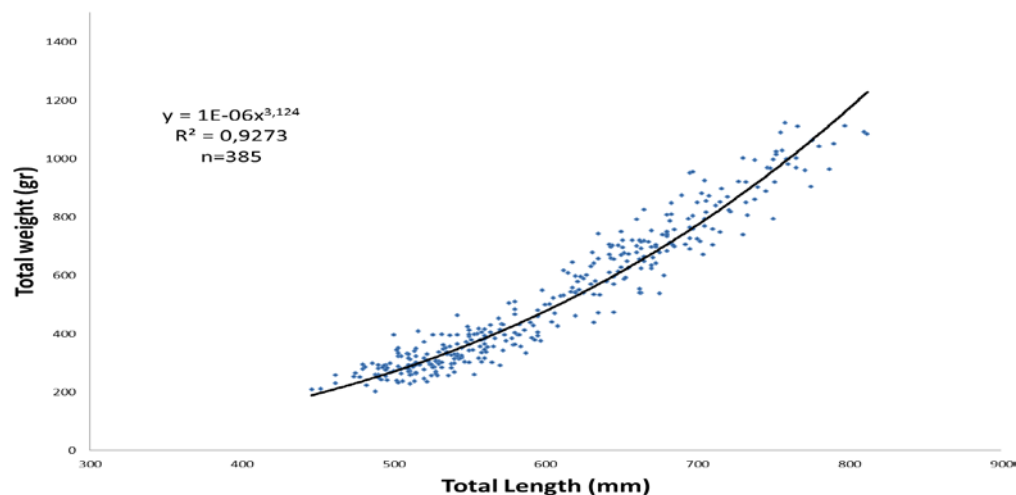


Figure 10.6. Length–weight relationship of the 2014 eel samples from River Evros.

10.2 Parasites and pathogens

The parasite found is the nematode *Anguillicoloides crassus*, which mainly affects the swimbladder of eels.

EMU-1

Out of a total of 488 individuals of *A. anguilla* from Messolonghi-Aitoliko lagoons that were collected and examined in the laboratory, 97 were detected (19.9%) to carry parasites. The distribution of the number of parasites per infected person is presented in Figure 11.7. The majority of infected individuals had one parasite but some of them were carrying even 40 parasites. The infestation percentage is significantly higher than in 2013, but the difference may be due to observational methodological changes that led to more accurate counting.

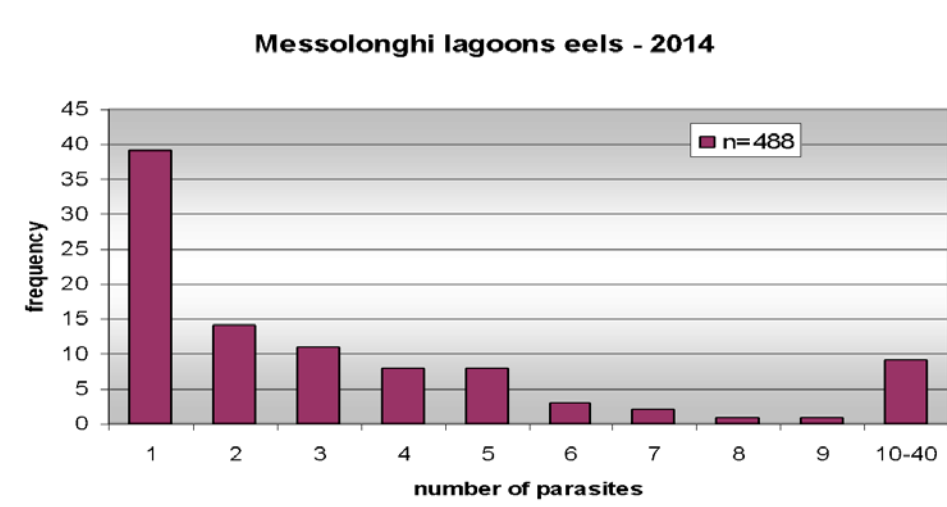


Figure 10.7. Distribution of the number of parasites in infected eel specimens of Messolonghi-Etoliko lagoons for year 2014.

EMU-2

A total of 61 individuals of *A. anguilla* were collected and tested in the laboratory, from the lagoons of Prokopos and Papas, and in eleven of them (18%) the parasite *Anguillicoloides crassus* was detected. This rate is compatible with both the estimates of 2013 for the same region and those of 2014 from the Messolonghi lagoons. The majority of affected individuals had less than four parasites but individuals with 25 parasites were also observed.

EMU-3

Similarly to 2013, the eel samples collected from Lake Vistonida in 2014, were found to be infected by a large number of parasites. Of the total individuals collected (70 specimens), 20 were found without parasites while 50 individuals (71.4%, 23.46% in 2013) had parasites, the average of which was seven parasites per specimen. The distribution of the number of parasites in infected eel individuals from Lake Vistonida for the year 2014 is presented in the graph of Figure 10.8.

In the Evros eel samples (405 persons) that were examined in the laboratory, 89 individuals were found not to carry parasites, 43 individuals with one parasite, 13 had two while the rest had more than two. The distribution of the number of parasites in

the infected Eel individuals from the Evros river delta in 2014, is presented in Figure 10.9.

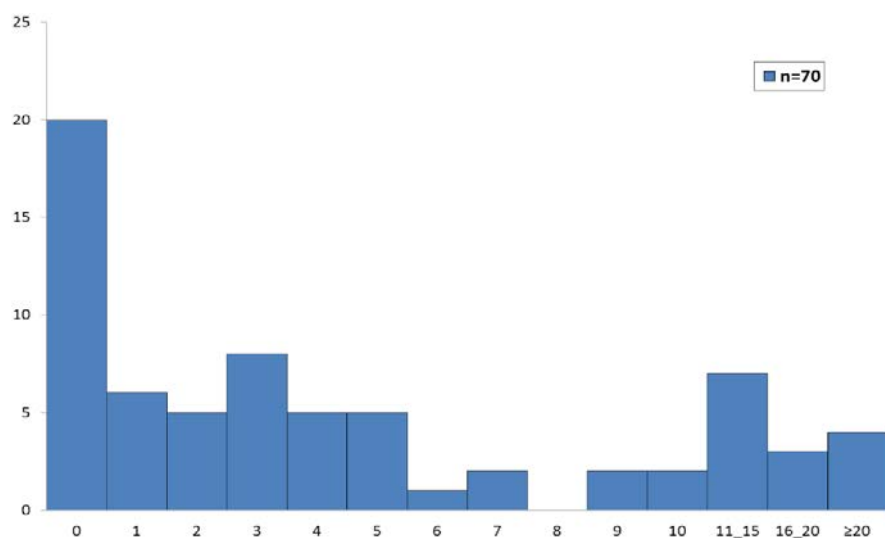


Figure 10.8. Distribution of the number of parasites in infected eel specimens of Vistonida lagoon for year 2014.

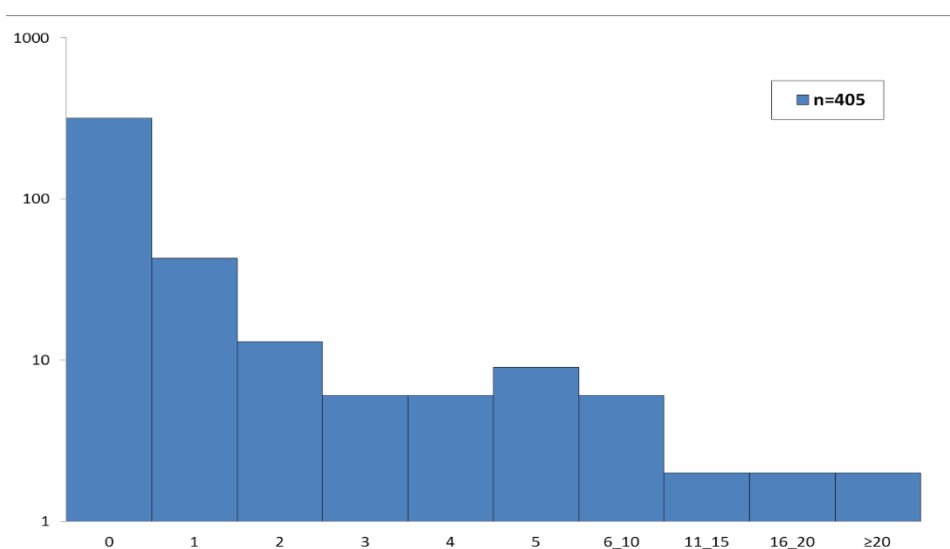


Figure 10.9. Distribution of the number of parasites in infected eel specimens of Evros Delta for year 2014. The values of the vertical axis are fitted to a logarithmic scale.

10.3 Contaminants

No data.

10.4 Predators

No data.

11 Other sampling

Due to the implementation of WFD and 92/43 EC directives, many of the eel habitats are sampled for a big variety of parameters including physic-chemical parameters of

water, hydro-morphological parameters, invertebrates species richness and abundances (rivers), phytoplankton species richness and abundances (lakes), aquatic flora species richness and abundances (lagoons) and habitat quality.

12 Stock assessment

Table 12.1. Evaluation of Biomass and Mortality Indices (all values in kg).

		EMU1	EMU2	EMU3	GREECE
B0	Lagoons	92900	5300	69110	167310
	Rivers*	1080	0	3030	4110
	Lakes*	6310	0	100	6410
	TOTAL*	100290	5300	72240	177830
Bbest	Lagoons	30060	21100	1750	52910
	Rivers*	330	0	3230	3560
	Lakes*	660	0	100	760
	TOTAL*	31050	21100	5080	57230
Bcurrent	Lagoons	13400	5615	0	19015
	Rivers*	330	0	1960	2290
	Lakes*	660	0	100	760
	TOTAL*	14390	5615	2060	22065
(Bcurrent/B0)%*		14,35%	105,94%	2,85%	12,41%
ΣF		23700	21100	1760	46560
ΣH*		1185	1055	950	3190
ΣA*		24885	22155	2710	49750

*: Estimation.

Due to lack of necessary data for the proper use of existing Eel stock simulation models that have been developed for the needs of other countries (UK, France, Germany), the data used to calculate these indicators have largely arisen (except the data used for the calculation of B₀ and B_{best} and partly of B_{current} of Lagoons) by simple methods of assessment and based on some assumptions. That is why it should be considered provisional and will be revised after the meeting of WGEEL 2015 (Antalya, Turkey in November 2015).

13 Sampling intensity and precision

There is no data analysis yet.

14 Standardization and harmonization of methodology

14.1 Survey techniques

14.2 Sampling commercial catches

14.3 Sampling

14.4 Age analysis

Eels were collected and transported to the laboratory. Then they were placed in freezer where they remained until the time of examination.

After length measurements (accuracy of 1 mm) and weight (precision 0.1 g), eels were dissected and the swimbladder was removed, which was tested for the presence of parasites.

The procedure following dissection was the identification of the two larger otoliths (sagittae) in the skull of eels, afterwards, the otoliths were cleaned and stored in small individual containers. Then the otoliths were processed as follows: first they were rubbed in various grain size polishing papers. Starting with the thicker grain size and ending up with the thinnest grain. Then they were observed under a stereoscope with transmitted light placed on a slide in a drop of glycerol. During the observation recorded the number of annual rings, the distance of each of the center of the otolith and the interval between the last annual ring and the edge of the otolith. Observations were always upon a certain radius.

14.5 Life stages

14.6 Sex determinations

15 Overview, conclusions and recommendations

The collected data exhibit a long and steady decline in eel stocks, as recorded by the eel catches declared by the fishing cooperatives managing the lagoons. However, this year was observed for the first time since 2009, a slight increase of catches of around 4% and is consistent with studies from other European countries that also observed an improvement of the catches.

It is also worth noting that this year, for the first time, an initial attempt to estimate Indices of Biomass and Mortality of eel stocks in Greece was carried out.

Although a small increase was observed in the eel production, there is the impression that the production was a bit higher. It seems that the obligation to release part of the eel catches pushed the fishing cooperatives to conceal part of the real catches. Probably this refers just to the beginning of the season because in most areas was just the second year of the implementation of the measure introduced by the Management of European Eel. In the process, given that licences are needed to export eels, this tendency diminished. In any case a review of the implementation of the country's commitment to EMP only positive effects on the quality of data and management could have.

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Report on the eel stock and fishery in Ireland 2014/2015

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Inland Fisheries Ireland
Irish Standing Scientific Committee for Eel
Marine Institute
National University of Ireland, Galway

Reporting Period: This report was completed in October 2015, and contains data up to the end of 2014 and recruitment data for 2015.

The data presented in this report has been drawn from various sources including the Irish Standing Scientific Committee on Eel Report to IFI/DCENR (2015), the annual IFI Eel Monitoring Programme Annual Reports (O’Leary *et al.*, 2009–2014), annual reports to the ESB and the SSCE by NUIG on Silver Eel Research and trap and transport monitoring (McCarthy *et al.*, 2009–2014), ESB annual data on recruitment and silver eel trap & transport activity, Marine Institute annual stock assessments for the Burrishoole and the 2012 and 2015 Irish Reports to the EU on the Progress of Implementation of the Eel Management Plans.

The most recent reports from which this Country Report is collated were the Irish Progress Report (2015) to the EU Commission and the accompanying Stock Annex for the Assessment of the Eel Stock in Ireland, including the transboundary IE_NorW (NWIRBD).

2 Introduction

This report continues the sequence of reporting annual national eel data to the EIFAAC/ICES/GFCM Working Group on Eel (WGEEL). In line with the requirements of the EU Eel Recovery Plan (Action Plan; COM 2003, 573; Regulation; COM (2005) 472) and the EU Data Collection Regulation for fisheries (Council Regulation 1543/2000 and Commission Regulations 1639/2001, 1581/2004) the National Eel Reports were restructured under the standard headings of the DCR. The EU requires under the Regulation for the Recovery of the Eel Stock (COM (2007) 1100) that Eel Management Plans be established and implemented. There is a requirement for reporting on the progress of implementation of the EMPs and on the stock status indicators as set out in Council Regulation No. 1100/2007 and in the reporting guidance provided by the EU Commission in 2012.

2.1 The Irish National Programme

The Irish National Programme is conducted in close cooperation between the following organisations.

Department of Communications Energy and Natural Resources (DCENR)-DCENR is the main governmental department with responsibility for inland fisheries policy, management, control and enforcement.

Department of Environment, Heritage and Local Government (DEHLG)-DEHLG is the main governmental department with responsibility for core functional areas of environment, water and natural heritage, built heritage and planning, housing, local government and meteorological services and implementation of the Habitats and Waterframework Directives.

The Marine Institute (MI) DAFM-The MI is a semi-state marine research organisation with national responsibility for the provision of scientific advice on eel and the collection of scientific data on the fisheries sector and the implementation of the module on evaluation of inputs, fishing capacities and fishing effort and the module of evaluation of catches and landings as defined in the Application Regulation of EU Council Regulation 1543/2000.

Inland Fisheries Ireland DCENR-Inland Fisheries Ireland (IFI) was formed in 2010 following the amalgamation of the Central Fisheries Board and the seven former Regional Fisheries Boards into a single agency. Inland Fisheries Ireland is responsible for the protection, management and conservation of the inland fisheries resource across the country, including implementation and monitoring of the Irish eel Management Plans. Ireland has over 70,000 kilometres of rivers and streams and 144,000 hectares of lakes all of which fall under the jurisdiction of IFI. The agency is also responsible for sea angling in Ireland.

National Parks & Wildlife DAHG-The National Parks and Wildlife Service (NPWS) section of the Department manages the Irish State's nature conservation responsibilities under national and European law. A particular responsibility of the NPWS is the designation and protection of Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Natural Heritage Areas (NHAs). NPWS is responsible for CITES.

Electricity Supply Board (ESB)-The ESB is a state owned utility company that generates, supplies and sell electricity in Ireland. As part of the generation portfolio, the ESB has a statutory role in preserving and developing the Shannon fishery, since the establishment of a hydroelectric scheme on the river when the government transferred all fishing rights to the company in 1935. Under the Eel management Plan, the ESB is responsible for implementing the silver eel trap and transport schemes on the Shannon, Erne and Lee along with the recruitment trapping and movement upstream of juvenile eel (which form an important part of the national recruitment time-series).

The Loughs Agency-The Loughs Agency aims to provide sustainable social, economic and environmental benefits through the effective conservation, protection, management, promotion and development of the fisheries and marine resources of the Foyle and Carlingford Areas.

Standing Scientific Committee on Eel-The Standing Scientific Committee on Eel (SSCE) was established under Section 7.5 (a) of the 2010 Inland Fisheries Act. The purpose of the committee is to provide independent scientific advice to guide IFI in making the management and policy decisions required to ensure the conservation and sustainable exploitation of the Ireland's eel stocks. The SSCE is comprised of representatives from the relevant State Agencies, and its ToR is to define and oversee a programme of monitoring, stock assessment and post-evaluation of management measures and to provide advice on eel.

2.2 Eel Management Plans – Ireland

Eel management plans were submitted to the EU in early January 2009 and these were accepted by the EU in early July 2009 and implemented by Ireland in 2009. The plans were continued through 2009–2011 and again for 2012–2014. The only modification in 2012 being how the target for the silver eel trap and transport programme on the Erne was determined.

The following is the Executive Summary from the National Report (Irish EMPs) to the EU (2008) updated where relevant with new information.

2.2.1 Introduction

Ireland established a National Working Group on eel management in 2006, in advance of the agreement of the Regulation (EC) No. 1100/2007, in order to begin the preparatory work required and Irish scientists participated in Working Groups and EU projects (i.e. EU SLIME) in developing methodologies and data collection and modelling for eel stock assessment.

2.2.2 Organisation of the Eel Management Units

The Eel Management Plans were established and implemented for River Basin Districts as defined in Directive 2000/60/EC and in accordance with Article 2 of the Eel Regulation. Ireland submitted a National Report encompassing five River Basin EMPs and one transboundary EMP. These are the Eastern EMP, South Eastern RBD EMP, South Western RBD EMP, Shannon IRBD EMP, Western RBD EMP and the transboundary North Western RBD EMP (Figure 2.1). Figure 2.1 also shows the transboundary agreement for the Eastern RBD and Neagh Bann RBDs.

All Irish EMUs are in the ICES Celtic Seas Ecoregion (E)

Inland and estuarine eel fisheries in Ireland were managed by seven Regional Fisheries Boards, divided into Fisheries Districts, and the Loughs Agency. Fisheries District boundaries largely conformed to the arrangement of river catchments. Fisheries management is now undertaken by Inland Fisheries Ireland using the WFD boundaries.

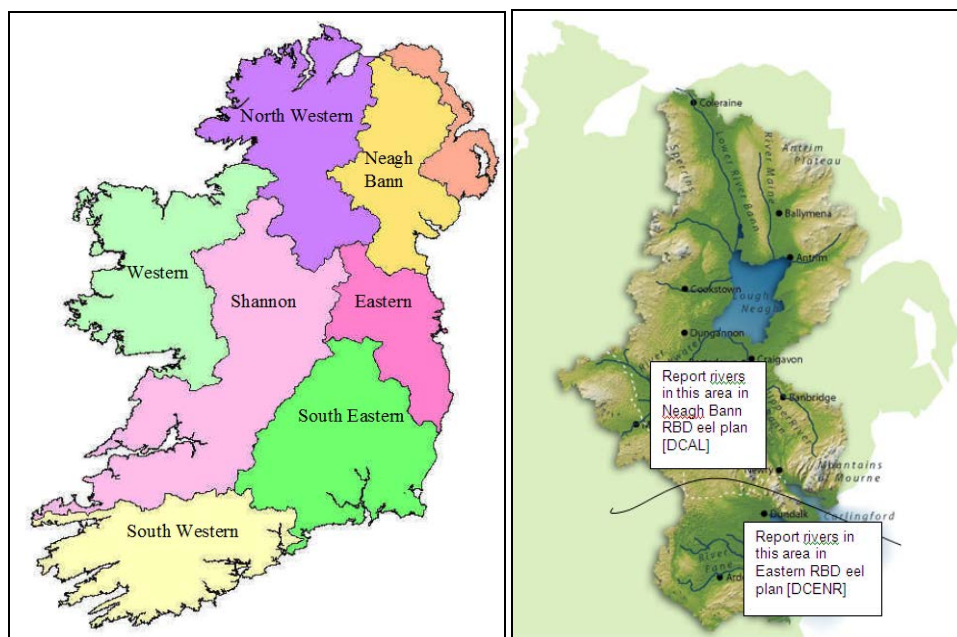


Figure 2.1. Map (left) showing the River basin Districts and the map (right) showing the transboundary agreement between the Neagh/Bann RBD and the Eastern RBD.

2.2.3 Description of the Eel Management Units

Current management of migratory species in Ireland, salmon and sea trout, has been at the catchment level and it is therefore logical to expand this to encompass the management of eel. A GIS based data model was established for the quantification of the freshwater salmon habitat asset and for the determination of the quantity of habitat available to migratory salmonids. 261 discrete migratory salmonid 'Fishery Systems' were identified. Four Northern Ireland catchments have now been included in this quantification in support of the NWIRBD transboundary management plan. It is likely that eels are present in the majority or all of these systems. Commercial fishing probably only takes place in 4.6% of the catchments, although this accounts for some 71% of the total wetted area.

The estimated total wetted area of the 265 lake, river and stream habitat accessible to migratory fish (including 1st order streams) in Ireland (including the Northern Ireland part of the Erne and the Loughs Agency Rivers in the Foyle and Carlingford areas) is 153 881 ha. The 265 "migratory" systems were estimated to contain 132 275 ha of lake habitat and 21 606 ha of fluvial habitat, of which 2826 ha is estimated to be 1st order stream. The ShIRBD, WRBD and NWIRBD are dominated by lacustrine habitat.

The catchments have been characterised on the basis of their underlying geology, specifically in terms of the proportion of the surface area comprising calcareous and non-calcareous types. This catchment characterisation led to a continuous summary variable for catchment freshwaters, i.e. the proportion of wetted area comprising non-calcareous geology. Lacustrine habitat dominates Ireland's freshwaters, comprising more than 85% of the wetted area. Similarly, calcareous habitat heavily dominates overall.

Water quality in Ireland is generally good and compares favourably with other Member States. The main challenge for water quality is to deal with eutrophication arising from excess inputs of nutrients from all sources. The extent of eutrophication

has been increasing persistently since the 1970s and is probably the most serious environmental pollution problem in Ireland. Poor water quality impacts on the potential of rivers to produce salmon. It is unknown whether similar poor water quality levels have an effect on eel. Nationally (RoI), the current water quality in 82.7% of the habitat available for salmon production is unpolluted, a further 12.8% is considered slightly polluted and the remaining 4.5% is considered to be moderately or seriously polluted. In general, persistent organic pollutants were relatively low in the Irish eels sampled to date.

Anguillicola crassus continues to spread and more than 70% of the wetted area is now infested (Beccera-Jurado *et al.*, 2014; SSCE, 2014).

Six catchments in Ireland have major hydropower installations in the lower catchments. 46% of the available wetted habitat is upstream of major barriers, although there is a greater proportion (53%) of the potential silver eel production when the differences in relative productivity are taken into account. An average mortality of 28.5% per turbine installation (ICES, 2003) was used in assessing the impact of hydropower for the purpose of setting up the EMPs. This mortality figure has since been updated for both the Erne and the Shannon with catchment specific estimates reported in the 2012 AND 2015 Reports to the EU (Anon, 2012, 2015; SSCE, 2014) see also Chapter 8 of this report. Immediate measures will were put in place to mitigate against turbine mortality, including silver eel trap and transport on the Erne, Shannon and Lee, with the aim of establishing long-term 'engineered' solutions to reduce HPS mortality. These measures are outlined in the management actions section of the National Eel Management Plan (2008). It is also recommended that all new hydropower turbines and potential barriers to upstream migration should be evaluated in Environmental Impact Assessments for potential impacts on eel.

Natural mortality of eels is a major, but relatively unknown, factor in the population dynamics of eels and mortality caused by predation is one of the factors contributing to natural mortality. There are few data on the level of predation on eel in Ireland or on the impact on the eel stock. The most recent census of cormorants in Ireland (Seabird 2000 breeding survey) reports that the Irish coastal population has remained stable since the previous census (1985–1988). Other legislation must be complied with when considering possible actions against predators.

2.2.4 The eel fishery

Glass eel and elver fishing in Ireland is prohibited by law (1959 Fisheries Act). The commercial eel fishery involved harvesting both yellow and silver eel in freshwater and in estuarine or tidal waters. Yellow eel were fished using a variety of techniques, the most common of which are baited longline, fykenets and baited pots. When silver eel were migrating downstream are caught in fykenets and stocking-shaped nets called "coghill nets" which are attached to fixed structures in the river flow, often at "eel weirs". The declared commercial eel catch in the Irish Republic, 2001–2007, ranged from 86 t to 120 t involving about 150–200 part-time fishermen, but inadequate reporting and illegal fishing makes this difficult to quantify accurately and it maybe a substantial underestimate. A total maximum of 278 licences were issued in 2006 and a maximum of 182 of these were actively fished in 2005. The value of the reported catch was therefore in the order of €0.5 million to €0.75 million.

In May 2008, a byelaw was introduced (Conservation of Eel Fishing (Annual Close Season) Bye-law No. C.S. 297, 2008) restricting the fishing season for both yellow and silver eel. Analysis of the impact of implementing a Yellow eel fishing season from 1st June to 31st August and a Silver eel season from the 1st of October to 31st Decem-

ber showed the impact of the reduced fishing season would have been different in each Region with the level of reduction ranging from 7 to 42% in yellow eel catch and 0–40% in silver eel catch.

Recreational eel fishing is only carried out by a minority of rod anglers and there is no legal, or voluntary, declaration of catch which is probably relatively small. There is no legislation protecting eels from angling. All other fishing engines, including, fykenet and baited pots, are authorized under the commercial legislation.

There is no eel culture in Ireland at the present time and none is envisaged in the near future.

NOTE: the commercial eel fishery was closed in Ireland in 2009 and possession of eel caught in the State was deemed illegal. Eel captured in the recreational fishery (angling) should be released.

2.2.5 Escapement–local stock modelling

The Irish Management Plans will include a time period for detailed data collection and a parallel program of stock assessment, including silver eel escapement estimates, and model development. In the interim, the three options proposed in the Eel Regulation were used to make preliminary estimates of pristine production and current escapement. The approach outlined in Article 2 of the Eel Regulation (EC No. 1100/2007) was followed to calculate pristine and current escapement and a simple model was proposed to project the impact of management actions on escapement from freshwaters.

No estimates of truly pristine escapement exist for Irish eel freshwater catchments. Historical production of silver eels was calculated (for freshwaters only) using catch series for four catchments (where the fishery efficiency was estimated) for periods prior to 1980. These data were calibrated using eel growth rates for 17 catchments and a regression model was developed relating production to catchment geology, a proxy for productivity. This gave historic production rates of 0.93 kg/ha (Burrishoole - unproductive) to 5.5 kg/ha (Moy - productive) and total historic silver eel potential production (without anthropogenic mortality) of 589.4 t per annum.

Current production estimates were calculated for each year from 2009 and for averages for the 2009–2011 and 2012–2014 periods using the regression model relating production to catchment geology, a proxy for productivity (IMESE). These data are reported in Chapter 13 of this report.

Due to the last 18+years of low and declining recruitment, regardless of which management actions are taken, achieving the 40% EU target in the long term will require a recovery of recruitment arising from concerted international action and cannot be achieved in Ireland alone. It was difficult to assess a time frame for recovering the predicted downward trend in escapement in the absence of knowing what the European recruitment levels will be in future and in the absence of a clear time frame from the EU. To facilitate setting a time-scale to recovery it was decided to adopt the approach used by Astrom and Dekker (2007) in predicting the recovery time for recruitment under different reduced levels of mortality. Two assumptions were made: the first that Europe responds in a similar fashion to reducing mortality and the second, that as recruitment recovers towards historical, the Spawning–Stock Biomass is recovering towards the target. Therefore, recruitment recovery is used as an alternative target towards the escapement target. It is also possible that the EU biomass es-

capement target may be reached in a shorter time-scale than will full historical recruitment.

2.2.6 Stocking

Purchase of glass eel for stocking from outside the state has not taken place in the last 20 years (at least) and does not currently take place. Assisted migration of upstream migrating pigmented elvers takes place in the Shannon (Ardnacrusha) and Erne (Cathaleen's Fall) and of pigmented young eel (bootlace) on the Shannon (Parteen Regulating Weir). Prior to 2009, small amounts of glass eel and elver were taken in the Shannon estuary and in neighbouring catchments and these were stocked into the Shannon above Ardnacrusha and Parteen HPSs. Given the widespread presence of *Anguillicola* and the move towards risk averse management strategies at low recruitment levels, this practice was **discontinued**.

2.2.7 Monitoring and post-evaluation

The national plan describes a comprehensive programme of monitoring and evaluation of management actions and their implementation, and also a programme of eel stock assessment to establish a stock baseline, estimate silver eel escapement and monitor the impact of the management actions on the local stocks.

Ireland is committed to compliance with the Data Collection Framework. Given the cessation of the fishery there was no obligation to undertake sampling under the DCF in 2009–2011.

Ireland has submitted the 2012 Report to the EU with an annexed science report on the status of the eel stock in Ireland.

2.2.8 Management actions

There are four main management actions aimed at reducing eel mortality and increasing silver eel escapement in Irish waters. These are a cessation of the commercial eel fishery and closure of the market, mitigation of the impact of hydropower, including a comprehensive silver eel trap and transport plan, ensure upstream migration of juvenile eel at barriers and improve water quality including fish health and biosecurity issues.

3 Time-series data

Figure 3.1 gives the locations of the recruitment time-series in Ireland. Recruitment monitoring of 0+ age glass eel (elvers) takes place on the Shannon at Ardnacrusha and the Erne at Cathaleen's Fall (Ballyshannon) and of >0+ age recruits at Parteen Regulating weir on the Shannon. Additional monitoring takes place at a number of locations, mostly in the Shannon Region and on the Lee (south coast); Ballysadare, Corrib (west coast) and the Liffey (east coast).

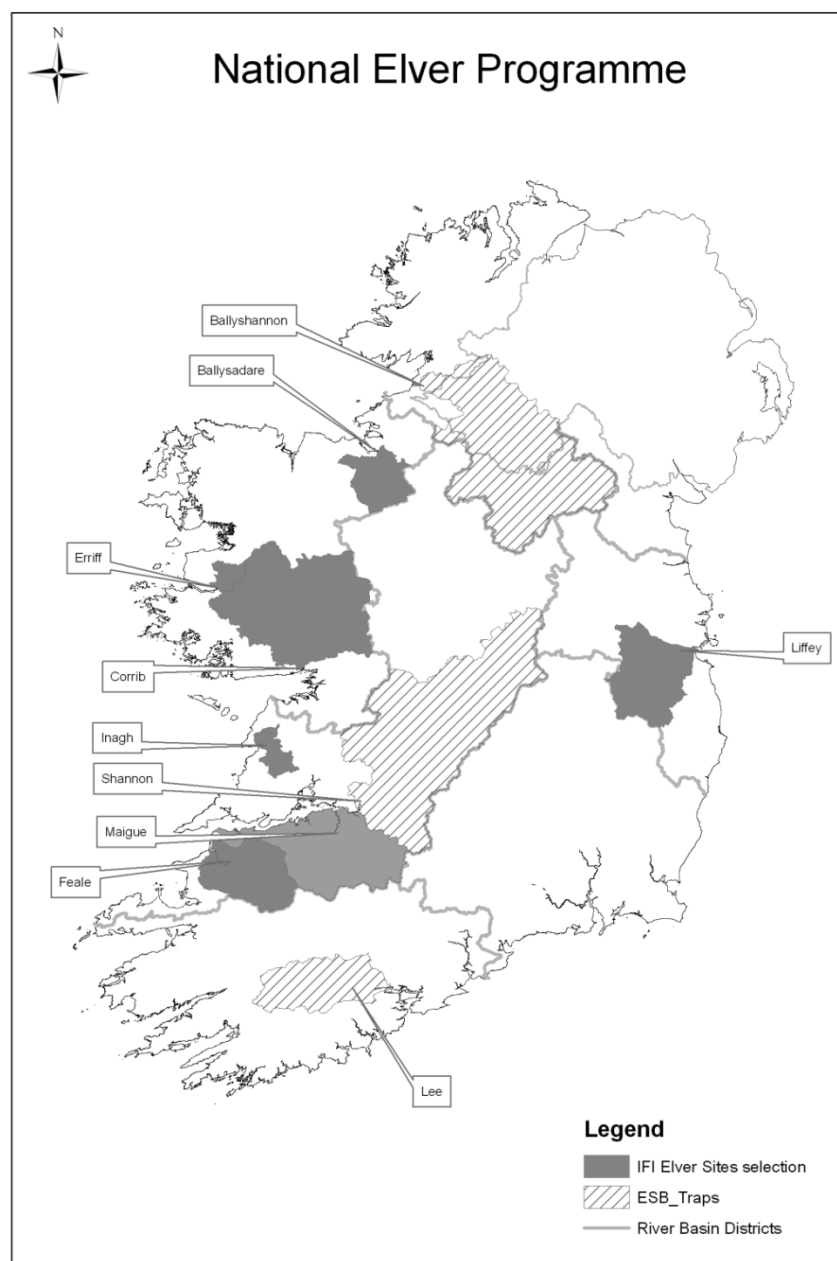


Figure 3.2. Location of recruitment monitoring stations in Ireland.

3.1 Recruitment

3.1.1 Glass eel recruitment

3.1.1.1 Commercial

There is no authorised commercial catch of juvenile eel in Ireland as glass eel and el-ver fishing in Ireland is prohibited by law (1959 Fisheries Act, Section 173).

3.1.1.2 Recreational

There is no recreational catch of juvenile eel in Ireland as glass eel and elver fishing in Ireland is prohibited by law (1959 Fisheries Act, Section 173).

3.1.1.3 Fishery-independent

There is no authorised commercial catch of juvenile eel in Ireland, but some fishing has been authorised in the past under Section 18 of the Fisheries Act for enhancement of the fisheries. Catches are made at impassable barriers and this is reported in the relevant Regional Eel Management Plans.

Long-term monitoring of elver migrating at Ardnacrusha (Shannon) and Cathaleen's Fall (Erne) is undertaken by the ESB (Figure 3.2). In the Erne recruitment has shown an increase each year since 2011.

Major refurbishment of the elver traps was undertaken in early 2015 and this may have improved the efficiency of the Erne traps thereby likely introducing a discontinuity into the time-series. A third new trap was also installed and the data for this trap are being handled and reported separately in order to preserve the original time-series.

Data for the Ardnacrusha Shannon trap have been low in recent years.

Long-term monitoring of migrating elvers also takes place at on the Feale, Inagh and Maigue Rivers and fishing was also previously undertaken in the Shannon Estuary for glass eels (Tables 3.1–3.2).

All catches reported in Tables 3.1–3.2 were transported upstream within the catchment and restocked. Additional elver monitoring is shown in Table 3.3.

Due to the unseasonal high rainfall during summer of 2015, some of the trapping sites experienced difficulties with high water levels. High water levels also assisted elvers in crossing partial barriers reducing the trapping efficiency at those sites (e.g. Liffey, Ballysadare). No elvers were trapped in Ballysadare in 2015, probably due to consistently high water levels.

Recruitment for the 2015 season indicated that there was a general decrease in the recruitment levels to Ireland in 2015 compared to 2014. The Erne was the only location to show an increase but it should be noted that this site also received considerable refurbishment of the traps.

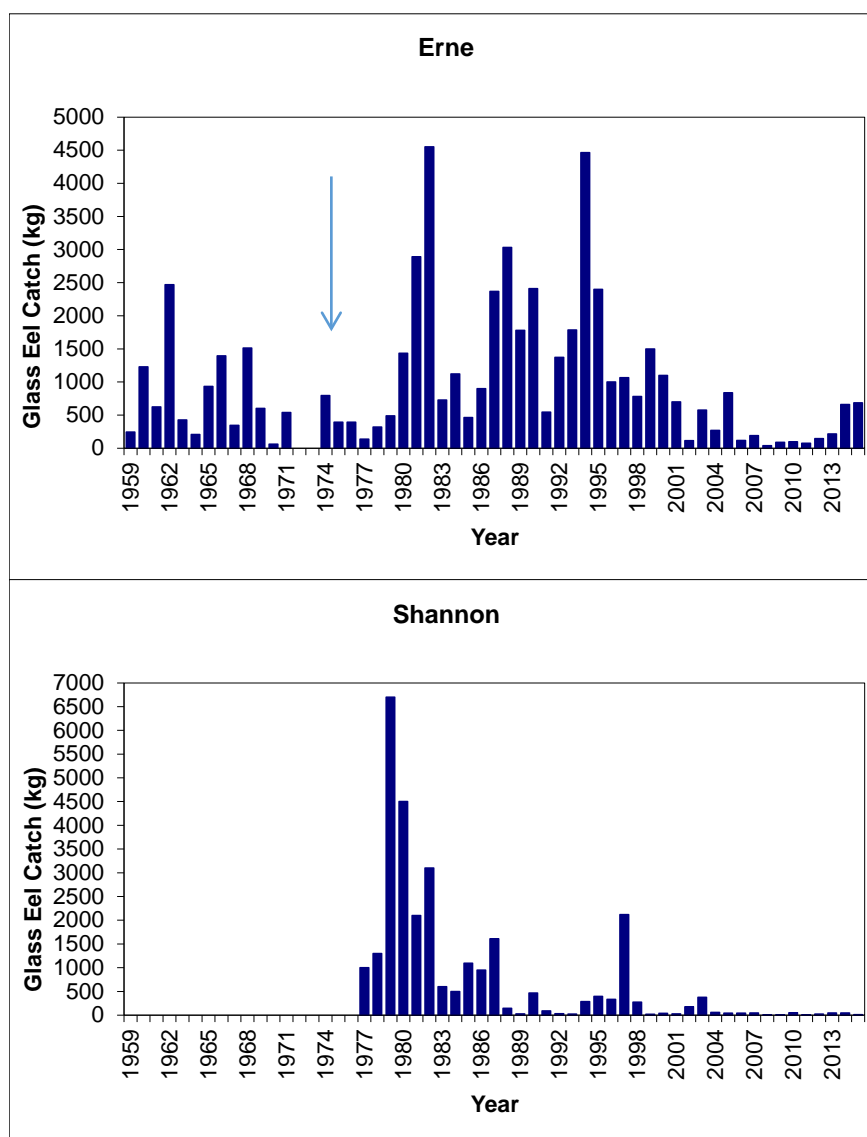


Figure 3.3. Annual elver catches (t) in the traps at Ardnacrusha (Shannon) and Cathaleen's Fall (Erne); data from ESB. Full trapping of elvers took place on the Erne from 1980 onwards indicated by the arrow. Erne 2015 does not include the additional new trap.

Table 3.1. Annual elver catches (kg) in the traps at Ardnacrusha (Shannon) and Cathaleen's Fall (Erne).

YEAR	ERNE (KG)	SHANNON (KG)	YEAR	ERNE (KG)	SHANNON (KG)
1952			1984	1121	500
1953			1985	463	1093
1954			1986	898	948
1955			1987	2367	1610
1956			1988	3033	145
1957			1989	1781	27
1958			1990	2409	467
1959	244		1991	546	90
1960	1229		1992	1371	32
1961	625		1993	1785	24
1962	2469		1994	4463	287
1963	426		1995	2400	398
1964	208		1996	1000	332
1965	932		1997	1065	2120
1966	1394		1998	782	275
1967	345		1999	1500	18
1968	1512		2000	1100	39
1969	600		2001	699	27
1970	60		2002	113	178
1971	540		2003	576	378
1972			2004	269	58
1973			2005	838	41
1974	794		2006	118	42
1975	392		2007	189	45
1976	394		2008	39	7
1977	138	1000	2009	88	8
1978	320	1300	2010	97	50
1979	488	6700	2011	74	7
1980	1434	4500	2012	146	23
1981	2892	2100	2013	215	47
1982	4550	3100	2014	659	45
1983	728	600	2015	686	11

Table 3.2. Glass eel catches (kg), 1985 to 2015 (blanks = not fished).

YEAR	ERNE ESTUARY	MOY ESTUARY	R FEALE	R MAIGUE	INAGH R	SH. ESTUARY GLASS EELS	R. LIFFEY FISH PASS	R. LIFFEY WEIR
1985			503					
1986								
1987								
1988								
1989								
1990								
1991								
1992								
1993								
1994			70	14				
1995			0	194				
1996			0	34	140			
1997			407	467	188	616		
1998	46		81	8	11	484		
1999	441		135	0	0	416		
2000	188		174	0	120	43		
2001		13	58	2	18	1		
2002		21	116	5		37		
2003		36	36	72	111	147		
2004		0	0	0	24	1		
2005		14	0	1	0	41		
2006		0	1	0	4	3		
2007		0	0	0	39	12		
2008		0	0	0	83	2		
2009		1	42					
2010		7	20	3	1.3	3		
2011		0	5	5	8			
2012		0	55		*		0.5	0.2
2013			68	14	43		1.1	2.7
2014			5	29**	40		0.3	0.3
2015			3	15	25		0.2	0.2

* trap flooded, ** partial trapping effort to avoid mortality due to large run.

Table 3.3. Recruitment data for the years 2010–2015.

LOCATION	YEAR	TOTAL WT. ELVERS (KG)	EST. NO. ELVERS	AV WT. ELVER (G)	TOTAL WT. YELLOW EELS (KG)	EST. NOS YELLOW EELS	AV. WT. YELLOW EEL (G)
Ballysadare	2013	0.924	2,640	0.35	4.612	1,005	4.59
	2014	0.842	2,148	0.35	0.873	203	4.51
	2015	0	0		0	0	
Corrib pipe trap	2010	29.696	95,254	0.33	7.401	728	9.83
	2011	4.189	11,970	0.35	24.493	3,244	7.55
	2012	2.383	5,168	0.34	7.487	1,143	8.55
C Ramp and pipe	2013	14.260	42,064	0.34	12.520	2,149	5.41
Corrib Ramp trap	2013*	10.168	29,994	0.34	0	0	-
	2014	3.283					
	2015	12.32	37,333	0.33		50	
Feale	2010	20.361	42,161	0.48			
	2011	1.099	3,139	0.35	6.298	834	7.55
	2012	35.975	102,785	0.35	10.860	1,601	5.47
	2013	44.661	71,854	0.62	23.313	6,133	4.31
	2014	3.224	6,466	0.48	1.343	301	4.88
	2015	2.49kg Total Weight; 2036 total count					
Inagh	2010	1.417	2,931	0.5			
	2011	8.168	23,338	0.35	7.134	945	7.55
	2012	*	*	*	*	*	*
	2013	31.069	88,641	0.35	12.581	4,089	3.07
	2014	34.894	90,153	0.39	4.690	1,152	4.25
	2015	20.131			4.775		
Liffey Weir	2012	0.213	608	0.35	-	-	-
	2013	2.742	7,849	0.35	-	-	-
	2014	0.285	746				
	2015	0.145	629				
Liffey Fish Pass	2012	0.454	1,298	0.35	-	-	-
	2013	1.144	3,359	0.36			
	2014	0.311	1,402	0.231		4	
	2015	0.159	690			0	
Maugue	2010	2.772	5,650	0.42	-	-	-
	2011	5.061	13,678	0.37	0.054	7	7.55
	2012	*	*	*	*	*	*
	2013	14.032	39,665	0.35	0.019	3	6.4
	2014	29.020	78,042	0.37	-	-	-
	2015	15.050			0.164	20	8.69

3.1.2 Yellow eel recruitment

3.1.2.1 Commercial

There is no authorised commercial catch of juvenile eel in Ireland as glass eel and elver fishing in Ireland is prohibited by law (1959 Fisheries Act, Section 173). Fishing for juvenile eel is also prohibited under the conservation bye-laws.

3.1.2.2 Recreational

There is no authorised recreational catch of juvenile eel in Ireland as glass eel and elver fishing in Ireland is prohibited by law (1959 Fisheries Act, Section 173).

3.1.2.3 Fishery-independent

Monitoring of juvenile yellow eel migrating at Parteen Regulating Weir (Shannon) and Inniscarra on the R. Lee takes place using fixed brush traps.

The data for Parteen are presented in Figure 3.3 and Table 3.4. In 2009 and 2010, due to maintenance work by ESB at the Parteen regulating weir the discharge patterns were less favourable than in 2008. This may partly account for the poor catches recorded in 2009 and 2010. However, catches in the original Parteen hatchery trap continued to decline in 2011, 2012 and 2013. The catch in 2014 was 365 kg and in 2015 it was 301.1 kg.

A new trap was installed in 2012 on the Shannon at Parteen, on the opposite bank (Co. Clare). The catch was 6.6 kg and 6.8 kg in 2013 and 7.8 kg in 2014. The Co. Clare trap and a new one installed in 2015 near the hatchery (Tipperary), trapped 26.95 kg in 2015.

In 2010, less than one kg was recorded in the Inniscarra trap on the River Lee and in 2011, 48 kg were recorded. The catch has declined since 2011 with only 0.6 kg recorded in 2014 and 0.94 kg in 2015.

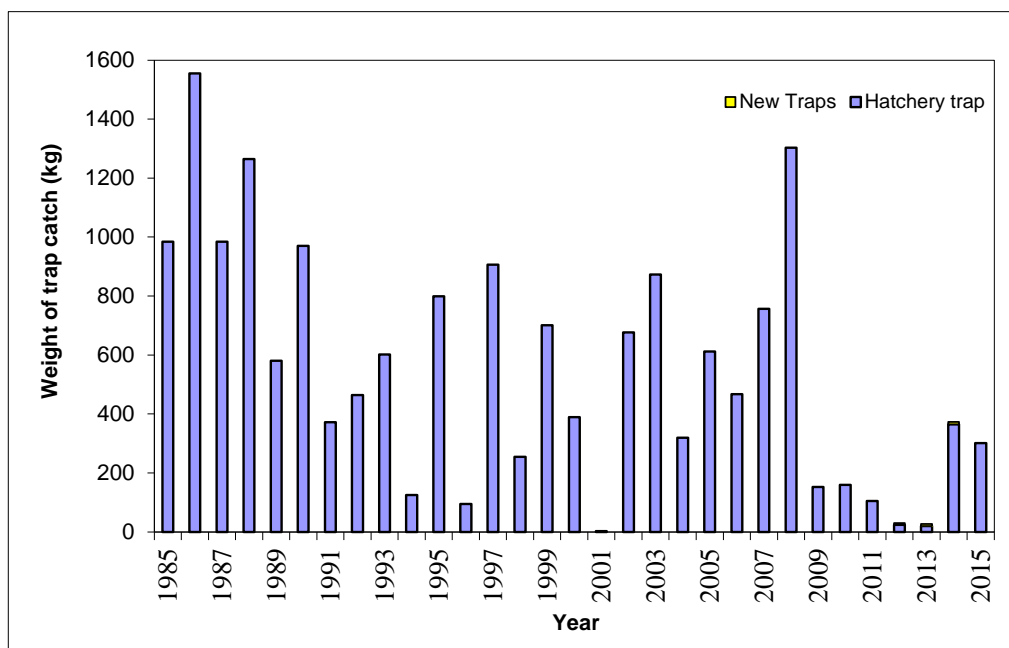


Figure 3.4. Juvenile yellow eel catches (kg) at Parteen Weir, 1985 to 2015. From 2012, a second trap was installed on the opposite bank (Clare) and in 2015 near the hatchery (Tipperary) and these data are included in the graph as separate bars.

Table 3.4. Juvenile yellow eel catches (kg), 1985 to 2015.

Year	SHANNON	SHANNON	LEE
	Parteen hatchery	Parteen 2 New traps	Inniscarra
1985	984		
1986	1555		
1987	984		
1988	1265		
1989	581		
1990	970		
1991	372		
1992	464		
1993	602		
1994	125		
1995	799		
1996	95		
1997	906		
1998	255		
1999	701		
2000	389		
2001	3		
2002	677		
2003	873		
2004	320		
2005	612		
2006	467		
2007	757		
2008	1303		
2009	153		
2010	159.5		1
2011	104.5		48
2012	23.9	6.6	23.8
2013	20.3	6.8	5
2014	365.3	7.8	0.6
2015	301.1	26.95	0.94

3.2 Yellow eel landings

There are no true index series for yellow eel landings. Most of the data were aggregated by RBD.

3.2.1 Commercial

There are no new landings data since 2008 as the commercial fisheries were closed in 2009.

3.2.2 Recreational

There are no data available for yellow eel caught by recreational fishermen (only rod angling).

3.3 Silver eel landings

Commercial Silver Eel Fisheries were closed in 2009 and remain closed each year until 2015.

3.3.1 Commercial

3.3.1.1 Shannon

Analysis of River Shannon silver eel migrations has been undertaken annually by NUIG since 1992 and considerable experience has been gained since the initial intensive studies in 1992–1994 (e.g. Cullen and McCarthy, 2000; 2003; McCarthy and Cullen, 2000; McCarthy *et al.*, 1999; 2008). The focus changed in recent years, from fishery monitoring to eel conservation issues. This led *inter alia* to the development of a Lower River Shannon silver eel trap and transport programme, in which ESB arranged for release of the entire Killaloe eel weir catch downstream of Parteen weir.

The annual downriver migrations of silver eels have traditionally been exploited in the River Shannon and the three commercial eel weirs, owned by ESB, since 1937. Since 2001, ESB have continued this practice with the introduction of a pilot trap and transport of a portion of the silver eel catch to downstream of the HPS (Figure 3.4; Table 3.5). In 2009, the fishery closed and the full agreed trap and transport plan was put into action. (See previous Country Reports and Anon, 2012; 2015).

The silver eel run was fished at a limited number of stations in 2012/13 as a conservation fishery for trap and transport around the barriers at Parteen and Ardnacrusha. The silver eel catch at Killaloe was 12.48 t which was over half the total catch (24.23 t) on the Shannon in 2012. The fishing season at Killaloe extended from 19/10/2012 to 09/02/2013 and a total of 97 nights were fished at that location. Fishing at the other sites ended in late November (Finea and Rooskey) and late December (Athlone).

The silver eel run was fished at a limited number of stations in 2013/2014 as a conservation fishery for trap and transport around the barriers at Parteen and Ardnacrusha. The silver eel catch at Killaloe was 12.808 t which was over half the total catch (22.561 t) on the Shannon in 2013. The fishing season at Killaloe extended from 23/10/2013 to 26/02/2014. Fishing at the other sites ended in early December.

The silver eel run was fished at a limited number of stations in 2014/2015 as a conservation fishery for trap and transport around the barriers at Parteen and Ardnacrusha. The silver eel catch at Killaloe was 15.122 t which was over half the total catch (26.452 t) on the Shannon in 2014. The fishing season at Killaloe extended from 10/11/2014 to 26/01/2015. Fishing at the other sites ended in early December.

Note: while the effort in Killaloe has probably remained similar in recent years, the catch and cpue may now be influenced by changes in management and fishing effort further upstream in the Shannon. Upstream sites are fished with a fixed quota.

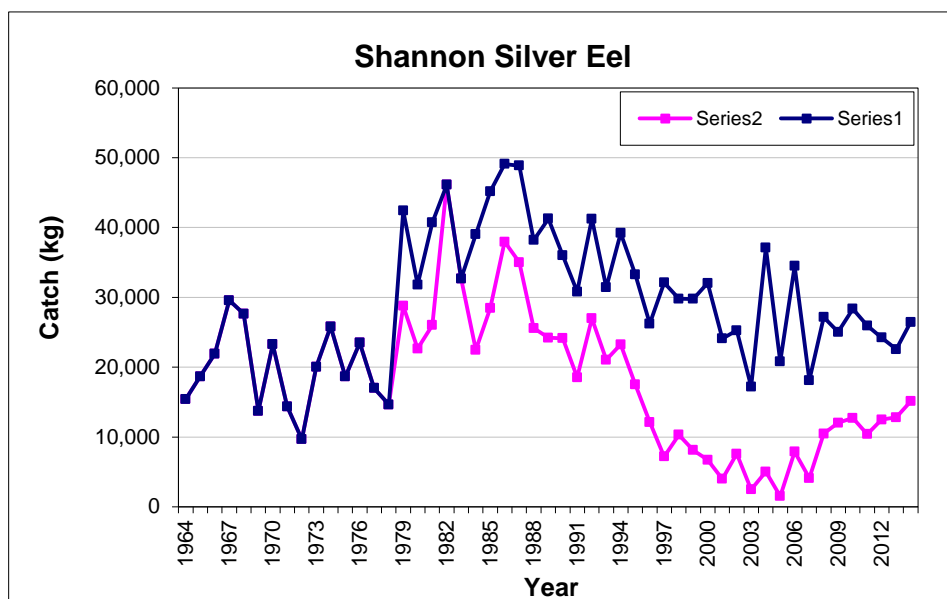


Figure 3.5. Silver eel catches from the Killaloe eel weir and the total Shannon system, for 1964 to 2015. Note that the totals in 2009–2015 are for a conservation fishery with reduced effort: Killaloe effort remains comparable.

3.3.1.2 Corrib

The Galway Fishery comprised a weir with 14 coghill nets. These were fished throughout the dark moon phases and could be lifted during periods of very high water. The fishery was purchased by the state in 1978 and has been fished consistently since then. Fishing effort may have increased in later years. The downward trend in silver eel catch (Figure 3.5; Table 3.5) therefore probably reflects the decreasing stock in the greater Corrib catchment and falling silver eel escapement. The catch in 2007 was 9.3 t, in 2008 it was 5.2 t and in 2009 it was 12.65 t. The data in 1976 and 1977 for the Galway Fishery are estimates.

The Galway Fishery was not fished in since 2010 due to structural safety issues with the weir.

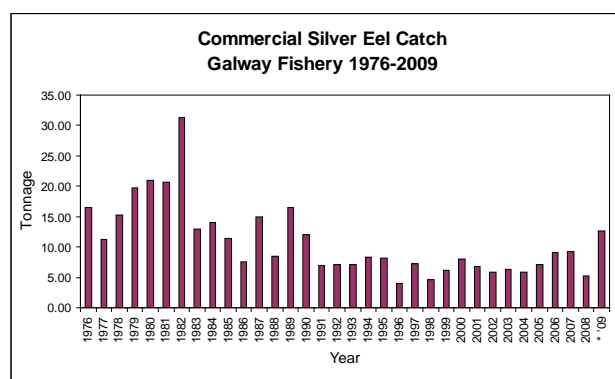


Figure 3.6. Annual silver eel catch (t) in the commercial Galway Fishery, Corrib System, for 1976 to 2009. *Note the fishery was operated as a research catch & release fishery in 2009 and was closed since 2010.

Table 3.5. Annual silver eel catch (t) in the commercial Galway Fishery, and for the Killaloe Fishery and total Shannon catch. Note: 2009–2015 was a non-commercial fishery. nf = not fished.

SEASON	YEAR	GALWAY FISHERY	SHANNON KILLALOE	SHANNON TOTAL
1964/65	1964		15.4	15.4
1965/66	1965		18.7	18.7
1966/67	1966		21.9	21.9
1967/68	1967		29.6	29.6
1968/69	1968		27.6	27.6
1969/70	1969		13.7	13.7
1970/71	1970		23.3	23.3
1971/72	1971		14.4	14.4
1972/73	1972		9.7	9.7
1973/74	1973		20.0	20.0
1974/75	1974		25.8	25.8
1975/76	1975		18.6	18.6
1976/77	1976	16.5	23.5	23.5
1977/78	1977	11.3	17.0	17.0
1978/79	1978	15.3	14.6	14.6
1979/80	1979	19.7	28.8	42.4
1980/81	1980	20.9	22.7	31.8
1981/82	1981	20.6	26.0	40.7
1982/83	1982	31.3	46.1	46.1
1983/84	1983	13.0	32.7	32.7
1884/85	1984	14.0	22.5	39.0
1985/86	1985	11.4	28.4	45.1
1986/87	1986	7.5	37.9	49.1
1987/88	1987	15.0	35.0	48.9
1988/89	1988	8.5	25.6	38.2
1989/90	1989	16.5	24.2	41.3
1990/91	1990	12.1	24.1	36.0
1991/92	1991	7.0	18.5	30.8
1992/93	1992	7.2	27.0	41.2
1993/94	1993	7.1	21.0	31.4
1994/95	1994	8.3	23.2	39.2
1995/96	1995	8.2	17.5	33.3
1996/97	1996	4.1	12.1	26.2
1997/98	1997	7.3	7.2	32.1
1998/99	1998	4.6	10.3	29.8
1999/00	1999	6.1	8.1	29.8
2000/01	2000	8.0	6.7	32.0
2001/02	2001	6.8	4.0	24.1
2002/03	2002	5.8	7.6	25.2
2003/04	2003	6.3	2.5	17.2
2004/05	2004	5.8	5.0	37.1
2005/06	2005	7.2	1.5	20.8

SEASON	YEAR	GALWAY FISHERY	SHANNON KILLALOE	SHANNON TOTAL
2006/07	2006	9.2	7.9	34.5
2007/08	2007	9.3	4.1	18.1
2008/09	2008	5.2	10.5	27.2
2009/10	2009	12.7	12.0	25.0
2010/11	2010	nf	12.7	28.3
2011/12	2011	nf	10.4	26.0
2012/13	2012	nf	12.5	24.2
2013/14	2013	nf	12.8	22.6
2014/15	2014	nf	15.1	26.5

3.3.2 Recreational

There is no recreational silver eel fishing in Ireland. All silver eel fishing was authorised and recorded under the commercial effort. Silver eel fishing is currently closed.

3.3.3 Fishery-independent

3.3.3.1 Burrishoole

The only total silver eel production and escapement data available in Ireland are for the Burrishoole catchment in the Western RBD, a relatively small catchment (0.3% of the national wetted area), in the west of Ireland. The Burrishoole consists of rivers and lakes with relatively acid, oligotrophic, waters. The catchment has never been commercially fished for yellow eels, not been stocked and there are no hydropower turbines.

The eels have been intensively studied since the mid-1950s; total silver eel escapement from freshwater was counted since 1970 (Poole *et al.*, 1990); and an intensive baseline survey was undertaken in 1987–1988 (Poole, 1994). The detailed nature of the Burrishoole data makes it suitable for model calibration and validation (e.g. Dekker *et al.*, 2006; Walker *et al.*, 2011).

3.3.3.2 Catch

Silver eel trapping was continued in 2014. The total run amounted to 3122 eels. The main run (71%) occurred in October following periods of low water during August, September and early October (Figure 3.6).

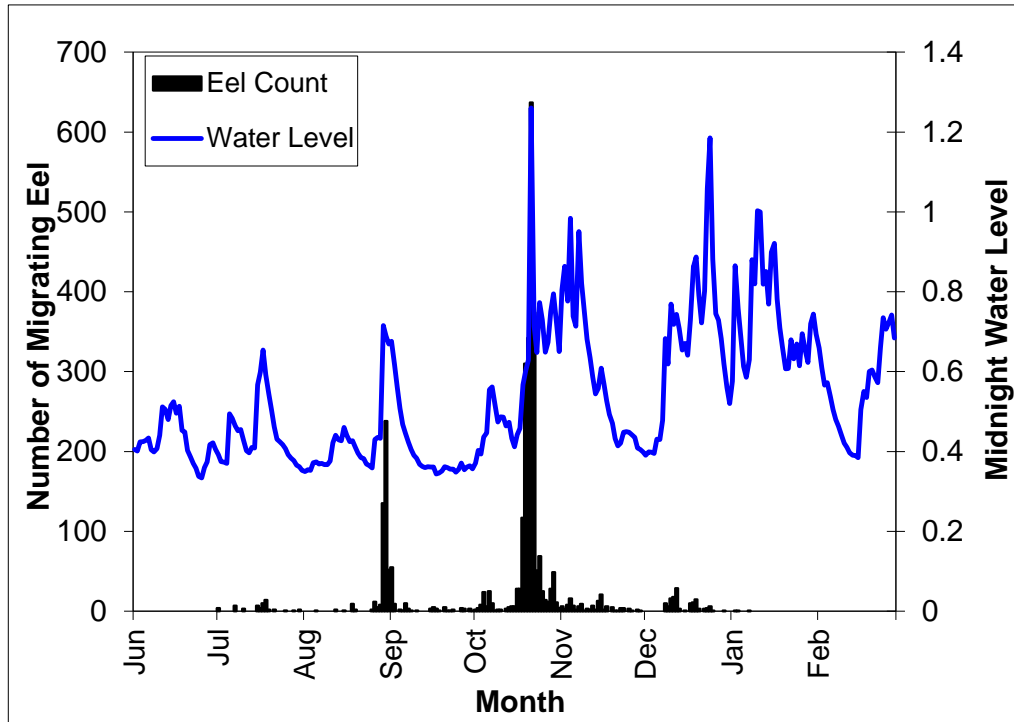


Figure 3.7. Daily counts of downstream migrating silver eel and midnight water levels (m) in the 2014 migration season.

Counts of silver eel between the years 1971 (when records began) and 1982 averaged 4400, fell to 2200 between 1983 and 1989 and increased again to above 3000 in the 1990s (Figure 3.7). The average weight of the eels in the samples has been steadily increasing from 95 g in the early 1970s to 216 g in both the 1990s and the 2000s (Figure 3.7).

In 2012, the majority of the eel run was sampled ($n=3317$; 99.5%). The run increased from 1969 eels in 2011 to 3335 eels in 2012 and the average weight decreased from 180 g to 163.5 g. The sex ratio changed from 24% to 45% over the past five years. Male eels have remained the same length over the past 15 years (36 cm) whereas the females have changed on average from 53 cm (1997–2005) to 50 cm (2008–2012) and they were 49.2 cm in 2012.

In 2013, the migration was 3623 eels and 1332 (37%) were sampled. The mean weight was 157.3 g and the proportion of male eels was similar to that in 2012 at 45.7%.

In 2014, the migration was 3122 eels and 548 (18%) were sampled. The mean weight was 186 g and the proportion of male eels was similar to that in 2010 at 35.27%.

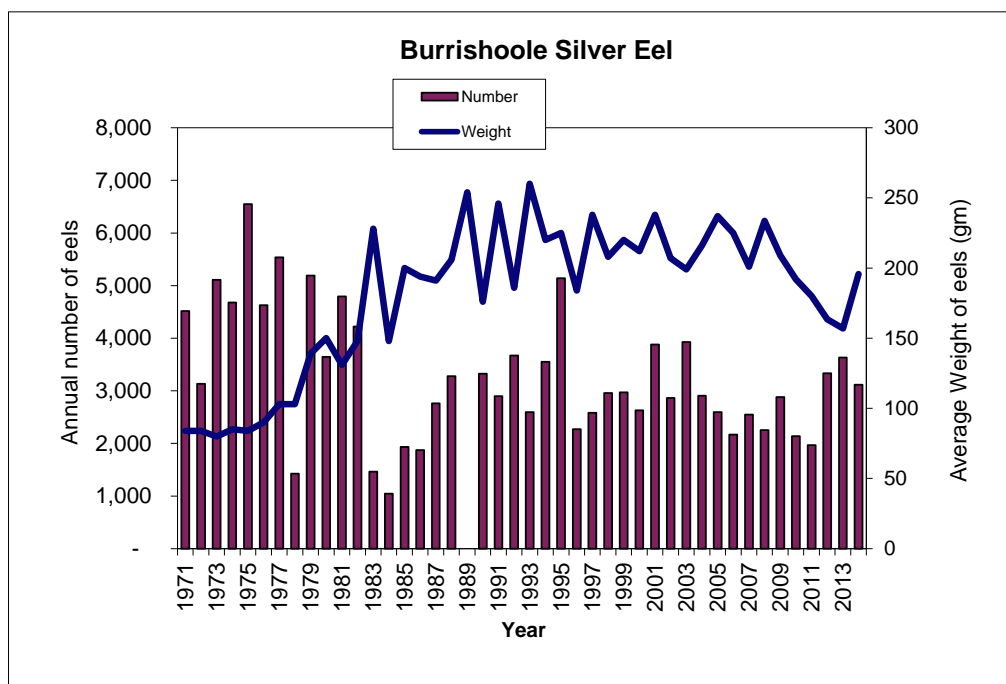


Figure 3.8. Annual number and mean weight of silver eels trapped in the downstream traps.

3.4 Aquaculture production

Not Applicable; no culture in Ireland.

3.4.1 Seed supply

Not relevant.

3.4.2 Production

Not Applicable; no culture in Ireland.

3.5 Stocking

No stocking of imported eel takes place in Ireland. The only stocking that takes place is an assisted upstream migration around the barriers on the Shannon, Erne and Lee. All recruits reported in Tables 3.1–3.3 were moved upstream in assisted migration.

3.5.1 Catch of eel <12 cm and proportion retained for restocking

No stocking of imported eel takes place in Ireland. There is no catch of eel <12 cm in Ireland and therefore no retention for stocking.

3.5.2 Reconstructed time-series

Not relevant to Ireland as most stocking is upstream assisted migration within the same catchment.

3.6 Trade in eel

There was no trade of eel in Ireland and no official import or export of any life stage of eel.

Illegal trade 2014

Two regions have reported some level of illegal fishing which led to gear and equipment seizures (ShIRBD, NWIRBD). The most significant activity appeared to be in the Shannon IRBD with 54 fykenets and 2000 m of longline seized on L. Ree. Eleven x 10 m lines were also seized on Doon Lake. Twenty fykenets were seized on the Erne system in the NWIRBD.

No seizures of eel dealers transport trucks have been reported and no illegal activity was reported in relation to the silver eel trap and transport programmes. It is likely, however, that some illicit eel sales may have occurred in the Shannon IRBD given the level of seizures of gear mentioned previously.

The poor quality of the export data currently available to the SSCE makes it difficult to determine the level of illegal catch. There were no instances of seizures of illegal or undocumented eel shipments.

4 Fishing capacity

Prior to 2009

Bye-law No. C.S. 297

In May 2008, the Minister for Communications, Energy and Natural Resources introduced a bye-law (Conservation of Eel Fishing (Annual Close Season) Bye-law No. C.S. 297, 2008). This Bye-law prohibited the taking or fishing for yellow eel under 30cm in length. The Bye-law also provided for a close season for yellow eel, from 1 September to 31 May of the following year. The Bye-law also provided for a close season for silver eel from 1 January to 30 September in any year.

Bye-Law No. 838, 2008

In May 2008, the Minister for Communications, Energy and Natural Resources introduced a bye-law (Conservation of Eel Fishing (Restriction on Issue of Licences) Bye-Law No. 838, 2008). This Bye-law capped the number of eel fishing licences which may be issued in each Fishery District in 2008 or any year thereafter.

The Management of Eel Fishing Bye-Law No.752, 1998 capped the number of longline licences that a Regional Fisheries Board may issue for longline fishing for eels in any district. In addition, the Fisheries (Amendment) Act 1999 delegated authority to the Regional Fisheries Boards to issue authorisations for the use any fishing engine for the capture of eels including any longline, as it sees fit.

Each Regional Fisheries Board had a policy on the number of fykenets permitted for each licence and in some cases the locations where they are permitted to fish. It was difficult to convert the number of licensed nets into an actual fishing effort, as many licensed fisherman either didn't fish at all or only fished for a limited period of the year. In some areas for example, such as in the southeast, fykenets were used during the weaker tides and baited pots were used when the tides were too strong for fykenets.

4.1 2009–2015 Bye-laws

CONSERVATION OF EEL FISHING BYE-LAW NO. C.S. 303, 2009

In May 2009, the Minister for Communications, Energy and Natural Resources introduced a bye-law (Conservation of Eel Fishing Bye-law No. C.S. 303, 2009). This Bye-law prohibits fishing for eel, or possessing or selling eel caught in a river in the State.

CONSERVATION OF EEL FISHING (PROHIBITION ON ISSUE OF LICENCES) BYE-LAW NO. 858, 2009

*In May 2009, the Minister for Communications, Energy and Natural Resources introduced a byelaw (Conservation of Eel Fishing (Prohibition on Issue of Licences) Bye-Law No. 858, 2009). This Bye-law prohibits the issue of any licences for fishing for eels of the species *Anguilla anguilla* by any fishing method in any fishery district.*

These two bye-laws revoked the previous bye-laws enacted in 2008 and close all fisheries for 2009–2012.

It should be noted that since EU Commission ratification of the Ireland/UK NWIRBD transboundary plan in March 2010, the fishery in the NI portion of the Erne was closed from April 2010 to date.

Following a public consultation in June 2012, Minister O'Dowd signed a new bye-law (C.S. 312/2012) on the 7th December prohibiting the fishing for eel in Ireland and the possession of eel caught in Ireland.

Bye-law No C.S. 312, 2012 prohibits fishing for eel, or possessing or selling eel caught in a Fishery District in the State until June 2015.

4.2 Glass eel

There was no authorised commercial fishing of juvenile eel in Ireland as glass eel and elver fishing in Ireland is prohibited by law (1959 Fisheries Act, Section 173).

4.3 Yellow eel

There was no authorised commercial fishing of yellow eel in Ireland for 2009–2014. No licences were issued from 2009 to 2015.

4.4 Silver eel

There was no authorised commercial fishing of silver eel in Ireland for 2009–2014. No licences were issued from 2009 to 2015.

4.5 Marine fishery

There was no authorised commercial fishing of any eel in marine waters in Ireland for 2009–2014. No licences were issued from 2009 to 2015.

5 Fishing effort

In May 2008, the Minister for Communications, Energy and Natural Resources introduced a bye-law (Conservation of Eel Fishing (Annual Close Season) Bye-law No. C.S. 297, 2008) restricting the fishing season for both yellow and silver eel as follows:

- a) to take or to attempt to take, or to fish for or to attempt to fish for, or to aid or assist in the taking or fishing for or the attempting to take or fish for, or to be in possession of brown eel during:

- i) from 16 May 2008 to 31 May 2008, and
- ii) in any year from 1 September to 31 May in the next following year.
- b) to take or to attempt to take, or to fish for or to attempt to fish for, or to aid or assist in the taking or fishing for or the attempting to take or fish for, or to be in possession of silver eel during the period:
 - i) from 16 May 2008 to 30 September 2008, and
 - ii) in any year from 1 January to 30 September.

Fishing effort was not monitored in the Irish eel fishery. There was no logbook or compulsory recording system for fishermen and there is no eel dealer register or regular monitoring of eel dealers. There is also no registration of fishing boats in the eel fishery. Efforts were made to improve on the data collection by circulating an agreed catch reporting form which may lead to data discontinuity.

In May 2009, the Minister for Communications, Energy and Natural Resources introduced bye-laws prohibiting fishing for eel, or possessing or selling eel caught in a river in Ireland and prohibiting the issue of any licences for fishing for eels of the species *Anguilla anguilla* by any fishing method in any fishery district.

In December 2012, the Minister for Communications, Energy and Natural Resources signed a new bye-law (C.S. 312/2012) on the 7th December prohibiting the fishing for eel in Ireland and the possession of eel caught in Ireland. *Bye-law No C.S. 312, 2012 prohibits fishing for eel, or possessing or selling eel caught in a Fishery District in the State until June 2015.*

5.1 Glass eel

There is no authorised commercial effort for juvenile eel in Ireland as glass eel and elver fishing in Ireland is prohibited by law (1959 Fisheries Act, Section 173). No licences were issued from 2009 to 2015.

5.2 Yellow eel

No licences were issued from 2009 to 2015.

5.3 Silver eel

No licences were issued from 2009 to 2015.

5.4 Marine fishery

There was no authorised marine fishery in Ireland. Fishing took place in transitional estuaries and lagoons and this effort was licensed and managed along with the inland fisheries.

6 Catches and landings

Until 2008 there was no compulsory declaration of eel catch in Ireland and in many Regions, declarations of catches are not complete and underreporting is probably widespread. Reported catches were available on an annual basis at the Fisheries Regional Level with most RFBs reporting on a District basis. The introduction of a new catch reporting form led to considerable improvement in the system after 2005.

For the Eel Management Plans, catches (RoI) of yellow and silver eel have been collated from the District returns and are presented in the 2010 Country Report for Ireland. Also included were the catches for the N. Ireland part of the NWIRBD on the Erne supplied by DCAL and AFBINI.

It would appear from the declared catch data that the conservation bye-laws implemented in 2008 had little impact on the catch. This may be due to a number of factors, including greater effort in a shorter season, better data reporting and recording since 2005 and changes in reporting practices by fishermen.

With the introduction of the Conservation of Eel Fishing bye-laws in 2009, all regions confirmed a closure of the eel fishery for the 2009 to 2012 seasons with no licences issued. In the transboundary areas 'The Foyle Area and Carlingford Area (Conservation of Eels) Regulations 2009' was created which prohibits the taking or killing of eels within the FCILC area. Some illegal fishing was reported and there were concerns about the traceability of eels in dealer trucks passing through some areas. Overall, illegal activity was thought to be relatively low (Ireland 2012).

6.1 Glass eel

There is no authorised commercial catch of juvenile eel in Ireland as glass eel and eel fishing in Ireland is prohibited by law (1959 Fisheries Act, Section 173).

6.2 Yellow eel

No official catch 2009–2015.

6.3 Silver eel

No official catch 2009–2015.

6.4 Marine fishery

No official catch 2009–2015.

6.5 Recreational fishery

The legislation (CONSERVATION OF EEL FISHING BYE-LAW NO. C.S. 303, 2009) prohibits the possession of eel caught in Ireland and this extends to cover recreational angling. There was no legal recreational catch and rod angling for eel, even as by-catch during angling for other species, was on a catch and release basis (Table 6.1).

Table 6.6. Recreational Fisheries: Retained and Released Catches.

Year	RETAINED				RELEASED			
	Inland		Marine		Inland		Marine	
	Angling	Passive Gears	Angling	Passive gears	Angling	Passive gears	Angling	Passive gears
2012	0	0	0	0	Catch & Release	Not fished	Catch & Release	Not fished
2013	0	0	0	0	Catch & Release	Not fished	Catch & Release	Not fished
2014	0	0	0	0	Catch & Release	Not fished	Catch & Release	Not fished
2015	0	0	0	0	Catch & Release	Not fished	Catch & Release	Not fished

Passive gears were not fished from 2012–2014 so there is zero % mortality of released eels (Table 6.2). The number of eels caught by anglers is unknown and the % of angler caught eels released that die is also unknown. This has not been taken into account in the 2009–2011 or 2012–2014 stock indicators.

Table 6.7. The catch and release mortality (%) used in your country for angling in marine and inland waters.

Year	RELEASED			
	Inland		Marine	
	Angling	Passive gears	Angling	Passive gears
2012	Unknown	0	Unknown	0
2013	Unknown	0	Unknown	0
2014	Unknown	0	Unknown	0

6.6 Bycatch, underreporting, illegal activities 2014

Two regions have reported some level of illegal fishing which led to gear and equipment seizures (ShIRBD, NWIRBD). The most significant activity appeared to be in the Shannon IRBD with 54 fykenets and 2000 m of longline seized on L. Ree. Eleven x 10 m nightlines were also seized on Doon Lake. Twenty fykenets were seized on the Erne in the NWIRBD.

No seizures of eel dealers transport trucks have been reported and no illegal activity was reported in relation to the silver eel trap and transport programmes. It is likely, however, that some illicit eel sales may have occurred in the Shannon IRBD given the level of seizures of gear mentioned previously.

The poor quality of the export data currently available to the SSCE makes it difficult to determine the level of illegal catch. There were no instances of seizures of illegal or undocumented eel shipments.

Table 6.8. Estimation of underreported catches in Country, per EMU and Stage.

Year	EMU_code	Glass eel				Yellow eel				Silver Eel				Combined (Y + S)			
		Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)
2014	EEMU	0	0	0	0	0				0				0			
	SERBD	0	0	0	0	0				0				0			
	SWRBD	0	0	0	0	0				0				0			
	ShIRBD	0	0	0	0	0				0				0			
	WRBD	0	0	0	0	0				0				0			
	NWIRBD	0	0	0	0	0				0				0			
	Total/mean (%)	0	0	0	0	0				0				0			

Table 6.9. Existence of illegal activities, its causes and the seizures quantity they have caused.

Year	EMU	Glass eel			Yellow eel			Silver Eel			Combined (Y + S)		
		Y/N/?	Cause	Seizures (kg)	Y/N/?	Seizures (kg)	Cause	Y/N/?	Seizures (kg)	Cause	Y/N/?	Seizures (kg)	Cause
2013	EEMU	N		0	N	0		N	0		N	0	
	SERBD	N		0	N	0		N	0		N	0	
	SWRBD	N		0	N	0		N	0		N	0	
	ShIRBD	N		0	Y	0	Gear	N	0		Y	0	Gear
	WRBD	N		0	N	0		N	0		N	0	
	NWIRBD	N		0	Y	0	rods/Gear	N	0		Y	0	rods/Gear

7 Catch per unit of effort

There was no authorised commercial catch of juvenile eel in Ireland as glass eel and elver fishing in Ireland is prohibited by law (1959 Fisheries Act, Section 173).

7.1 Glass eel

No new data, refer to 2009 Country Report.

7.2 Yellow eel

No new data, refer to 2009 Country Report.

7.3 Silver eel

No new data, refer to 2009 Country Report.

7.4 Marine fishery

No new data, refer to 2009 Country Report.

8 Other anthropogenic and environmental impacts

The turbine mortality rates are determined using acoustic tagged and tracked silver eel and these data are reported in the 2012 report (SSCE 2012) and in the 2015 report (SSCE Stock Annex, 2015). Additional data for the Erne were reported to the SSCE in 2012 (McCarthy *et al.*, 2013). See Table 8.1 for summary data on Hydropower Station mortality. It should be noted that operational regimes change according to the catchment, the water levels and the year, with turbine on/off, spillways open/closed and with high/low discharge. Full details are given in the Irish Progress Reports to the EU (2012 and 2015) and in Table 8.1.

For the Shannon, summarising the annual data gives mortality ranges of 16.6% to 25% and an overall average mortality of $21.15 \pm 8\%$ for 104 tagged eel arriving at Ardnacrusha HPS (SSCE, 2012). In the Eel Management Plan, a figure of 30% was used to account for the amount of eel potentially using the bypass route down the old river channel and around Ardnacrusha HPS. For 2009–2011, the actual amount of eels estimated to bypass were used in determining the escapement (59%, 4.4% and 12.5% respectively) and between 2012 and 2014, 1.6%, 24.3% and 15.9% respectively were estimated to have used the bypass channel. A general figure estimated to use the bypass in recent years is 17.8% (SSCE, 2012).

In 2013 (SSCE 2014), in the silver eel migration season there was high spillage at the Parteen Regulating Weir. It has been estimated by NUIG that 24.27% of the eels migrating downstream of Killaloe are likely to have travelled via the old river route. The hydropower dam passage mortality for the remaining (75.73%) silver eels that are assumed to have entered the Ardnacrusha headrace canal was estimated using the 21.15% rate determined by NUIG using acoustic telemetry in 2008–2011. During the 2013 season one turbine was removed for refurbishment and an equivalent amount of water was discharged via the Ardnacrusha spillway. However, it was not possible to estimate the extent to which this may have reduced turbine passage mortality because of loss of telemetry receivers downstream of the dam during extreme winter flood events.

In 2014 (SSCE, 2015) silver eel migration season there was high spillage at the Parteen Regulating Weir. It has been estimated by NUIG that 15.93% of the eels migrat-

ing downstream of Killaloe are likely to have travelled via the old river route. The hydropower dam passage mortality for the remaining (84.07%) silver eels that are assumed to have entered the Ardnacrusha headrace canal was estimated using the 21.15% rate. As in the 2013 season, one turbine was removed for refurbishment and an equivalent amount of water was discharged via the Ardnacrusha spillway, up until 21st December 2014. However, it was not possible to estimate the extent to which this may have reduced turbine passage mortality as no telemetry was undertaken during 2014.

For the Erne, Summarising the data from 2009 to 2011 gives mortality ranges for Cliff HPS of between 6.9% and 8.5% and an average of $7.8\% \pm 5\%$ and mortality for Cathleen's Fall of 22% (9 tags) in 2009. In 2010 and 2011, one turbine was removed for renovation and therefore the mortalities were lower at 6.1% and 7.7%. It is likely that these will at least double when both turbines return to full operation which will necessitate further assessment to confirm site-specific mortality rates.

Currently there is no solid information about the proportions of eel that migrate via spillways compared to via the turbine passages. There may be selective migration towards the spillways, especially at Cliff, and this may be indicative of safe passage and help to explain the low HPS mortality levels observed on the Erne.

The 2012 silver eel migration season was characterized by an almost complete absence of spillage at Cliff dam. In contrast, at Cathleen's Fall dam high spillage occurred throughout much of the migration season. Planned telemetry experiments, which were intended to provide estimates of eel mortality during periods in which the hydropower stations were on full load, had to be postponed to 2013. Because of the limited spillage, a pre-cautionary estimate of mortality (25%) at the Cliff HPS dam was used in the calculation of silver escapement in the 2012 season. Telemetry results from previous research were used for estimation of the hydropower passage mortality rate (8%) at the Cathleen's Fall HPS dam.

In 2013 (SSCE 2014), during the experimental period (20 December, 2013–20 February, 2014), Cliff HPS had no turbines operating with spillage at volumes equivalent to generation at the downstream Cathleen's Fall HPS. 100% hydropower passage success occurred during this period. Outside the experimental period, spillage occurred at Cliff HPS with turbines in operation, following the generation protocols from previous seasons (2009–2011). Therefore, the combined mortality (7.9%, 8/101) from these years was used in escapement calculations. When turbines were operating without spillage, the mortality estimate from the 2012 season (26.7%, 8/30) was used in calculations.

The hydrometric situation at the Cathleen's Fall HPS was relatively complex during the experimental period in 2013. Initial analysis of discharge patterns at Cathleen's Fall identified two basic generation protocols during period when telemetry studies were undertaken:

- 1) Two turbines operational with no spillage.
- 2) Two turbines operational with spillage.

The mortality rate at Cathleen's Fall HPS during generation protocol 1 was calculated to be 27.3% (3/11). During generation protocol 2, the mortality rate was calculated to be 15.4% (22/26). For the remainder of the silver eel season, outside the experimental period, a third generation protocol was also in operation. This was one turbine plus spillage. During the previous three migration seasons this was the

generation protocol in operation. Therefore, the average mortality (7.7%, N=91) from this period (2010–2012) was used in the calculation of hydropower passage mortality on dates in which this generation protocol was being implemented.

These estimates of mortality (three generation protocols) were incorporated into the escapement calculations for the 2013 season on the Erne.

During the 2013 and **2014** silver eel seasons the patterns of generation and spillage at the River Erne hydropower stations were similar. In the analyses of eel hydropower passage, varying mortality levels were incorporated, per calendar day, into the escapement model. These were based on dusk–dawn hydrometric data, power generation activity and results of previous years silver eel acoustic telemetry. Generation protocols and associated mortality rates have been described in previous reports. For the 2013 and 2014 seasons different mortality rates were applied as follows: *Cliff HPS* (0%, only spillage); 7.9% (Generation plus spillage) and 26.7% (Only generation), *Cathaleen's Fall HPS*: 0% (only spillage); 7.7% (spillage plus half generation load); 15.4% spillage plus full generation load); 27.3% (only generation).

Table 8.1. Summary mortality data for acoustic telemetry on the Shannon (mortality and bypass) and Erne (two Stations-Cliff & Cathaleen's Fall stations).

YEAR	NUMBER OF TAGGED EEL	MORTALITY*	NUMBER OF TAGGED EEL	MORTALITY	% USING BYPASS
Shannon					
2006–2009	44	20.4%	-	-	59%
2010	40	22.5%	-	-	4%
2011	20	20.6%	-	-	13%
Average 2006–2011		21.15%			
2012	No direct assessment, 21.15% used in estimating escapement				1.6%
2013	No direct assessment, 21.15% used in estimating escapement				24.3%
2014	No direct assessment, 21.15% used in estimating escapement				15.9%
	NUMBER OF TAGGED EEL	MORTALITY*	NUMBER OF TAGGED EEL	MORTALITY**	
	CLIFF HPS		CATHALEEN'S FALL HPS		
Erne	2009	13	7.7%	9	22
	2010	29	6.9%	26	7.7 one turbine
	2011	60	8.5%	49	6.1 one turbine
	2012	30	26.7%	No assessment; 8% used in estimating escapement	
	2013	26.7%/7.9%/0% used***		0%/7.7%/15.4%/27.3% used****	
	2014	26.7%/7.9%/0% used***		0%/7.7%/15.4%/27.3% used****	

* Ardnacrusha on the R. Shannon; Cliff on the R. Erne.

** Cathaleen's Fall on the R. Erne.

*** Cliff HPS Estimates applied with and without spillage, no direct assessment.

**** Cathaleen's Fall HPS Estimates applied with and without spillage, no direct assessment.

9 Scientific surveys of the stock

9.1 Recruitment

This was described previously in Chapter 3.1 and in the Irish Standing Scientific Committee Report for 2014 (SSCE, 2015).

9.2 Yellow eel assessment

Yellow-eel stock monitoring is integral to gaining an understanding of the current status of local stocks and for informing models of escapement, particularly within transitional waters where silver eel escapement is extremely difficult to measure directly. Such monitoring also provides a means of evaluating post-management changes and forecasting the effects of these changes on silver eel escapement. The monitoring strategy aims to determine, at a local scale, an estimate of relative stock density, the stock's length, age and sex profiles, and the proportion of each length class that migrate as silvers each year. A second objective of the yellow eel study was to carry out an indirect estimation of silver eel escapement.

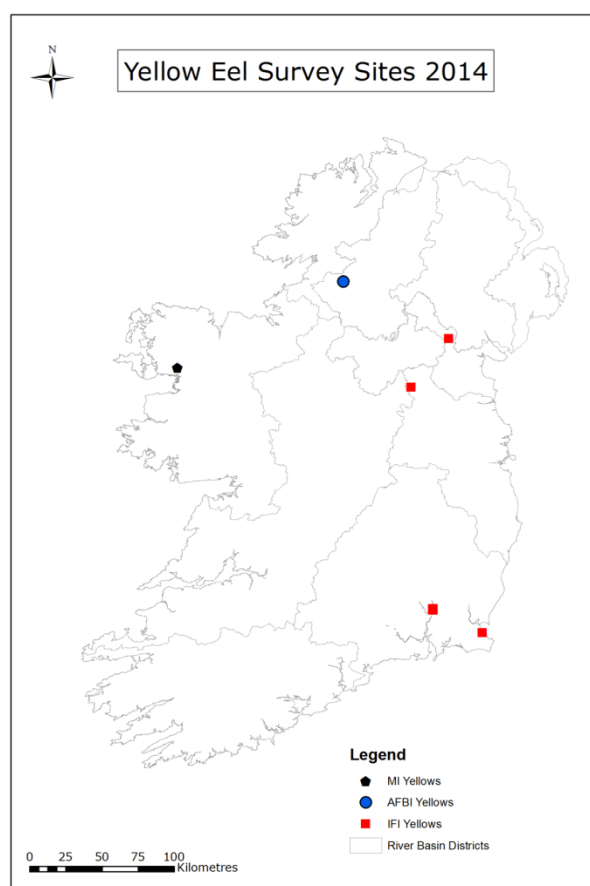


Figure 9.9. Locations of yellow eel survey work 2014.

2014 Fykenet Survey

In 2014 intensive sampling of yellow eels took place at five locations (Figure 9.1) (Burrishoole (two lakes), Lough Muckno, L. Ramor and the South Sloblands. The standard procedure in the field was to set chains of five fykenets joined end to end, set overnight and lifted the following morning, as described by Moriarty (1975). The sampling process in 2014 consisted of setting approximately 6–8 chains of five fykenets during two or three monthly sessions of two or three nights per session.

Of the lakes sampled, the South Sloblands had the highest mean cpue (2.53) with relatively high nightly cpues in L. Ramor (2.48 and 2.15) and L. Muckno (3.03) and low cpues were recorded in the western lakes, Bunaveela and Feeagh.

Transitional waters (Barrow, Burrishoole (Furnace, Furnace lwr)) were also surveyed in 2014 and the cpues were 6.87, 1.27 and 2.35 eels per net per night respectively.

Locations sampled under the Water Framework Directive gave a total of 24 lakes (spanning 16 catchments), 75 river sites (31 catchments) and ten transitional waters (from five catchments) were sampled by the WFD team in 2013. Eels were present in all 20 sampled lakes (100% of sites), 54 river sites (72%) and eight transitional waters (80%) sampled.

The WFD river sites have a 72% eel presence rate, 35% of sites have ≤ 5 eels, 9% of sites caught between five and ten eels and 28% had ≥ 10 eels.

A total of 422 eels were caught during lake surveys (with 407 eels processed for length and weight). They ranged in length from 29.7 to 84.2 cm. The river surveys caught a total of 653 eels, ranging from 6.9 to 67.0 cm. The transitional water surveys caught a total of 428 eels. However, the catch was not processed at several sites.

Transboundary

An eel survey of Lower Lough Erne was carried out over one week in August 2014, at a subset of the full 2011 survey sites. 30 fykenets were set per night (standard 10 m double ended 50 cm hoop Dutch fykes). Silver eels were recorded but not included in the overall count of yellow eel. Eel were released alive. Catch per Unit of Effort cpue was higher than in the 2011 survey reported in the 2012 SSCE report. It should be noted that some of the highest cpues recorded in the eel monitoring programme were from Lower Lough Erne in 2014 with up to 28 eels per net per night being caught.

Under The EU Interreg funded DOLMANT (development of Lake Management Tools) project, AFBI sampled in 2011 and 2012 a number of small lakes in the NWIRBD for fish, to standard Irish WFD protocols (half CEN multimesh gillnetting effort, with fykenets added for Eel, number according to lake size and depth). Eels were found at Loughs Auva, Bunerky, Derg, Formal, Golagh, Lee, Mardal, Nalughoge, Scolban, Screeby and Shivenagh, and no eels were recorded in Loughs Akibbon, Bawn, Drumgay, Jenkin, Kilturk, Nadarra, Salt and Vearty. These data are not fully quantitative but give a picture of the general distribution of eel throughout the RBD, which appears to reflect distance from the sea, elevation and presence of natural barriers.

9.3 Silver eel assessment

The Council Regulation (EC) No 1100/2007 sets a target for silver eel escapement to be achieved in the long term. Ireland is therefore required to provide an estimate of contemporary silver eel escapement. The Regulation also requires post-evaluation of

management actions by their impact directly on silver eel escapement. Quantitative estimates of silver eel escapement are required both to establish current escapement and to monitor changes in escapement relative to this benchmark. Quantifying migrating silver eel each year is a difficult and expensive process but it is the only way of ultimately calibrating the outputs of the assessments.

Silver eels are being assessed by annual fishing of locations on the Shannon, Erne, Burrishoole, Fane and Barrow catchments (Figure 9.2). Trials will also be carried out at other locations identified in the EMP using coghill nets, mark-recapture and technology options such as electronic counters or DIDSON technology.

Silver eel trap and transport on the Erne and the Shannon and monitored and integrated with the stock assessments for those catchments (refer to Irish Progress Report to the EU 2012, 2015).

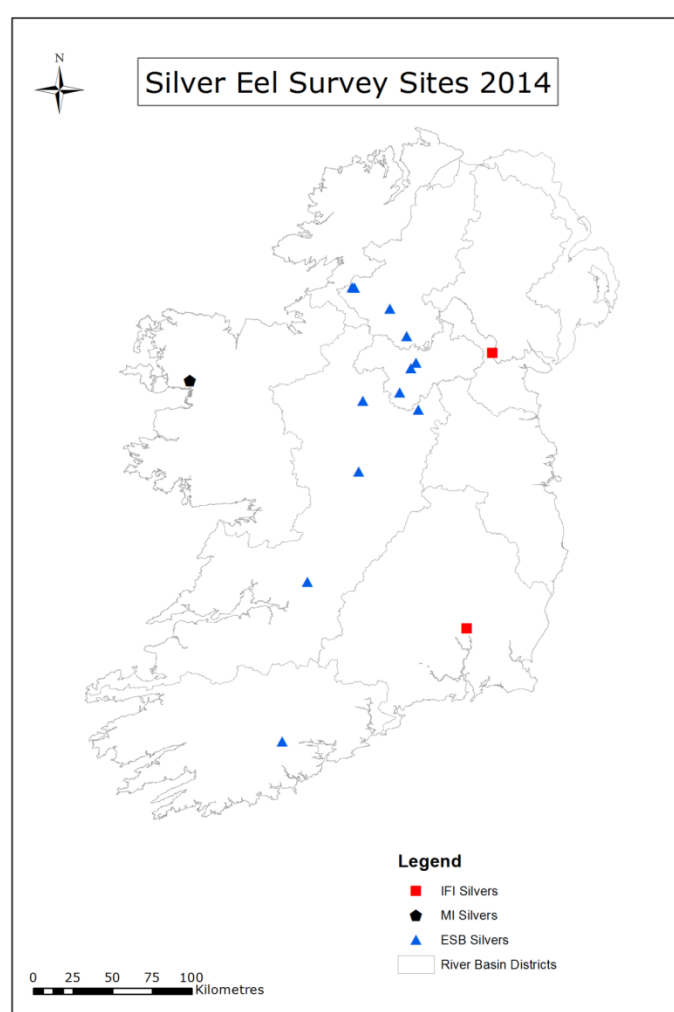


Figure 9.10. Location of silver eel monitoring in 2014.

Shannon

Eels have been fished on the Shannon in both historic and more recent times. Commercial fishing was initially established by the ESB in 1937. The ESB control the fishing rights as a result of the Shannon Fisheries Acts of 1935 and 1938. In 2009,

commercial silver eel fishing ceased on the Shannon. The pre-EMP pilot trap and transport system of fishing at Killaloe (2001–2008) has been continued as part of the EMP and the catch, along with that of the four contracted fishermen, was transported downstream of Ardnacrusha HEP and released.

The Killaloe catch in 2014 was 15 122 kg. Fishing was also undertaken by ESB contracted crews upstream of Killaloe and their catches (11 330 kg) were also transported downstream.

Following adoption of new analytical protocols for estimation of Shannon silver eel production (MacNamara and McCarthy, 2013), the 2014 production/escapement results were 70 725 kg and 62 980 kg (with 21.15% turbine mortality and 15.6% bypass in the old river channel).

Figures 9.3–9.5 present full details of the quantities of silver eel transported downstream and the estimates of mortality, production and escapement as documented in the EU Progress Report 2015.

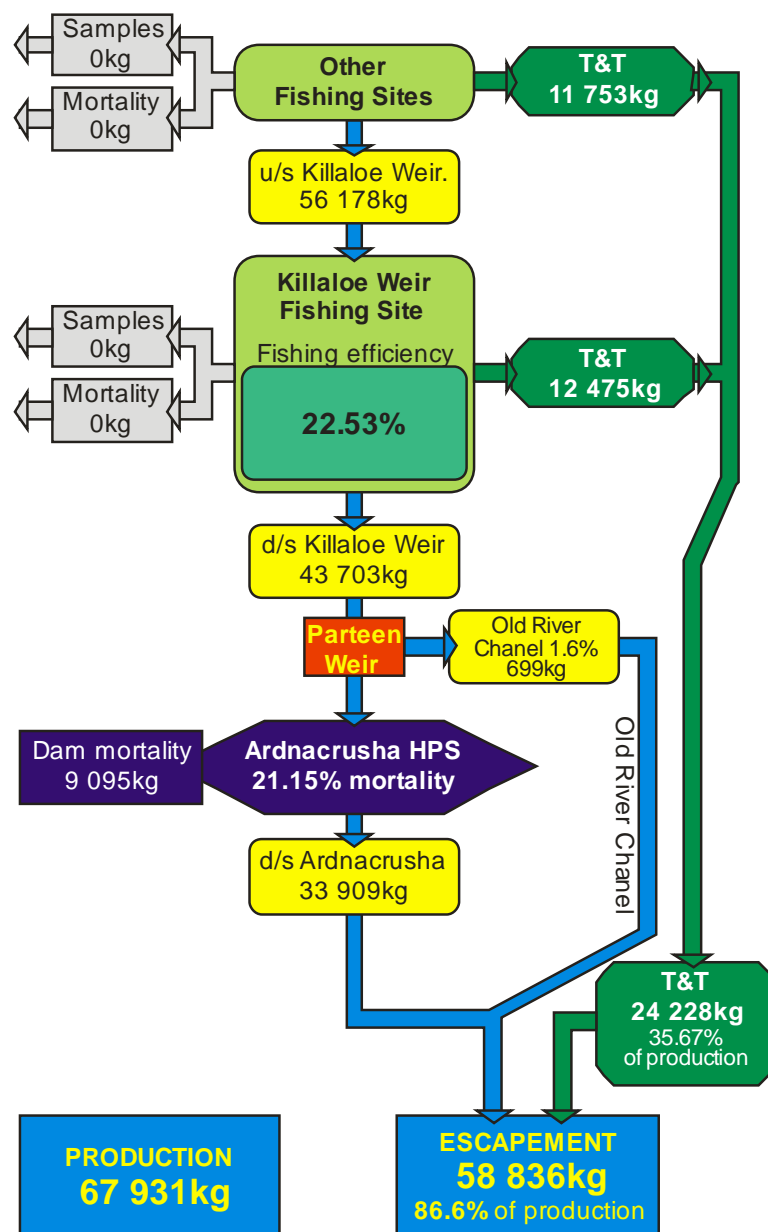


Figure 9.11. Summary silver eel biomass production and escapement estimate for River Shannon system 2012/2013.

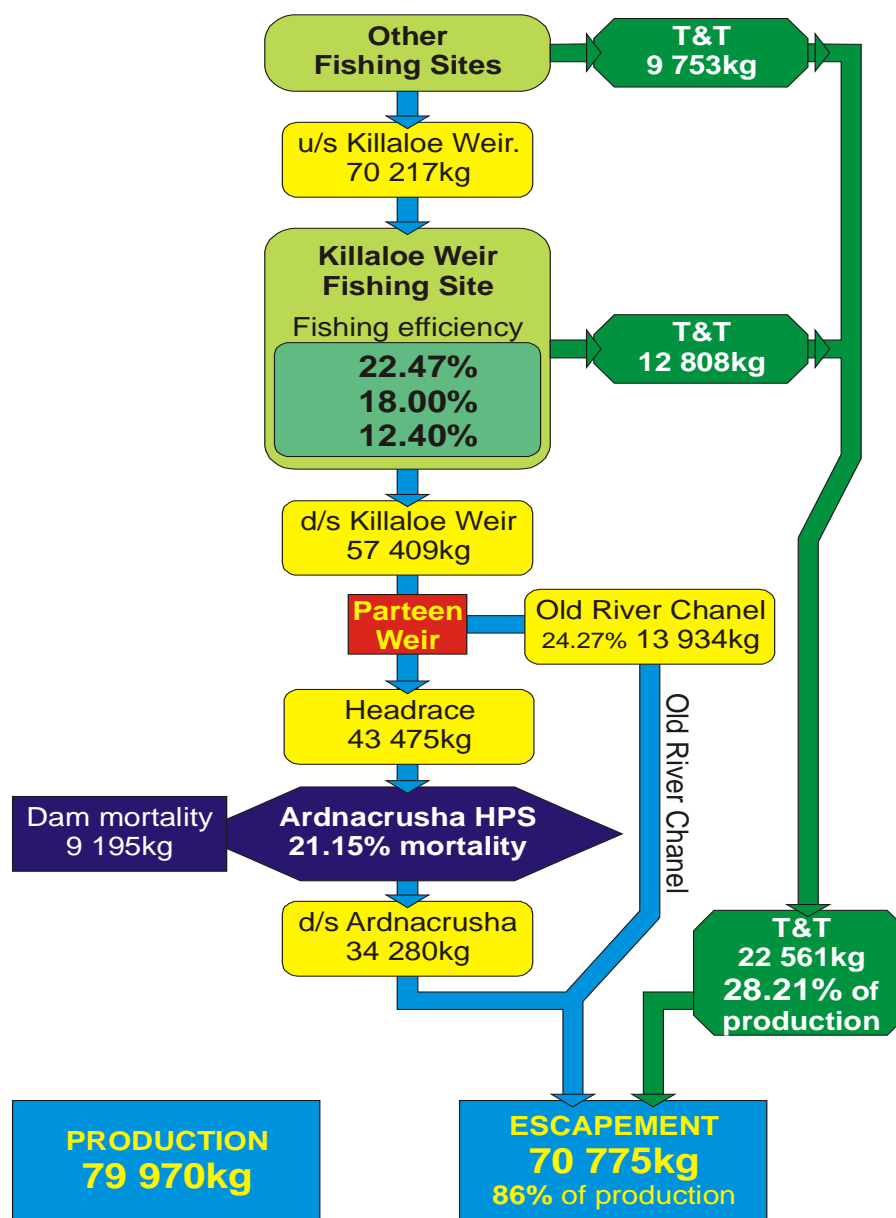


Figure 9.12. Summary silver eel biomass production and escapement estimate for River Shannon system 2013/2014.

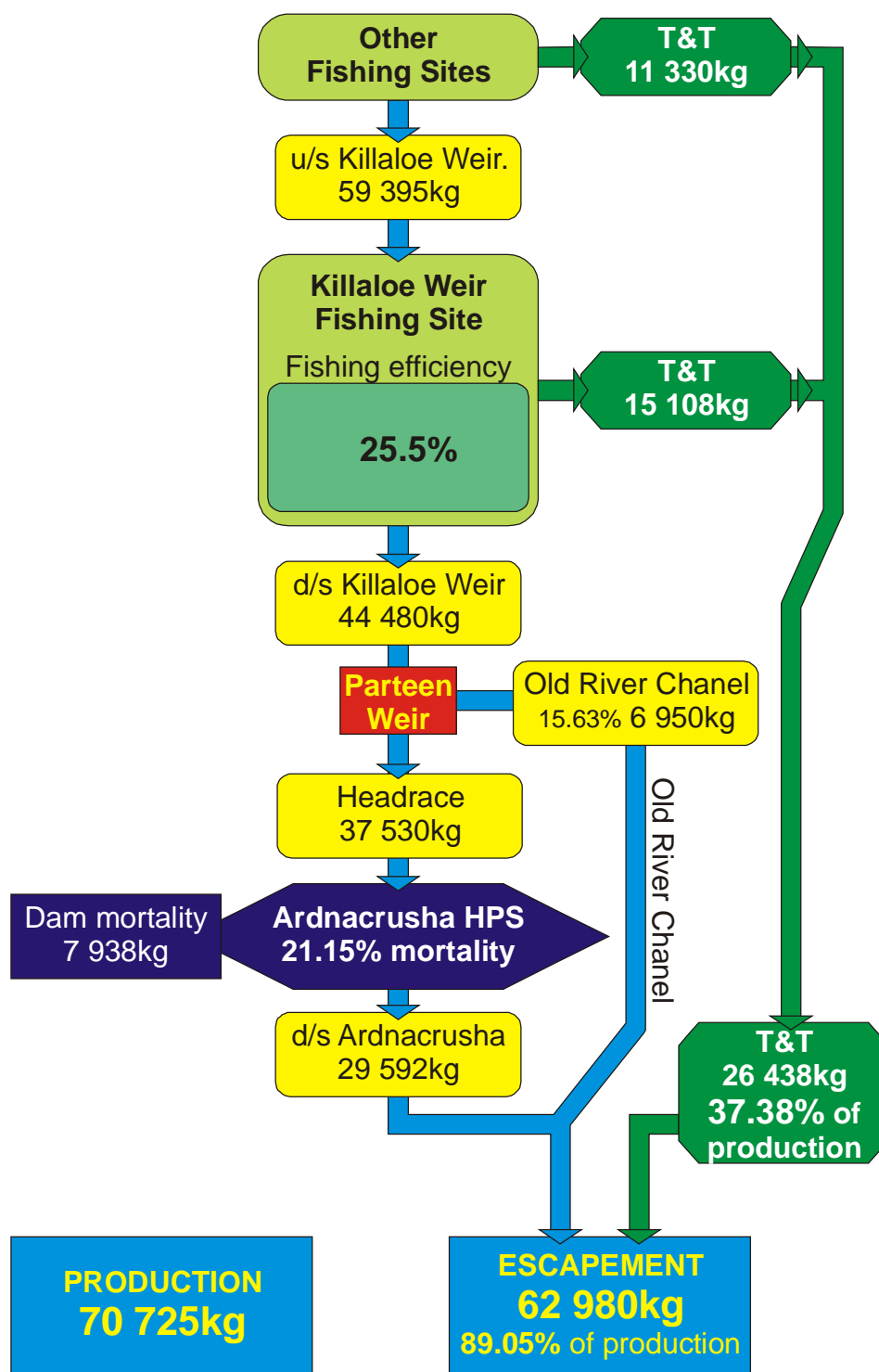


Figure 9.13. Summary silver eel biomass production and escapement estimate for River Shannon system 2014/2015.

Burrishoole

Silver eel trapping was continued in Burrishoole in 2014. The main run occurred in October (71%). The total run amounted to a count of 3117 eels or a production/escapement of 580 kg. The run had a mean weight of 0.186 kg and was composed of 35.3% male eels.

Erne

The analysis of downstream migrating silver eel population dynamics was complicated in 2009 by: Lack of reliable historical fishery data for the River Erne system; delayed fishery closure in part of the system; difficulties in establishing an effective monitoring site in the lower part of the system and development of research protocols. Following establishment in 2010 of an experimental fishing weir, which was scientifically monitored by NUIG, at Roscor Bridge significant progress became possible culminating in a useful protocol now published (McCarthy *et al.*, 2013). Estimates of both silver eel production and escapement rates were possible in the 2010 and 2011 seasons and these have been reported previously (SSCE, 2012). In both the 2010 and 2011 season's estimation of eel mortalities associated with downstream passage at the two hydropower dams (Cliff HPS and Cathaleen's Fall HPS) was undertaken by means of acoustic telemetry. In 2012 it was possible to adapt protocols developed in 2009–2011 and to refine the methodology used for calculation of silver eel production in the River Erne system. The 2012 season was characterised by unusual weather and discharge patterns. These were reflected in the eel migration patterns and in the catches obtained in the conservation fishing undertaken during the ESB trap and transport programme. In addition to an experimental fishery established by NUIG at Roscor Bridge, seven sites were fished by ESB contract crews on the Erne system during 2012/2013. All sites contributed catches to the ESB silver eel trap and transport system.

In the 2014 season the River Erne conservation fishery and the trap & transport programme were monitored by NUIG in conjunction with studies on silver eel production and escapement. The scientific protocols used in the 2014 season were those described in McCarthy *et al.* (2014).

The trap and transport total (48 126 kg) represented 66.4% of silver eel production. The silver eel production was estimated as 72 943 kg and escapement as 66 525 kg (91.8% of production). The combined Cliff HPS and Cathaleen's Fall hydropower mortalities were estimated provisionally as 5859 kg (8% of production). In 2014 a relatively large proportion of male silver eels, also noted in 2011–2013, was observed in upper catchment sites as well as at Roscor Bridge.

Figures 9.6–9.8 present full details of the quantities of silver eel transported downstream and the estimates of mortality, production and escapement as documented in the EU Progress Report 2015.

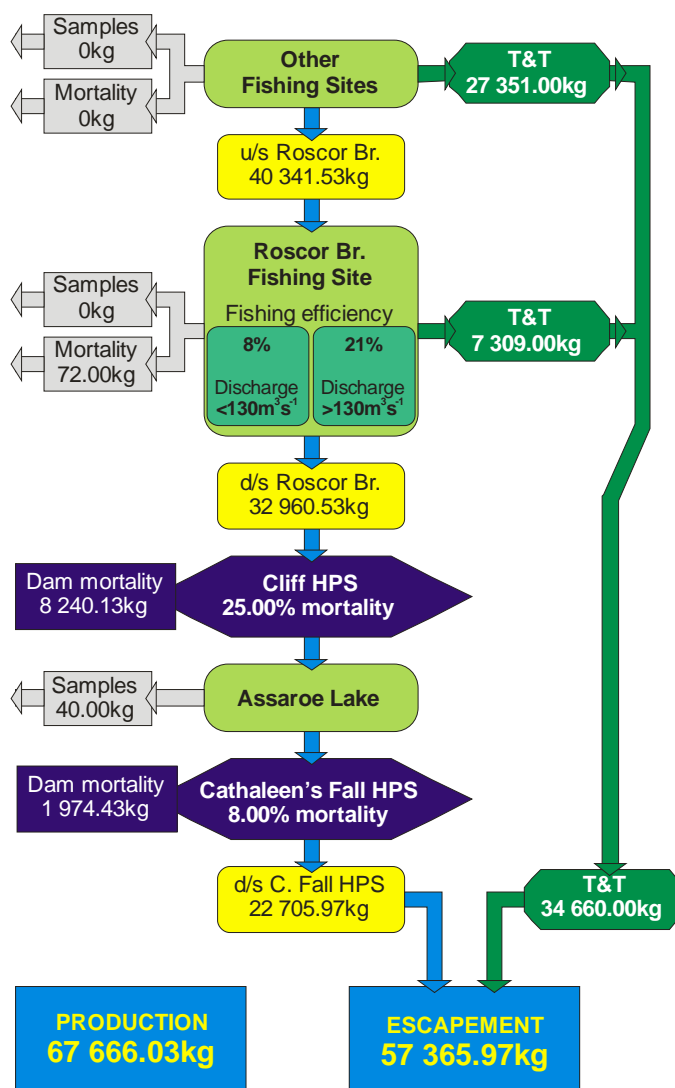


Figure 9.14. Summary silver eel biomass production and escapement estimate for River Erne system 2012/2013.

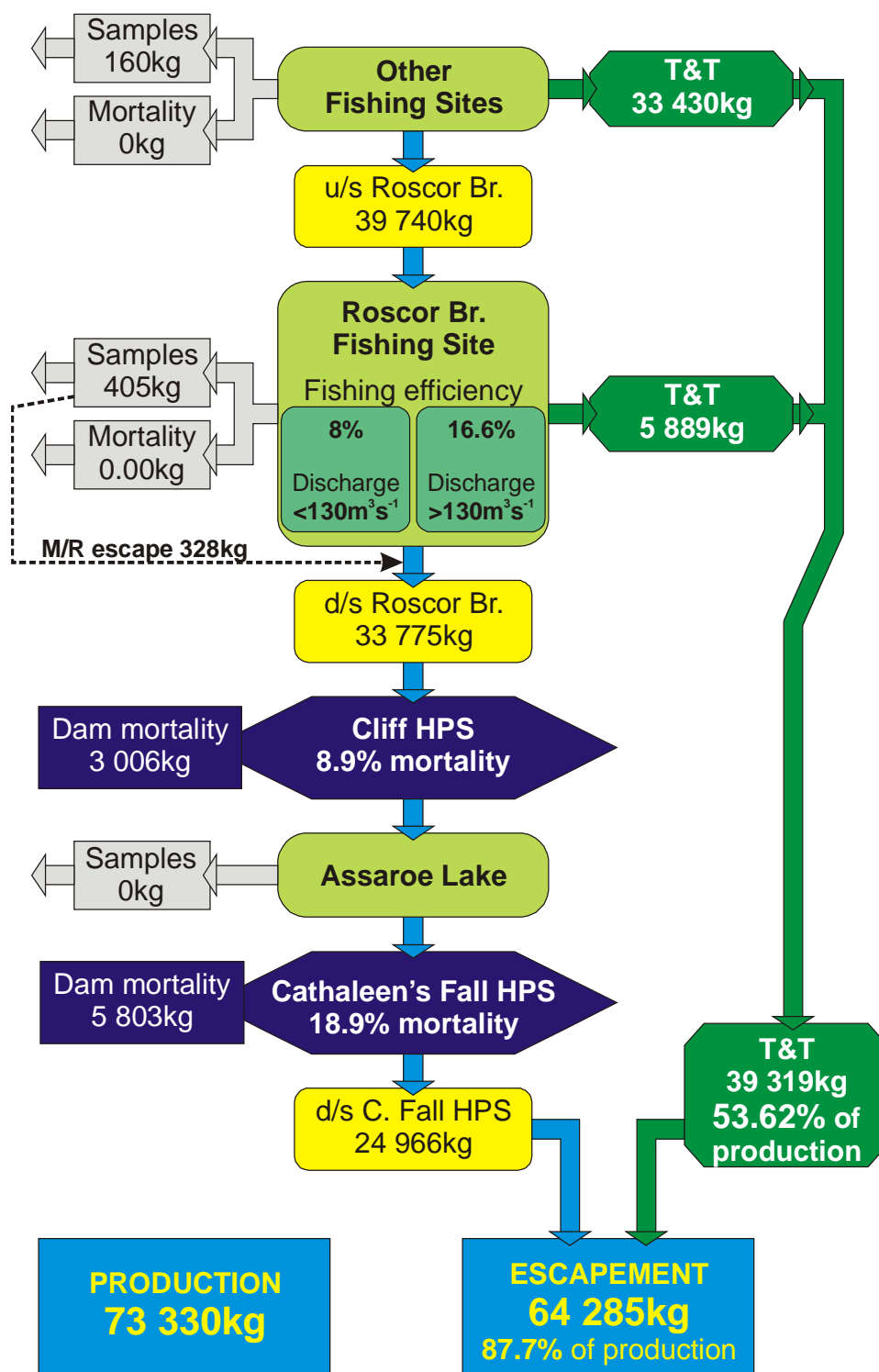


Figure 9.15. Summary silver eel biomass production and escapement estimate for River Erne system 2013/2014.

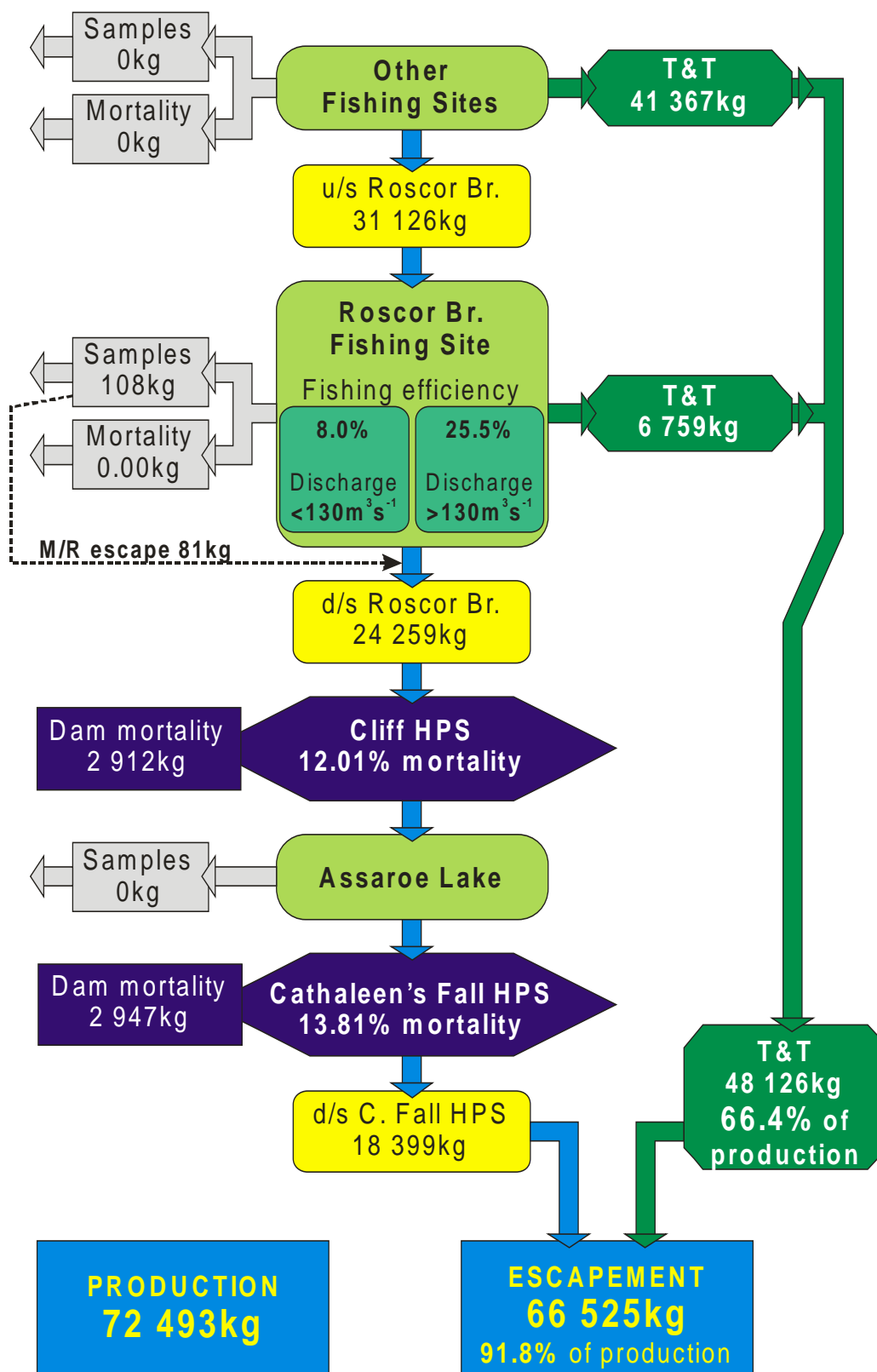


Figure 9.16. Summary silver eel biomass production and escapement estimate for River Erne system 2014/2015.

Fane

The Fane is a relatively small catchment with the silver eel fishery located in the upper reaches of the system approximately 28 km from the coast. The Fane has a riverine wetted area of 21 ha (84 ha 2012 wetted area) and a lacustrine wetted area of 553 ha. A research silver eel fishery was carried out on the Clarebane River on the outflow of Lough Muckno in the Fane catchment since 2011. The site was at the location of a previous commercial fishery until 2008. For the 2014 season, the fishing commenced in October following low water levels in August and September.

In 2013, a new tag release site was used at the mouth of the Clarebane River and additional deflector nets were used to improve fishing efficiency. A recapture rate of 20% was achieved in 2013 and using this to determine the efficiency of the fishing site gives a production of 5755 kg.

A total catch of 797 kg was caught in 2014. In 2014, a mean recapture rate of 29% from two releases was determined. The length of eels caught during the season had a mean length of 47.1 cm and a mean weight of 0.251 kg.

The Fane data have not yet been incorporated into the national stock assessment until the local assessments have been deemed robust.

Barrow

The Barrow catchment is a large riverine catchment located on the east coast of Ireland in the South Eastern River Basin District (SERBD). The SERBD is 60% calcareous bedrock which makes it a very productive habitat for eels. There was previously a commercial fishery on the River Barrow and the presence of historical catch will aid in the assessment of the current silver eel escapement levels from the river. The assessment of the silver eel stocks from a river dominated catchment will help highlight any difference in production and escapement of eels compared with catchments with large lake/lacustrine wetted areas. The Barrow will be the first riverine dominated silver eel index catchment assessed to date.

Four nets were fished from lock gates of the canal section of the River Barrow during the 2014 silver eel season. The location is upstream of Graiguenamanagh; approximately 5 kms upstream from the tidal limit in the River Barrow. It is currently not possible to fish the entire freshwater channel of the river. A pilot mark-recapture study was used to assess the efficiency rate of the fishing site and estimate what proportion of the run is bypassing the nets.

The fishery was fished for 22 nights with a total catch of 174 kg. The location of the nets on the lock gates means the fishery is operated by fishing periods of high water as well as concentrating on the nights of the new moon. A mark-recapture survey was carried out with 202 eels were tagged with floy tags and released 2 kms upstream of the fishing site. Seven eels were recaptured giving a recapture rate of 3.5%.

It is intended to repeat the mark-recapture and incorporate river flow data in future years to improve the estimates of escapement. Given the issue mentioned above relating to the canal vs. the main river channel, the Barrow assessment requires development and multiple years before it will be incorporated into the national assessment as an index location.

Other sites

Additional studies are taking place on the Baronscourt Lakes (Tyrone) and L. Finn (Donegal) in the NWIRBD as part of a PhD study on eels through IBIS (Integrated

Aquatic Resource Management between Ireland, N Ireland and Scotland - funded through the EU INTERREG IVA Programme). These studies should yield useful data.

10 Data collected for the DCF

Currently no data are collected under the DCF. With the closure of fisheries in 2009, Ireland was not eligible for funding for data collection under the DF. Ireland awaits clarity on the inclusion of eel in the new DCF and intends to apply for funding as soon as eel is included by the Commission. Ireland supports the recommendations of the ICES Workshop WKESDCF 2012.

11 Life history and other biological information

11.1 Length and weight and growth (DCF)

No sampling took place under the DCF. The following summarises the sampling under the national monitoring programme.

11.1.1 Length & Weight

Length and weight are measured for all the yellow eel surveys and for some of the silver eel locations. Tables 11.1–11.2 give the summarised data for the national fykenet surveys and the eel captured under the WFD monitoring programme 2013 (Tables 11.3–11.6).

11.1.2 Growth

Samples of yellow and silver eels were taken from 2009 to 2012 during the yellow eel and silver eel surveys undertaken by IFI. Otoliths were prepared by burning and cracking (Christensen, 1964; Moriarty, 1973), mounted against a glass slide in silicone rubber (Hu and Todd, 1981) and measured under *100 magnification with an eye-piece graticule (Poole *et al.*, 1992; Poole, 1994).

11.1.2.1 Preliminary Results

Early results suggest that transitional water sites (with higher productivity in comparison to inland waters) present the highest mean (and fastest) growth rates (Table 11.7). On average, the eels aged from 2009 to present demonstrate a growth rate of 2.65 cm/year. Yellow eels average at 2.75 cm/year, while silvers demonstrated lower growth in later years which led to an average growth rate of 2.52 cm/year. The growth rates and descriptive statistics for growth for all eels currently aged are presented in Table 11.7.

When considering yellow eels, the average growth rate was 2.75 cm/year (n=1462). The fastest growth rate recorded was for the eels captured from the Waterford Barrow Estuary (4.07 cm/year, n=65). The Barrow Estuary also had the lowest mean age of nine years (± 2 years). In contrast, the slowest yellow eel growth rate was noted at Lough Ballynahinch (1.57 cm/year, n=81), where the highest mean age for yellow eels to date was also recorded (mean 21+ years, ± 6 years). This site also presented some of the oldest yellow eels so far (45+ yrs). The low growth rate here may be linked to the acid-sensitive nature of the catchment (Table 11.7 and Figure 11.1).

Silver eel growth rates were more uniform. Lower growth rates in later years, led to an overall lower average among silvers as opposed to yellows. The average growth rate was 2.52 cm/year (n=1028). The highest growth rates were recorded for eels cap-

tured at sites on the Erne catchment (L. Oughter: 3.50 cm/year, n=21 and Lower Lough Erne (Portora): 3.39 cm/year, n=20). The lowest mean age was also found among Erne silver eels (L. Oughter: 15 years, ± 3 years). The lowest growth rate was recorded among the Fane silvers sampled in autumn of 2011, which presented an average growth rate of 1.95 cm/year (n=140). The highest mean age for silvers of 30 years (± 5 years) was noted at Lough Mask (Cong), (Table 11.7 and Figure 11.2).

11.2 Growth, silvering and mortality

These data are not included here but are available if required.

von Bertalanffy parameters: L_{inf} , K , t_0

Historic data are available (Moriarty, various) and these are also available for some current catchments, such as Burrishoole, Erne and Galway.

L_{50} = the length at which 50% of the population has silvered (my interpretation of 50% maturity)

These are available for some catchments, such as Burrishoole, Erne, Shannon, Fane and Galway.

Length and age at silvering

These are available for some catchments, such as Burrishoole, Erne, Shannon, Fane and Galway.

Fecundity

These are available for the Shannon. See chapter 12 of this report.

Weight-at-age

These are available for some catchments, such as Burrishoole, Erne, Shannon, Fane and Galway.

Length–weight relationship

These are available for silver eel for some catchments, such as Burrishoole, Erne, Shannon, Fane and Galway and for yellow eel from the catchments covered in the National Survey.

11.3 Parasites and pathogens

A. crassus was introduced into Europe in the early 1980s and it has since spread widely and has successfully colonized most European countries. It was first recorded in Ireland (Waterford Harbour) in 1997. Later records came from the Erne catchment in 1998 and it is now present in approximately 74% of the wetted area of Ireland. The most likely infective route to Ireland was the commercial eel trade although localised spread can be through natural eel movements and paratenic hosts.

Under the IFI and WFD monitoring programme samples of eels from various locations are examined for the presence of the parasite. This information has been supplied to the European Eel Quality Database.

11.3.1 Burrishoole

The Burrishoole catchment remained free of the parasite until recently. In the fykenet survey in 2012, samples of yellow eels captured in L. Furnace (saline) and at the Back of the House (tidal lough below L. Furnace) were found to be infected with *A. crassus*.

Samples of yellow eels from L. Feeagh were negative and a comprehensive sample of silver eels from the traps was also negative indicating that in 2012 the infection seemed to be confined to the tidal lough. This was somewhat surprising as a number of environmental factors have been shown to influence *A. crassus* infections. High salinity has been shown as having a negative impact in the egg hatching and larvae survival of the parasite although the effects of water salinity remain unclear as various surveys have shown no differences in infection levels in waters with different salinity values.

Examination of previous samples would indicate that the parasite was likely to have been introduced into L. Furnace in 2010 or early 2011 (Table 11.8).

The infection intensity in L. Furnace eels continued to rise in 2014. To date it has not been recorded in the freshwater catchment above the fish traps, although in 2014 the parasite was found in 57% of yellow eels sampled in the Mill Race upstream from L. Furnace up to the Fish Fence, and in 18% of the eels between the Fish Fence and the outflow from L. Feeagh possibly indicating that upstream migrating eel are likely to carrying the parasite.

11.4 Contaminants

No new data.

11.5 Predators

No new data.

Table 11.10. Catch details of the yellow eel survey in the national EMP Survey, 2014.

SITE	DATES	NO. EELS	NETS*NIGHTS	CPUE	TOTAL WEIGHT (KG)	MEAN LENGTH (CM)	MIN. LENGTH (CM)	MAX. LENGTH (CM)	MEAN WEIGHT (KG)	MIN. WEIGHT (KG)	MAX. WEIGHT (KG)
Lough Muckno	02/09/2014	121	40	3.03	28.556	50.4	33.7	76.1	0.236	0.059	0.834
	03/09/2014	64	40	1.60	14.831	49.4	32.7	74.9	0.232	0.050	0.758
	04/09/2014	36	40	0.90	9.332	50.8	36.4	72.3	0.259	0.076	0.755
	2014	221	120		52.710	50.2	32.7	76.1	0.238	0.050	0.834
Lough Ramor	19/8/2014	99	40	2.48	26.645	51.5	23.1	75.5	0.269	0.65	0.912
	20/8/2014	86	40	2.15	22.747	51.7	34.2	81.8	0.265	0.051	1.141
	21/8/2014	29	40	0.73	6.809	48.0	32.8	78.4	0.235	0.059	1.032
	2014	214	120		56.201	51.1	23.1	81.8	0.263	0.051	1.141
South Sloblands	12/8/2014	71	29	2.45	11.437	42.4	29.0	59.8	0.161	0.032	0.533
	13/8/2014	76	29	2.62	12.798	42.9	28.6	66.5	0.168	0.042	0.708
	2014	147	58		24.235	42.7	28.6	66.5	0.165	0.032	0.708
Barrow – New Ross	2014	206	30	6.87	60.41	39.5	22.6	75.4	0.293	0.052	1.806
Bunaveela Lough L.	3/7/2014	11	30	0.37	2.13	47.3	35.7	61.1	-	-	-
Lough Feeagh	9-10/7/2014	47	60	0.78	6.37	41.5	30.6	54.8	0.130	0.045	0.290
L. Furnace tidal	16-17/7/2014	76	60	1.27	12.00	41.6	30.4	78.0	0.140	0.040	1.135
Lwr. L. Furnace tidal	23/7/2014	47	20	2.35	5.05	45.0	21.9	78.0	0.183	0.015	0.810

Table 11.11. Biological data from the yellow eel surveys, 2014.

LOCATION	TOTAL EELS	NO. FEMALES	NO. MALES	No.		%		% PREVALENCE A. CRASSUS	MEAN INTENSITY A. CRASSUS	PREFERENTIAL DIET FROM STOMACH CONTENTS
				IMMATURE	% FEMALE	% MALE	IMMATURE			
Lough Ramor 2014	99	88	10	1	88.90	10.10	1.00	83.84	9.66	Chironomid larvae
Ramor 2011	89	86	1	2	97	1	2	78.7	4.76	Chironomid & Asellus spp

Table 11.12. WFD Lake Summary Data 2013; N.r. not recorded, n.a. not applicable.

[illegible]

RBD	CATCHMENTS	LAKE NAME	No. NIGHTS	No. NETS	No. EELS	CPUE	AVERAGE LENGTH (CM)	MIN. LENGTH (CM)	MAX. LENGTH (CM)	AVERAGE WEIGHT (KG)	MIN. WEIGHT (KG)	MAX. WEIGHT (KG)	TOTAL WEIGHT (KG)
WRBD	Corrib	Maumwee Lough	1	2	3	1.5	49.7	39.5	54.8	0.2197	0.091	0.331	0.659
WRBD	Kilcolgan	Rea, Lough	1	3	115	38.33	47.8	35.4	73.5	0.1995	0.066	0.674	22.937
WRBD	Corrib	Ross Lake	1	3	4	1.33	46.4	30.1	56.9	0.1683	0.044	0.274	0.673
WRBD	Coastal	Shindilla, Lough	1	3	7	2.33	40.1	32.6	50.8	0.1079	0.058	0.192	0.755

Table 11.4. Summary data from WFD Rivers Survey 2013. (n.r. not recorded).

RBD	CATCHMENTS	RIVER NAME	RIVER SITE	No. SETS	No. RUNS	AREA (M2)	DENSITY (No./ M2)	No. EELS
ERBD	Boyne	Blackwater (Kells), River	Just u/s L. Ramor_A	3	3	391	0.05375	21
ERBD	Liffey	Dodder, River	Bushy Park_A	3	3	385	0.0052	2
ERBD	Liffey	Dodder, River	D/s Piperstown Stream, Bohernabreena_A	3	3	274	0	0
ERBD	Liffey	Dodder, River	Firhouse_A	2	3	238	0.0042	1
ERBD	Liffey	Dodder, River	Footbr. Beaver Row_B	3	3	514	0.11861	61
ERBD	Liffey	Dodder, River	Knocklyon_A	2	3	264	0.00379	1
ERBD	Liffey	Dodder, River	Mount Carmel Hospital_A	3	3	339	0.00885	3
ERBD	Liffey	Dodder, River	Oldbawn_A	3	3	311	0.00322	1
ERBD	Liffey	Liffey, River	500 m d/s Ballyward Br._A	2*	3	4228	0	0
ERBD	Liffey	Liffey, River	Kilcullen Br._A	4*	1	8688	0.00012	1
ERBD	Avoca	Avonbeg River	Greenan Br._A	3	3	313	0	0
ERBD	Vartry	Vartry River	Annagolan Br._A	2	3	231	0	0
ERBD	Vartry	Vartry River	Ashford Br._A	3	3	378	0.02383	9
ERBD	Vartry	Vartry River	Newrath Br._A	3	3	347	0.03742	13
ERBD	Vartry	Vartry River	Nun's Cross Br._A	3	3	369	0.07588	28
NBIRBD	Dee	Dee, River	Br. at Drumcar_A	3	3	500	0.126	63
NBIRBD	Dee	White River (Louth)	Athclare_A	2	3	212	0.00944	2
NBIRBD	Dee	White River (Louth)	Coneyburrow Br._B	3	3	294	0.00681	2
NBIRBD	Dee	White River (Louth)	Dunleer_A	2	3	212	0.05189	11
NBIRBD	Dee	White River (Louth)	Gibber's Br._A	1	3	123	0.00816	1

RBD	CATCHMENTS	RIVER NAME	RIVER SITE	No. SETS	No. RUNS	AREA (M2)	DENSITY (No./ M2)	No. EELS
NBIRBD	Dee	White River (Louth)	Martinstown Br. _A	1	3	103	0	0
NBIRBD	Fane	Fane River	Br. d/s of Inniskeen_A	3	2	336	0.04165	14
NWIRBD	Erne	Annalee River	0.2km d/s Cavan R confl_A	4*	3	3300	0.00182	6
NWIRBD	Erne	Cullies River	Br. nr Kilbrackan House_A	2	3	227	0	0
NWIRBD	Erne	Dromore River	Drummuck_A	2	3	252	0	0
NWIRBD	Erne	Erne, River	Bellahillan Br._A	2*	3	2921	0.00034	1
NWIRBD	Erne	Erne, River	Kilconny Belturbet (RHS)_A	4*	1	5304	0.00094	5
NWIRBD	Erne	Finn River (Monaghan)	Cumber Br._A	2	3	2835	0	0
SERBD	Barrow	Gowran River	Br. N of Goresbridge (S Channel)_A	1	3	171	0.02339	4
SERBD	Barrow	Gowran River	Grange Lower_A	2	3	205	0	0
SERBD	Nore	Ballyroan River	Ballydine Br._A	2	3	163	0.00612	1
SERBD	Nore	Ballyroan River	Gloreen Br._D	1	3	163	0	0
SERBD	Nore	Glory, River	Br. E of Raheen_A	2	3	320	0.00937	3
SERBD	Nore	Nuenna River	Br. d/s Clomantagh_B	2	3	207	0	0
SERBD	Owenavorrigh	Banoge River	Br. u/s Owenavorrigh R confl_A	2	3	219	0.07306	16
SERBD	Owenavorrigh	Banoge River	d/s of N11 bridge_A	2	3	223	0.01796	4
SERBD	Slaney	Clody, River	Ford (Br.) 3km u/s Bunclody_B	3	3	300	0.00333	1
SERBD	Slaney	Douglas River (Ballon)	Sragh Br._B	2	3	177	0	0
SERBD	Slaney	Slaney, River	Waterloo Br._A	3	3	477	0.01468	7
SERBD	Suir	Nier, River	Br. ENE of Ballymacarby_A	4	3	662	0.02115	14
SHIRBD	Annagh	Glendine River (Clare)	Knockloskeraun Br. S of M_A	1	1	153	0.01961	3
SHIRBD	Bunratty	Broadford River	Br. u/s Doon Lough_A	2	3	203	0	0
SHIRBD	Bunratty	Broadford River	Broadford (Village)_A	2	3	216	0.00926	2

RBD	CATCHMENTS	RIVER NAME	RIVER SITE	No. SETS	No. RUNS	AREA (M2)	DENSITY (No./ M2)	No. EELS
SHIRBD	Bunratty	Gourna River	Beside railway br._A	2	3	233	0.11578	27
SHIRBD	Bunratty	Gourna River	Br. u/s Owenogarney R confl_C	2	3	182	0.03841	7
SHIRBD	Burrishoole	Newport River	Rossaguile Br._A	3	3	380	0	0
SHIRBD	Fergus	Fergus, River	Br. near Clonroad House_A	4*	1	5487	0.00346	19
SHIRBD	Fergus	Fergus, River	Poplar Br._B	3	3	318	0.06918	22
SHIRBD	Fergus	Moyree River	Br. u/s Fergus River_A	3	3	347	0.00288	1
SHIRBD	Fergus	Spancelhill River	Br. NW, near Spancelhill_A	1	3	115	0.0087	1
SHIRBD	Inny	Mountnugent River	Mountnugent Br._A	3	3	309	0	0
SHIRBD	Shannon Lw.	Ballyfinboy River	Ballinderry Br._A	2	3	254	0	0
SHIRBD	Shannon Lw.	Ballyfinboy River	Br. just u/s L. Derg_A	2	3	209	0.01439	3
SHIRBD	Shannon Lw.	Bow River	Bow River Br._A	2	3	240	0	0
SHIRBD	Shannon Lw.	Glenafelly River	Br. 3km E of Longford_A	1	3	128	0	0
SHIRBD	Shannon Lw.	Graney River	Caher Br. S of L.Graney_A	2	3	228	0	0
SHIRBD	Shannon Up.	Boor River	Br. NW of Kilbillaghan_B	2	3	214	0.01401	3
SHIRBD	Suck	Suck, River	Ballyforan Br._A	4*	1	7896	0.00013	1
SHIRBD	Suck	Suck, River	Cloondacarra Br._A	2*	3	2195	0.00046	1
SWRBD	Adrigole	Adrigole River	0.5km d/s of Glashduff Adrigole confluence_A	3	3	401	0.06739	27
SWRBD	Bandon	Blackwater (Munster), River	Killavullen Br._A	4*	1	10704	0.00159	17
SWRBD	Bandon	Blackwater (Munster), River	Lismore Br._A	4*	1	8712	0.00161	14
SWRBD	Bandon	Blackwater (Munster), River	Nohaval Br._A	2*	3	2029	0	0
SWRBD	Blackwater	Dalua River	Footbr. SW of Liscongill_A	3	3	456	0.01536	7
SWRBD	Blackwater	Funshion, River	Br. u/s Blackwater R confl_A	2*	1	2537	0.00355	9
SWRBD	Blackwater	Licky River	Br. NE of Glenlicky_A	2	3	267	0.03745	10

RBD	CATCHMENTS	RIVER NAME	RIVER SITE	No. SETS	No. RUNS	AREA (m2)	DENSITY (No./ m2)	No. EELS
SWRBD	Colligan	Araglin River	Elizabeth's Br._A	3	3	560	0.03571	20
SWRBD	Cummeragh	Cummeragh River	Footbr. u/s Owengarriff confl_A	2	3	255	0.00785	2
SWRBD	Lee	Lee (Cork), River	Inchinossig Br._A	3	3	428	0	0
SWRBD	Lee	Lee (Cork), River	Lee Fields_A	4*	1	10656	0.0045	48
SWRBD	Owvane	Owvane River (Cork)	Lisheen / Piersons Br. (LHS)_A	3	3	614	0.0765	47
WRBD	Corrib	Abbert River	Bridge at Bullaun_A	3	3	351	0.00285	1
WRBD	Kinvarra	Owendalluleegh River	Br. SE Killafeen_A	3	3	387	0.06724	26
WRBD	Owenboliska	Owenboliska River	Caravan Park_A	3	3	441	0.05672	25
WRBD	Screeb	Screeb River	L. Aughawoolia_A	3	3	282	0.04973	14

Table 11.5. Summary length and weight data from WFD Rivers Surveys. (n.r. not recorded).

RBD	CATCHMENTS	RIVER NAME	RIVER SITE	AVERAGE LENGTH (CM)	MIN. LENGTH (CM)	MAX. LENGTH (CM)	AVERAGE WEIGHT (KG)	MIN. WEIGHT (KG)	MAX. WEIGHT (KG)	TOTAL WEIGHT (KG)
ERBD	Boyne	Blackwater (Kells), River	Just u/s L. Ramor_A	23.5	13.3	44.5	0.0247	0.003	0.129	0.518
ERBD	Liffey	Dodder, River	Bushy Park_A	20.3	16.8	23.7	0.0143	0.0085	0.02	0.0285
ERBD	Liffey	Dodder, River	Firhouse_A	23.7	23.7	23.7	0.02	0.02	0.02	0.02
ERBD	Liffey	Dodder, River	Footbr. Beaver Row_B	20.5	11.1	32.4	0.0164	0.002	0.061	0.967
ERBD	Liffey	Dodder, River	Knocklyon_A	33	33	33	0.057	0.057	0.057	0.057
ERBD	Liffey	Dodder, River	Mount Carmel Hospital_A	45.7	37	52	n.r.	n.r.	n.r.	n.r.
ERBD	Liffey	Dodder, River	Oldbawn_A	38	38	38	0.096	0.096	0.096	0.096
ERBD	Liffey	Liffey, River	Kilcullen Br._A	44.6	44.6	44.6	0.124	0.124	0.124	0.124
ERBD	Vartry	Vartry River	Ashford Br._A	23.3	16.6	34.3	n.r.	n.r.	n.r.	n.r.
ERBD	Vartry	Vartry River	Newrath Br._A	21.3	14.8	29	0.0156	0.005	0.038	0.1715
ERBD	Vartry	Vartry River	Nun's Cross Br._A	23.7	14.6	37	n.r.	n.r.	n.r.	n.r.
NBIRBD	Dee	Dee, River	Br. at Drumcar_A	11.2	6.9	30.2	0.0032	0.0005	0.0475	0.1985
NBIRBD	Dee	White River (Louth)	Athclare_A	35.9	34.1	37.7	n.r.	n.r.	n.r.	n.r.
NBIRBD	Dee	White River (Louth)	Coneyburrow Br._B	27.8	26	29.5	0.031	0.024	0.038	0.062
NBIRBD	Dee	White River (Louth)	Dunleer_A	25.1	15.1	38.9	0.0448	0.006	0.1185	0.179
NBIRBD	Dee	White River (Louth)	Gibber's Br._A	19	19	19	n.r.	n.r.	n.r.	n.r.
NBIRBD	Fane	Fane River	Br. d/s of Inniskeen_A	24.9	12.7	35.2	0.0283	0.0065	0.0645	0.3115
NWIRD	Erne	Annalee River	0.2km d/s Cavan R confl_A	36.2	24.6	51	0.0907	0.0215	0.198	0.544
NWIRD	Erne	Erne, River	Bellahillan Br._A	65	65	65	0.6	0.6	0.6	0.6
NWIRD	Erne	Erne, River	Kilconny Belturbet (RHS)_A	50.4	37	58	0.2345	0.0765	0.366	1.1725

RBD	CATCHMENTS	RIVER NAME	RIVER SITE	AVERAGE LENGTH (CM)	MIN. LENGTH (CM)	MAX. LENGTH (CM)	AVERAGE WEIGHT (KG)	MIN. WEIGHT (KG)	MAX. WEIGHT (KG)	TOTAL WEIGHT (KG)
SERBD	Barrow	Gowran River	Br. N of Goresbridge (S Channel)_A	37.6	30.6	51.2	0.0931	0.0365	0.219	0.3725
SERBD	Nore	Ballyroan River	Ballydine Br._A	29	29	29	0.0385	0.0385	0.0385	0.0385
SERBD	Nore	Glory, River	Br. E of Raheen_A	22.8	16	31.6	0.0245	0.0065	0.053	0.0735
SERBD	Owenavorrigh	Banoge River	Br. u/s Owenavorrigh R confl_A	18.7	11.4	33.1	0.0167	0.002	0.07	0.2665
SERBD	Owenavorrigh	Banoge River	d/s of N11 bridge_A	23.4	17.7	34	0.0285	0.004	0.0855	0.114
SERBD	Slaney	Clody, River	Ford (Br.) 3km u/s Bunclody_B	17.5	17.5	17.5	0.063	0.063	0.063	0.063
SERBD	Slaney	Slaney, River	Waterloo Br._A	30.3	16.7	50.5	0.0604	0.006	0.239	0.8455
SERBD	Suir	Nier, River	Br. ENE of Ballymacarby_A	24.8	16.8	34.3	0.0275	0.006	0.075	0.385
SHIRBD	Annagh	Glendine River (Clare)	Knockloskeraun Br. S of M_A	26.3	17.1	32	0.0384	0.0005	0.396	9.4395
SHIRBD	Bunratty	Broadford River	Broadford (Village)_A	28.3	18	38.5	0.0568	0.0075	0.106	0.1135
SHIRBD	Bunratty	Gourna River	Beside railway br._A	21.7	9.1	33.4	0.0233	0.001	0.067	0.605
SHIRBD	Bunratty	Gourna River	Br. u/s Owenogarney R confl_C	17.7	11.8	28.9	0.0148	0.005	0.037	0.074
SHIRBD	Fergus	Fergus, River	Br. near Clonroad House_A	36.7	10.2	67	0.1312	0.001	0.625	2.361
SHIRBD	Fergus	Fergus, River	Poplar Br._B	29.6	19	41.1	0.0464	0.01	0.101	0.975
SHIRBD	Fergus	Moyree River	Br. u/s Fergus River_A	35	35	35	0.073	0.073	0.073	0.073
SHIRBD	Fergus	Spancelhill River	Br. NW, near Spancelhill_A	28	19.4	33.3	0.045	0.012	0.096	0.315
SHIRBD	Shannon Lw.	Ballyfinboy River	Br. just u/s L. Derg_A	39	23	53	0.1517	0.024	0.33	0.455
SHIRBD	Shannon Up.	Boor River	Br. NW of Kilbillaghan_B	42	34.5	48	0.1133	0.052	0.172	0.34
SHIRBD	Suck	Suck, River	Ballyforan Br._A	41.5	41.5	41.5	0.103	0.103	0.103	0.103
SHIRBD	Suck	Suck, River	Cloondacarra Br._A	57.4	57.4	57.4	0.396	0.396	0.396	0.396
SWRBD	Adrigole	Adrigole River	0.5km d/s of Glashduff Adrigole confluence_A	26.6	14	50.5	0.031	0.004	0.1675	0.5265
SWRBD	Bandon	Blackwater (Munster), River	Killavullen Br._A	26.5	12.9	35.5	0.053	0.017	0.0915	0.318

RBD	CATCHMENTS	RIVER NAME	RIVER SITE	AVERAGE LENGTH (CM)	MIN. LENGTH (CM)	MAX. LENGTH (CM)	AVERAGE WEIGHT (KG)	MIN. WEIGHT (KG)	MAX. WEIGHT (KG)	TOTAL WEIGHT (KG)
SWRBD	Bandon	Blackwater (Munster), River	Lismore Br._A	22.2	7.4	38	0.0294	0.0005	0.0975	0.411
SWRBD	Blackwater	Dalua River	Footbr. SW of Liscongill_A	24	16	34.3	0.0273	0.006	0.0715	0.191
SWRBD	Blackwater	Funshion, River	Br. u/s Blackwater R confl_A	29.7	17.9	49.8	0.0674	0.008	0.2995	0.5395
SWRBD	Blackwater	Licky River	Br. NE of Glenlicky_A	18	9.7	32.7	0.0131	0.001	0.067	0.1305
SWRBD	Colligan	Araglin River	Elizabeth's Br._A	23.5	12.1	33.5	0.0254	0.002	0.0675	0.507
SWRBD	Cummeragh	Cummeragh River	Footbr. u/s Owengarriff confl_A	29.5	18.1	40.9	n.r.	n.r.	n.r.	n.r.
SWRBD	Lee	Lee (Cork), River	Lee Fields_A	30.3	7.4	60.6	0.0711	0.009	0.381	3.1295
SWRBD	Owvane	Owvane River (Cork)	Lisheen / Piersons Br. (LHS)_A	30.6	21.6	50.5	0.034	0.0005	0.396	3.74
WRBD	Corrib	Abbert River	Bridge at Bullaun_A	22	22	22	0.019	0.019	0.019	0.019
WRBD	Kinvarra	Owendalluleegh River	Br. SE Killafeen_A	22.4	7	37	0.0257	0.0005	0.093	0.6415
WRBD	Owenboliska	Owenboliska River	Caravan Park_A	24.8	16.8	34.3	0.0275	0.006	0.075	0.385
WRBD	Screeb	Screeb River	L. Aughawoolia_A	12.2	7.4	32.6	0.0061	0.0005	0.056	0.262

Table 11.6. Summary data from WFD Transitional Waters 2013. (n.r. not recorded).

RBD	CATCHMENTS	TRANSITIONAL WATER	NO. NIGHTS	NO. NETS	NO. EELS	CPUE	AVERAGE LENGTH (CM)	MIN. LENGTH (CM)	MAX. LENGTH (CM)	AVERAGE WEIGHT (KG)	MIN. WEIGHT (KG)	MAX. WEIGHT (KG)	TOTAL WEIGHT (KG)
SERBD	Barrow	Barrow Est., Up.	1	6	36	6	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
SERBD	Barrow	Barrow Nore Est., Up.	1	2	59	29.5	37.1	24.6	74.4	0.1331	0.028	0.994	7.852
SERBD	Barrow	Barrow Suir Nore Est.	1	4	0	0	-	-	-	-	-	-	-
SERBD	Barrow	New Ross Port	1	4	21	5.25	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
SERBD	Nore	Nore Estuary	1	4	73	18.25	38.5	23.2	61.8	0.1211	0.022	0.398	8.838
SERBD	Suir	Suir Estuary, Lower	1	4	62	15.5	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
SERBD	Suir	Suir Estuary, Middle	1	6	141	23.5	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
SERBD	Suir	Suir Estuary, Upper	1	2	0	0	-	-	-	-	-	-	-
SWRBD	Coastal	Drongawn Lough	1	6	33	5.5	33	30	78	n.r.	n.r.	n.r.	n.r.
SWRBD	Coastal	Gill, Lough	1	6	3	0.5	27.8	24	30.4	n.r.	n.r.	n.r.	n.r.

Table 11.7. Growth rates for sacrificed eels, 2009–present (n = 2490 eels).

LOCATION	YEAR	LIFE STAGE	NO. OF EELS	GROWTH RATE		
				(CM/YR)	MEAN AGE (YEARS)	STANDARD DEVIATION
Waterford Estuary	2009	Yellow	65	4.07	8.74	2.15
Lough Cullen	2009	Yellow	81	3.37	11.26	2.61
Lough Conn	2009	Yellow	95	2.88	13.54	4.19
Lough Corrib Lower	2009	Yellow	1	3.06	13.00	-
Lough Corrib Upper	2010	Yellow	83	2.39	17.33	5.49
Lough Ree *	2010	Yellow	82	2.92	12.62	3.02
Lough Erne Upper	2010	Yellow	76	3.08	13.27	2.83
Lough Derg °	2009 & 2010	Yellow	139	2.25	16.16	4.61
Barrow Canal	2010	Yellow	39	2.01	15.95	4.58
Grand Canal	2011	Yellow	32	2.41	16.03	5.65
Lough Inchiquin	2011	Yellow	89	2.59	17.73	5.93
Lough Ramor	2011	Yellow	80	2.61	14.94	3.93
Lough Ballynahinch	2011	Yellow	81	1.57	21.04	6.28
Lough Oughter	2011	Yellow	99	3.65	12.37	3.79
Lough Muckno	2012	Yellow	91	2.23	17.71	3.96
Lough Ramor	2014	Yellow	92	2.74	16.13	3.90
Corrib (Galway Weir)	2009	Silver	91	2.45	16.48	6.19
Corrib (Moycullen) ∞	2010 & 2011	Silver	127	2.50	18.67	5.70
Mask (Cong)	2010	Silver	92	2.02	30.60	5.33
Killaloe ♦	2009 & 2010	Silver	114	2.20	17.87	5.52
Athlone	2010	Silver	87	2.24	24.12	7.52
Erne (Lower L. Erne/Ferny Gap)*	2009 & 2010	Silver	140	2.50	17.59	5.68
ERNE LLE (Portora)	2010	Silver	20	3.39	15.70	2.90
ERNE (L. Oughter Seized Eels)	2010	Silver	21	3.50	14.62	3.11
Fane (L. Muckno)	2011	Silver	140	1.95	18.29	4.42

* Upper and Lower Lough Ree were sampled in two separate surveys in summer 2010 and are pooled above.

° Lower and Upper Lough Derg were surveyed in summers of 2009 and 2010 respectively, and are pooled above.

∞ Corrib silvers sampled at Moycullen (Lower Lough Corrib) using fykenets in autumn 2010 and 2011 are pooled.

♦ Killaloe silver eels fished at the weir in autumn 2009 and 2010 are pooled above.

* Erne silver eels sampled at Lower Lough Erne (Ferny Gap) in autumn 2009 and 2010 are pooled above.

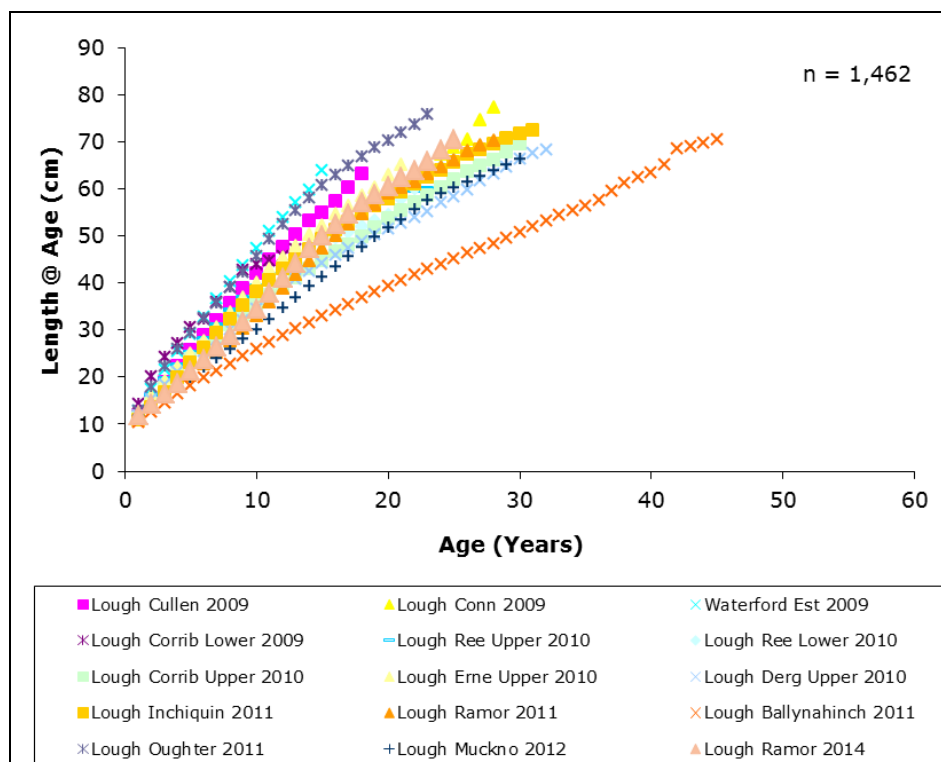


Figure 11.17. Observed growth rates (length-at-age) for yellow eels surveyed from 2009–present (n=1462).

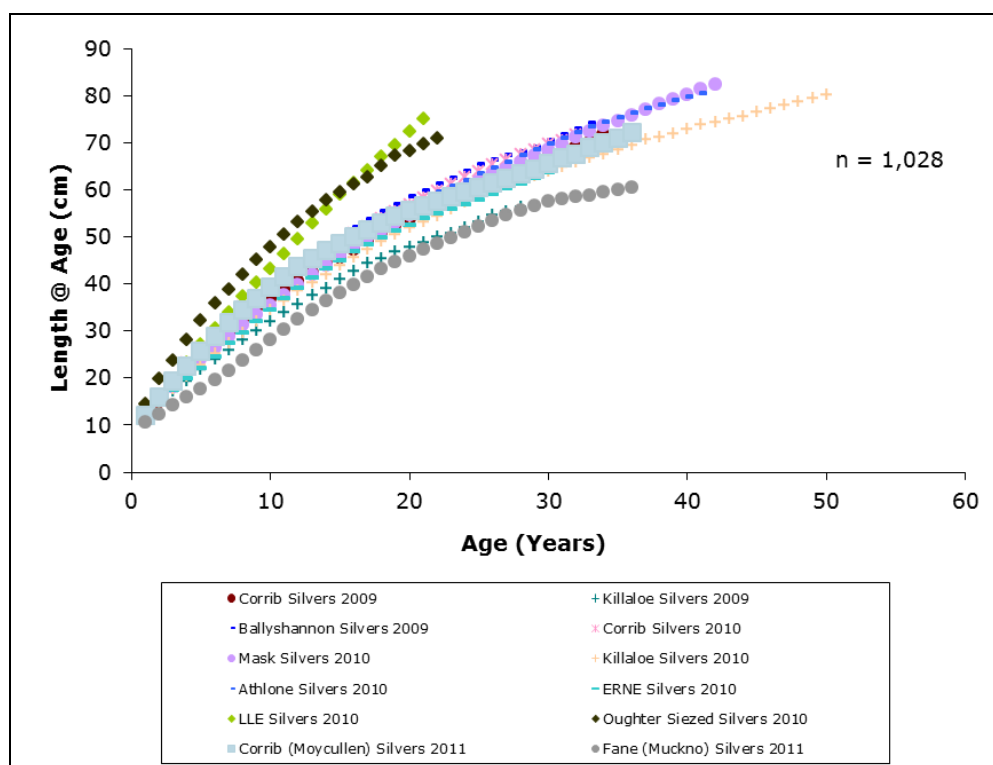


Figure 11.18. Observed growth rates (length-at-age) for silver eels surveyed from 2009–present (n=1028).

Table 11.8. Location and sample details for eels in Burrishoole examined for the presence of *Anguillicola crassus*.

YEAR	LOCATION	No. OF EELS CHECKED	STAGE	No. INFECTED	PREVALENCE	INTENSITY
Freshwater						
2009	Traps	50	Silver	0	0	0
2010	Yellow R.	5	Yellow	0	0	0
2010	Black Lakes	3	Yellow	0	0	0
2010	Glenamong R.	3	Yellow	0	0	0
2010	Feeagh	2	Yellow	0	0	0
2010	Traps	17	Silver	0	0	0
2011	Traps	50	Silver	0	0	0
2011	Feeagh	30	Yellow	0	0	0
2012	Feeagh	4	Yellow	0	0	0
2012	Traps	168	Silver	0	0	0
2013	Traps	106	Silver	0	0	0
2014	Traps	94	Silver	0	0	0
2014	Mill Race Lwr	7	Yellow	4	57.1	2.25
2014	Mill Race Uppr	11	Yellow	2	18.2	1.00
Saline Water						
2008	Furnace	60	Yellow	0	0	0
2009	Fu Nixons	47	Silver	0	0	0
2010	Furnace	10	Yellow	0	0	0
2010	Fu Nixons	50	Silver	0	0	0
2011	Furnace	4	Yellow	2	50	1.0
2012	BOH	6	Yellow	6	100	2.0
2012	Furnace	10	Yellow	7	70	4.4
2013	Furnace	6	Yellow	6	100	13.5
2014	Furnace	9	Yellow	5	56	17.6

12 Other sampling

Anguilla anguilla fecundity, based on samples of female silver eels from the River Shannon system in 2007–2009, has been reported by MacNamara and McCarthy (2012). The laboratory analysis followed protocols used in a similar study of fecundity of American eel, *Anguilla rostrata*, previously published by Barbin and McCleave (1997). Fecundity estimates for the eels examined ranged from 626 000 to 8 006 667 for individuals for individual eels of 465 mm (211 g) to 1003 mm (2472 g). The estimates of fecundity were higher than those previously reported for *A. anguilla*. The latter were based on research involving hormonally treated eels, rather than wild-caught specimens. Fecundity varied positively with eel length, eel body weight and gonad weight. Size-related fecundity did not differ significantly between upper Shannon (Lough Ennell outlet) and lower Shannon (Killaloe). A \log_{10} transformed fecundity-length regression equation ($\text{fecundity} = -2.992 + 3.293 * \text{length}$) can be used for estimation of the potential contribution that particular silver eel runs may make in terms of egg production to the spawning stock (e.g. MacNamara and McCarthy, 2013).

13 Stock assessment

13.1 Method summary

The Irish assessment is built around the use of index catchments, where the silver eel escapement and mortality is assessed directly using mark–recapture (Shannon, Erne, Fane), DIDSON (Erne, Shannon), acoustic tracking for mortality assessment (Shannon, Erne) or by total trap (Burrishoole). A comprehensive wetted area database of habitat is used along with the index catchments and eel growth data from 18 catchments to extrapolate to other catchments where there are no eel data.

The index catchments (Shannon, Erne, Fane and Burrishoole) contribute to 45% of the total freshwater wetted area.

The transitional and coastal waters have not been assessed for silver eel production. Transitional waters are being surveyed using fykenets under the National Eel Monitoring Programme and for the WFD, but these yellow eel data have not yet been incorporated in an assessment.

13.2 Local stock assessment

A national database is in the process of being compiled and this contains local stock assessment data. The main assessments included in the database are, single pass electrofishing surveys, multispecies 3 fishing depletion electrofishing surveys, boat electrofishing multispecies surveys, fykenet and electrofishing surveys under the Waterframework Directive and eel specific fykenet surveys.

A national programme of stock assessment and monitoring is outlined in the Eel Management Plan and in the Irish report to the EU. Index catchment have been intensively studied (Shannon, Erne, Corrib, Burrishoole) and these have been used to calibrate a wider assessment of data-poor catchments. The stock surveys were all reported in the Irish Reports to the EU 2012 and 2015.

These data were used for a first application of the French Eel Density Analysis model (EDA) and the years 2009–2011 were analysed.

13.3 EMU stock assessment

The following sections are drawn from the National Eel Management Report which accompanied the EMPs submitted to the EU in 2008/2009. It was updated in the Ireland Report to the EU (2012).

13.3.1 Habitat

13.3.1.1 Introduction

A GIS based data model was established for the quantification of the freshwater salmon habitat asset and for the determination of the quantity of habitat available to migratory salmonids. 261 discrete migratory salmonid 'Fishery Systems' were identified nationally (McGinnity *et al.*, 2003; 2012). An additional four Northern Ireland catchments have been included in the quantification in support of the NWIRBD transboundary management plan. It is likely that eels are present in the majority or all of these systems although commercial fishing probably only takes place in 4.6% of them accounting for 71% of the total wetted area. It is also possible that this number of 265 catchments may change in future as more information becomes available.

The river and lake network held in the EPA and CFB GIS and used for Water Framework Directive and other applications is derived from original 1:50 000 scale Ordnance Survey of Ireland mapping. The original OSI data have been subject to a thorough examination, removal of errors and addition of extra descriptor values so that the GIS version now contains:

- All component lines are 'with flow' in direction.
- Spurious breaks in the linework have been removed.
- Each "reach" or section between an upstream confluence and downstream confluence comprises a single line.
- Lines have been inserted through lakes to connect inflowing tributaries with the lake outflow point to enable linear network analysis in the GIS.
- Each reach is provided with a unique code identification number.
- Additional variables (including reach length, reach gradient, Strahler stream order number (Strahler, 1952), Shreve link magnitude number (Shreve, 1967), EPA river code have been added.

The number of lakes in the 1:50 000 scale GIS dataset comprises >12 000 units. Many are small and many are not connected to the river network by mapped channels. Each contains a unique identification number and measurement of surface area.

The national river network and lakes have been assigned to River and Lake Waterbodies for implementation of the Water Framework Directive. Rivers with a catchment area ≥ 10 km² are included. In most instances the derived river waterbodies comprise a series of original 'reach' segments merged into longer waterbodies using Strahler stream order values to group connected reaches. Some 4500 waterbodies are identified.

The logic for the derivation of Lake Waterbodies from the national lake dataset requires that ≥ 1 of the following three criteria are applicable:

- Lake surface area > 50 ha.
- Lake is used for water abstraction.
- Lake occurs within a Protected Area designation.

Some 805 lake waterbodies are identified on this basis.

13.3.1.2 Wetted area

The wetted area model (2007) has its origin in a CFB methodology (Quantification of the Freshwater Salmon Habitat Asset in Ireland, 2003). It predicts the likely river width along rivers based on a statistical model built from information derived in a GIS (McGinnity *et al.*, 2012).

The core GIS datasets used in the development of the model include the river and lake network at 1:50 000 scale (EPA WFD GIS); estimates of the catchment area u/s of each reach; the total length of river channel u/s of each reach, the gradient of each reach and the stream order value (Strahler, 1952). These factors were related to field survey measurement of the river width at some 277 sites to allow derivation of a statistical formula that predicts the width at any reach where these GIS variables are known.

* a 'reach' is defined in the GIS as the river line between an upstream confluence and a downstream confluence; typically of the order of ½–1 km in length.

An exercise to derive an improved model for river width prediction was undertaken in 2006/2007 (McGinnity *et al.*, 2012). A new series of field measurements of width were obtained with a more complete distribution across the national river network (in the 2003 study the surveyed rivers were concentrated in the northwest and excluded the larger rivers from the sample). Arising from exploratory statistical analysis it was determined that the most appropriate model to estimate river width would be based on two predictive variables - the catchment area u/s of each reach and the stream link magnitude (Shreve, 1967) which is a less conservative form of hierarchical numbering of streams in a network than the Strahler stream order. Comparisons in Irish and Scottish rivers between modelled and measured widths were highly correlated and suggest that the model may be transferable to neighbouring areas.

The estimated total freshwater wetted area of the 265 lake, river and stream habitat accessible to migratory fish (including 1st order streams) in Ireland (including the Northern Ireland part of the Erne and the Loughs Agency Rivers in the Foyle and Carlingford areas) is 153 881 ha (Table 13.1). The 265 "migratory" systems were estimated to contain 132 275 ha of lake habitat, 21 606 ha of fluvial habitat, of which 2826 ha is estimated to be 1st order stream (calculated at a nominal width of 0.8m). The ShRBD, WRBD and NWIRBD are clearly dominated by lacustrine habitat.

It is intended to refine this database in the future, adding in additional information such as obstacles to migration and natural barriers and ground-truthing the potentially productive area with the presence/absence of eels.

Habitat quality data using the Amiro (Amiro, 1993) and Rosgen (Rosgen, 1994) gradient classification systems are available. For example, in the Kerry Fisheries District 48% of the potential salmon producing habitat has a gradient of <0.5% (Amiro Class 1).

The area of transitional and coastal waters is summarised in Table 13.2 for each RBD. The area is taken for the mean high tide level. Transitional and coastal waters were not considered in the productivity modelling for silver eel due to lack of eel data on these areas and a lack of a suitable methodology for estimating eel quantities.

Table 13.13. Total freshwater wetted areas (ha) for lake, first order fluvial and greater than first order fluvial habitat for each River Basin District, including Northern Ireland* (Erne, Drowes, Foyle, Roe and Faughan). *Data supplied by Inland Fisheries Ireland, Compass Informatics, the Loughs Agency and EHS Water Management Unit, Northern Ireland.

	LAKE	> 1ST ORDER FLUVIAL	1ST ORDER FLUVIAL	TOTAL WETTED AREA
EEMU	4,861	1,920	262	7,043
SERBD	178	3,626	412	4,216
ShRBD	40,241	4,487	590	45,317
SWRBD	7,534	2,714	419	10,666
WRBD	46,602	2,869	473	49,944
NWIRBD	32,859	3,165	670	36,694
Total	132,275	18,780	2,826	153,881

Table 13.14. Total wetted areas (km²) for transitional and coastal waters for each River Basin District, including Northern Ireland (NWIRBD), but excluding the RoI part of the NBIRBD in the EEMU.

	TRANSITIONAL WATERS	COASTAL WATERS	TOTAL TIDAL AREA
EEMU*	23	359	383
SERBD	90	1,024	1,114
ShRBD	250	1220	1,470
SWRBD	166	3,576	3,743
WRBD	133	4,574	4,707
NWIRBD	131	2,230	2,361
Total (km ²)	795	12,984	13,780

*excludes the RoI part of NBIRBD.

13.3.2 Silver eel production

Ireland used a system of extrapolating from index data-rich catchments to data-poor catchments for calculating estimates of pristine and current biomass as described in the Irish Eel Management Plan (Chapter 5) and the WGEEL report (ICES, 2008).

Note: tidal and transitional waters were not included in the production and escapement analysis.

As set out in the EU template for the National Report 2012, the following definitions are adhered to:

- B_0 The amount of silver eel biomass that would have existed if no anthropogenic influences had impacted the stock.
- B_{current} The amount of silver eel biomass that currently escapes to the sea to spawn.
- B_{best} The amount of silver eel biomass that would have existed if no anthropogenic influences had impacted the current stock.
- ΣF The fishing mortality rate, summed over the age groups in the stock, and the reduction effected.
- ΣH The anthropogenic mortality rate outside the fishery, summed over the age groups in the stock, and the reduction effected.
- R The amount of glass eel used for restocking within the country.
- ΣA The sum of anthropogenic mortalities, i.e. $\Sigma A = \Sigma F + \Sigma H$.

13.3.2 Introduction

The estimation of pristine and current (2008 based on the average of 2001–2007) silver eel biomass being produced and escaping was fully described in the National Eel Plan (2008, Chapter5) and in ICES (2008, page 47). The calculation of pristine productivity for exploited catchments requires estimates of silver eel escapement along with historic silver and yellow eel catches, raised to account for unreported and also illegal catches. Historical catch records for silver eel fisheries were available for the five catchments of the Corrib, Moy, Garavogue, Burrishoole and Erne. The efficiencies of the fisheries had been previously estimated for the Shannon, Corrib and Erne silver

eel fisheries. Where fishery efficiency was not measured an approximately average value of 33% was used to calculate escapement. In addition to the catch at the recording station and escapement past the recording station the yellow eel and silver eel catches made upstream were included to estimate pristine productivity. In the absence of historic data for these latter parameters (yellow and silver eel catches upstream of the recording station) it was assumed that the yields were equal to those currently observed (2001–2007). A similar process was used to calculate the 2008 production, based on the average of 2001–2007, and escapement using data from four catchments, the Shannon, Corrib, Burrishoole and Lough Ennell (estimate based on depletion fishing surveys by NUIG).

In the EMP (2008) for those catchments with hydropower at the lower end of the catchment (Shannon, Erne, Liffey and Lee), an estimate of the impact was derived by imposing a 28.5% mortality per turbine passage (ICES, 2003). Therefore, the probability of surviving passage through 'n' number of hydropower installations is $(0.715)^n$. In the 2012 and 2015 reports to the EU, we have recalculated these estimates using the newly available HP mortality data.

Silver eel production was then determined for the other catchments by using a habitat-based approach. The method involved determining the relationship between productivity and the geological characteristics of the catchment.

In the EMP and the 2012 report to the EU, growth rates of eel were available for 17 catchments (Moriarty, 1988; Poole, pers com., WFD). The wetted area within each catchment was quantified using a geographical information system and classified according to the proportion of the catchment area comprising non-calcareous geology. For 17 catchments growth rate was found to be closely negatively related to the proportion of the catchments comprising non-calcareous geology. This allowed the estimation of silver eel production to be made on the basis of geology (natural productivity) and growth rate.

The growth rates data were updated in 2014 with new validated data collected during the 2009–2012 surveys. These data were used in this report to reanalyse the 2008 and 2009–2011 extrapolations and to calculate the production in 2012–2014 and these are reported here.

Note: tidal and transitional waters were not included in the production and escapement analysis.

13.4 Summary data

13.4.1 Stock indicators and targets

Stock indicator and mortality data unchanged from Ireland (2012, 2015) reports (Tables 13.3–13.5).

Table 13.15. Historic (B_0) and current silver eel production (B_{best}) (kg) and escapement ($B_{current}$) (kg) for 2008–2014 and average production and escapement for 2009–2011 and 2012–2014 calculated using the IMESE model and inserting actual catchment data where they exist. These data are extracted from the electronic tables.

EMU CODE	EMU NAME	Bo PROD	PRODUCTION (B _{BEST})							Av 2009–2011	Av 2012–2014
			kg	2008	2009	2010	2011	2012	2013	2014	
IE_East	EEMU	20,517	16,768	14,755	10,865	9,928	13,936	15,079	14,756	10,484	14,592
IE_NorW	NWIRBD	135,732	102,502	57,295	52,447	52,956	82,099	89,376	87,747	52,883	86,286
IE_Shan	SHIRBD	201,401	95,979	83,464	75,608	71,669	76,507	89,250	80,151	76,073	81,855
IE_SouE	SERBD	14,836	11,229	9,877	7,271	6,645	9,333	10,098	9,878	7,018	9,774
IE_SouW	SWRBD	24,577	15,914	13,975	10,274	9,395	13,230	14,312	13,978	9,932	13,864
IE_West	WRBD	192,377	101,892	83,128	98,543	90,029	126,447	136,795	133,872	69,545	132,404
	Total	589,440	344,285	262,494	255,010	240,623	321,553	354,910	340,383	225,936	338,776
EMU CODE	EMU NAME	Bo PROD	ESCAPEMENT (B _{CURRENT})							Av 2009–2011	Av 2012–2014
			kg	2008	2009	2010	2011	2012	2013	2014	
IE_East	EEMU	20,517	9,557	14,561	10,722	9,798	13,753	14,881	14,562	10,346	14,401
IE_NorW	NWIRBD	135,732	47,787	47,554	49,348	50,515	71,817	80,494	81,817	50,035	77,921
IE_Shan	SHIRBD	201,401	21,636	79,369	67,398	63,996	67,412	80,055	72,213	69,414	73,112
IE_SouE	SERBD	14,836	9,867	9,877	7,271	6,645	9,333	10,098	9,878	7,018	9,774
IE_SouW	SWRBD	24,577	15,379	13,576	10,067	9,389	12,910	14,189	13,807	9,767	13,659
IE_West	WRBD	192,377	46,546	83,128	98,543	90,029	126,447	136,795	133,872	69,545	132,405
	Total	589,440	150,771	248,064	243,350	230,372	301,673	336,512	326,149	216,126	321,272

Table 13.16. The % $B_{current}/B_{best}$ (%EU target) for each EMU and for the total production, for 2008 to 2014 and for the average for 2009–2011 and 2012–2014. The data come from Table 13.3. These data are extracted from the electronic tables.

EMU CODE	EMU NAME	Bo PROD	%B _{CURRENT} /B _{BEST} (EU TARGET)							Av 2009– 2011	Av 2012– 2014
		kg	2008	2009	2010	2011	2012	2013	2014		
IE_East	EEMU	20517	46.6	71.0	52.3	47.8	67.0	72.5	71.0	50.4	70.2
IE_NorW	NWIRBD	135732	35.2	35.0	36.4	37.2	52.9	59.3	60.3	36.9	57.4
IE_Shan	SHIRBD	201401	10.7	39.4	33.5	31.8	33.5	39.7	35.9	34.5	36.3
IE_SouE	SERBD	14836	66.5	66.6	49.0	44.8	62.9	68.1	66.6	47.3	65.9
IE_SouW	SWRBD	24577	62.6	55.2	41.0	38.2	52.5	57.7	56.2	39.7	55.6
IE_West	WRBD	192377	24.2	43.2	51.2	46.8	65.7	71.1	69.6	36.2	68.8
	Total	589,440	25.6	42.1	41.3	39.1	51.2	57.1	55.3	36.7	54.5

Table 13.17. Annual fishing (ΣF), other anthropogenic (ΣH) and total mortality (ΣA) rates for each Eel Management Unit and the total annual mortality rate for all EMUs. These data are extracted from the electronic tables.

INDICATOR	ΣF	ΣF	ΣF	ΣF	ΣF	ΣF	ΣF	ΣH	ΣH	ΣH	ΣH	ΣH	ΣH	ΣH	ΣA	ΣA	ΣA	ΣA	ΣA	ΣA	ΣA
Unit	rate	rate	rate	rate	rate	rate	rate	rate	rate	rate	rate	rate	rate	rate	rate	rate	rate	rate	rate	rate	rate
Year	pre-EMP	2009	2010	2011	2012	2013	2014	pre-EMP	2009	2010	2011	2012	2013	2014	pre-EMP	2009	2010	2011	2012	2013	2014
EMU_code																					
IE_East	0.539	0.000	0.000	0.000	0.000	0.000	0.000	0.019	0.013	0.013	0.013	0.013	0.013	0.013	0.559	0.013	0.013	0.013	0.013	0.013	0.013
IE_NorW	0.584	0.000	0.000	0.000	0.000	0.000	0.000	0.186	0.186	0.061	0.047	0.134	0.105	0.070	0.770	0.186	0.061	0.047	0.134	0.105	0.070
IE_Shan	1.240	0.000	0.000	0.000	0.000	0.000	0.000	0.242	0.050	0.115	0.113	0.127	0.109	0.104	1.482	0.050	0.115	0.113	0.127	0.109	0.104
IE_SouE	0.129	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.129	0.000	0.000	0.000	0.000	0.000	0.000
IE_SouW	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.048	0.029	0.020	0.001	0.024	0.009	0.012	0.054	0.029	0.020	0.001	0.024	0.009	0.012
IE_West	0.783	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.783	0.000	0.000	0.000	0.000	0.000	0.000
Total															0.83	0.06	0.05	0.04	0.06	0.05	0.04

13.4.2 Habitat coverage

Table 13.18. Areas of habitat (ha for freshwater, km² for saline) and assessment status (2009–2011; 2012–2014).

EMU CODE	RIVER		LAKE		ESTUARY & LAGOON		LAGOON		COASTAL	
					Area (km ²)	A'd Y/N	Area (ha)	A'd Y/N	Area (km ²)	A'd Y/N
EEMU	2,182	Y1	4,861	Y2	23	N	*3	N	359	N
SERBD	4,038	Y1	178	Y2	90	N	*3	N	1,024	N
ShRBD	5,077	Y1	40,241	Y2	250	N	*3	N	1220	N
SWRBD	3,133	Y1	7,534	Y2	166	N	*3	N	3,576	N
WRBD	3,342	Y1	46,602	Y2	133	N	*3	N	4,574	N
NWIRBD	3,835	Y1	32,859	Y2	131	N	*3	N	2,230	N
Total	21,607	Y1	132,275	Y2	795	N	*3	N	12,984	N

Y¹ rivers not assessed separately. All freshwater assessed as a whole.

Y² rivers not assessed separately. All freshwater assessed as a whole.

*3, area of lagoons included with estuaries.

13.4.3 Impact

It should be noted that for the Irish EMU's, the assessment of silver eel stock indicators and mortalities is undertaken at the freshwater basin scale and rivers and lakes are not assessed separately of each other. This table (Table 13.7) is referenced to the period 2009–2014.

A = assessed, MI = not assessed, minor, MA = not assessed major, AB = impact absent.

Table 13.19. Assessment of the different impacts x habitat.

EMU CODE	HABITAT	FISH COM	FISH REC	HYDRO & PUMPS		BARRIERS	RESTOCKING	PREDATORS	INDIRECT IMPACTS
IE_East	Riv	AB	AB	MI	MI	AB	MI	MI	
	Lak	AB	AB	MI	MI	AB	MI	MI	
	Tot Fresh	AB	AB	A	MI	AB	MI	MI	
	Est	AB	AB	AB	AB	AB	MI	MI	
	Lag	AB	AB	AB	AB	AB	MI	MI	
	Coa	AB	AB	AB	AB	AB	MI	MI	
	All	AB	AB	AB	AB	AB	MI	MI	
IE_NorW	Riv	AB	AB	MA	MI	AB	MI	MI	
	Lak	AB	AB	MA	MI	AB	MI	MI	
	Tot Fresh	AB	AB	A	MI	AB	MI	MI	
	Est	AB	AB	AB	AB	AB	MI	MI	
	Lag	AB	AB	AB	AB	AB	MI	MI	
	Coa	AB	AB	AB	AB	AB	MI	MI	
	All	AB	AB	AB	AB	AB	MI	MI	

EMU CODE	HABITAT	FISH COM	FISH REC	HYDRO & PUMPS		BARRIERS	RE STOCKING	PREDATORS	INDIRECT IMPACTS
IE_Shan	Riv	AB	AB	MA	MI	AB	MI	MI	
	Lak	AB	AB	MA	MI	AB	MI	MI	
	Tot Fresh	AB	AB	A	MI	AB	MI	MI	
	Est	AB	AB	AB	AB	AB	MI	MI	
	Lag	AB	AB	AB	AB	AB	MI	MI	
	Coa	AB	AB	AB	AB	AB	MI	MI	
	All	AB	AB	AB	AB	AB	MI	MI	
IE_SouE	Riv	AB	AB	AB	MI	AB	MI	MI	
	Lak	AB	AB	AB	MI	AB	MI	MI	
	Tot Fresh	AB	AB	AB	MI	AB	MI	MI	
	Est	AB	AB	AB	AB	AB	MI	MI	
	Lag	AB	AB	AB	AB	AB	MI	MI	
	Coa	AB	AB	AB	AB	AB	MI	MI	
	All	AB	AB	AB	AB	AB	MI	MI	
IE_SouW	Riv	AB	AB	MI	MI	AB	MI	MI	
	Lak	AB	AB	MI	MI	AB	MI	MI	
	Tot Fresh	AB	AB	A	MI	AB	MI	MI	
	Est	AB	AB	AB	AB	AB	MI	MI	
	Lag	AB	AB	AB	AB	AB	MI	MI	
	Coa	AB	AB	AB	AB	AB	MI	MI	
	All	AB	AB	AB	AB	AB	MI	MI	
IE_West	Riv	AB	AB	MI	MI	AB	MI	MI	
	Lak	AB	AB	MI	MI	AB	MI	MI	
	Tot Fresh	AB	AB	A	MI	AB	MI	MI	
	Est	AB	AB	AB	AB	AB	MI	MI	
	Lag	AB	AB	AB	AB	AB	MI	MI	
	Coa	AB	AB	AB	AB	AB	MI	MI	
	All	AB	AB	AB	AB	AB	MI	MI	

Table 13.20. Losses in tonnes by the different impacts for 2009–2011 following implementation of fishery closure and silver eel trap and transport around hydropower stations.

A = assessed, MI = not assessed, minor, MA = not assessed major, AB = impact absent.

EMU CODE	STAGE	FISH COM	FISH REC	HYDRO & PUMPS	BARRIERS	RESTOCKING	PREDATORS	INDIRECT IMPACTS
IE_East	Glass	0	0	0	MI	0	MI	MI
	Yellow	0	0	MI	MI	0	MI	MI
	Silver	0	0	0.2	MI	0	MI	MI
	Silver EQ	0	0	na	MI	0	MI	MI
IE_NorW	Glass	0	0	0	MI	0	MI	MI
	Yellow	0	0	MI	MI	0	MI	MI
	Silver	0	0	2.9	MI	0	MI	MI
	Silver EQ	0	0	na	MI	0	MI	MI
IE_Shan	Glass	0	0	0	MI	0	MI	MI
	Yellow	0	0	MI	MI	0	MI	MI
	Silver	0	0	6.7	MI	0	MI	MI
	Silver EQ	0	0	na	MI	0	MI	MI
IE_SouE	Glass	0	0	0	MI	0	MI	MI
	Yellow	0	0	MI	MI	0	MI	MI
	Silver	0	0	0	MI	0	MI	MI
	Silver EQ	0	0	na	MI	0	MI	MI
IE_SouW	Glass	0	0	0	MI	0	MI	MI
	Yellow	0	0	MI	MI	0	MI	MI
	Silver	0	0	0.2	MI	0	MI	MI
	Silver EQ	0	0	na	MI	0	MI	MI
IE_West	Glass	0	0	0	MI	0	MI	MI
	Yellow	0	0	MI	MI	0	MI	MI
	Silver	0	0	0	MI	0	MI	MI
	Silver EQ	0	0	na	MI	0	MI	MI

Table 13.21. Losses in tonnes by the different impacts for 2012–2014 following implementation of fishery closure and silver eel trap and transport around hydropower stations.

A = assessed, MI = not assessed, minor, MA = not assessed major, AB = impact absent.

EMU CODE	STAGE	FISH COM	FISH REC	HYDRO & PUMPS		RESTOCKING	PREDATORS	INDIRECT IMPACTS
				BARRIERS				
IE_East	Glass	0	0	0	MI	0	MI	MI
	Yellow	0	0	MI	MI	0	MI	MI
	Silver	0	0	0.2	MI	0	MI	MI
	Silver EQ	0	0	na	MI	0	MI	MI
IE_NorW	Glass	0	0	0	MI	0	MI	MI
	Yellow	0	0	MI	MI	0	MI	MI
	Silver	0	0	8.4	MI	0	MI	MI
	Silver EQ	0	0	na	MI	0	MI	MI
IE_Shan	Glass	0	0	0	MI	0	MI	MI
	Yellow	0	0	MI	MI	0	MI	MI
	Silver	0	0	8.7	MI	0	MI	MI
	Silver EQ	0	0	na	MI	0	MI	MI
IE_SouE	Glass	0	0	0	MI	0	MI	MI
	Yellow	0	0	MI	MI	0	MI	MI
	Silver	0	0	0	MI	0	MI	MI
	Silver EQ	0	0	na	MI	0	MI	MI
IE_SouW	Glass	0	0	0	MI	0	MI	MI
	Yellow	0	0	MI	MI	0	MI	MI
	Silver	0	0	0.2	MI	0	MI	MI
	Silver EQ	0	0	na	MI	0	MI	MI
IE_West	Glass	0	0	0	MI	0	MI	MI
	Yellow	0	0	MI	MI	0	MI	MI
	Silver	0	0	0	MI	0	MI	MI
	Silver EQ	0	0	na	MI	0	MI	MI

13.4.4 Precautionary diagram

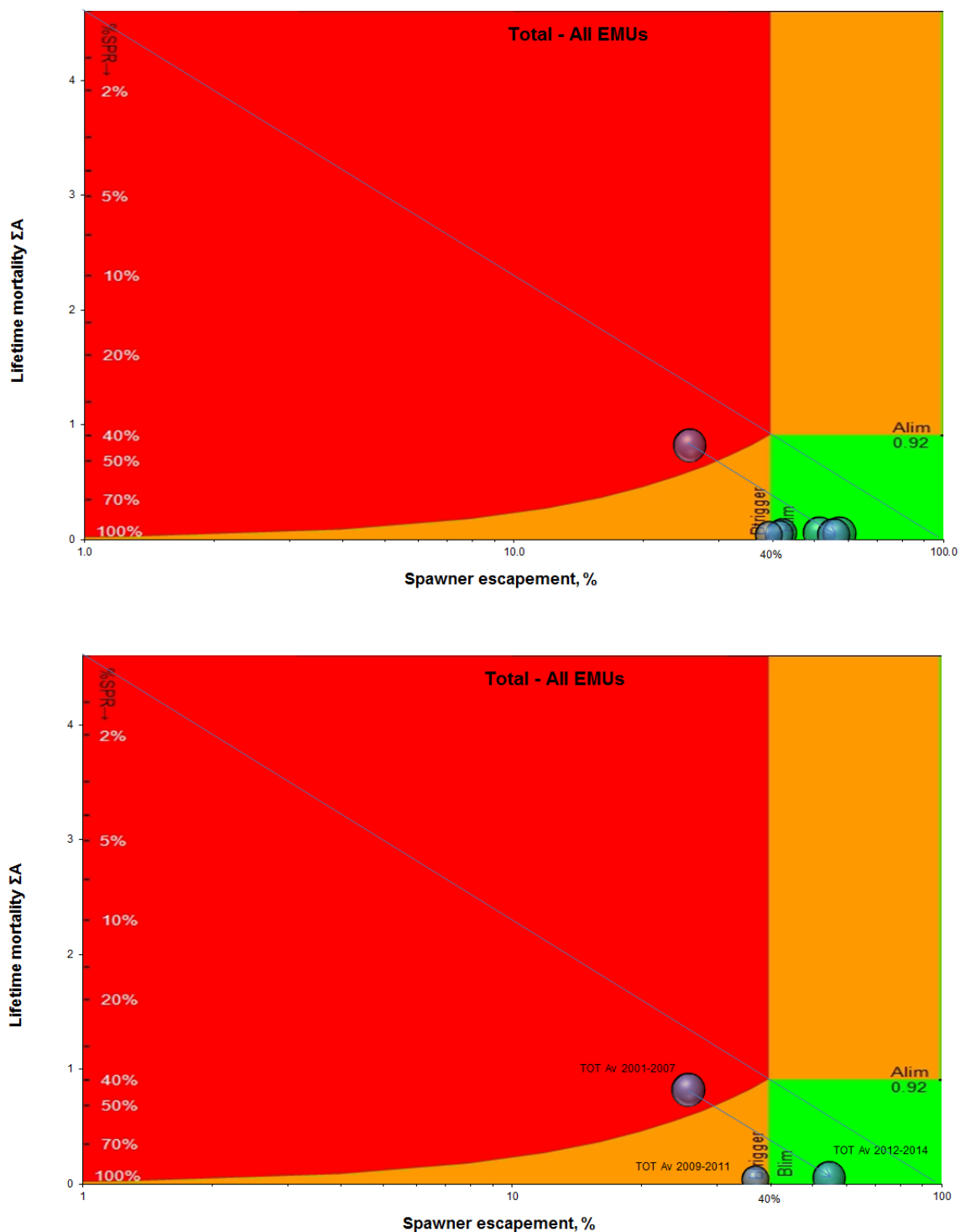


Figure 13.19. Status of the stock and the anthropogenic impacts, for the TOTAL EMUs as presented in the Eel Management Plans in 2008 (average 2001–2007), for 2008–2014 (top), and for the average of 2001–2007, 2009–2011 and 2012–2014 (bottom). For each, the size of the bubble is proportional to B_{best} , the best achievable spawner escapement given the recent recruitment, while the centre of the bubble gives the stock status relative to the targets/limits. The horizontal axis represents the status of the stock in relation to pristine conditions, while the vertical axis represents the impact made by anthropogenic mortality.

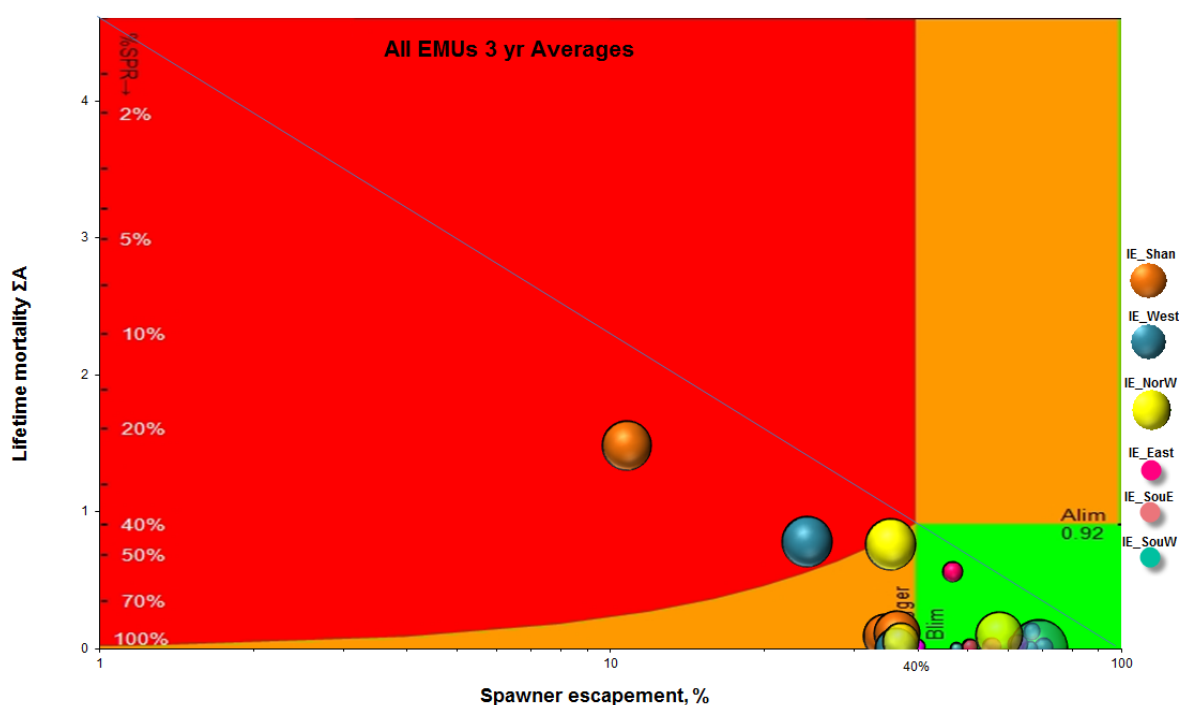


Figure 13.20. Status of the stock and the anthropogenic impacts, for the All EMUs for the average of 2001–2007, 2009–2011 and 2012–2014. For each, the size of the bubble is proportional to B_{best} , the best achievable spawner escapement given the recent recruitment, while the centre of the bubble gives the stock status relative to the targets/limits. The horizontal axis represents the status of the stock in relation to pristine conditions, while the vertical axis represents the impact made by anthropogenic mortality.

13.5 Eel density analysis

Eel Density Analysis (EDA) is a modelling framework that can be used to estimate eel populations in aquatic habitats. Survey data (primarily electrofishing operations) are used to build predictive models describing the presence/absence and the density of eel. These models are then applied to the entire network of aquatic habitat in the area of interest to estimate the total population size. The fluvial (riverine) population of yellow eel in Ireland was estimated (de Eyto, Briand, Poole, and O'Leary, in prep. 2015) using the EDA (v2.0) model (Jouanin *et al.*, 2012).

A total fluvial population of 8 032 834 yellow eels and 200 821 silver eels (using a sil-vering rate of 2.5%) was estimated for **2011**. Eel presence and abundance decreased as the distance to the sea increased, and the percentage of calcareous geology in the catchments decreased. Stock indicators (B_0 , B_{best} and $B_{current}$) were calculated from these yellow eel estimates to enable the display of precautionary diagrams for each EMU in Ireland. Lake production was also calculated for 2011, using empirical data from a small number of catchments. A precautionary diagram for this total production (fluvial and lacustrine habitat) was presented, and compared with previous estimates of stock indicators for Ireland.

It was encouraging to see that the stock indicators calculated using EDA and a proxy for lake productivity are quite similar to those previously calculated for Ireland (Table 4.5). The best example of this is for the southeastern EMU, which has a very small proportion of lacustrine habitat (4%). The EDA fluvial estimate of $B_{current}$ for the southeastern EMU is 6.4 tonnes for 2011, while the Irish model (Anon., 2012) predict-

ed B_{current} at 6.8. Both of these estimates exceed the biomass target (40%) set by the EU Regulation. These two statistical methods use very different data in their calculation, and the fact that they are very similar gives some confidence that production value for the southeastern EMU is correct. Similarly, when we add in lake production, the estimates of B_{current} for all EMU's are roughly similar, and, with one exception, give the same indication of whether the biomass target is being met (i.e. they are given the same colour coding in Table 13.10). The only exception is the eastern EMU, where the Irish model estimate of B_{current} is 9.4 tonnes, which is greater than 40% of the target, while the EDA model (flu + lake) gives an estimate of 6.5 tonnes, which is below the biomass target. In comparing the Irish model estimate with the EDA (flu + lake) estimate, we note that the raw data used to calculate lake production come from the same source for the two models (i.e. total production from the Burrishoole, Shannon, Corrib and Erne catchments). However, the treatment of these data differs considerably between the two models, and again, this gives confidence that both estimates are in the correct range. This is a significant result as the estimation of eel production from EMUs is inherently difficult. The fact that we have two models giving roughly similar estimates strengthens the assessment of eel production from Ireland, and gives us complimentary methods with which to assess the success of future management actions. As EDA is run on current (or recent) surveys of yellow eel densities, any increase or decrease in recruitment in the coming decades should be captured by this model, allowing comparison with B_0 in future.

The EDA model produced biomass estimates which were in line with those previously calculated using the Irish model, giving confidence that the two methods (IMESE and EDA) are successfully estimating total eel production for the country.

Table 13.22. Stock indicators in Ireland, comparison with previous EU reporting (2012) and between 2015 fluvial (EDA) and 2015 fluvial + lake (EDA) estimates. B_{current} is colour coded according to whether it is greater than (green) or less than (red) the biomass target (40% of B₀) set by the EU Regulation. ΣA is colour coded according to whether it is less than (green) or greater than (red) the mortality target equivalent to the biomass target (after (ICES, 2012)). Note that the target for ΣA is lower than 0.92 if B_{current} < 0.4 B₀.

	Source	Year	Biomass (t)			Mortality		
			B _{current}	B _{best}	B ₀	ΣF	ΣH	ΣA
NorW								
	2012	2011	51.5	54.3	135.8	0	0.05	0.05
	2015 flu	2011	2.9	2.9	13.6	0	0.01	0.01
	2015 flu+lake	2011	42.4	58.0	135.8	0	0.31	0.31
West								
	2012	2011	68.7	68.7	189.2	0	0.00	0.00
	2015 flu	2011	5.5	5.5	13.2	0	0.00	0.00
	2015 flu+lake	2011	60.1	60.1	189.2	0	0.00	0.00
Shan								
	2012	2011	68.7	75.4	201.2	0	0.09	0.09
	2015 flu	2011	7.6	7.6	22.1	0	0.00	0.00
	2015 flu+lake	2011	72.6	79.1	201.2	0	0.09	0.09
SouW								
	2012	2011	11.3	11.6	24.5	0	0.03	0.03
	2015 flu	2011	4.5	4.5	7.1	0	0.01	0.01
	2015 flu+lake	2011	13.8	14.4	24.5	0	0.05	0.05
SouE								
	2012	2011	6.8	6.8	14.8	0	0.00	0.00
	2015 flu	2011	10.5	10.5	14.2	0	0.00	0.00
	2015 flu+lake	2011	10.7	10.7	14.8	0	0.00	0.00
East								
	2012	2011	9.4	9.6	20.5	0	0.01	0.01
	2015 flu	2011	1.9	1.9	6.4	0	0.00	0.00
	2015 flu+lake	2011	6.5	7.1	20.5	0	0.09	0.09

13.5.1 Management measures

This management table was provided to WGEEL in March 2013 and also to the WKEPEMP.

13.6 Summary data on glass eel

No glass eel were landed, imported or exported to or from Ireland in 2012, 2013 or 2014.

14 Sampling intensity and precision

14.1 Fykenet surveys—extracted from SGAESAW 2009

Fykenets are a common gear for capturing anguillid eels in both commercial and research fisheries. Researchers may use fykenet catches for estimating biological parameters of local populations, for tracking abundance trends, or for mark-recapture population estimates. Size selectivity of fykenets and the relation between fykenet catch per unit of effort (cpue) and its standard deviation were examined using data from western Ireland.

In 1987 and 1988, 2614 eels were captured in fykenets, marked and released in the Burrishoole (Poole and Reynolds, 1996a). The proportion of these eels which were recaptured in fykenets increased from nil at length 30–35 cm to over 0.2 at length 60–65 cm (Figure 14.1). This size bias must be accounted for if slopes of length–frequency distributions are used to determine biological parameters.

Based on data from >20 000 net-nights (Matthews *et al.*, 2001; Poole, 1994), the standard deviation of cpue increased linearly with cpue (Figure 14.2). Increasing the number of fykenets in a chain of nets from five to ten, did not decrease standard deviation of cpue (Figure 14.3). This suggests that increasing chain length does not assist in achieving accurate estimates. Instead, more locations or more fishing nights may be more helpful in producing accurate estimates. A power analysis indicates that the sample size required to achieve a given precision in cpue is strongly influenced by population density. Overall, cpue is an insensitive tool with wide variation in numbers and weight per net. A relatively high effort is required to attain tight precision in cpue.

For the Irish surveys, the number of hauls required to achieve even modest precision in cpue (e.g. CV =10%) is high, especially where eel density is low (Figure 14.4). Achieving a CV of 10% where the average cpue is high, requires approximately 50 hauls. Assuming chains of five fykenets are used this equates to 250 net nights.

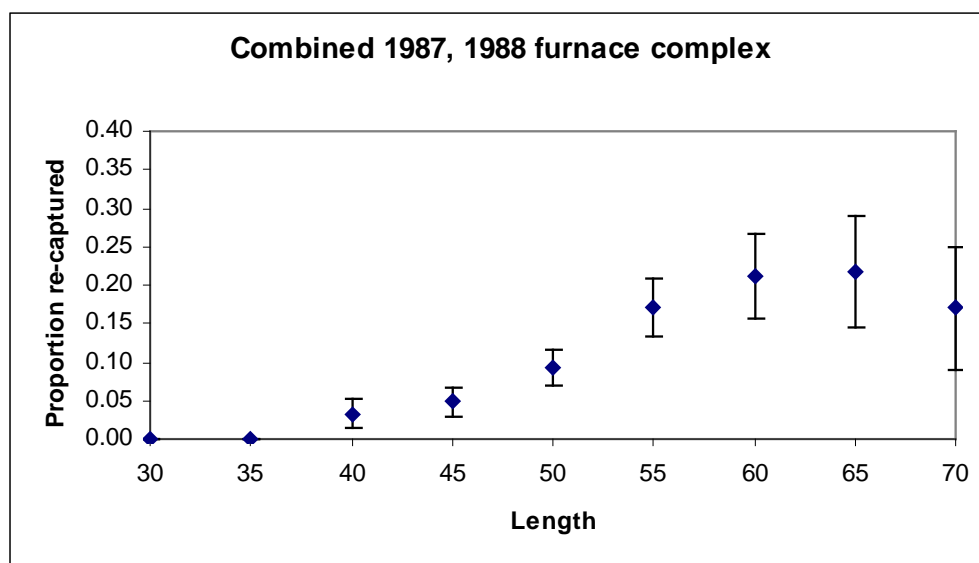


Figure 14.21. Proportion of European eels recaptured in fykenets in relation to length.

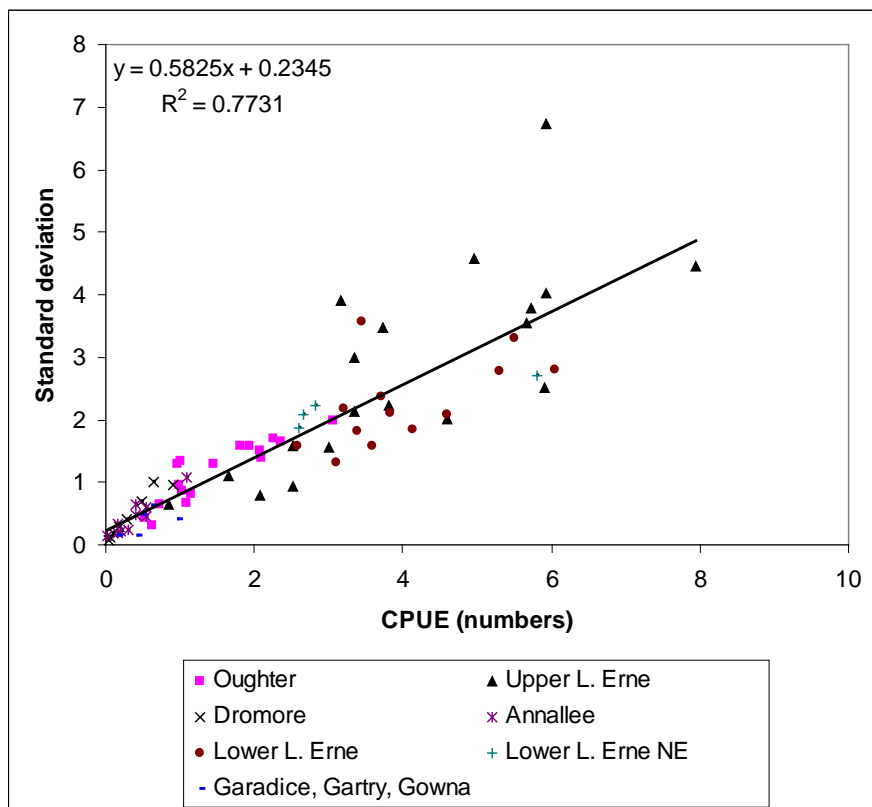


Figure 14.22. Relation between the standard deviation of five fyke chain cpue and cpue.

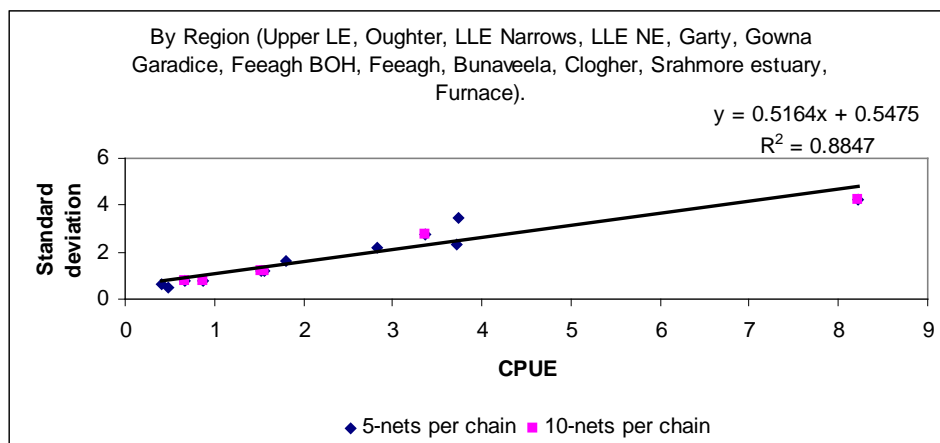


Figure 14.23. Relation between standard deviation and cpue for fykenets with five and ten nets per chain.

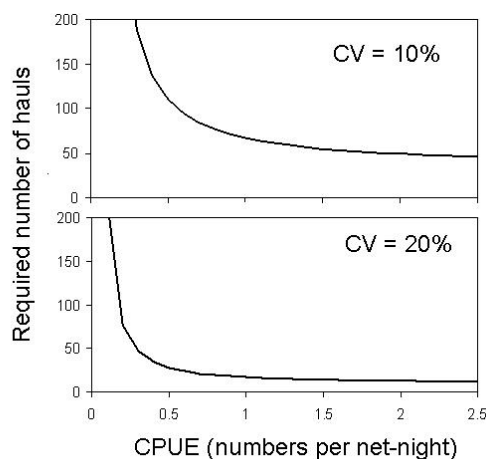


Figure 14.24. Power analysis of the number of hauls required to achieve precision levels in cpue consistent with indicated coefficients of variation. The required sample size is highly sensitive to the population density (assuming cpue is directly related to density).

14.2 Length sampling of silver eel

Data for length, weight age, etc. have not been analysed in detail as a time-series or to look at change over time. Annual variation has been observed in silver eel lengths and this raises an issue relating to timing of sampling and differential timing of migration of large and small eel.

The lunar silver eel length data collected in 1995, and in other years (i.e. 2012), indicate a change in length distribution of the migrating silver eels throughout the season (Figure 14.5). This means that careful planning of silver eel sampling is required.

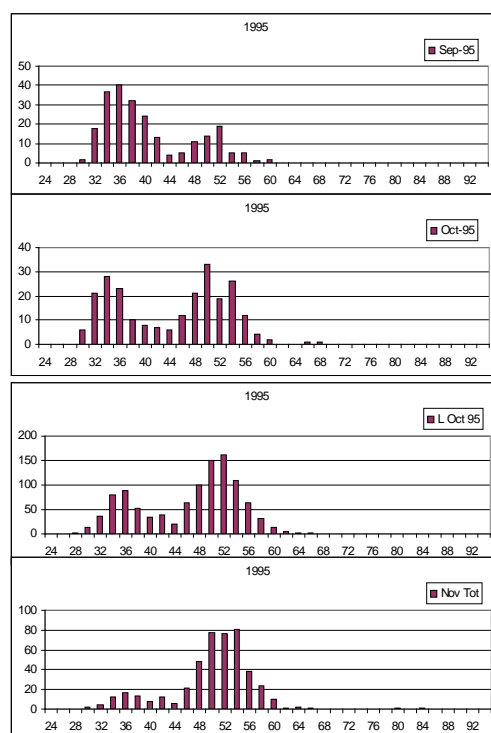


Figure 14.25. Monthly length distributions, taken for each lunar phase, for Burrishoole silver eels

15 Standardisation and harmonisation of methodology

15.1 Survey techniques

Fykenets—Standard summer fykenets (Matthews *et al.*, 2001; McCarthy *et al.*, 1994; Moriarty, 1975; Poole, 1990; 1994; Poole and Reynolds, 1996a) have been widely used in eel surveys around Ireland since the early 1970s. The nets used have been generally similar in all the surveys, normally fished in chains of five or ten nets. A "typical" summer fykenet consists of two traps (each 3.3 m in length), facing each other, joined by a leader net (8 m in length), mesh size 16–18 mm. Each trap consists of two chambers and a codend with knot to knot mesh sizes of 16, 12, and 10 mm respectively. The diameter of the trap entrance was 58 cm and the outer ring of each trap was 'D' shaped.

Catch per unit of effort (cpue) data are normally reported in number of eels, or weight, per net (pair of traps) per night fished.

Fykenets are the standard tool for the 2009–2011 and 2012–2014 monitoring programmes.

Fykenet Enclosure Survey

Ubl and Dorow (2015) developed a novel enclosure method suitable for waters <10 m deep but to date this has only been used in the Baltic Sea. The method was trialled in lakes in Burrishoole in 2015. A long time-series of yellow eel fykenetting is available in Burrishoole for two freshwater lakes, one tidal lagoon and an estuarine area with catch per unit of effort (cpue) and eel size data. Efforts to calibrate cpue to eel density (Nos/hectare) using mark–recapture were relatively unsuccessful due to the behavioural aspects of eel and the limitations of fykenetting. Data from the 2015 trial are currently being analysed. The standard annual fykenet survey was also fished (six sites per lake) and these data will be compared with the enclosure data, and previous mark–recapture estimates.

Longlines—Longlines have not been extensively used as a survey tool in Ireland. On the Shannon (McCarthy and Cullen, 2000) longlines were standardised and the bait was restricted to earthworm allowing some comparisons to be made between fishing areas and years.

River Surveys—In deeper rivers and estuaries, fykenets have been the standard survey tool. In smaller rivers electrofishing is generally employed, despite being fraught with difficulties when applied to eel, with a variety of back-pack portable and bankside generator gear being used. Single pass and three fishing depletion methods are used, but often eel assessments are carried out as a "by-product" of other surveys, in particular salmonid surveys.

15.2 Sampling commercial catches

There was no National programme for sampling commercial catches during 2009–2011.

Erne—The survey of the Erne catchment 1998–2001 was carried out using a semi-commercial research team of crews (Matthews *et al.*, 2001). An observer was placed with each crew at least once a week to ensure standardisation. Eels were stored in keepnets or boxes similar to those used by commercial fishermen. Eels were graded and sold to eel dealers at the lake shore. The entire catch was sampled prior to grading and the fishermen were paid full price for undersized eel, before their release.

Shannon—Before 2009, commercial crews were authorised by the ESB sell to eel dealers at lakeside locations on designated dates. ESB staff and NUIG researchers attended at sales points, to monitor catches and to obtain samples for length, weight, age and parasitology analyses. Dealers were required to provide advance notice of their collection schedules. Comparisons were made annually between sales statistics and cumulative catches, reported in logbooks, by the fishing crews. Dealers were required to disinfect truck tanks, monitored by ESB staff, before collections begin and to ensure that no water/potential pathogens were introduced to the river system.

15.3 Sampling

Catch sampling is normally carried out on anaesthetised eel, although some samples may be taken from either freshly sacrificed or frozen samples. Lengths measured to ± 0.1 cm and weights to ± 5 g. Otoliths are stored dry in paper envelopes.

15.4 Age analysis

Age analysis of eel in Ireland has generally followed the methodology of burning & cracking (Christensen, 1964; Cullen and McCarthy, 2003; Hu and Todd, 1981; Moriarty, 1983; Poole and Reynolds, 1996b; Vollestad *et al.*, 1988). Otoliths are extracted as described by Moriarty (1973), stored dry and prepared by burning in either gas or spirit flame. There is no formal validation or quality control in Ireland. Some cross validation and double reading has been carried out between projects and between agencies and this has ensured some degree of continuity between samples and surveys, (i.e. Moriarty, 1983; Poole *et al.*, 1992; Matthews *et al.*, 2001; Matthews *et al.*, 2003; Maes, unpublished). Comparisons have also been made between age derived growth (back-calculations) and tag/mark-recapture determined growth, thereby validating the use of burning & cracking otoliths for age and growth determinations in slow growing Irish eel (Poole and Reynolds, 1996a; Moriarty, 1983).

Ireland is using the recommendations and manual of the ICES Workshop on Eel Age WKAREA 2009 and 2011. An initial training workshop was held in Inland Fisheries Ireland in February 2010, using the WKAREA information as a guideline and a follow-up workshop was held in the Marine Institute in February 2012. Further inter-calibration took place in 2014.

15.5 Life stages

Glass eel /elver life stages are determined the pigmentation classification using that published by Elie *et al.* (1982).

Yellow eel and silver eel are categorised by a combination of capture method and season, colouration and eye size. Silver eels are generally captured during their downstream migration, or can be recognised in the yellow eel catch by the enlarged eyes and onset of coloration change.

15.6 Sex determinations

Yellow eel <25 cm are problematical to sex and >25 cm up to 45 cm are sexed by dissection.

Silver eel are sexed by length and some studies have carried out dissections on eels between ~38 cm and 48 cm in order to determine the length overlap between the sexes. Histological verification has not been used to any extent in Ireland.

15.7 Data quality issues

An all-Ireland eel age inter-calibration workshop was carried out in December 2014.

Interpretation of subjective variables, such as fish colour, presence of lateral line dots in silver eels, can be interpreted differently between observers.

Very low levels of fishing effort, such as some fykenet effort in transitional waters under WFD sampling, need to be interpreted with caution.

16 Overview, conclusions and recommendations

Recruitment time-series are largely effort independent and up to date (2014) for all sites. Recruitment generally increased in Ireland in 2012, 2013 and 2014 and, with the exception of the Erne, fell again in 2015.

Catch statistics are up to date to 2008 and with the closure of the fisheries in 2009–2015, these data cease to exist.

Ireland submitted an EMP and this was accepted in July 2009.

Ireland has implemented its management actions in 2009–2011 and 2012–2014 and has undertaken the National Monitoring programme also in 2009–2011 and 2012–2014.

Ireland intends determining current escapement on a three year rolling average (2009–2011 and 2012–2014) in line with the reporting schedule laid out in the EU Regulation. Where available, historic production estimates, wetted areas, etc. were also be improved and updated for 2012. Ireland submitted Reports to the EU in 2012 and 2015 with 3B & A estimates for all freshwaters. Estimates were not provided for transitional and coastal waters.

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Report on the eel stock and fishery in Italy 2014/2015

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Reporting Period: This report was completed in October 2015, and contains data up to 2014.

2 Introduction

In the present report, data on eel stock and fisheries are reported for Italy relative to the year 2014, based on the data and assessments prepared in the Italian report to DG Mare required to assess progress achieved through the implementation of the National EMP, as foreseen by Article 9 of Regulation 1100/2007 (PNG Italia, 2014) and based on the National Report relative to the Data Collection Framework, modules “Eel recreational and commercial fishery” and “eel biological samplings”, also relative to the year 2014.

The period 2010–2015 has been important in Italy with regards to eel management. Following the submission of the Italian Eel Management Plan (IT-EMP), with the latest amendment submitted to the European Community September 30, 2010, the Plan was finally adopted in July 2011 (PNG Italia, 2010). With it, Italy has set the instrument to participate in the process recovery of the eel stock, as required by Regulation 1100/2007. Notwithstanding the initial delay, Italy has recovered the lag in the application of the Eel Management Plan because since 2009 at different levels in Italy the process of implementation of the IT-EMP was already in place. The work concerning the IT-EMP has been coordinated within a National Working Group that has involved Administrations, Technicians and Scientists. During 2013 and 2014, the work of the Nat Working Group has been finalized to the gathering of data for the evaluation of the parameters required to assess progress achieved through the implementation of the National EMP, as foreseen by Article 9 of Regulation 1100/2007, for the second report in 2015 (PNG Italia, 2015), following the first Report of 2012, to which Italy also complied with other Reports in 2013 and 2014 (PNG Italia, 2012, 2013, 2014). Italy, as extensively explained in the IT-EMP and as discussed during the consultation meetings organized by the EC - DG Mare, has followed the approach of using for the assessment process a database progressively implemented during the years. Compared to 2008, when the work for the compilation of the IT-EMP was initiated, a series of tools and activities have been put in place between 2009 and 2014, that have resulted in a database much more detailed and reliable, and therefore for the evaluation of the reference points required for the assessment foreseen by art.9, this updated dataset has been used.

Eel (*Anguilla anguilla* L.) exploitation in Italy has a long standing tradition, and is still important, despite a progressive and increased loss of interest towards this species. Fisheries still concerns all continental stages, i.e. glass eel, yellow and migratory silver eel. The most distinctive exploitation pattern for eel in Italy has been in the past

coastal lagoon fishery, that yielded most of yellow and silver eel extensive culture and fishery production (Ciccotti, 1997; Ciccotti *et al.*, 2000; Ciccotti, 2005; Ciccotti, 2014; Aalto *et al.*, 2015; Leone *et al.*, under review). Quite important was also eel intensive aquaculture, that played a major role within the national and European context up to some years ago and that has strongly reduced today (Ciccotti *et al.*, 2000; Ciccotti and Fontenelle, 2001; Ciccotti, 2014).

Eel is still present in lagoons and inland waters in all the regions, but its density, population characteristics and growth vary widely depending on the type of environment (lagoons, rivers, lakes), hence production patterns are also very diverse.

Lagoons cover around 1420 km², 610 of which are exploited at the present moment. Of the exploited area, about 300 km² are located in the upper Adriatic and 120 in the Po delta, the rest being scattered in Puglia, Campania, Lazio, Toscana, Sicilia and Sardegna (Ardizzone *et al.*, 1988; Ciccotti, 2014; Cataudella *et al.*, 2014; Aalto *et al.*, 2015). In the upper Adriatic lagoons the typical form of management was the *vallicoltura* that slightly differed from other lagoon management and fisheries because relying on fry stocking and active hydraulic management (Ciccotti, 2014; Cataudella *et al.*, 2014).

Inland eel fisheries are still found in main rivers and lakes, even if a relic activity. Professional eel fisheries in rivers have never been important, confined to the low course of a small number of rivers even in the past, and further reduced now. Most of the eel catches were from the great Alpine lakes in the northern regions, but the eel also was an important target species for professional fisheries in some volcanic lakes of Central Italy. In lakes, fisheries were enhanced by eel restocking, because accessibility to lakes was reduced also in pristine times owing to the structure of river-lakes systems, and secondarily to presence of dams, most of which were implemented after the II world war. Recreational eel fisheries were common in some specific regions in relation to local traditions, and are still present, where allowed, with a patchy pattern.

Administrative responsibility for eel fisheries is still fragmented in theory, despite the coordination required by the application of the Regulation 1100: sea fisheries and sea fishing up to river mouths are under the responsibility of central government (Ministry of Agricultural, Food and Forestry Policy - Directorate-General for Sea Fishing and Aquaculture), whereas Regions are responsible for freshwater fisheries, including eel fishing, because Presidential Decrees No 11 of 15 January 1972 and No 616 of 24 July 1977 gave them this responsibility. Therefore the only eel fisheries under a central Administration are glass eel fisheries practised in estuaries, as no marine adult eel fishery exists in Italy. With regards to inland fisheries, that include lagoon as well as lake and river fisheries, each Region has its own regulation. Since 2009, some specific regulations for eel are being issued, in relation to the application of the Eel Management Plans. Usually, as a rule individual professional fishing licences are issued, which are valid for six years, by each Region, and are enlisted in registers kept by the Provinces. The permitted gears vary from region to region, also in relation to local traditions, and are specified by each Administration, together with authorised times and places. For the nets, mesh sizes and minimum and maximum dimensions of gears are listed.

The management framework described above has influenced the setting up of the Eel National Management Plan (IT-EMP) foreseen by Regulation 1100/2007. The IT-EMP has taken into account the complexity of the situation in the country, and is therefore a combined plan: it provides a national framework covering coastal waters and those administrative regions which preferred to delegate eel management to central gov-

ernment (eleven regions in all, see Table IT.1.). For these 11 Regions, a total closure of all eel fishing has been applied, both commercial and recreational, and the transposition of this indication into Regional regulations is nearly completed. The remaining nine regions have drawn up their own Regional Eel Management Plans, which were prepared on a coordinated basis and using a standard calculation method for defining targets, while the intervention measures and implementation aspects were defined according to regional regulations and local choices. Italy has in fact decided to avail itself of the opportunity provided in Article 2 of the regulation, which stipulates that *'if appropriate justification is provided, a Member State may designate the whole of its national territory or an existing regional administrative unit as one eel river basin'* and, for the reasons highlighted above, therefore has proposed the regional administrations as Eel Management Units, point accepted by the Commission.



Figure 2.1 The 20 Italian Regions (EMU). Nine produced an Eel Regional Management Plan (green), eleven Regions have closed commercial eel fisheries (white), and are closing recreational fisheries.

Figure 2.1 shows the geographical distribution of the regions (EMU) that have provided their regional Plans. In all these, areas of particular importance for eel fishing are included, either in terms of the presence of wetland areas (Grado and Marano Lagoons, the Venice Lagoon, the Po Delta and Valli di Comacchio, Lesina and Varano Lagoons, Orbetello Lagoon, Pontini Lakes and Sardinia's coastal wetlands) or in terms of the historical importance of eel fishing in the region's inland waters (Lombardia, Umbria, Lazio). For what concerns the assignment of Italy and its EMU to ICES Ecoregions, it must be considered that Italy is located in the Mediterranean, lying across two Ecoregions, the Western Mediterranean Sea and the Adriatic Ionian Sea. Therefore, some Management Units fall within the WMS ecoregion and some look out on the AIS. In Table 2.1, attribution of each EMU to its ICES ecoregion is reported.

In each Region/Management Unit, different habitat typologies (such as coastal lagoons, with or without fish barriers, lakes and rivers) have been considered. In fact in the different Italian EMUs, a great ecological heterogeneity exists, that reflects also in a diversified productivity of the different aquatic environments within each Region/Management Unit. The habitat categories that were identified are as follows: coastal lagoons, lakes, rivers. In the case of coastal lagoons, for those regions that follow different management strategies an explicit distinction has been introduced, within the lagoons specifically managed (fish stockings, presence of fish barrier) from the lagoons where only artisanal fisheries are present. In Table 2.1, the wetted areas for the different habitat typologies in each administrative Region in Italy are reported. A distinction is made between Regions without a MP, where eel fishing has closed definitively, and Regions with a Management Plan, that have been identified as EMU.

Table 2.1. Wetted area for the different habitat typologies in each administrative Region in Italy. A distinction is made between Regions without a MP, where eel fishing has closed definitively, and Regions with a Management Plan, that have been identified as EMU. First column gives reference of the attribution of EMUs to ICES Ecoregions (I: Adriatic-Ionian seas; H: Western Mediterranean Sea). Habitat code: River, RIV; Lake, LAK; Lagoon, LGN; Managed lagoon, MLG.

ATTRIBUTION OF EMU TO ICES ECOREGION	REGION OR EMU	CODE OF REGION OR EMU	REGIONAL EEL MANAGEMENT PLAN	LAGOONS (HA)	MANAGED LAGOONS (HA)	PRIVATE LAGOONS (HA) *	RIVERS (HA)	LAKES (HA)	TOTAL WETTED AREA (HA)
I	Valle D'Aosta	VDA	N	-	-	-	-	-	0
I	Piemonte	PIE	N	-	-	-	-	780	780
I	Lombardia	EMU_LOM	Y	-	-	-	1.676	4.487	6.163
I	Trentino Alto Adige	TAA	N	-	-	-	-	370	370
I	Friuli Venezia Giulia	EMU_FVG	Y	12.700	-	1.660	1.356	-	15.715
I	Veneto	EMU_VEN	Y	63.120	-	18.597	9.252	1.665	92.633
H	Liguria	LIG	N	-	-	-	344	-	344
I	Emilia Romagna	EMU_EMR	Y	3.100	12.263	6.000	5.663	-	27.026
H	Toscana	EMU_TOS	Y	-	2.700	-	1.025	39	3.764
I	Marche	MAR	N	-	-	-	228	-	228
H	Umbria	EMU_UMB	Y	-	-	-	-	12.800	12.800
H	Lazio	EMU_LAZ	Y	913	630	-	714	1.145	3.402
I	Abruzzo	ABR	N	-	-	-	236	-	236
H	Campania	CAM	N	-	487	-	570	-	1.057
I	Molise	MOL	N	-	-	-	73	-	73
I	Calabria	CAL	N	-	-	-	192	-	192
I	Basilicata	BAS	N	-	-	-	218	-	218
I	Puglia	EMU_PUG	Y	11.533	-	-	414	-	11.947
H	Sardegna	EMU_SAR	Y	3.336	4.625	-	600	-	8.561
I	Sicilia	SIC	N	-	278	-	238	-	516
* Private lagoons are not included in Regional Management Plans									
Total Italy				94.702	20.983	26.257	22.799	21.286	186.025

A distinctive feature of the IT-EMP, which reflects on management at the national level, concerns the reforming of the regulation for glass eel fishing. Up to 2008, professional glass eel fisheries were regulated by the Ministero delle Politiche Agricole Alimentari e Forestali by a national legislation (DM March 22, 1991; D.M August 7 1996) that did not contain specific indications for the eel, *Anguilla anguilla*, because generally targeting juvenile fish of all euryhaline species caught for aquaculture purposes. Glass eel fisheries did occur in many river mouths, and in many channel mouths as well. Most of the glass eel yield was from the Central and Southern Tyrrhenian area (Western Mediterranean Sea). The main sites of glass eel catches were the estuaries of rivers such as the Arno and Ombrone in Toscana, the Tiber and the Garigliano in Lazio, and the Volturno and Sele in the Campania region. Those sites were frequented not only by local fishermen but occasionally also by fry fishermen from other regions, who reached those sites with trucks equipped with oxygenated tanks to collect mullet, sea bass, sea bream and eel fry. Local fishermen were usually single or Cooperative fishermen that are were equipped with boats and structures to store the product alive. Fishing instruments vary depending on the characteristics of the site.

The Italian National Management Plan has contemplated the implementation of a new legislation specific for glass eel fishery, on the basis of the fact that this fishing takes place in sites (estuarine areas and low river courses) legally partitioned between State and Regions. The new legislation prepared by the Ministero delle Politiche Agricole Alimentari e Forestali (MIPAF) (DM 12/01/2011, 26/01/2011 OJ, 20 - "Regulation of fishing and marketing of juvenile eels, glass eel and elvers, of the species *Anguilla anguilla* L") regulates fishing of glass eels (eels <12 cm) in marine and brackish waters of the Italian territory. This new legislation lays down rules regarding monitoring of the fishing and end-use of the product and gives priority to use for restocking purposes (thus aiming to reach the target of 60% of catches by 2013, as provided in Article 7 of the regulation), specifying that this quota relates to restocking into waters which flow into the sea, so that the measure will contribute to recovery of the eel stock. One of the ways envisaged for meeting the obligations under the Council regulation is to create a system which will include a national register of fishermen authorised to fish glass eel, allocation of quotas and the obligation to submit catch returns. This new legislation has come in force in 2011, and, together with reinforced controls by the Corpo Forestale dello Stato, should ensure that information on recruitment in Italy is available from year to year, that most glass eel is conveyed to restocking and that illegal fishing is definitively broken off. Glass eel fishing in inland waters, i.e. in rivers above the limit of salt and brackish waters, are under Regional regulations. Therefore, the EMUs (Regions) that have their own Regional Eel management Plans have taken steps to regulate glass eel fishing in inland waters in a manner consistent with the National law. Glass eel fisheries are at the moment allowed in inland waters of two EMUs on the Tyrrhenian coast: Toscana (TOS) and Lazio (LAZ, D.G.R. n. 76 of 2/3/2012). Tuscany has, through a Regional Document for the implementation of the Eel Management Plan, set up the instrument for the implementation of the measures provided for Eel Regional Plan, financed by regional laws that regulate the fishing industry (LR 66/2005 and L.R. 7/2005). Among these actions, the provinces of Grosseto and Pisa have created two facilities for stocking glass eels fished within the region, while the EMU Lazio has taken steps to enact a specific discipline for glass eel fishery, which provides inter alia that the juvenile eel caught in inland waters of the Lazio region is exclusively for farming or restocking inland waters of the region. Glass eel fisheries are explicitly prohibited fishing in inland waters of the Veneto region (VEN, DGR n. 91 18/05/2012), Emilia Romagna (EMR) and Friuli Venezia Giulia (FVG), while the remaining EMUs are not interested by this fishery for natural reasons (no

access to the sea, scarce glass eel ascent) or have not yet enacted specific rules. In the eleven Regions which have not submitted any Eel Man Plan, glass eel fishing is prohibited as well as any other activity involving eels, such as commercial and recreational fishing for eels. For the moment, only five regions (Piemonte, Valle d'Aosta, Liguria, Marche and Sicily) have implemented such forbiddance with explicit rules, the other six regions are still providing.

Italy has established, since 2009, its Data Collection Framework for Eel, as foreseen by the Regulation 199/2008, and therefore eel has been included in the DCF Italian National Programme. The Eel Fisheries Data Collection (under Reg. 199/2008, DCF) is at present definitively in place, and concerns all eel fisheries in inland and coastal waters, commercial as well recreational. Most data presented in this Report for the year 2014 are derived from the Eel Fisheries DCF, presented for the national level or environmental typology (such as inland or coastal waters), and disaggregated by Region (EMU) as well.

The management framework for DCF is the same that has been set up for the eel management under Regulation 1100/2007. In the 11 Regions that preferred to delegate eel management to central government (Directorate-General for Sea Fishing and Aquaculture of the Ministry of Agricultural, Food and Forestry Policy) where commercial eel fishing has been stopped completely since the year 2009, no data collection is carried out. In the remaining nine regions -EMUs, where eel fisheries are still ongoing, eel fishery data are collected with a standard methodology, as foreseen by the Italian National Plan for the Data Collection Framework.

3 Time-series data

The Data Collection Framework for Eel, as foreseen by the Regulation 199/2008, has replaced the previous statistical system, (ISTAT) in place up to 2004 for the marine compartment and to 2008 for inland fisheries. In this report, time-series for eel catches are presented only when available, joining data derived by the old official statistical system (ISTAT) and the new data from the Eel Fisheries Data Collection (under Reg. 199/2008). The data from the ISTAT system present some gaps such as uncertain estimates, possible overlaps with aquaculture production, no distinction between stages, no information on the fishing effort. Nevertheless, these time-series represent at the moment the only official source for eel for the period before 2009.

3.1 Recruitment

Time-series of glass eel recruitment in Italy with details of series and short description of the recruitment sites are shown in Table 3.1.

The recruitment dataserie supplied in the past to the Working Group was relative to a fishery-based monitoring (com.catch) on the river Tiber estuary, specifically carried out within a series of research projects for the resource assessment. The fishery ceased its activity in 2001, but some monitoring of recruitment (com. catch + sci. monit.) continued within research projects up to 2006. When the mentioned projects stopped, this monitoring ceased as well. As this fishery has stopped to exist, no monitoring on the Tiber is at present in place on a similar basis. No information on a continuative basis can be derived, and no centralised monitoring programme of recruitment is in place anywhere in Italy at the present moment.

On the other hand, since 2011 in some Regions recruitment monitoring have been progressively activated on a local basis (EMU Toscana, EMU Lazio, EMU Puglia), each following a specific methodology but based on a common approach. Most of these monitoring are active within specific programmes for Eel Regional Plans im-

plementation supported by the European Fisheries Funds as well as by funding at the local level (Regional).

Also for the EMU Lazio, a regional monitoring has begun, that takes into account some sites in the Region (rivers and coastal lagoons), the river Tiber and the river Marta among others. Even if the methodology will not be exactly the same, because of the closure of the fishery, it will be important to have again in place these monitoring sites in central Italy, for comparison with the past time-series. Some other monitoring have been carried out in other EMUs, such as Tuscany (TOS) and Emilia Romagna (ER), but no details have been provided by the Regions for the present Report, nor in the Report for the EMP, for what concerns sites, data and methodologies.



Figure 3.1 Monitoring sites for recruitment - blue: river mouths; green: coastal lagoons.

Table 3.1. Available time-series and/or monitoring of glass eel recruitment in Italy, and monitoring that have been activated within the Regional Eel Management Plans or other Eel specific projects.

EMU	HABITAT	SITE	SAMPLING TYPE	UNIT	TIME-SCALE	MIN	MAX
LAZ	RIV	Tevere	com. catch	kg	year	1974	2001
LAZ	RIV	Tevere	com. catch+sci. monit.	kg	daily	1990	2006
LAZ	RIV	Tevere	weekly monit.	Number	1 week/month	2013	2015
LAZ	RIV	Marta	com. catch+sci. monit.	kg	daily	1999	2008
LAZ	RIV	Marta	weekly monit.	Number	1 week/month	2013	2015
LAZ	LGN	Fogliano	weekly monit.	Number	1 week/month	2013	2015
LAZ	LGN	Caprolace	weekly monit.	Number	1 week/month	2014	2015
LAZ	LGN	Lungo_San Puoto	weekly monit.	Number	1 week/month	2014	2015
LAZ	RIV	Garigliano	com. catch	kg	daily	1999	2002
PUG	LGN	Lesina	sci. monit.	Number	daily	2013	2015
PUG	LGN	Varano	sci. monit.	Number	daily	2013	2015
PUG	LGN	Torre Guaceto	sci. monit.	Number	daily	2014	2015
PUG	RIV	Fiume Morelli	sci. monit.	Number	daily	2014	2015

Monitoring is carried in each site out on a daily basis for a week each month (weekly monitoring) for the whole duration of the ascent season (five months, October–March). At the moment, no time-series can be derived because the monitoring with such a methodology have begun only recently, but it is foreseen to process data in order to compare present results with historical dataserries.

3.1.1 Glass eel recruitment

NA.

3.1.1.1 Commercial

NA.

3.1.1.2 Recreational

NA.

3.1.1.3 Fishery-independent

NA.

3.1.2 Yellow eel recruitment

NA.

3.1.2.1 Commercial

NA.

3.1.2.2 Recreational

NA.

3.1.2.3 Fishery-independent

NA.

3.2 Yellow eel landings

3.2.1 Commercial

Detailed data on catches and landings (by life stage, by type of fishing gear, by EMU, commercial and recreational, etc.) are available only from 2009, when the DCF has been definitively put in place. Time-series with this degree of detail (stage yellow and silver) are not available for the period antecedent to 2009, apart from some figures for 2007, year in which a pilot project for eel fisheries assessment took place. At present, therefore, time-series for eel landings are available only from the old statistical system (ISTAT), that are national catches (also available at the Region disaggregated level) separated for inland and coastal waters. These time-series for Italy landings are cumulated, i.e. yellow and silver eels. Inland waters catches are referred to lakes and reservoirs, riverine fisheries being too negligible also in pristine periods, while statistics for coastal waters are relative to coastal lagoons fisheries, marine fisheries not being present in Italy. These data are the landing data forwarded to FAO Fishery Statistical Department, and therefore coincide with the FAO FishStat data.

The ISTAT system has discontinued the collection of data from the brackish and marine waters compartment since 2004, which have been resumed only in 2009 within the DCF. Therefore a discontinuity in this dataseries shall probably remain. The ISTAT system is still going on for inland water fisheries, but up to now no cross-check with the DCF has been done, so the two sources might present discrepancies.

Eel total landings from lagoon fisheries in Italy from 1969 to 2014 are reported in Figure 3.4, data refer to coastal lagoons only, no marine fisheries existing, and are derived from the ISTAT system up to 2004 and to the DCF from 2009, while the 2007 figure is from Unimar (2007).

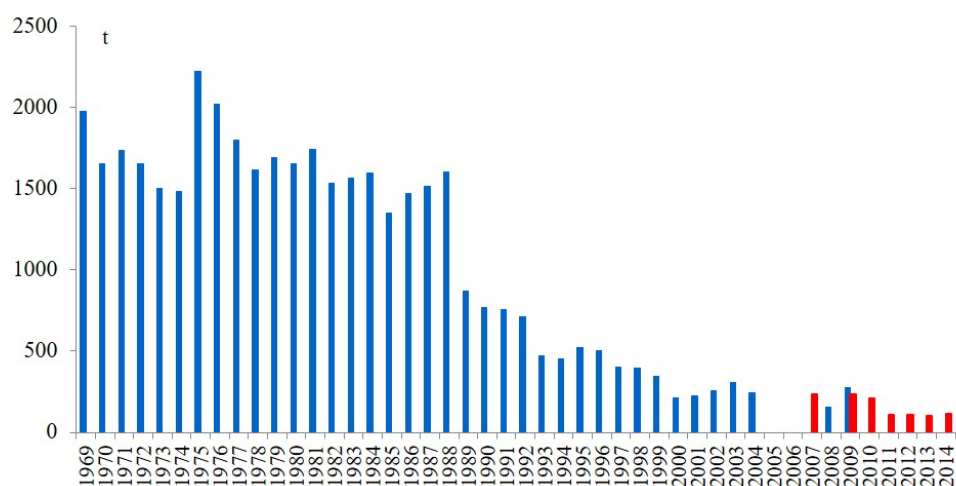


Figure 3.4. Eel landings (yellow and silver cumulated) in Italy, period 1969–2011, from coastal lagoon fisheries (Istituto Nazionale di Statistica 1969–2004, blue; Unimar, 2007, and DCF, 2009–2014, red).

Inland waters eel landings from 1969 to 2013 are reported in Figure 3.5; statistics refer only to lakes and artificial basins for the ISTAT dataserie (green), and include rivers for the 2007–2013 DCF data (red).

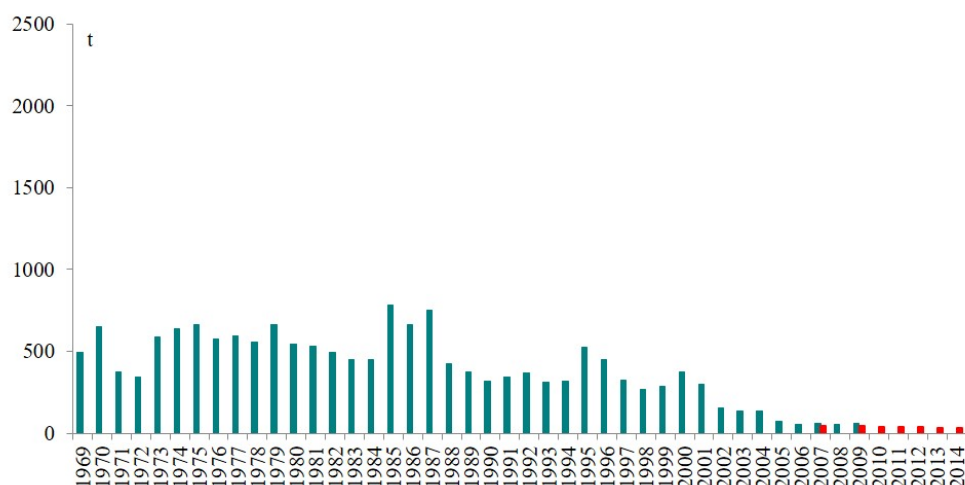


Figure 3.5. Eel landings (yellow and silver cumulated) in Italy, period 1969–2011. Data sources: 1969–2006 ISTAT, Istituto Nazionale di Statistica, referred only to lakes and artificial basins; 2007: Unimar and DCF, 2009–2014: riverine fisheries included.

In Table 3.1, the DCF dataserie from 2009 is presented, with data disaggregated by stage, with the 2007 reference value from the Unimar (2007) pilot study.

Table 3.1. DCF new catch dataserie (2009–2014): commercial landings (t) disaggregated by stage, and 2007 value from the Unimar (2007) pilot study.

YEAR	INLAND WATERS: LAKES & RIVERS			COASTAL WATERS: LAGOONS			NATIONAL
	Yellow	Silver	Total	Yellow	Silver	Total	
2007	25.08	19.70	44.78	151.82	81.79	232.32	277.10
2008	na	na	na	na	na	na	Na
2009	23.58	19.99	43.57	149.27	88.33	237.61	281.18
2010	22.14	18.40	40.54	73.13	135.73	208.85	249.39
2011	23.26	17.14	40.40	48.74	60.54	109.28	149.68
2012	21.29	15.52	36.81	65.56	40.07	105.62	142.43
2013	21.12	13.00	34.14	51.03	51.32	102.35	136.49
2014	18.67	12.86	31.53	52.88	61.15	114.03	145.56

The conspicuous reduction in landings that occurred in 2012 and 2013 that concerned mostly silver eel catch, was a consequence of the fact that the reduction in fishing effort foreseen by the IT-EMPs was put in force starting in 2010.

3.2.2 Recreational

No time-series are available for yellow eel recreational fisheries, recreational fisheries are being recorded only since 2009 within the DCF (Table 3.2).

Table 3.2. DCF new catch dataseries (2009–2014): recreational landings (t).

YEAR	YELLOW	SILVER	TOTAL
2009	-	-	56.00
2010	136.73	12.81	149.54
2011	59.76	12.81	72.57
2012	60.81	11.97	72.78
2013	68.53	1.29	82.63
2014	68.52	14.78	83.30

3.3 Silver eel landings

3.3.1 Commercial

See above.

3.3.2 Recreational

See above.

3.4 Aquaculture production

In Italy, total aquaculture production accounted for 587 t in 2009, with intensive production accounting for 278 t and extensive for 309 t. Data concerning 2011 production included only the exportation.

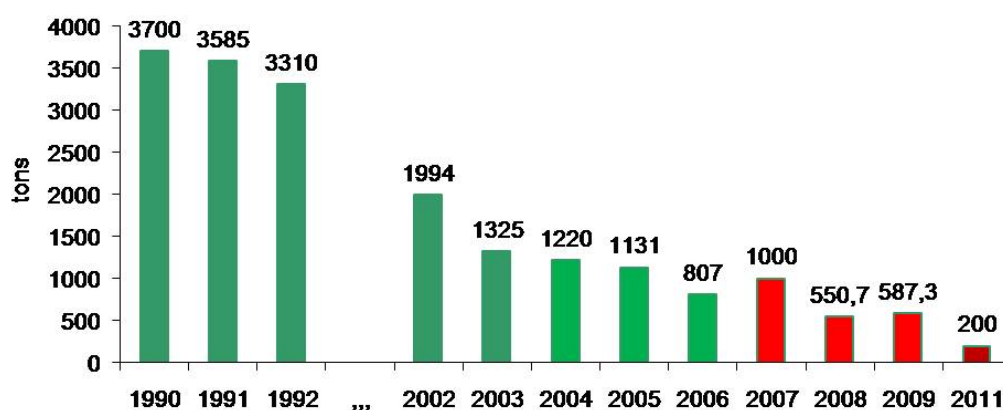


Figure 3.6. Aquaculture production in Italy from 2002 to 2011 (Source: 2002–2007 Idroconsult, green; 2008–2011: Unimar and API, red).

3.4.1 Seed supply

NA.

3.4.2 Production

NA.

3.5 Stocking

3.5.1 Amount stocked

See below, Section 3.5.2.

3.5.2 Catch of eel <12 cm and proportion retained for restocking

The glass eel regulation foresees that glass eel fisheries can continue on a local scale, provided that 60% is used for restocking in national inland waters open to the sea, and provided that fishers compile specific and detailed logbooks of catches and sales. This system, together with reinforced controls by the Corpo Forestale dello Stato, should ensure that information on recruitment in Italy is available from year to year, that most glass eel is conveyed to restocking and that illegal fishing is definitively broken off. Up to 2010, the new regulation was not in force, its definite approval being achieved in 2011, therefore no licences were issued in 2010 and there were no catches, nor information on quantities used for restocking. From 2011, the new regulation being in force, fishing has started again and catches are declared to the Ministry on a weekly basis. In Table 3.2 glass eel catches in kg for the season 2014/2015 are reported, as inferred by the fishers declarations, separated for coastal waters (estuaries) under the Central Administration, and inland waters (rivers up of the tidal limit), under Regional Administrations.

With regard to destination of glass eel catches, and to the proportion retained for restocking, on the basis of the forms returned to Administrations it has been possible to document the destination of glass eel only in a generic way. Glass eel destination from national fisheries seems documented, while import data apparently escape registration. In some EMUs, there are still quantities whose origin and destination are only generically declared.

In some EMUs (EMUS Toscana, EMU Puglia) restocking have been performed with quarantined or on grown elvers, kept after capture in specific facilities.

The unavailability or scarcity of glass eels on the domestic market has resulted in the fact that some Regions used eels of size greater than 12 cm (20–30 g, and in some cases (EMU Veneto) also of larger size (400 g) to make restocking in public waters, as foreseen by the Regional Management Plans. The source of this restocking seed is aquaculture or imported (France). This highlights the need to pay attention to health and quality when dealing with restocking of eel of size exceeding 12 cm.

A summary of the amounts of glass eels, quarantined elvers and bootlace and yellow eels (size >12 cm) restocked in 2014 are reported in Table 3.3.

Table 3.3. Quantities (kg) of wild glass eels (<12 cm) , glass eels ongrown to elvers and small eels (size >12 cm) stocked in Italy by EMU for year 2014.

	WILD GLASS EELS (<12 CM)	ONGROWN ELVERS	BOOTLACE AND YELLOW EELS (>12 CM)
EMU_LOM	0	0	0
EMU_FVG	0	0	500
EMU_VEN	0	0	6301
EMU_EMR	0	0	0
EMU_TOS	0	317	0
EMU_UMB	np	np	np
EMU_LAZ	166	0	55
EMU_PUG	10		0
EMU_SAR	0	0	0
Totale	177	317	6856

At present, it is not possible to document where exactly restocking were performed, as provinces and regions have not provided documentation that allows to document exact destination.

Overall, the two first years of implementation of the new regulatory framework for glass eel fisheries (2011 and 2012) must be considered as a pilot period, accounting for the setting up of the declaration system. At present (2014 and 2015), filling of the forms is still lacking, and the details of the documents of purchase and sale are also deficient. This does not allow complete traceability of movements on the Italian territory. To overcome this problem, a full traceability system is currently being studied, developed in collaboration with the Corpo Forestale dello Stato - Unit CITES. This system should ensure the full traceability of all glass eel movements, either from national waters or imported, also aiming to definitively eradicate illegal fishing of glass eels.

3.5.3 Reconstructed time-series on stocking

Not possible at the moment.

With recent developments in stocking, including quarantine and on-rearing it is getting more difficult to track the quantity and sizes of eels being stocked. This information will be required for assessing the biomass (and mortality rates) derived from stocked eel.

This task should reconstruct the time-series of stocked eel into different categories: split restocking categories into (local or foreign) by (glass eel, quarantined glass eel, wild bootlace, cultured eels), not all combinations will exist.

Where possible, this reconstruction of the time-series should be retrospective as well as current and future.

In Table 3.4, a reconstruction of time-series of stockings is tentatively presented, on the basis of data gathered for the Report prepared for the DG Mare on the basis of art. 9 of the Regulation 1100/2007 (PNG Italia 2014).

Table 3.4. Reconstructed time-series of stockings since 2009.

Year	LOCAL SOURCE				FOREIGN SOURCE			
	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured
2009 *	100			9.502 °				
2010 *	44,5			8.940 °				
2011 *	248,49			6.857 °	130			
2012	145,25			1.930 °	200			
2013	67	+ 125,8		9.352				
2014		492.79		55			500	

* in the years 2009, 2010 and 2011 glass eel fisheries were closed, apart a few particular cases of experimental fishing or Province authorizations for stocking purpose. Glass eel fisheries under the new rule began again in 2011/2012.

° bootlace and yellow eels used for stocking are in part wild eels from France (Camargue), and part from ongrown cultured (Italy, Netherlands), but the exact quantities of each source are not available.

3.6 Trade in eel

Trade of eel in Italy is regulated by current rules for fisheries products, live fish, import and export, etc. It is not in the possibility nor the capacity of the scientists participating to this WG to outline a picture of the trade and market on eel in Italy at the present moment.

4 Fishing capacity

Total fishing capacity for eel in Italy is difficult to assess, it should coincide with the whole amount of fishers licensed for fishing in inland waters (river and lakes) and coastal lagoons, both commercial and recreational, and for authorized glass eel fishers in coastal and inland waters. Glass eel fishing is allowed by authorization on a yearly basis, both in coastal and inland waters, in the nine EMUs. For 2011 the new regulation was entered in force only in December, and hence only a few authorizations were issued (four firms).

For the eel commercial fishing capacity relative to the nine MUs where eel fisheries are present, fishing being prohibited in the remaining eleven Regions where non EMP is in place, the best estimates are from census returns (the first carried out in 2007 and then a revision in 2011) of the total number of fishermen involved in eel fishing.

Commercial eel fisheries occur in nine Regions: Lombardia, Veneto, Friuli Venezia Giulia, Emilia Romagna, Toscana, Umbria, Lazio, Puglia e Sardegna. Within these regions, four main habitat typologies have been identified, where eel fishing takes place that are rivers, lakes, lagoons and managed lagoons. The latter differs from lagoons, where only artisanal fisheries occur, for the fact that more detailed management strategies are carried out, such as stocking or water management.

Overall, 1456 operators are involved in eel fishing, in the nine Regions all typologies included (see Table 4.1). These fishermen are licensed fishers as well as employees in the managed lagoons, and they do not target only eel, but other freshwater or euryhaline fish as well. In most cases, eel importance in catches is quite low. An assessment of eel importance among catches has been performed in 2010, on all the fishermen

operating in rivers lakes and lagoons, and it revealed that for about 77% of the fishermen, eel represents at most 15 % of total catch. For 23% of the fishermen, eel is less than 1% of total catch.

Table 4.1. Total number of commercial fishermen, by EMU and by habitat typology, from the census DCF 2011 and confirmed in DCF 2014.

EMUs	RIVER	LAKE	LAGOON	MANAGED LAGOON	TOTAL/ EMU	%
EMU_LOM	0	30	0	0	30	2
EMU_FVG	70	0	106	0	176	12
EMU_VEN	173	0	170	0	343	24
EMU_EMR	5	0	141	0	146	10
EMU_TOS	0	0	0	26	26	2
EMU_UMB	0	28	0	0	28	2
EMU_LAZ	5	25	11	0	41	3
EMU_PUG	0	0	59	0	59	4
EMU_SAR	42	0	121	442	605	42
total/HT	295	83	608	468	1454	100
%	20	6	42	32	100	100

For recreational fisheries, potential fishing capacity coincides with all licensed fishers on the whole national territory, all Regions included. The effective number of recreational fishermen involved in eel fishing is obviously much lower. The estimate of the total amount of eel recreational fishermen was obtained within the DCF programme, on the basis of the information provided by two different Recreational fishermen organizations (FIPSAS and ARCI Pesca), that account for most of inland waters recreational fisheries. The effective number of eel recreational fishers estimated for 2014 amounts to 2950 (see Table 4.2).

Table 4.2. Total number of recreational fishermen in the 20 Regions in year 2014.

REGION	EMU CODE	TOTAL LICENCES
Valle d'Aosta	-	NA
Piemonte	-	34.000
Lombardia	EMU_LOM	104.591
Trentino Alto Adige	-	11.350
Friuli Venezia Giulia	EMU_FVG	17.583
Veneto	EMU_VEN	89.000
Liguria	-	4.700
Emilia Romagna	EMU_EMR	42.881
Toscana	EMU_TOS	34.200
Umbria	-	15.035
Marche	EMU_UMB	8.000
Lazio	EMU_LAZ	44.309
Abruzzo	-	11.621
Molise	-	3.227
Campania	-	16.351
Calabria	-	18.500
Basilicata	-	2.262
Puglia	EMU_PUG	462
Sardegna	EMU_SAR	12.128
Sicilia	-	3.157
Total		473.357

For both commercial and recreational fisheries, target are both the yellow and the silver eel stage that are exploited by the same fishers on a seasonal basis.

4.1 Glass eel

Glass eel fishing is allowed by authorization on a yearly basis, in coastal or in inland waters, in most EMUs. For 2014, with regards to the authorizations issued by the Central Administration, three firms were authorized, one in the EMU Veneto and two in the EMU Toscana. At the Regional Level, two firms were authorized but the EMU Toscana and two single fishermen were authorized by the EMU Lazio.

4.2 Yellow eel

See above.

4.3 Silver eel

See above.

4.4 Marine fishery

No marine fishery exists for eel in Italy.

5 Fishing effort

The methodology to describe the commercial fishing effort is based on direct and detailed interviews to a sample of fishermen, extracted on a statistical basis for each habitat typology in each MU. Almost total eel catch is from fykenets fisheries, used in all habitat typologies in all MUs, with the exception of fish barriers used in managed coastal lagoons. Longlines are sporadically used only in one or two lakes.

The interviews consist of questionnaires where each fisherman reports catch data (yellow and silver eel separated), type of gear, number of gears used daily, and number of fishing days per year. A detailed cpue in each habitat typology of all nine MUs has been derived from a reliable subset of interviewed fishermen: an average parameter of fishing effort (number of gears * number of fishing days) was multiplied by the total fishermen operant in each habitat typology. Results are reported in Table 5.1. Yellow and silver eel catches were assessed with the same method.

Table 5.1. Effort parameters used for eel commercial fishing in Italy in 2014, disaggregated by EMU and habitat typology. NA: not applicable.

REGION (EMU)	HABITAT TYPOLOGY	GEAR TYPE	EEL STAGE	NUMBER OF GEARS USED PER DAY		NUMBER OF FISHING DAYS PER YEAR		NUMBER OF FISHERMEN	EFFORT
EMR	LGN	FYK	Y/S	21		42		141	189.561
EMR	MLG	BAR	S	NA		NA		NA	
EMR	RIV	FYK	Y/S	31		35		5	10.938
FVG	LGN	FYK	Y/S	51		105		106	725.603
FVG	RIV	FYK	Y/S	70		60		70	138.180
LAZ	LAK	FYK	Y/S	12		63		25	19.247
LAZ	LGN	FYK	Y/S	9		75		11	14.850
LAZ	RIV	FYK	Y/S	267		57		5	151.106
LOM	LAK	FYK	Y/S	8		48		22	17.410
PUG	LGN	FYK	Y/S	50		36		59	164.869
SAR	LGN	FYK	Y/S	5		32		121	34.320
SAR	MLG	BAR	S	NA		121		NA	NA
SAR	MLG	FYK	Y/S	6		50		442	280.051
SAR	RIV	FYK	Y/S	8		77		42	51.744
TOS	LAK	FYK	Y	0		0		0	0
TOS	MLG	BAR	S	NA		90		NA	NA
TOS	MLG	FYK	Y/S	11		75		26	21.131
TOS	RIV	FYK	Y/S	0		0		0	0
UMB	LAK	FYK	Y/S	24		72		28	97.853
VEN	LGN	FYK	Y/S	52		105		170	1.539.147
VEN	RIV	FYK	Y/S	47		87		173	636.844

The same methodology (interviews to a sample of fishermen) has been used to assess data for recreational fishermen (Table 5.2).

Table 5.2. Effort parameters used for eel recreational fishing in Italy in 2014, disaggregated by EMU and habitat typology and type of gears.

Region	Pool sample (Recreational fishing association members)	Eel fishermen interviewed	Sample representa- tiveness (%)	Habitat typology	Eel fishermen interviewed per gears type	Effort				
						Fishing rod	Umbrella	Shore lift net	Big Shore lift net	Number of fishing days * year
VDA	NA	NA	NA	RIV	NA	NA	NA	NA	NA	NA
PIE	11,453	243	33,7	RIV	243	0	0	0	243	8
EMU_LOM	23,291	222	22,3	LAK	322	0	0	63	385	71
		385	22,3	RIV	222	0	0	0	222	28
		388	22,3	RIV/LAK	388	0	0	0	388	23
TAA	2,181	NA	19,2		NA	NA	NA	NA	NA	NA
EMU_FVG	6,477	16	36,8	RIV/LAK	16	0	0	0	16	15
EMU_VEN	31,817	280	35,8	RIV	280	0	0	0	280	30
		276	35,8	RIV/LGN	276	0	0	0	276	18
LIG	4,333	470	92,2	RIV	254	216	0	0	470	12
EMU_EMR	26,670	1049	62,2	RIV	817	24	208	0	1,049	17
EMU_TOS	20,354	297	59,5	RIV	156	133	8	0	297	10
EMU_UMB	4,363	158	29,0	RIV/LAK	158	0	0	0	158	9
MAR	4,538	NA	56,7		NA	NA	NA	NA	NA	NA
EMU_LAZ	7,800	41	17,6	RIV	41	0	0	0	41	10
		16	17,6	RIV/LAK	16	0	0	0	16	15
ABR	3,477	NA	29,9	RIV	NA	NA	NA	NA	NA	NA
CAM	6,576	NA	40,2		NA	NA	NA	NA	NA	NA
MOL	693	NA	21,5		NA	NA	NA	NA	NA	NA
CAL	4,470	113	24,2	RIV	113	0	0	0	113	27

5.1 Glass eel

Glass eel fishing is allowed by specific authorization on a yearly basis, both in coastal and inland waters, in most EMUs, to firms dealing with juvenile fish harvest and commercialization. Authorized firms are obliged to return catch data inclusive of details on the fishing site and fishing effort, but for this first period of implementation, returned forms were unsatisfactory with regards to these information.

5.2 Yellow eel

See above.

5.3 Silver eel

See above.

5.4 Marine fishery

No marine fishery exists for eel in Italy.

6 Catches and landings

Annual catch by life stage for commercial fisheries in the year 2014, as evaluated under the DCF programme, is reported in Table 6.1, by EMU, and by stratum (EMU_Habitat typology) in Table 6.2. For glass eel catches, data for 2011 are reported in Section 3.5.2.

Table 6.1. Yellow and silver eel commercial catches, and total for the two stages cumulated, for 2014, disaggregated by EMU (DCF, 2014).

EMUs	YELLOW EELS (KG)	SILVER EELS (KG)	TOTAL (KG)	TOTAL (TONS)
LOM	1,035	1,215	2,250	2,3
FVG	2,659	1,300	3,959	4,0
VEN	11,980	10,602	22,582	22,6
EMR	7,630	4,253	11,883	11,9
TOS	9,966	20,234	30,200	30,2
UMB	4,000	0	4,000	4,0
LAZ	5,980	3,776	9,756	9,8
PUG	5,543	10,359.5	15,902.5	15,9
SAR	22,755	22,275	45,030	45,0
Total	71,548	74,014.5	145,562.5	145.6

Table 6.2. Yellow and silver eel commercial catches, and total for the two stages cumulated, for 2014, disaggregated by stratum (EMU and habitat typology) (DCF, 2014).

EMUS	HABITAT TYPOLOGY	YELLOW EELS (KG)	SILVER EELS (KG)	TOTAL (KG)	TOTAL (TONS)
LOM	LAK	1,035	1,215	2,250	2.3
VEN	LGN	2,154	1,273	3,427	3.4
VEN	RIV	505	27	532	0.5
FVG	LGN	5,180	4,077	9,257	9.3
FVG	RIV	6,800	6,525	13,325	13.3
EMR	LGN	7,500	453	7,953	8.0
EMR	MLG	0	3,800	3,800	3.8
EMR	RIV	130	0	130	0.1
TOS	LAK	0	0	0	0.0
TOS	MLG	9,966	20,234	30,200	30.2
TOS	RIV	0	0	0	0.0
UMB	LAK	4,000	0	4,000	4.0
LAZ	LAK	2,465	1,951	4,416	4.4
LAZ	LGN	715	1,760	2,475	2.5
LAZ	RIV	2,800	65	2,865	2.9
PUG	LGN	5,543	10,359.5	15,902.5	15.9
SAR	LGN	11,320	4,215	15,535	15.5
SAR	MLG	10,500	14,980	25,480	25.5
SAR	RIV	935	3,080	4,015	4.0
Total		71,548	74,014.5	145,562.5	145.6

6.1 Glass eel

Table 3.2. Glass eel catches (eel <12 cm) - kg -, season 2014/2015.

	EMU TOSCANA	EMU LAZIO	TOTAL
Inland waters	89.22	177.2	266.42
Coastal waters	119.59	0	119.59
TOTAL	208.81	177.2	386.01

See above.

6.2 Yellow eel

See above.

6.3 Silver eel

See above.

6.4 Marine fishery

No marine fishery exists for eel in Italy.

6.5 Recreational fishery

Total catch by life stage for recreational fisheries by Region is reported in Table 6.3, relative to 2014, evaluated under the DCF Programme.

Further data at the level of detail requested for this report are not available.

Table 6.3. Yellow and silver eel catches, and total for the two stages cumulated, from recreational fisheries in 2014, disaggregated by Region (DCF, 2014).

REGION	CODE	YELLOW EEL (KG)	SILVER EEL (KG)	TOTAL (KG)	TOTAL (TONS)
Valle d'Aosta	VDA	NA			
Piemonte	PIE	1,781	0	1,781	1.8
Lombardia	EMU_LOM	29,693	898	30,591	30.6
Trentino Alto adige	TAA	0	0	0	0.0
Friuli Venezia Giulia	EMU_FVG	217	150	367	0.4
Veneto	EMU_VEN	17,771	2,697	20,468	20.5
Liguria	LIG	3,580	0	3,580	3.6
Emilia Romagna	EMU_EMR	7,693	8,092	15,785	15.8
Toscana	EMU_TOS	1,428	540	1,968	2.0
Umbria	EMU_UMB	1,378	0	1,378	1.4
Marche	MAR	0	0	0	0.0
Lazio	EMU_LAZ	1,363	1,350	2,713	2.7
Abruzzo	ABR	0	0	0	0.0
Campania	CAM	0	1,050	1,050	1.1
Molise	MOL	0	0	0	0.0
Calabria	CAL	2,318	0	2,318	2.3
Basilicata	BAS	870	0	870	0.9
Puglia	EMU_PUG	0	0	0	0.0
Sardegna	EMU_SAR	0	0	0	0.0
Sicilia	SIC	428	0	428	0.4
Total		68,520	14,777	83,297	83.3

6.6 Bycatch, underreporting, illegal activities

At present, no data collection are implemented on aspects such as bycatch, underreporting or illegal activities concerning eel fishing.

All these activities are present in Italy: the fight against illegal fishing is conducted by the Forest Service and the State Police forces, with controls, confiscations and seizures, penalties, both in the Regions where fishing is permitted (nine EMUs) and in the regions where fishing is closed. It is not possible to give any estimate of the volume concerned, not even for glass eel, the stage for which the controls are more frequent and organized, because there is no centralization of the information.

7 Catch per unit of effort

Catch per Unit of effort (cpue) has been assessed under the DCF Programme for year 2014, for both commercial and recreational fisheries. Cpue has been calculated as mean catch of the year per fisherman. The detailed Cpue has been derived for a small

and reliable subset of fishers, and then referred to the whole set of fishermen. In Table 7.1, annual mean cpue for 2014 are reported by stratum (EMU_Habitat typology), for commercial landings. In Table 7.2, annual mean cpue for 2014 are reported by stratum (EMU_Habitat typology), for recreational landings.

Table 7.1. Yellow and silver eel cpue (kg/fisherman) for commercial fisheries for 2014, disaggregated by stratum (EMU and habitat typology) (DCF, 2014).

EM U	HABITAT TYPOLOGY	TYPE OF GEAR	CPUE YELLOW EEL	CPUE SILVER EEL
			Kg/fisherman	Kg/fisherman
LOM	LAK	FYK	35	41
FVG	LGN	FYK	20	12
FVG	RIV	FYK	7	0
VEN	LGN	FYK	31	24
VEN	RIV	FYK	39	38
EMR	LGN	FYK	53	3
EMR	MLG	BAR	NA	NA
EMR	RIV	FYK	26	0
TOS	LAK	FYK	NA	NA
TOS	MLG	BAR	111	225
TOS	RIV	FYK	NA	NA
UMB	LAK	FYK	143	0
LAZ	LAK	FYK	99	78
LAZ	LGN	FYK	65	160
LAZ	RIV	FYK	560	0
PUG	LGN	FYK	94	176
SAR	LGN	FYK	94	35
SAR	MLG	BAR	24	34
SAR	RIV	FYK	22	73

Table 7.2. Yellow and silver eel cpue (kg/fisherman) for recreational fisheries in 2014, disaggregated by stratum (EMU and habitat typology) (DCF, 2014).

EMU	HABITAT TYPOLOGY	CPUE YELLOW EEL	CPUE SILVER EEL
		Kg/fisherman	Kg/fisherman
PIE	RIV	2.5	0.0
EMU_LOM	RIV	2.5	0.0
EMU_LOM	LAK	11.4	0.5
EMU_FVG	RIV/LAK	5.0	0.0
EMU_VEN	LAK	20.0	0.0
EMU_VEN	RIV	3.0	0.0
LIG	RIV	7.1	0.0
EMU_EMR	RIV	4.7	0.3
EMU_TOS	RIV	2.9	0.1
EMU_UMB	LAK	2.5	0.0
EMU_LAZ	RIV	4.1	0.0
EMU_LAZ	RIV/LAK	4.4	0.0
BAS	RIV	5.8	0.0
CAL	RIV	5.6	0.0
SIC	RIV	4.0	0.0

7.1 Glass eel

See above.

7.2 Yellow eel

See above.

7.3 Silver eel

See above.

7.4 Marine fishery

No marine fishery exists for eel in Italy.

8 Other anthropogenic and environmental impacts

Anthropogenic and environmental impacts are considered in Italian stock assessment only for EMUs where stocking practices have been carried out in rivers over dams. The model used allows to consider this anthropogenic mortalities such as the silver eels survival during the downstream migration, by considering the number of dams with hydroelectric turbines and their correspondent probability of survival of each plant ($\varsigma = 0,682$; ICES, 2011).

9 Scientific surveys of the stock

A number of scientific monitoring on eel local stocks in Italy have been carried out in the past, and some scientific surveys are currently underway within the framework of many projects in many EMUs, most of which carried out within the framework of

European Fisheries Funds containing specific measures for the implementation of Eel Management Plans. It is not possible to mention here specific Projects, nor to report here results.

However, most results are conveyed to a national working group, supported by the Ministero delle Politiche Agricole Alimentari e Forestali and up to now coordinated by the University of Rome Tor Vergata (Dr E. Ciccotti and Dr F. Capoccioni, with the collaboration of Dr Marcello Schiavina, Politecnico di Milano, and Professor De Leo, Stanford University) that has also provided for the assessments and reporting required by the Regulation 1100/2007.

Outputs of monitoring, research projects and scientific surveys are all stored in a database that is progressively implemented. Compared to 2008, when the work for the compilation of the IT-EMP was initiated, this database is now significantly more complete because many sites are covered and many biological information are available for many local stocks. Therefore the updated dataset is used each year for the assessment of the required reference points and year-on-year assessments are more accurate.

10 Data collected for the DCF

Biological surveys under the DCF National Program are carried out for every EMU (Region), in a site, lagoon or catchment, representative of the EMU in terms of habitat extent and/or amount of eel landings. Sampling is usually carried out by taking a random batch of eels from a fisherman cumulated catch of the day or of the week. Sample processing foresees different procedures depending on data to be obtained from the samples. Usually length and weight are directly measured on anaesthetized eel, and digital pictures for subsequent specific morphometric measurements are obtained. Samples are released if no other observations are due, or else sacrificed or frozen for further analyses.

For 2014, only length and weight measurements were foreseen, that were carried out at eight sites (eight EMU in four Habitat typologies) for a total of 738 eel.

EMU	HABITAT TYPOLOGY	YELLOW EEL	SILVER EEL
EMU_LOM	LAK	15	50
EMU_FVG	LGN	-	-
EMU_VEN	RIV	45	41
EMU_EMR	MLG	48	44
EMU_TOS	MLG	54	40
EMU_UMB	LAK	48	25
EMU_PUG	LGN	69	45
EMU_SAR	LGN	50	50
EMU_LAZ	LGN	60	54
Total		389	349

Table 10.1. Summary of the DCF monitoring implementation per EMU.

Data	River	Lakes	Estuaries	Lagoons	Coastal & Marine
No. of production / escapement surveys ¹					
No. of recruitment time-series surveys ²					
No. fished aged					
No. of fished sexed	86	138		514	
No. of fish examined for parasites					
No. of fish examined for contaminants					
No. of non-fishery mortality studies ³					
Socio-economic survey					

¹ Surveys to estimate B_{best} and/or $B_{current}$ [These should include WFD surveys where the data are being used to estimate production and/or escapement of eel].

² Fishery-independent surveys.

³ Studies to determine ΣH for non-fisheries anthropogenic impacts, such as hydropower, barriers, predation, etc.

11 Life history and other biological information

11.1 Growth, silvering and mortality

Von Bertalanffy growth parameters of local stocks, for male and females:

EMU	k_male	L_inf_male	k_female	L_inf_female
EMR LGN	0,28	777	0,25	1107
LAZ LAK	0,44	400	0,07	988
LAZ LGN	0,74	378	0,15	724
LAZ RIV	0,49	394	0,28	692
LOM LAK	0,44	400	0,07	988
LOM RIV	0,44	400	0,07	988
PUG LGN	0,87	413	0,30	712
SAR LGN	0,96	393	0,28	707
TOS MLG	0,46	450	0,38	524
UMB LAK	0,44	385	0,24	576

Length and age at silvering

EMU			LT	Age
LAZ	RIV	Male	386	7
		Female	588	8
LOM	LAK	Male	na	na
		Female	772	17
UMB	LAK	Male	354	5
		Female	471	7
LAZ	LAK	Male	401	8
		Female	673	12
VEN	LGN/MLG	Male	na	na
		Female	630	10
PUG	LGN/MLG	Male	418	5
		Female	660	6
LAZ	LGN/MLG	Male	66,0	7
		Female	573,0	10
SAR	LGN/MLG	Male	394	4
		Female	623	7
TOS	LGN/MLG	Male	404	5
		Female	490	7
EMR	LGN/MLG	Male	na	na
		Female	817	5

11.2 Parasites and pathogens

No relevant data because new data were not available and no routine monitoring have been implemented.

11.3 Contaminants

Some lake fisheries have been closed since 2012. These concerned also eel (such as the Lago di Garda, Lombardia), in relation to fish contamination by dioxin or other contaminants. Contaminant data are not available, because carried out by local Health Agencies.

11.4 Predators

Ichthyophagous birds have a strong impact in the area of the lagoon of Venice and in all the North Adriatic area, mainly in relation to fish predation in the valli, and represent one of the main causes of product loss (Ciccotti, 2014; Cataudella *et al.*, 2014).

Predation by ichthyophagous birds represents the main factor limiting fish productions in Italian coastal lagoons or in the North Adriatic extensive aquaculture situations (valli). The specific impact on eel cannot be quantified; it depends on a number of factors that vary among lagoons. On the other hand, the presence of other water birds represents a main attraction in these same sites, in relation to the different usages of lagoons (tourism, conservation, hunting).

Another predator of eel that is found in some rivers and estuaries is *Silurus glanis*. Its presence is ascertained in the Tiber River (Lazio) and in the river Po lower course

(Emilia Romagna), but its impact on eel local stocks cannot be quantified at the present moment.

12 Other sampling

NA.

13 Stock assessment

13.1 Method summary

Italy presented a mixed Eel Management Plan that includes a National EMP and nine Regional EMPs. The former deals only with coastal waters, and hence only with glass eel fisheries. The stock assessment for eel was however carried out for all the 20 Italian Regions, i.e. including the nine MUs with a Regional Eel Management plan and the other eleven Regions where no recovery plans for the eel were foreseen.

Within each Region, a habitat-based approach was used for assessments, considering separately lake, river and estuarine waters and lagoon surfaces. Local stock assessment was performed at EMUs (i.e. regions) for wetted areas and also taking into account specific habitat typologies (lakes, lagoons, rivers), by means of a demographic model tuned on available data on recruitment, fishing effort and age/size structure or on bibliographic data. The model (DemCam), developed by Bevacqua *et al.* from University of Parma and Politecnico di Milano and evaluated in the ICES working group SGIPEE, was used, specifically revised for this purpose.

Such modellistic approach has been used in different contexts in Mediterranean habitats and it has been revised in several peer-reviewed scientific journals (Aalto *et al.*, 2015; Bevacqua *et al.*, 2015; Schiavina *et al.*, 2015).

DemCam was developed specifically for the assessment of the eel stock and catches in spatially implicit environments such as lagoons, lower water systems or uniform traits of rivers. A general formulation makes it suitable to describe the demography of different eel stocks, provided that a sufficient number of data are available for parameter calibration. The model covers the whole continental phase of the European eel's life cycle, from the recruitment at the glass eel stage up to the escapement of migrating silver eels. It defines the eel stock and the harvest structured by age, length, sex and maturation stage (yellow or silver) on an annual basis. The model allows also considering the system in pristine conditions by using the extension of pristine habitat in the absence of human pressure (fishing mortality and presence of dams) and the abundance of recruitment to the maximum carrying capacity.

As far as the data of body growth curves are concerned, the model proposed by Melià *et al.* (2006a) was used: for each Region (MU) and habitat type parameters calibrated with the data obtained from DCF biological samplings in the respective reference site of the habitat typology have been used, or from other available data, extending these parameters in those cases where no other data were available.

The probability of reaching sexual maturity, and natural mortality were estimated with the model proposed by Bevacqua *et al.* (2006; 2011).

Fishing mortality rate (F) was calculated as the result of the effort applied, the selectivity of the nets used (depending on the length and the mesh size of the gears), and the catchability, (Bevacqua *et al.*, 2009), specifically calibrated for each combination of EMU and habitat typology.

In the case of managed lagoons, where fishing barriers are present, all silver eel caught by these traps were deducted from the total silver eel biomass estimated by the DEMCAM model in these habitat typology.

The model allows to consider other anthropogenic mortalities such as the silver eels survival during the downstream migration, by considering the number of dams with hydroelectric turbines and their correspondent probability of survival of each plant ($\varsigma = 0,682$, ICES, 2011).

On the basis of the escapement pristine data, B_0 , (assessed with different levels of productivity for each habitat typology, from 3,2 to 34,5 kg/ha taken from scientific literature) and the pristine available wetted areas (in hectares), the model estimates the pristine level of recruitment R_0 . Considering the current recruitment $R_{current}$ as a fraction of the pristine one (ICES, 2013), the model calibrate a negative exponential function for recruitment time-series (1950–2009) (ICES, 2013) imposing $R_{1980} = R_0$ and $R_{2009} = R_{current}$, with an increment in the subsequent years (2010–2013) following the analysis reported by ICES (2013). With this series and considering the current actual available wetted areas, the model simulates the system in the absence of human pressure, to obtain an estimate of the potential silver eel biomass (B_{best}), and in actual conditions, assessing the annual escapement of silver eels ($B_{current}$).

With regards to recruitment, an estimation of the fraction of actual recruitment by considering in Italy four macroareas differing in recruitment level. With this procedure it was estimated that recruitment is currently 10% for the pristine inland waters (not directly connected to the sea), 15% for the Northern Adriatic Sea, 20% for the Southern Adriatic Sea and 30% for the Tyrrhenian area and the islands.

The limits to the application of this model are largely due to the lack of specific data for each site. The generalization process for a particular species so may lead to over-estimates or underestimates the biomass of spawners. In particular the value of recruitment, both pristine and actual, has a strong influence on model predictions and the lack of specific data for the estimation of this parameter makes assessments less reliable.

13.1.1 Estimate of B_0

Table 13.1. Reference period for B_0 .

EMU_code	B_0 (kg/ha)	Reference time period	Whether or not changed from value reported last year (Y/N)
VDA_RIV	3.2		N
PIE_RIV	3.2		N
PIE_LAK	4.2		N
TRN_RIV	3.2		N
TRN_LAK	4.2		N
EMR_VAL	20.0		N
EMR_LGN	20.0		N
EMR_MLG	20.0		N
EMR_RIV	3.2		N
FVG_LGN	20.0		N
FVG_RIV	3.2		N
FVG_VAL	20.0		N
LAZ_LAK	4.2		N
LAZ_LGN	20.0		N
LAZ_MLG	20.0		N
LAZ_RIV	11.6		N
LOM_LAK	4.2		N
LOM_RIV	3.2		N
LIG_RIV	3.2		N
PUG_LGN	34.5		N
PUG_RIV	3.2		N
SAR_LGN	24.2		N
SAR_MLG	24.2		N
SAR_RIV	13.7		N
TOS_LAK	4.2		N
TOS_MLG	24.5		N
TOS_RIV	3.2		N
MAR_RIV	3.2		N
UMB_LAK	0		N
UMB_RIV	3.2		N
ABR_RIV	3.2		N
VEN_LAK	4.2		N
VEN_LGN	20.0		N
VEN_RIV	11.7		N
VEN_VAL	20.0		N
CAM_LGN	20.0		N
CAM_RIV	3.2		N
MOL_RIV	3.2		N
CAL_RIV	3.2		N
BAS_RIV	3.2		N

EMU_code	B0 (kg/ha)	Reference time period	Whether or not changed from value reported last year (Y/N)
SIC_LGN	20.0		N
SIC_RIV	3.2		N

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13.2 Summary data

13.2.1 Stock indicators and targets

Table 13.2. Stock indicators, mortality rates and EMP targets for each IT-EMU calculated with 2014 data (ΣA accounts for all anthropic mortalities including the negative effect of restocking; ΣA_r accounts for all anthropic mortalities without the restocking effect, i.e. glass eel mortality, habitat loss, fishing mortality, hydropower mortality). All mortalities are calculated on individual abundances as average mortalities experienced by escaping spawners of 2014, and shown both on annual and lifetime basis.

EMU	INDICATORS			MORTALITY [YR-1]				MORTALITY [LIFETIME-1]				TARGET
	B0 (ton)	Bbest (ton)	Bcurr (ton)	ΣH	ΣF	ΣA	ΣA_r	ΣH	ΣF	ΣA	ΣA_r	EU 40% (ton)
ABR	1.928	0.401	0.333	0.019	0.000	0.019	0.019	0.137	0.000	0.137	0.137	0.771
BAS	2.318	0.630	0.481	0.030	0.000	0.030	0.030	0.212	0.000	0.212	0.212	0.927
CAL	1.580	0.429	0.229	0.023	0.029	0.053	0.053	0.162	0.202	0.364	0.364	0.632
CAM	14.339	5.182	3.722	0.009	0.021	0.030	0.030	0.053	0.130	0.183	0.183	5.736
EMR	458.236	122.901	78.608	0.010	0.034	0.014	0.044	0.092	0.300	0.119	0.392	183.294
FVG	293.033	68.434	51.517	0.009	0.029	0.035	0.039	0.090	0.296	0.356	0.386	117.213
LAZ	71.054	30.270	4.928	0.093	0.236	0.278	0.329	0.469	1.129	1.341	1.597	28.422
LIG	1.684	0.658	0.397	0.015	0.026	0.040	0.040	0.101	0.177	0.278	0.278	0.673
LOM	65.561	7.616	3.815	0.500	0.000	0.167	0.500	2.912	0.000	1.019	2.913	26.224
MAR	3.516	0.731	0.433	0.037	0.015	0.052	0.052	0.252	0.104	0.356	0.356	1.406
MOL	0.903	0.245	0.179	0.036	0.000	0.036	0.036	0.249	0.000	0.249	0.249	0.361
PIE	15.632	2.078	0.145	Inf	0.002	0.266	Inf	Inf	0.016	1.700	Inf	6.253
PUG	399.772	104.327	78.055	0.024	0.026	0.050	0.051	0.115	0.125	0.236	0.240	159.909
SAR	210.386	80.949	21.257	0.030	0.242	0.273	0.273	0.136	1.042	1.178	1.178	84.155
SIC	7.871	3.038	1.656	0.032	0.031	0.063	0.063	0.159	0.153	0.312	0.312	3.149
TOS	75.404	26.808	2.766	0.006	0.369	0.372	0.374	0.034	2.456	2.474	2.489	30.162
TRN	7.195	0.950	0.061	Inf	0.004	0.142	Inf	Inf	0.021	0.894	Inf	2.878
UMB	3.569	0.509	0.000	Inf	0.000	Inf	Inf	Inf	0.000	Inf	Inf	1.428
VDA	1.082	0.154	0.000	Inf	0.000	Inf	Inf	Inf	0.000	Inf	Inf	0.433
VEN	1773.133	411.102	336.570	0.015	0.015	0.013	0.030	0.137	0.130	0.114	0.267	709.253

13.2.2 Habitat coverage

All habitats have been assessed (Table 2.1 for wetted areas).

13.2.3 Impact

NA.

13.2.4 Precautionary diagram

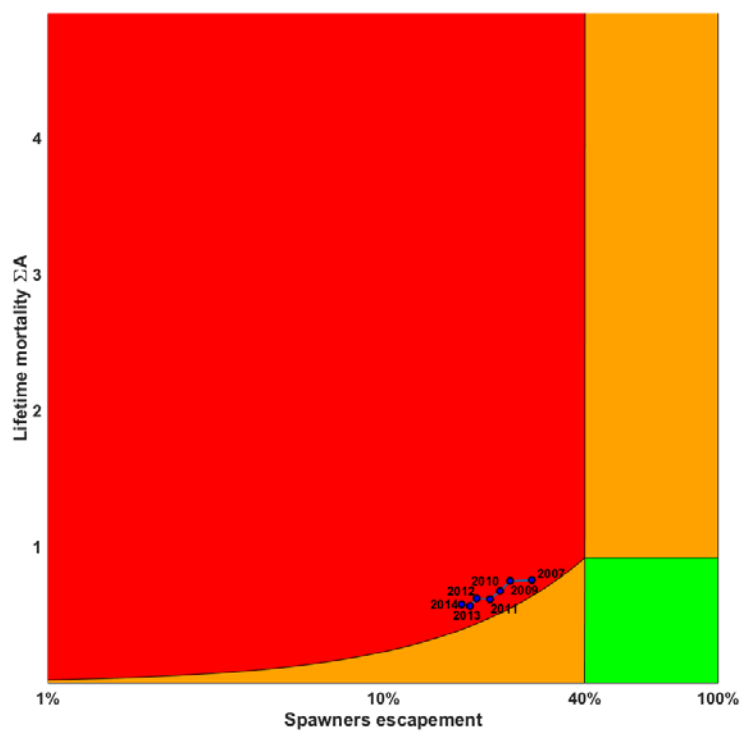


Figure 13.1. Precautionary Diagram for Italian country. It displays the evolution since 2007 showing the effect of the implementation of the EMP (downward evolution). The rightward evolution is due to the effect of recruitment decline. Lifetime mortality accounts for the negative effect of restocking.

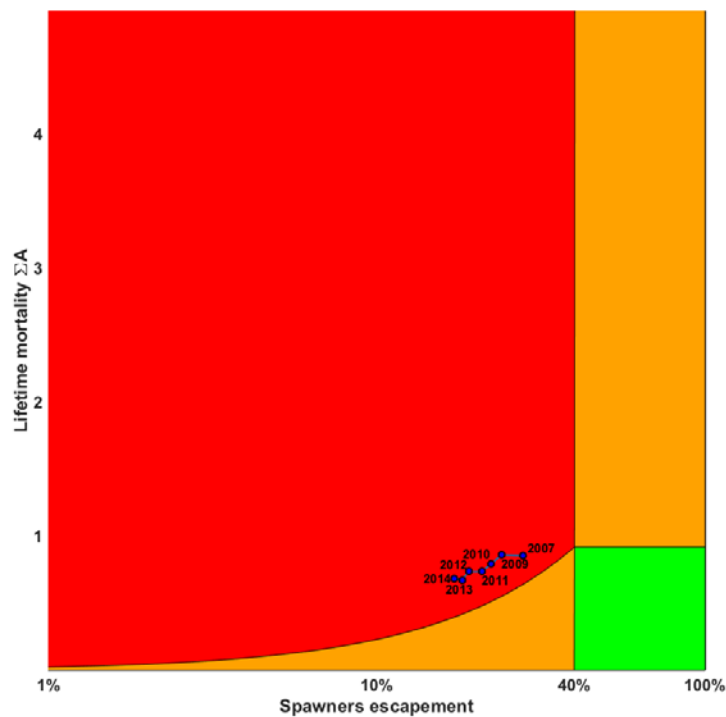


Figure 13.2. Precautionary Diagram for Italian country. It displays the evolution since 2007 showing the effect of the implementation of the EMP (downward evolution). The rightward evolution is due to the effect of recruitment decline. Lifetime mortality does not account for the negative effect of restocking.

13.2.5 Management measures

Table 13.2. Management measures and implementation status for each IT-EMU.

ACTION TYPE	COM FISH	REC FISH	COM FISH	COM FISH	REC FISH	RESTOCKING	HYDRO&PUMPS	OTHER	OTHER	HYDRO&PUMPS	OTHER	OTHER	OTHER
EMU	Professional fishery closure	Recreational fishery closure	Glass eel fishery	Reduction of professional effort	Reduction of recreational effort	Restocking	Transport programs	Habitat restoration	Predators control	Sistemi dissuasivi sulle reti	Habitat improvement	Monitoring programs	Other
VDA	Y	Y	n.r.	-	-	-	-	-	-	-	-	-	-
PIE	Y	Y	n.r.	-	-	-	-	-	-	-	-	-	-
LOM	-	-	n.r.	Y	Y	Y	N	Y	N	N	N	Y	N
TAA	?	?	n.r.	-	-	-	-	-	-	-	-	-	-
FVG	-	-	NA/NA	N	Y	Y	N	N	N	N	N	N	N
VEN	-	-	NA/A	Y	Y	N	Y	Y	N	N	N	N	N
LIG	Y	?	n.r.	-	-	-	-	-	-	-	-	-	-
EMR	-	-	NA/NA	Y	Y	Y	N	Y	N	N	N	Y	N
TOS	-	-	A/A	Y	Y	Y	Y	Y	N	N	N	Y	N
MAR	-	-	n.r.	-	-	-	-	-	-	-	-	-	-
UMB	-	-	n.r.	Y	Y	N	N	N	N	N	N	ns	N
LAZ	-	-	A/A	Y	Y	Y	N	N	N	N	N	N	N
ABR	?	?	n.r.	-	-	-	-	-	-	-	-	-	-
MOL	?	?	n.r.	-	-	-	-	-	-	-	-	-	-
CAM	?	?	?	-	-	-	-	-	-	-	-	-	-
BAS	?	?	n.r.	-	-	-	-	-	-	-	-	-	-
PUG	-	-	NA/NA	Y	Y	Y	N	N	N	N	N	Y	N
CAL	?	?	n.r.	-	-	-	-	-	-	-	-	-	-
SIC	Y	?	n.r.	-	-	-	-	-	-	-	-	-	-
SAR	-	-	NA/NA	Y	Y	N	N	N	N	N	N	Y	N

Legend :

Y : Implemented

N : Not yet implemented

n.r. : Not relevant

- : Not applicable

NA: Not allowed (inland waters/coastal waters)

A: Allowed (inland waters/coastal waters)

13.3 Summary data on glass eel

quantities caught in the commercial fishery

Glass eel catches (eel <12 cm) - kg -, season 2012/2013.

	EMU_VEN	EMU_TOS	EMU_LAZ	TOTAL
Inland waters	0.00	35	83.25	118.25
Coastal waters	145.45	60.2	86	291.65
Total	10.00	95.2	169.25	409.9

Glass eel catches (eel <12 cm) - kg -, season 2013/2014.

	EMU_VEN	EMU_TOS	EMU_LAZ	TOTAL
Inland waters	0.00	135.54	139.00	274.54
Coastal waters	7.00	142.0	19.69	168.69
TOTAL	7.00	277.54	158.69	443.23

Glass eel catches (eel <12 cm) - kg -, season 2014/2015.

	EMU_TOS	EMU_LAZ	TOTAL
Inland waters	89.22	177.2	266.42
Coastal waters	119.59	0	119.59
TOTAL	208.81	177.2	386.01

exported to Asia

NA.

used in stocking

Reconstructed time-series of stockings since 2009.

Year	LOCAL SOURCE				FOREIGN SOURCE			
	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured
2009 *	100			9.502 °				
2010 *	44,5			8.940 °				
2011 *	248,49			6.857 °	130			
2012	145,25			1.930 °	200			
2013	67	+ 125,8		9.352				
2014		492.79		55			500	

* in the years 2009, 2010 and 2011 glass eel fisheries were closed, apart a few particular cases of experimental fishing or Province authorizations for stocking purpose. Glass eel fisheries under the new rule began again in 2011/2012.

° bootlace and yellow eels used for stocking are in part wild eels from France (Camargue), and part from on-grown cultured (Italy, Netherlands), but the exact quantities of each source are not available.

used in aquaculture for consumption

NA.

consumed direct

NA.

Mortalities

NA.

14 Sampling intensity and precision

No relevant data available.

15 Standardisation and harmonisation of methodology

NA.

15.1 Survey techniques

NA.

15.2 Sampling commercial catches

Surveys are currently carried out on a regular basis only under the DCF National Programme 2009–2010, and are foreseen for the 2011–2013 Programme. Samplings are foreseen for every Eel Management Unit (EMU). In Article 2(1) of Regulation (EC) No 1100/2007 for the recovery of the eel stock the river basin units should be generally considered as EMU. Contrary Italy has decided to avail itself of the opportunity provided in the above-mentioned Article 2 of the regulation, which stipulates that 'if appropriate justification is provided, a Member State may designate the whole of its national territory or an existing regional administrative unit as one eel river basin' and, for the reasons highlighted above, therefore proposes the regional administrations as Eel Management Units. This point has been accepted by the Commission and shall therefore remain in the amended version of the Italian Eel Management Plan.

Triennial biological surveys under the DCF National Program are carried out for every EMU (Region), in a site, lagoon or catchment, representative of the EMU in terms of habitat extent and/or amount of eel landings. Eel fishery is still allowed in only nine Regions, which presented a management plan.

About 100 individuals for each eel life stage (yellow and silver eel) are sampled in order to assess stage composition (reconfirm yellow or silver stage), length and age frequency distributions and sex ratio. Sampling is usually carried out by taking a random batch of eels from a fisherman cumulated catch of the day or of the week. Sample processing foresees different procedures depending on data to be obtained from the samples. Usually length and weight are directly measured on anaesthetized eel, and digital pictures for subsequent specific morphometric measurements are obtained. Samples are released if no other observations are due, or else sacrificed or frozen for further analyses.

15.3 Sampling

NA.

15.4 Age analysis

Eel otoliths, once removed from fish heads, were both immersed in distilled water and then cleaned from attached tissues with the absorbent side of a laboratory bench paper. Then otoliths were stored dry in labelled Eppendorf micro tubes and left in a heater (70°C) overnight. Then Eppendorf were closed and stored until otolith examination.

Procedure for aging eel otoliths by grinding and polishing used in the Tor Vergata University Rome for *A. anguilla* species

This procedure provides a safe and reliable method for processing eel otoliths and assessing the age of the eel by counting the annuli illuminated via polarized or transmitted light as a result of the grinding and polishing. This method has been developed at the Cemagref laboratories (Bordeaux, France) but has been modified in several steps in our laboratories.

Each left otolith was placed on the bottom of a numbered mold cavity, external side face up (concave side). Then some drops of an epoxy resin preparation were added each cavity until the mold is filled up. The bubbles under the otoliths were gently removed by moving the sample with a needle. The mold was left drying overnight until the resin is hard, then the resin blocks with the embedded otoliths were removed from the molds.

Each embedded otolith is mounted with the convex side up, on a histological slide with a drop of Eukitt (transparent glue) by quickly pressing the corresponding resin block on it. Glass slides are labelled with appropriate code for the otolith.

The grinding procedure was carried on using a Struers grinding machine (LABPOL-5) beginning with 1200 grits silicon-carbide sanding papers, increasing to 4000 grits until the centre and edge are visible. Slide is checked every so often to ensure that the grinding is in sufficient direction and force and that the origin has not been removed. When satisfied with the level of grinding the otolith is then polished using a jewellery cloth with an abrasive paste (suspension of 1µalumina) to remove any score lines.

The sample is now ready for the hatching with an acid preparation and then for the staining process. A drop of 5% EDTA was applied on each otolith for three minutes and then rinsed with distilled water. Subsequently a drop of 5% toluidine blue is applied on the grinded otolith surface. The stained otoliths were left to dry overnight and then rinsed with water.

Now the otoliths are ready for the observation with the binocular microscope and PC with image acquisition. Each result is recorded within an EXCEL file database.

100% of otoliths were re-read by another operator and “second opinion” was recorded. Moreover after three weeks the first operator makes a second and definitive reading.

Fish age was determined by reading annual otolith rings (annuli) from the first growth check (age 1+) outside the so called “zero band”. This band is commonly assumed as the beginning of continental growth in eel (Moriarty, 1983; Poole *et al.*, 2004; ICES, 2009).

15.5 Life stages

Maturation stage was determined combining gonad development, Pankhurst's (1982) ocular index (OI) which reflects changes in eye diameter during metamorphosis to the silver stage (Acou *et al.*, 2009) and Durif's silvering index (Durif *et al.*, 2005).

15.6 Sex determinations

Sex was assessed macroscopically whenever possible, or by histological examination of gonads (Colombo and Grandi, 1996).

15.7 Data quality issues

NA.

16 Overview, conclusions and recommendations

In the present report, data on eel stock and fisheries are reported for Italy for 2014. As pointed out in the Introduction, notwithstanding the initial delay, Italy has recovered the lag in the application of the Eel Management Plan, approved in 2011, because since 2009 at different levels in Italy the process of implementation of the IT-EMP was already in place. The work concerning the IT-EMP has been up to now coordinated within a National Working Group, that has involved Administrations, Technicians and Scientists.

During 2012, 2013 and 2014, the work of the Nat Working Group has been finalized to the gathering of data for the evaluation of the parameters relative to escapement (B_0 , B_{curr} , B_{best}) required to assess progress achieved through the implementation of the National EMP, as foreseen by Article 9 of Regulation 1100/2007.

This has been done for the first Report in 2012 (PNG Italia, 2012), for the following years in 2013 and 2014 (PNG Italia, 2013; PNG Italia, 2014) and for the second official Report in 2015 (PNG Italia, 2015). Italy, as extensively explained in the IT-EMP and in all Reports and communications, has followed the approach of using for the assessment process a database progressively implemented. Compared to 2008, when the work for the compilation of the IT-EMP was initiated, a series of tools and activities have been put in place between 2009 and 2014, that have resulted in a database much more detailed and reliable, and therefore for the evaluation of the reference points required for the assessment foreseen by art.9, this progressively updated dataset has been used.

In this report, as in the Report 2015 (PNG Italia, 2015), revised estimates of B_0 and estimates of B_{curr} and B_{best} have been presented, calculated using revised estimates of wetted areas and using productivity values in kg/ha diversified by habitat type, based on new evidence from the literature. This approach seems more appropriate, and the only one that allows to take into account the diversity of situations in the various EMU in Italy, balancing the roles of different Management Units in the process of recovery of the eel stock, depending on the type of habitat prevailing in each.

In this report, estimates of some parameters are provided for those regions (eleven) that do not have presented a Regional Management Plan, choosing the option of a total closure of the eel fisheries in their waters. For these regions, which do not participate for the moment in the process of recovery of the eel stock, no data of eel biomass in pristine conditions or in current conditions had been provided in the IT-EMP (PNG Italia, 2009). However, it became necessary to quantify the role that the complete closure of the fishery in these regions can have in terms of biomass of escaping silver eels.

The National Management Plan and the Regional Management Plans are operating in all EMU, Many EMUs (Veneto, Lazio, Toscana, Puglia) and have activated many management projects and initiatives, based on Regional Fundings and specific pro-

jects under the EFF, that are resulting in a management framework well established at the regional level.

A better coordination should be foreseen with regards to glass eel fisheries and glass eel use for restocking, also in consideration that this is a major point of interest. The fragmentation between Central Administration (for coastal waters) and Regions (for inland waters) results in a system lacking coherence for all the aspects involved, i.e. catch registration, sales declaration etc. In some Regions, on the other hand, such as Tuscany, a complete coordination has been set up at the local level, and the system is well established, that foresees specific licences, transfer of catches in specific facilities where glass eels are ongrown to elvers and then used for restocking in the EMU, on the basis of a specific yearly regional restocking plan.

At the national level, the DFC for eel is definitively in place, and this has proven to be a valuable tool for eel management and fisheries evaluation, that also provides a co-ordinated framework for other actions for eel monitoring and assessment.

Overall, the general structure of the Eel Management Plan and the implementation framework are now in place at the National level as well as at the Regional level, despite the fact that some regions are less willing to be involved. To resolve this critical issue, a coordination table which involves the central and regional administrations has been set up, with the support of scientists and technicians, which is unprecedented in Italy for the fisheries and management of inland waters.

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Report on the eel stock and fishery in Latvia 2014/2015

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Reporting Period: This report was completed in November 2015, and contains data up to 2014 and some provisional data for 2015.

2 Introduction

According to Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for the Community action in the field of water policy and Article 2(1) of the Council Regulation (EC) No. 1100/2007 of 18 September 2007 establishing measures for the recovery of the stock of European eel, it has been proposed in Latvia to define only one eel management unit or a single 'eel river basin', which includes part of four river basin districts established for in Latvia while separating the natural eel distribution waters with the adjacent coastal and transitional waters.

Rivers and lakes accessible for eel upstream migration and rivers and lakes without downstream migration obstacles as HPS. Private lakes and lakes, where regular fish winterkills occurs were not included in EMU.

All together 27 rivers with eel habitat area 8718 ha, 15 lakes-15 507 ha and coastal and transitional waters-89 776 ha proposed as LV_Latv EMU waterbodies.

Latvia's EMU belongs to Baltic Sea Ecoregion according to ICES classification or 15. Ecoregion- Baltic province according to WFD.

3 Time-series data

Time-series of landings (yellow and silver eel mixed) in inland and coastal waters and data of restocking by lakes or rivers of country are available from 1949. Electro-fishing surveys in rivers (since 1992) accessible for eel and lakes and rivers restocked by eel:

- historical restocking from 1920s all;
- restocking in frame of EMP from 2011–2014 are available.

3.1 Recruitment

NC.

3.1.1 Glass eel recruitment

NP.

3.1.1.1 Commercial

NP.

3.1.1.2 Recreational

NP.

3.1.1.3 Fishery-independent

NP.

3.1.2 Yellow eel recruitment

NC.

3.1.2.1 Commercial

NC.

3.1.2.2 Recreational

NC.

3.1.2.3 Fishery-independent

Electrofishing data?

3.2 Yellow eel landings

NC.

3.2.2 Commercial

NC.

3.2.3 Recreational

NC.

3.3 Silver eel landings

Mixed silver and yellow eel landings since 1949 from three lakes situated in EMU.

3.3.1 Commercial

NC.

3.3.2 Recreational

NC.

3.4 Aquaculture production**3.4.1 Seed supply**

NP.

3.4.2 Production

NP.

3.5 Stocking**3.5.1 Amount stocked**

From 2011 all glass eel restocked only in EMU lakes and rivers. All previous restockings carried out in lakes up from dams, inaccessible for eel. Some municipalities restock ongrown eel in lakes not included in LV_Latv.

3.5.2 Catch of eel <12 cm and proportion retained for restocking

NP.

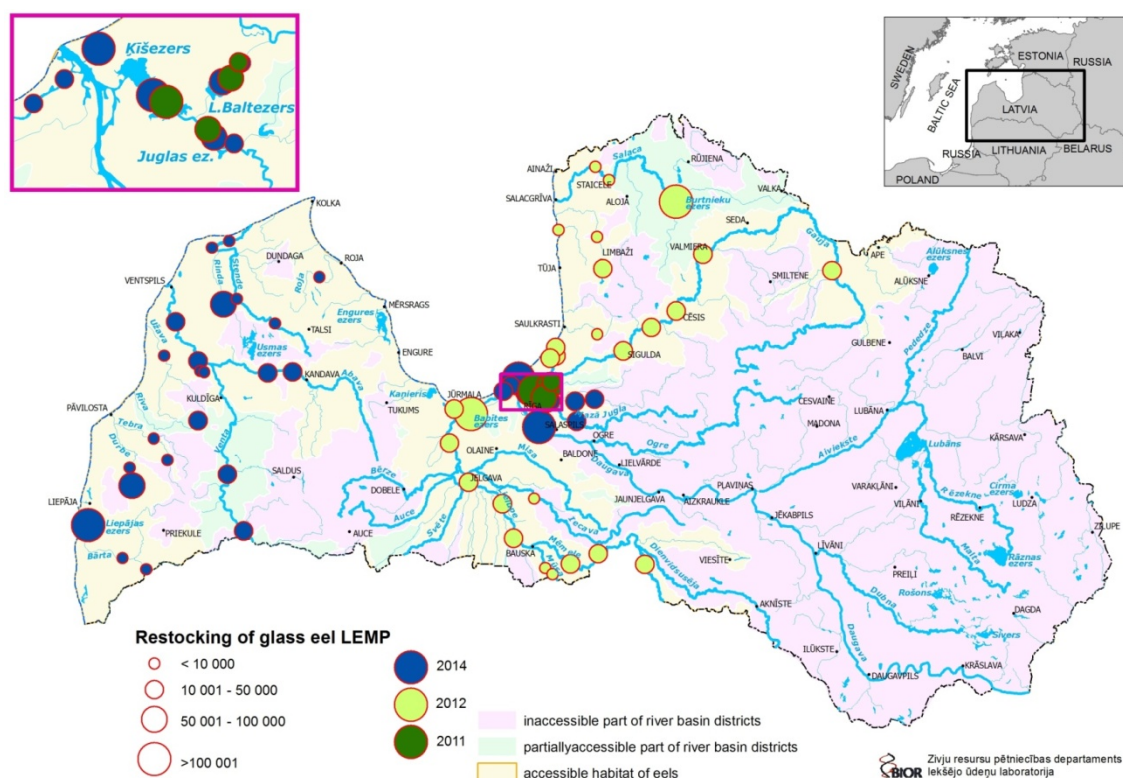
3.5.3 Reconstructed time-series on stocking

Restocking in EMU waterbodies x 1000.

Table 3.1. Stocking of cultured and wild eel in country since 1984.

Year	Local Source					Foreign Source				
	Glass eel (n)	Quarantined Glass (n)	Wild Yellow (n)	On-grown cultured (n)	Total	Glass eel (nx1000)	Quarantined Glass (n)	Wild Yellow (n)	On-grown cultured (nx1000)	Total GEE (n)
1984										
1985						1481				
1986										
1987						260				
1988						2978			72,5	
1989										
1990										
1991										
1992										
1993										
1994										
1995						572				
1996										
1997										
1998										
1999						294				
2000										
2001										
2002						270,8				
2003										
2004										
2005						120				
2006						3			3	
2007						15			3 (8)	
2008									4,25 (18)	
2009										
2010									8,7 (14)	
2011							386		3,64 (3-5)	
2012							1030		4	
2013									6,285 (5-10)	
2014							1386,2			

All restocking- foreign source; EEL- restocked in frame of EMU; EEL- restocked by fishing rights owners, inland lakes outside EMU; EEL- restocked by municipalities; ()- in brackets weight in g.



NOTES:

- Local Source: The source of the stocked eels is local;
- Foreign Source: Eels come from another country;
- Split the stocked eels into the stages in the column headings, do not add anymore;
- Please, translate the number of Wild Yellow and ongrown cultured into GEE (Glass Eel Equivalents). If you are not able to do that, you must provide average size of stocked eels; and in case you have it, mortality rates and growth and/or age in order to make the transformation to GEE.

3.6 Trade in eel

Catches are too low for trade outside from Latvia. Market price for fresh eel was 16–20 Euros/kg in 2014–2015. These prices were first sale prices about eel >1 kg. Price of foreign aquaculture eel (probably Dutch origin) was 10–12 EUR in market.

4 Fishing capacity

Table 4.1. Data regarding number of gear allowed and number of companies operating in eel fishery in EMU LV_latv lakes available from 2007.

Year	Number of gear in operation	Number of companies
2007	64	16
2008	68	16
2009	68	15
2010	68	13
2011	68	12
2012	68	14
2013	68	13
2014	68	13

Number of licences issued are same as number of companies operating in fisheries. Largest part of these companies belongs to smallest enterprises form where owner is also only fisherman in one person.

4.1 Glass eel

NP.

4.2 Yellow eel

Mixed, but more probably silver eels.

4.3 Silver eel

Mixed, but more probably silver eel. Same as in Table 4.1.

4.4 Marine fishery

NP, eel caught only as bycatch in coastal gears, less than 0,2 t/year. In 2014 44 fisherman's reported eel bycatch all together 0,19 t.

5 Fishing effort

Number of gear are limited annually every year by Cabinet Instruction. Table 4.1 shows: number of gear allowed in LV_Latv approved for calendar year by Instruction.

Landings are reported in monthly logbooks by the date, number and type of gear, catch/landing in kg. Logbooks are obligation. Zero catches are registered too. Fishing effort would be calculated as gear days.

Two type trapnets are allowed in LV_Latv waterbodies:

- trapnets with side arm less than 30 m;
- trapnets with side arm more than 30 m.

Number of gear by waterbody is limited, total limit for EMU is 70 trapnets, 68 in operation.

5.1 Glass eel

NP.

5.2 Yellow eel

NP.

5.3 Silver eel

Bycatch of other species are allowed in eel fisheries. Low catches of eel is not reason to decrease the number of gear or length of fishing season.

Table 5.3. Fishing effort and landings (kg) of eel LV_EMU (three lakes).

Year	Effort (trap days)	Landing of eel
2004	10760	651
2005	13820	619
2006	14257	412
2007	14625	412
2008	13254	420
2009	11052	400
2010	11023	322
2011	9759	231
2012	10845	287
2013	13480	381
2014	n.a.	n.a.

5.4 Marine fishery

Number of gear are limited. Effort calculation possible, but no reason to do that due to very low catch.

6 Catches and landings

Eel landings in Latvia (t).

	YEAR								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Coastal	2	1,1	1	0,8	1,0	0,7	0,5	0,3	0,19
Lakes ¹	6	8,5	12,0	4,2	8.2	5.4	5,9	4,4	4,2
Total	8,0	9,6	13,0	5,0	9,0	6,1	6,4	4,7	4,4

¹- Eel landings in rivers and reservoirs are <50 kg, added to landings in lakes.

Mixed landings. In coastal waters more probably silver eel.

Table 6. Eel landings (kg) in LV_Latv (EMU waters).

	FRESHWATER	FRESHWATER	SALT WATER
	LAKES	RIVERS	COASTAL
1949	2004		
1950	3083		10000
1951	2655		10000
1952	2729		10000
1953	2137		20000
1954	2644		20000
1955	6149		40000
1956	4448		20000
1957	4510		20000
1958	4999		20000
1959	4410		24000
1960	6245		37000
1961	6603		43000
1962	4257		41000
1963	7952		56000
1964	5927		37000
1965	5252		35000
1966	5380		33000
1967	3727		39000
1968	4182		28000
1969	4813		36000
1970	3072		21000
1971	3175		17000
1972	1700		15000
1973	1185		19000
1974	800		12000
1975	1000		10000
1976	794		12000
1977	389		10000
1978	505		6000
1979	381		6000
1980	838		1000
1981	759		2000
1982	1010		2000
1983	621		1000
1984	590		1000
1985	660		2000
1986	850		1000
1987	622		2000
1988	1180		1000

	FRESHWATER	FRESHWATER	SALT WATER
	LAKES	RIVERS	COASTAL
1989	650		1000
1990	374	86	1000
1991	380	111	1000
1992	71		1000
1993	318	79	1000
1994	900	111	1000
1995	815	89	1000
1996	1406	42	2000
1997	894	92	1000
1998	253	23	2000
1999	460	78	2000
2000	599	43	2000
2001	765	76	2000
2002	807	52	2000
2003	811	206	2000
2004	599	34	2000
2005	619	37	2600
2006	472	74	2100
2007	430	24	1100
2008	420	4	1000
2009	400	9	900
2010	322	4	1000
2011	231	4	660
2012	287	0	498
2013	381	0	280
2014	200	0	194

6.1 Glass eel

NP.

6.2 Yellow eel

NP.

6.3 Silver eel

More probable silver eel for last decade (Table 6.).

6.4 Marine fishery

No reason reduce due to losses for other sectors of fishery.

6.5 Recreational Fishery

NC, planned from 2016.

Recreational Fisheries: Retained and Released Catches

Retained					Released			
Inland			Marine		Inland		Marine	
Year	Angling	Passive Gears	Angling	Passive gears	Angling	Passive gears	Angling	Passive gears

Provide the catch and release mortality (%) used in your country for angling in marine and inland waters.

Recreational Fisheries: Catch and Release Mortality

Released			
Inland		Marine	
Angling	Passive gears	Angling	Passive gears
Year			

6.6 Bycatch, underreporting, illegal activities

All eel caught in coastal waters are bycatch, proportion of eel is less than 1% from total catch in herring poundnets, traps, bottom longlines and eelpout fyknets (all fixed gear). Dataseries from 1992 available.

Table 6.2. Estimation of underreported catches in Country, per EMU and Stage.

		Glass eel				Yellow eel				Silver Eel				Combined (Y + S)			
Year	EMU_code	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)
2013	EMU_a																
	EMU_b																
	EMU_c																
	EMU_d																
	EMU_e																
	EMU_f																
	Total/mean (%)																

Table 6.3. Existence of illegal activities, its causes and the seizures quantity they have caused.

[illegible]

7 Catch per unit of effort

BIOR using system of fishermen and observers reporting all the catch and bycatch including sea mammals, birds, invasive species, strayers, etc. in coastal gear by type and date of fishing for all season. Data not used for eel assessment due to very low catches. Important for herring stock assessment and DCF.

7.1 Glass eel

NP.

7.2 Yellow eel

NC.

7.3 Silver eel

NC.

7.4 Marine fishery

Few years' data for one trap in the Gulf of Riga reported as number of eel by date of fishing. All caught eels sampled for DCF.

8 Other anthropogenic and environmental impacts

Some research results (but not about eel) are reported in book: Climate change in Latvia and adaptation to it /Eds. Maris Klavins and Agrita Briede. Riga: University of Latvia press, 2012. 188 pp. Increase of water temperature and eutrophication would be factors improving eel living conditions in Latvia.

9 Scientific surveys of the stock

No surveys.

10 Data collected for the DCF

From Latvia's DCF report

The precision levels have been calculated for length and weight-at-age, sex ratio and sexual maturity of all collected fish species Latvia has planned the sampling at CV 0.025.

During 2014 for the estimation of precision, the methods included into the COST toolbox (for species that had data in COST format) as well as analytical and bootstrap methods adopted for the calculation of precision were used.

The main reasons why the precision levels of national data are deviating from target can be summarized as follows:

- 1) Differences in growth of males and females and also in sex distribution by ages;
- 2) For sex ratio age variable there were not enough age readings by species. If target should be met it is necessary to increase age reading samples or the target should be changed;
- 3) Smaller number of sampled fish in youngest and eldest age groups;

- 4) There were too many length classes and métier groups and small number of fish in each group;
- 5) Evidently that the required precision levels are too high and to reach them the number of samples had to be substantially increased and accordingly the expenses of the sampling.

Table 10.1. Summary of the DCF monitoring implementation per EMU in 2014.

Data	River	Lakes	Estuaries	Lagoons	Coastal & Marine
No. of production / escapement surveys ¹					
No. of recruitment time-series surveys ²					
No. fished aged ¹					30 Otoliths collected
No. of fished sexed					76
No. of fish examined for parasites					76
No. of fish examined for contaminants					
No. of non-fishery mortality studies ³					
Socio-economic survey					

¹ Surveys to estimate B_{best} and/or $B_{current}$ [These should include WFD surveys where the data are being used to estimate production and/or escapement of eel].

² Fishery-independent surveys.

³ Studies to determine ΣH for non-fisheries anthropogenic impacts, such as hydropower, barriers, predation, etc.

11 Life history and other biological information

Research and popular publications on eel in Latvia:

Andrušaitis, G. 1960. Zivju savairošana un aklimatizācija Latvijā. –In: LPSR Iekšējo ūdeņu zivsaimniecība, IV, Rīga [The fish re-stocking and acclimatization in Latvia].

Cimermanis, S.1998. In.: Zveja un zvejnieki Latvijā 19.gs.Latvijas Zinātņu Akadēmijas Vēstis, Rīga. [Fisheries and fishermen in Latvia].

Eglītis, P. 1937. Zušu audzēšana Latvijas ezeros. Zvejniecības Mēnešraksts, II, Nr.2, Rīga. [Eel re-stocking in the lakes of Latvia].

Kairov E.A., Rimsh E.Y. Biocommervial characteristic of the Gulf of Riga eel. (In Russian)- In: Rybokhozaistvenniye issledovanya (BaltNIIRKH), Rīga, Zvaigzne, 1979, p 83–90.

Ludvigs, P. 1940. Zvejniecība un zivkopība. In.: Latvijas zeme, zemnieki un viņu darbs, XIX Lauksaimniecības pārvalde, Rīga [Latvia, Latvia's farmers and their labour].

Mansfelds, V.1936. Latvijas zivis. In.: Latvijas zeme, daba un tauta, II., Rīga, 1936.

[The fish of Latvia].

Mansfelds, V. 1937. Zušu sarkansērga Liepājas ezerā. Zvejniecības Mēnešraksts, II, Nr.7, Rīga, 1937.

Miežis, V. 1925–1939. In.: Latvijas jūras zvejniecība 1924–1938. Rīga, Lauksaimniecības pārvalde, 1925–1939.

[Sea fisheries in Latvia].

Miežis, V. 1938. Zušu zveja. Zvejniecības Mēnešraksts, II, Nr.7, Rīga, 1938.

[Eel fisheries].

Sapunovs, A. 1893. Reka Zapadnaja Dvina (in Russian). Tipografija G. A. Malkina, Vitebsk, 1893.

[The river Daugava]

Volkova L.V., Tarkach G.M. Growth of eel in lakes of Latvia. (In Russian) In: Rybokhozaistvenniye issledovanya (BaltNIIRKH), Riga, Zvaigzne, 1971, p. 83–89.

11.1 Growth, silvering and mortality

NC, ND.

11.2 Parasites and pathogens

Sampled eel examined for *Anguillicola* presence.

11.3 Contaminants

NR.

11.4 Predators

NC.

One research project carried out in 2011. Available in Latvian. Reason for project- assessment of losses for inland fish resources due to cormorants.

12 Other sampling

13 Stock assessment

13.1 Method summary

NC.

13.1.1 Estimate of B_0

NC.

Table 13.1. Reference period for B_0 .

EMU_code	B0 (kg/ha)	Reference time period	Whether or not
			changed from value reported last year (Y/N)

13.2 Summary data

NC.

13.2.1 Stock indicators and Targets

NC.

EMUCODE	INDICATOR	BIOMASS (T)	MORTALITY (RATE)	TARGET					
	B ₀	B _{best}	B _{curr}	ΣA	ΣF	ΣH	Source	Biomass (t)	ΣA (rate)
XY_abcd							EMP		
							EU Reg		
							WGEEL		
XY_abcd							EMP		
							EU Reg		
							WGEEL		

13.2.2 Habitat coverage

EMU code	River		Lake		Estuary		Lagoon		Coastal	
	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)
LV_Latv	8718		15 507						89 776	

13.2.3 Impact

A = assessed, MI = not assessed, minor, MA = not assessed major, AB = impact absent.

EMU code	Habitat	Fish com	Fish rec	Hydro & pumps	Barriers	Restocking	Predators	Indirect impacts
LV_Latv	Riv	AB	MI	AB	A	A	MI	
LV_Latv	Lak	MI	MI	AB	A	A	MI	
	Est							
	Lag							
LV_Latv	Coa	MI	MI	AB	AB	AB	MI	
	All							

EMU code	Stage	Fish com	Fish rec	Hydro & pumps	Barriers	Restocking	Predators	Indirect impacts
XY_abdc	Glass							
	Yellow							
	Silver							
	Silver EQ							

13.2.4 Precautionary diagram

NC.

13.2.5 Management measures

EMU code	Action Type	Action	Life Stage	Planned	Outcome
LV_Latv	Com Fish				
	Rec Fish	Bag limit decreasing		three from 2016	
	Hydropower & Pumps				
	Restocking	Realised as planned			
	Other				

13.3 Summary data on glass eel

Data on number restocked glass eel in chapter 3.5.

quantities caught in the commercial fishery
exported to Asia
used in stocking
used in aquaculture for consumption
consumed direct
mortalities

14 Sampling intensity and precision

Sampling of eel from commercial fishery carried by sampling of all caught eels from one trap in the Gulf of Riga, last two years number of sampled eel <100. Data are not analysed, otoliths stored in collection.

Young yellow eel caught in rivers and lakes sampled in same way- length, weight, sex, eye diameter, pectoral fin length. Otoliths stored in collection.

15 Standardisation and harmonisation of methodology

15.1 Sampling commercial catches

Fishermen as observer. All landed eels sampled.

15.2 Sampling

All landed eels from one trap, all season. Fresh eel analysed.

15.3 Age analysis

Ages were not analysed.

15.4 Life stages

Criteria for life stages: *as in* EELREP Project (1 November 2001–31 January 2005) *Summary & Recommendations*. Estimation of the reproduction capacity of European eel.

15.5 Sex determinations

From macroscopic examination of the gonads.

15.6 Data quality issues

16 Overview, conclusions and recommendations

17 Literature references

Report on the eel stock and fishery in Lithuania 2014/2015

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Reporting Period: This report was completed in November 2015, and contains data up to 2014 and some provisional data for 2015.

2 Introduction

2.1 ICES ecoregion

Baltic Sea.

2.2 Eel habitats

Eel habitats in Lithuania include lakes, reservoirs, the Curonian Lagoon and the Baltic Sea coastal zone. According to Barak and Mason (1992), natural populations of eel in rivers are concentrated in estuaries or lower reaches. Eel are found more than 1000 km upstream. However, normally the migration rate of their populations is less than 20 km a year (Dekker, 2004). It is evident that this migration, when occurring during the stage of the yellow eel, depends on the population density. Eel migration route from the Curonian Lagoon to upstream of the Nemunas can reach more than 100 km, but the population density in the upstream is relatively small. According to the survey results, yellow eels occasionally caught in lower reaches of Nemunas by amateur fishermen. According Commercial fishing statistics eel catches in the Nemunas delta fluctuated between between 0.1 t and 0.3 t per year during the period 1950–1969. Eels fishing with typical fishing gears is complicated in the lower reaches of river Nemunas, because streams and bottom structure. At present commercial eel fishing is banned in the river Nemunas. Yellow eel are extremely rare in small Lithuanian rivers; according to Virbickas (pers. comm.) in Lithuania and Birzaks in Latvia (pers. comm.), decades-long studies of electrofishing have shown just a few eels caught in rivers. Those few eel in rivers have been found in the streams at short distance from the lakes stocked with eel (Lithuania) or by river dams near the sea (Latvia). Thus, in the present state of stocks, small rivers in Lithuania are not considered typical eel habitats, but they are ways of silver eel migration. Most of the bigger lakes are located in the eastern part of Lithuania, 300 km from the sea. Only artificially stocked eels were found there.

2.3 River basins in Lithuania and EMU according to national EMP

Lithuania has 2782 lakes with areas exceeding 0.5 ha (88 548 ha) and 1159 reservoirs with areas over 0.5 ha (28 306 ha), also 4418 rivers longer than 3 km, their total length measuring 37 636 km and their surface area totalling 33 200 ha. Lakes and reservoirs over 50 ha number 285 (68 754 ha) and 70 (21 291 ha) respectively. Lithuanian territory covers 41 300 ha (26%) of the Curonian Lagoon (total area 158 400 ha). The Baltic Sea coastal zone is the area between the coastline and the 20 m depth isobath. This zone makes up an area of 41 500 ha. According to Directive 2000/60/EC, there are four RBDs in the territory of Lithuania (Figure 2.2.1).

- 1) Nemunas RBD (73.9% of the LT territory);
- 2) Daugava RBD (2.8% of the LT territory);
- 3) Lielupe RBD (13.7% of the LT territory);
- 4) Venta RBD (9.6% of the LT territory).

All four RBDs are transboundary basins. The largest one is the Nemunas RBD where 41.9% of the river basin area is in the territory of Lithuania, 39.6% in Belarus, 9.7% in Poland, 8.7% in Russia (the Kaliningrad region) and 0.1% in Latvia.

The Daugava, Lielupe and Venta RBDs are situated in the territories of Lithuania and Latvia. The Daugava RBD is also located in the territories of Russia and Belarus. Only 2.8% of the territory of this RBD is in Lithuania, where eel habitats (lakes) are not numerous. In addition, the habitats are not viable for the recovery of eel stocks as there are as many as three large HPs on the Daugava River in the territory of Latvia. With regard to this, Lithuania does not find it reasonable to recover stocks in this part of the Daugava RBD as long as the HPs should cause mortality for migrating the silver eel. Lithuania will apply common EMP measures by way of fishery restrictions in this part of the Daugava RBD, just as it does in the remaining territory of the country.

The Lielupe and Venta RBDs are situated in the territories of Lithuania and Latvia only. In Lithuania, these two basins cover 23.3% of the country's area, but habitats appropriate to eel (lakes and reservoirs) make up only 4.2% and 4.4%, respectively. It should be noted that over the past ten years the annual eel catch in inland waterbodies has only been 5.1 tonnes on average and has depended on stocking. The Lielupe and Venta RBDs practically have no eel as no stocking in the waterbodies of the Lielupe basin has occurred since 1983, while stocking in the Venta basin has amounted to 0.1% of the total quantity of stocked eel in the same period. In addition, the Venta basin has a number of hydropower plants built in series on rivers that have their source in the basin's largest lakes. Under these circumstances Lithuania does not see need to prepare the individual plans for the RBDs where eel are practically non-existent at present. However, common EMP measures will be applied to the territories of these RBDs by imposing fishery restrictions. With a view to recovering the eel population in these RBDs, Lithuania will apply measures similar to those in the whole territory of the country. However, it would implement those actions only upon coordinating them with Latvia to ensure migration of silver eel.

Lithuania has designated one Management Unit for the EMP based on Council Regulation (EC) 1100/2007 where Article 2(1) stipulates such a possibility and is developing one EMP for the whole territory of the country. The EMP Management Unit has been designated according to Lithuania's division into RBDs under Directive 2000/60/EC. The EMP also includes the Baltic Sea coastal zone. Assumptions for the designation of one EMU:

- The commercial catch and stocks of eel are not high in the territory of Lithuania and have averaged around 15 t annually over the past ten years;
- The Nemunas RBD comprises 74% of the territory of Lithuania and 81% of eel habitats;
- About 99% of eels stocked since 1983 are found in the Nemunas RBD;
- About 99% of the eel catch and stocks are attributed to the Nemunas RBD;
- The Nemunas RBD includes 96% of lakes of reservoirs from which eel can escape unaffected by turbines or through passes installed on HP dams;

- Although the Daugava RBD comprises a fairly large part of lakes and reservoirs (11.6%), escapement of eel to the sea is restricted by three large HPs in Latvia;
- Conditions in the other RBDs are similar (except for the different impacts of HPs), thus no specific measures for implementation of the plan in the other basins are needed.

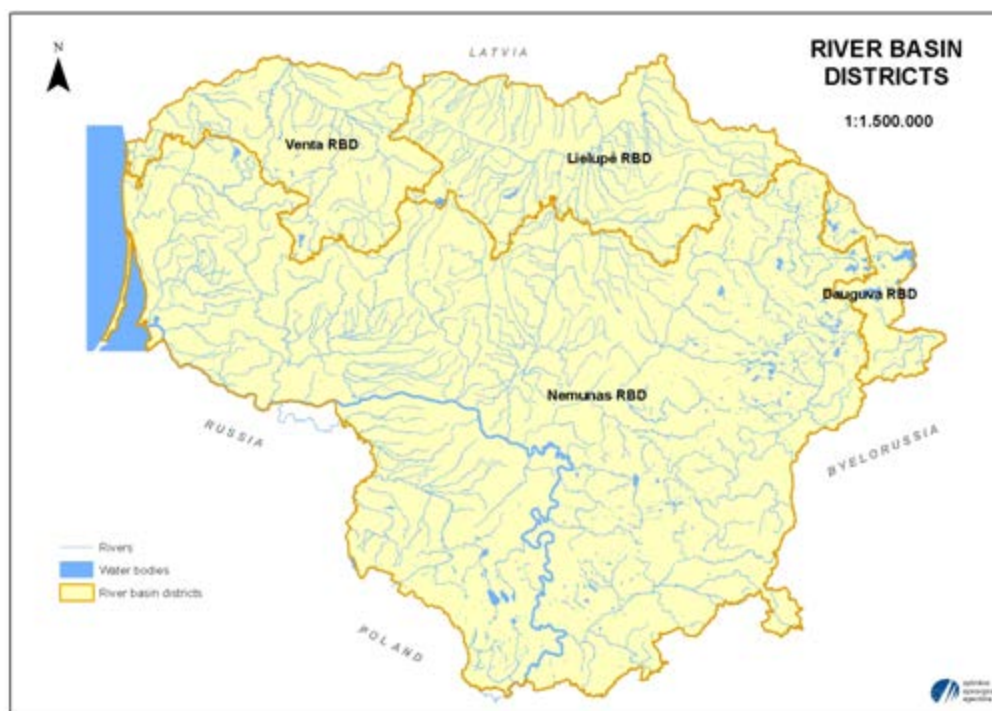


Figure 2.3.1. Lithuanian River Basin Districts.

2.4 Eel fishery

According to importance, fishery features, catches and the origin of eels, fisheries in Lithuania should be divided into fishery in inland waters and the Curonian Lagoon, and very small-scale fishery in the Baltic Sea. Commercial fishery statistics have been available since 1926. That year saw a 55.1 tonne catch of eel. Similar catches were recorded until 1938. Active fishing began again from the early 1950s (at least statistics became available), and the average catches of eel were 141 tonnes during 1953–1978. The largest catches amounting to 260 tonnes were recorded in 1963. Catches went into decline from the mid-1970s, and over the last ten years they have made up 13 tonnes on average. During 1926–1990, the major part of catches (more than 90%) came from the Curonian Lagoon.

During the period from 1947 to 1980, eels on average accounted for 48% of the total value of fish products in the Curonian Lagoon. The value of catches from these waterbodies in 2001–2010 amounted to about 200 000 EUR. Eels consisted 9% of the value of catches at the price of 20 EUR/kg (the average price of other fish was 1.5 EUR/kg). Therefore, despite relatively low catches, income from the eel fishery in the structure of fishermen's income was significant.

2.5 Fishery management and authorities responsible for EMP implementation

Pursuant to the Law on Fisheries of the Republic of Lithuania (27 June 2000, No VIII-1756), the regulatory authorities in the fisheries sector are:

The Ministry of Agriculture which participates in the making and implementation of the Lithuanian fisheries policy, conducts management of the fisheries sector, implements the Common Fisheries Policy of the European Union, organises and implements conservation and control of fish stocks in maritime waters; establishes the procedure for commercial fishery and issues permits for fishing in maritime waters; owns, manages and uses a data system of fisheries in maritime waters (exploitation of fish stocks, users, economic and biological data, etc.).

The Ministry of Environment which participates in the making and implementation of the fish stock conservation and control policy, conducts public management of the fisheries sector in inland waterbodies; establishes the regulation for commercial and recreational fisheries in inland waterbodies and issues permits (except for private fish waterbodies); owns, manages and uses a data system of fisheries in inland waterbodies (use of fish stocks, users, economic and biological data, etc.).

The Ministry of Agriculture and the Ministry of Environment which, within their respective competence, organise the recovery of fish stocks and fisheries research in fisheries waterbodies.

The Ministry of Environment is responsible for the exploitation of fish stocks in inland waterbodies, including the Curonian Lagoon. The Ministry of Agriculture is responsible for the implementation of the Common Fisheries Policy of the European Union. Since the Council Regulation contains the obligation to prepare and implement the EMP, therefore both ministries assume the responsibility for preparing and implementing the plan. In addition, conservation measures for protected fish species, including the eel, and their habitats and migratory routes are established and their implementation is controlled by the Ministry of Environment, while the work of improving the conditions for farming, spawning and migration of protected fish species is organised by the Ministry of Agriculture or a body authorised by it. The procedure for fisheries in public fisheries waterbodies and also of eel stocking, carried out according to the programmes approved by the Ministry of Agriculture and agreed with the Ministry of Environment, is also established by both ministries.

3 Time-series data

Only time-series of landings (yellow and silver eel mixed) in inland and coastal waters and data of restocking by waterbody available.

3.1 Recruitment series and associated effort

3.1.1 Glass eel

Glass eel do not occur in Lithuanian waters. The likelihood that eel used to come to the Lithuanian coast in the glass eel stage at the beginning of the 20th century cannot be ruled out. However, the last two reports on glass eel found in coastal streams come from the mid-1940s.

3.1.1.1 Commercial

Glass eel do not occur in Lithuanian waters.

3.1.1.2 Recreational

Glass eel do not occur in Lithuanian waters.

3.1.1.3 Fishery-independent

Glass eel do not occur in Lithuanian waters.

3.1.2 Yellow eel recruitment

No available data.

3.1.2.1 Commercial

No available data.

3.1.2.2 Recreational

No available data.

3.1.2.3 Fishery-independent

A study of eel otoliths' microchemistry intending to restore the migratory past and origin of eels have established that all eel examined in inland waterbodies are stocked, while in the Curonian Lagoon and the Baltic Sea coastal zone 80% and 98% of eel respectively come from natural migration and 20% and 2% are stocked. These studies indicate that eel arrive in Lithuania's freshwater bodies in the stage of the yellow eel at the age ranging between one and ten years (average 5.2 (± 2.1)) (Schiao *et al.*, 2006; Lin *et al.*, 2007). 2014–2015 studies indicated that more than 90% commercial catch of eels in Curonian Lagoon consist of artificially stocked eels.

3.2 Yellow eel landings**3.2.1 Commercial**

Total landings of yellow and silver eels combined. Landings separated using 2012–2014 DCF data.

Table 3.2.1.1. Yellow Eel landings (in tons) in the Lithuania waterbodies.

YEARS	***0	***1	***2	***3	***4	***5	***6	***7	***8	***9
1940–1949	n/d	n/d	n/d	n/d	n/d	n/d	n/d	2.5	4.5	6.7
1950–1959	9,0	10,2	12,5	25,6	47,3	52,9	42,5	54,6	48,3	50,2
1960–1969	53,5	45,1	50,1	84,4	73,1	40,2	76,8	48,9	52,7	42,6
1970–1979	36,6	38,7	39,5	37,1	26,6	35,5	27,4	20,8	21,0	16,5
1980–1989	13,5	7,9	7,7	6,5	6,6	7,9	8,8	5,3	6,4	5,4
1990–1999	4,7	3,9	3,1	2,7	3,2	2,5	2,5	2,8	4,5	5,2
2000–2009	3,2	3,5	3,8	3,6	4,4	5,8	4,5	3,9	3,5	2,3
2010–2019	4,3	2,6	1,7	3,3	2,3					

3.2.2 Recreational

No available data.

No statistics of the recreational fishery on eels are available. Studies of the impact of recreational fishery on eels have been performed in 2012. Data on eel landings to the inland waters from the recreational fishery was collected using the questionnaires strategy. Data on total catch volume was estimated using the questionnaires on the number of anglers participating at inland angling trips in different parts of Lithuania. Data on the total number of fishermen were taken from the Ministry of Environment. There are no records for eel catches in the marine waters of Lithuania. Total volume of eel catch in the inland waters and Curonian Lagoon estimated was nearly 1.4 tonnes in 2012, 3.0 tonnes in 2013 and 1.8 tonnes in 2014.

3.3 Silver eel landings

3.3.1 Commercial

No available data. Total landings of yellow and silver eels combined. Landings separated using 2012–2014 DCF data.

Table 3.3.1.1. Silver Eel landings (in tons) in the Lithuania waterbodies.

YEARS	***0	***1	***2	***3	***4	***5	***6	***7	***8	***9
1940–1949	n/d	n/d	n/d	n/d	n/d	n/d	n/d	5.1	9.4	13.9
1950–1959	19,9	22,1	26,8	53,9	99,2	110,4	88,8	113,6	100,3	104,8
1960–1969	111,4	94,0	104,9	175,5	152,2	84,4	161,3	103,9	112,0	91,0
1970–1979	80,9	85,4	86,4	82,5	59,6	78,4	61,0	47,5	49,1	40,2
1980–1989	31,6	19,1	20,6	16,9	19,9	20,7	23,2	14,8	16,8	15,4
1990–1999	13,8	11,9	8,5	7,5	9,2	7,0	6,1	7,9	12,7	12,8
2000–2009	7,9	8,3	8,8	8,7	11,9	15,9	11,4	11,0	10,0	6,3
2010–2019	14,5	8,5	6,1	12,5	5,4					

3.3.2 Recreational

No available data.

3.4 Aquaculture production

3.4.1 Seed supply

No available data.

3.4.2 Production

In Lithuania, eel have been reared by one company since 1998, which in recent years has produced about ten tonnes of eel annually (Table 3.4.2.1). The aquaculture company, Auksinis ungurys Ltd, is about to complete building a new aquaculture facility and expects to produce 100 tonnes of eel per year. After it is completed the company will need 280 kg of glass eels annually. According to the company, they exported eels for stocking to Belarus in 2004–2008 (Table 3.4.2.2).

Table 3.4.2.1. Marketable and Values yellow and silver eel production in aquaculture during 1998–2013.

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Production, t	2	2	1	5	17	20	9	8	12	13
Values, million*EUR	0.1	0.1	0.05	0.25	0.85	1.0	0.45	0.4	0.6	0.65
	2008	2009	2010	2011	2012	2013	2014			
Production, t	10.6	12.0	8,3	12,6	3,5	3.0	13			
Values, million*EUR	0.53	0.6	0.415	0.63	0.175	0.15	0,17			

Table 3.4.2.2. Auksinis ungurys Ltd. information on exports to Belarus.

YEAR	QUANTITY, UNITS	SIZE
2004	375 000	1–4 g
2005	1 050 000	glass eels
2006	150 000	1–5 g
2007	350 000	1 g
2008	260 000	1–5 g
Total	2 185 000	

3.5 Stocking

3.5.1 Amount stocked

Stocking of lakes with glass eel in the territory of Lithuania was carried out in 1928–1939 in the Vilnius area (a part of the area and the stocked lakes now belong to Belarus). Back then, about 3.2 million glass eel were stocked. In the post-war period, stocking of Lithuanian inland waterbodies with glass eel originating in France or Great Britain began in 1956 (or 1952, according to other data). During 1956–2007, a total of 148 lakes and reservoirs covering an area of 95 618 ha was stocked. About 50 million glass and juvenile eels were stocked in total, or 1.25 million per year on average (Figure 3.5.1.1). Some 89% of them were stocked in the Nemunas RBD, mostly in the basins of the rivers Žeimena and Šventoji. Stocking during the most intensive period of 1960–1986 amounted to 33.2 million eel. The area of waterbodies where stocking was carried out comprised 40 204 ha, and the average stocking density made up almost 826 individuals/ha throughout the whole period. Later on, the quantities declined and stocking was sporadic, but small quantities were stocked on an annual basis. The last more sizeable stocking took place in 2004 with 70 100 juvenile eel stocked. From 1983 (a period when at least some eel could have remained in the country's waterbodies) about ten million eel were stocked, their major part (96.5%) being in the Nemunas basin (99% of the Nemunas RBD). Lakes of the Žeimena (60%) and the Šventoji (19%) sub-basins saw the most intensive stocking. Stocking in the Curonian Lagoon (143 000) in that period was low (Figure 3.5.1.2). Stocking activities started again in 2010 (Table 3.5.1.3.). 28 895 individuals were released in 2010, 152 000 individuals were released in 2011, 490 660 individuals in 2012 in inland waters. About 10 % of released individuals were marked by colorant Alizarin. Main stocking activity was performed by Fishery service under the Ministry of Agriculture of the Republic

of Lithuania. Stocking by fisheries companies and individual fishermen was less important.

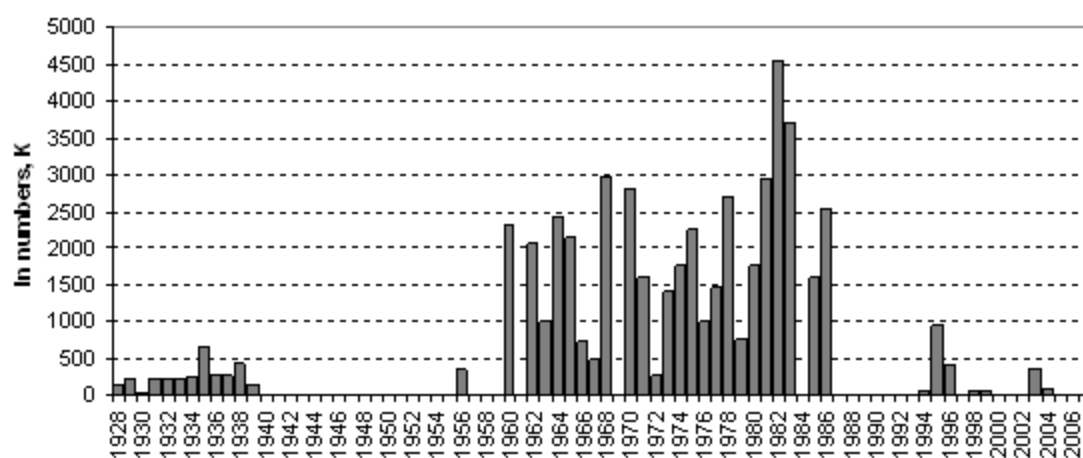


Figure 3.5.1.1. Stocking of inland waterbodies with glass eels in the period 1928 to 2006 (thousand units).

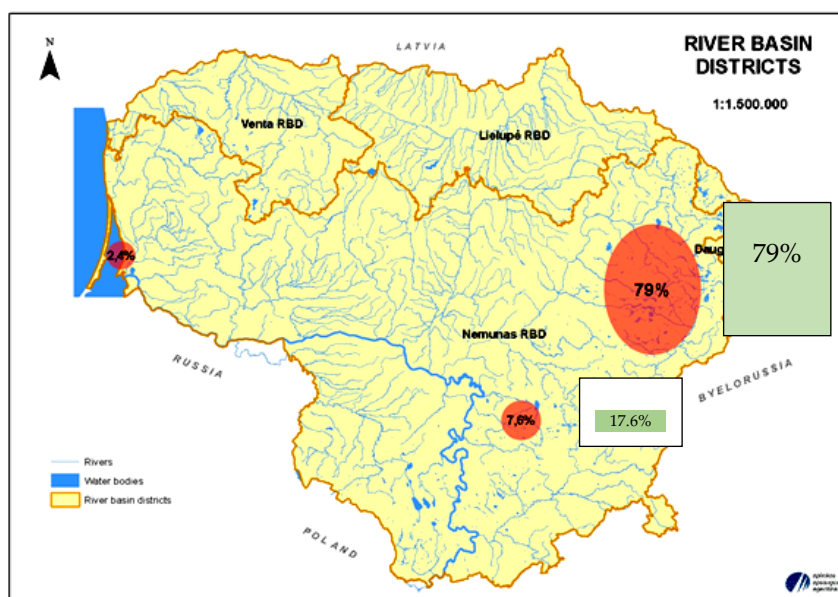


Figure 3.5.1.2. Major eel stocking regions since 1983.

Table 3.5.1.3. Stocking of inland waterbodies with eels in Lithuania in the period 2007–2015.

	Year	Number	Type of eel stocking material [g/indiv.]	Total weight of eel stocking material, kg
Fisheries companies and individual fishermen	2007	4500	2,1	9,25
	2008	5000	1,5–2,6	10,58
	2009	11 200	1,2–10,0	43,24
	2010	28 895	6,9–16	187,62
	2011	18 000	15	270
	2012	150 000	10	1500
	2013	100 000	5	500
	2014	18 900	5	95
Fishery Service	2011	134 000	2,5	335
	2012	444 000	2,5	1108
	2013	1 300 000	0.3–1.0	462
	2014	380 500	1.0–1.2	380
	2015	449 400	0.8–1.4	539.3

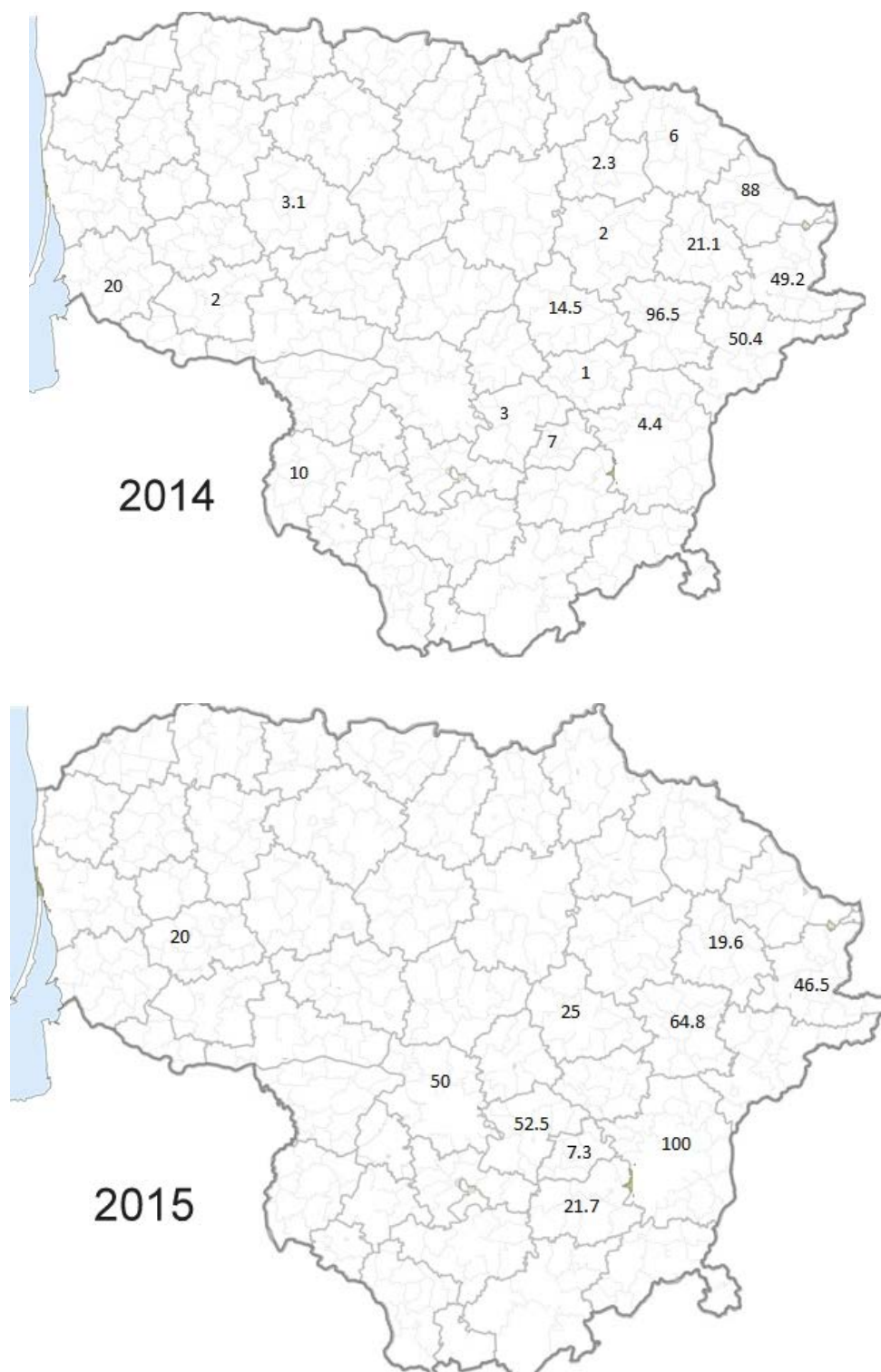


Figure 3.5.1.3. Fishery service stocking in inland waterbodies with eels in Lithuania by districts in 2014–2015.

3.5.2 Catch of eel <12 cm and proportion retained for restocking

There is no fishery of eel <12 cm.

3.5.3 Reconstructed time-series on stocking

Table 3.5.3.1. Stocking of eels in Lithuania (in millions) stocked.

Year	LOCAL SOURCE				FOREIGN SOURCE			
	Glass Eel	Quarantined Glass Eel	Wild Bootlace	Ongrown cultured	Glass Eel	Quarantined Glass Eel	Wild Bootlace	Ongrown cultured
1950					-			
1951					-			
1952					-			
1953					-			
1954					-			
1955					-			
1956					0.344			
1957					-			
1958					-			
1959					-			
1960					2.300			
1961					-			
1962					2.100			
1963					1.000			
1964					2.400			
1965					2.200			
1966					0.750			
1967					0.500			
1968					3.000			
1969					-			
1970					2.800			
1971					1.600			
1972					0.237			
1973					1.400			
1974					1.750			
1975					2.240			
1976					1.000			
1977					1.450			
1978					2.700			
1979					0.750			
1980					1.750			
1981					2.950			
1982					4.550			
1983					3.700			
1984					-			
1985					1.600			
1986					2.550			
1987					-			
1988					-			
1989					-			

Year	LOCAL SOURCE				FOREIGN SOURCE			
	Glass Eel	Quarantined Glass Eel	Wild Bootlace	Ongrown cultured	Glass Eel	Quarantined Glass Eel	Wild Bootlace	Ongrown cultured
1990					-			
1991					-			
1992					-			
1993								0.013
1994					0.065			
1995					0.529			
1996					0.394			
1997								0.004
1998					0.064			
1999								0.050
2000								0.004
2001								0.009
2002								
2003					0.353			
2004								0.071
2005								0.002
2006								
2007								0.005
2008								0.005
2009								0.011
2010								0.029
2011								0.152(2.5 g)
2012								0.491(2.5g) 0.15(10g)
2013					1.197			0.103(1 g) 0.1(5 g)
2014								0.3994(1–5 g)
2015								449 400(0.8–1.4 g)

3.6 Trade in eel

See Table 3.4.2.1.

4 Fishing capacity

4.1 Glass eel

There is no glass eel fishery.

4.2 Yellow eel

Fishery in Inland waters. In 2013 eel fishing quota was distributed to 34, in 2014 to 29 fishing companies and individual fishermen, which are small enterprises only with one or three employees. Fishing sites are established and fishing permits are issued by the Ministry of Environment, while the Ministry of Agriculture distributes fishing quotas among fisheries companies and individual fishermen by way of competition. In 2005–2008, the number of fishing sites in rivers was reduced from 77 to 44

and in 2012 it increased to 51 (Figure 5.2.1). Fishing with one trap is allowed in each fishing site at a time. On average, one company fished in 4.3 sites in 2004, in 1.8 sites in 2007, in 1.5 in 2013 and 2.0 in 2014.

Fishery in the Curonian Lagoon. Fykenets are distributed by 48 local fishing companies, which mostly are small enterprises only with two or three employees (Figure 5.2.2). Not all companies are catching eels. Most companies own between one and three small vessels or boats (up to 10 m long). There are only a few vessels with the length exceeding 10 m. A total of 148 boats and vessels are registered in the Curonian Lagoon. Pursuant to the rules of implementation of the activity 'Modification for re-assignment of inland fishing vessels' of priority axis 2 'Aquaculture, inland fishing, processing and marketing of fishery and aquaculture products' under the Operational Programme for the Lithuanian Fisheries Sector for the period 2007–2013, approved by Order No 3D-549 of the Minister for Agriculture of 9 October 2008, 3 million EUR are to be allocated to modification for reassignment of inland fishing vessels to other activities. Up to now, 20 fishing companies that were fishing in the Curonian Lagoon participated in the Operational Programme, fishing fleet was reduced by 73 vessels in 2009.

4.3 Silver eel

See above.

4.4 Marine fishery

During the Soviet occupation, commercial fishery in the coastal zone was banned until 1991. Since 1991, about 100 mainly small companies with two to three employees and one or two small vessels (up to 10 m) have fished in the coastal zone. Most employees are only engaged in fishing part-time. Recently, the number of fisheries companies has dropped and stood at 56 in 2012.

5 Fishing effort

Fisheries companies provide information according to their logbooks (each fishing case, including gears used and catch must be obligatory recorded) about fishing effort on a monthly basis to the authority issuing permits: a regional environmental protection department under the Ministry of Environment of the Republic of Lithuania if a company is engaged in inland fisheries (including the Curonian Lagoon), or the Fisheries Service of the Ministry of Agriculture of the Republic of Lithuania if a company is engaged in maritime fisheries.

5.1 Glass eel

There is no glass eel fishery.

5.2 Yellow eel

There is no statistical information divided catch by life stage.

In Lithuania's inland waters (rivers) in 2014 eel fishing quota was established in 51 rivers (51 eel traps) (Figure 5.2.1). At present (2010–2014) eel fishing season continues in spring (about 45 days). Before 2010 eel fishing season was continued from spring to autumn.

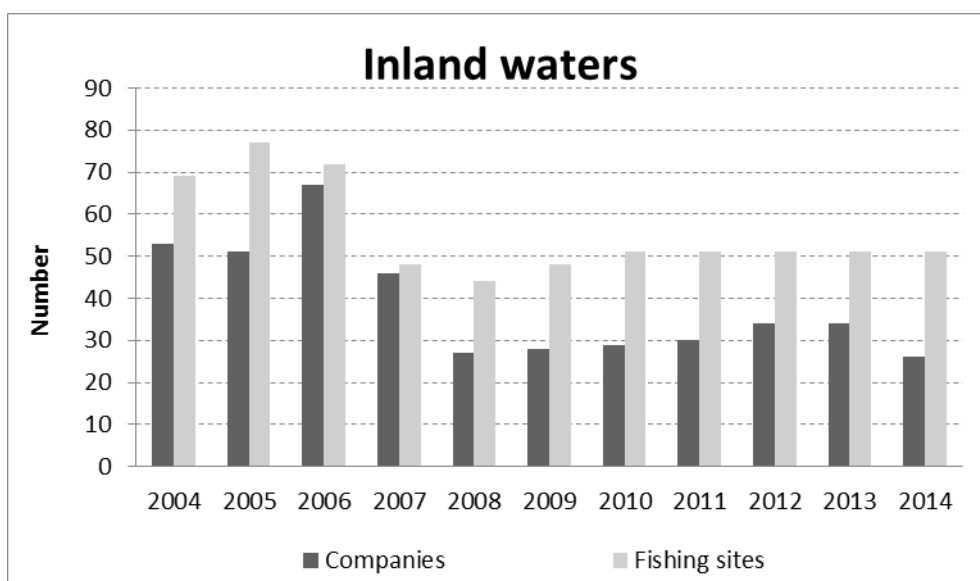


Figure 5.2.1. Number of companies engaged in the eel fishery with river traps and trap quotas in 2004–2014.

In Curonian lagoon eel fishing season continues from spring to autumn (about 180 days). In Curonian lagoon established quota for fishermen in 1991–1997 was 600 units of fykenets, in 2004 350 units, from 2010 is reduced to 223 units (Figure 5.2.2).

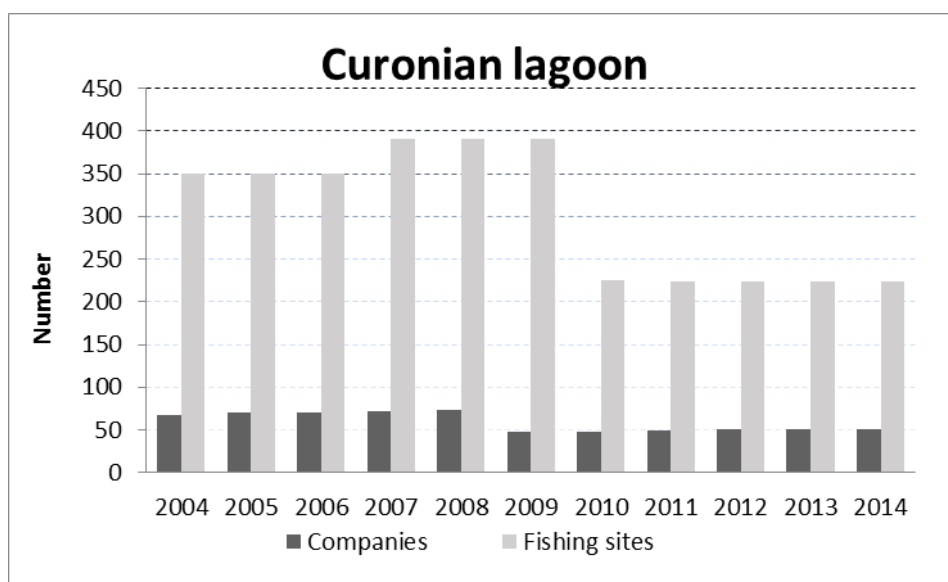


Figure 5.2.2. Number of fishing sites and companies engaged in the eel fishery with fykenets in 2004–2014.

5.3 Silver eel

There is no statistical information divided catch by life stage.

5.4 Marine fishery

No data.

6 Catches and landings

6.1 Glass eel

There is no glass eel fishery in Lithuania.

6.2 Yellow and silver eel

In Lithuania's inland waters, comparing statistical data on eel catches during the period of 2008–2014, 88% of eel is caught in rivers using traps, 12% in lakes using small fyknets and traps, while a small amount is caught using longlines (Table 6.2.1). Eel traps in the river outlets at lakes consist from two wings with a cage or trap placed between them. According to statistical data, in the period from 1970 to 2000, the eel catches have slightly decreased (Figure 6.2.2). Over the past ten years, the eel catches began to increase.

Table 6.2.1. Eel catches (in tons and %) in the Inland Lithuania waterbodies.

YEARS	LAKES		RIVERS		TOTAL
	Tonnes	%	Tonnes	%	
2008	1.207	18,9	5.167	81,1	6.374
2009	1.249	33,7	2.456	66,3	3.705
2010	0.758	5,8	13.081	94,5	13.839
2011	2.223	28,1	5.685	71,9	7.908
2012	1.423	22,9	4.801	77,1	6.224
2013	2.273	18.1	10.282	81.9	12.555
2014	0.4	6	6.0	94	6.4

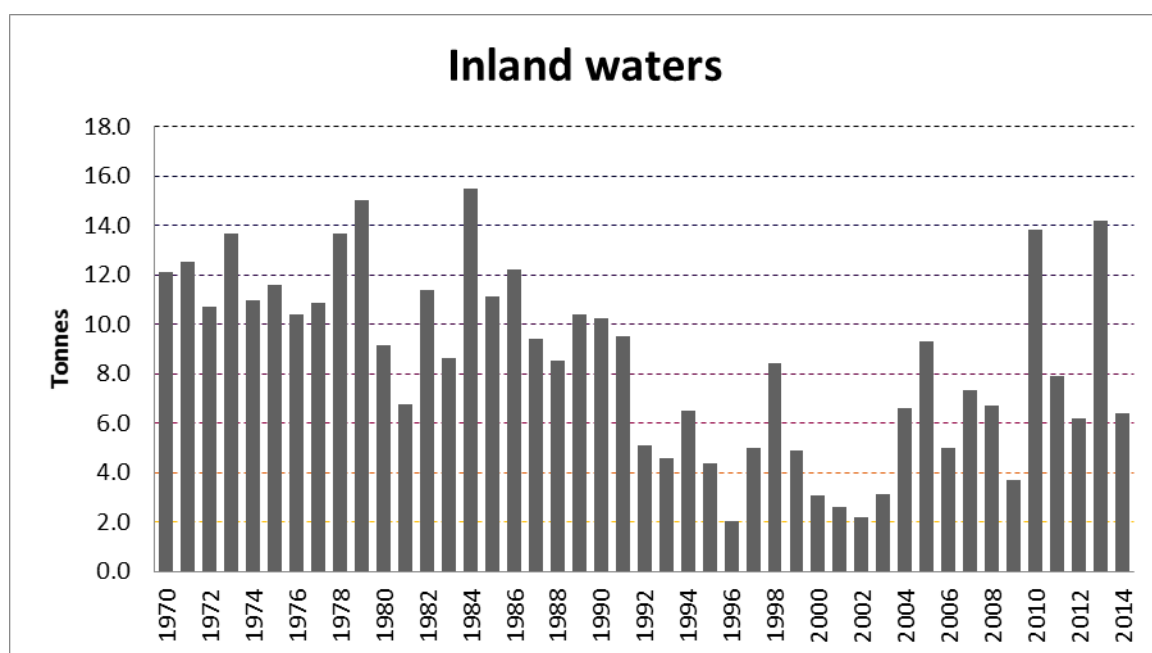


Figure 6.2.2. Eel landings Lithuanian fishermen in the Inland waters during the period of 1970–2014.

In Curonian Lagoon, comparing statistical data on eel catches during the period of 1947–2012, since 1963 eel catches continuously decreasing (Figure 6.2.3.). Comparing the relative catches with Kaliningrad obl., Lithuanian catches increasing (Figure 6.2.4.). Now 99% of eel is caught in Lagoon using fykenets, while a very small amount is caught using longline. Fykenets in Lagoon are stationary, big-size fykenet with a 100–120 m long fence and a three cages fastened at both ends.

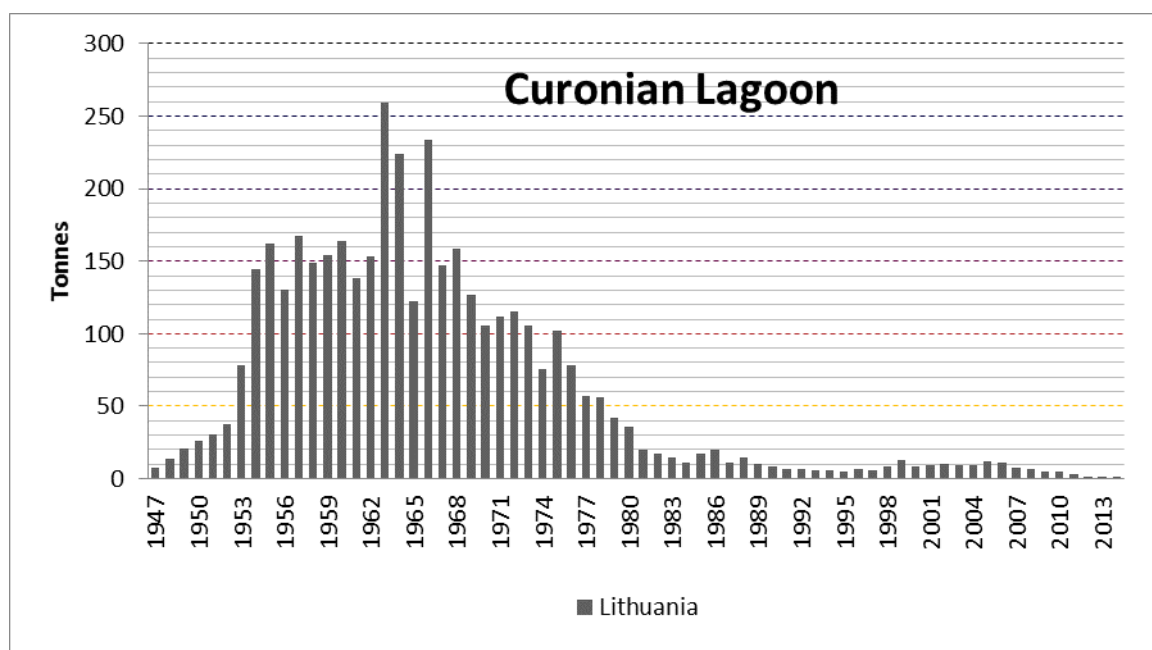


Figure 6.2.3. Eel landings Lithuanian fishermen in the Curonian lagoon during the period of 1947–2014.

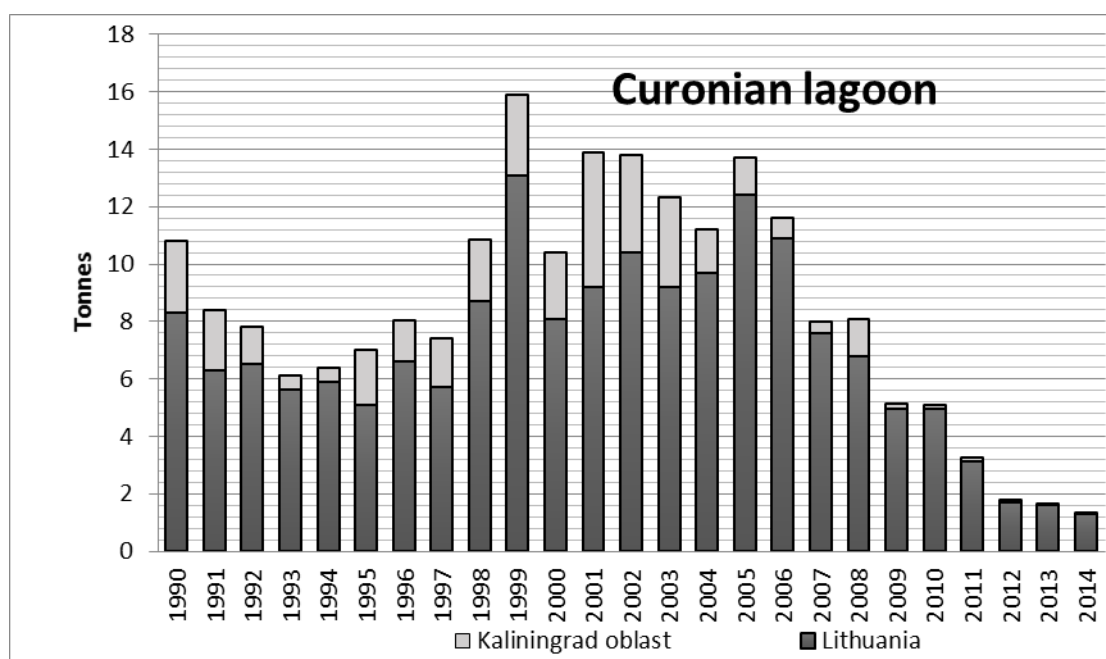


Figure 6.2.4. Eel landings (in tonnes) in the Kaliningrad oblast (Russia) and Lithuanian fishermen in the Curonian lagoon during the period of 1947–2014.

Fisheries companies provide information according to their logbooks (each fishing case, including gears used and catch must be obligatory recorded) about catch on a monthly basis to the authority issuing permits: a regional environmental protection department under the Ministry of Environment of the Republic of Lithuania if a company is engaged in inland fisheries (including the Curonian Lagoon), or the Fisheries Service of the Ministry of Agriculture of the Republic of Lithuania if a company is engaged in maritime fisheries.

6.3 Silver eel

Statistical data do not provide information on the eel stage. Yellow eel fishery is mixed with silver eel (Table 6.3.1).

Table 6.3.1. Total landings of eel in Inland waters and Curonian lagoon (1995–2015).

LAKES AND RIVERS (SMALL FYKENETS AND TRAPNETS)		CURONIAN LAGOON (FYKENETS)	BALTIC SEA (LONGLINES)
Inland		Inland	Coastal
Yellow/silver		Yellow/silver	Yellow
1995	4.3	5.1	0.1
1996	2.0	6.6	0.1
1997	5.0	5.7	0.0
1998	8.4	8.7	0.1
1999	4.7	13.2	0.3
2000	2.9	8.1	0.2
2001	2.3	9.2	0.3
2002	2.4	10.4	0.2
2003	2.1	9.7	0.6
2004	6.3	9.7	0.3
2005	9.9	12.4	0.1
2006	4.9	10.9	0.1
2007	7.3	7.6	0.0
2008	6.7	6.8	0.0
2009	3.7	4.9	0.0
2010	13.8	5.0	0.0
2011	7.9	3.4	0.0
2012	6.2	1.7	0.0
2013	12.6	1.6	0.0
2014	6.4	1.3	0.0
2015		0.8	0.0

6.4 Marine fishery

The eel fishery in the Baltic Sea coastal zone has never been significant. Pre-war commercial fishery statistics mentioned eels in 1931 (0.6 tonnes), with catches in 1937 and 1938 making up 0.5 tonnes and 0.2 tonnes respectively. In the subsequent years, there must have been no eel catches at all, as commercial fishery statistics were sufficiently accurate and well managed in Lithuania at that time. Eel are fished with longlines in the stage of the yellow eel. Eel recorded in commercial fishery in the period 1995 to 2011 inclusive made up only about 0.14 tonnes on average. Only a few com-

panies have been engaged in the specialised eel fishery in recent years, their number (five in 2005 and no one in 2012) and catches have been declining. By reason of eel fishing ban in coastal zone according to 2011 commercial fishery statistics, eel catches were 0 kg. Low catch rates are probably a result of low stocks and low fishing efforts. Almost all eels studied in the coastal zone were of natural origin.

6.5 Recreational fishery

Table 6.5.1. Recreational Fisheries: Retained and Released Catches.

Year	Retained				Released			
	Inland		Marine		Inland		Marine	
	Angling	Passive Gears	Angling	Passive gears	Angling	Passive gears	Angling	Passive gears
2008	3,3	NA	NA	NA	NA	NA	NA	NA
2009	2,2	NA	NA	NA	NA	NA	NA	NA
2010	4,3	NA	NA	NA	NA	NA	NA	NA
2011	3.0	NA	NA	NA	NA	NA	NA	NA
2012	1.4	NA	NA	NA	NA	NA	NA	NA
2013	3.0	NA	NA	NA	NA	NA	NA	NA
2014	1.8	NA	NA	NA	NA	NA	NA	NA

Table 6.5.2. Recreational Fisheries: Catch and Release Mortality.

Year	Released			
	Inland		Marine	
	Angling	Passive gears	Angling	Passive gears
2008	NA	NA	NA	NA
2009	NA	NA	NA	NA
2010	NA	NA	NA	NA
2011	NA	NA	NA	NA
2012	NA	NA	NA	NA
2013	NA	NA	NA	NA
2014	NA	NA	NA	NA

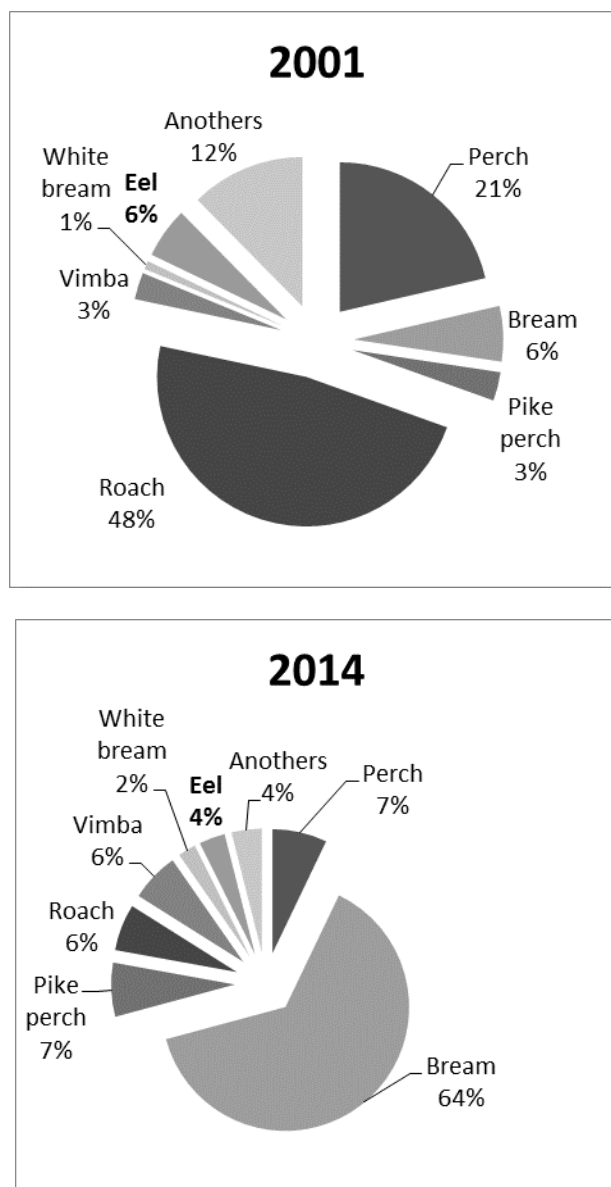
6.6 Bycatch, underreporting, illegal activities

Figure 6.6.1. The fykenets composition of fish catches (by weight) in Curonian lagoon in 2001 and 2014.

Table 6.6.2. Estimation of underreported catches in Country, per EMU and Stage.

Year	EMU_code	Glass eel				Yellow eel				Silver Eel				Combined (Y + S)			
		Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)
2013	Curonian Lagoon	0				n/d				n/d				1.6	n/d		
	Inland waters	0				n/d				n/d				12.6	n/d		
	Total/mean (%)													14.2	n/d		

Table 6.6.3. Existence of illegal activities, its causes and the seizures quantity they have caused.

Year	EMU	Glass eel			Yellow eel			Silver Eel			Combined (Y +S)		
		Y/N/?	Cause	Seizures (kg)	Y/N/?	Seizures (kg)	Cause	Y/N/?	Seizures (kg)	Cause	Y/N/?	Seizures (kg)	Cause
2013	Curonian Lagoon	N		N	Y	n/d		Y	n/d		Y	n/d	Illegal selling of catches.
	Inland waters				Y	n/d		Y	n/d		Y	n/d	Fishing out of the season; Fishing without licence; Fishing using illegal gears; Retention of eel below or above any size limit; Illegal selling of catches.

7 Catch per unit of effort

7.1 Glass eel

There is no fishery for glass eel.

7.2 Yellow eel

Statistical data do not provide information on the eel stage.

Lithuania's inland waters. Comparing statistical and DCF data catch per fishing site (eel trap) or cpue, in 2014, fishing efficiency was almost similar (Table 7.2.1).

Table.7.2.1. Catch per fishing site in Inland waters during the period of 2009–2014.

YEARS	CATCHES IN THE RIVERS, TONNES	NUMBER OF PLACES	CATCH PER FISHING SITE, KG	CATCH PER FISHING SITE BY DCF DATA, KG
2009	2.5	48	51,2	NA
2010	13.1	51	256,5	NA
2011	5.7	51	111,5	NA
2012	4.8	51	94,1	79,7
2013	12.6	51	201.6	242.5
2014	6.0	51	117,4	126.7

Curonian lagoon. Catch per fykenet by DCF data were twice bigger comparing with catch per fykenet calculated by commercial catch data in 2014 (Table 7.2.2).

Table.7.2.2. Catch per fykenet in Curonian lagoon during the period of 2009–2014.

YEARS	CATCHES, TONNES	NUMBER OF FYKENETS	CATCH PER FYKENET, KG	CATCH PER FYKENET BY DCF DATA, KG
2009	4,9	223	22	NA
2010	5,0	223	22,4	NA
2011	3,4	223	15,2	NA
2012	1,7	223	7,6	19,6
2013	1,6	223	7,2	24,7
2014	1.3	223	5,8	11.8

Dynamics of fishing efficiency (or cpue) shows intensity of eel migrations in inland waters (Figure 7.2.3) and Curonian Lagoon (Figure 7.2.4).

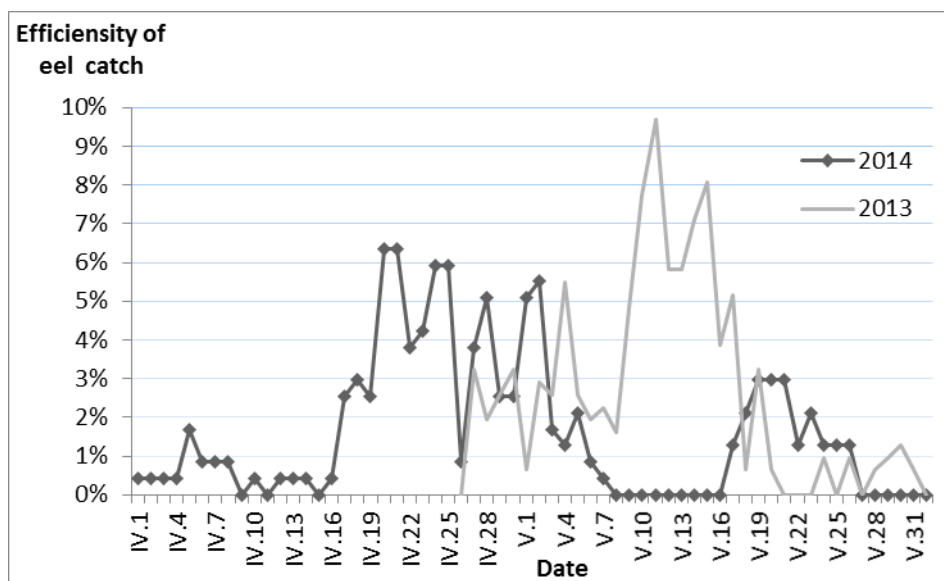


Figure 7.2.3. Eel migrations (efficiency of eel catch (%)) per fishing season (April–May) in Inland waters in 2013–2014.

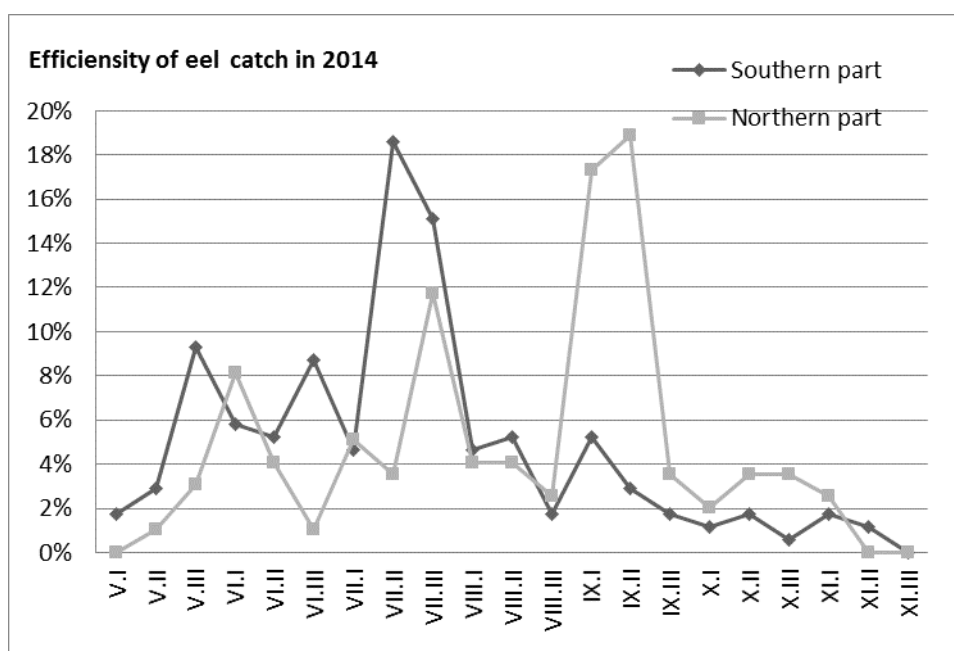
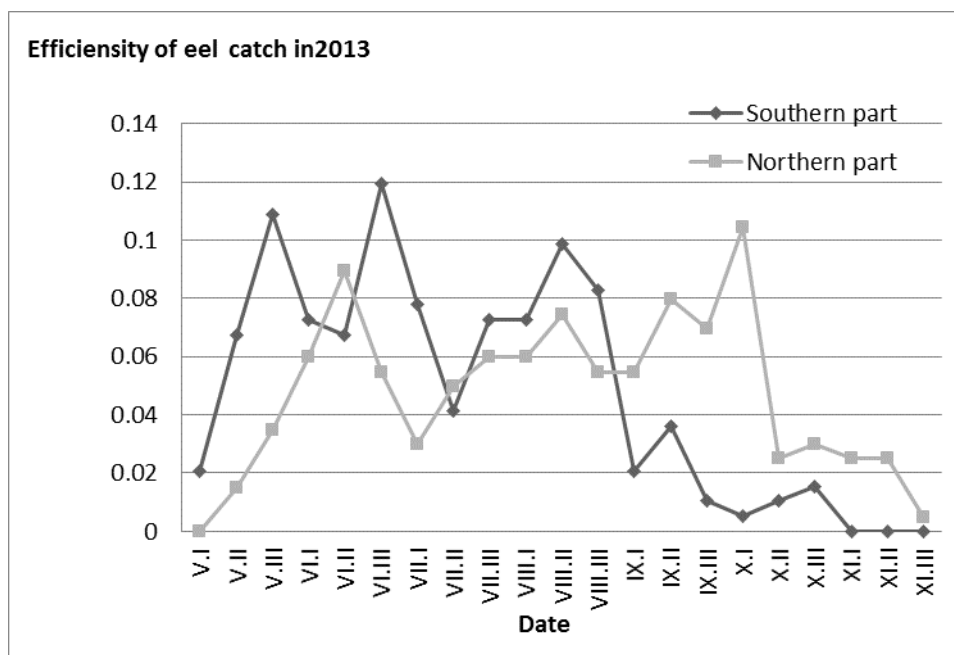


Figure 7.2.4. Eel migrations (efficiency of eel catch (%)) per fishing season (May–November) in Curonian lagoon in 2013–2014.

7.3 Silver eel

See above.

7.4 Marine fishery

No available data.

8 Other anthropogenic impacts

According to a rough GIS analysis, 32% of eel stocked to inland lakes during the last 20 years are in the basins blocked by hydropower stations. Detailed analyses as well as surveys of mortality in turbines are started in 2013.

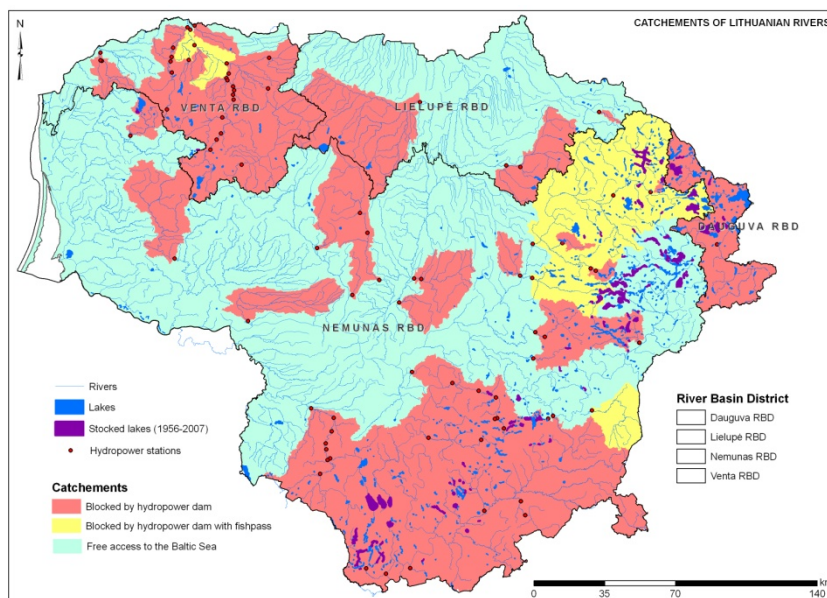


Figure. 8.1. Catchments of Lithuanian rivers and hydropower stations.

9 Scientific surveys of the stock

Information provided using Nature Research Center study “Assessment of silver European eel’s mortality in inland waters of Lithuania using telemetry methods. Assessment of impact of hydropower turbines on European eels using tagged eels and overview of hydropower plants turbines in Lithuania. Report. Contract No. F11-223. January 30, 2015. Contractor Fisheries Service under the Ministry of Agriculture of the Republic of Lithuania.

Overall 28,6% of tagged silver eels immediately died while passing Kauno HPP. Baltic Sea entered 36% of all tagged eels released above Kauno HPP or 60% of eels that survived then passing Kaunas HPP. This is considerably higher than overall average from release sites without HPP. Share of eels that entered Baltic Sea may be considerably higher if not registered eels are alive and will continue migrate in spring 2015. Eels mortality determined in present study falls within mortality range in Kaplan type turbines (15–38%) according estimates by International Council of the Seas exploration. Mortality of migrating silver eels while passing small CINK type turbines is 100%. Mortality rates could be lower for bigger CINK type turbines, but more studies are needed to prove that. Overall share of tagged eels that reached Nemunas lower reaches is 44,3% and could be considerably higher if not registered eels are alive and will continue migrate in spring 2015. Overall share of tagged eels that entered Baltic sea is 27,1% and could be considerably higher if not registered eels are alive and will continue migrate in spring 2015. Share of eels that reached lower river Nemunas reaches did not correlated significantly with migration distance, however trend line was negative ($R^2 = -0,192$). Then using only those eels that survived in Kaunas HPP turbines correlation significance between share of eels reached Curonian lagoon and migration distance substantially increases ($R^2 = -0,453$), though still falls

short of statistical significance ($p > 0,05$). Maximum possible mortality (MGM) of silver eels in rivers is 55,7% and in Curonian lagoon is 38,71%. This variable may be considerably lower if not registered eels are alive and will continue migrate in spring 2015. Eels MGM determined in present study were similar to western European data, though this does not meet minimum targets set by European eel management plan. However MGM could be significantly lower due to delayed eel migration. Study results proved, that all future telemetry studies must be conducted with slightly bigger tags with tags operational time being at least 2,5 years. This methodology will ensure more accurate MGM assessment, because literature suggests eel migration could be delayed up to few seasons. In future all eel telemetry studies must have few additional arrays of telemetry receivers in Nemunas river (80–100 km upstream from river mouth) and in Neris river mouth. Additional array sites, subject to receivers' availability, could be in Šventoji and Žeimenė rivers mouths. As eel mortality is highly dependent on HPP size and turbines type, therefore future projects are needed to assess eel mortality in small and/or medium size HPP with Kaplan type turbines (Kavarskas HPP strongly recommended) and in at least one HPP with Francis and/or Cink type turbine. Cink type turbine must be considerably bigger than Bagdanonių HPP which was investigated in 2014. Based on current study results eel stocking recommended in waterbodies above Kaunas HPP subject to permission from ICES and European Commission Eel stocking in waterbodies above not evaluated HPP is not recommended.

10 Data collected for the DCF

Data were obtained during eel fishing season. In Curonian lagoon eel was regularly sampled in harbours from May to October. In inland waters eel was sampled from three rivers sites in April-May. 200 fish are analysed by age and 1526 by length and weight in 2013. Sampling started in 2011.

Table 10.1. Summary of the DCF monitoring implementation in Lithuania in 2014.

Data	River	Lakes	Estuaries	Lagoons	Coastal & Marine
No. of production / escapement surveys ¹	478			503	
No. of recruitment time-series surveys ²					
No. fished aged	100			100	
No. of fished sexed	100			100	
No. of fish examined for parasites					
No. of fish examined for contaminants					
No. of non-fishery mortality studies ³					
Socio-economic survey					

11 Other biological sampling

11.1 Growth, silvering and mortality (DCF)

Length, weight, silvering, growth are collected as part of DCF.

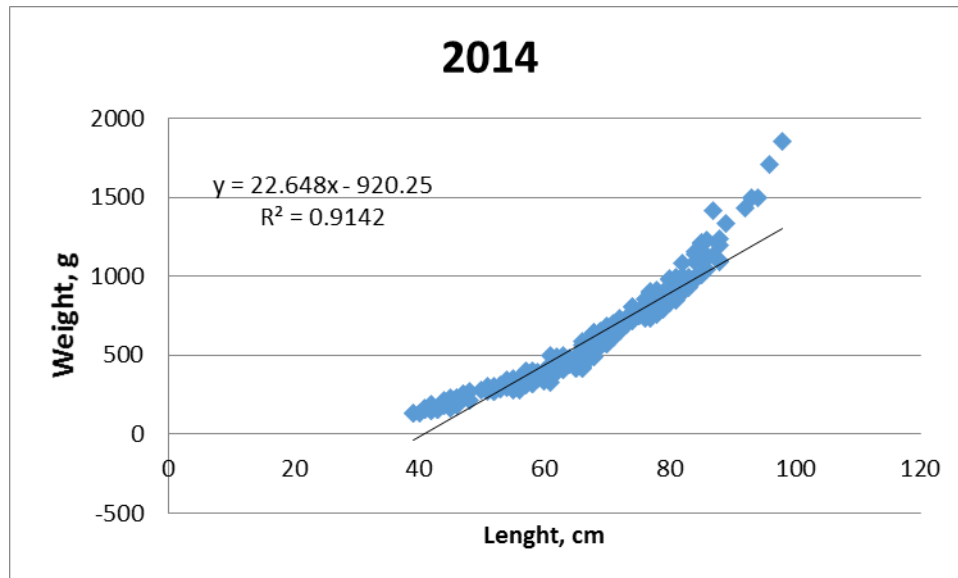


Figure 11.1.1. Length–weight relationship of eel samples from Inland waters (river Zeimena) in 2014 (n=378).

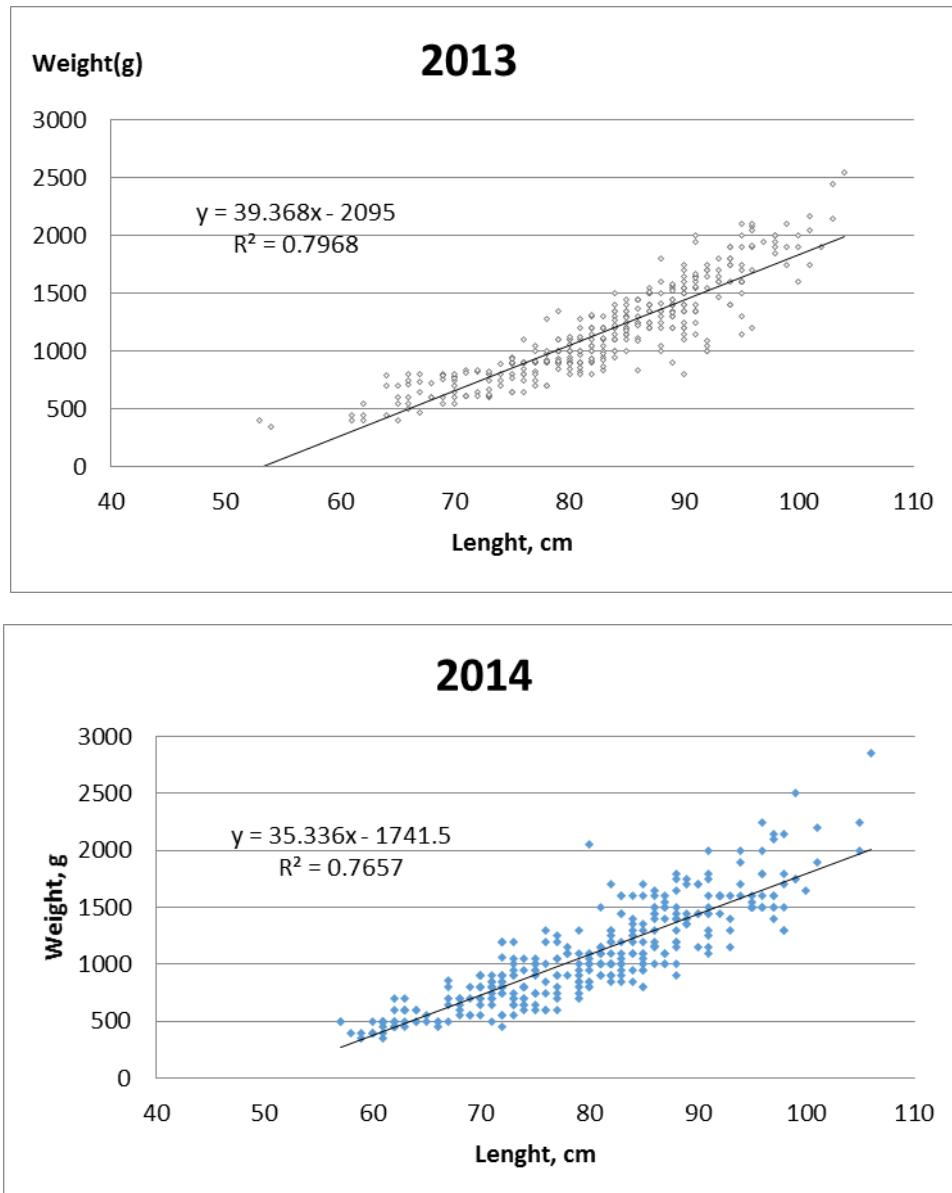


Figure 11.1.2. Length–weight relationship of eel samples from Curonian lagoon in 2013 (n=405) and 2014 (n=726).

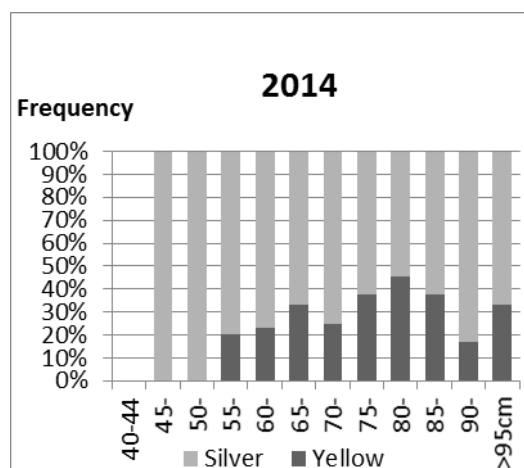
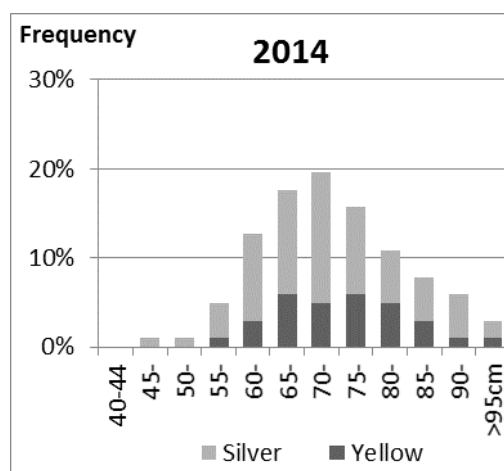
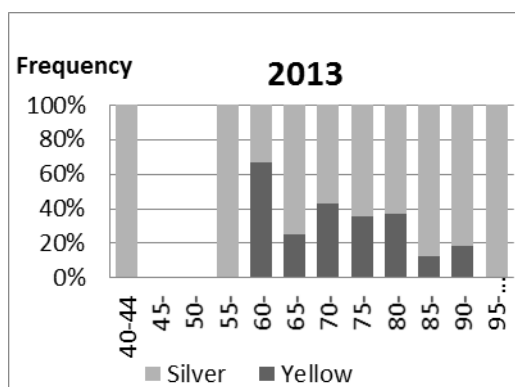
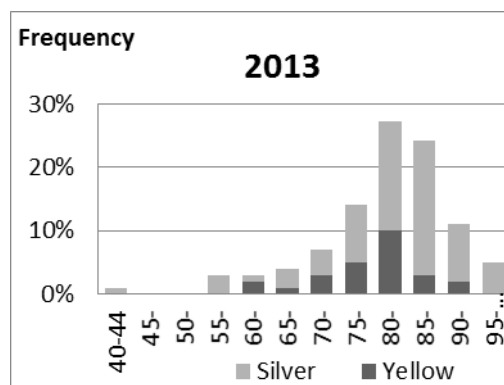


Figure 11.1.3. Length at silvering eel from Inland waters (Zeimena) (n=200) in 2013–2014.

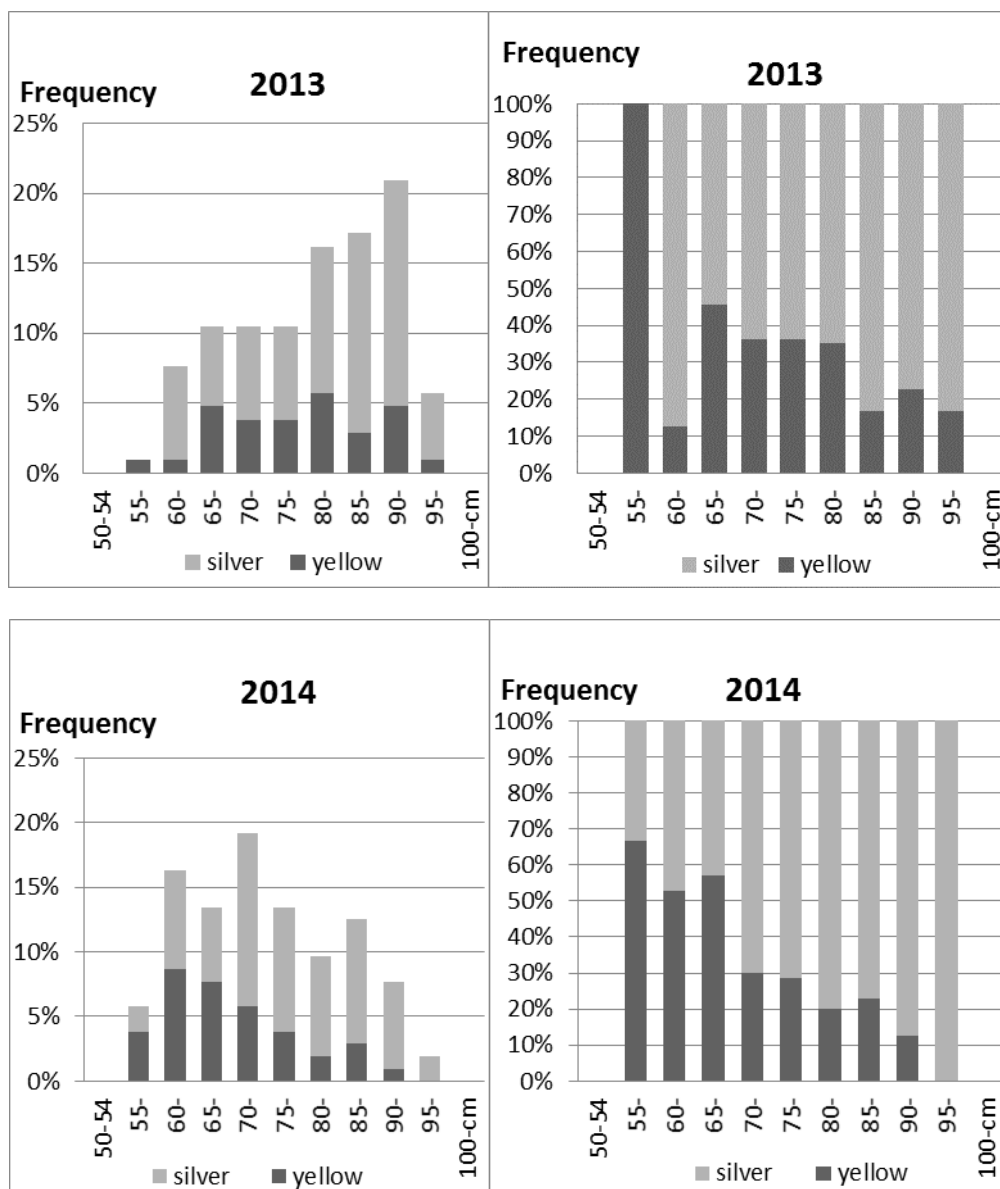


Figure 11.1.4. Length at silvering eel from Curonian lagoon (n=200) in 2013–2014.

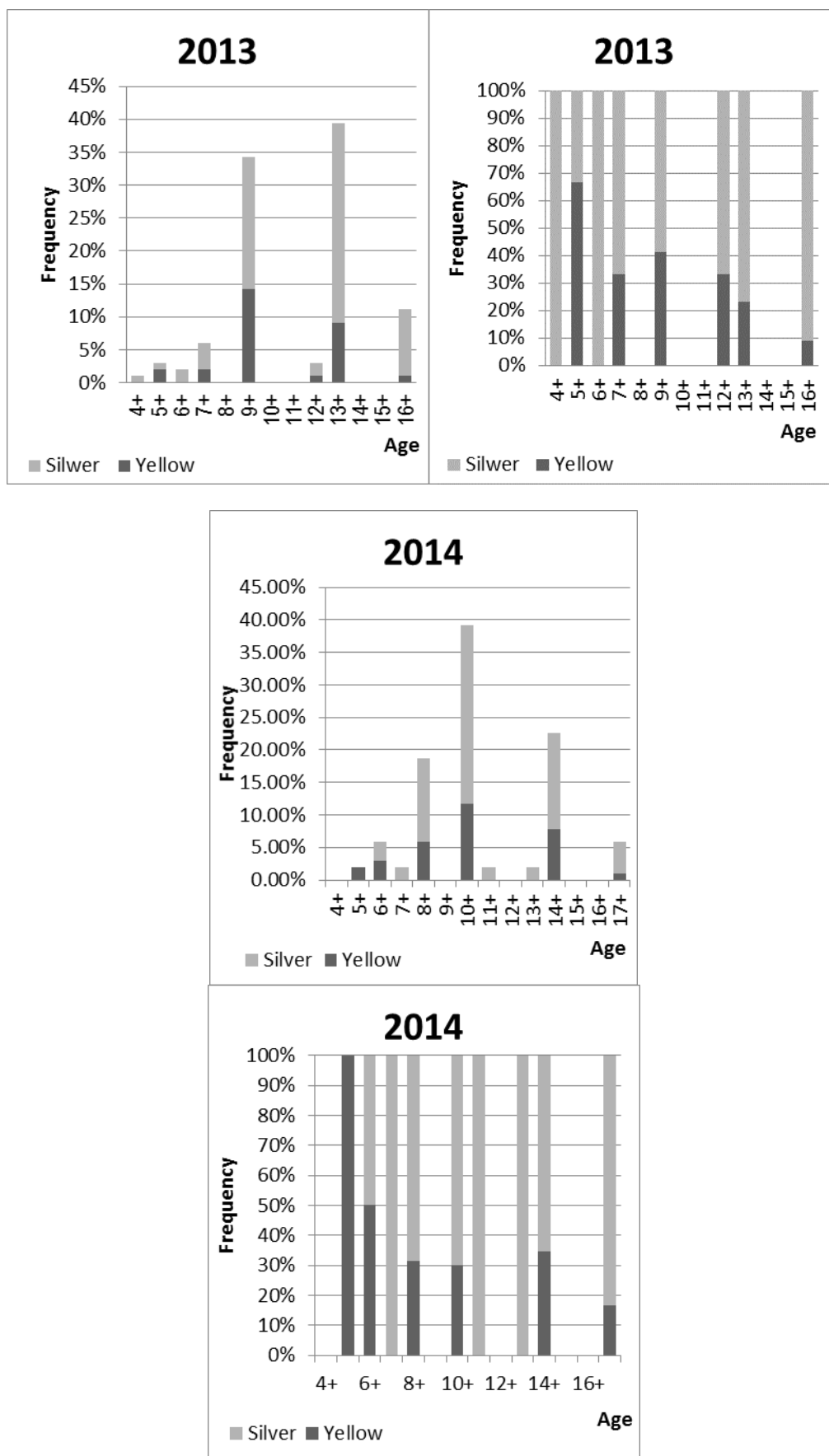


Figure 11.1.5. Age at silvering eel from Inland waters (Zeimena) (n=200) in 2013–2014.



Figure 11.1.6. Age at silvering eel from Curonian lagoon (n=200) in 2013–2014.

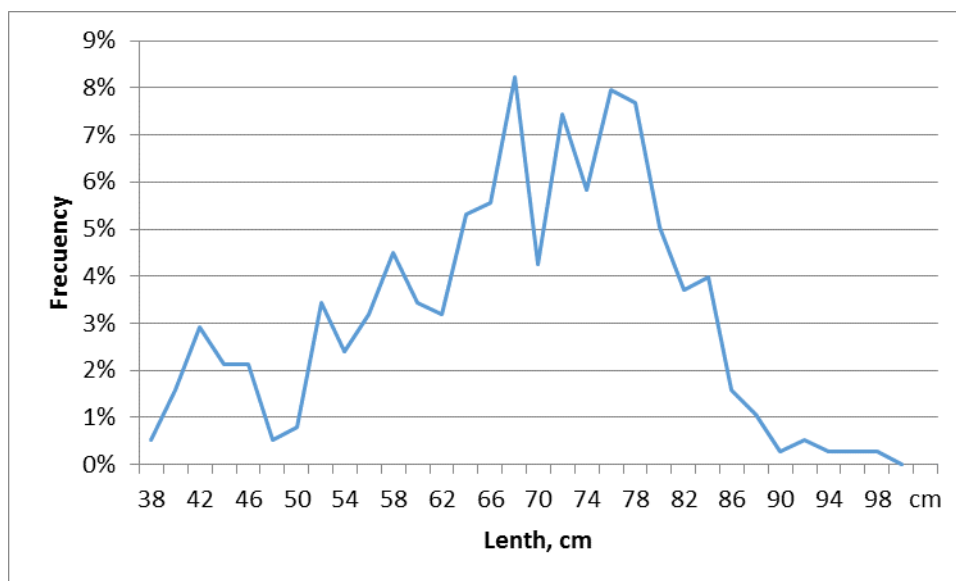


Figure 11.1.7. Length frequencies of commercial catch in Inland waters (Zeimena) in Lithuania (2014 DCF data n=377).

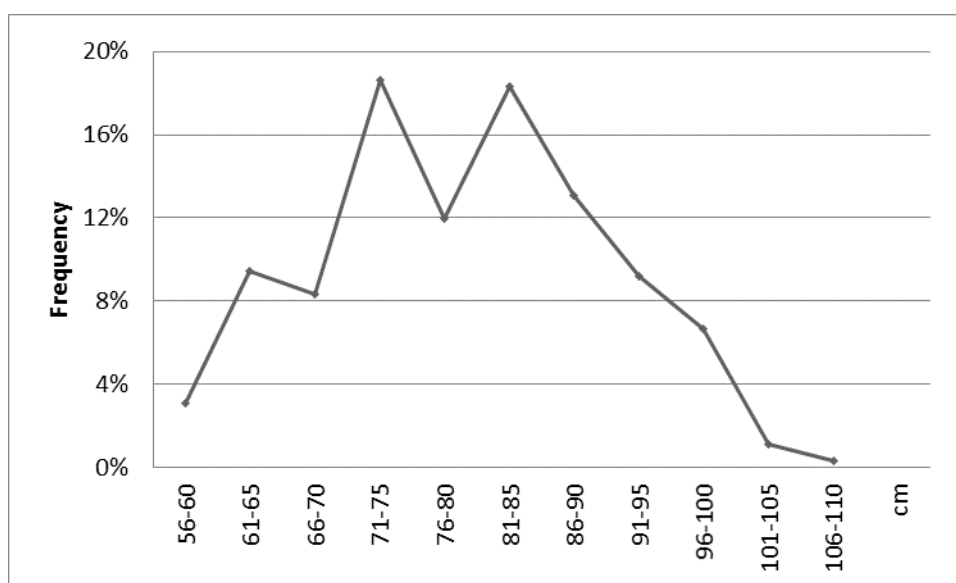


Figure 11.1.8. Length frequencies of commercial catch in Curonian lagoon in Lithuania (2014 DCF data n=360).

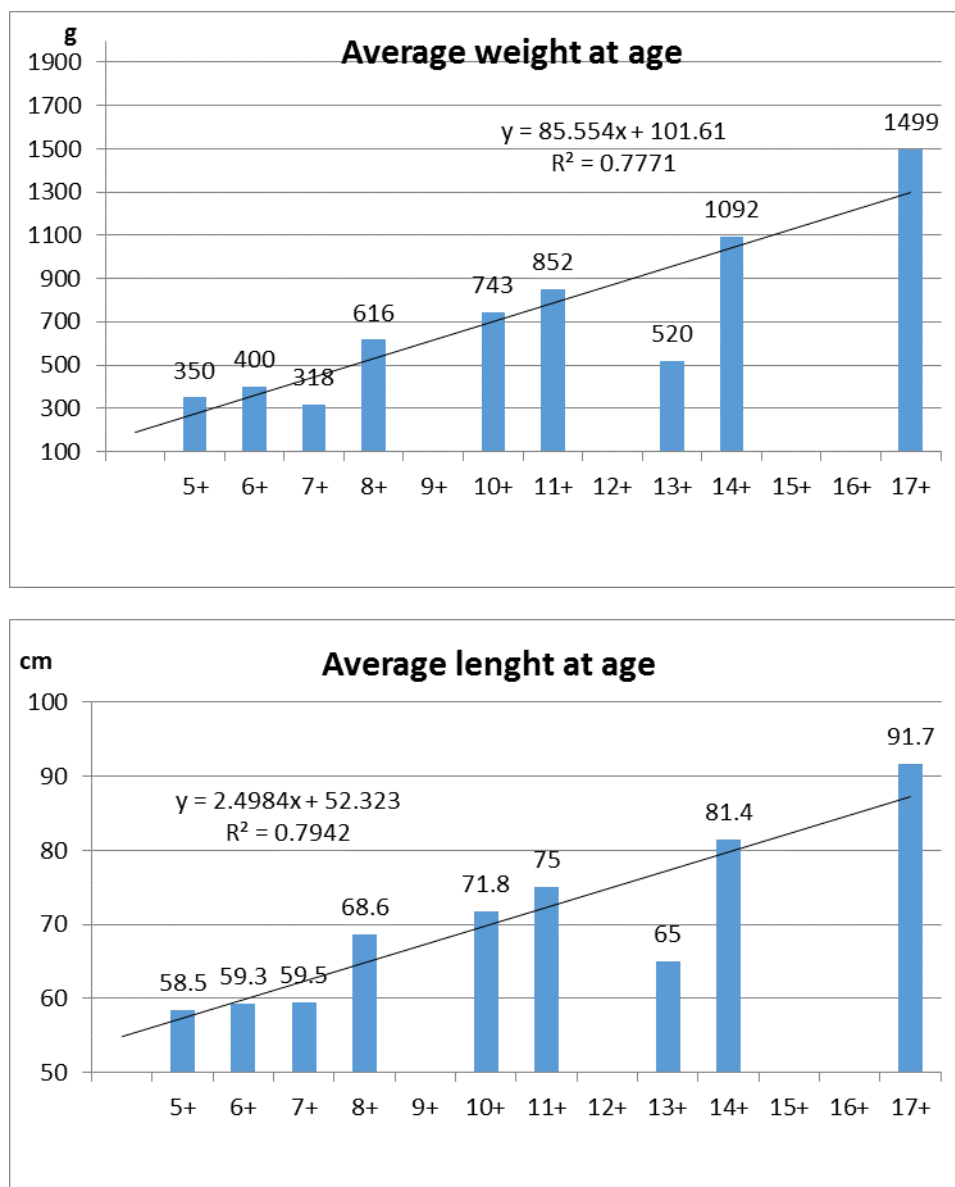


Figure 11.1.11. Average Weight and Length-at-Age eel from Inland waters (n=100) in 2014.

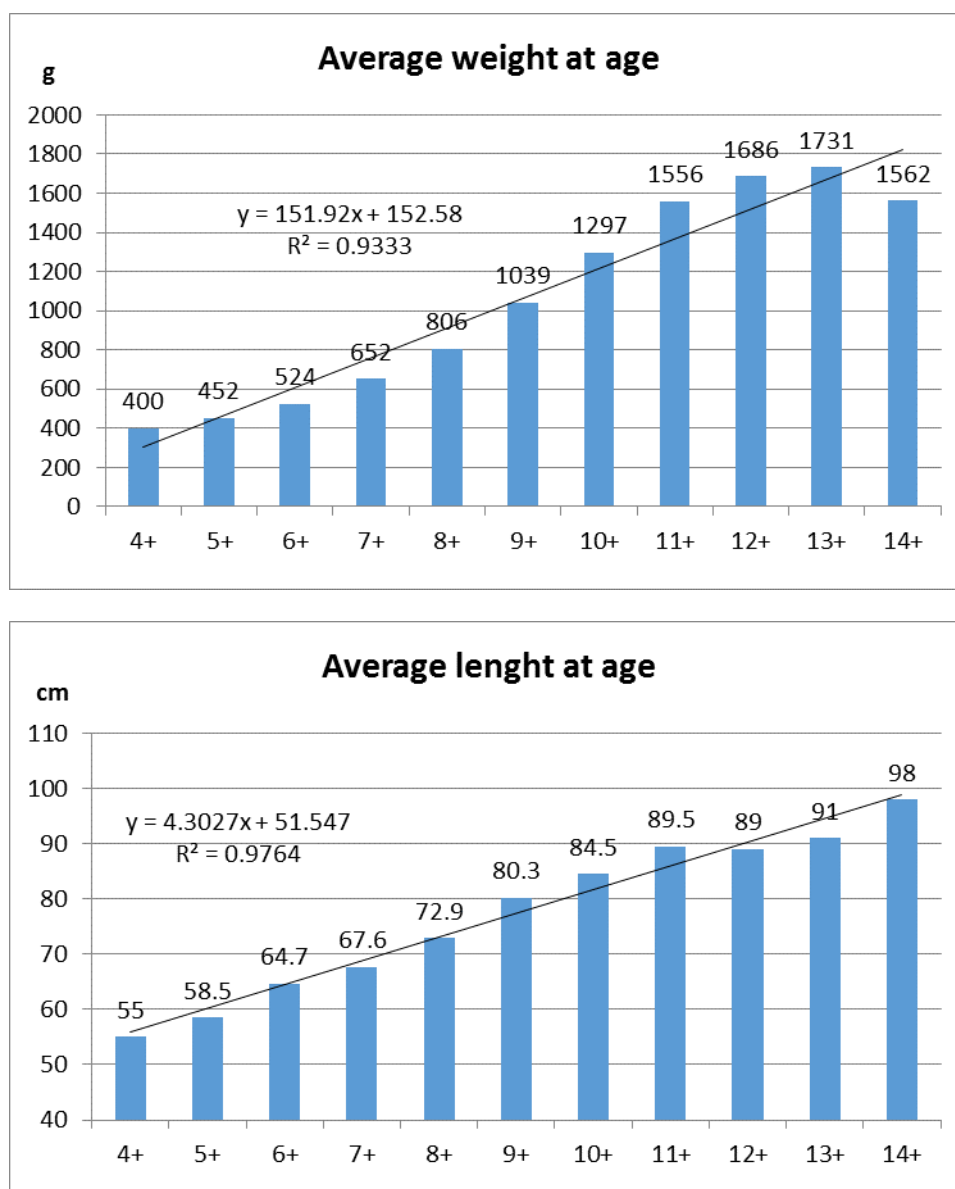


Figure 11.1.12. Average Weight and Length-at-Age eel from Curonian lagoon (n=100) in 2014.

11.2 Parasites and pathogens

Information provided using Nature Research Center study “Evaluation of effectiveness of eel restocking measures, with special emphasis on eel survival, infection with parasites, growth rates and sex ratio (2014)”. Report. Contract No F11-222; December 30, 2014. Contractor Fisheries service under the Ministry of Agriculture of the Republic of Lithuania.

Out of 20 eels at age 3+ caught in the Balsys Lake 85% were females and 15% males. Age group 2+ was dominated by females (57.1%), the remaining 42.9% were males. All eight eels at age 15+ were females. Five different taxons of parasites were found as the result of parasitological analysis of collected samples from the Balsys Lake. The dominant species was swimbladder parasite *Anguillicola crassus* (Nematoda). 36,8% out of 38 studied eels were infected with this parasite. 10,5% of eels were infected by *Dactylogyrus* sp., 13,2% of eels were infected by *Camallanus lacustris*. 10,5% of studied eels were infected with *Bothriocephalus claviceps* (Cestoda). *Acanthocephalus lucii* (Acan-

thocephala) was found in the intestine of four (10,5%) out of 38 studied eels. No parasites were found in the livers of studied eel.

Out of 24 eels at age 3+ caught in the Karvys Lake 87,5% were females and 12,5% males. Age group 2+ was dominated by females (83,3%) and only one eel (16,7%) was male. Two eels at age 18+ were females. Five different taxons of parasites were found as the result of parasitological analysis of collected samples from the Karvys Lake. The dominant species was swimbladder parasite *Anguilicola crassus* (Nematoda). 31,3% out of 32 studied eels were infected with this parasite. 15,6% of eels were infected by *Dactylogyrus* sp., 9,4% of eels were infected by *Camallanus lacustris*. 6,3% of studied eels were infected with *Bothriocephalus claviceps* (Cestoda). *Acanthocephalus lucii* (Acanthocephala) was found in the intestine of one (3,1%) out of 32 studied eels. No parasites were found in the livers of studied eel.

Out of 18 eels at age 3+ caught in the Riešė Lake 88,9% were females and 11,1% were males. Age group 2+ was dominated by females (66,7%), the remaining 33,3% were males. Six different taxons of parasites were found as the result of parasitological analysis of collected samples from the Riešė Lake. The dominant species was swimbladder parasite *Anguilicola crassus* (Nematoda). 23,3% of studied eels were infected with this parasite. 10% of eels were infected by *Dactylogyrus* sp., 6,7% of eels were infected by *Trichodina* sp. (Ciliophora). 10% of eels were infected by *Camallanus lacustris*, *Bothriocephalus claviceps* (Cestoda) and *Acanthocephalus lucii* (Acanthocephala). No parasites were found in the livers of studied eel.

According to literature review, intensive infestation with *A. crassus* and other parasites may negatively affect condition of infected eels (reduce of forage activity, increased sensitivity for reduce in oxygen concentrations, reduced growth rate and lower content of energy resources (lipids) in muscle tissues) or even death in exceptional cases. However, the current study did not reveal cases of very intense infestation as well as it was not found statistically significant correlation between detected cases of infestation and Fulton condition factor. Therefore, it could be concluded that it was not found significant effect of the observed rates of infestations on studied eel populations.

11.3 Contaminants

No available data.

11.4 Predators

No available data.

12 Other sampling

Sampling for cormorant diet analysis is done on regular basis as part of PhD project on Cormorant effect on fish stocks in the Curonian Lagoon since 2005. About 1000 samples were analysed and no eel are found in the diet.

13 Stock assessment

13.1 Local stock assessment

There are no stock assessment surveys in Lithuania. However, first stock assessment was conducted in 2008 using Simplified model of the eel population dynamics (Dekker *et al.*, 2008). Using the model natural escapement levels of silver eel under pristine conditions were calculated as well as current escapement.

13.2 International stock assessment

13.2.1 Habitat

Wetted Area:

Lacustrine: 117 000 ha (lakes and reservoirs);

Riverine: 33 200 ha (38 000 km);

Transitional and lagoons: 41 300 ha (Curonian Lagoon);

Coastal: 41 500 ha (Baltic Sea).

Lithuania has 2782 lakes with areas exceeding 0.5 ha (88 548 ha) and 1159 reservoirs with areas over 0.5 ha (28 306 ha), also 4418 rivers longer than 3 km, their total length measuring 37 636 km and their surface area totalling 33 200 ha (Table 13.1.1.1). Lakes and reservoirs over 50 ha number 285 (68 754 ha) and 70 (21 291 ha) respectively. Lithuania has 41 300 ha (26%) of the Curonian Lagoon (total area 158 400 ha). The Baltic Sea coastal zone is the area between the coastline and the 20 m depth isobath. This zone makes up an area of 41 500 ha. According to Directive 2000/60/EC, there are four RBDs in the territory of Lithuania (Figures 13.2.1.1 and 13.2.1.2).

Table 13.2.1.1. Eel habitats in Lithuania.

HABITAT	NUMBER	LENGTH, AREA
Rivers	4418	37 636 km
Lakes	2782 (>0.5 ha)	88 548 ha
Reservoirs	1159 (>0.5 ha)	28 306 ha
Curonian Lagoon	1	41 300 ha
Baltic Sea coastal zone	1	41 500 ha

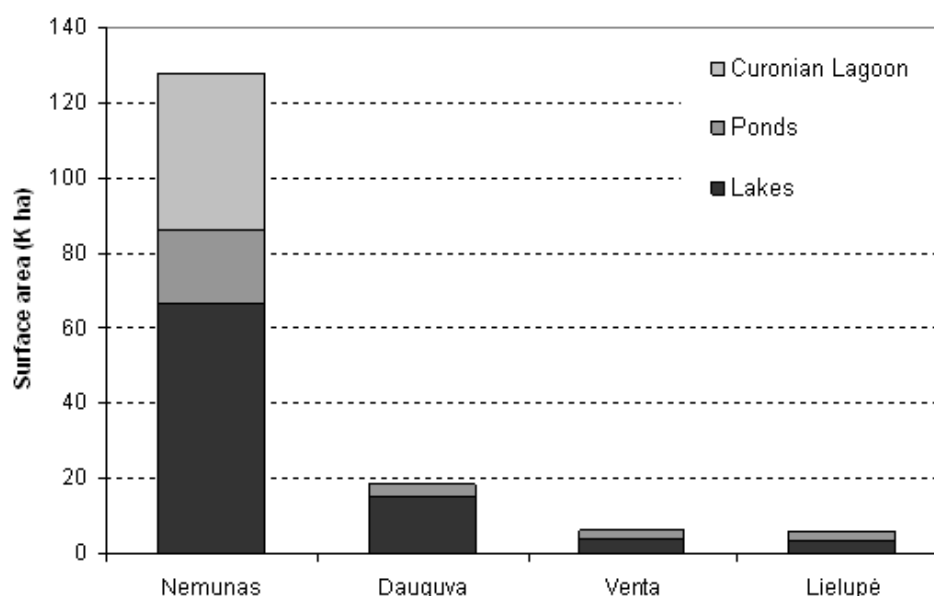


Figure 13.2.1.2. Areas of RBD waterbodies in Lithuania (thousand ha).

13.3 Silver eel production

Based on historical data on eel catches and information about the structure of catches, the average production of silver eel was calculated simplified model of the eel population dynamics (Dekker *et al.*, 2008).

According to the calculations presented in Tables 13.2.2.1 and 13.2.2.1.1, in the Lithuanian EMP the 40% target level of escapement of the spawning-stock biomass from Lithuanian waterbodies (SSB is calculated under pristine conditions) makes up 35 tonnes of silver eel per year. Meanwhile, according to theoretical calculations, the current escapement from the Curonian Lagoon, where the major part of the eel population is natural, and from stocked lakes should be around five tonnes. Thus, to achieve the objective set by the Council Regulation, Lithuania would have to stock at least such a quantity of glass eel that would allow additional production of at least 30 tonnes of silver eel in Lithuanian waterbodies, provided that the natural eel population and its recruitment with new individuals in the Curonian Lagoon do not decline in future.

Table 13.3.1. Eel production in the absence of anthropogenic impacts.

EEL HABITAT	PERIOD	STOCKING	CATCH, T	CATCHNAT. INDIV., T	SSBNAT, T
Curonian Lagoon (total area)	1954–1978	0	250	250	333

13.4 Historic production

Calculations of the historical production are done using simplified model of the eel population dynamics (Table 13.3.1.). It was assumed that the effectiveness of the silver eel fishery in the past was similar to that of other Baltic countries (the level established by experiments with tagged eel in Scandinavia, i.e. 25%). In addition, the calculations were based on the assumption that an insignificant overfishing of yellow eel had occurred, with the rate of yellow eel exceeding that of silver eel in catches. The calculation was only done for the Curonian Lagoon, as catches in other inland waterbodies had been extremely poor in the past, while current catches mostly include stocked eel. In the Baltic Sea coastal zone, eel catches have always been insignificant, usually amounting to a few hundred kilograms per year or no eel fishery has occurred at all. Plans are made to support the eel fishery of very low intensity (<100 kg/year) and to prohibit any specialised fishery in the Baltic Sea. Thus, it can be assumed that there were no and there will be no anthropogenic impacts on eel in Lithuania's coastal zone of the Baltic Sea. For that reason, the spawning eel stock biomass under pristine conditions and the target level of escapement in these waterbodies were not included in the calculations.

Table 13.4.1. Calculation of EMP target SSB (SSB_{prist} is SSB under pristine conditions and SSB_{curr.} is the current level of escapement).

ESCAPEMENT	SPAWNING-STOCK BIOMASS, T
SSB _{prist} , t (Curonian Lagoon, total area)	333
SSB _{prist} , t (Curonian Lagoon, LT section (26%))	87
SSB, 40% under pristine conditions)	35
SSB _{curr.} (lakes and Curonian Lagoon (LT section))	5

13.5 Current production

Table 13.5.1. LT current and escapement production.

YEAR	BIOMASS(T)			TARGET		MORTALITY	
	B ₀	B _{best}	B _{current}	Biomass	F	Ahp	ΣA
2008	87	28,0	11,1	34,8	0.453	n.d.	0.60
2009	87	18,8	7,6	34,8	0.432	n.d.	0.60
2010	87	47,0	23,3	34,8	0.395	n.d.	0.50
2011	87	28,4	12,6	34,8	0.393	n.d.	0.56
2012	87	18,5	8,3	34,8	0.422	n.d.	0.55
2013	87	32,4	13,7	34,8	0.442	n.d.	0.58
2014	87	18.4	8.8	34.8	0.416	0.25	0.52

13.6 Current escapement

See above and Table 13.5.1.

13.7 Production values e.g. kg/ha

Table. 13.7.1. EEL catch in kg/ha in Curonian lagoon.

Year	Curonian Lagoon, LT section area (ha)	Catches, tonines	Production, kg/ ha
1954–1978	41 300	250	6.053
2008	41 300	6,8	0,165
2009	41 300	4,9	0,119
2010	41 300	5,0	0,121
2011	41 300	3,4	0,082
2012	41 300	1,7	0,041
2013	41 300	1.6	0.039
2014	41 300	1,3	0.032
2015	41 300	0.8	0.019

13.8 Impacts

There are no calculations.

13.9 Stocking requirement eels <20 cm

The quantity of glass eel needed for stocking was calculated by taking into account the optimal stocking density for the area's latitude where Lithuania is located (100 glass eel ha⁻¹) and the area of waterbodies appropriate to stocking. The Lithuanian EMP contains a specific stocking strategy: in stocking, priority will be given to habitats that are unaffected or partially affected by HP turbines (HPs have fish passes), have low levels of pollution and are remote from cormorant colonies. Stocking of priority lakes unaffected by HP turbines (excluding rivers and the Curonian Lagoon) requires one tonne of glass eel per year approximately (≈€ 0.5 million per year). If the country has sufficient financial resources and the possibility to acquire glass eel (if recruitment of glass eel does not decline, their fishery is not banned and all Member States have sufficient glass eel resources for implementing their national EMPs),

Lithuania plans to stock up to 30 000 ha of waterbodies in implementing the EMP (Table 13.8.1). This would allow expecting a larger escapement level of silver eel than that set out in the Council Regulation (40% of natural production). The maximum total surface area of priority lakes was calculated, as not all lakes will be stocked due to various risk factors, and stocking in some lakes and reservoirs will be below 100 units ha⁻¹ where a waterbody has lower productivity. In addition, some waterbodies still contain eels and these basins will not be stocked or stocking will be low-scale.

Stocking activities started again in 2010. 28 895 individuals were released in 2010, 152 000 individuals were released in 2011, 490 660 individuals in 2012 in inland waters. About 10% of released individuals were marked by colorant Alizarin.

Table 13.9.1. LT. Quantity of glass eel needed for stocking and expected annual costs (if the price is about 500 €/kg).

WATERBODIES BY ORDER OF PRIORITY	SURFACE AREA, HA	QUANTITY OF GLASS EELS, KG (UNITS, MILLION)	SSB PRODUCTION, T*
Lakes and reservoirs unaffected by HPs	23 995	800 (2.4)	44
Lakes and reservoirs partially affected by HPs	15 159	500 (1.5)	28
Curonian Lagoon	41 300	1400 (4.2)	78

Note: *SSB production without prohibiting the fishery (catches of 5% of yellow eel and 25% of silver eel per year).

13.10 Summary data on glass eel

No glass eels caught in Lithuania. All glass eels or on grown are imported and used for stocking in Lithuania.

13.11 Data quality issues

No available data.

14 Sampling intensity and precision

Sampling started in 2011. Samples of 200 individuals are collected for further ageing in 2013. Sampling is implemented by Fisheries Service under the Ministry of Agriculture.

15 Standardisation and harmonisation of methodology

Sampling under DCF started in 2011; sampling activities are implemented by Fisheries Service under the Ministry of Agriculture.

15.1 Survey techniques

Studies of the intensity and dynamics of eel migrations are realized using traditional fishing gears.

15.2 Sampling commercial catches

Eels were collected from fykenet fishery in the Curonian Lagoon and from river traps from three fishing sites in Inland waters.

15.3 Sampling

Sampling carried out by local fisherman.

Eel sampling 200 specimens per year:

Length (mm), weight (g), eye diam. (mm) (vertical and horizontal), sex by macroscopic examination, otoliths.

15.4 Age analysis

Otoliths were soaked ten minutes in xylene ((CH₃)₂C₆H₄), after that observation of rings was made with binocular changing intensity of light.

15.5 Life stages

No available data.

15.6 Sex determinations

Sex was not determined, however, according to earlier studies in Lithuania and eel size, it is presumed that most sampled eels were females.

15.7 Date quality issues

No available data.

16 Overview, conclusions and recommendations

Eel studies in Lithuania in the past were undertaken only in occasional cases aiming to collect samples for different research purposes (e.g. otolith microchemistry, recreational fishery study). Implementation of the national EMP until the end of 2010 was limited to legal regulations which are aimed to reduce fishery impact on the stock. Lithuania submitted national DCF program and started collect data in 2011. In 2011 Lithuania started programme for implementation of the EMP using financial mechanism of the European Fisheries Fund. The programme is aimed to restock lakes and to fulfil gaps in the research on the eel stock. Future plans for the eel management plan: to continue investigations using telemetry methods; to continue Monitoring of Curonian Lagoon European eel population state and recovery; to stock with young eels the waterbodies above the biggest Lithuanian hydropower plant station (Kaunas HPP).

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Report on the eel stock and fishery in Netherlands 2014/2015

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Contributors to the report: Ingeborg de Boois (IMARES: survey data coastal areas), Mennobart van Eerden (Rijkswaterstaat – Waterdienst; cormorant breeding pairs IJsselmeer area), Ben Griffioen (IMARES; glass eel index); Arjan Heinen (Combinatie van Beroepsvissers; stocking data; silver eel fisheries data), Twan Leijzer (IMARES; parasite infections); Jaap van der Meer (NIOZ; yellow eel data NIOZ fyke), Michiel Kotterman (IMARES; data on contaminants), William Swinkels (DUPAN, glass eel data and eel aquaculture production), Oscar Bos (editing).

2 Introduction

2.1 General overview fisheries

Eel fisheries in the Netherlands occur in coastal waters, estuaries, larger and smaller lakes, rivers, polders, etc. Management of eel stock and fisheries has been an integral part of the long tradition in manipulating water courses (polder construction, river straightening, ditches and canals, etc.). Governmental control of the fishery is restricted to on the one hand a set of general rules (gear restrictions, size restrictions, for course fish: closed seasons), and on the other hand site-specific licensing. Within the licensed fishing area, and obeying the general rules, fishermen are currently free to execute the fishery in whatever way they want. Since 1/1/2010 there is a general registration of landings, whereas a general registration of fishing efforts has not yet been implemented. In recent years, licensees in state-owned waters are obliged to participate in so-called Fish Stock Management Committees ['Visstand Beheer Commissies' VBC], in which commercial fisheries, sports fisheries and water managers are represented. The VBC is responsible for the development of a regional Fish Stock Management Plan. The Management Plans are currently not subject to general objectives or quality criteria. The future of VBC and their role in fish stock management is under debate.

Until April 2011 the total fishery involved approx. 200 companies, with an estimated total catch of nearly 442 tonnes in 2010. However, on 1 April 2011 a large part of the fishery was closed due to high PCB-levels in the eel (Figure 1). This closure has affected about 50 fishing companies catching 170 tonnes of eel in 2010, roughly a third of the annual landings of inland waters in the Netherlands.



Figure NL. 1. Overview of the areas closed for eel and Chinese mitten crab fishery as of 1 April 2011 (Source Ministry of Economic Affairs).

2.2 Spatial subdivision of the territory

The fishing areas can be categorised into five groups:

- 1) The Wadden Sea; 53°N 5°E; 2591 km². This is an estuarine-like area, shielded from the North Sea by a series of islands. The inflow of seawater at the western side mainly consists of the outflow of the river Rhine, which explains the estuarine character of the Wadden Sea. The fishery in the Wadden Sea is permitted to licence holders and assigns specific fishing sites to individual licensees. Fishing gears include fykenets and poundnets; the traditional use of eelpots is in rapid decline. The fishery in the Wadden Sea is obliged to apply standard EU fishing logbooks. Landings statistics are therefore available from 1995 onwards; <50 tons per year. In 2009 there were 21 companies having a commercial license for fishing eel, and the total number of fykenets was estimated at 400.
- 2) Lake IJsselmeer; 52°40'N 5°25'E; now 1820 km². Lake IJsselmeer is a shallow, eutrophic freshwater lake, which was reclaimed from the Wadden Sea in 1932 by a dike (Afsluitdijk), substituting the estuarine area known before as the Zuiderzee. The surface of the lake was reduced stepwise by land reclamation, from an original 3470 km² in 1932, to just 1820 km² since 1967. In preparation for further land reclamation, a dam was built in 1976, dividing the lake into two compartments of 1200 and 620 km², respectively, but no further reclamation has actually taken place. In managing the fisheries, the two lake compartments have been treated as a single management unit. The discharge of the river IJssel into the larger compartment (at 52°35'N 5°50'E, average 7 km³ per annum, coming from the River Rhine) is sluiced through the Afsluitdijk into the Wadden Sea at low tide, by passive fall. Fishing gears include standard and summer fykenets, eel boxes and longlines; trawling was banned in 1970. Licensed fishermen are not spatially restricted within the lake, but the number of gears is controlled by a gear-tagging system. The registered landings at the auctions are assumed to cover some the actual total. There are, however, differences in estimated landings reported by PO IJsselmeer, PVIS and catch registration system of

the Ministry of Economic Affairs. In 2009 there were 70 fishing licences, owned by about 30 companies. The total number of gears allowed in 2013 was: fixed fykes 1579, train fykes 6386, eel boxes 7415 and unknown numbers of longlines.

- 3) Main rivers; 180 km² of water surface. The Rivers Rhine and Meuse flow from Germany and Belgium respectively, and in the Netherlands constitute a network of dividing and joining river branches. Traditional eel fisheries in the rivers have declined tremendously during the 20th century, but following water rehabilitation measures in the last decades, is now slowly increasing. The traditional fishery used stownets for silver eel, but fykenet fisheries for yellow and silver eel now dominates. Individual fishermen are licensed for specific river stretches, where they execute the sole fishing right. No registration of effort is required. In 2009 there were 28 fishing companies, using an estimated number of 318 fixed fykes, 2433 train fykes, 551 eel boxes, and unknown quantities of other gears (electric dipnet, longlines, etc.) Since 1 April 2011 the eel fishery on the main rivers has been closed due to high levels of pollutants in eel.
- 4) Zeeland; 965 km². In the Southwest, the Rivers Rhine, Meuse and Scheldt (Belgium) discharge into the North Sea in a complicated network of river branches, lagoon-like waters and estuaries. Following a major storm catastrophe in 1953, most of these waters have been (partially) closed off from the North Sea, sometimes turning them into freshwater bodies. Fishing is licensed to individual fishermen, mostly spatially restricted. Fishing gears are dominated by fykenets. Management is partially based on marine, partly on freshwater legislation. In 2009 there are 27 companies, using an estimated number of 174 fixed fykes, 233 train fykes, and unknown numbers of eelpots. This area has also been affected by the ban on eel and Chinese mitten crab fishery due to high pollution levels.
- 5) Remaining waters; inland 1340 km². This comprises 636 km² of lakes (average surface: 12.5 km²); 386 km² of canals (>6 m wide, 27 590 km total length); 289 km² of ditches (<6 m wide, 144 605 km total length); and 28 km² of smaller rivers (all estimates based on areas less than 1 m above sea level, 55% of the total surface; see Tien and Dekker, 2004 for details). Traditional fisheries are based on fykenetting and hook and line. Individual licences permit fisheries in spatially restricted areas, usually comprising a few lakes or canal sections, and the joining ditches. Only the spatial limitation is registered. Eight small companies operating scattered along the North Sea coast have been added to this category. In 2009 there are about 100 companies, using unknown quantities of gears of all types.

The Water Framework Directive subdivides the Netherlands into four separate River Basin District (RBD), all of which extend beyond our borders. These are:

- 1) the River Ems (Eems), 53°20'N 7°10'E (=river mouth), shared with Germany. This RBD includes the northeastern Province Groningen, and the eastern part of Province Drenthe. Drainage area: 18 000 km², of which 2400 km² in the Netherlands.
- 2) the River Rhine (Rijn), 52°00'N 4°10'E, shared with Germany, Luxemburg, France, Switzerland, Austria, Liechtenstein. Drainage area: 185 000 km², of

which 25 000 km² in the Netherlands, which is the major part of the country.

- 3) the River Meuse (Maas), 51°55'N 4°00'E, shared with Belgium, Luxemburg, France and Germany. Drainage area: 35 000 km², of which 8000 km² in the Netherlands.
- 4) the River Scheldt (Schelde), 51°30'N 3°25'E, shared with Belgium and France. Most of the southwestern Province Zeeland used to belong to this RBD, but water reclamation has changed the situation dramatically. Drainage area: 22 000 km², of which 1860 km² in the Netherlands.

Within the Netherlands, all rivers tend to intertwine and confluent. Rivers Rhine and Meuse have a complete anastomosis at several places, whereas a large part of the outflow of the River Meuse is now redirected through former outlets of the River Scheldt. Additionally, the coastal areas in front of the different RBDs constitute a confluent zone. Consequently, sharp boundaries between the RBDs cannot be made, neither on a practical nor on a juridical basis. This report will subdivide the national data on a pragmatic basis.

In the following, we will subdivide the national data on eel stock and fisheries by drainage area on a preliminary assumption that water surfaces and fishing companies are approximately equally distributed over the total surface, and thus, totals can be split up over RBDs proportionally to surface areas.

3 Time-series data

3.1 Recruitment

3.1.1 Glass eel recruitment

3.1.2 Commercial

Glass eel fisheries is forbidden, no available data.

3.1.3 Recreational

Glass eel fisheries is forbidden, no available data.

3.1.4 Fishery-independent

Recruitment of glass eel in Dutch waters is monitored at Den Oever and eleven other sites along the coast (Figure NL. 2; see Dekker, 2002 for a full description). In Den Oever (Figure NL.3), recruitment has significantly increase in the last two years and was at the highest level since the mid-1990s. However, overall the recruitment levels are still low compared to the reference period (1960–1979). The data from the other sites (Figure NL.2) confirmed the overall trend, though individual series may deviate. Note that in contrast to previous years the glass eel data are presented simply as the average number of glass eels per haul in the months April and May, between 18:00–8:00 and only years with >5 hauls are included.



Figure NL. 2. Locations of glass eel monitoring in the Netherlands.

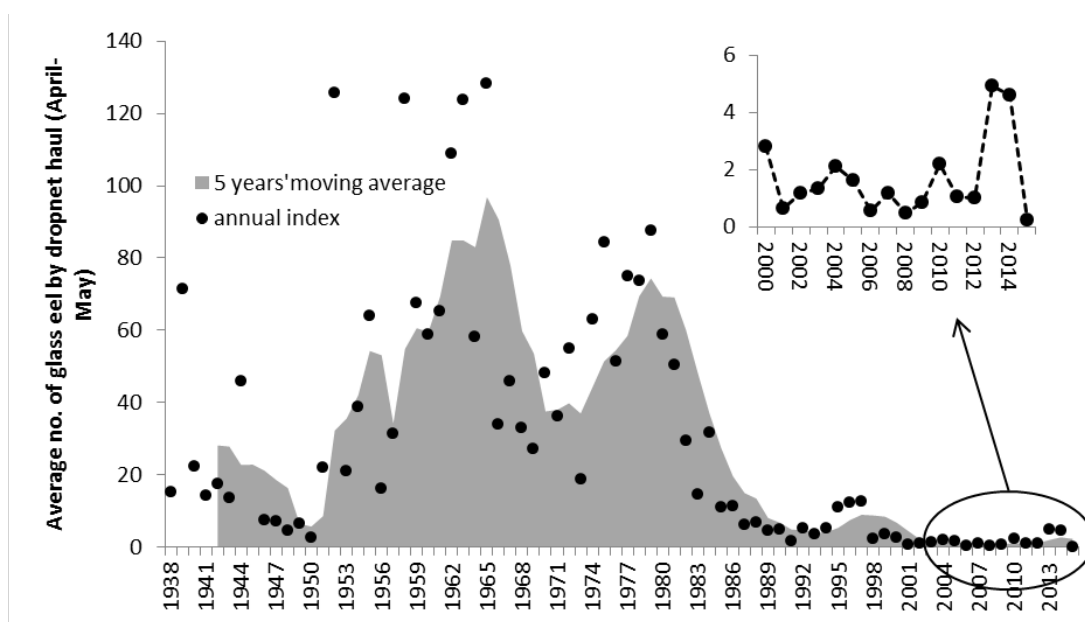


Figure NL. 3. Trend indices (mean number per haul in April and May) of glass eel recruitment at Den Oever (1938–2015).

Table NL. A. Average number of glass eel caught per lift net haul at the sluices in Den Oever in the period April–May.

DECADE									
YEAR	1930	1940	1950	1960	1970	1980	1990	2000	2010
0		22.4	2.7	58.9	48.1	59.0	4.9	2.8	2.2
1		14.3	21.9	65.2	36.1	50.4	1.8	0.6	1.1
2		17.5	125.6	108.9	55.0	29.4	5.2	1.2	1.0
3		13.7	21.1	123.7	18.8	14.7	3.5	1.3	4.9
4		46.1	38.8	58.1	63.0	31.6	5.4	2.1	4.6
5		NA	64.1	128.3	84.3	11.2	11.1	1.6	0.2
6		7.5	16.1	34.0	51.4	11.4	12.5	0.6	
7		7.2	31.3	45.8	75.0	6.2	12.6	1.2	
8	15.3	4.8	124.0	32.9	73.6	7.0	2.5	0.5	
9	71.5	6.6	67.6	27.1	87.7	4.8	3.7	0.9	

Table NL. B. Average number of glass eel caught by dropnet haul between 18:00 and 8:00 hrs in the period April-May at twelve sites in the Netherlands (1979–2015). If five or less hauls were carried out, this was recorded as NA. 1 = very early season (warm spring), sampling stopped early (early May), small number of empty samples. 2 = sampling took place in part of the season.

	OTHEENSE KREEK	BATH	KRAMMERSLUIS	BERGSCHIE DIEP	STELLEDAM	KATWIJK	IJMUIDEN	DEN OEVER (SCHIPLOCK)	HARLINGEN	LAUWERSMEER	NIEUWSTATEN-ZIJL	TERMUNTEN-ZIJL
RBD	Scheldt		Meuse			Rhine					Ems	
1979										100.4		
1980												
1981										75.9		
1982										21.6		
1983										15.8		
1984										9.6		
1985							0.6			25.2		
1986							3.3			1.3		
1987							7.7					
1988					13.8					1.0		
1989					4.4					14.3		
1990	0.3		0.3		10.9					6.0		
1991	0.0		0.2	1.3	3.1	5.1				6.6		0.5
1992	0.0	6.6	0.4		16.9	9.1			16.7	12.1		0.6
1993	0.0	22.7	0.4		10.1	13.5				33.2		1.2
1994	0.0	14.2	0.5		4.0				16.0	31.0		2.8
1995	0.5		0.4		3.3	29.7	2.0	34.7	6.6	16.9		3.7
1996	1.3	22	0.7		0.5	25.3		11.0	34.2	49.4	27.5	7.7
1997			0.6		2.8	12.9		11.4	11.2	27.8	30.0	15.6
1998	0.7		0.6		1.0	38.8	2.0	6.5	18.3	14.4	21.8	1.4
1999	1.4		0.5		1.2	140.1		7.2		31.7	12	10.2
2000	0.9	10.2	1.0	3.8	7.1	11.6		5.0		7.2	38.8	8.7
2001	0.4		0.1		1.0			1.7		2.4	39.7	1.1
2002		1.9	0.2		4.2	13.2	0.1	1.4	3.2	5.5	36.4	1.6
2003		7.5	0.1		0.3	12.7		4.8		1.7	23.6	0.8
2004	0.0	16.42	0.1		0.3	4.5			14.32	2.3	28.1	1.9
2005	0.0	15.3	0.6		0.2	5.6				1.4	21.1	1.8
2006	0.0	12.4	0.2		0.0	1.4		0.3	0.6	1.7	8.3	1.3
20071	0.0	43.9	0.1	0.4	0.1	27.9	0.1		1.7	1.0	21.7	4.0
2008	0.0	13.2	0.0	2.5	0.0	4.5	0.1	0.8	1.1	2.8	15.6	1.3
2009	0.0	9.1	0.0	1.3	0.5	3.5	0.1		0.7	0.6	13.6	1.2
2010		28.4	0.0	1.7	0.2		0.0	1.2	1.0	1.1	13.0	1.2
2011		39.2	0.1	1.3	0.3		0.0		3.1	1.4	11.6	1.4
2012		25.8	0.2	0.8	0.1	1.6	0.2		1.1	2.9	27.6	1.3
2013		73.8	0.0	16.7	0.2	1.6	0.0		5.2	9.1	60.5	1.9

	OTHEENSE KREEK	BATH	KRAMMERSLUIS	BERGSCHIE DIEP	STELLENDAM	KATWIJK	IJMUIDEN	DEN OEVER (SCHIPLOCK)	HARLINGEN	LAUWERSMEER	NIEUWSTATEN-ZIJL	TERMUNTEN-ZIJL
RBD	Scheldt		Meuse			Rhine					Ems	
2014	96.3		0.0	6.3	0.6	0.4	0.0		5.8	18.0	72.0	2.1
2015	24.2			2.2	0.2	0.6	0.1	0.2		1.0		3.0

3.1.5 Yellow eel recruitment

3.1.6 Commercial

No available data.

3.1.7 Recreational

No available data.

3.1.8 Fishery-independent

One of the few long time-series for eel is the fyke monitoring at NIOZ (Den Burg, Texel; van der Meer *et al.*, 2011). This dataset shows a familiar pattern of a steep decline in abundance since the 1980s.

In the past almost all catches were yellow eel, based on their length. More recently, the catches also comprise silver eel.

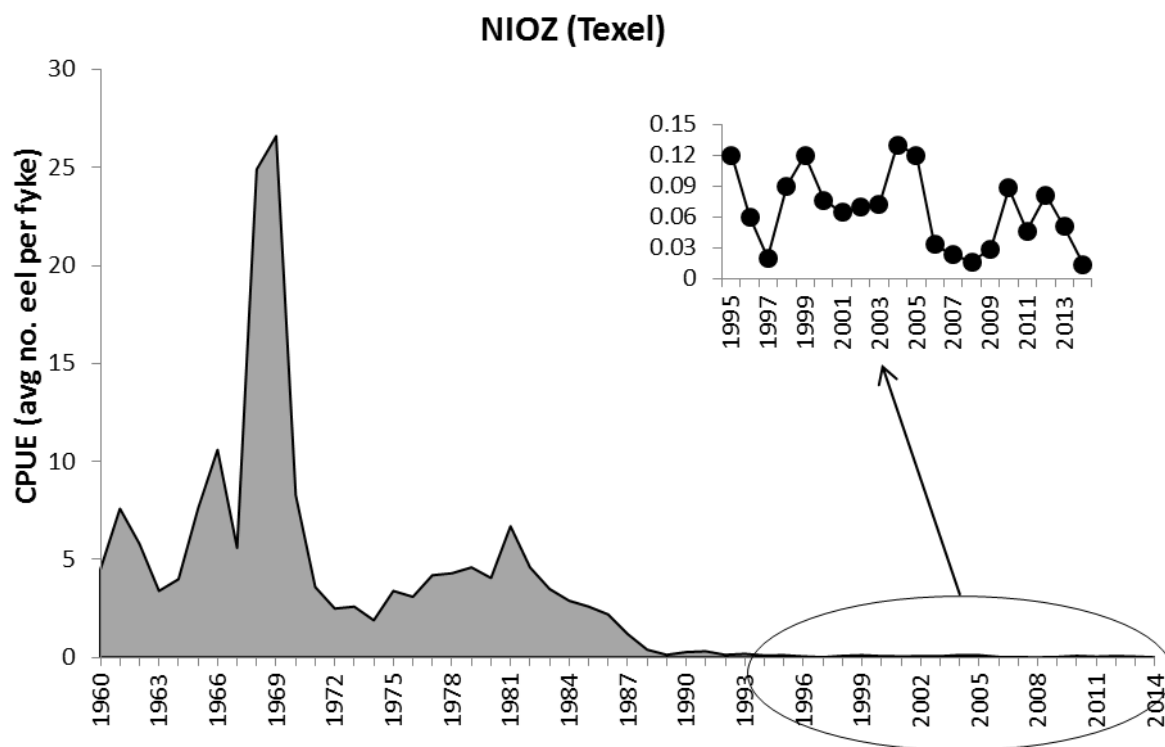


Figure NL. 4. Time-series of the mean catch per fyke (numbers) of yellow eel at NIOZ 1960–2014 (data NIOZ and van der Meer *et al.*, 2011).

3.2 Yellow eel landings

3.2.1 Commercial

No reliable long-term time-series of yellow eel landing exist; total landings of yellow and silver eel combined have been reported.

Statistics from the auctions around Lake IJsselmeer were kept by the government (EZ, previously LNV) until 1994; since then and until 2012 statistics were kept by the Fish Board (PVis; Table NL.E; Figure NL. 5, main graph). These statistics are broken down by species, month, harbour and main fishing gear. The quality of this information has deteriorated considerably over the past decades, due to misclassification of gears, and the trading of eel from other areas at IJsselmeer auctions. In the data from auctions around Lake IJsselmeer yellow and silver eel were reported separately, but information in recent decades (from early 1990s onwards) is unreliable: yellow eel from eel boxes and silver eel from all gears have been combined (see Section NL.6.2.1 for further details).

In addition, the fishers organisation (PO IJsselmeer) has kept records of the catches of their associated fishers (>90% of the fishers active in the IJsselmeer area) from 2001 onwards (Figure NL. 5, insert graph).

An obligatory catch registration system was introduced in the Netherlands in January 2010 by the Ministry of Economic Affairs (EZ). Weekly catches of eel are reported, but yellow eel and silver eel catches are combined in this program and no information on effort and gears is reported. Information from this registration system is reported in Section NL.6.2.1.

Table NL. C. Landings in tons by year, from the auctions around Lake IJsselmeer, Rhine RBD. Only landings recorded at the auctions are included; other landings are assumed to represent a minor and constant fraction. Figures in italics (since 1995) are suspect, due to misclassification of catches and trade from areas outside Lake IJsselmeer at the IJsselmeer auctions. Source Ministry of Economic Affairs (EZ; 1900–1994), Productschap Vis (PVIS; 1995–2012); PO IJsselmeer (in brackets; 2001–current).

DECADE												
YEAR	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
0	324	620	1157	838	3205	4152	2999	1112	641	472	368	21(79)
1	387	988	989	941	4563	3661	2460	853	701	573	381 (405)	62(124)
2	514	720	900	1048	3464	3979	1443	857	820	548	353 (343)	59(121)
3	564	679	742	2125	1021	3107	1618	823	914	293	279 (293)	NC(90)
4	586	921	846	2688	1845	2085	2068	841	681	330	245 (280)	
5	415	1285	965	1907	2668	1651	2309	1000	666	354	234 (238)	
6	406	973	879	2405	3492	1817	2339	1172	729	301	230 (224)	
7	526	1280	763	3595	4502	2510	2484	783	512	285	130 (188)	
8	453	1111	877	2588	4750	2677	2222	719	437	323	122 (141)	
9	516	1026	1033	2108	3873	3412	2241	510	525	332	58 (105)	

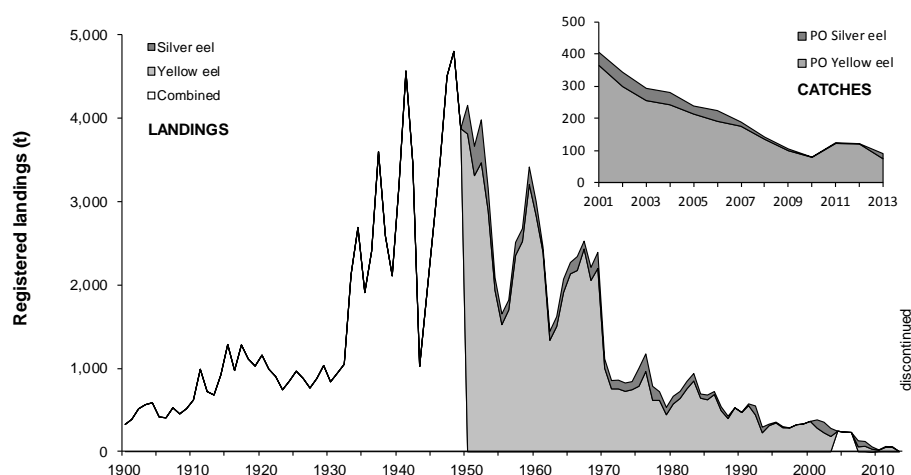


Figure NL. 5. Main graph: Time-series of landings of yellow eel and silver eel from Lake IJsselmeer/Markermeer at auctions. Source data main graph EZ and Productschap Vis. Insert graph: catches of yellow eel and silver eel recorded by PO IJsselmeer.

3.2.2 Recreational

No available data.

3.3 Silver eel landings

3.3.1 Commercial

No reliable long-term time-series of yellow eel landing exist. Data on total landings of yellow and silver eel combined have been reported for Lake IJsselmeer/Markermeer. Data from auctions around Lake IJsselmeer did report yellow and silver eel separately, but information in recent years (early 1990s onwards) is unreliable: yellow eel from eel boxes and silver eel from all gears have been combined and labelled 'silver eel' (see Section NL. 6.2. for details). In addition, catches registered by the PO IJsselmeer from 2001 onwards do distinguish silver eel from other eel catches. However, some silver eel may still be reported among the catches of 'other eel'. Still, landings and catches of silver eel are included "as is" in the figure of yellow eel landings and catches (Figure NL. 5). An obligatory catch registration system has been introduced in the Netherlands in January 2010 by the Ministry of Economic Affairs (EZ). However, weekly catches of eel are reported, but they consist of combined data for yellow eel and silver eel and no information on effort or gears is reported.

In 2012, a fisheries time-series of silver eel catch data from three closely related sites in **Friesland** were made available. Two series covered the years 1933–1968 (Figure NL. 6), the other series covered the years 1974–1978 and 1990–2012 (Figure NL. 7; Figure NL. 8).

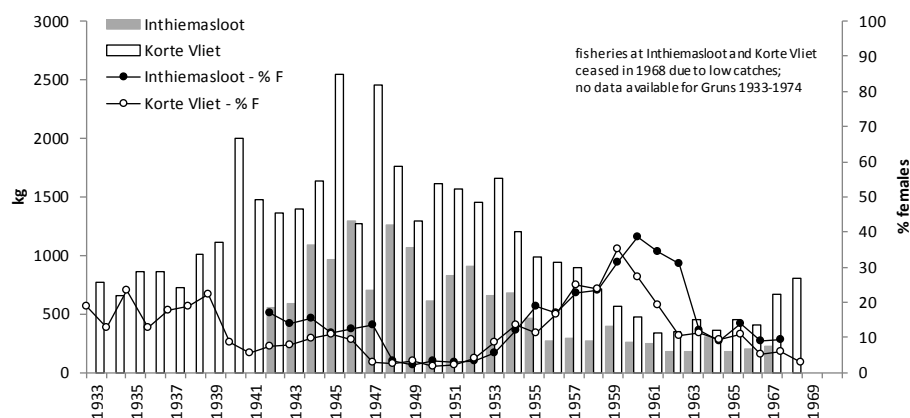


Figure NL. 6. Silver eel catches in kg at two sites in Friesland between 1933 and 1968. The catch composition is represented by the percentage of females in the catch.

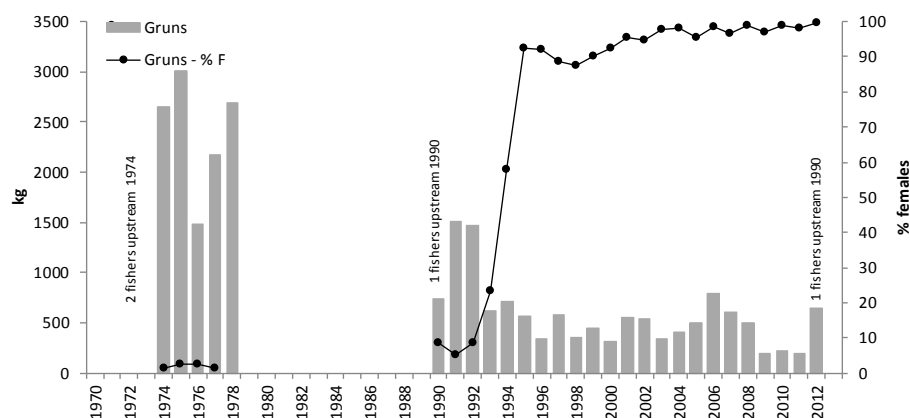


Figure NL. 7. Silver eel catches in kg at a site in Friesland between 1974 and 1978 and between 1990 and 2012. The catch composition is represented by the percentage of the catch that consists of females.

Silver eel catches at two sites (Inthiemasloot and Korte Vliet) in Friesland declined already in the late 1950 and fishing for silver eel at those two locations ceased in 1968 due to reduced catches. This decline coincided with a temporary change in the sex ratio of the catch from predominantly males to a higher fraction (>25%) of females. After less than ten years, however, the catch composition was again dominated by male silver eel. The third site (Gruns), with silver eel catch data from 1974–1978 and from 1990 onwards, shows declined catches in the early 1990s compared to the 1974–1978 data. In addition to the decline in the total volume of the annual catch, the sex ratio reversed from a male dominated catch to a female dominated catch. This reversal in sex ratio means that the decline in *numbers* of silver eel caught is more pronounced than the decline in catch weight, as the average female silver eel (*ca.* 700 gr) weighs significantly more than the average male (*ca.* 100 gr). This is illustrated in Figure NL. 8.

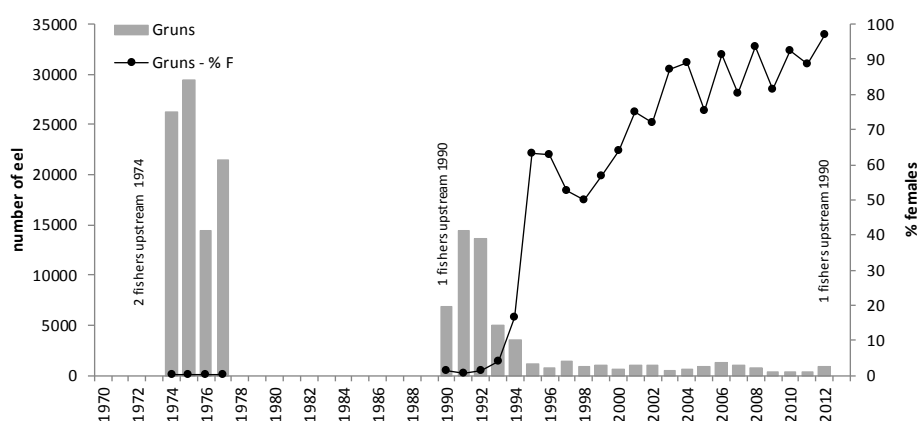


Figure NL. 8. Silver eel catches in numbers at a site in Friesland between 1974 and 1978 and between 1990 and 2012. The catch composition is represented by the percentage of females in the catch.

3.3.2 Recreational

No available data.

3.4 Aquaculture production

3.4.1 Seed supply

Table NL. D. Origin of glass eel used for aquaculture in the Netherlands since 2010 (Source DUPAN).

SEASON	FRANCE	SPAIN	ENGLAND	TOTAL (KG)
2010/2011	4725	1890	135	6750
2011/2012	5325	1350	100	6775
2012/2013	5500	650	550	6700
2013/2014	3400	250	1250	4900
2014/2015	4400	500	300	5200

3.4.2 Production

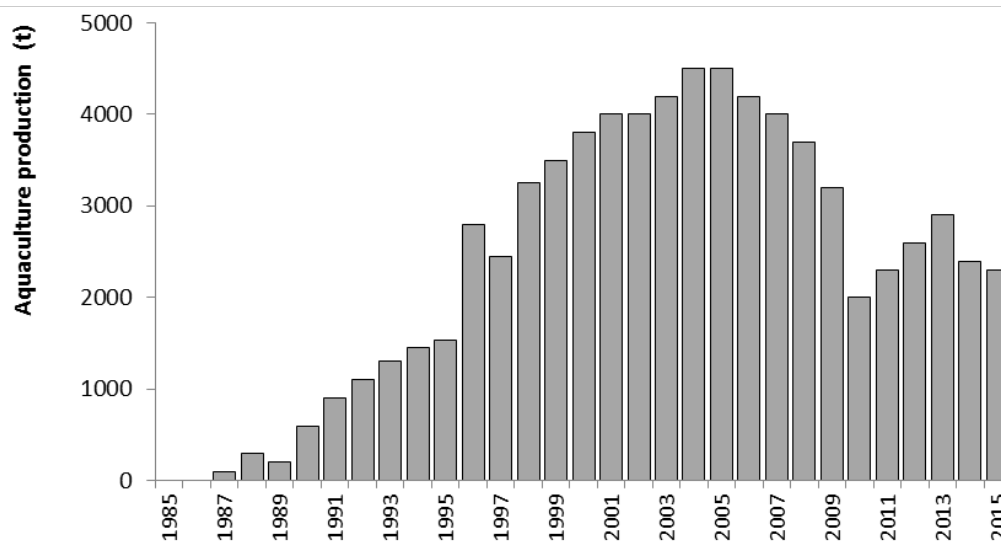


Figure NL. 9. Trend in aquaculture production of yellow eel for consumption in the Netherlands (Source DUPAN).

3.5 Stocking

3.5.1 Amount stocked

Table NL. E. Overview of glass eel and young yellow eel stocked in the Netherlands in 2015 (Source DUPAN and CvB). For yellow eel, the location where they have been raised is set between brackets in the column 'Origin'.

DATE	STOCKING LOCATION	ORIGIN	QUARAN- TINED	KG	#	#/KG
GLASSEEL						
14/04/2014	Veluwe Randmeren	?	?	278	863,226	3100
TOTAL				278	863,226	
YOUNG YELLOW EEL						
10/06/2015	Zuidelijke Randmeren (?)	?	?	1023	435,055	425
21/08/2015	Zuidelijke Randmeren (?)	?	?	682	126,235	185
21/08/2015	Veluwe Randmeren (?)	?	?	532	97,839	185
28/08/2015	Veluwe Randmeren (?)	?	?	1141	83,285	73
?	Reeuwijk (Viss. Coop. De Schakel)	?	?	200	51,517*	278*
?	Kampen (Putten)	?	?	133	36,856	240
?	NW Overijssel (Bergeijk)	?	?	100	24,000	256
TOTAL				3811	803,270*	

*estimated, based on average weight/eel of 'Kampen' and 'NW Overijssel'.

3.5.2 Catch of eel <12 cm and proportion retained for restocking

Catch and retention of eels <28 cm is illegal. There is no organised trap and transport of undersized eels.

3.5.3 Reconstructed time-series on stocking

No (historical) data available with regards to origin and whether or not stocked eels were quarantined, overall all stocked of glass eel (see Figure .NL.6) is sourced outside the Netherlands.

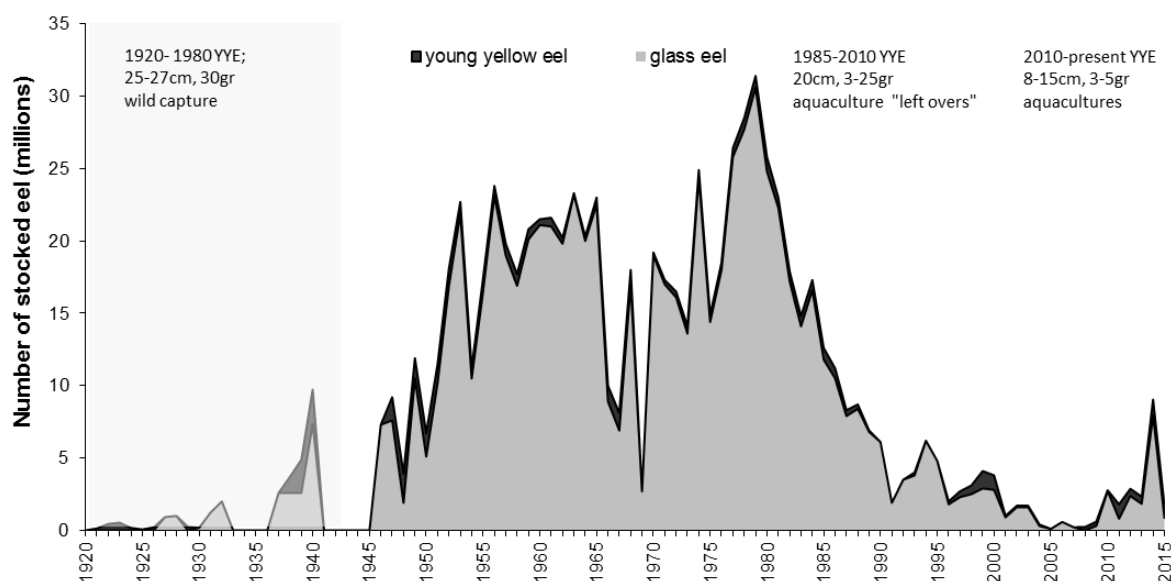


Figure NL. 10. Overview of stocking of glass eel and young yellow eel in the Netherlands (1920–2015). Note that the average weight of stocked young yellow eel decreased from ~30 g to ~3 g between 1920 and 2010.

3.6 Trade in eel 2015

SOURCE	DESTINATION	STAGE	KG	MARKET VALUE
				(€/KG)
South France	Netherlands	glass eel	3811	?
TOTAL			3811	

4 Fishing capacity

For marine waters and Lake IJsselmeer a register of ships is kept, but for the other waters no central registration of the ships being used is available. Registration of the number of gears owned or employed was lacking until recently.

For Lake IJsselmeer/Markermeer (Figure NL. 11), an estimate of the number of gears actually used is available for the years 1970–1988 (Dekker, 1991). In the mid-1980s, the number of fykenets was capped, and reduced by 40% in 1989. In 1992 the number of eel boxes was counted, and capped. Subsequently, the caps have been lowered further in several steps, the latest being a buy-out in 2006. Since the number of companies has reduced at the same time, the nominal fishing effort per company has not reduced at the same rate, and underutilisation of the nominal effort probably still ex-

ists. The effort in the longline fishery is not restricted, other than by the number of licences.

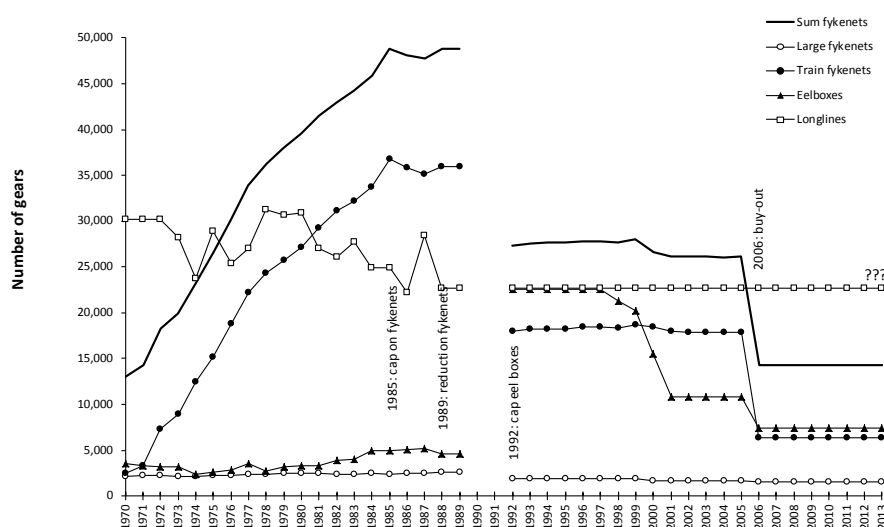


Figure NL. 11. Trends in the nominal number of fishing gear employed in the eel fishery on Lake IJsselmeer/Markermeer. Information before 1989 is based on a voluntary inquiry in 1989 (Dekker, 1991); after 1992, the licensed number of gear is shown. Note that longline fishery is only restricted by the number of licences, the number of longlines per licence is not regulated. The number of longlines since 1992 is unknown.

5 Fishing effort

5.1 Glass eel

No fishing on glass eel.

5.2 Yellow eel

No distinction between fishing effort on yellow eel and silver eel. Data are combined.

For most of the country, fishing effort was unknown until 2012. In areas where fishing capacity was known (IJsselmeer/Markermeer), no record had been kept of the actual usage of fishing gears. For Lake IJsselmeer, a maximum number of gears by company is enforced (authenticated tags are attached to individual gears; see Chapter 4), but the actual usage is often much lower, among others since restrictions apply on the combinations of types of fishing gears (e.g. fykenets and gillnets should not be operated concurrently, since perch and pikeperch are the target species of the gillnetting, whereas landing perch and pikeperch from fykenets is prohibited).

A national catch registration system was introduced by Ministry of Economic Affairs on 1/1/2010. Since 2012, eel fishers are obliged for the first time to weekly record their effort in addition to their catches; all eel fishers have to record the type of gear and number of gear used. Overviews of the number and type of gear deployed weekly throughout 2013 is presented in Figure NL 12A for Lake IJsselmeer/Markermeer (combined) and in Figure NL 12B for the other locations in The Netherlands (combined). In general, effort was fairly constant throughout the season, with at most a slight increase during the season. Only eel boxes were deployed mainly in the first

half of the season. In Figure 13 the developments between years is shown for cpue, effort and catch.

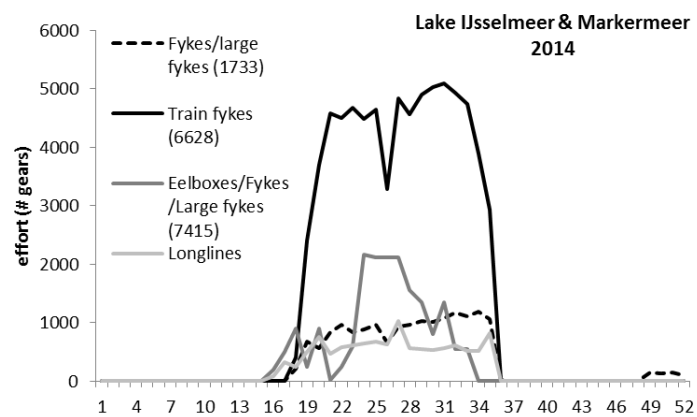


Figure NL. 12A. The number of fishing gear employed weekly in 2014 in the eel fishery on Lake IJsselmeer and Markermeer (Source Ministry of Economic Affairs).

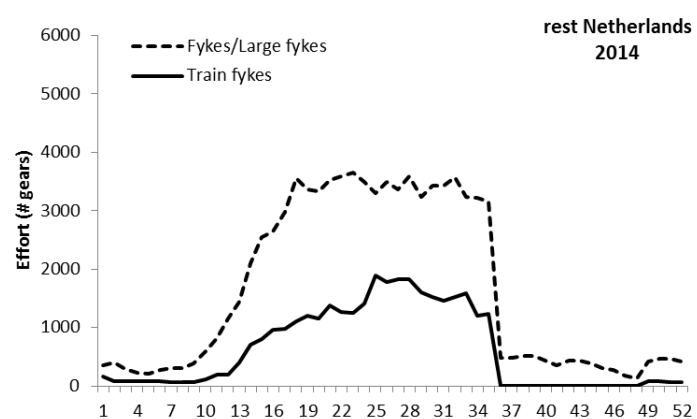


Figure NL. 12B. Number of fishing gear employed weekly in the Dutch eel fishery in 2014 on other locations throughout the Netherlands (source Ministry of Economic Affairs).

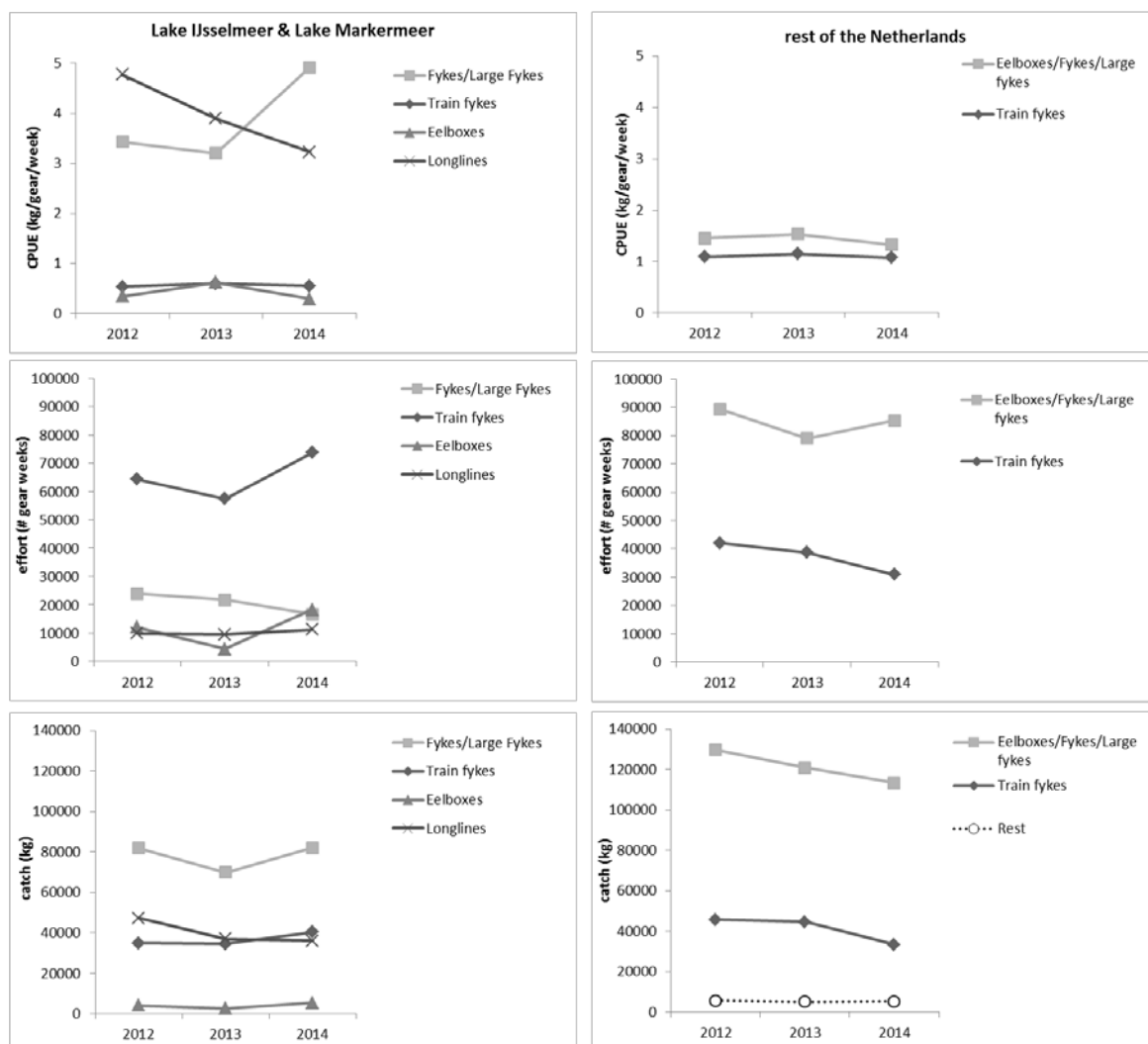


Figure NL. 13. Time-series of fishing gear in the Dutch eel fishery in Lake IJsselmeer+Markermeer vs. the rest of the Netherlands (source Ministry of Economic Affairs).

The comparison of the maximum number of each eel fishing gear type deployed in Lake IJsselmeer/Markermeer in 2012 and 2013 with the maximum number of markers allowed (Table NL. F) demonstrates that for most gears there was an 'overcapacity' of fishing gears; the number of actually used fishing gears was considerably lower than the number of legally allowed gears.

Table NL. F. Maximum number of eel fishing gear deployed weekly by the eel fishery in 2012 and 2013, on Lake IJsselmeer and Markermeer and on other locations. The number of fishing gear ("markers") allowed on Lake IJsselmeer/Markermeer is also given (6th column). ¹ Longlines employed in Lake IJsselmeer/Markermeer are bottom lines, longlines employed elsewhere are surface lines; ²The gear type listed as "Fykes" has been included in the gear type large fykes.

Gear type	IJSELMEER/MARKERMEER					OTHER LOCATIONS	
	2012		2013		Available	2012	2013
	no.	%	no.	%		no.	no.
Longlines ¹	755	--	695	--	no limit	1330	1040
Eelboxes	1300	18	800	11	7400	125	300
Large fykes ²	1795	19	1706	18	9400	4953	4523
Train fykes	4311	68	3842	60	6380	2955	2861
Electrofishing equipment	--		--			6	57

5.3 Silver eel

No distinction between fishing effort on yellow eel and silver eel. Data are combined and reported under yellow eel (Paragraph 5.2).

5.4 Marine fishery

Only the number of vessels reporting eel catches are known. These are reported in paragraph 6.4, Figure NL. 14.

6 Catches and landings

6.1 Glass eel

Glass eel fishing is forbidden; no data available.

6.2 Yellow eel

6.2.1 Catches and/or landings from Lake IJsselmeer/Markermeer

The fishers organisation (PO IJsselmeer) has kept records of the catches of their associated fishers (>90% of the fishers active in the IJsselmeer area) from 2001 onwards (see Section NL 3.2.1). Yellow eel catches and silver eel catches are reported separately (Table NL. G). In addition, in January 2010 an obligatory catch registration system was introduced in the Netherlands by the Ministry of Economic Affairs. In this program weekly catches of eel are reported, but yellow eel and silver eel catches are combined (Table NL. H, Figure 13). No information on effort and gears is reported.

Catches from Lake IJsselmeer have declined following the partial ban on eel fishery (September–November annually) as a result of the Council regulation for European Eel (2008) and the ensuing Dutch Eel management plan.

Table NL. G. Left table: Catches of yellow eel in tonnes by year for the IJsselmeer area. Right table: Catches of silver eel in tonnes by year for the IJsselmeer area (data 2001–2013). (Source: PO IJsselmeer).

YELLOW EEL			SILVER EEL		
Decade	2000	2010	Decade	2000	2010
Year			Year		
0		78	0		1
1	364	122	1	41	2
2	299	120	2	44	1
3	255	74	3	38	16
4	242		4	38	
5	213		5	25	
6	191		6	33	
7	175		7	13	
8	135		8	7	
9	99		9	5	

6.2.2 Catches and/or landings from other areas

In January 2010, an obligatory catch registration system was introduced in the Netherlands by the Ministry of Economic Affairs. In this program weekly catches of eel are reported, but yellow eel and silver eel catches are combined (Table NL. H). No information on effort and gears is reported.

The reduction in catches following the closure of a most river systems due to high contaminant levels in eel is apparent (Table NL. H).

Table NL. H. Comparison of combined yellow eel and silver eel catches (2010–2014) from different sources for IJsselmeer area and other areas in The Netherlands.

SOURCE	IJSELMEER		OTHER AREAS	TOTAL
	PO	EZ	EZ	EZ
2010	79	128	324	452
2011	124	179	188	367
2012	121	168	182	350
2013	90	144	171	315
2014	?	163	153	317

6.3 Silver eel

The fishers organisation (PO IJsselmeer) has kept records of the catches of their associated fishers (>90% of the fishers active in the IJsselmeer area) from 2001 onwards (see Section NL 3.2.1). Yellow eel catches and silver eel catches are reported separately (Table NL. G).

Catches from the IJsselmeer area have declined following the partial ban on eel fishery (September–November annually) as a result of the Council regulation for European Eel (2008) and the ensuing Dutch Eel management plan. Catches in 2013 were high compared to the previous years.

6.4 Marine fishery

Catches and landings in marine waters are registered in EU logbooks, but these do not allow for a break down by river basin district (RBD). Annual registrations are available since 1995; data prior to 1984 are presented in the 2009 Country Report. Until 2001, vessels with a total length (LOA) ≥ 15 m were obliged to report all their eel catches; this obligation did not apply to smaller vessels. From 2001 onwards, vessels with a total length ≥ 10 m are obliged to report their eel catches, but only if their landings per day exceeded 50 kg. Thus, in 2001 the number of ships potentially reporting eel catches rose, but the actual reporting per ship potentially declined. This change the regulation was partly driven by changing practices, and vice versa.

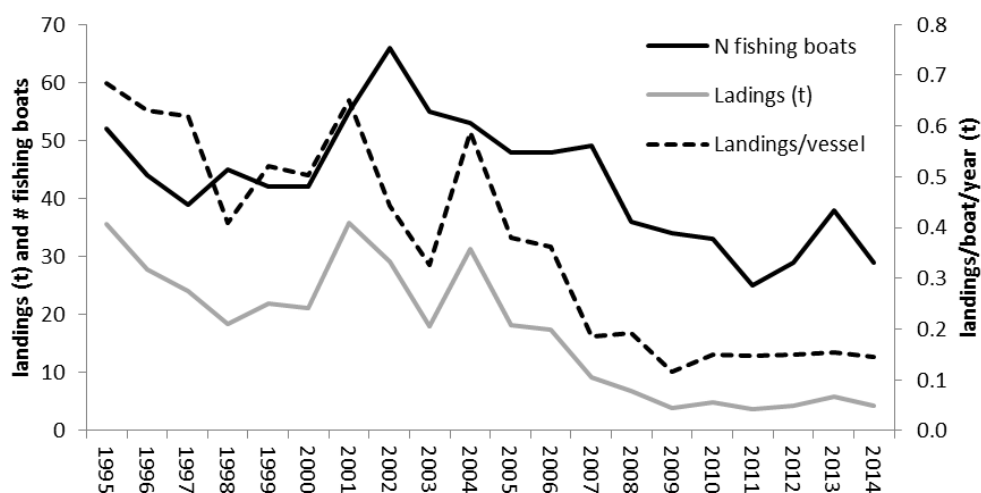


Figure NL. 14. Registered landings of eel (no distinction available between yellow eel and silver eel) from marine waters in Dutch harbours between 1995–2014.

The number of vessels reporting eel catches, total landings and the landings per vessel have declined from 2001 until 2009. Since 2009, landings and landings by vessel have remained more or less constant, whereas the number of vessels reporting catches varied, with smaller numbers in 2011 and 2012, an increase in 2013 and a decrease in 2014.

6.5 Recreational fishery

In 2009 an extensive Recreation Fisheries Program was started in the Netherlands. In December 2009, 50 000 households were approached during the screening survey to determine the number of recreational fishermen in the Netherlands (result 1.69 million recreational fishermen). In 2010, 2000 recreational fishermen were selected for a 12-month logbook programme (March 2010–February 2011). In the Netherlands about 1 500 000 eels are caught by recreational fishermen, while about 500 000 eels are retained. Due to the lack of reliable length–frequency data of the eel caught, raising the number of eel caught to a biomass estimate of eel caught remains difficult (van der Hammen and de Graaf, 2012). The program was repeated in 2012/2013 (van der Hammen and de Graaf, 2015) with 2400 fisherman from the 2009 survey with an additional 100 fanatic fishermen that were recruited through recreational fishery websites. It was estimated that recreational fishers in marine waters retained 91 000 eels and returned 67 000 eels (in total 18 tons retained), although these numbers are less precise than those of freshwater catches. In freshwaters the anglers were estimated to have retained 313 000 eels and have returned 1 517 000 eels (41 tons retained). The

number of recreational fishers was estimated to have declined from 1.7 million in 2009 to 1.4 million in 2011 and 1.3 in 2013. In 2012, the 41 tons of landed eels made 11% of the total landings, the major part consisting of 372 t of commercial landings (van der Hammen and de Graaf, 2015).

Table NL. I. Recreational Fisheries: Retained and Released Catches of eel (in numbers) in the Netherlands in inland and marine areas. Only estimated numbers from angling were available (van der Hammen and de Graaf, 2013, 2015). *data less accurate.

Year	RETAINED				RELEASED			
	Inland		Marine		Inland		Marine	
	Angling	Passive Gears	Angling	Passive gears	Angling	Passive gears	Angling	Passive gears
2010	341 000	Not allowed	180 000	Not known	887 000	Not allowed	117 000	Not known
2012	313 000	Not allowed	91 000*	Not known	1 517 000	Not allowed	67 000*	Not known

Table NL. J. Recreational Fisheries: Catch and Release Mortality for eel in the Netherlands (van der Hammen and de Graaf, 2015 based on Bartholomew and Bohnsack, 2005).

Year	RELEASED			
	Inland		Marine	
	Angling	Passive gears	Angling	Passive gears
2012	12%	Not allowed	12%	Not known

6.6 Bycatch, underreporting, illegal activities

6.6.1 Bycatch

No available data.

6.6.2 Underreporting and illegal catches

The task of adherence to rules and regulations pertaining to eel fishery is carried out by Netherlands Food and Consumer Product Safety Authority (NVWA). Following indication of illegal eel fishing in 2012, they intensified their monitoring in 2013. The overall result (number of fishers involved and total illegal catch) of the illegal fishing activities are reported in the annual report of the NVWA over 2013: <http://www.nvwa.nl/onderwerpen/meest-bezocht-a-z/dossier/jaarverslag-2013/palingstoperij> (Table NL. L). For 2014 no data are reported by the NVWA.

Table NL. K. Estimation of underreported catches in 2013 by stage.

	GLASS EEL				YELLOW EEL				SILVER EEL				COMBINED (Y + S)			
	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)	Reported catches (kg)	Underrept. %	Underrept. (kg)	Total catches (kg)
EMU																
NL																
Total/mean (%)															NC	

Table NL. L. Existence of illegal activities, its causes and the seizures quantity they have caused. For indications used in the column 'Cause' see Table NL. M. (2013).

		Glass eel			Yellow eel			Silver Eel			Combined (Y +S)		
EMU	Y/N/?	Cause	Seizures (kg)	Y/N/?	Seizures (kg)	Cause	Y/N/?	Seizures (kg)	Cause	Y/N/?	Seizures (kg)	Cause	
NL	NP			ND			ND			Y	4.402	1.	

Table NL. M. Overview of suspected causes of illegal fishing activities in the Netherlands (2013).

CAUSE		IJSSELMEER	OTHER AREAS
1.	Fishing out of the season	Y	Y
2.	Fishing without licence	Y	Y
3.	Fishing using illegal gears	Y	Y
4.	Retention of eel below size limit	?	?
5.	Illegal selling of catches	Y	Y

7 Catch per unit of effort

No data available.

8 Other anthropogenic and environmental impacts

8.1 Assisted migration of silver eel

Since 2011 several (pilot)projects have started at migration barriers (pumping stations) to assist the migration of silver eel. In 2011 0.54 t of silver eel was caught and released again past barriers at four sites ('assisted migration'). In 2012 this amount increased almost tenfold to 4.80 t (15 sites), and in 2013 to 9.32 t (25 sites; Figure NL. 15).

However, the mortality rates of silver eel passing the selected barriers has been assessed at moderate to low (Bierman *et al.*, 2012; Winter *et al.*, 2013). Thus, the net amount of eels saved by the assisted migration is much lower than the amount caught and released. In 2013 the barriers for silver eel were prioritised (Winter *et al.*, 2013) to improve the selection and efficiency of assisted migration initiatives. Applying location-specific mortality rates, the net amount of 'saved' eels was 0.14 t in 2011, 0.72 t in 2012 and 0.86 t in 2013, a fivefold (2012) to sixfold increase (2013) compared to 2011 (Figure NL. 15).

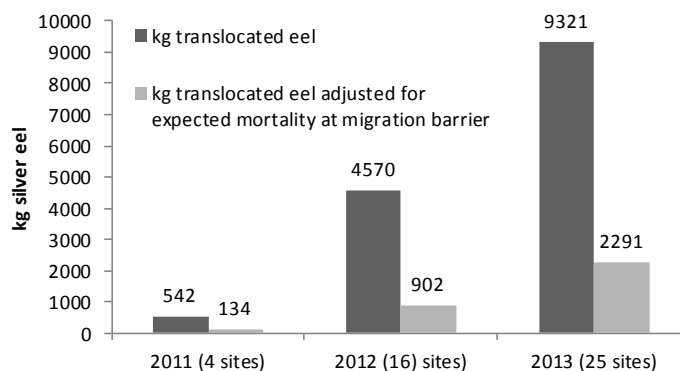


Figure NL. 15. Overview of the "gross" and "net" amount of silver eel assisted over migration barriers in the Netherlands.

9 Scientific surveys of the stock

9.1 Recruitment surveys, glass eel

See paragraph 3.1.1.3.

9.2 Stock surveys, yellow eel

9.2.1 Lake IJsselmeer/Markermeer (active gear)

Figure NL.16 presents the trends in cpue for the annual (yellow) eel surveys in Lake IJsselmeer (25 sites) and Lake Markermeer (15 sites), using the electrified trawl.

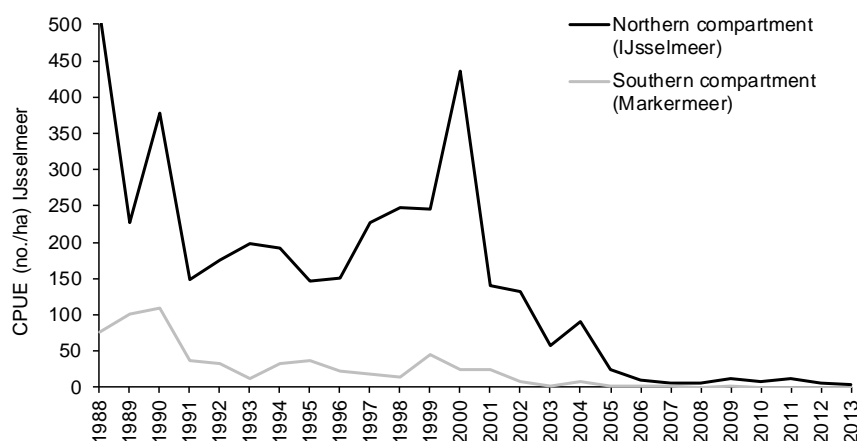


Figure NL. 16. Cpu trends in Lake IJsselmeer stock surveys, in number per hectare swept-area, using the electrified trawl. Note: The northern and southern compartments have been separated by a dyke since 1976.

9.2.2 Main rivers (active gear)

Data collected for the main rivers, but not (yet) available.

9.2.3 Main rivers (passive gear)

No new data.

9.2.4 Coastal waters (active gear)

The number of eels caught in a coastal survey (Demersal young Fish Survey) is presented in Figure NL.17. Until the mid-1980s, considerable catches of eel were observed, after which a gradual decrease was observed. A more elaborate statistical analysis of the abundance and length composition of the eel stock in coastal waters is presented in Dekker (2009).

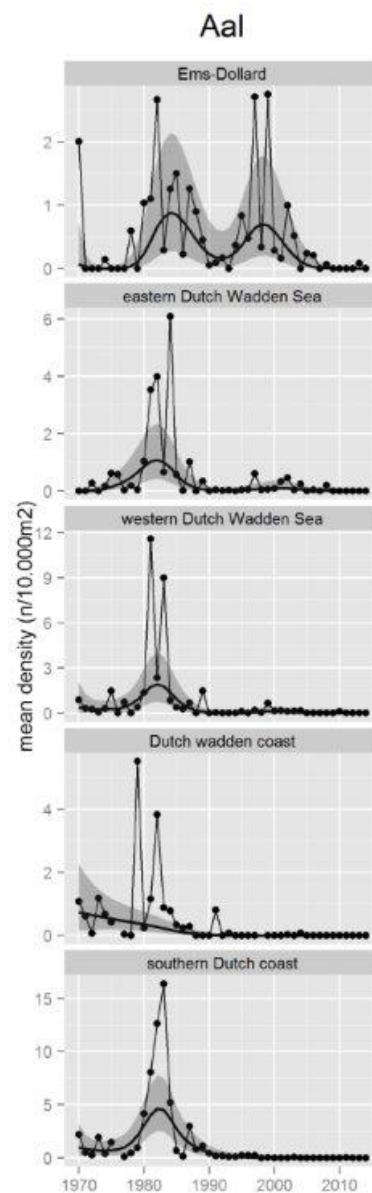


Figure NL. 17a. Trends in coastal survey (mean density n/ha). Most of the Wadden Sea belongs to RBD Rhine; the coastal area belongs to RBD Rhine.

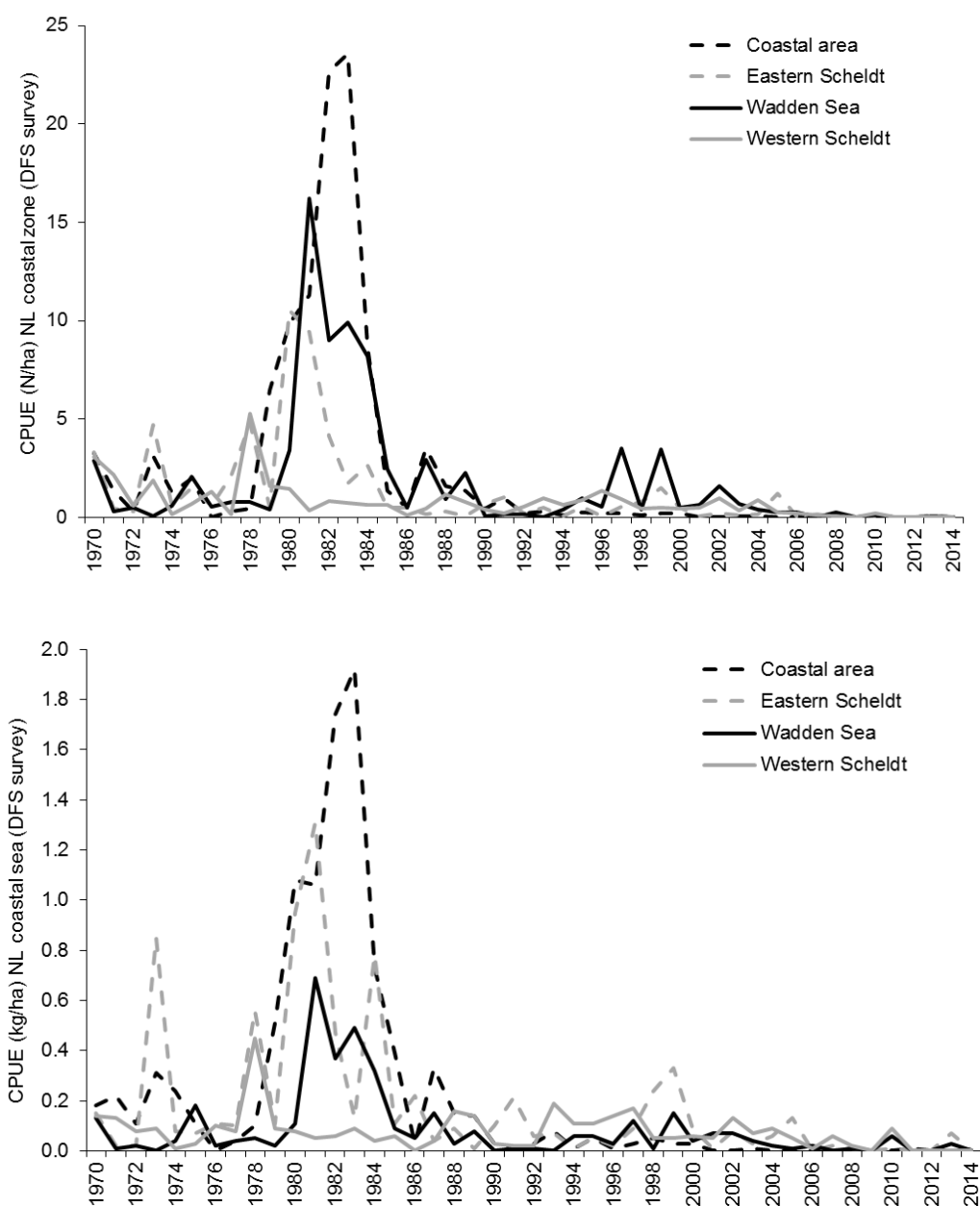


Figure NL. 17b. Trends in coastal survey cpue 1970–2014. Top graph: n/ha; lower graph: kg/ha. Most of the Wadden Sea belongs to RBD Rhine; Eastern Scheldt is mixed RBD Scheldt and Meuse; Western Scheldt belongs to RBD Scheldt (with an extra inflow from Meuse), the coastal area belongs to RBD Rhine (data: Ingrid Tulp/IMARES).

9.3 Silver eel

The Silver Eel Index has been implemented in the Netherlands since 2012. In cooperation with commercial fishermen the abundance of migrating silver eel is monitored on seven locations (main entry and exit points for migratory fish) during the months September–November. The programme and the results will be presented and discussed when sufficient data have become available, after at least five years.

10 Data collected for the DCF

Table NL. N. Summary of the DCF monitoring implementation for The Netherlands 2014.

DATA	RIVER	LAKES	ESTUARIES	LAGOONS	COASTAL & MARINE
Production / escapement surveys ¹	Y (WFD)	Y (WFD)	NP	NP	NP
No. of recruitment time-series surveys ²	10	1	NP	NP	NP
No. fished aged		49	0	0	0
No. of fished sexed		280	0	0	0
No. of fish examined for parasites		280	0	0	0
No. of fish examined for contaminants	ca. 475 (in 2013)		0	0	0
No. of non-fishery mortality studies ³	1	0	0	0	0
Socio-economic survey	0	0	0	0	0

¹ Surveys to estimate B_{best} and/or $B_{current}$, including WFD surveys of which the data are being used to estimate production and/or escapement of eel.

² Fishery-independent surveys.

³ Studies to determine ΣH for non-fisheries anthropogenic impacts (hydropower, barriers, predation, etc.)

11 Life history and other biological information

11.1 Growth, silvering and mortality

See Bierman *et al.*, 2012.

11.2 Parasites and pathogens

The swimbladder nematode *Anguillicoloides crassus* was introduced from Southeast Asia in wild stocks of European eel in The Netherlands in the early 1980s. The market sampling for Lake IJsselmeer collects information on eels showing *Anguillicoloides crassus* infection based on inspection of the swimbladder by the naked eye. We scored an infection as 'present' when either we observed one or more *Anguillicoloides crassus* or a thickened swimbladder. As part of the extended market sampling program in 2009, data on *Anguillicoloides* infection rates have since also been collected in two other areas (Friesland and Rivers), and since 2011 the market sampling was conducted in most of the country.

Following the initial break-out in the late 1980s, infection rates in Lake IJsselmeer have been stable around 50%. Over the past years, infection rates appear slightly lower both in the southern compartment of Lake IJsselmeer (i.e. Markermeer) and on average in the rest of the Netherlands (Table NL. L).

Table NL. O. Infection rates of eel with *A. crassus* in the Netherlands. ¹Median infection rates of all sampled locations.

	IJSELMEER		MARKERMEER			FRYSLAN			OTHER LOCATIONS	
	N eels	% infected	N eels	% infected	N locations	N eels	% infected	N locations	N eels	% infected ¹
2010	390	49	225	48	11	534	46	10	1660	48
2011	293	43	104	34	5	107	37	17	1087	33
2012	320	53	253	38	5	133	33	17	1235	34
2013	159	55	93	43	2	17	47	9	531	38
2014	202	50	46	26	3	49	63	8	291	32

11.3 Contaminants

In 2013, 19 locations have been sampled to assess contaminant levels (dioxins and dioxin-like PCBs) in eel. Samples consisted of about 25 individuals, 30–40 cm or >45 cm length, and were pooled prior to analysis. (Table NL. P).

Table NL. P. Monitoring data of PCBs and dioxin-like PCBs in eel in The Netherlands. Grey-shaded results are above limits (data from 2014 report).

AREA, LOCATION	SIZE CLASS (CM)	NO. EELS	MEAN LENGTH (CM)	MEAN WEIGHT (G)	SUM TEQ (UB,PG/G)	PCB 153 (NG/G)	SUM DIOXIN-LIKE PCBs (UB, NG/G)
Amsterdam-Rijnkanaal	30–40	25	36	84	10.5	138	330
Amsterdam-Rijnkanaal	>45	8	50	239	14.9	256	
Haringvliet, seaside	30–40	5	38	73	1.7	26	42
Haringvliet, seaside	40–45	11	44	112	2.6	25	38
Haringvliet, seaside	>45	23	56	259	5.5	47	77
Hollands Diep	30–40	25	36	89	6.3	179	390
Hollands Diep	>45	15	61	493	21.4	471	970
IJssel, Deventer	30–40	17	36	69	4.0	90	200
IJsselmeer, Lelystad	30–40	25	36	85	3.1	31	64
IJsselmeer, Lelystad	>45	14	51	251	7.6	75	150
IJsselmeer, Urk	30–40	25	35	74	4.0	44	92
IJsselmeer, Urk	>45	12	53	326	6.6	76	170
IJsselmeer, Medemblik	30–40	25	35	80	1.5	13	25
IJsselmeer, Medemblik	>45	12	54	334	3.9	26	52
Kan Gent-Terneuzen	30–40	2	39	104	7.8	154	370
Kan Gent-Terneuzen	>45	5	53	277	9.7	189	460
Kan Wessem-Nederweert	>45	17	61	415	11.2	228	510
Ketelbrug, north side	30–40	17	36	84	7.1	118	250
Ketelbrug, south side	30–40	21	34	70	5.9	151	300
Ketelbrug, south side	>45	13	53	313	12.0	216	460
Ketelbrug, north side	>45	15	55	341	14.0	173	380
Ketelmeer, north	30–40	11	36	87	7.1	128	270
Ketelmeer, north	>45	14	56	388	23.2	246	550
Lek, Culemborg	30–40	21	35	74	4.7	124	280
Maas, Eijsden	30–40	8	35	79	6.8	216	500
Maas, Eijsden	>45	5	50	253	13.0	355	830
Rijn, Lobith	30–40	4	36	77	5.3	110	250
Rijn, Lobith	>45	9	53	302	8.3	153	350
Volkerak shiplock	30–40	25	36	83	3.7	83	180
Volkerak shiplock	40–45	10	43	155	7.3	117	260
Volkerak shiplock	>45	15	50	238	10.6	151	350
Volkerak southwest	30–40	25	37	88	4.5	53	110
Volkerak southwest	>45	18	54	399	8.2	98	210
Vossemeer	30–40	25	34	75	7.4	111	240
Vossemeer	>45	5	55	345	12.5	151	340
Waal, Tiel	30–40	9	37	87	6.9	125	300
Waal, Tiel	>45	22	60	443	14.7	215	530

Contaminant concentrations are higher in larger eel than in smaller eel from the same locations. In 2013, several samples have contaminant levels above the revised regulatory limits of 2012 (10 pg/g Sum TEQ and 350 ng/g PCB-153, 10% uncertainty included). All locations that did have eels with a concentration of Sum TEQ or Sum dioxins and dioxin-like PCBs above the regulatory levels were fed by the rivers Rhine (IJssel), Meuse or Scheldt. Following the closure of these areas to eel fishery, samples are no longer available from these Rhine- or Meuse-fed locations.

Since 1978/1979 several locations have been monitored annually for PCB-153. Concentrations in 2013 were about similar to those in previous years.

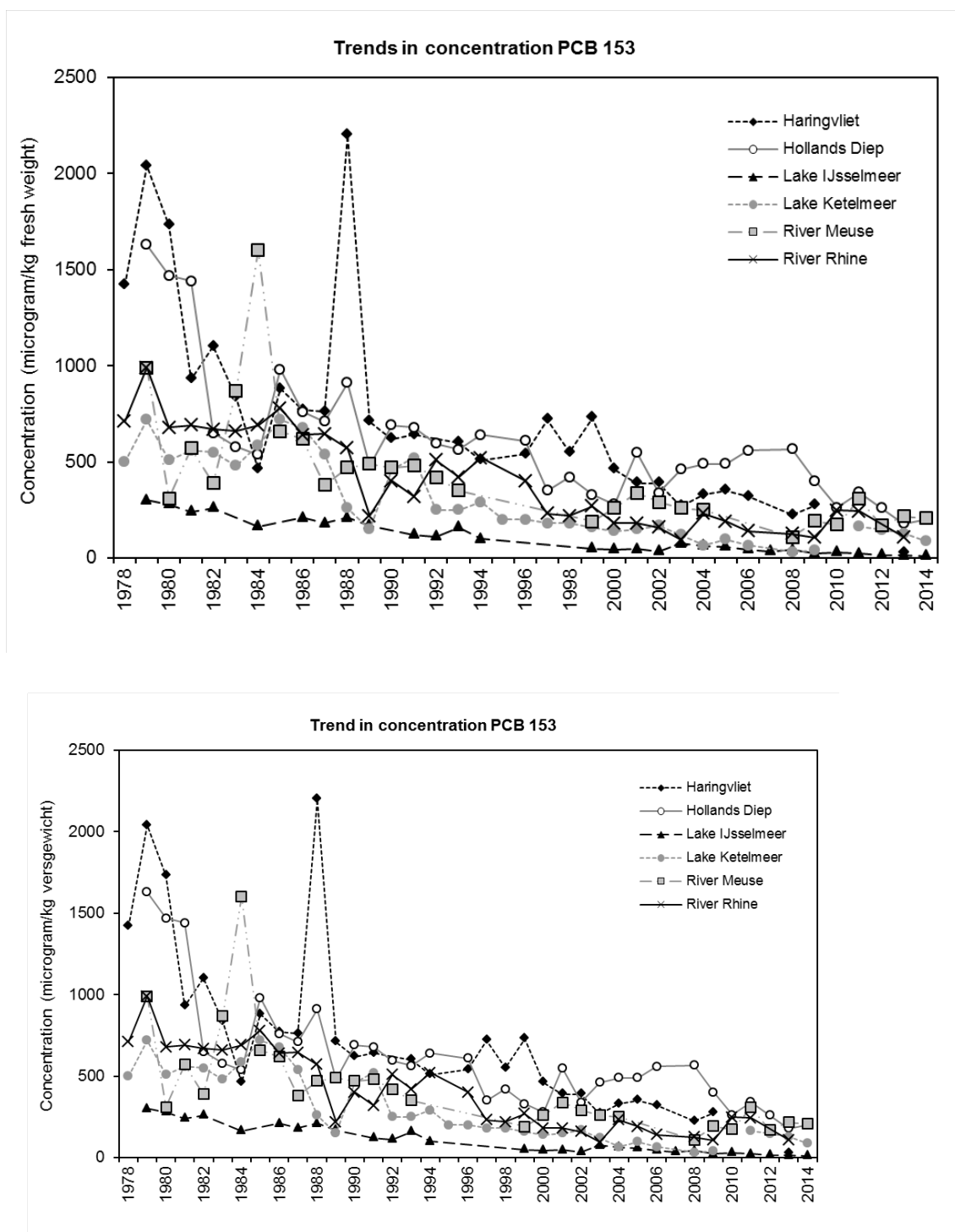


Figure NL. 18. Trend in PBC-153 in 30–40 cm eel (1978–2014) (data: IMARES and RIKILT).

11.4 Predators

Predation of eel by cormorants (*Phalacrocorax carbo*) is much disputed among eel fishermen and bird protectors. The number of cormorant breeding pairs increased rapidly until the early 1990s, then stabilised and even decreased in recent years (Figure NL. 18). For Lake IJsselmeer, food consumption has been well quantified (van Rijn and van Eerden, 2001; van Rijn, 2004); eel constitutes a minor fraction of the diet of cormorants. In other waters, neither the abundance, nor the food consumption is accurately known.

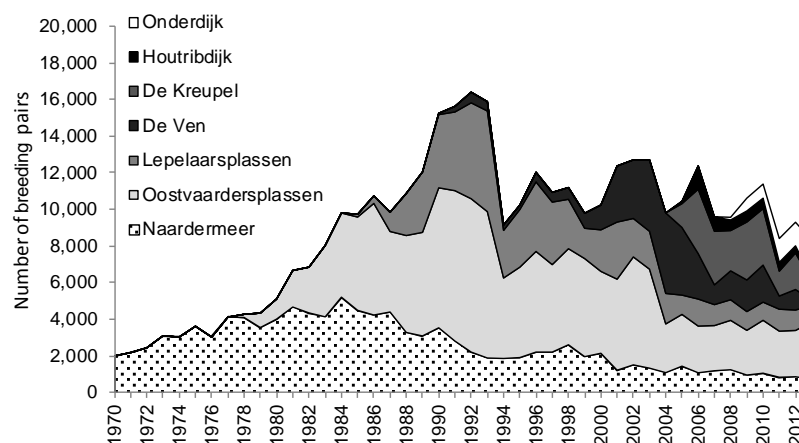


Figure NL. 19. Trends in the number of breeding pairs of cormorants (*Phalacrocorax carbo*) in and around Lake IJsselmeer/Markermeer (Source: Waterdienst RWS).

12 Other sampling

Nothing to report.

13 Stock assessment

13.1 Method summary

Van de Wolfshaar *et al.* (2015).

13.1.1 Estimate of B_0

Table NL. Q. Reference period for B_0 .

EMU_CODE	B_0 (KG/HA)	REFERENCE TIME PERIOD	WHETHER OR NOT CHANGED FROM VALUE REPORTED
			LAST YEAR (Y/N)
NL_Neth	10.400	2011	N

13.2 Summary data

The summary data in the tables below are from “2011–2013” as presented in Van de Wolfshaar *et al.* (2015).

13.2.1 Stock indicators and targets

Table NL. R. Stock indicators and Target derived from: Van de Wolfshaar *et al.*, 2015, p.72.

EMUCODE	INDICATOR			BIOMASS (T)			MORTALITY (RATE)			TARGET
	B_0	B_{best}	B_{curr}	ΣA	ΣF	ΣH	Source	Biomass (t)	ΣA (rate)	
NL_Neth	10 400	1697	1057	0.47	0.35	0.12	EMP			
							EU Reg	4160		
							WGEEL		0.106	

13.2.2 Habitat coverage

Table NL. S. Habitat coverage derived from Van de Wolfshaar *et al.*, 2015.

EMU CODE	RIVER		LAKE		ESTUARY		LAGOON		COASTAL	
	Area (ha)	A'd (Y/N)	Area (ha)	A'd (Y/N)	Area (ha)	A'd (Y/N)	Area (ha)	A'd (Y/N)	Area (ha)	A'd (Y/N)
NL_Neth	88 391	Y	232 758	Y	NP	NP	NP	NP	358 802	N

13.2.3 Impact

Table NL. T. Overview of the assessed impacts per habitat type or for 'All' habitats where the assessment is applied across all relevant habitats. Barriers include habitat loss; indirect impacts are anthropogenic impacts on the ecosystem, but only indirectly on eel (e.g. eutrophication). A = assessed, MI = not assessed, minor, MA = not assessed major, AB = impact absent.

EMU CODE	HABITAT	FISH COM	FISH REC	HYDRO & PUMPS	BARRIERS	RE STOCKING	PREDATORS	INDIRECT IMPACTS
NL_Neth	Riv	A	A	A	A	MI/MA	MI/MA	MI/MA
	Lak	A	A	A	A	MI/MA	MI/MA	MI/MA
	Est	NP	NP	NP	NP	NP	NP	NP
	Lag	NP	NP	NP	NP	NP	NP	NP
	Coa	MI	A	AB	AB	AB	AB	MI
	All							

Table NL. U. Loss of eel (kg) for each impact per developmental stage. MI = not assessed, minor; MA = not assessed major; AB = impact absent. ¹All eel caught recreationally were assumed to be yellow eel. ²Including 6 t mortality of GER/BE silver eel.

EMU CODE	STAGE	FISH COM	FISH REC	HYDRO & PUMPS	BARRIERS	RE STOCKING	PREDATORS	INDIRECT IMPACTS
NL_Neth	Glass	AB	AB	MI/MA	MI/MA	MI	MI/MA	MI/MA
NL_Neth	Yellow	290	100	MI/MA	MI/MA	AB	MI/MA	MI/MA
NL_Neth	Silver	77	AB1	762	MI/MA	AB	MI/MA	MI/MA
NL_Neth	Silver EQ							

13.2.4 Precautionary diagram

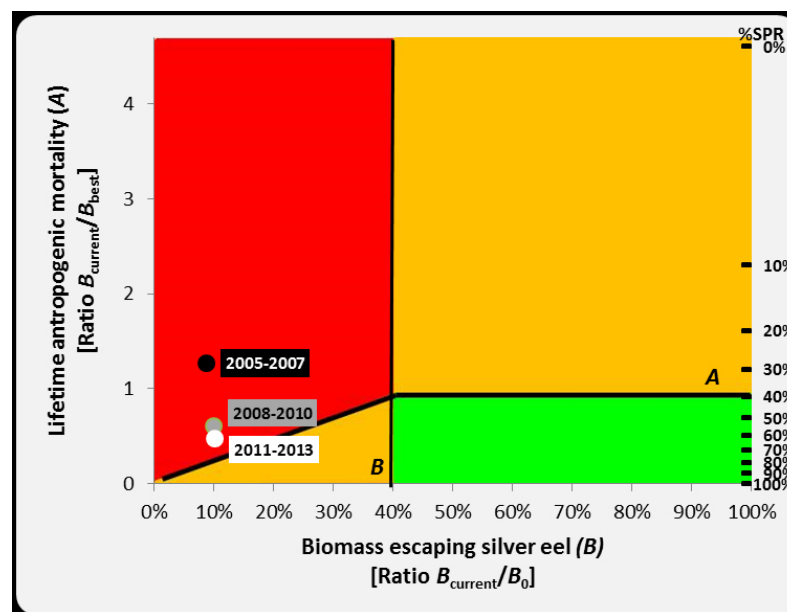


Figure NL. 20. Modified precautionary diagram for the Netherlands EMU (Van de Wolfshaar *et al.*, 2015 after WGEEL 2012), see Section 1.3.2 of ICES (2013) for more information.

13.2.5 Management measures

Table NL. V. Proposed and implemented management measures. 'Com fish': commercial fisheries; 'Rec fish': recreational fisheries; 'Hydropower & Pumps' includes obstacles; 'Other' refers to indirect measures (e.g. implementing data collection and conducting studies).

EMU CODE	ACTION TYPE	ACTION	LIFE STAGE	PLANNED	OUTCOME
NL_Neth	Com Fish	Closing fishing season	M	EMP	Fulfilled
NL_Neth	Com Fish	Introducing fishery-free zones	M	EMP	Fulfilled
NL_Neth	Com Fish	Closure of fishery in contaminated areas	M	After EMP	Fulfilled
NL_Neth	Com Fish	Snigging Ban	M	EMP	Fulfilled
NL_Neth	Rec Fish	Eel releasing by anglers	M	EMP	Fulfilled
NL_Neth	Rec Fish	Ban on recreational fishery using professional gears	M	EMP	Fulfilled
NL_Neth	Rec Fish	Closing fishing season	M	EMP	Fulfilled
NL_Neth	Rec Fish	Snigging ban	M	EMP	Fulfilled
NL_Neth	Hydropower & Pumps	Barriers reduction from 2015	M	EMP	Partially
NL_Neth	Hydropower & Pumps	Hydroelectric stations barriers reduction	M	EMP	Partially
NL_Neth	Restocking	Stocking with glass eels	M	EMP	Fulfilled

13.3 Summary data on glass eel

Table NL. W. Overview of use of glass eel. ¹Not all translocated glass eel is stocked for recovery purposes.

USE OF GLASS EEL	2009	2010	2011	2012	2013	2014	2015
Caught in commercial fishery	0	0	0	0	0	0	0
Used in stocking ¹	100	904	244	766	630	2,460	278
Used in aquaculture for consumption	?	?	6,750	6,775	6,700	4,900	5,200
Consumed directly	0	0	0	0	0	0	0
Mortalities	?	?	?	?	?	?	?

14 Sampling intensity and precision

No new information.

15 Standardisation and harmonisation of methodology

15.1 Survey techniques

GLASS EEL MONITORING				
Gear	Location	Frequency	Time	Period
liftnet (1x1 m; mesh 1x1 mm)	Den Oever	daily	five hauls every two hours between 22:00– 5:00	~March–May
liftnet (1x1 m; mesh 1x1 mm)	ten other locations along the coast	weekly	two hauls at night-time	~March–May
SILVER EEL MONITORING				
Gear	Location	Frequency	Time	Period
Fykes (six sites)	Den Oever, Kornwerderzand, Noordzeekanaal, Nieuwe waterweg, Haringvliet, upper reaches river Meuse	continuous	weekly	September– November
Eel shocker	upper reaches river Rhine	continuous	once a week	September– November

PASSIVE MONITORING PROGRAM: MAIN RIVERS AND LAKE IJsselmeer			
Gear	Location	Frequency	Period
Fykes (four) (stretched mesh 18–20 mm)	Veerse Meer, Haringvliet (North Sea)	continuous	~May–September
Fykes (ten) or summer fykes (20–40) (stretched mesh 18–20 mm)	seven locations in main rivers, estuaries and lakes	continuous	September–November
Fykes (ten) or summer fykes (20–40) (stretched mesh 18–20 mm)	six locations in main rivers, estuaries and lakes	continuous	March–May

Due to closure of the eel fishery in polluted areas, this program, which started in the 1990s, has been interrupted. Almost two thirds of the sampling locations were located in the polluted areas and sampling ceased on 1 April 2011. An alternative program to study diadromous fish started in 2012.

ACTIVE MONITORING PROGRAM: MAIN RIVERS			
Gear	Location	Frequency	Period
Bottom trawl (channel; 3 m beam; 15 mm stretched mesh)	~50 locations in main rivers	10 min trawl, ~1000m transect	~May–September
Electrofishing (shore area)	~50 locations in main rivers	20 min, 600m transect	~May–September

15.2 Sampling commercial catches

AREA	SAMPLING FREQUENCY	NO. OF FISHERS SAMPLED	GEAR
Grevelingen	once	1	large fyke
Friesland	once	2	large fyke
Hollands Noorderkwartier	twice	2	large fyke
IJssel Plus	twice	1	large fyke
Lauwersmeer	once	1	large fyke
Noorderzijlvest	once	1	large fyke
Veluwe Randmeren	twice	1	large fyke
Rijnland	twice	1	large fyke
Volkerak-Zoommeer	twice	1	large fyke
Lake IJsselmeer	once	1	train fyke
Lake IJsselmeer	once/twice	2	large fyke
Lake IJsselmeer	twice	1	eel boxes
Lake IJsselmeer	once	1	longlines
Lake Markermeer	once/twice	2	large fyke
Lake Markermeer	twice	1	longlines
Parameter	Sample details		
No. eels for length–frequency	max. 150 eels per sample		
No. eels for biology (sex, life stage, parasites)	< 50 cm: four eels per 10 cm size class ≥ 50 cm: two eels per 10 cm size class		
Period	June–August (Fryslan: February–April)		

15.3 Sampling

Nothing to report.

15.4 Age analysis

Since 2010, age readings have been obtained annually of ~150 otoliths, which were collected from eels in different areas of the Netherlands. The number of annuli were counted to determine the age of individuals (“crack and burn” method). Furthermore, distances between consecutive annuli were measured using image analysis software to determine individual growth curves.

15.5 Life stages

Life stages (yellow, silvering, and silver) are visually determined based on colouration of body and fins and eye diameter. Criteria for life stages are at present not formally described.

15.6 Sex determinations

Sex is determined by macroscopic examination of the gonads.

15.7 Data quality issues

Nothing to report.

16 Overview, conclusions and recommendations

During the development of the current models for the evaluation of the eel management plan in the Netherlands, the main weaknesses of the current methodology surfaced quickly. Here we list the main recommendations to improve the quality of the assessment before the next evaluation in 2015.

Dynamic Population Model

Key biological parameters: improve the quality of the following key biological parameters.

Sex-ratio of cohorts: estimates could be improved by using eels smaller than 30 cm. These eels could be obtained during the water framework directive (WFD) fish sampling.

Growth rate: estimates could be improved by including eels smaller than 30 cm. These eels could be obtained during WFD fish sampling. Population models could be improved by including variation in growth curves between individuals and locations.

Maturation-at-age: estimates of the silvering ogive for a given area could be improved by using data collected year-round. Furthermore, it is recommended to record the stage of the eel (yellow/silver) during research surveys (e.g. IJsselmeer electro-trawl survey). Quantitative data on maturity stage should be collected such as eye diameter, rather than a purely visual (informal) assessment. **Anthropogenic mortalities:** quantify sources of anthropogenic mortalities that are excluded from the current assessments; 1) catch-&-release mortality of recreational fisheries, 2) yellow eel mortality pumping stations and hydropower plants.

Static Spatial Model

WFD survey data: improve the accessibility of WFD fish survey data of regionally managed waters by establishing a central database for The Netherlands, and ensure that the data are properly checked to ensure the quality of data.

Catch efficiency: conduct experiments to determine efficiencies of electrofishing for eel in different WFD water types in both nationally and regionally managed waters.

Spatial distribution: conduct experiments to determine the spatial distribution of eel in wide rivers and lakes in both nationally and regionally managed waters.

Ditches: conduct electrofishing surveys for eel in ditches to supplement the existing WFD eel survey data in regionally managed waters.

Habitat: correct eel densities for habitat in nationally and regionally managed waters.

Electro-beam trawl: develop an electro-beam trawl to provide reliable estimates of eel (>30 cm) densities in large lakes and wide rivers.

Silver Eel Migration Model

Migration routes: finalise the GIS model (Appendix A in Bierman *et al.*, 2012) to improve the estimate of silver eel mortality during migration. When this proves difficult or too expensive, an alternative is to further refine the simpler model based on hierarchies of waterbodies (Chapter 6 in Bierman *et al.*, 2012) by creating such a model for various spatially separate parts. For example, such a simple model could be constructed for various water boards. The proportions of silver eels choosing different routes could be set equal to water discharge levels. It is not clear which of the two

methods (GIS model, or further refinement of the 'simple' model) would lead to the best results or would be most cost-effective to get up and running. The GIS method would certainly need a lot more investment, but would be generic and work for the whole of The Netherlands and could be adapted for other species too. For the 'simple' model based on hierarchies of waterbodies, information will have to be collected from water boards which will also take a lot of time and the results will apply only to that particular water board.

Silver eels migrating downstream from Belgium and Germany: The mortality caused by hydropower stations on silver eels migrating downstream on the river Meuse from Belgium and the river Rhine from Germany ('foreign' silver eels) have not been taken into account in the estimation of LAM in this report. It is unclear at the time of the writing of this report whether these mortalities have been included in the LAM of silver eels that were produced in German and/or Belgian waters. It is recommended that come to an agreement on how these mortalities should be accounted for.

Furthermore, as many other European countries (France, UK, Ireland) are using similar spatial models to estimate yellow eel standing stock and silver eel production, close international cooperation and collaboration will enhance the quality and uniformity of these models in the years to come.

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Report on the eel stock and fishery in: Norway 2014/2015

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Reporting Period: This report was completed in November 2015, and contains data up to 2014 and some provisional data for 2015.

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2 Introduction

The data given in this report is relevant to the North Sea (F) ecoregion.

2.1 Distribution

Eel occurs in coastal areas and numerous watersheds along the entire coastline, with a reduced abundance towards the north. The occurrence and abundance of eel is generally not well known. The length of the continental coastline is 25 148 km (including fjords and bays). Including islands, the total shoreline adds up to 83 281 km. Occurrence of eel is registered in 1788 lakes in 361 precipitation areas, but many areas and habitats have not been surveyed, so this is a minimum estimate (Thorstad *et al.*, 2010).

2.2 Fishing

Eel fishing is banned in Norway since January 1st 2010, except for a quota of 50 tons for which fishers have to apply. However, no fishers have applied since 2011 because they were unable to export their catch in (due to CITES export regulations) and there is no local market for eels.

Traditionally, eel fishing mainly took place along the coast in southern (Skagerrak coast) and southwestern Norway, in estuarine, brackish and salt-water areas around coastal islands, but also to some extent in freshwater. Some eel fishing also took place in Middle Norway. Fykenets were set on soft and muddy bottom, with preference of areas with seagrass beds (eelgrass *Zostera marina*). No distinction was made between yellow and silver eels and they were both caught with eelpots and fykenets. Glass eel fishing has always been prohibited in Norway. Catch in the sea was officially recorded by the Fisheries Directorate, but there was no record of effort by the authorities (only the number of licences). There was a minimum legal size of 37 cm for silver eels and 40 cm for yellow eels.

Recreational fishing (prohibited since 2009) was quite important relative to commercial fishing (represented approximately 100 tons: average between 2000 and 2008). Recreational fishers along the south coast of Norway caught eel and sold them through fishmongers. There was no limitation on fishing gear, and it was allowed to sell the catch up to 6250 Euros/year.

Some fishers were asked by the Institute of Marine Research to report their catch in logbooks since 1971. They recorded fishing gear, the number of days the traps were set out, and the number of small and large eels (limit was approximately 200 g because fishers obtained different prices for those eels). This stopped in 2010.

2.3 Management plan

The European eel is included in the Norwegian Red List since May 2006, categorized as critically endangered. The status of the eel was reassessed in 2015 and moved to the VU (vulnerable category) under the reduction criterion (A1). This was due to the increase in all three Norwegian abundance indices in the recent years.

In 2007, a working group was appointed to write a report on the status of eel in Norway and to draft a subsequent management plan. The report was completed in 2008¹. Several research needs were identified among which the necessity to investigate the distribution of eels in salt water. The report concluded in two alternative management strategies: 1) that all eel fishing should be banned in Norway for a period of 15 years, or 2) that eel fishing catches be halved compared to the level of 2004–2007. Finally, it was decided that all recreational fishing for eel in freshwater and marine waters in Norway must be stopped from 1 July 2009 (not allowed to catch, land, or keep eel on board). The total quota for commercial fisheries in 2009 was 50 t, with cessation of fishing when this quota was reached. All commercial fisheries were stopped from 1 January 2010. However, since 2010 and onwards, fishers could apply to a 'scientific fishery' with an annual quota of 50 t, aiming at monitoring eel and collecting scientific catch data. This scientific fishery was supposed to be financed by the fishers being allowed to keep and sell the catch. However, since eels cannot be imported into the EU², and there is no local market, all fishing has ceased.

2.4 Eel monitoring

The following monitoring plan (details are available upon request) was submitted (by IMR in March 2011) to the authorities (Nature Directorate) to monitor eel in salt water:

- 1) Monitoring eel abundance trend using existing time-series (Skagerrak IMR beach-seine survey, cpue of scientific fishery);
- 2) Monitoring biological characteristics (age, length, weight, sex, maturity);
- 3) Monitoring eel quality (parasites, contaminants);
- 4) Filling in knowledge gaps (salt vs. freshwater residency, geographic distribution in the sea).

The Norwegian Environment Agency is funding annual monitoring of yellow eel recruitment and silver eel escapement in the River Imsa in southwestern Norway. A

¹ Anonymous (2008) Forvaltning av ål i Norge: rapport med forslag til revidert forvaltning av ål i saltvann fra arbeidsgruppe nedsatt av Fiskeridirektøren. Bergen, 15.10.2008.

² In 2007, CITES listed the species in Appendix II (this came into force in March 2009) and requires exporting states to have an export permit which can only be issued if the export will not be detrimental to the survival of the species. Norway has not obtained such an export permit.

plan for extended monitoring of eels in freshwater was developed in 2011 (together with a review of known information on eel in Norway, Thorstad *et al.*, 2011).

A mark-recapture program was started in August 2015, in Austevoll by IMR to obtain growth estimates from eels living in salt water.

3 Time-series data

3.1 Recruitment

3.1.1 Glass eel recruitment

3.1.1.1 Commercial

NP.

3.1.1.2 Recreational

NP.

3.1.1.3 Fishery-independent

Table 1. Recruitment of elvers at the NINA research station on the River Imsa (see Section 9 for details).

YEAR	TOTAL ELVERS
1975	51 250
1976	57 750
1977	34 000
1978	15 000
1979	3000
1980	41 500
1981	18 500
1982	54 250
1983	19 250
1984	7607
1985	4971
1986	6723
1987	4348
1988	18 385
1989	8805
1990	33 138
1991	6588
1992	11 078
1993	8774
1994	2085
1995	2208
1996	1177
1997	5765
1998	1842
1999	4338
2000	1717
2001	2003
2002	1576
2003	3774
2004	418
2005	494
2006	468
2007	15
2008	1428
2009	6947
2010	1312
2011	5
2012	485
2013	3611
2014	8138

3.1.2 Yellow eel recruitment

3.1.2.1 Commercial

NP.

3.1.2.2 Recreational

NP.

3.1.2.3 Fishery-independent

NR.

3.2 Yellow eel landings

3.2.1 Commercial

NP.

3.2.2 Recreational

NP.

3.3 Silver eel landings

3.3.1 Commercial

NP.

3.3.2 Recreational

NP.

3.4 Aquaculture production

3.4.1 Seed supply

NP.

3.4.2 Production

NP.

3.5 Stocking

3.5.1 Amount stocked

NP.

3.5.2 Catch of eel <12 cm and proportion retained for restocking

NP.

3.5.3 Reconstructed time-series on stocking

NP.

3.6 Trade in eel

NP.

4 Fishing capacity**4.1 Glass eel**

NP.

4.2 Yellow eel

NP.

4.3 Silver eel

NP.

4.4 Marine fishery

NP.

5 Fishing effort**5.1 Glass eel**

NP.

5.2 Yellow eel

NP.

5.3 Silver eel

NP.

5.4 Marine fishery

NP.

6 Catches and landings**6.1 Glass eel**

NP.

6.2 Yellow eel

NP.

6.3 Silver eel

NP.

6.4 Marine fishery

NP.

6.5 Recreational Fishery

NP.

6.6 Bycatch, underreporting, illegal activities

NP.

7 Catch per unit of effort

7.1 Glass eel

NP.

7.2 Yellow eel

NP.

7.3 Silver eel

NP.

7.4 Marine fishery

NP.

8 Other anthropogenic and environmental impacts

Norway has abundant rivers and lakes, and 6% of the total area of 323 802 km² is covered by freshwater. There are 144 river systems with a catchment area ≥ 200 km². Approximately one third of the water covered areas are influenced by hydropower development. There are between 600 and 700 hydropower stations with an installed effect larger than 1 MW in operation. Effects by hydropower development on eel and eel distribution have not been studied or quantified.

Acidification has caused the loss or reduction of many Atlantic salmon (*Salmo salar* L.) populations in southern Norway, and some rivers are still severely affected by chronic or episodic acid water. The areas affected by acidification have likely been among the most important areas for eel in Norway. Based on surveys in 13 rivers that are now limed, it seems that occurrence and density of eel was reduced due to acidification (Thorstad *et al.*, 2010; Larsen *et al.*, 2014). Densities of eel increased more than fourfold after liming when compared with pre-liming levels.

9 Scientific surveys of the stock

9.1 Recruitment surveys, glass eel (*includes yellow eel in Scandinavia*)

The only available time-series of elvers is from a trap at the mouth of the River Imsa in southwestern Norway (58°50' N, 5°58' E) (Figures 1 and 2, Tables 1, 2 and 3). Staff at the Norwegian Institute for Nature Research (NINA) Research Station at Ims have been trapping and recording upstream migration of elvers annually since 1975. There is a wolf trap across the river at this site, collecting all downstream migrating fish as well. A few elvers may be able to migrate upstream at this site without being trapped, but probably not in large numbers. Larger elvers (>3 mm diameter) are counted, whereas smaller ones are measured in litres, with the assumption that there are 2000 elvers per litre. This assumption should have been checked. There should also have been a control check of the historical data, but still, the quality of the data series seems good. It should be noted that in Imsa, recruits migrating upstream are

not true glass eel, but have already achieved a brown colour, and are here therefore termed elvers (true transparent glass eels do occur in Norway and were collected in 2014 for a population genetics study).



Figure 1. Map of Norway showing the location of the eel monitoring sites River Imsa and Skagerrak coast.

Table 2. Elver data from Imsa. The trap was destroyed during a flood in 2007, and the number of elvers not counted this year. These are repeated data from 3.1.1.3). Numbers have been revised (there had been some variation in the way the number of glass eels were calculated) and updated since the previous country reports.

YEAR	TOTAL ELVERS
1975	51 250
1976	57 750
1977	34 000
1978	15 000
1979	3000
1980	41 500
1981	18 500
1982	54 250
1983	19 250
1984	7607
1985	4971
1986	6723
1987	4348
1988	18 385
1989	8805
1990	33 138
1991	6588
1992	11 078
1993	8774
1994	2085
1995	2208
1996	1177
1997	5765
1998	1842
1999	4338
2000	1717
2001	2003
2002	1576
2003	3774
2004	418
2005	494
2006	468
2007	15
2008	1428
2009	6947
2010	1312
2011	5
2012	485
2013	3611
2014	8138

9.2 Stock surveys, yellow eel

The Skagerrak beach-seine survey data from Norway constitute the longest non-fishery-dependent set of data (Table 3). It is also the only potential time-series on the subpopulation of marine eels. This unique monitoring program was initiated at the Norwegian Skagerrak coast (Figure 1) as a result of a controversy between the founder of the Flødevigen Marine Research Station Gunder Mathiesen Dannevig (1841–1911) and the great pioneer in marine research Johan Hjort (1869–1948). Every year, a series of beach-seine hauls are carried out in some selected fjords of the Norwegian Skagerrak coast.

The first hauls of the Skagerrak monitoring program were conducted in 1904, and during the following years, new sampling stations were added, and a standard routine for the hauls was developed. Approximately 130 stations are sampled in 20 different areas. All hauls are taken at the same season (autumn) and always during daytime. Based on the initial results from these hauls, the monitoring program was established and reached its present form in 1919. These data have been analysed up to 2010 and compared to oceanic factors (Durif *et al.*, 2011).

The SSC (standardized Skagerrak catch) index has been calculated using sampling areas where eels represented at least 4% of the grand total. See Durif *et al.*, 2011 for complete details. These calculations (SSC) have not been updated for the most recent figures.

Data from the Skagerrak beach-seine survey. It includes yellow (approximately 70%) and silver eels (30%).

Table 3. Data from the Skagerrak beach-seine survey.

YEAR	NB OF EELS	NB OF HAULS	NB OF SAMPLED AREAS	EELS PER HAUL
1925	4	68	12	0.06
1926	3	69	12	0.04
1927	8	66	12	0.12
1928	0	69	12	0.00
1929	12	69	12	0.17
1930	11	68	12	0.16
1931	14	72	12	0.19
1932	10	69	12	0.14
1933	2	66	12	0.03
1934	8	67	12	0.12
1935	4	68	13	0.06
1936	15	121	17	0.12
1937	38	121	17	0.31
1938	36	122	17	0.30
1939	30	118	17	0.25
1940	NO DATA			
1941				
1942				
1943				
1944				
1945	41	120	17	0.34
1946	28	120	17	0.23
1947	33	121	17	0.27
1948	25	119	17	0.21
1949	21	118	17	0.18
1950	20	117	17	0.17
1951	29	119	17	0.24
1952	14	101	17	0.14
1953	21	132	18	0.16
1954	30	128	18	0.23
1955	31	126	18	0.25
1956	23	133	18	0.17
1957	12	130	18	0.09
1958	44	131	18	0.34
1959	15	132	18	0.11
1960	12	133	18	0.09
1961	29	134	18	0.22
1962	12	138	20	0.09
1963	18	135	20	0.13
1964	28	135	20	0.21
1965	8	112	20	0.07
1966	26	112	20	0.23
1967	14	109	20	0.13

YEAR	NB OF EELS	NB OF HAULS	NB OF SAMPLED AREAS	EELS PER HAUL
1968	13	108	20	0.12
1969	11	109	20	0.10
1970	34	110	20	0.31
1971	19	111	20	0.17
1972	11	110	20	0.10
1973	15	107	20	0.14
1974	27	108	20	0.25
1975	28	112	20	0.25
1976	20	109	20	0.18
1977	26	106	20	0.25
1978	15	108	20	0.14
1979	16	106	20	0.15
1980	31	106	20	0.29
1981	45	104	20	0.43
1982	20	109	20	0.18
1983	19	108	20	0.18
1984	24	107	20	0.22
1985	28	110	20	0.25
1986	27	110	20	0.25
1987	17	111	20	0.15
1988	50	119	20	0.42
1989	31	122	20	0.25
1990	20	121	20	0.17
1991	18	118	20	0.15
1992	25	118	20	0.21
1993	15	119	20	0.13
1994	32	119	20	0.27
1995	16	120	20	0.13
1996	39	121	20	0.32
1997	19	120	20	0.16
1998	22	119	20	0.18
1999	23	119	20	0.19
2000	7	126	20	0.06
2001	15	129	20	0.12
2002	6	130	20	0.05
2003	5	130	20	0.04
2004	1	131	20	0.01
2005	2	129	20	0.02
2006	9	130	20	0.07
2007	0	130	20	0.00
2008	3	130	20	0.02
2009	9	85	!!Series was truncated that year	0.11
2010	4	135	20	0.03
2011	9	134	20	0.07
2012	5	136	20	0.04

YEAR	NB OF EELS	NB OF HAULS	NB OF SAMPLED AREAS	EELS PER HAUL
2013	21	136	20	0.15
2014	13	136	20	0.10

9.3 Silver eel

Downstream trap on the river Imsa

The only available time-series of downstream migrating silver eel is from a wolf trap at the mouth of the River Imsa in southwestern Norway (58°50' N, 5°58' E) (Table 4). Staff at the Norwegian Institute for Nature Research (NINA) Research Station at Ims have been trapping and counting downstream migrating silver eel annually since 1975. All descending fish are captured in this wolf trap, except at days of extreme flood. The quality of the dataserie is good.

Table 4. Number of silver eels counted at the trap on the River Imsa (Sandnes).

YEAR	ESTIMATED TOTAL SILVER EELS
1975	5491
1976	4175
1977	5882
1978	4985
1979	2934
1980	3382
1981	2354
1982	3818
1983	3712
1984	3377
1985	4427
1986	3733
1987	1895
1988	4274
1989	2107
1990	2196
1991	1347
1992	1859
1993	681
1994	1704
1995	1515
1996	1420
1997	2833
1998	1723
1999	2596
2000	1749
2001	4580
2002	1850
2003	2824
2004	2076
2005	1894
2006	2827
2007	3067
2008	1952
2009	3246
2010	2133
2011	2776
2012	2519
2013	1995
2014	2459

Skagerrak beach-seine survey

Silver eels are sampled along with yellow eels, but stages are not differentiated in the data. Lengths have been measured since 1993.

Eels have also been caught during the seasonal IMR cruises in the North Sea. Approximately 3000 eels have been caught since 1980. Data are not yet collated.

10 Data collected for the DCF

NC.

11 Life history and other biological information

11.1 Growth, silvering and mortality

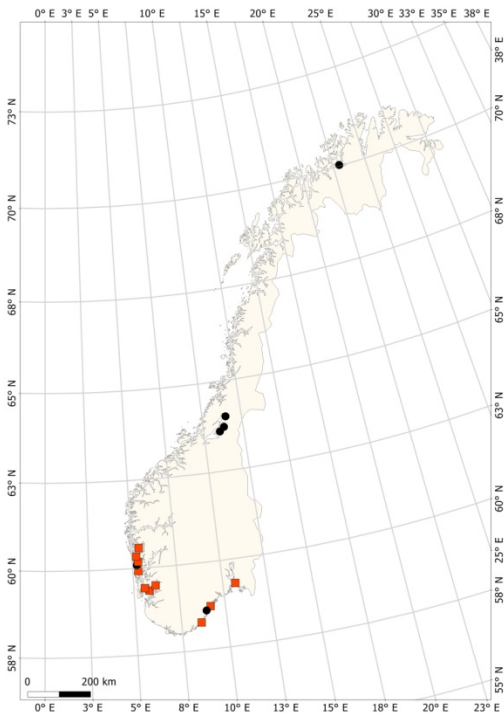


Figure 2. Map of Norway showing the locations where eels were sampled for life-history analyses.

Table 5. Von Bertalanffy parameters: Linf, K, t0.

	All eels	brackish & freshwater	Salt water
Linf	648	641	899
K	0.195	0.15	0.056
tO	0.714	0.068	-7.13

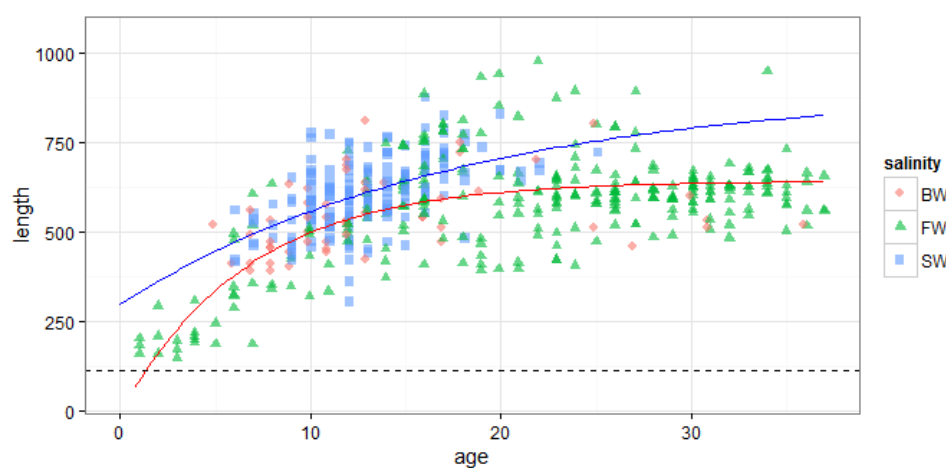


Figure 3. Length (mm)-age relationship for eels sampled in brackish (BW), fresh (FW) and salt water (SW).

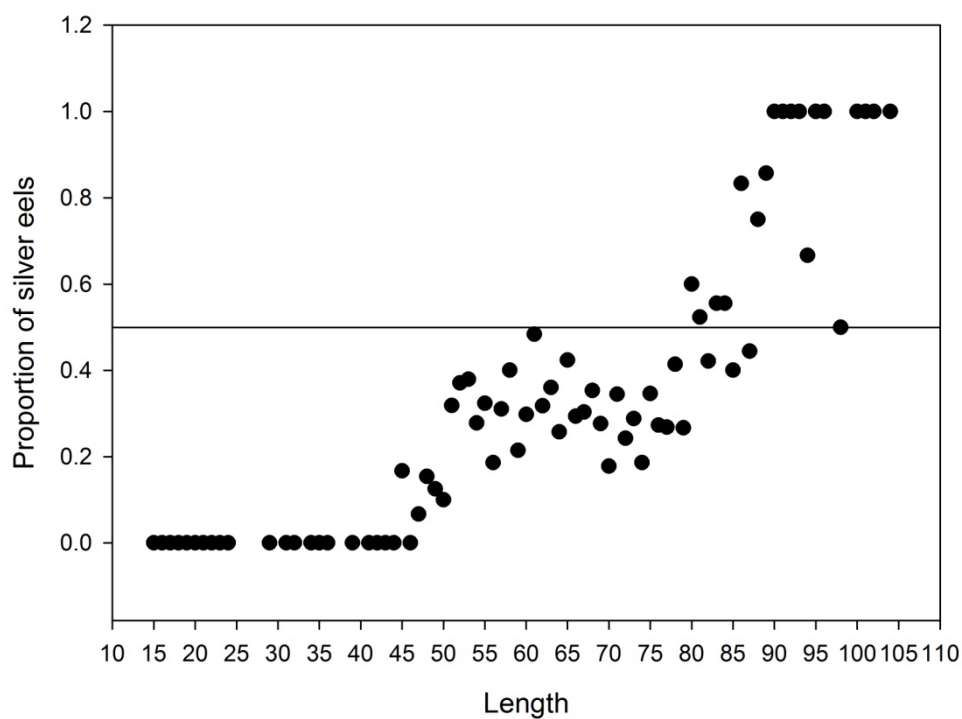
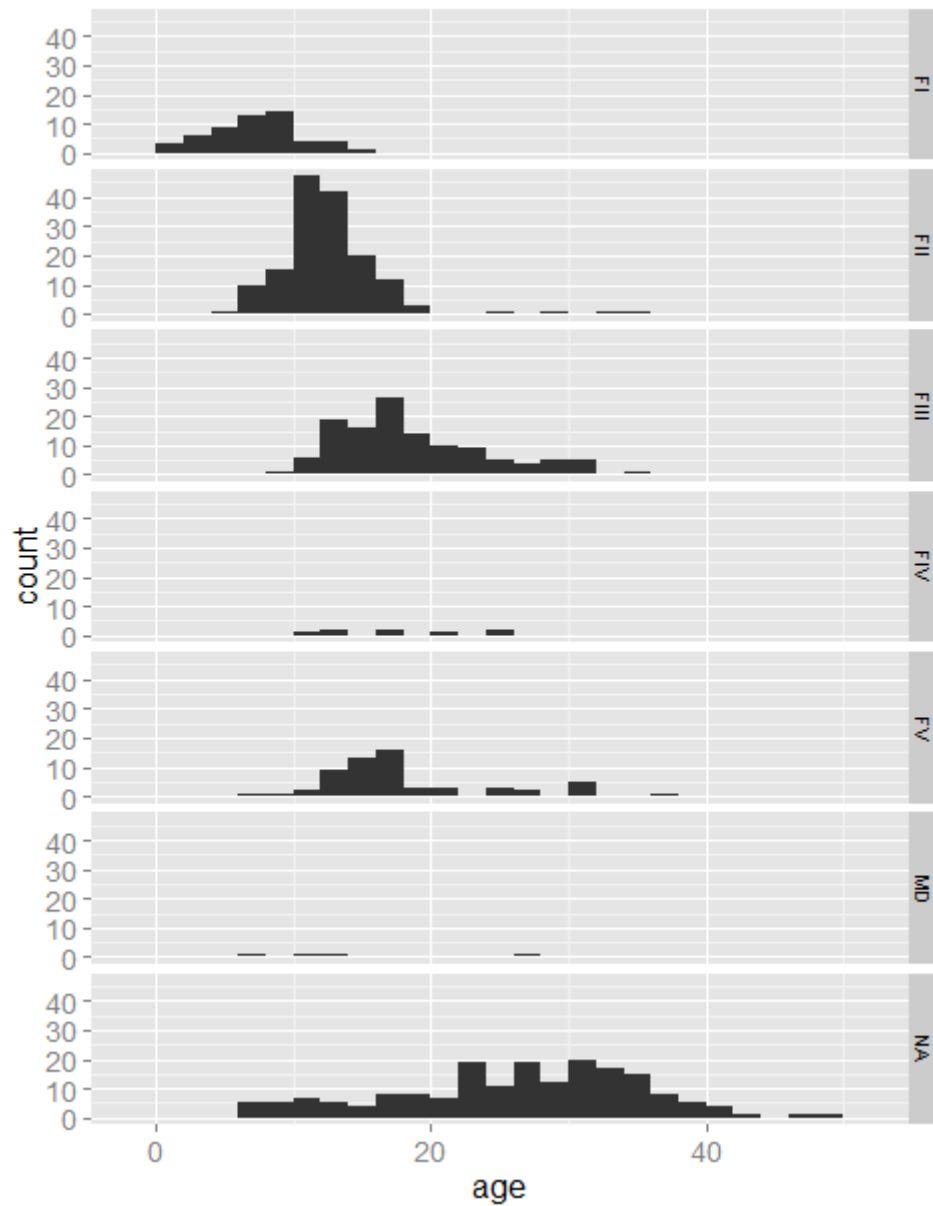


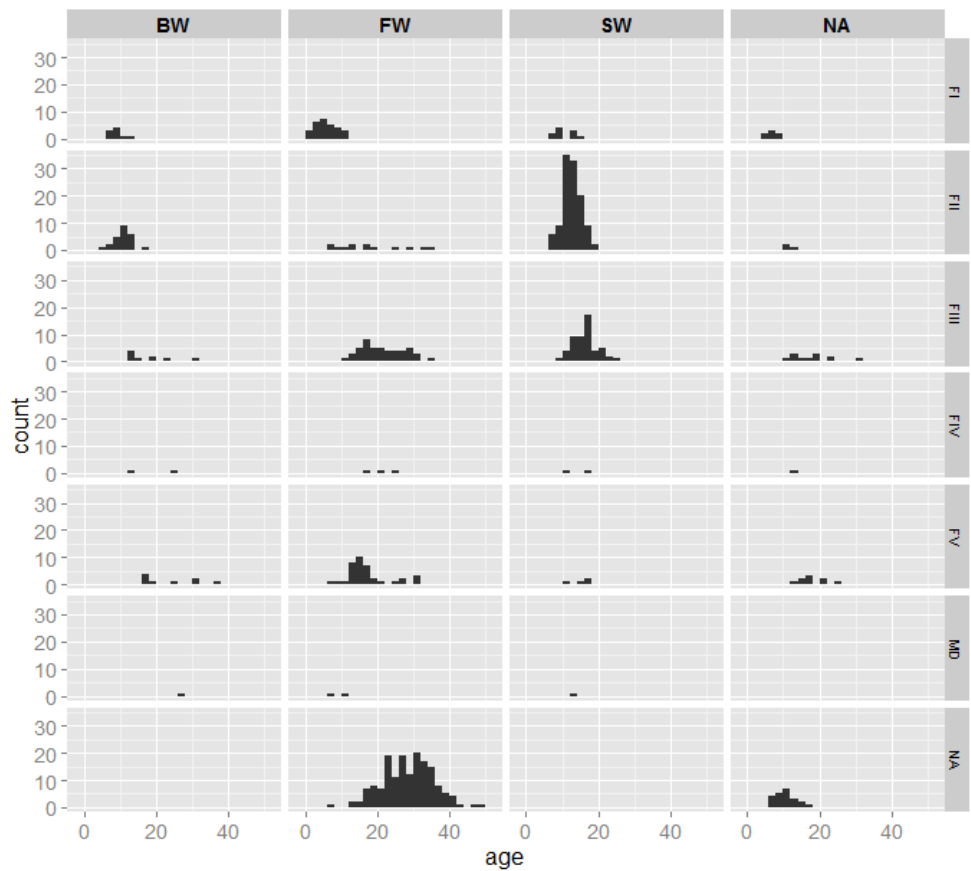
Figure 4. Relationship between proportion of silver eels and body length (mm) based on sampling of female eel at different sites.

Length and age at silvering

In 2014, a subsample of 565 downstream migrating silver eel in the River Imsa were length measured and weighed. Mean body length was 693 mm (range 410–1035 mm, SD 77) and mean body mass was 625 g (range 218–2625 g, SD 260).



Data for all Norwegian eels



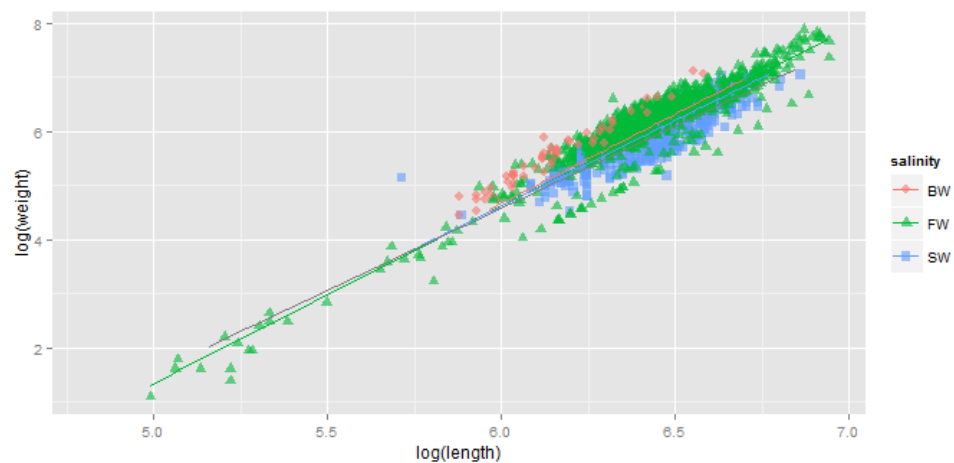
Fecundity

NC.

Weight-at-age



Length-weight relationship



11.2 Parasites and pathogens

ND.

11.3 Contaminants

ND.

11.4 Predators

ND.

12 Other sampling

Glass eels were collected in spring 2014 for a population genetics study.

13 Stock assessment

13.1 Method summary

There is no stock assessment.

13.2 Summary data

NC.

13.3 Summary data on glass eel

The only “glass eel” data are the number of ascending elvers caught in a trap (re-search) in the river Imsa. The trap was destroyed during a flood in 2007, and the number of elvers not counted this year. These are repeated data from Section 3.1.1.3).

YEAR	TOTAL ELVERS
1975	51 250
1976	57 750
1977	34 000
1978	15 000
1979	3000
1980	41 500
1981	18 500
1982	54 250
1983	19 250
1984	7607
1985	4971
1986	6723
1987	4348
1988	18 385
1989	8805
1990	33 138
1991	6588
1992	11 078
1993	8774
1994	2085
1995	2208
1996	1177
1997	5765
1998	1842
1999	4338
2000	1717
2001	2003
2002	1576
2003	3774
2004	418
2005	494
2006	468
2007	15
2008	1428
2009	6947
2010	1312
2011	5

YEAR	TOTAL ELVERS
2012	485
2013	3611
2014	8138

14 Sampling intensity and precision

NR.

15 Standardisation and harmonisation of methodology

15.1 Survey techniques

- Annual standardized beach-seine survey along the south coast of Norway;
- Counting ascending elvers, and downstream migrating silver eels in a trap at the river Imsa.

15.2 Sampling commercial catches

We collect eels from wrasse fishermen (eelpots and fykenets) along the coast of Norway (only in the marine habitat). A lot of these samples are waiting to be processed.

15.3 Sampling

Eels are frozen alive.

15.4 Age analysis

Age is read from the otoliths (polishing and staining).

15.5 Life stages

We measure: body length, body weight, eye diameters, and pectoral fin length. Life stage is determined according to Durif *et al.*, 2005 and using equations from Durif *et al.*, 2009.

15.6 Sex determinations

Sex is determined macroscopically.

15.7 Data quality issues

We record the number of *A. crassus* in the swimbladder.

16 Overview, conclusions and recommendations

Only two time-series of eel are available from Norway, which are beach-seine surveys in the Skagerrak (since 1904), and counting of upstream and downstream migrating eel in the River Imsa (since 1975). Both time-series shows a decline (Durif *et al.*, 2008), with a collapse in the freshwater recruitment (number of ascending elvers) in the River Imsa from 1981. The silver eel escapement from the River Imsa showed a significant decline seven years after, which corresponds to the mean age of silver eels in this river. A collapse in eel numbers was also observed in the Skagerrak time-series at the end of the 1990s.

Recreational fishing was prohibited in Norway since 2009, and commercial fishing since 2010.

There are limited data on occurrence, abundance and biological characteristics of eel in Norway, and the knowledge level should generally be increased.

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Report on the eel stock and fishery in: Poland 2014/2015

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2 Introduction

The data given in this report are relevant to the Baltic Sea (L) ecoregion.

Eel fisheries in Poland is conducted in lakes, rivers, coastal open waters, and two brackish water basins; the Szczecin and Vistula lagoons. Part of the Szczecin Lagoon belongs to Germany, while part of the Vistula Lagoon belongs to Russia. Inland and coastal fisheries target silver and yellow eel, but no data on the shares of these forms in the catches are available. The total area of inland lakes and reservoirs exceeding 50 ha is 2293 km². Dams in the Vistula and Oder rivers and in many of their tributaries prevent migrations of eel and other fish species.

Eel fisheries have a long tradition in Poland. Prior to World War II it was conducted mainly in inland waters because the short length of coastline within Polish borders did not provide enough access to conduct sea fisheries. Following the war, the length of the Polish coastline increased considerably to over 500 km. With this broader access to the Baltic Sea, Polish coastal eel fisheries developed and landings were as much as 388 tons annually. Inland eel fisheries also expanded to a substantially larger number of lakes, and landings were as much as 1500 tons annually. In the 1974–1994 period, inland catches comprised up to 75% of the total annual Polish eel catch. Since the end of this period, catches have declined considerably, and the two types of eel fisheries together currently land about 200 tons annually.

Until the late 1950s Polish eel fisheries were based almost exclusively on natural recruitment. Later, extensive stocking programmes that released mainly glass eel were conducted in many lakes and in both lagoons. Changes in fishery management and the high price of glass eel put a near stop to these programmes by the late 1990s. This, in turn, resulted in very serious decrease in eel catches, mainly in inland fisheries.

2.1 River basins in Poland according to the Water Framework Directive, eel management units according to the Polish Eel Management Plan

The following river basins were designated based on the Water Framework Directive:

Oder – including the basins of Pomeranian rivers to the west of the Śłupia mouth and those flowing into the Szczecin Lagoon;

Vistula – including the basins of Pomeranian rivers to the east of the Śłupia mouth and those flowing into the Vistula Lagoon;

Other – river basins located within the territory of the Republic of Poland that are part of the international basins of the Dniestr, Danube, Jarft, Elbe, Neman, Pregola, Świeża, and Ucker rivers.

For the needs of the Eel Management Plan, in consideration of the availability of data essential to estimating the population size and the potential escapement of silver eel and in consultation with countries that share transboundary river basins, the territory of Poland was divided into two Eel Management Units (Figure 1).

- Oder (Odra) EMU
- Vistula EMU

These EMUs include the following river basins, running waters, and maritime waters:

Oder EMU:

- the transboundary Oder River basin within Poland;
- the Szczecin Lagoon with nearby Polish waters;
- the coastal zone (to 12 miles) of ICES Subdivision 24 (Pomeranian Bay);
- the coastal zone (to 12 miles) of ICES Subdivision 25;
- the transboundary Elbe and Ucker river basins within Polish borders.

Vistula EMU:

- the Vistula River basin;
- the transboundary Vistula River basin within Poland;
- the inner Gulf of Gdańsk;
- the coastal zone (to 12 miles) of ICES Subdivision 26;
- the transboundary Jarft, Neman, Pregola, and Świeża river basins within Polish borders.



Figure 1. EMUs in Poland according to the Polish EMP.

2.2 Fishery management

Areas of inland surface waters referred to as fisheries districts were established by the directors of the individual Regional Boards for Water Management, with the exception of waters located within the borders of national parks and nature reserves, where fishing is banned. The basis for obtaining a permit to conduct fisheries in a fisheries district depends on winning a tender and signing a long-term exploitation agreement with the director of the corresponding Regional Board for Water Management.

Fisheries conducted within fisheries district are based on fishery plans. These documents set forth precise descriptions of proposed fishery operations, with details regarding stocking programmes. Fishery plans must receive positive evaluations from an authorized institution. In total, there are 2370 fisheries districts in Poland. These support approximately 800 enterprises (natural persons and legal persons).

Recreational fisheries in inland waters are permitted if fishers hold fishing permits or underwater hunting licences. Local government officials issue these documents after the applicant has demonstrated knowledge of protection and catch regulations to a commission comprising volunteers from recreational fisheries organizations. Additionally, recreational fishers must have a fishing permit.

Marine fisheries is conducted using fishing vessels that have catch licences and special catch permits for a given calendar year. Special catch permits are issued by:

the minister in charge of fisheries – for the Polish Exclusive Economic Zone, in territorial maritime waters, in the Puck Bay and the Gulf of Gdańsk and outside Polish maritime regions;

the regional inspector in charge of marine fisheries – for catches in the Vistula Lagoon, the Szczecin Lagoon, the Kamieńskie Lagoon, and Lake Dąbie.

Sport and recreational catches can be made in Polish marine areas after sport catch permits are obtained. These are issued by regional marine fisheries inspectors or District Inspectorates for Marine Fisheries inspectors with permission to issue them. Permits are valid throughout the Polish EEZ.

2.3 Polish Eel Management Plan (EMP)

The first version of Polish EMP was submitted to the EU in December 2008, and was updated by the document submitted in June 2009. The EU officially accepted the Polish EMP in January 2010. Regulations for protecting eel, such as designated minimum length and closed seasons, were introduced into Polish law in 2010, and stocking started in August 2011. In June 2015 Poland submitted Joint Polish-Russian Transboundary Eel Management Plan in Pregola RBD and Vistula Lagoon. The Plan has not been revised yet.

The major elements and measures of the Polish EMP are as follows:

stocking – 6 million glass eels annually in the Oder River basin and 7 million in the Vistula River basin, or 1.2 and 1.4 million elvers <20 cm, respectively;

make migration routes passable – removing barriers, building passes, closing hydro-electric facilities periodically during eel escapement, technical modifications;

designate closed seasons – to achieve the principles of the plan and reduce fishing mortality by 25% there must be a month-long closed fishing season from June 15 to July 15 throughout Poland;

unify minimum length – the optimum protected size for European eel in Polish waters should be 50.0 cm *L.t.* regardless of weight;

improve fishing gear selectivity – the selectivity of the most commonly used trap gear can be increased by installing selective sieves or by increasing the mesh size in the chamber to 20 mm (bar length);

limit daily rod catches to two eel – Polish regulations do not limit daily rod catches; doing so will counteract the increased mortality caused by recreational catches above that foreseen in the population model applied;

limit great cormorant pressure (predation);

limit IUU;

include protected areas in the eel protection process (national parks).

3 Time-series data

3.1 Recruitment series and associated effort

3.1.1 Glass eel

Glass eel do not occur in Polish waters.

3.1.1.1 Commercial

Glass eel do not occur in Polish waters.

3.1.1.2 Recreational

Glass eel do not occur in Polish waters.

3.1.1.3 Fishery-independent

Glass eel do not occur in Polish waters.

3.1.2 Yellow eel recruitment

3.1.2.1 Commercial

No commercial dataserries on recruitment exist; minimum landing size is 50 cm.

3.1.2.2 Recreational

No recreational dataserries on recruitment exist.

3.1.2.3 Fishery-independent

No fishery-independent dataserries on recruitment exist; first estimation are in elaboration and will be available later.

3.2.1 Yellow eel landings

3.2.1.1 Commercial

No dataserries exist; total landings of yellow and silver eels combined (see Section 6.2).

3.2.1.2 Recreational

No dataserries exist. Total landings of yellow and silver eels combined (see Section 6.2).

3.3.1 Silver eel landings

3.3.1.1 Commercial

No dataserries exist; total landings of yellow and silver eels combined. (See Section 6.2).

3.3.1.2 Recreational

No dataserries exist; total landings of yellow and silver eels combined. (See Section 6.2).

3.4 Aquaculture production

3.4.1 Seed supply

3.4.2 Production

Since last years there has been only one eel rearing facility in Poland, run by Polish Anglers Association. It still produces about 1.5 tonnes of fingerlings annually for internal restocking market in Poland. From 2012 some new eel productions unit has started, but data on production quantity is unknown.

3.5 Stocking

3.5.1 Amount stocked

Eel stocking was initiated in regions within current Polish borders as early as at the beginning of the 20th century, and it produced good results (Sakowicz, 1930). This was done mainly in rivers within the Vistula River basin and in the Vistula Lagoon. The stocking material of the day originated from the coasts of Great Britain (glass eel), although the Vistula Lagoon was also stocked with eel inhabiting the River Elbe (20–30 cm total length; Roehler, 1942). In the 1950s, great demand developed in Western Europe for live eel, and this fuelled efforts to stock all appropriate waters with this species. The restocking programme collapsed after the socio-economic changes of 1989 transformed the former state fisheries enterprises into private ones. The Stocking Fund, which had been a department of the central government budget office, was also discontinued at this time. Private fisheries enterprises leased waters in which stocking had once been performed, and the import of eel recommenced in the mid-1990s (Table 1). Because of economic concerns and the increasing price of glass eel, these were mostly fingerlings. Stocking did not recommence in either lagoon until 2005 as part of the stocking plan for Polish Marine Areas. The intensity of European eel stocking in inland waters in 2012–2014 was determined using data obtained from the users of fisheries districts.

A slight decrease in the number of enterprises vs. public stocking of eel was noted in the period analysed in the Oder and Vistula RBDs.

The mean share of these enterprises in the Vistula RBD was 77%, while in the Oder RBD it was 86%.

The index of surface stocked with eel was higher in the Vistula RBD (86%) than in the Oder RBD (76%). This index remained practically unchanged throughout the 2012–2014 period analysed, and the average was 83%.

Information provided by the respondents indicated that the weight and number of eel specimens released as stocking material into the waters of the fisheries districts increased successively from 2012. The mean quantity of eel released into the fisheries districts was 1 011 674 eel with a weight of 10 096 kg.

The number of eel specimens released into the waters of the RBDs per unit of surface area stocked in the period analysed increased from 3.4 indiv./ha to 5.2 indiv./ha (mean 4.2 indiv./ha). The mean value of this index was higher in the Oder RBD (6.2 indiv./ha) than in the Vistula RBD (3.4 indiv./ha).

The mean number of eel per unit of weight of stocking material (indiv./kg) increased from 92 indiv./kg to 118 indiv./kg, which is an average of 101 indiv./kg. In the Oder RBD in 2012–2014 it was 98 indiv./kg, and in Vistula RBD it was 101 indiv./kg.

Table 1. Data on stocking quantities (mln. indiv.).

DECADE	1950		1960		1970		1980		1990		2000		2010	
Year	glass eel	young yellow eel	glass eel	young yellow eel	glass eel	young yellow eel	glass eel	young yellow eel	glass eel	young yellow eel	glass eel	young yellow eel	glass eel	young yellow eel
0			64.4		23.5		52.9		8.6	1.0	3.1	0.8		1.4
1			65.1		17.4		60.5		1.7	0.1	0.7	0.6		2.7
2	17.6		61.6		21.5		64	0.1	13.8	0.1	0.0	0.6		1.7
3	25.5		41.7		61.9	0.2	25.1	2.3	10.6		0.5	0.5		3.5
4	26.6		39.2		71		49.2	0.3	12.2	0.1	2.3	0.5		2.3
5	30.8		39.8		70		36.3	0.5	23.7			0.7		
6	21.0		69.0		68		54.4	0.2	2.8	0.5		1.1		
7	24.7		74.2		77	0.1	56.8		5.1	1.1		0.9		
8	35.0		16.6		73		15.9	0.1	2.5	0.6		1.0		
9	52.5		2.0		74.3		5.9	0.7	4.0	0.5		1.4		

3.5.2 Catch of eel <12 cm and proportion retained for stocking

There was no catch of eel <12 cm.

3.5.3 Reconstructed time-series on stocking

All eels are foreign source, glass eels: France, England, yellow eels, ongrown cultured: Denmark, Germany, and the Netherlands.

4 Fishing capacity

There is a lack of precise data regarding the number and type of fishing gear deployed and the types of fishing boats active in Polish inland waters, and there is no system in place to collect this type of statistical data. There are 800 enterprises authorized to catch eel on the basis on long-term agreements for their exploitation with directors of the responsible Regional Boards for Water Management.

4.1 Glass eel

No catches.

4.2 Yellow eel

Estimated data from questionnaires:

ODER EMU: 250 fishing boats

VISTULA EMU: 470 fishing boats

4.3 Silver eel

See above.

4.4 Marine fishery

Fisheries in coastal and transitional waters are limited with regard to the number of vessels operating and the maximum number of gears deployed. Eel are fished almost exclusively by vessels of up to 12 m in the 12-mile zone (Table 2). Special permits specify which types and the number of gear used.

As of 31 December 2014, the fishing capacity was as follows (boats up to 12 meters).

Table 2. Fleet, number of vessels, 2014.

ICES Area	EEL VESSELS <12 M*		TOTAL ACTIVE VESSELS <12 M IN 2014
	eel directed**	total	
24-25	26	83	344
26	103	151	329

* vessels which reported eel catches (regardless amount).

** vessels which reported even a single day of directed eel catches.

5 Fishing effort

There is a lack of precise data regarding the number and type of fishing gear deployed and the types of fishing boats active in Polish inland waters, and there is no system in place to collect this type of statistical data. All data comes from questionnaires and are estimated values.

5.1 Glass eel

No catches.

5.2 Yellow and silver eel

ODER EMU

The fishing effort in inland waters is estimated at 1000 sets of trap gear, 50 sets of towed gear, and 120 fixed gears in flowing waters. The most important are fixed gears in flowing waters (Table 3). Data are available only for 2013.

Table 3. Fishing effort in inland waters of the Oder EMU in 2014.

	SHARE OF GEAR IN EEL CATCHES [%]	ESTIMATED EXPLOITATION INTENSITY [ONE GEAR/ 100 HA LAKE]
Trap	45,3	1.14
Towed	2,3	0.06
Fixed gear on flowing waters	35,6	0.14
Electric	3,2	No data
Longlines	13,4	No data

VISTULA EMU

The fishing effort in inland waters was estimated at approximately 4200 sets of trap gear, 120 sets of hauled gear, and 500 sets of fixed gear set in running waters. The most important type of gear is fykenets, and other trapnets (Table 4). Data are available only for 2013.

Table 4. Fishing effort in inland waters of the Vistula EMU in 2014.

	SHARE OF GEAR IN EEL CATCHES [%]	ESTIMATED INTENSITY OF DEPLOYMENT [ONE GEAR/100 HA LAKE]
Trap	46,2	2.66
Hauled	4,2	0.07
Fixed gear on flowing waters	37,6	0.32
Electric	2,0	No data
Longlines	9,9	No data

5.3 Marine fishery (DCR data)

In coastal waters, eel is most frequently bycatch in catches of other species. The majority of catch is fished in fykenets. Some minor landings are also noted in longline fishery in Gulf of Gdańsk and Puck Bay.

Eel catch and effort in marine waters 2014 (DCF data) is presented in Table 5.

Table 5. Eel catch and effort in Polish marine waters in 2014.

Gear	ICES Subdivision	EEL AS A BYCATCH			EEL DIRECTED FISHERIES*			TOTAL: DAYS	TOTAL: KG	TOTAL: NO OF GEARS
		days	Kg	no of gears	days	kg	no of gears			
FPN	27.3.d.24	6	15	78				6	15	78
FPN Total		6	15	78				6	15	78
FPO	27.3.d.24	2315	18296	56199	41	612	1270	2356	18908	57 469
	27.3.d.25				2	10	12	10	10	12
	27.3.d.26	1524	10612	14670	511	4964	21071	2035	15575	35 741
FPO total		3839	28908	70869	554	5586	22353	4393	34494	93 222
GNS	27.3.d.24	3	12	270				3	12	270
	27.3.d.25									
	27.3.d.26	60	648	27137	12	112	863	72	760	28 000
GNS total		63	660	27407	12	112	863	75	772	28 270
LLS	27.3.d.24	34	404	166600	25	451	95500	59	855	262 100
	27.3.d.25	27	388	83400	23	560	73000	50	948	156 400
	27.3.d.26	92	544	187050	243	1446	301942	335	1990	488 992
LLS total		153	1336	437050	291	2457	470442	444	3793	907 492
SDN	27.3.d.26	7	382	266					382	266
SDN Total		7	382	266				7	382	266
Total		4068	31 301	535670	857	8 155	493658	4925	39 456	1 029 328

* these days where eel constituted 50 or more percent of total catches.

FPN- Stationery uncovered poundnet.

SDN – Anchored seine.

6 Catches and landings

6.1 Glass eel

There is no glass eel fishery in Poland.

6.2 Yellow and silver eel

No distinction has been made between yellow and silver eel in statistics. The data on inland catches were obtained by surveying selected fisheries facilities, then extrapolating the results for the entire river basin. These data are thus approximated. The data from the lagoons were drawn from official catch statistics (logbooks). These might also be incomplete because of poor statistics, the quality of which declined notably following 1990.

6.3.1 Total landings (time-series)

Table 6. Total landings of eel in entire basins and marine waters (1954–2014).

DECADE							
YEAR	1950	1960	1970	1980	1990	2000	2010
0		733	847	1221	697	305	178
1		640	722	1018	580	296	119
2		663	696	1033	584	236	119
3		762	636	822	495	204	137
4	609	884	796	831	531	148	116
5	732	682	793	1010	507	284	
6	656	804	803	982	499	257	
7	616	906	903	872	384	244	
8	635	943	946	923	397	227	
9	566	935	912	752	406	156	

6.4 Recreational fishery

Table 7. Recreational Fisheries: Retained and Released Catches.

Year	RETAINED (TONS)				RELEASED			
	Inland		Marine		Inland		Marine	
	Angling	Passive Gears	Angling	Passive gears	Angling	Passive gears	Angling	Passive gears
2014	29,5	NA	<1 ton	NA	NA	NA	NA	NA

Table 8. Recreational Fisheries: Catch and Release Mortality

Year	RELEASED			
	Inland		Marine	
	Angling	Passive gears	Angling	Passive gears
2014	NA	NA	NA	NA

6.5 Bycatch, underreporting, illegal activities

In legal fishery activities eel is mostly taken as a bycatch and eel directed fishery represents about 20% of total landings there (Table 5).

Volume of illegal catches (Table 9) is available from IFI estimations based on questioning private enterprises and lake owners.

Table 9. Illegal fishing activities – seizures and causes.

Year	EMU	Y/N/?	COMBINED (Y +S)	
			Seizures (kg)	Cause
2012	Oder	Y	13 800	Fishing without licence
2012	Vistula	Y	16 700	Fishing without licence
2013	Oder	Y	10 800	Fishing without licence
2013	Vistula	Y	16 700	Fishing without licence
2014	Oder	Y	18 600	Fishing without licence
2014	Vistula	Y	12 800	Fishing without licence

7 Catch per unit of effort

7.1 Glass eel

There is no glass eel fishery in Poland.

7.2 Yellow eel

No data.

7.3 Silver eel

Studies of the intensity and dynamics of eel migrations are realized using traditional fishing gears and other useful devices such as electric barriers.

Range of operations: during eel migrations in spring and fall the numbers and mass of migrating eel are recorded daily at designated sites for 35 days in spring and 35 days in fall. The studies will be conducted annually for six years at sites located on the Vistula and Oder rivers, and at two-year intervals at the remaining sites. The data obtained are used to estimate the overall number of migrating eel in the two river basins.

Hydro acoustic methods combined with monitoring catches could prove to be a quick and relatively precise method for evaluating the number and biomass of migrating eel. In shallow waters, hydro acoustic methods are not yet used on a broader scale, mainly because of difficulties connected with the proximity of environmental borders (the surface and the bottom), which disturb signals from eel. However, in the case of analysis of hydroacoustic data used to determine the numbers of individual eel, and not their concentrations, the influence of such disruptions is not so important.

Scientific hydroacoustic measurements for monitoring purposes are performed with a Simrad EK-60 echosounder (Norway) at a frequency of 70 and 120 kHz at varying impulse ranges of 0.1 to 1.0 ms. The measurements are taken with a stationary beam with a horizontal split-beam. This permits determining the direction and speed at which the eel are moving through the water column. Transmitters are deployed on specialized constructions that permit regulating and adjusting the angle of the beam axis relative to the water surface.

The hydroacoustic data collected are analysed with Sonar 5 software. This permits obtaining data from selected water layers that are 15 to 20 cm thick. These results are used to determine the number of eel that swim through the zone monitored by the transmitter. The results of hydroacoustic analysis are verified by catches of eel made with set gear.

Eel catch statistics from 2012–2014 indicate there has been a further decline in their size. The short, three-year observation period does not, however, permit a credible evaluation of this trend. Factors such as high water levels that persisted in 2013 could have affected catch size, because they made it impossible to deploy traditional gears (i.e. alham) in rivers to catch migrating eel. The introduction of catch limits to protect the species that have been in force since 2013, e.g. on the Pomeranian lakes Lebsko and Gardno, could also impact catches. Underreporting catches by fishers or natural fluctuations in population size over a period of years could also be factors.

Catches made by fishers using traditional gear (alhams, fykenets, fykenets with one leader, set gear that is deployed perpendicular to the water flow, ropes, and filtering barriers), provided 3776 eel that were measured, including 1968 silver eel (52%) and 1453 green eel (39%). The developmental stage of 355 individuals (9%) was not established. The length of the eel ranged from 8 to 120 cm (mean length 65.4 cm), and weight ranged from 10 to 3000 g (mean weight of 3661 individuals was 638 g). The total weight of the sample was 2454 kg. The length of silver eel ranged from 25 to 120 cm (mean length 71.6 cm), and weight ranged from 10 to 1550 g (mean weight 392.4 g). The sample weight was 570 kg. The length of the remaining eel ranged from 15 to 99 cm (mean length 62.9 cm), and weight was from 40 to 2900 g (mean weight 625.6 g). The sample weight was 222 kg.

A comparison of the size of the eel catch with the cpue of alhams deployed in the Vistula River near to its mouth (Tczew) and on those of the Oder River near its mouth (Gryfino), which are locations through which all eel from these RBDs pass when migrating, confirms that there is still a quite intensive, natural eel migration. For example, the analysis of 2013 catches shows that during the deployment of alham:

- in the lower Vistula 0.194 eel/alham/hour were caught;
- in the lower Oder 0.025 eel/alham/hour were caught.

Therefore, the general conclusion is that there is still a quite intensive migration of eel from Poland, one that is connected with the basins of the two largest rivers in the country. It appears that the Vistula RBD remains of greater importance. This is doubt-

less connected with the surface area of the lakes in the two RBDs, but also with fisheries management, in which eel stocking has been very important in the past, as it is now in the present.

7.4 Marine fishery

The catch per unit of effort was only estimated in coastal waters. The negative trend is significant, and cpue is at the lowest reported level since 1995. See the WGEEL 2008 Poland country report for details (ICES, 2008).

8 Other anthropogenic impacts

Not applicable.

9 Scientific surveys of the stock

Routine electrofishing surveys are conducted every year in Pomeranian rivers to estimate abundance of salmon and sea trout. Every ten years each of lake and rivers owners must investigate structure and abundance of fish fauna on their own. Some data are available, but quality and usefulness of these datasets is considered to be low.

Tagging of silver eel by NMFRI from the waters situated on Polish territory started in September 2011 and continued in subsequent years. The fish originated from the Szczecin Lagoon and the Pomeranian lakes of Koszalin region. Eels were tagged with PIT (Personal Identification Tag) and Floy Tags. Eels were released directly into the sea. From 2011 more than 1500 eels were released. Returns have already been noted in the following years after tagging. Overall, from 2012 onwards it has been noted more than 40 tag returns, mostly from fishermen operating in the eastern part of Germany, coast of southern Sweden and Denmark in the eastern part of the island of Zealand in Copenhagen. Tags were also found by consumers during standard processing.

10 Data collected for the DCF

Landings are regularly sampled in marine harbours, and the main gears sampled are fykenets within FWS métier, because eel is only a bycatch in coastal freshwater fishery. Approximately 200–400 fish have been analysed since 2005 (Table 10).

Table 10. Summary of the DCF and EMP monitoring implementation for Poland. Note that DCF is applicable only for métier and biological variables sampling.

DATA	RIVER	LAKES	ESTUARIES	LAGOONS	COASTAL & MARINE
No. of production / escapement surveys ¹					
No. of recruitment time-series surveys ²	4				
No. fished aged	20	100		399	
No. of fished sexed	20	100		399	
No. of fish examined for parasites	20	100		399	
No. of fish examined for contaminants		30*		30*	
No. of non-fishery mortality studies ³	2				
Socio-economic survey					

*number of samples (one sample consists of 1–5 eels).

11 Life history and other biological information

11.1 Growth, silvering and mortality

Data regarding biological variables such as length (Figure 2, 3), weight, and growth (Figures 4, 5, 6 and Table 11) are collected regularly as part of DCF. NMFRI is responsible for collecting these data.

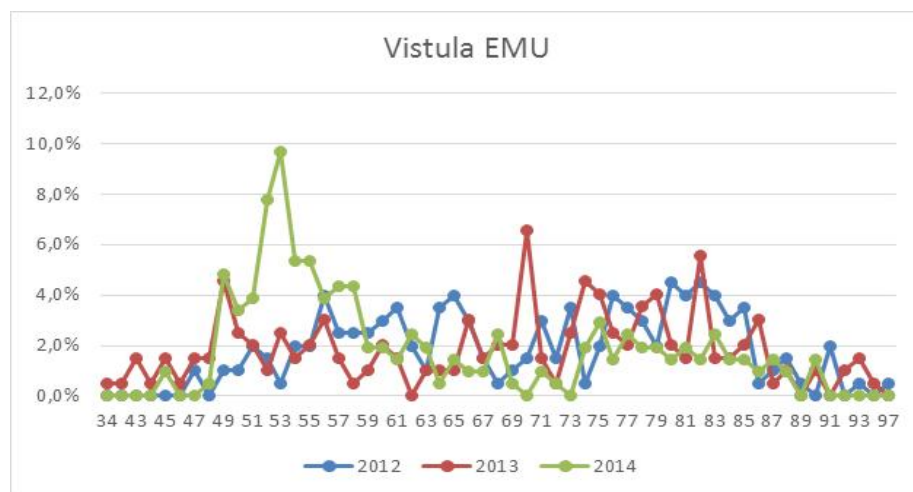


Figure 2. Eel length composition from Vistula EMU in 2012–2014 period.

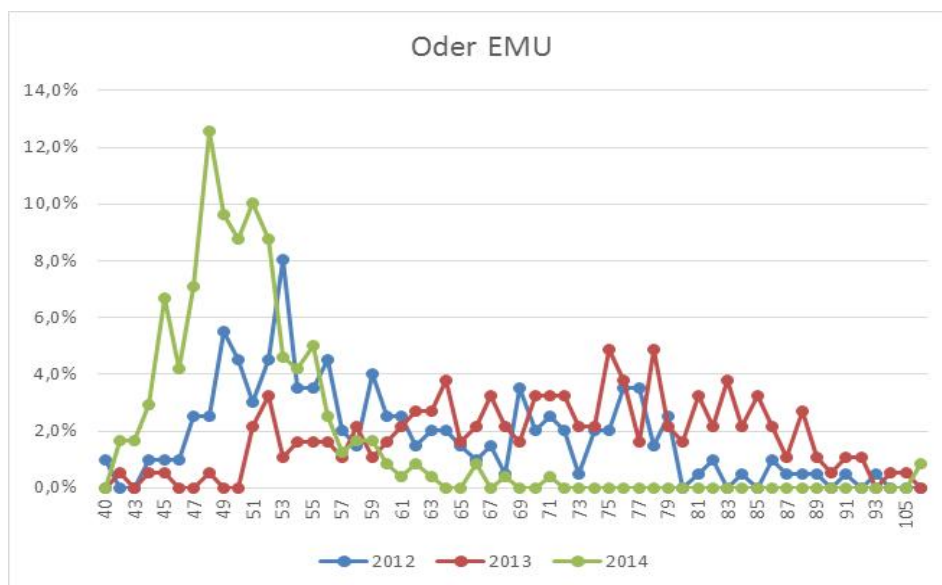


Figure 3. Eel length composition from Oder EMU in 2012–2014 period.

Table 11. Von Bertalanffy parameters of eel.

RBD	STAGE	L_{∞}	K	t_0
Oder	II–IV	102	0,135	0,641
Oder	IV	95,2	0,147	-1,393
Vistula	II–V	111,7	0,116	-0,459
Vistula	IV, V	98,1	0,189	-1,189

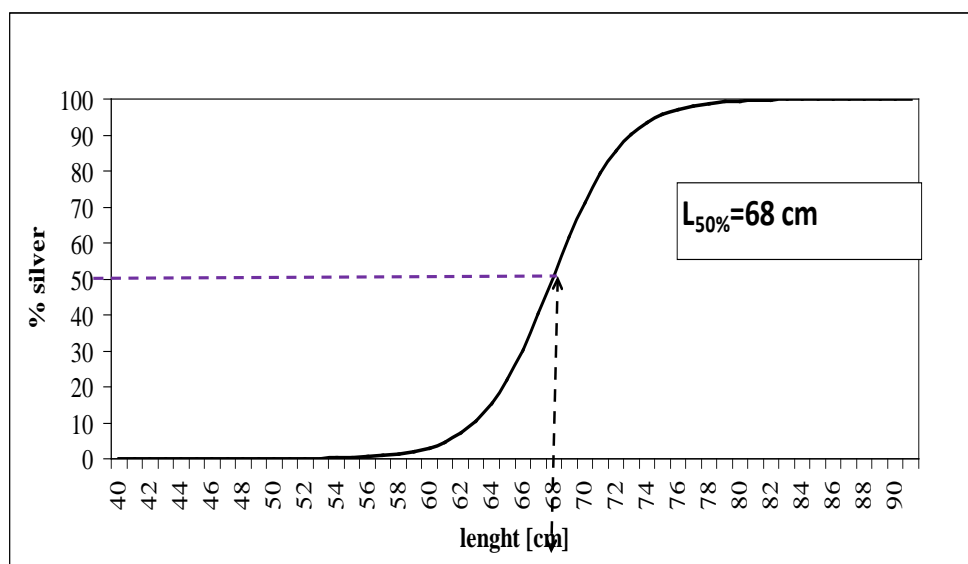


Figure 4. Length at which 50% of the population has silvered. Data from Vistula Lagoon 2013.

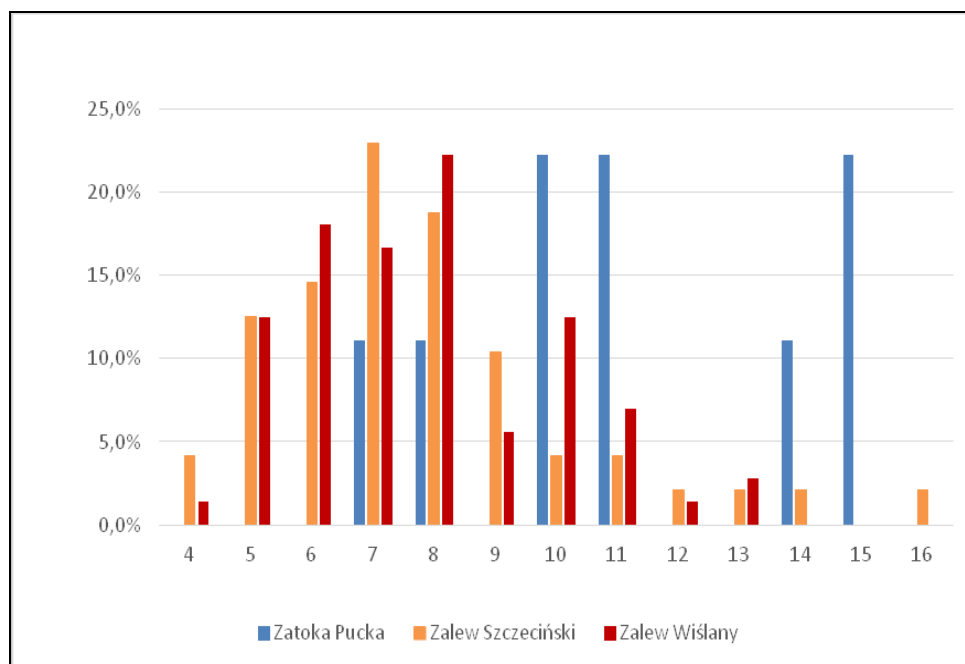


Figure 5. Age of eels in Oder and Vistula RBD in 2014.

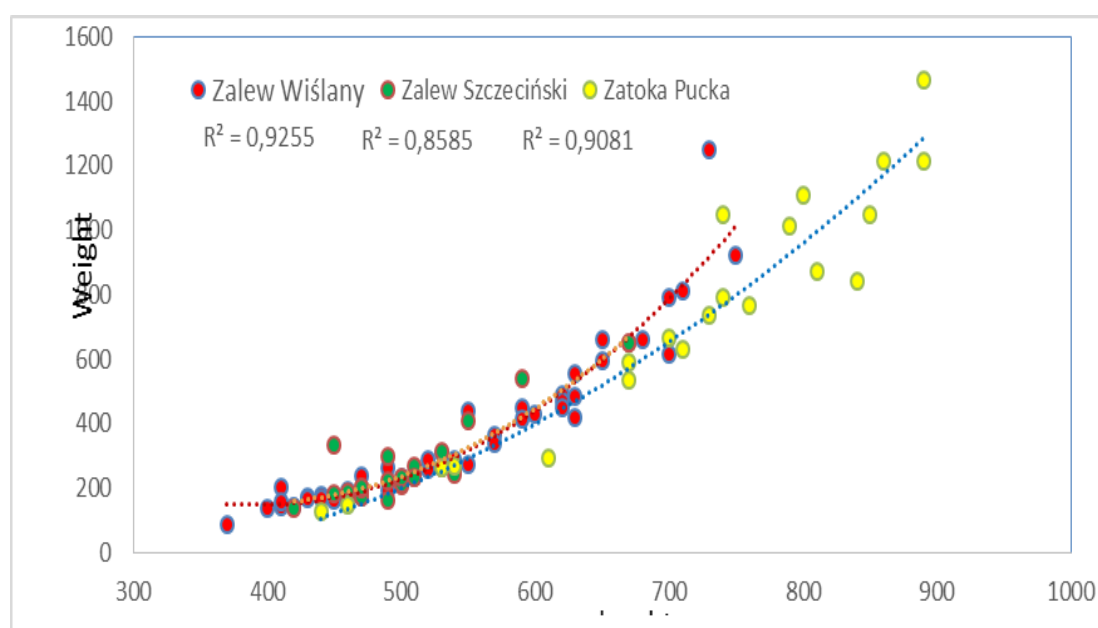


Figure 6. Length-at-weight of eel from commercial catches conducted in 2014 in Oder and Vistula RBD.

11.2 Parasites and pathogens

The analysis of study results indicated that the eel from different basins in the Vistula and Oder RBDs were in varied states of health. Among the fish examined from different catch sites, no clinical pathology was noted on the skin or gills that would be symptomatic of disease. Approximately 60% of the eel from the Oder River examined exhibited changes on the skin in the form of lesions near the snout, on the head, or near the caudal fin. While mechanical damage to the caudal fin was noted in fish examined from nine catch sites, but this did not exceed 30% of the fish. Anatomic pathological examinations indicated no changes in the kidney, spleen, heart, or diges-

tive tract that would be symptomatic of disease. Liver degeneration was noted in some eel, particularly those from the Oder RBD. Fibrous connective tissue proliferations and blood in the swimbladder were noted in single specimens examined from each of the catch sites. These are symptoms of swimbladder parasites, which were confirmed by parasitological tests. All of the eel examined were heavily infected with the nematode parasite *Anguillicoloides crassus*. The analysis of individual test results permitted concluding that the degree of *A. crassus* parasite infection influences the activity of non-specific cellular and humoral defence mechanisms that determine resistance to infection.

Bacteriological examinations of the skin, gills, and internal organs indicated a lack of pathogenic bacteria in all fish examined. Only saprophytic bacteria, which occur permanently in aquatic environments, was isolated from the body surface and internal organs. The body surfaces were dominated by the bacteria *Aeromonas hydrophila* and *Photobacterium damsela*, while the internal organs were dominated by *Chryseomonas luteola*.

Virology examinations indicated the lack in all eel examined of the EVEX and AnHV viruses, which are pathogenic to these fish. A significant element of the examinations was that no viruses were isolated from the fish examined that are pathogenic to other fish species (VHSV, IHNV, IPNV, SVCV, or CyHV-3), which indicated that the eel examined were not carriers of viruses that are pathogenic to other species of cultured fish. The analysis of the results indicated that the activities of macrophages and lymphocytes in fish from the catch sites were on similar levels; however, the levels of macrophage metabolic and phagocytic activity and the proliferative activity of T and B lymphocytes isolated from the kidney were lower in fish caught in the Oder River were statistically significantly lower ($P < 0.05$). Similar results were obtained in studies of the development of non-specific humoral defence mechanisms. The activities of lysozyme, ceruloplasmin, and serum Ig levels were similar. Only in fish from the Oder River was statistically significantly lower levels ($P < 0.05$) of lysozyme and serum Ig levels with a statistically significant increase in ceruloplasmin, acute phase protein produced in the liver. This is evidence of hepatocyte damage, which was confirmed by pathology test that conformed 100% of the fish caught in the Oder River had liver degeneration.

Biochemical tests on serum obtained from the fish indicated that levels of total protein, glucose, and cortisol were at similar levels. However, the fish from the Oder River had statistically significantly ($P < 0.05$) lower levels of total protein and glucose, which suggests that their access to food or feeding was limited. No significant differences were noted in cortisol, a parameter that indicates the influence of stressors on fish. This is evidence of a lack of the negative impact of polyetiological stress on the fish.

In summation, the adult eel examined did not exhibit any pathology indicative of progressive disease, while specialist microbiological studies confirmed the fish were in good health. Immunological and biochemical tests also indicated the fish were in very good condition and health that is associated with high immune potential. However, the lowered cellular activity and humoral defence mechanisms confirmed in the fish from the Oder River, which suggest that the impact of environmental factors (xenobiotics) associated with the contamination of the aquatic environment induced immunosuppression in the fish, is linked to lowered resistance to infection. Lower levels of total protein and glucose suggest that the fish inhabiting the Oder River are frequently without food, and this can have a direct impact on the activity of non-specific humoral defence mechanisms and resistance to infection.

11.3 Contaminants

While the cause of the eel stock collapse has yet to be identified, it has been suggested that the accumulation of contaminants might be a factor in the decreasing quality of potential spawners, which negatively affects the reproductive success of the species (van Ginneken and van den Thillart, 2000; Robinet and Feunteun, 2002; Darnerud, 2003). The impact of chemical compounds is determined by their type and the possible synergetic reactions occurring in mixtures of compounds. It is believed that, depending on the type, these compounds can disrupt the functioning of immune and nervous systems in organisms, disrupt hormonal balance, and negatively impact the ability of individuals to reproduce and are detrimental to the development of their offspring. Depending on the type, these compounds can affect organisms at the sub-cellular level, in the organs, or even throughout populations (Darnerud, 2003; Geeraerts and Belpaire, 2010). To date, the best understood toxic mechanisms are those of polychlorinated biphenyls (PCBs), organochlorine pesticides, polycyclic aromatic hydrocarbons (PAHs), and heavy metals. Numerous studies have demonstrated the impact of PCBs on the ability of eel to migrate and reproduce because of, among other things, the impact they have on lipid metabolism. Belgian studies on the dependence between eel fat content and the level of chemical contamination revealed that PCBs and DDTs have a negative impact on fat content (Geeraerts and Belpaire, 2010). Heavy metals, such as cadmium (Pierron *et al.*, 2007), and perfluorocarbons (Hu *et al.*, 2003) can also affect fat metabolism. Additionally, the intense metabolism of lipids, such as that which happens during eel spawning migrations, causes the sudden release of previously accumulated organic contaminants into the blood. This can cause damage to reproductive organs and have a negative impact on embryogenesis. Fat content above 20% is thought to be the minimum level required for normal migration and reproduction (Belpaire *et al.*, 2009).

Therefore, the quality of habitat should be taken into account when eel restocking programs are planned. The control of contaminants levels in eel is also important because of concern for consumer health. Because of high fat content, this species tends to accumulate high levels of contaminants and in many European countries, the levels of pollutants in eel exceed limits permitted by law.

The objective of the study conducted in the period from 2012 to 2014 was to provide information on the levels of pollutants in the tissues of eel caught in Polish waters. The contaminants included in the study are those that are of concern in relation to the environment and human health: toxic metals, organochlorine pesticides, polychlorinated biphenyls (PCBs), diphenyl ethers (PBDEs), hexabromocyclododecane (HBCDD), and metabolites of polycyclic aromatic hydrocarbons. In addition, the fat content that is considered to be a general indicator of eel population health and is related to the reproductive success of the species was determined, among other things. Based on the available toxicological data, various types of standards and assessment thresholds were developed to interpret chemical data. Maximum permissible limits in food are set for organochlorine pesticides, PCDD/Fs, and PCBs, but there are currently no EU maximum limits for brominated flame retardants (BFRs) in food stuffs. Nonetheless, the EFSA recommends monitoring BDE, PBB 153, and HBCDD in foods and feeds. In addition, EU Environmental Quality Standards (EQS), which should not be exceeded in the aquatic environment, are proposed for pollutants that are classified as Priority Substances under the Water Framework Directive (HCB, α -HCH, PBDE, HBCDD). The results of the study were evaluated in terms of environmental quality and consumer health according to these criteria. The reference values used are presented in Table 20.

One-hundred and sixty eel samples were tested in from 2012 to 2014. The samples were collected mainly in northern Poland from sites in various geographic regions and catchments with differing land use pressures. Sampling was conducted in the Vistula and Szczecin lagoons, Puck Bay, the Vistula River near Tczew, Wegrą River and in lakes Jamno, Mamry, Świątajty, Nidzkie, Roce, Stręgiel, Świątajno, Dargin, and Niegocin.

Fat content

The samples tested from 2012 to 2014 varied widely in fat content from 4.89% (Vistula River near Tczew, the sample comprised eight individuals with a mean weight of 57.3 g) to 37.49% (Szczecin Lagoon, one eel weighing 1007 g). Eel caught in lakes had lower fat contents than did those sampled in the Szczecin and Vistula lagoons.

Fat content higher than 20% was observed in 50% of samples collected in 2012–2013. In samples collected in 2014, fat content was higher than that measured in eel collected previously. In all 60 samples collected in 2014 the lipid content was higher than 20% and ranged from 20.74% (Lake Jamno, one eel weighing 463.2) to 37.49%, (the individual from the Szczecin Lagoon mentioned previously). The mean fat content in eel sampled in the Szczecin Lagoon (mean weight 927.85 ± 227.65 g) and in Lake Jamno in the period from 2012 to 2013 was $19.79 \pm 3.75\%$ and $17.55 \pm 3.94\%$, respectively, while in eel collected in the Szczecin Lagoon in 2014 (mean weight 801.10 ± 267.20 g) and in Lake Jamno had mean fat contents of $32.50 \pm 3.10\%$ and $28.2 \pm 3.0\%$, respectively.

Metal content

Levels of toxic metals were compared with permissible limits set forth by Commission Directive 2006/1881/EC. The permissible limits for eel are higher than for other fish species, as follows: 100 µg/kg for cadmium; 300 µg/kg for lead; 1000 µg/kg for mercury. Among the toxic metals studied, the highest levels were noted for mercury. However, in the majority of samples tested, metal levels were low and the average mean contents of cadmium, lead, and mercury were about 4%, 4.5%, and 20% of the permissible limits.

The permissible limit of toxic metals for eel was exceeded in just one of the tested samples in an individual weighing 615 g caught in the Vistula Lagoon. The concentration of mercury in it 1199 µg/kg. However, if the results are referred to EQS for mercury designated in the WFD (0.020 mg/kg), all the samples assayed had elevated levels of this contaminant.

Organochlorine pesticides and indicator PCBs

In the majority of samples, the levels of indicator PCBs were also much lower than the permissible limit established for eel (300 ng/g), but in 15% of the samples assayed, the limit established for other fish species (75 ng/g) was exceeded. One sample from the Vistula Lagoon exceeded the limit of 300 ng/g with a concentration of 316.7 ng/g.

Samples caught in the Szczecin and Vistula lagoons had higher levels of PCBs than did eel sampled in lakes. The levels of marker PCBs measured in eel caught in Polish waters were low compared with those observed in eel sampled in other European countries, where levels exceeded 300 ng/g (ww) and reached as much as 1512 ng/g (the Netherlands).

Concentrations of organochlorine pesticides measured in the muscle tissue of eel caught in Polish waters are much lower than the EQS values set for these compounds. The highest levels of these contaminants were found in fish from the Szcze-

cin Lagoon and the Vistula River. Eel caught in the Vistula River had levels of α -HCH, γ -HCH, HCB, and Σ DDT of 0.81 $\mu\text{g/kg}$, 0.88 $\mu\text{g/kg}$, 23.87 $\mu\text{g/kg}$, and 643.9 $\mu\text{g/kg}$, respectively. This means that the highest pesticide levels constituted 4.1%, 0.44%, 23.9%, and 65% of permissible limits set for these compounds.

Brominated flame retardants

Monitoring HBCDD in eel started in 2014, while PBDEs have been measured since 2012. Concentrations of HBCDD in the muscle tissue of eel caught in Polish waters ranged from 0.26 to 5.36 ng/g, which was much lower than the EQS value (167 ng/g) proposed for this contaminant. The highest mean concentrations of HBCDD were noted in eel samples from Lake Jamno, the Węgorapa River, and the Szczecin Lagoon. Assessing Σ PBDE levels poses some difficulties because of the very controversial value of EQS set for biota monitoring under the WFD. The EQS value for PBDEs (0.0085 ng/g) was calculated to protect human consumers based on observed effects of only one congener (BDE99) on rats. (European Commission, 2011). At the same time, the authors of a dossier on PBDEs proposed a level of 44.4 ng/g as appropriate to protect wildlife predators (European Commission, 2011). In none of the samples examined in 2012–2014 did the concentrations of Σ PBDEs (sum of six congeners: 28, 47, 99, 100, 153, 154) exceed 44.4 ng/g, but the level of 0.0085 ng/g was exceeded in each sample. The highest level of Σ PBDEs, 16.37 ng/g, was observed in an eel caught in the Szczecin Lagoon, weighing 1194 g.

Dioxins and dl-PCBs (PCDD/F/dl-PCBs)

Dioxins and dl-PCBs were measured in samples from 2012. The results obtained were evaluated in relation to maximum permissible limits of PCDD/F and dl-PCBs in food of marine origin as defined in Council Directive 1259/2011. The results indicated that dioxin residues (PCDD/Fs) in the eel tissues examined are at relatively low levels. The highest concentration at 1.0 ng WHO-TEQ/kg was measured in an individual caught in Lake Jamno (411g). This concentration constitutes 29% of the permissible limit. The highest mean PCDD/F levels were measured in samples from the Vistula River and from the Szczecin Lagoon (Trzebież). Concentrations of dl-PCBs were much higher than those of PCDD/F, nonetheless, the permissible limit of 10 ng WHO-TEQ/kg for the sum of dioxins and dl-PCBs in eel was not exceeded in any of the samples examined. The highest level of PCDD/F/dl-PCBs (5.11 ng WHO-TEQ/kg) was observed in an individual weighing 1332g, caught in the Szczecin Lagoon (Trzebież).

PAH metabolites

PAH metabolites were included in monitoring in 2014. The problem of fish exposure to PAHs present in the environment is important from the perspective of the toxic effects induced by PAH metabolites in fish. These compounds have been proven to induce multiple toxic, mutagenic, and carcinogenic effects in vertebrates including delayed growth, reduced survival, and developmental malformations. It is currently difficult to conclude whether the levels of PAH metabolites occurring in eel from Polish waters present a major potential threat to their health. The environmental assessment criteria (EAC) developed for different marine species by ICES are in the range 483–909 ng ml/bile for 1-OH Pyr and 262–1832 ng ml/bile for 1-OH Phe. BAC criteria established by OSPAR for different fish species are in the range of 13–151 ng/ml for 1-OH Pyr and 0.8–7.9 ng/ml for 1-OH Phe. Compared with these criteria, the levels of PAH metabolites measured in eel from Polish waters appear to be high. The highest levels were observed in fish from Lake Śniardwy. However, it should be emphasized that species differ in their susceptibility to the toxic effects in-

duced by contaminants, and, currently, risk assessment criteria specific for eel are unavailable. Additionally, the usefulness of the proposed risk assessment criteria will remain singularly limited until data normalization aimed at reducing the impact of feeding status on the concentrations of PAH metabolites measured is taken into consideration, when assessment criteria are developed.

Conclusions

- 1) The levels of contaminants measured in the muscle tissue of eel collected in Poland do not appear to pose a risk to human health. The levels of contaminants surveyed were low in relation to permissible limits established for food.
- 2) The contaminant levels found in eel indicated that the environmental status of Polish waters covered by the study is good in a relation to a majority of contaminants studied. The exception was PBDE and Hg levels, which are much higher than EQS values currently proposed for these contaminants. Nonetheless, PBDEs concentrations in the eel collected in the current study are much lower than those reported for some other European countries, like the Netherlands, Belgium, Scotland, France, or Germany. In addition, levels of PBDEs in eel from Polish waters are much lower than the levels designated for the protection of top predators.
- 3) Levels of PAH metabolites measured in the samples tested were also high compared with EAC criteria proposed by OSPAR for different fish species, but it is important to note that fish species differ significantly in their susceptibility to the toxic effects induced by these contaminants and currently there are no limits specific for eel.
- 4) Fat content above 20% was observed in a majority of the samples assayed. All samples examined in 2014 exhibited high levels of fat.

11.4 Predators

Great cormorant breeding colonies are located mostly in the northern part of Poland. The largest group consists of lake colonies, which also have the largest number of nests. In all, there were 25 761 pairs of nesting cormorants in 52 colonies in 2013.

The abundance of the great cormorant population in spring in breeding colonies is determined by counting nesting pairs (nests). Populations are linked permanently to these nesting sites until their young leave the nests. The cormorant nests are counted in early spring (April) before they are hidden by the leaves of the trees.

During the period studied, steady growth in the number of cormorant nests in lake breeding colonies was observed, which in 2012, 2014, and 2015 was calculated based on annual observations and counts in colonies located in the Vistula drainage basin, i.e. in the areas in which the majority of "lake" cormorants in Poland nest (Figure 7).

Throughout the cormorant residence period, which lasts for about 200 days, pellets were collected every two weeks at selected spots in above colonies. Using the otoliths recovered and the known number of cormorants in the colonies, the numerical and weight shares of eel in their diet was determined. It was accepted that the mean daily portion of eel consumed by a cormorant is 400 g. Regurgitated eel were also collected, and based on their numbers and the measurements of individuals found, their share in the cormorant diet was determined.

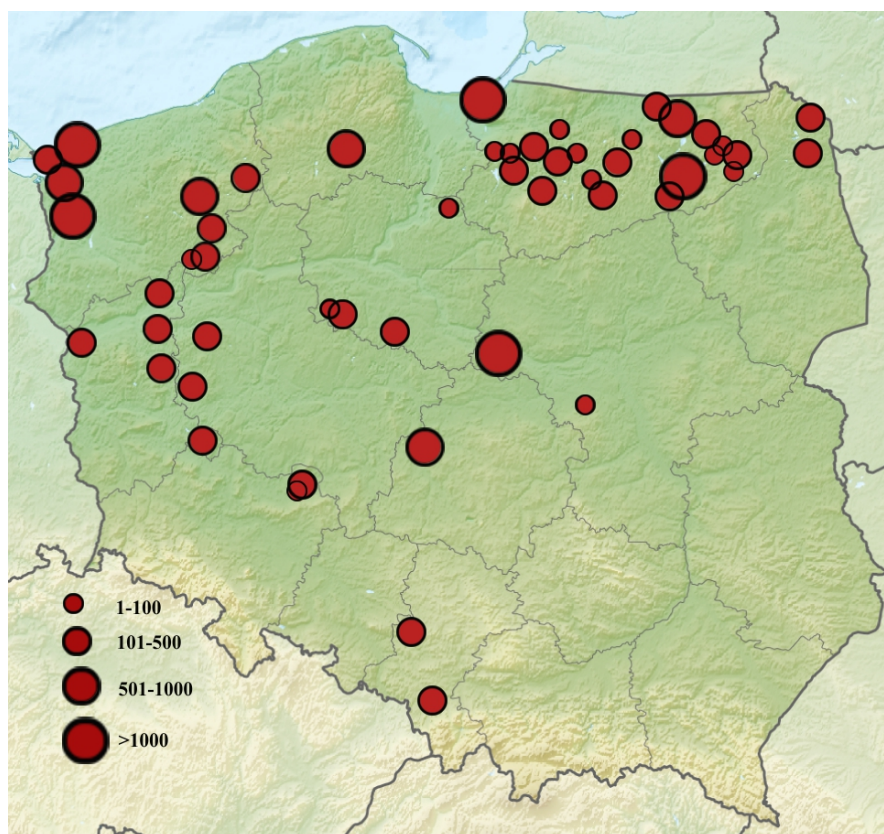


Figure 7. Breeding colonies abundance in Poland according to the list of 2013 with the number range of nests.

In the collected samples of regurgitated eel and eel from pellets in 2012–2014, the weight of the individuals fluctuated between 13 and 442 g, and body length fluctuated between 20.5 and 61 cm. Smaller individuals predominated decidedly. In earlier research on great cormorants, the largest eel weighed 867 g and was approximately 22 years old. This was something of an exception that underscored the great potential of the cormorant.

Research conducted in 2012–2014 indicates that the share of eel in the cormorant diet increased annually in both lagoons, and its increase was especially large in the lakes that are the primary cormorant habitats in Poland.

In 2014, compared with the previous year, the weight of eel caught in lakes by cormorants increased by 83%. Samples collected show that eel are most frequent in the cormorant diet in June (36%) and July (23%).

12 Other sampling

No new information is available.

13 Stock assessment

13.1 Method summary

The stock dynamics of eel in both river basin districts was estimated using a version of CAGEAN model (Deriso *et al.*, 1985). The model was fitted to data covering period 1960–2011. It were a lot of gaps in the age-structured data, and for some data only

approximate or assumed values were available, so the model was fitted using simplifying assumptions. The available data included:

- Fishery and recreational catches covering whole period.
- Restocking numbers covering whole period.
- Age structure and weight-at-age for several years, but in most years these data were not available. The best covered by age and weight data period was since 2006.
- Predation on eels by cormorants.

In the CAGEAN model fishing mortality (F) was separated into year effect (fishing mortality at reference age in a year) and age effect (selection). Up to 2005 data for estimating year effect in F were too scarce, the F has been presented as time-dependent polynomial of 7th degree, and coefficients of such polynomial were estimated within the model. Since 2006 F has been calculated for each year due to age data availability. Predation mortality from cormorants was included, but it appeared to be low (usually at 0.01–0.02). Recruitment to the model was assumed as proportional to recruitment indices estimated using GLM by WGEEL (ICES, 2011) and coefficient of proportionality (R_{alfa}) was estimated in the model. Selection was estimated at ages 3–6, at others it was assumed at 1. Other parameter was Z_{ini} , total mortality used to estimate initial stock numbers (in 1960) from average recruitment at the beginning of simulation period.

The model was fitted by minimizing the sum of squared residuals between observed and modelled catch and observed and modelled catch-at-age in those years in which age distribution was available. The residuals were determined from logged values. Details of the model were presented in 2008 Polish eel management plan. The inverse of variance weighting was applied to weight terms of total sum of squared residuals. The estimated fishing mortality and R_{alfa} were inversely correlated and it was relatively little information in the data to select most representative estimate of R_{alfa} . Thus, the model was run for series of R_{alfa} values, and as a representative for eel dynamics it was selected such R_{alfa} , at which minimized sum of squared residuals showed low changes, while the total mortality was relatively close to mortality estimates from catch curve. Otherwise, the minimizing procedure tended to select high R_{alfa} and produced unrealistically low fishing mortality.

The model fit in 2014 differs from the model in 2008 for a few reasons:

- Recruitment indices were now taken from GLM estimates presented in WGEEL Report in 2014;
- Weight-at-age were updated and appeared to be much higher than previously used at younger ages;
- Data from 2008–2014 were included in the analysis;
- As a result the biomass estimates now are similar to previous estimates at the beginning of series (1960s) and comparable at the end of series (after 2000), however in middle of the assessed period present biomass estimates are markedly higher from previously estimated.

13.1.1 Estimate of B_0

EMU_CODE	B_0 (T)	REFERENCE TIME PERIOD	WHETHER OR NOT CHANGED FROM VALUE REPORTED LAST YEAR (Y/N)
PL_ODER	1611	1960–1979	N
PL_VISTULA	1343	1960–1979	N

13.2 Summary data

13.2.1 Stock Indicators and target

EMUCODE	INDICATOR	BIOMASS (T)	MORTALITY (RATE)						TARGET
	B_0	B_{best}	B_{curr}	$\sum A$	$\sum F$	$\sum H$	Source	Biomass (t)	
PL_ODER	1611	217	44	1.56	1.05	0.51	EMP	645	
							EU Reg		
							WGEEL		
PL_VISTULA	1343	211	23	2.31	1.52	0.8	EMP	537	
							EU Reg		
							WGEEL		

B_0 is based on average recruitment from reference period taken as 1960–1979;

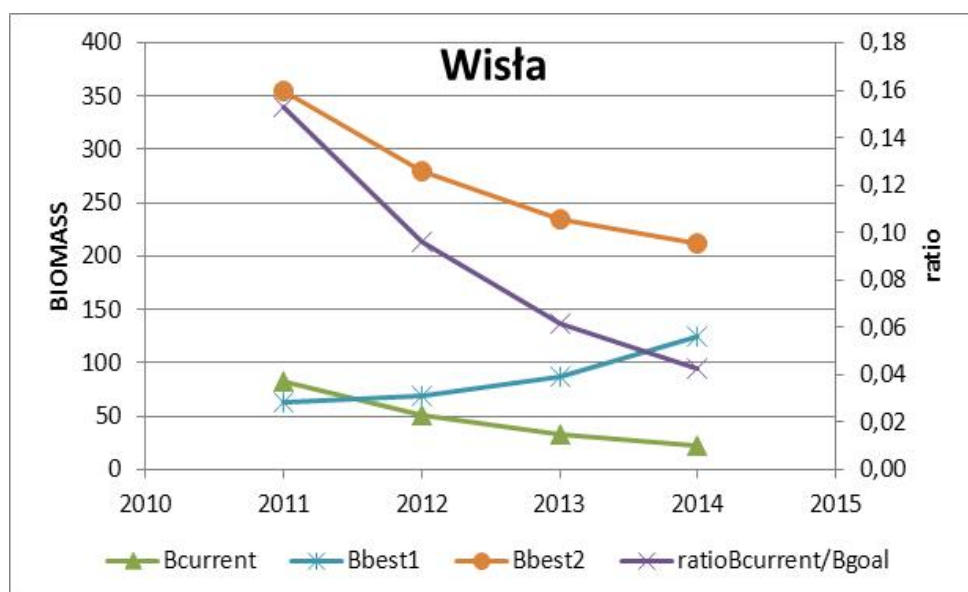
B_{best1} is based on current recruitment (2013);

B_{best2} is based on recruitment from those year classes, which form current escapement of silver eel to spawn;

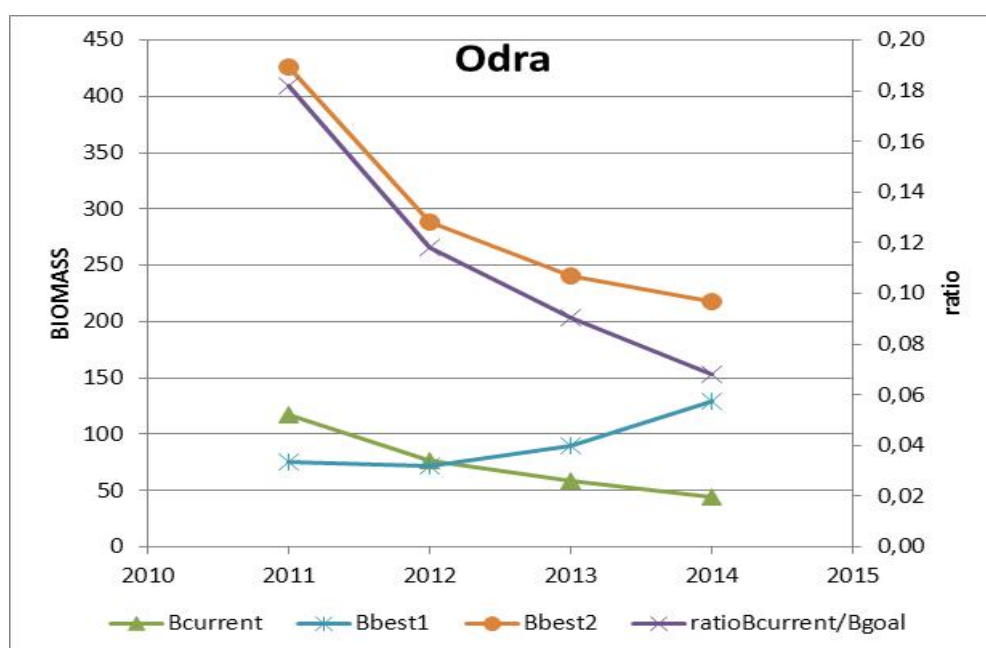
$\sum F$, $B_{current}$, B_{best} are provided in 2014.

Two versions of B_{best} were provided, as it was not fully clear from the guidelines how B_{best} is defined. In addition, it is not clear how to calculate B_{best} from $B_{current}$, $\sum F$ and $\sum H$, because to calculate B_{best} , the $\sum F$ referring to generations forming current escapement should rather be used instead of $\sum F$ from current years.

Changes in silver eel biomass and mortality factors over the last three years are presented in figures below.

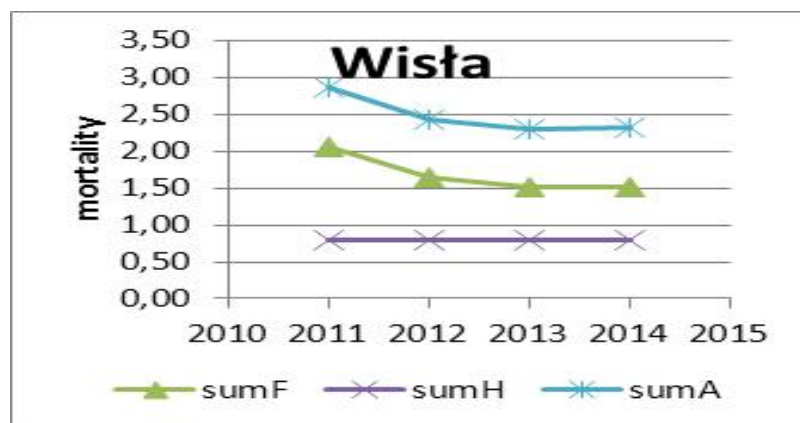


A

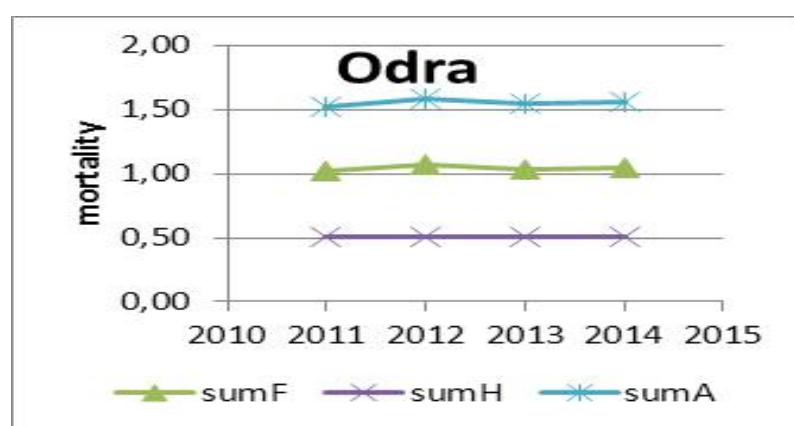


B

Figure 8. Stock dynamics in Vistula EMU (A) and Oder EMU (B) presented as a $B_{current}$, B_{best} and ratio in 2011–2013.



A



B

Figure 9. Changes in mortality factors in Vistula EMU (A) and Oder EMU (B) in 2011–2013.

13.2.2 Habitat coverage

Natural eel habitats in Poland are found in nearly all waters (Table 12), the only differences are in their importance for the occurrence of eel. Rivers are of the least importance to the occurrence of eel because they are routes for feeding and spawning migrations (silver eel escapement). The most important eel habitats have been and are transitional waters (Vistula and Szczecin lagoons) and lakes which comprise the lake lands situated in northern Poland.

Table 12. Surface areas of water categories in the EMUs (ha).

TYPES OF WATERS	ODER EMU	VISTULA EMU	TOTAL POLAND
Rivers, width >3 m	-	-	134 700*
Lakes, surface area >1 ha	163 000	118 400	281 400
Dam reservoirs	16 000	32 000	48 000
Transitional waters	45 700	32 800	78 500
Maritime waters**	646 450	344 100	990 550

* length in km.

** maritime waters include the inner Gulf of Gdańsk, which nominally belongs to inner maritime waters.

13.2.3 Impacts

Mortality in eel is caused by a number of factors, the most important of which include hydroelectric power facilities, fishery, cormorant predation, water pollution, parasite infection, and illegal catches (Table 13).

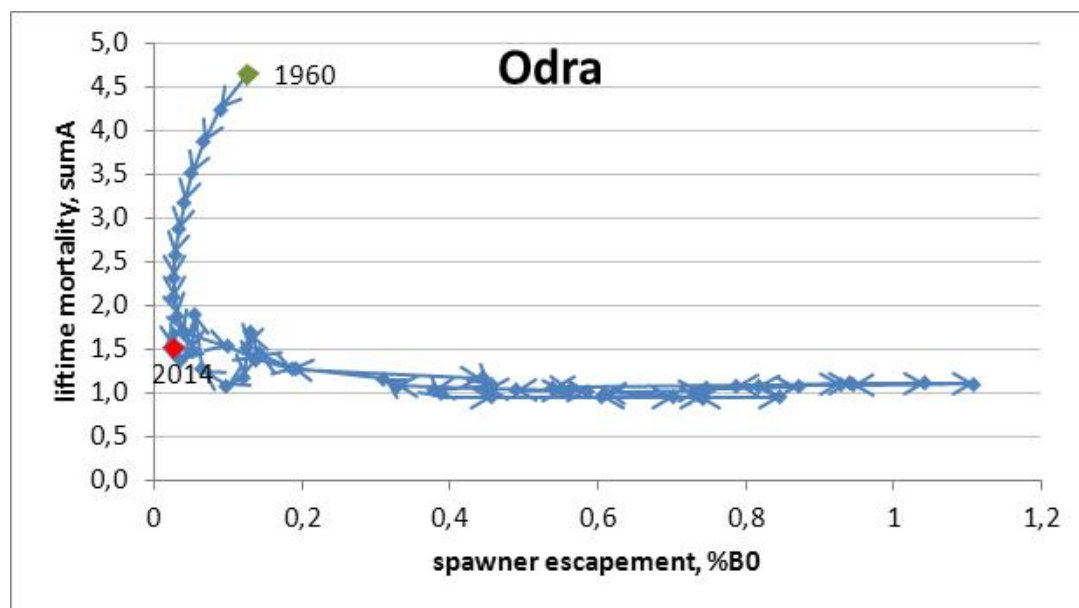
Detailed study on impacts is currently ongoing (see chapter Other sampling), so the first results will be ready in 2015.

Table 13. Causes of mortality in eel other than fishing.

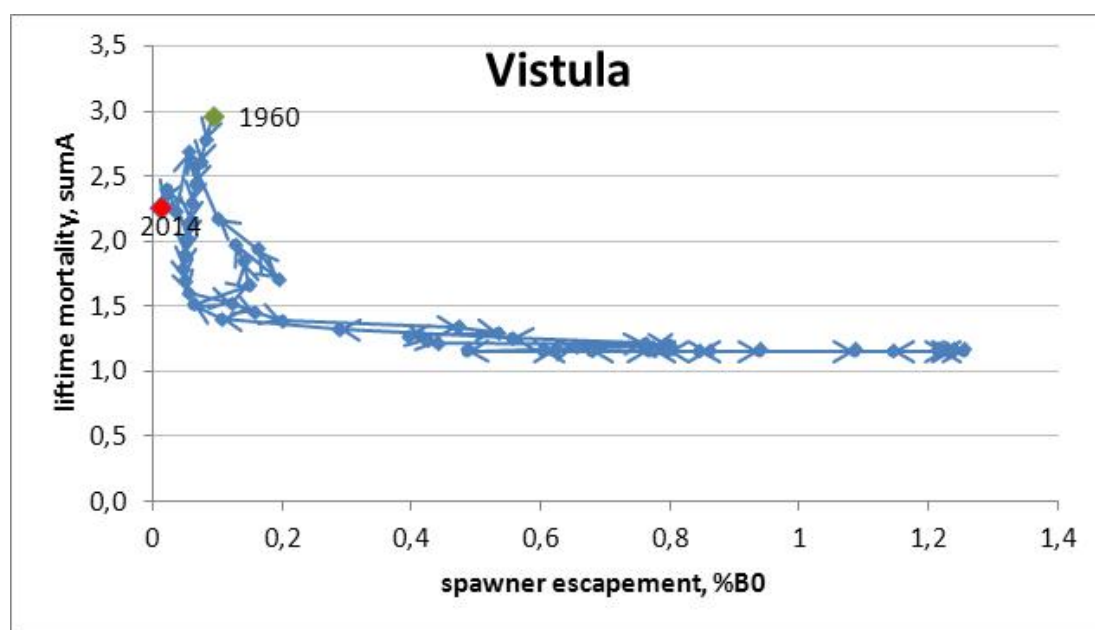
EMU CODE	HABITAT	FISH COM	FISH REC	HYDRO & PUMPS	BARRIERS	RESTOCKING	PREDATORS	INDIRECT IMPACTS
PL_ODER	All	A	A	A	NA	AB	A	MI
PL_VISTULA	All	A	A	A	NA	AB	A	MI

No.	CAUSE OF MORTALITY	HABITAT TYPE	IMPACT
6.1	Hydroelectric power facilities	Rivers	Vistula EMU – 44% (EMP) Oder EMU – 30% (EMP) New data – 0 to 22%
6.2	Predation	All	Potentially substantial (research required)
6.3	Pollution	All	Quality data (low impact)
6.4	Diseases and parasites	All	Quality data
6.5	Illegal catches	All	Quantity data

13.2.4 Precautionary diagram



A



B

Figure 10. Precautionary diagrams in one of the form, i.e. lifetime mortality (sumF+sumH) plotted against spawner escapement (in terms of percent of B_0). The estimates for the beginning and end of the considered period are marked in green and red. High spawner escapement biomass at end of 1970s up to beginning of 1990s is effect of the intensive restocking in 1960s till middle of 1990s. Lifetime mortality (sumF+sumH) plotted against spawner escapement (fraction of B_0) for 1960–2014 (A- Oder EMU, B- Vistula EMU).

13.2.5 Management measures

Table 14. Management measures in Polish EMUs.

EMU CODE	ACTION TYPE	ACTION	LIFE STAGE	PLANNED	OUTCOME
PL_ODER PL_VISTULA	Com Fish	Closed period 15 June–15 july	Y/S	2009	2010 Fully
PL_ODER PL_VISTULA	Rec Fish	Closed period 15 June–15 july	Y/S	2009	2010 Fully
PL_ODER PL_VISTULA	Hydropower & Pumps	Limiting mortality	S	2019	NA
PL_ODER PL_VISTULA	Restocking	Restocking		2009	2009 supplemented in 2011, 2010 and 2011 supplemented in 2013 Partially
PL_ODER PL_VISTULA	Com Fish	Minimum landing size 50 cm	Y/S	2009	2010 Fully
PL_ODER PL_VISTULA	Rec Fish	Minimum landing size 50 cm	Y/S	2009	2010 Fully
PL_ODER PL_VISTULA	Com Fish	Gear Selevtivity >20 mm	Y/S	2013	2013 Partially (not in all areas)
PL_ODER PL_VISTULA	Rec Fish	Decreasing daily catch	Y/S	2009	2010 Fully
PL_ODER PL_VISTULA	Other	Reducing cormorants	Y/S	In case of negative impact	NA (small impact now)

14 Sampling intensity and precision

Since 2006, Poland has participated in the programme for collecting fisheries data, which includes sampling eel landings. Until 2008, the framework for data collection was set forth in Council Regulation (EC) No. 1639/2001. Thus far, samples have been collected in the Szczecin and Vistula lagoons and survey forms have been completed and entered into the SFI database.

The detailed ichthyological analysis of eel from landings follows standard procedure for population sampling, and includes recording parameters such as length, weight, sex, stomach fullness, and parasitic infection (nematode *Anguillicola crassus*). Otoliths are also collected for later age and growth-rate determinations. Because commercial fisheries do not differentiate between yellow and silver eel, the metamorphosis stage is determined using the silvering index.

From 2009, there has been a shift in the framework of collecting dataset forth in Council Regulation (EC) No. 199/2008 concerning the establishment of a Community

framework for the collection, management, and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy.

Specifically, this was a move away from single-species sampling performed in the 2005–2008 period toward multispecies sampling based on métiers or fleet segments. In the case of eel, sampling since 2010 should be introduced in inland waters as part of commercial and recreational catches. Although the framework for data collection in maritime fisheries is quite precisely described (Guidelines for the new DCR (SGRN-08-01), for inland fisheries there is just one short notation regarding the required number of fish analysed to determine age. The SFI planned a monitoring system that functions on similar principles to those of the marine system (Table 15). The catches sampled will be those made with gear groups that include up to 90% of the entire fishing effort. It is planned to analyse 200 fish from each of EMUs yearly.

Table 15. Basic scheme for collecting marine fisheries data from eel catches from 2009 onwards.

CHOICE OF REGION(BALTIC REGION; FISHING GROUNDS)	ICES SD 22–24 ODER EMU	ICES SD 25–32 VISTULA EMU
Choice of métier (fleet segment) for eel	Pot and trap gear (FPO)	
Degree of sampling segment (landings + discards)	Minimum of one cruise per month	
Total number of sample	Depending on the variation coefficient CV, assumed CV=12.5% for eel	
Age analysis	100 yellow eel 100 silver eel	100 yellow eel 100 silver eel
Other biological parameters*	as above	as above

* sex, silvering index – gonad maturity, degree of parasitic infection with *Anguillicola crassus*.

The level of precision regarding age required by DCF regulations was not achieved. The numerous length and age classes would require performing age analysis on a thousand fish annually to achieve a CV coefficient of 12.5%.

15 Standardization and harmonization of methodology

15.1 Survey techniques

See chapter “other sampling.”

15.2 Sampling commercial catches

Data regarding commercial fisheries are collected in fishing ports in which eel catches are reported. Measurements and analysis are performed at the SFI laboratory. Prior to analysis the fish are anaesthetized then sacrificed.

15.3 Age analysis

Age analysis is conducted at the SFI laboratory. Age is calculated based on the number of growth interval rings visible as dark rings and clearly differing from the light protein matrix on the surface of otoliths (Moriarty, 1983; Campana, 1992; Campana and Jones, 1992; Lecomte-Finiger, 1992; Tzeng *et al.*, 1994). Two otolith preparation methods are used, the more common break and burn and the less common section and stain. Thin sections are cut using a high-speed Acutome-50 micro-tome with a diamond blade (Figure 11).

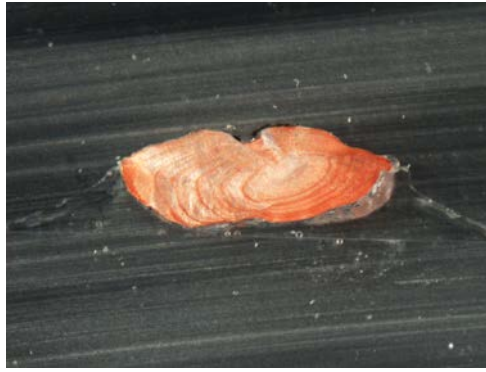


Figure. 11. Sectioned eel otolith prepared in NMFR laboratory.

15.4 Life stages

Eel life stage is determined using the method described in Durif *et al.* (2005).

15.5 Sex determinations

Eel sex is determined macroscopically according to established schema of ovary and core build.

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Report on the eel stock and fishery in Spain 2014/2015

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Reporting Period: This report was completed in November 2015, and contains data up to 2014 and some provisional data for 2015.

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2 Introduction

2.1 Spanish EMUs

Spanish River Basin Districts (RBDs), charged of the design of the hydrological plan and the management of continental waters, were defined after the approval of the Royal Decree 125/2007 by which the territorial limits of the RBDs were fixed (Figure 1).

All the territory of the RBDs of Guadalquivir, Galicia Costa, Basque Country Inner basins, Catalonia Inner basins, Canary Islands basins, Balearic Islands basins and Atlantic and Mediterranean basins of Andalucía belongs to a single autonomous region (Figure 2) and are managed by the autonomous region they belong to. On the contrary, Segura, Júcar, Miño-Sil, Cantábrico, Duero, Tajo, Guadiana, Ebro and Guadalquivir RBDs extend over different autonomous regions and are managed by the Spanish Ministry of the Environment and Rural and Marine Affairs (MARM) through eight hydrographical confederations. Additionally, the Miño, Duero, Tajo and Guadiana RBDs are shared with Portugal, whereas the Ebro RBD is shared with France.

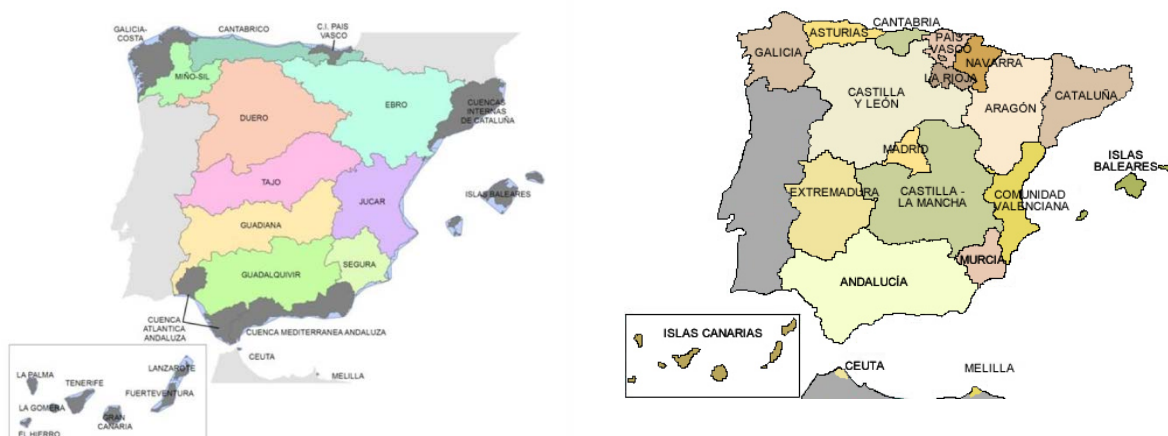


Figure 1. RBDs and Autonomous regions of Spain.

The main characteristics of the River basins included in this report are:

AUTONOMY	RBD	RIVER BASIN	LATITUDE	LONGITUDE	DRAINAGE AREA (KM ²)	RIVER LENGTH (KM)
Basque	B. Inner	Bidasoa	43°19'	1°58'W	700	69
		Oria	43°16'	2°06'W	882	77
		Urola	43°17'	2°14'W	342	65
		Deba	43°19'	2°26'W	530	60
		Artibai	43°21'	2°29'W	104	26
		Lea	43°22'	2°35'W	99	26
		Oka	43°21'	2°40'W	183	27
		Butrón	43°23'	2°56'W	172	44
		N. Ibaizabal	43°19'	3°00'W	1798	72
		Barbadun	43°17'	3°07'W	128	27
Asturias	Cantábrico	Nalón	48°17'	5°23'W	4866	142
Galicia	G. Coast	Ferrol	43°27'	8°08'W	27	17
		Eo	43°4'	7°05'W	819	78
		Vigo	42°09'	8°36'W	176	33
		Pontevedra	42°15'	8°41'W	145	23
		Arousa	42°26'	8°46'W	230	33
	Miño	Miño	41°5'	8°52'W	9775	308
Murcia	Segura	Mar menor lagoon	37° 41	00° 50' W	170	
Valencia	Jucar	Albufera lagoon	39°22'	0°18' E	738	
	Segura	El Hondo lagoon	38°11	0°46'W	23.9	
	Segura	Santa Pola lagoon	38°11	0°37'W	25.0	
	Ebro	Ebro	40°41'	0°44'E	85362	910
Catalonia	C. Inner	Muga	42°14,2'	3°7,6E	758	
		Fluvià	42°12,2'	3°6,7E	974	
		Ter	42°1,4'	3°11,7'E	2955	

2.2 Review of the main regional characteristics of the eel fishery in Spain

The autonomous regions are in charge of the management of the fishery in inner waters (including coastal waters). This causes great differences among the autonomous regions:

- The amplitude of the historical dataseries is variable among the autonomous regions, depending on the date in which the regulation of each autonomous region was issued.
- In some of the autonomous regions, the same regulation is applied to all the River basins while in others, each basin or even a particular zone with-

in the same basin has its own regulation. Additionally, even in the same autonomous region, the fishery is regulated for some River basins but not in others.

- In some of the autonomous regions, fishermen are professional and have to sell their catches to the fish market, while in others, they are non-professional. In this sense, the accuracy of the information related to catches and landings differs greatly among those autonomous regions.
- Each autonomous region has its own way of managing the stock: different fishing techniques are allowed.
- In many cases, the organizations that are involved in the management of the eel could differ within the same autonomous region, depending on the eel development stages.

In the 2008 year report, a table detailing eel fishery in Spain was included which contained the legislation in force at that time. The management plans include some fishery restrictions. In the Atlantic, the most important glass eel fishery River basins are the Miño (Miño-Sil RBD), the Asturian River basins (Cantabrico RBD), the Basque River basins (Basque inner RBD) and the Guadalquivir. In the Mediterranean, the most important glass eel fishing points are the Delta of the Ebro River (Ebro RBD) in Catalonia and the Albufera (Júcar RBD) in the C. Valenciana. In addition, there is an important yellow and silver eel fishery in Galicia, C. Valenciana and Catalonia.

Spanish government does not compile eel catches data recorded in the different autonomous regions, and there is not any official statistics about landings in Spain at the national level. Different autonomous regions have contributed to the present report providing their data.

As explained above, the available information from each autonomous region is variable:

BASQUE COUNTRY: There is not a professional yellow or silver eel fishery in the Basque Country and recreational fishery catches were historically insignificant. It was forbidden in 2009. On the contrary, glass eel fishery is very traditional in the Basque Country and affects to zones associated to River mouths, including beaches, estuaries and River banks. Glass eel fishery is located in most of the River basins of Bizkaia (Artibai, Lea, Oka, Butrón and Nervión- Ibaizabal) and Gipuzkoa (Bidasoa, Oiarzun, Urumea, Oria, Urola, and Deba). Basque fishermen cannot sell the catches and therefore they should be classified as recreational. Although the fishery was very traditional, there was not any management plan for glass eels until 2001, when the Basque Government with the advice of AZTI, launched a fisheries monitoring plan. In 2003, a new regulation for glass eel fisheries was issued. It stated that there must be only one license per person and fishing basin and that it is mandatory to fill in the Daily Catches report with catches and effort data.

There are a lot of little River basins in the Basque Country. The River mouths of those basins are included in the Basque Inner River basins district (Basque Inner RBD), but the upper parts of some of these Rivers are included in Cantábrico RBDs (Figure 1).

CANTABRIA: There is not a professional yellow or silver eel fishery, and the catches of recreational fishery are insignificant. On the contrary, both, professional and recreational glass eel fishery exists in Cantabria, mainly located in the Nansa, Pas and Campiazo River basins. Recreational fishermen must have the maritime fishing recreational licence and cannot sell the catches. Professional fishermen sell their catches in the market or in other licensed establishments. Fishermen fish in land and they are

only allowed to use one sieve ($\leq 1.2 \text{ m}^2$) per fishermen. Since 2005, fishermen report their catches.

ASTURIAS: There is only one professional eel fishermen in Asturias, and the recreational fishery was forbidden in 2007.

Glass eel fishery, is very traditional in the zones associated to River mouths, including beaches, estuaries and River banks. The Fisheries General Direction of Asturias has provided the data concerning the number of issued licences and the glass eel sales data in Asturias using fish auctions. There are 18 fishermen guilds in Asturias; in the San Juan de la Arena fisherman guild data are available since 1952 and for the other 17, data are available since 1983. In the 2006 report (ICES, 2006), all the catches from Ribadesella fishermen guild were attributed to the Sella River which is the closest one. However, fishermen from other eastern Rivers of Asturias sell their catches in Ribadesella also, and therefore it is not correct to attribute all the sales of Ribadesella to the Catches of the Sella. In fact, until now, the origin of the sold glass eel must be identified only in the fishermen guilds corresponding to the Nalón River (San Juan de la Arena and Cudillero). In addition, the catches of the Nalón are sold only in the San Juan de la Arena and Cudillero fish markets. So, it is possible to identify the glass eel from the Nalón. For that reason, from the 2007 report on, the fishery data are split into the Nalón and the "Other Rivers" from Asturias. In October 2010, a new regulation was implemented in the Nalón River (*Resolución de 7 de octubre de 2010, de la consejería de Medio Rural y Pesca, por la que se regula la campaña 2010/2011 de pesca de la angula y se aprueba el Plan de explotación de la Ría del Nalón*; BOPA No 241, 18-10-2010). This regulation limits the number of boat and land licences in the Nalón River to 45 and 55 respectively. The gear type is also limited to a sieve no bigger than 200x60 cm. Boat dimensions and power together with fishing effort has also been regulated in this area. The rest of fishermen guilds are asked to record the glass eel catches and the fishing effort data of the free zone. In Asturias there are many little River basins and all of them are included in the Cantábrico RBD (Figure 1).

GALICIA: Only one management unit has been defined in the Galicia-Costa RBD, in which recreational fishing activity has been completely forbidden. Yellow and silver eel fishery is performed from boat and the number of gear types is limited per boat. The boats need a specific licence for the fishing gear that will be used in each fishing trip. They might have more than one fishing gear licence, but only one of them can be used in each fishing operation. According to the resolution that allows eel fishing in the Arousa, Ferrol and Vigo Rivers ("*Resolución do 23 de decembro de 2010, da Dirección Xeral de Ordenación e Xestión dos Recursos Mariños, pola que se autoriza o plan de pesca de anguía para as confrarías de pescadores das rías de Arousa, Ferrol e Vigo*" publicado no DOG nº 251 de 31 de diciembre de 2010), the maximum number of sieves is 80, and the fishing period is limited from the 1st of February to the 29th of October. Nowadays, there are 66 boats allowed to fish using the 'butrón' sieve, but only 37 of them are active nowadays. Regarding the 'anguila' sieve, there are 41 boat licences but this gear has been practically abandoned, and there is only one boat currently working with it.

As mentioned in the introduction, Miño-Sil RBD is one of the most important eel fishing areas in Spain. The Miño River is the most important fishing point. There is both, professional and non-professional glass eel and yellow and silver eel fishery in this RBD. The lower part of the Miño River limits the border of Spain and Portugal and for that reason the permanent International Commission of the Miño is responsible for the management of this part of the River. In the present report, the information collected by the Galician autonomous region regarding the Galicia-Costa RBD is included together with the data from the Miño RBD. The catches are established using

auctions data from the different fishermen guilds, which are assigned to a determined River basin. In the Galician fishermen guilds, yellow and silver eel catches are not split up. The estuaries are considered basins themselves because of their size, and are managed as basin units. In this way, the estuaries listed below contain catches data from the following fishermen guilds:

- Arousa Estuary: Cambados, Carril, and Rianxo fishermen's guilds.
- Eo River: Asturian fishermen's guilds.
- Ferrol Estuary: Barallobre, Mugardos and Ferrol fishermen's guilds.
- Pontevedra Estuary: Pontevedra fishermen's guilds.
- Vigo Estuary: Arcade and Redondela fishermen's guilds.

Data from this River are collected from the Miño River Command. Two thirds of the River basin drainage area is located inside the autonomous region of Galicia. The rest of the area is located among Asturias and Castilla-León autonomous regions of Spain, whereas a little part of the lower basin belongs to Portugal. Eel fishing is regulated according to the autonomous region where fishing is carried out. There is an international stretch of Miño between Spain and Portugal. There, the eel fishing is professional and land fishing is allowed only if sieves are used. The conic tackle was allowed only for two years after the publication of the regulation of the international stretch of Miño and until the sand barrier of the Miño estuary is dredged that will facilitate the entry of the migratory species.

ANDALUCIA: A new regulation is in force in Andalucía since November 2010, in which several measures have been established in order to implement a recovery plan for the European Eel (*DECRETO 396/2010, de 2 de noviembre, por el que se establecen medidas para la recuperación de la anguila europea (Anguilla anguilla)*). A complete closure of the eel fishery has been issued. Only some aquaculture factories will get a permission to fish and then grow a certain amount of eel per year. At least 60% of this catches should be directed to restocking activities, whereas the rest of the eels could go to the market.

MURCIA: Eel fishery is professional and the minimum landing size for eel is set at 38 cm. The number of boats varies between 30 and 40 per year. Eel are fished using a "paranza" (a fixed box made with net or/and canes) or bottom-set longlines. This fishery takes place in the Mar Menor and catches are sold through the "Lo Pagán" guild.

C. VALENCIANA: Glass eel fishery is a professional fishery, while the yellow and silver fishery are both, professional and recreational.

There are two types of professional yellow/silver fisheries depending on the province. In Valencia, there are four fishing associations: in the Albufera, El Palmar, Silla, Catarroja associations exercise their rights to exploit the yellow and silver eel around the Albufera which is a 2.100 ha costal lagoon between Turia and Júcar Rivers; on the other hand, Molinell association operates in Pego-Oliva fen which constitutes an agrarian landscape with a traditional economic activity. The fishermen community of El Palmar is the fishing organization with the major tradition and number of members, and the only one that is allowed to fish in fixed places in the lagoon. Eel fishery in the Albufera has its own regulation and two types of fishing are considered: the fixed place fishing (named "redolins") and the travelling fishing.

Regarding glass eel fishery, there are six professional associations of glass eel fishermen distributed between the provinces of Valencia and Castellón, with 168 fishing

licenses and 89 fishing points (“postas”). In the Albufera, Perelló-Perellonet fishing association has the exploitation rights. Fishermen of the Albufera fish in different “Golas”, the channels that connect the Albufera with the sea. In the province of Alicante, professional fishery occurs in eleven fishing preserves located between the El Hondo wetlands (Elche) and the salt flats of Santa Pola. In the fishing preserve of Alicante, a maximum number of fishing tackles (named “mornells”) is allowed. The fishermen guilds and associations give their catches data to the territorial service of each province responsible for the continental fishing. In the case of glass eel, they also report the fishing days.

CATALONIA: There are two RBDs in Catalonia: the Catalonia Inner River basins, which include small and medium Rivers, and the Ebro RBD, which is the second largest River basin in Spain. The delta of the Ebro River is the most important eel fishing point in Catalonia regarding the number of active fishermen with licence and eel catches. The glass eel fishery is professional in the Ter, Muga and Fluviá Rivers (province of Gerona) and the delta of the Ebro River (province of Tarragona). Adult eel recreational fishing is only allowed with rods, except from the lagoons of the Delta, where there is a professional yellow and silver eel fishery.

BALEARIC ISLANDS: There is not any glass eel fishery in the Balearic Islands. Professional eel fishery (>40 cm) was allowed only in Mallorca and Menorca, but there has not been any licence in Menorca during the last two seasons. Fishermen fish using a conic pot called “gánguil”. In the Albuferas of Mallorca recreational fishery is allowed, but catches are very low. Nowadays, there are 1000 licences for River fishing and it is estimated that only from 10 to 20% of them are devoted to eel fishery.

2.3 Spanish EMPs

The Ministry of Environment, and Rural and Maritime Environment (MARM), responsible for fisheries and environmental issues, submitted the Spanish Eel Management Plan in December 2008. In May 2009 were submitted the clarifications and additional information required by the commission. Spanish EMP was revised in October 2009 by ICES, and the commission asked MARM to modify the Spanish EMP according to that evaluation. The revised version of the Spanish EMP was sent to the commission on June 2010, and was approved in October 2010. **Spain and Portugal made the Miño international River plan that was approved in May 2012** (all the plans are available at <http://www.magrama.gob.es/es/pesca/temas/planes-de-gestion-y-recuperacion-de-especies-pesqueras/planes-gestion-anguila-europea/>).

The Marine Secretary from MARM has coordinated the plan. *Anguilla anguilla* is a native species in Spain, whose population has undergone a significant decline in recent years as in the rest of Europe. The construction of large dams since the 1960s has led to its disappearance from most of the inland River basins of the Iberian Peninsula; eel were historically widespread throughout the Iberian Peninsula, but have lost over 80% of their original range, mainly due to river fragmentation by dams (Clavero and Hermoso, 2015; Figure 2). However, some punctual individuals can be found in the inner area due to restocking.

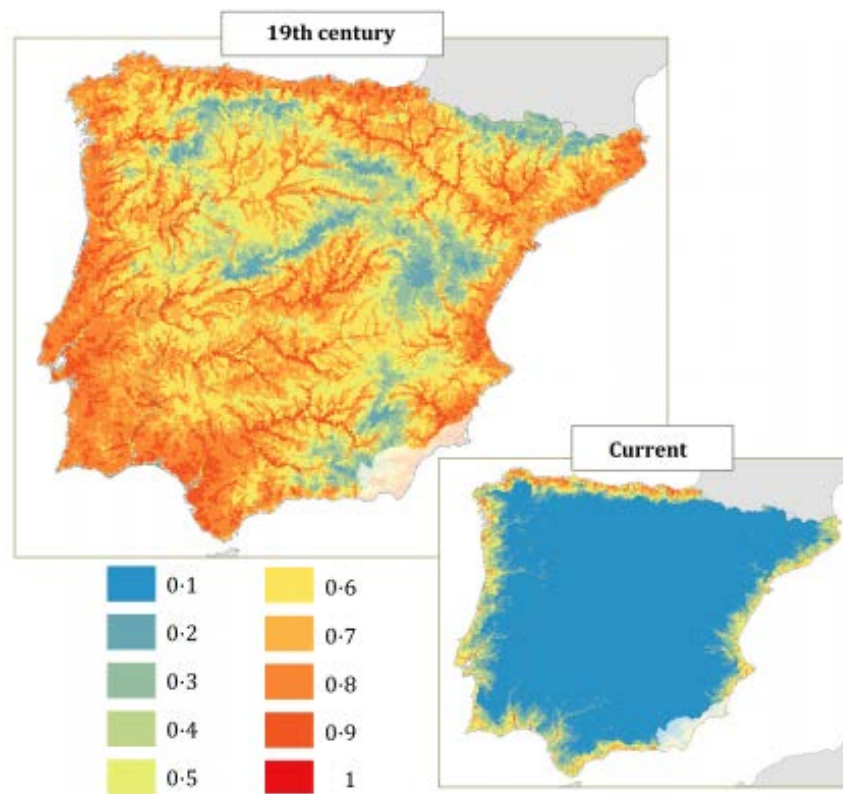


Figure 2. Probability of occurrence of the eel in the Iberian Peninsula in the 19th century and the present (Clavero and Hermoso, 2015).

Given Spain's national and regional structures, the Spanish management plan is based on a **National Eel Management Plan (EMP)** and **12 specific EMPs** (11 EMPs for the Autonomous Communities with eel populations that can complete their life cycle in these basins, and 1 EMP specific for the Ebro River Basin also with eel populations):

- 1) EMP of Galicia;
- 2) EMP of Asturias;
- 3) EMP of Cantabria;
- 4) EMP of Basque Country;
- 5) EMP of Navarra;
- 6) EMP of Catalonia;
- 7) EMP of the Ebro RBD (only Catalonia);
- 8) EMP of C. Valenciana;
- 9) EMP of Castilla La Mancha, only for the eels in the upper part of the Júcar and in coordination with C. Valenciana;
- 10) EMP of Murcia;
- 11) EMP of Balearic Islands;
- 12) EMP of Andalucía.

The National EMP defines the structure and methodology, the monitoring and evaluation measures and the objectives at national level. It also contains a summary of the

twelve specific EMPs. Each participating Autonomous Community, with exclusive competences on eel fisheries, has been defined as an **Eel Management Unit (EMU)** that shall undertake an Eel Management Plan, in accordance with Article 2(1) of Council Regulation (EC) 1100/2007. According to the Spanish EMP, the selection of the EMUs and of the areas that currently have natural occurrence of eel is based on the scientific data available. There are large differences between the monitoring and evaluation, available data and the capacity for action between the inner regions with no current eel populations and the coastal regions that still have them. Those autonomous regions where the eel disappeared many years ago and that have no data or criteria for action cannot put forward effective measures in the short term according to the Spanish EMP. However, a commitment at national level was adopted within the Sectorial Environmental Conference on 7th June 2010, between the Ministry of Environment, Rural and Marine Affairs (MARM) and the Regional Ministers of Environment of the Autonomous Communities, allowing for effective measures to take place in the medium term to deliver the 40% silver eel escapement target in the Spanish territory.

This should be achieved by a two phase rolling plan:

- **In the first phase (2010–2015)** the coastal autonomous communities that had data available and management measures prior to the drafting of the plan will implement their proposed measures. These measures are based on the best available estimates of the pristine and current situation of the European eel in Spain. They aim to achieve 40% escapement in their area of competence, within the overall aim of reaching the 40% national escapement target. In the inland River basins, a series of commitments and specific measures will be adopted at national level such as the elimination of barriers, habitat improvement, monitoring, study and assessment of the eel population and more accurate definition of pristine habitat in order to develop specific measures. In addition to that, working groups comprising representatives of all the public administrations involved in the eel management and scientific experts will be created. Estimates of the pristine and current situations of the European eel in Spain will be updated on that basis. At the end of this first phase, the new data will allow to reassess the stock situation and to launch the second phase from 2016 on, with specific regional measures to strengthen and improve the plan's objectives across the potential surface defined.
- **The second phase (2016–2050)** kicks off in 2016 and will coincide with the time-scale for reviewing the River Basin Management Plans as set out in the Water Framework Directive to take account of further measures needed to meet the Directive objectives. Therefore, it makes sense to review the EMPs in parallel.

This two-step approach will be carried out without prejudice of the periodic evaluation of the proposed measures in the EMPs, both at regional and national level.

The measures provided for in the National EMP and in the specific EMPs aim to ensure the protection and sustainable exploitation of European eel and to restore the escapement levels of eel at national level, by the year 2050. In those autonomous communities where fishing for eel <12 cm is authorized, the reserve percentages of glass eels for restocking provided for in Article 7 of the Regulation are also met. In general, there is a clear difference between the measures proposed by the regions of the north of the Peninsula, with their waters flowing to the Atlantic, and those of the

Mediterranean. The first ones propose the reduction of fishing effort by up to 50% compared to reference periods as the main measure to comply with the objectives of the regulation. The last ones mainly focus on restocking measures and maintaining the fishing management measures already set in their legislation. In certain cases, these last ones also propose measures to reduce fishing effort or to ban certain fisheries. As a general rule, stricter control and catch monitoring measures to control illegal fishing or poaching are proposed.

Finally, Spain presented a post-evaluation report in July 2012 as required by the Commission which includes the revision of the eel habitat area and the silver eel biomass estimations for some of the autonomous regions.

The following EMU codes will be used for each of the EMUs:

EMU	EMU CODE	ECOREGION
Basque Country	ES_Basq	South European Atlantic shelf
Navarra	ES_Nava	South European Atlantic shelf
Cantabria	ES_Cant	South European Atlantic shelf
Asturias	ES_Astu	South European Atlantic shelf
Galicia	ES_Gali	South European Atlantic shelf
Andalucia	ES_Anda	South European Atlantic shelf (Guadalquivir, Tinto, Odiel, Piedras, Guadalete, Barbate) Wester Mediterranean Sea(Almanzora, Andarax, Adra, Guadalfeo, Guaro, Guadalorce, Guadiaro, Guardarranque y Palmones)
Murcia	ES-Murc	Wester Mediterranean Sea
Castillas la Mancha	ES_Cast	Wester Mediterranean Sea
Valencia	ES_Vale	Wester Mediterranean Sea
Catalunya	ES_Cata	Wester Mediterranean Sea
Balearic Island	ES_Bale	Western Mediterranean Sea
Inner Bassins	ES_inner	Western Mediterranean Sea

3 Time-series data

3.1 Recruitment series and associated effort

3.1.1 Glass eel

3.1.1.1 Commercial

All the data in this section are obtained from auctions or fishermen guilds (Table 1). Highest landings of glass eel in Spain were obtained in late 1970s prior to the decline in early 1980s (Figure 3). There are four historical dataseries for glass eel catches in Spain which are updated yearly:

- San Juan de la Arena fish market in Asturias: It includes almost all the catches from the Nalón River. Since 1995, the administration of Asturias also compiles data from the rest of the fish markets in Asturias. Until the 1970s only land fishing existed, then fishermen started to fish in boats, and the catches increased notably.
- The Albufera in C. Valenciana. In the 1949–2000 period data were collected from fishermen guilds corresponding to three fishing points (Golas of Pujol, Perelló and Perellonet). From 2001 on, the administration of C. Valen-

ciana also compiles data from other fishing points in the Albufera, and the rest of C. Valenciana. To maintain the coherence of the dataseries, the Pujol, Perelló and Perrellonet data will be taken into account for the historical dataseries of the Albufera.

- The Delta del Ebro lagoons in Catalonia. Data are obtained from the fish markets in the area. Since 1998, the administration from Catalonia compiles data for the fish markets corresponding to the Ebro River mouth, obtaining total catches in the Ebro. Additionally, since 1998 it compiles information from the rest of Catalanian Rivers also.
- The Miño. As this RBD is shared with Portugal it includes data from both, Spain and Portugal. The Miño River command compiles the Spanish catch data.

Table 1. Glass eel professional catches in Spain (kg), 1949 to 2015. Updated and modified data are shown in bold.

	SAN JUAN DE LA ARENA	ES_ASTU *	PUCHOL, PERELLONET, PERELLÓ **	ALBUFERA	DELTA DEL EBRO LAGOONS	EBRO RBD ***	CATALUNYA INNER BASINS	MIÑO SPAIN	MIÑO PORTUGAL	MIÑO RBD
1949		9319								
1950		3828								
1951		2093								
1952										
1953	14529	2535								
1954	8318	5910								
1955	13576	906								
1956	16649	884								
1957	14351	2833								
1958	12911	402								
1959	13071	6637								
1960	17975	9453								
1961	13060	16731								
1962	17177	11088								
1963	11507	7997								
1964	16139	11000								
1965	20364	4000								
1966	11974	6000			4651					
1967	12977	5000			4937					
1968	20556	4000			8858					
1969	15628	4000			2524					
1970	18753	5000			2947					
1971	17032	1000			2022					
1972	11219	1000			1261					
1973	11056	1000			1129					
1974	24481	2000			1354					

1975	32611		1000		2466			1600	50	1650
1976	55514		6000		5626			5600	5000	10600
1977	37661		5000		-			12500	7500	20000
1978	59918				3400			21600	15000	36600
1979	37468				4177			17300	7000	24300
1980	42110				3514			15400	13000	28400
1981	34645				3800			13000	3000	16000
1982	26295		1309		2636			18000	32000	50000
1983	21837		640		2327			9700	6700	16400
1984	22541		2387		1815			14000	16000	30000
1985	12839		2980		1690			15300	14800	30100
1986	13544		402		301			6000	7000	13000
1987	23536		2845		2027			6539	9500	16039
1988	15211		4255		-			5600	2600	8200
1989	13574		2513		-			7359	3000	10359
1990	9216		1321		1108			3962	4500	8462
1991	7117		1079		897			5743	2500	8243
1992	10259		830		323			2835	4500	7335
1993	9673		355		799			4893	3600	8493
1994	9900		303		350			2068	2900	4968
1995	12500		199		190			4701	5300	10001
1996	5900	7751	271		409			6523	8700	15223
1997	3656	7329	366		847	3033		4283	4400	8683
1998	3273	6514	1348		939	3379		2878	4500	7378
1999	3815	7113	615		465	1983	346	3812	3600	7412
2000	1330	3058	323		112	3373	401	3812	3000	6812
2001	1285	2732	569		1383	7425	368	1519	1200	2719
2002	1569	3105	557	574	922	3315	77	1427	1100	2527
2003	1231	2770	390	411	1558	4571	357	1755	1443	3155
2004	506	1351	269	320	564	1504	285	1562	814	2362
2005	914	2875	230	237	298	1805	134	1331	1174	2623
2006	836	2175	203	208	557	1209	147	320	2736	3056
2007	615	2265	283	292	611	611	148	1140	905	2045
2008	871	2379	119	125	445	1170	79	1333	750	2083
2009	272	749	77	78	411	1511	0	1178	1350	2528
2010	1089	2612	125	125	501	1536	131	2000	576	2576
2011	1231	2055	151	179	419	1426	101	1311	947	2258
2012	612	1812	123	151	1158	1967	193	1037		1037
2013	1327	3511	112	140	1117	2477	107	813		813
2014	2086	5820	109	123	1470	3648	121	985		985
2015	1778	4452	73	98	1397	2449	209	1158		1158

* Includes San Juan de la Arena fish market.

** This corresponds to the time-series formerly known as "Albufera"; it includes catches from Pujol, Perellonet, Perelló, Rey, San Lorenzo and Vaca.

*** Includes lagoons and River mouth catches.



Figure 3. Glass eel catches (kg) time-series in Spain during the 1952–2015 period.

3.1.1.2 Recreational

In the Basque Country glass eel fishing is recreational. It is obligatory to fill in the Daily Catches report with data regarding catches and effort (Table 2). In Cantabria the recreational fishermen report their data to the local administration; but 2015 data are not available.

Table 2. Glass eel recreational in Spain (kg), 2004 to 2014. Updated and modified data are shown in bold.

	ES_BASQ	ES_CANT
2004	858	
2005	1181	
2006	1282	373.6
2007	687	651.8
2008	1205	358.3
2009	212	227.1
2010	614	206.9
2011	376	12.7
2012	1082	21.7
2013	1534	21.08
2014	2405	8.24
2015	2316	ND

3.1.1.3 Fishery-independent

No historical data are available. However, some experimental fishing is being carried out in the Guadalquivir (Sobrino *et al.*, 2005; Arribas *et al.*, 2012), Nalón and Oria Rivers. (Aranburu *et al.*, 2015).

3.1.2 Yellow eel recruitment

Upstream migration data have been collected since 2005 in a trap located in the tidal limit of the Oria River. Excluding 2008, when the trap did not work properly, 2009 data were the lowest value of the historical series, which could be related to the very low recruitment in that year. However, apparently, recruitment has been increasing from then on, reaching to one of the highest value in the time-series in 2011 (Figure 4). In 2012 the recruitment dropped again coinciding with a very dry summer. The trap did not work during 2013, and data are not available for 2014 and 2015.

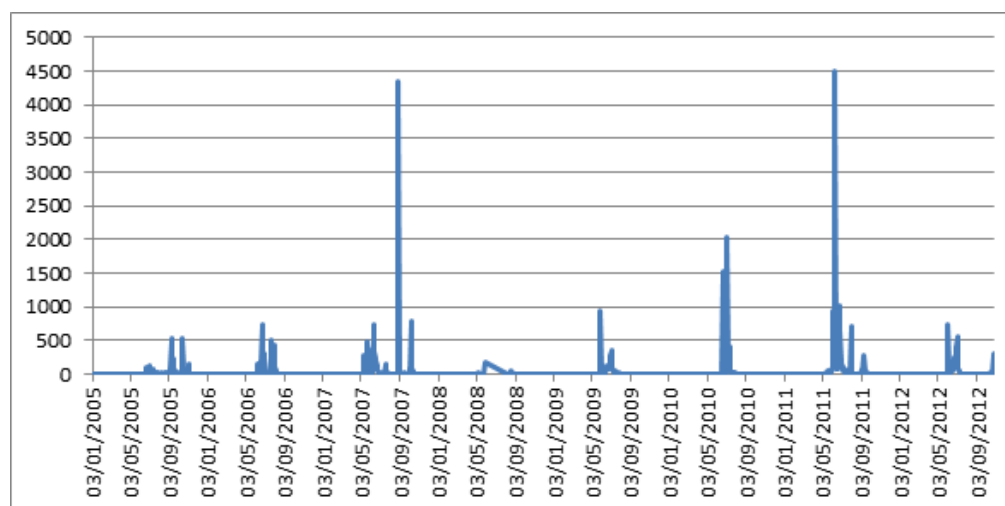


Figure 4. Number of eels collected in the Orbeldi trap (River Oria, Basque Country).

YEAR	2005	2006	2007	2008	2009	2010	2011	2012
Nº eels	2656	3868	8957	233	1823	3244	11466	3577

3.1.2.1 Commercial

Eel catches are only split up into yellow and silver in the Albufera and in the Mar Menor (Murcia).

3.1.2.2 Recreational

No data available.

3.1.2.3 Fishery-independent

All the autonomous regions carry out multispecific electrofishing samplings. However, data are not compiled at a national level.

3.2 Yellow eel landings

3.2.1 Commercial

Eel catches are only split up into yellow and silver in the Albufera and in Murcia (Table 3). Additionally, aggregated information exists for other RBDs (Table 4). The data sources are described in the introduction.

Table 3. Yellow eel catches (kg), 1951 to 2015. Updated and modified data are shown in bold.

	ALBUFERA	MAR MENOR
1951	30000	
1952	38000	
1953	30200	
1954	40400	
1955	30400	
1956	30260	
1957	40000	
1958	40000	
1959	40000	
1960	30000	
1961	30040	
1962	20200	
1963	22400	
1964	18000	
1965	12300	
1966	15000	
1967	59500	
1968	16000	
1969	11200	
1970	12600	
1971	11612	
1972	18300	
1973	12428	
1974	11210	
1975	6570	
1976	5300	
1977	4668	
1978		
1979		
1980		
1981	6848	
1982	9126	
1983	7697	
1984	3577	
1985	3464	
1986	2871	
1987	3611	
1988	2098	
1989		
1990	1843	
1991		

	ALBUFERA	MAR MENOR
1992	2330	
1993	2349	
1994	2155	
1995	2897	
1996	3105	
1997	2123	
1998	2563	
1999	2503	
2000	2047	
2001	1995	
2002	2126	
2003	2598	
2004	2138	
2005	1472	
2006	1479	
2007	1911	
2008	2245	
2009	4640	
2010	2029	
2011	1543	
2012	1634	
2013	1678	
2014	364	13 509
2015	ND	ND

Table 4. Yellow + silver eel catches (kg) per EMU, 1951 to 2015. Updated and modified data are shown in bold.

	ES_ASTU	ES_VALE*	ES_GALI	EBRO	MIÑO (SPAIN)	MAR MENOR	ES_BALE
1961						58497	
1962						24241	
1963						41453	
1964							
1965						54144	
1966						112518	
1967						84326	
1968						110001	
1969						79856	
197						76546	
1971						63358	
1972						75614	
1973						67170	
1974						68581	
1975					1600	60812	
1976					5600	69169	
1977					12500	63447	54
1978					21600	60734	63
1979					17300	90323	65
198					15400	83997	58
1981					13000	74089	45
1982					18000		39
1983					9700		43
1984					14000		
1985					15300		
1986					6000		
1987					6539		514
1988					5600		289
1989					7359		394
199					3962		4853
1991					5743	45150	3631
1992					2835	44014	3666
1993					4893	56718	361
1994					2068	43003	2457
1995					4701	61027	2417
1996					6523	49663	4738
1997			17639		4283	32285	578
1998		121	3789		2878	30150	1993
1999		174	4297	16522	3812	18512	221

	ES_ASTU	ES_VALE*	ES_GALI	EBRO	MIÑO (SPAIN)	MAR MENOR	ES_BALE
2000		5	15794	17921	3812	16002	69
2001		868	5544	35317	1519	35489	3756
2002		817	39700	2695	1427	30402	442
2003		191	31336	18626	1755	32671	3838
2004		141	35373	169	1562	22225	225
2005		1922	3175	1380	1331	32682	2159
2006	653	137	63114	1737	320	25631	267
2007	225	1165	2829	22640	1140	22789	638
2008	159	2953	32766		1333	20314	2138
2009	142	3779	4552			25631	1993
2010	1168	494	28497	12016		22789	933
2011	248	471	31984	1900		18662	339
2012	635	4232	36140	17600		19473	96
2013	450	3220	46030	6630		24490	70
2014	130	2778	38797	6473		33537	48
2015	ND	ND	28240	ND		ND	ND

* Albufera is not included.

3.2.2 Recreational

No data available.

3.2.3 Fishery-independent

No data available.

3.3 Silver eel landings

3.3.1 Commercial

The data from the Albufera and the Mar Menor are detailed in Table 5. The source of the data is the same as described above for glass eel catches in Albufera (Table 5).

Table 5. Silver eel catches (kg), 1951 to 2014. Updated and modified data are shown in bold.

	ALBUFERA	MAR MENOR
1951	60000	
1952	64200	
1953	50000	
1954	57300	
1955	72500	
1956	75860	
1957	40000	
1958	75000	
1959	60000	
1960	68000	
1961	65300	
1962	70500	
1963	73000	
1964	73500	
1965	64000	
1966	64000	
1967	20000	
1968	49600	
1969	45300	
1970	30250	
1971	32400	
1972	25500	
1973	20600	
1974	13612	
1975	10620	
1976	8260	
1977	6352	
1978		
1979		
1980		
1981	12269	
1982	6845	
1983	6397	
1984	7395	
1985	11013	
1986	9243	
1987	11228	
1988	7698	
1989		
1990	2000	
1991		
1992	3000	
1993	3000	

	ALBUFERA	MAR MENOR
1994	2000	
1995	1600	
1996	2960	
1997	2784	
1998	3100	
1999	2400	
2000	1537	
2001	1284	
2002	1432	
2003	4042	
2004	5591	
2005	4045	
2006	3632	
2007	4276	
2008	4910	
2009	6942	
2010	3688	
2011	2497	
2012	3822	
2013	3598	
2014	2293	20028
2015	ND	ND

3.3.2 Recreational

Yellow and silver eel recreational fishery is only allowed in Valencia and the Balearic islands, but historical data do not exist in these regions.

3.3.3 Fishery-independent

No data available.

3.4 Aquaculture production

In 2006 there were 19 eel farms in Spain:

- four of them were located in continental waters:
 - Two in Valencia: one of them ("C. Valenciana de Acuicultura") produces yearly around 300 tons of eels and is the main eel producer in Spain. The other one ("Puchades") can produce 150 tons of eels per year.
 - One in Andalucia, in the Guadalquivir River.
 - One in the Basque Country with capacity to produce 60 tons; but closed in 2011.
- 15 in brackish waters from Andalucia.

There was a fish farm in the Ebro Delta (Cataluña) that produced around 60 tons of eels per year but closed.

Additionally, in the Basque Country, in Aginaga (Oria River basin), there are six companies dedicated to the commercialization of glass eels.

3.4.1 Seed supply

The fish farms from C. Valenciana buy glass eel mainly to the Ebro Delta, Guadalquivir, Galicia, Asturias fishermen and to a lesser extent to UK and Morocco.

The companies from the Basque Country have hatcheries in Asturias, C. Valenciana, Catalonia and the Atlantic coast of France to maintain the glass eels they buy from local fishermen until they are transported to the hatcheries in Aginaga.

There are no quantitative data available.

3.4.2 Production

The production in Spain is stabilized in around 400 tons, which are mainly locally commercialized (Table 6).

Table 6. Aquaculture commercial production (Tons) in Spain per autonomous region until 2013 (source: Spanish Ministry of Agriculture, Food and Environment, <http://www.magrama.gob.es/es/pesca/temas/acuicultura/produccion-de-acuicultura/>).

	ES_BASQ	ES_CATA	ES_VALE	ES_ANDA	TOTAL
1998	0	0.70	200.1	146.7	347.5
1999	0	0.30	200.09	182.9	383.29
2000	0	3.70	275.48	131.5	410.68
2001	0	0.00	238.07	100.9	338.97
2002	0	0.00	260.38	34.54	294.92
2003	0	0.00	260.25	31.37	291.62
2004	0	0.00	316.69	60.01	376.7
2005	0	0.00	300.5	20.43	320.93
2006	0	0.00	185.65	89.17	274.82
2007	80	0.00	261.44	27.7	369.14
2008	65.00	0.00	369.73	25.07	459.8
2009	80.00	0.00	399.15	13.38	492.53
2010	31.45	0.00	348	12.23	391.68
2011	19.19	0.00	437.810	7.18	468.6
2012	0	0	371.86	0.86	372.72
2013	0	0	311.330	0	393.29
2014	0	0	384.63	11.2	395.83

3.5 Stocking

In Spain different restocking experiences have been carried out (Table 9):

- In Navarra stocking is carried out in the Ebro River but only as a measure of artificial maintenance of the presence of eel in the Rivers.
- Since 1988, C. Valenciana fishermen from the Albufera and from the Bul-lent and Molinell Rivers must give a percentage of their glass eels catches for restocking. These glass eels are raised in the public Centre for the Production and Experimentation of Warm Water Fishes until they reach a

weight of 8–10.g. Fattened eels are released up in the River waters and wetlands of C. Valenciana and other autonomous regions. The EMP of C. Valenciana contains a detailed stocking plan.

- In Asturias, the Head Office of Fishery purchased 6 kg and 8 kg of glass eel that were released in Sella and Nalón Rivers in 2010 and 2011 respectively. The price per glass eel kg was 531.8 € in 2010 and 577.8 € in 2011. No stocking has been performed during 2012–2015.
- In Catalonia Inner River Basins and the Ebro RBD, different stocking experiences have been carried out since 1996. During the 1998–2007 period, fishermen gave 5% of their seasonal glass eel catches approximately for restocking in the Fluvia, Muga, Ter and Ebro Rivers; restocked eels had an average weight between 0.15 and 0.33 g. During the 2005–2006 and 2006–2007 seasons, a pilot study was carried out by the government of Cataluña and the IRTA (Institut de Reserca i Tecnologia Agroalimentàries). Eel fishermen provided 38 276 eels with an average weight between 0.65–0.70 g. The initial biomass was 25.7 kg, and after fattening, the biomass was 1617 kg. So biomass increased in 1591.8 kg, and glass eel-yellow eel survival rate in the farm was 71.4%. This work has continued during the 2008–2009 and 2009–2010 seasons, and a total of 1300 of these individuals have been used in 2011 for restocking in the Ter River. All these individuals have been tagged for future monitoring experiences. The results of this pilot study will be used in the following years aiming to increase the success rate of the restocking operations.
- In Cantabria a 40% of the total glass eel landings of the 2010–2011 fishing season were used for restocking. Some of the catches were kept alive in tanks by the Council and stocked weekly along the fishing period in different River basins depending on the source of landings. The rest of glass eels were cultured and stocked in different stages of their life cycle, aiming to assess the efficiency of each of the methods. No data available for 2012–2014.
- In the Basque Country, a new pilot study started in the Oria River in 2011. In a first phase, 2400 young eels trapped in the Orbeldi trap (in Usurbil, Gipuzkoa) were translocated up to the Ursuaran River (in Idiazabal, Gipuzkoa). Both Rivers belong to the same River basin (Oria River basin). During 2012, and within the same project, 2.8 kg of glass eels from the fishery were stocked directly in the Oria River and another amount was kept for fattening in an eel farm; 1.7 kg of ongrown glass eel was stocked after. In 2013 6250 glass eels from the fishery in the Urola River were stocked directly upstream. During summer 2011, 2012, 2013 and 2014 different electric fishing operations have been carried out aiming to monitor the restocked individuals.

Table 7. Amount of eels stocked during 2008–2014 period. Updated and modified data are shown in bold.

	REGION	ORIGIN	NUMBER	WEIGHT (KG)	MEAN WEIGHT (G)	MEAN SIZE (MM)
2008	ES_Astu	On-grown cultured		14.82		200
	ES_Nava	On-grown cultured		101	8	
	ES_Astu	On-grown cultured		50		200
		On-grown cultured		50		150
2009	ES_Nava	On-grown cultured		102	10	
	ES_Cata	Wild eel-fishery		380	359	400–600
	ES_Vale	On-grown cultured	19 843	318	16	
2010	ES_Nava	On-grown cultured		90	7	
	ES_Vale	On-grown cultured	4577	141	30.8	
2011	ES_Astu	On-grown cultured		15		150
		On-grown cultured		9.5		150
	ES_Cant	Wild glass eel-fishery		4.9		
	ES_Nava	On-grown cultured		88	7	
		Wild eel-fishery		273	210	200–500
	ES_Cata	Wild eel-fishery		630	210	200–500
		Wild bootlace-fishery		30	4.7	120–150
		Wild bootlace-fishery		14	4.7	150–190
	ES_Vale	On-grown cultured	16 394	180	11.006	
		On-grown cultured		12		120
2012	ES_Andal	On-grown cultured		5.7		<120
		Forfeited		131		1000
	ES_Cant	Wild glass eel-fishery		12.35		
	ES_Basq	Wild glass eel-fishery	9333.33	2.8	0.3	70.3
		On-grown cultured	4722.22	1.7	0.36	6.7
		Forfeited		41		60–90
		Forfeited		16		60–90
		Forfeited		24		60–90
		Forfeited		24		60–90
		Forfeited		33		60–90
2012	ES_Cata	Forfeited		114		60–90
		Forfeited		114		60–90
		Forfeited		114		60–90
		Forfeited		33		60–90
		Forfeited		16		60–90
		Wild bootlace-fishery		72	2.9	60–140
		Wild glass eel-fishery		80	632	340–740
	ES_Vale	On-grown cultured	147 099	101	2.62	100–200
	Andalucía-Guadalquivir river	Quarantined Glass eel	28 540	53.3	1.91	112

	REGION	ORIGIN	NUMBER	WEIGHT (KG)	MEAN WEIGHT (G)	MEAN SIZE (MM)
	Andalucía-Palmones river-1st set	Quarantined Glass eel	2757	5.9	2.14	109
	Andalucía-Palmones river-2nd set	Quarantined Glass eel	1691	7.04	4.14	137
2013	Valencia	On-grown cultured	96 883	77.25	5.22	80–200
	ES_Basq	Wild glass eel-fishery	6250	2	0.32	69
2014	Valencia	On-grown cultured	16706	42.01	7.04	80–200

Catch of eel <12 cm and proportion retained for restocking.

Only the number of glass eels for restocking inside Spain is known, the destination of the rest of the catch is unknown (Table 8).

Table 8. Destine of the cached glass eels per EMU. NC: Not compiled.

	PRE-EMP					2011					2014				
	Catches (kg)	Stocking (kg)	Human consumption (kg)	for consumption (kg)	Catches (kg)	Stocking (kg)	Human consumption (kg)	for consumption (kg)	Catches (kg)	Stocking (kg)	Human consumption (kg)	for consumption (kg)	Catches (kg)	Stocking (kg)	Human consumption (kg)
ES_Basq	1090	0	1090	0	376	0	376	0	2406	0	2406	0			
ES_Cant	NC	NC	NC	NC	58	5	NC	NC	540	0	NC	NC			
ES_Astu	2273	NC	NC	NC	2067	NC	NC	NC	5820	NC	5820	NC			
ES_Andal	NC	0	NC	NC	4	4	NC	NC	38	38	NC	NC			
ES_Vale	257	45	NC	NC	262	55	NC	NC	185	46	NC	NC			
ES_Cata	1238	NC	NC	NC	1426	NC	NC	NC	3648	NC	NC	NC			

Recreational fishery

3.5.1 Reconstructed time-series on stocking

The time-series of stocked eels has been reconstructed converting all the stocked eels into glass eel equivalents (the equivalent number of naturally immigrating glass eels, related to the year that the naturally immigrated eels of the same size as the restocked eels did immigrate) (Table 9). All the eels are from a local source. The data for the period 2009–2014 have been changed according to the estimations of the Spanish EMP post-evaluation report (2015).

Table 9. Stocking of cultured and wild eel in Spain since 1984. Updated and modified data are shown in bold.

LOCAL SOURCE				
Year	Wild	On grown Cultured		Total (n)*
	Glass eels (n)	Elvers (n)*	Yellow-silver (n)*	
1984		19730		19730
1985		1444		1444
1986		0		0
1987		54136		54136
1988		66670		66670
1989		31866		31866
1990		68510		68510
1991		69160		69160
1992		201447		201447
1993		145944		145944
1994		259299		259299
1995		133165		133165
1996	66290	172478		238768
1997	74934	103920		178854
1998	95527	53197		148724
1999	161006	111755		272761
2000	0	104265		104265
2001	12750	187718		200468
2002	0	99999	2857	102856
2003	0	198406		198406
2004	35769	143938	373	180080
2005	0	2117		2117
2006	0	25028	8212	33239
2007	0	103432		103432
2008	0	36142		36142
2009	0	131082		131082
2010	0	45879		45879
2011	17748	90350		108098
2012	1283133	189101		1472234
2013	6250	160455		166705
2014	0	159545		159545

3.6 Trade in eel

Information from the customs department from the Spanish Tax Agency has been compiled in Tables 10–19. For 2015, only the January–August period is included.

Table 10. Living eels (<12 cm) export quantities (kg) and value per destination country in Spain.Source: <http://estacom.icex.es/estacom/desglose.html>

	2012		2013		2014		2015*	
Country	kg	Euros	kg	Euros	kg	Euros	kg	Euros
DE	280	168 000	0	0	0	0	0	0
DK	0	0	584	209 969	273	38 220	0	0
GB	145	3048	104	2212	154	2294	3593	1519
HU	0	0	35	20 250	20	6000	32	8000
IT	129	77 805	100	35 004	188	48 887	0	0
NL	2096	1 061 945	1365	443 062	0	0	0	0
PT	0	0	63	2111	0	0	0	0
PO	0	0	1860	972 800	622	202 194	0	0

*January–August period.

Table 11. Living eels (<12 cm) import quantities (kg) and value per origin country in Spain.Source: <http://estacom.icex.es/estacom/desglose.html>

	2012		2013		2014		2015*	
Country	kg	Euros	kg	Euros	kg	Euros	kg	Euros
FR	7948	1 949 142	10 677	2 665 722	7629	1 804 763	7185	2 188 243
IT	206	44 000	0	0	0	0	420	1575
NL	0	0	8	213	15	511	1070	3250
PT	115	46 066	128	32167	479	93 377	1887	103 562
GB	0	0	27	8025	500	35 000	87	6960

*January–August period.

Table 12. Living eels (all sizes) export and import quantities (kg) per destination country in Spain.Source: <http://estacom.icex.es/estacom/desglose.html>

	2011		2012		2013		2014		2015*	
Country	kg	Euros	kg	Euros	kg	Euros	kg	Euros	kg	Euros
China-Hong Kong	1840	376 000	0	0	0	0	0	0	0	0
DE	0	0	280	168 000	0	0	0	0	0	0
DK	0	0	0	0	584	209 970	273	38 220	0	0
FR	300	1500	0	0	0	0	0	0	6	90
GB	0	0	145	3050	104	2210	154	2290	3593	1520
GR	0	0	658	377 870	0	0	1480	8350	0	0
HU	0	0	0	0	35	20 250	20	6000	32	8000
IT	86 232	1 150 690	1098	96 590	376	39 980	679	62 490	0	0
NL	91 595	783 790	3733	1 079 950	2731	456 720	2124	16 990	5873	37 310
PT	58 586	596 780	30 709	311 910	29 133	293 650	40 540	355 790	19 501	192 740
RO	0	0	0	0	1860	972 800	622	202 190	0	0
Andorra	0	0	0	0	0	0	1	240	0	0

*January–August period.

Table 13. Living eels (all sizes) import quantities (kg) and value per origin country in Spain.
Source: <http://estacom.icex.es/estacom/desglose.html>

	2011		2012		2013		2014		2015*	
Country	kg	Euros	kg	Euros	kg	Euros	kg	Euros	kg	Euros
DE	0	0	3481	18	0	0	0	0	0	0
FR	2692550	13971	2014340	25696	2682194	12957	1820049	10692	2189874	7305
GB	0	0	0	0	38905	123	35000	500	6960	87
GR	0	0	54460	3900	303039	26700	144976	14550	120283	14350
IE	0	0	7	3	0	0	0	0	0	0
IT	0	0	44000	206	0	0	0	0	3778	695
NL	329484	35847	144763	13610	168067	23915	144814	11707	11653	2657
PT	253853	4849	83091	844	32167	128	93377	479	148970	5082

*January–August period.

Table 14. Fresh eel export and import quantities (kg) per destination country in Spain. **Source:**
<http://estacom.icex.es/estacom/desglose.html>

	2011	
Country	kg	Euros
FR	19	49
GB	582	14 827
GR	177	76 116
NL	550	243 020
PT	102 633	412 841

Table 15. Fresh eels import quantities (kg) and value per origin country in Spain. Source:
<http://estacom.icex.es/estacom/desglose.htm>.

2011			
Country	kg	Euros	
DK	22 466	111 790	
FR	75 791	1 053 682	
GB	62 282	134 648	
IT	36 979	233 437	
NL	40	8799	
PT	12 833	78 997	

Table 16. Frozen eel export and import quantities (kg) per destination country in Spain. Source:
<http://estacom.icex.es/estacom/desglose.html>

	2012		2013		2014		2015*	
Country	kg	Euros	kg	Euros	kg	Euros	kg	Euros
USA	0	0	0	0	0	0	2	428
China-Hong Kong	0	0	24 000	93 500	0	0	0	0
GR	0	0	0	0	0	0	20	6901
PT	740	1816	29	109	25	95	40	152
NL	59	710	0	0	0	0	400	2260

Table 17. Frozen eels import quantities (kg) and value per origin country in Spain. Source:
<http://estacom.icex.es/estacom/desglose.html>

2012			2013		2014		2015*	
Country	kg	Euros	kg	Euros	kg	Euros	kg	Euros
Cuba	1828	4266	0	0	0	0	0	0
México	315	10 292	0	0	0	0	0	0
Panamá	7	259	0	0	0	0	7	361
China	0	0	43	466	0	0	24	314
DE	0	0	2067	41 741	2511	41 569	0	0
DK	5005	106 377	4545	97 216	3281	75 412	207	6277
FR	0	0	24 000	96 192	0	0	0	0
GB	459	34 857	5183	579 221	740	46 568	3033	917 813
IE	0	0	48	4770	0	0	0	0
NL	308	387	424	584	281	405	0	0
PT	8231	13 328	1528	40 226	1834	28 189	8139	172 160

Table 18. Smoked eel export and import quantities (kg) per destination country in Spain. Source: <http://estacom.icex.es/estacom/desglose.html>

	2012		2013		2014		2015*	
Country	kg	Euros	kg	Euros	kg	Euros	kg	Euros
Marruecos	300	3420	0	0	0	0	0	0
PT	3	44	0	0	0	0	0	0
Andorra	0	0	0	0	0	0	2	80

Table 19. Smoked eel import quantities (kg) and value per origin country in Spain. Source: <http://estacom.icex.es/estacom/desglose.html>

	2012		2013		2014		2015*	
Country	kg	Euros	kg	Euros	kg	Euros	kg	Euros
FR	0	0	0	0	690	320 900	50	2 2000
IT	0	0	35	186	0	0	0	0
DE	0	0	6	150	0	0	0	0
NL	0	0	505	42 380	0	0	9	199
PT	0	0	0	0	0	0	0	0

4 Fishing capacity

4.1 Glass eel

The available information is shown in Table 20.

Table 20. Number of glass eel fishing licences or boats per EMU. Updated and modified data are shown in bold.

		RECREATIONAL				COMMERCIAL			
		ES_Basq	ES_Cant	ES_Astu	ES_Vale	Ebro	ES_Cata	ES_Cant	Miño
2010–2011	Boat	47		43					
	Land	349	35	183	89		10		160
2011–2012	Boat	45		37				5	
	Land	363	64	169	89				169
2012–2013	Boat	45		37		45		37	
	Land	354		160	89	354		160	154
2013–2014	Boat	43		33					
	Land	354		158	89	305	19		
2014–2015	Boat	42		38					
	Land	937		160	89	297	20		

4.2 Yellow eel

The available information is shown in Table 13.

Table 21. Number of yellow and silver eel fishing licenses per EMU. Updated and modified data are shown in bold.

YEAR	ES_GALI*	ES_ASTU "	ES-MURC ^	ES_VALE "	ES_BALE "
		2	45	4	76
2006–2007		2	39	4	53
2007–2008	104	2	42	4	45
2008–2009	105	1	47	4	41
2009–2010	107	1	38	4	32
2010–2011	107	1	40	4	39
2011–2012	107	1	46	4	
2012–2013	107	1	40	4	
2013–2014	107	1	43	4	
2014–2015	107	1			

Number of * tackles, "licences, ^boats and "posts.

4.3 Silver eel

See Section 4.2 above.

4.4 Marine fishery

This is not a target fishery.

5 Fishing effort

Not all the EMUs record effort data, and the ones recording it have their own data collection system (see introduction).

5.1 Glass eel

The available information is shown in Table 22.

Table 22. Number of hours (Basque Country and Catalonia) or days (Asturias and C. Valenciana) dedicated to glass eels fishing since 2005–2006 fishing season. Updated and modified data are shown in bold.

		RECREATIONAL	COMMERCIAL		
		ES_Basq*	ES_Astu ^	Albufera ^	ES_Cata *
	Boat	1271	963		
	Land	4227	2547	134	
2011–2012	Boat	3016,1	931		
	Land	5938,1	3501	123	770 700
2012–2013	Boat	2162	927		
	Land	8062	3936	155	
2013–2014	Boat	2162	805		
	Land	8062	3695	87	
2014–2015	Boat	3317	909		
	Land	14 904	3941	76	

*Hours.

^Days.

5.2 Yellow eel

Data for yellow and silver eel fishing in Marjal Pego-Oliva (C. Valenciana, Jucar RBD) is given in Table 23. This season's data from the Ría del Eo (Asturias) and Mar menor are available.

Table 23. Number yellow and silver eel fishing days in Marjal Pego-Oliva (ES_Vale), Ría del Eo (Es_Astu) and Mar Menor (ES_Murcia) during the 1998–2015 period. Updated and modified data are shown in bold.

SEASON	MARJAL PEGO–OLIVA	RÍA DEL EO	MAR MENOR
1998	53		
1999	55		
2000	23		
2001	26		
2002	42		
2003	73		
2004	33		
2005	39		
2006	44		
2007	46		
2008	82		
2009	57		
2010	34		
2011	47		
2012	50		
2013	26		
2014	33	20	124
2015	53		

5.3 Silver eel

See Section 5.2 above.

5.4 Marine fishery

There are no data available; however, this is not a target fishery, and the eel catches are accidental.

6 Catches and landings

Each EMU has its own data collection system (see introduction).

6.1 Glass eel

The available information is shown in Table 16.

Table 24. Glass eel catches (kg) in Spain since 2005–2006 season. Updated and modified data are shown in bold.

		ES_CANT	ES_BASQ	ES_ASTU	ES_VALE TOTAL	ES_CATA
	Boat		555	993		
	Land	398	666	1182		1356
	Boat		321	706		
2006–2007	Land	663	452	1559	341	148
	Boat		475	1054		
2007–2008	Land	382	683	1325	157	79
	Boat		54	213		
2008–2009	Land	241	142	536	117	87
	Boat		252			
2009–2010	Land	228	362	2612	167	1667
	Boat		128			
2010–2011	Land	58	248	2054	276	1528
	Boat			628		
2011–2012	Land	63	324	744	193	2241
2012–2013	Boat		497	1203		
	Land	45	1037	1639	223	2584
2013–2014	Boat		1037			
	Land	529	497		185	3769
2014–2015	Boat		848			
	Land	357	1470		137	2658

7 Glass eel prices

Glass eel prices recorded in fishermen guilds since 2008 are reported in Table 25, and since 1998 in Figure 5.

Table 25. Average annual glass eel prices (€) in Spanish fishermen's guilds since 2009.

	ES_ASTU	ES_CATA	ES_VALE	AVERAGE
pre-PGA	428	312	505	415
2009	410	347	362	373
2010	398	324	351	358
2011	370	349	411	377
2012	434	254	363	350
2013	324	218	271	271
2014	254	222	257	244

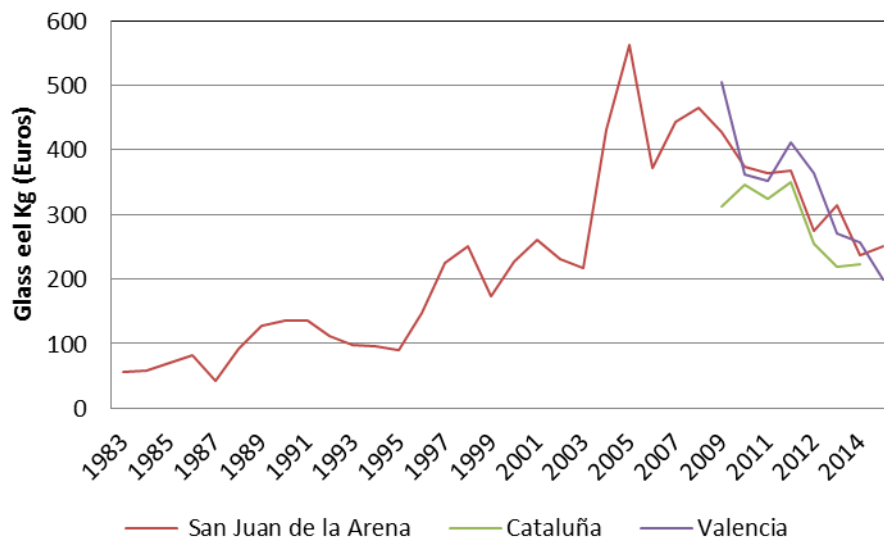


Figure 5. Glass eel price trends (€) in different Spanish regions.

7.1 Yellow eel

Only catches from the Albufera and Mar Menor (2013–2014 season) are split into yellow and silver (see Table 4).

7.2 Silver eel

Only catches from the Albufera and Mar Menor (2013–2014 season) are split into yellow and silver (see Table 5).

7.3 Marine fishery

This is not a target fishery.

7.4 Recreational fishery

There is a recreational glass eel fishery in the Basque Country and Cantabria (see Table 2) and a yellow and silver recreational fishery in Valencia, Catalunya and Balearic Island; but the catches are not recorded.

7.5 Bycatch, underreporting, illegal activities

Two papers have been published in Spain regarding the bycatch produced by glass eel fishery. Sobrino *et al.* (2005) stated that glass eel fishery negatively affected nursery function of the estuary: fishing is performed with 1 mm mesh size nets, and produces an average of 10–20 kg of juvenile bycatch, that could reach 90 kg when glass eel entrance is advanced to October or delayed to April/May.

Gisbert and Lopez (2008) revealed that glass eel fishery had a negative impact on bycatch ichthyofauna mainly composed of mugilid fry and small-size estuarine species of the Ebro delta. Data showed that between 10 and 69% of incidental species died as a consequence of glass eel capture and sorting procedures.

There has been a glass eel seizure in 2014. The SEPRONA (the environmental division of the Spanish police) has been in charge. The glass eels coming from Andalucía were sent to Lisboa by trucks, and then they were sent to China from Lisbon airport.

Although the exact number of glass eels is unknown (“hundreds”) the value of the seizure has been estimated in 500 000 euros.

(<http://www.guardiacivil.es/es/prensa/noticias/4975.html>)

8 Catch per unit of effort

8.1 Glass eel

The available information is shown in Tables 28 and 29.

Table 26. Glass eel cpues in Spain since the 2005–2006 fishing season. Updated and modified data are shown in bold.

		ES_CANT PROFESSIONAL *	ES_CANT RECREATIONAL *	ES_BASQA [^]	ASTURIAS NALÓN *	ES_ASTU *	VALENCIA ALBUFERA *	EBRO*	CATALUÑA INNER BASSIMS*
	Boat			0.429	0.750				
	Land			0.588	0.720		1.63		
	Boat			0.344	0.740				
2006–2007	Land			0.409	0.730		3.11		
	Boat			0.147	1.180				
2007–2008	Land			0.090	0.880		0.59		
	Boat			0.052	0.360				
2008–2009	Land			0.034	0.460		0.56		
	Boat			0.115	0.360				
2009–2010	Land			0.062	0.460		1.19		
	Boat			0.085	0.840				
2010–2011	Land			0.055	0.600		1.39		
	Boat		0.210	0.193	0.670	0.670			
2011–2012	Land	0.400		0.068	0.230	0.210	1.17		
2012–2013	Boat			0.204	1.270	1.270			
	Land			0.112	0.650	0.450	1.02		
2013–2014	Boat			0.234	2.050	2.050			
	Land			0.128	1.290	0.730	1.38	0.182	0.049
2014–2015	Boat			0.242	1.400	1.400			
	Land			0.081	1.010	0.635			

* kg/fykenet/day.

[^] kg/hour.

Table 27. Temporal trends in glass eel cpue (kg per fishing day) in the Albufera from C. Valenciana (includes Pujol, Perello and Perellonet fishing points). Updated and modified data are shown in bold.

YEAR	CPUE
1982	18.44
1984	14.83
1985	17.32
1987	17.89
1988	21.17
1989	12.76
1990	7.69
1993	4.23
1994	3.26
1995	2.31
1996	3.57
1997	3.42
1999	4.16
2000	1.9
2001	3.18
2002	7.43
2003	2.75
2004	1.75
2005	1.66
2006	1.63
2007	3.11
2008	0.59
2009	0.56
2010	1.19
2011	1.39
2012	1.17
2013	1.02
2014	1.38

8.2 Yellow eel

The available information is shown in Table 28.

Table 28. Catches of yellow and silver eel per day of fishing in Marjal Pego-Oliva (ES_Vale), Ría del Eo (Es_Astu) and Mar Menor (ES_Murcia) during the 1998–2015 period. Updated and modified data are shown in bold.

	MARJAL PEGO-OLIVA (VALENCIA)				RÍA DEL EO (ASTURIAS)			MAR MENOR (MURCIA)		
	Catches (Kg)	Fishing Days	kg/fishing day	kg/fishing day/fishing place	Catches (Kg)	Fishing Days	kg/fishing day	Catches (Kg)	Fishing Days	kg/fishing day
1998	1201	53	22.7	7.6						
1999	1074	55	19.5	6.5						
2000	500	23	21.7	7.2						
2001	868	26	33.4	11.1						
2002	817	42	19.5	6.5						
2003	1910	73	26.2	8.7						
2004	1041	33	31.5	10.5						
2005	1922	39	49.3	16.4						
2006	1370	44	31.1	10.4	653					
2007	1165	46	25.3	8.4	225					
2008	1413	82	17.2	5.7	159					
2009	1079	57	18.9	6.3	142					
2010	1375	34	40.4	13.5	1168					
2011	1369	47	29.1	9.7	248					
2012	995	50	19.9	6.6	635	60	10.58			
2013	619	26	23.8	7.9	450					
2014	566	33	17.2	5.7	130	35	3.71	33537	124	270.4
2015	374	53	7,1	2,4						

8.3 Silver eel

See Section 7.2 above.

8.4 Marine fishery

This is not a target fishery.

9 Other anthropogenic impacts

Major impacts are described in the Spanish EMP but quantitative data are not available in general terms.

There is a theoretical study in the Basque Country based on mortality rates per turbine type from bibliography and silver eel population estimates (Díaz *et al.*, 2012; https://www6.euskadi.net/u81-0003/es/contenidos/informe_estudio/2013_recuperando_anguila/es_docu/adjuntos/4.OBJETIVOC.pdf). The cumulative mortality among eels passing through the turbines is between 51.9 and 81.0% in the Oria River. In another study in the Basque Country (EKOLUR S.L.L 2012) the impact of a hydropower station in the Silver eel from the Urola was determined. Preliminary results showed that less than 10% of silver eel passed through the bypass channel.

There are two studies assessing the effectiveness of fish passages: Aparicio *et al.* (2012) used a combination of video recording, electrofishing and trapping to assess the effectiveness of the fishway in facilitating the passage of fish at the most downstream barrier of the Ebro River (NE Iberian Peninsula). Ordeix *et al.* (2011) aimed to test the functionality of fish passages to enhance these structures for optimizing their management. They analysed river connectivity and fish pass facilities in Catalan rivers according to international best practices.

There is no information regarding how the environment in ES_EMU has changed in the last 50 years that might have influenced eel production.

10 Scientific surveys of the stock

There is not any national eel specific survey program in Spain; but almost all the autonomous regions have multispecific electrofishing surveys. Additionally, some of the autonomous regions have eel specific monitoring programs. In the Basque Country, for example, glass and yellow eel recruitment and potential silver eel escapement are monitored in a yearly basis in the Oria River. There are some experimental fishing of glass eel in the Guadalquivir, Ter and Nalon Rivers. Some other punctual studies have been done by Spanish researches; however collaborative studies to exchange knowledge and methodologies are lacking. Some autonomous regions had promoted punctual studies too, but these data are not gathered at a national level. However, the autonomous regions envisaged making silvering eel specific surveys in their management plans.

10.1 Recruitment surveys, glass eel

Glass eel recruitment in the Oria River is sampled in a yearly basis (Diaz *et al.*, 2012). The results of these surveys have been partially published in Aranburu *et al.*, 2015.

During 2011–2012 and 2012–2013 fishing seasons, Asturias performed monthly experimental fishing in order to analyse the recruitment and it is planned to continue in the following years. Also, in the southernmost European estuary, the Guadalquivir glass eel recruitment was studied during nine successive migration seasons (June 1997–December 2006) using a fishery-independent experimental survey at three sampling sites in the estuary (Arribas *et al.*, 2012).

10.2 Stock surveys, yellow eel

All the autonomous regions make periodic multispecific electrofishing surveys for the WFD, but until now, none of them has been directed exclusively to eel. There is not any agreed protocol for sampling, and there is not any compilation of this information at the national level. Some of the autonomous regions envisaged making eel specific surveys in their management plans.

Yellow eel recruitment in the Oria River is sampled in a yearly basis in a fish pass in the tidal limit (see 3.1.2.).

10.3 Silver eel

The Basque management plan, determines the spawning potential according to Durif *et al.* (2003; 2005) in the different basins every five years. Results are available in the post-evaluation report. Additionally, in another study (EKOLUR S.L.L 2012) silver eel migration period and related environmental variables were studied in the Urola river (Basque Country). The silver eel migrated between October and January, with a peak

in November, and mainly during night and when there is high flow and turbidity. Valencia started to measure silvering in a yearly basin since 2012.

Total density of eels and the size and number of male silver eels were quantified between 1990–2011 at 15 sites spread along four Rio Esva tributaries (Asturias, north-western Spain) (Iglesias and Lobón, 2012).

Some of the autonomous regions envisaged making silvering eel specific surveys in their management plans.

11 Catch composition by age and length

No data available.

Until 2009, the eel was not included in Spanish DCF and since that year only glass eel catches from the Basque Country (recreational) were reported. Some of the autonomous regions have measured age and length punctually, but not in the DCF framework.

12 Life history and other biological information

Biological parameters are not sampled routinely in the autonomous regions, although the autonomous regions envisaged sampling them in their management plans.

12.1 Growth, silvering and mortality

The available information is shown in Tables 29 to 32.

Tabla 4. Parámetros biológicos de crecimiento y mortalidad estimados para la anguila para el mar Menor en el presente estudio. Año 2009. (Donde: L_{∞} , k , t_0 : parámetros de la ecuación de von Bertalanffy; y M : mortalidad natural).				
Especie	L_{∞}	k	t_0	M
Anguila	120	0,05	-1.39	0.119

Table 30. Length-at-age in Cadiz Bay and Guadalquivir wetlands (Es_Anda) and in the Mar Menor (Es_Murc).

SL (mm)			
Age	Cadiz Bay*	Guadalquivir wetlands**	Mar Menor***
0			
1	26.3	13.5	
2	35.1	28.7	
3	41.8	38.5	40.7
4	48.6	44.3	46
5	63.3	50.4	50
6	69	54.1	53
7	85.3		55
8			60
9	96		64
10			68

* Arias y Drake, 1985.

** Fernández-Delgado *et al.*, 1989.

*** Martínez Baños, 2010.

Table 31. Length–weight relationships in some Spanish EMUs.

EMU CODE	YEAR	LENGTH–WEIGHT	R
ES_Basq	2002–2005	$W = 0.0093L^{2.533}$	0.899
ES_Vale	1998–2002	$W = 0.0024L^{2.915}$	0.924
ES_Vale	2009–2014	$W = 0.0102L^{2.539}$	0.921
ES_Cata			
ES_Bale	2001	$W = 0.001L^{3.14}$	0.974

Table 32. Length–weight relationships in some Spanish EMUs.

	YEAR	% SILVER EELS	% FEMALE	SL SILVER FEMALE (mm)	SL SILVER MALE (mm)
ES_Basq	2012		31.0	628.9	376.3
ES_Basq	2013		40.9	630.2	371.0
ES_Basq	2014		33.3	537.6	367.4
ES_Vale	2012	21.9	80.6	675.0	340.0
ES_Vale	2013	17.1	40.3	618.2	399.3
ES_Vale	2014	40.0	55.6	635.0	346.3

12.2 Parasites and pathogens

There is new information regarding the presence of some parasites in the Mar Menor (Mayo *et al.*, 2014) (Table 33).

Table 33. Presence of parasites in the eels from the Mar Menor during 2010 (N:189, average size 52.8) (Source, Mayo *et al.*, 2014).

	PREVALENCE (%)	INFECTION INTENSITY	ABUNDANCE (N)
Trematode: <i>Deropristis inflata</i>	67	101	68
Trematode: <i>Bucephalus anguillae</i>	60	39	23
Nematode: <i>Contracaecum</i> sp	46	8	4
Cestodes: <i>Proteocephalidae</i> larvae	2	0.01	1

12.3 Contaminants

There is no new data or is available (see Spanish CR 2011).

12.4 Predators

In Catalunya fishing competitions have been made to remove fish species like bull-head, perch, pikeperch and black bass. Potential predators like American mink (*Neovision vison*) are controlled by trap in Catalunya. The cormorant (*Phalacrocorax carbo*) and heron (*Ardea cinerea*) populations are monitored and controlled, although predation on eel is practically non-existent.

A recent study in Andalucía showed that the impact of cormorants on eel population is not significant.

13 Other sampling

No data available.

14 Stock assessment

There is not stock assessment in Spain at a national level. Each autonomous region has assessed the stock for the management plan in a different way. The management plan of each autonomous region has its own objectives, methodology and structure.

In Spain, each autonomous government is in charge of the control, regulation and management of eel fishery and population. Thus population assessment is made at the autonomous region level, and the methodology data requirement and monitoring methods depend on the autonomy. Almost all the autonomies compile eel fishery data; but each autonomous region has its own methodology to compile data. AZTI-Tecnalia made the first data compilation for eel in Spain for the WGEEL report (2006). After, another two compilations of data were made for the EMP and for the post-evaluation of the EMP (2012 and 2015). But all these four, were data compilations since there is not any study or sampling program at the national level to compile eel information in a coordinated way (fishery data, biological information, etc.).

Similarly, there are some research projects going on in Spain, but there is not any that includes researchers from different regions. Finally, most of the autonomies made electric fishing surveys in the WFD framework; but only a few make eel specific electrofishing surveys.

In this way, the objectives of the different EMUs depend [on the region](#); therefore, some of the regions have focused mainly in restocking (mainly in the Mediterranean) and others in fishery or environmental measures.

14.1 Method summary

Regarding the assessment of the current eel population in the post evaluation report there is a great variability among EMUs. There have been three different situations:

- 1) **Total lack of data in the EMU:** those EMUs have applied reference area production values from bibliography or from similar nearby habitats.
- 2) **EMUs with electrofishing surveys:** those EMUs have their own production values from certain areas, and they have extrapolated these values to areas of similar habitats where no information was available.
- 3) **EMUs with fishery data and surveys:** They have calculated productivity based on these data.

As pristine production is concern, some EMUs have used reference values, and others have applied a conversion factor to current production. To calculate the equivalents, a six year generation time was considered; thus, the catches of glass and yellow eel, from six and three years ago and current silver eel catches were used. Also, 80% mortality in glass eel settlement and annual mortality of 0.138 were considered. (Dekker, 2000).

The Spanish EMP includes a series of calculations to define the pristine habitat and escapement. As the exact definition of the pristine habitat was unknown and due to the lack of complete sets of data or harmonized methods to estimate escapement levels, a series of general criteria were assumed, based on the data available in each region and on scientific literature consulted. These calculations had already been improved and reported in the 2012 post evaluation report and for some EMUs they have been reviewed again in the 2015 report.

The criterion generally adopted for the definition of the **pristine habitat** was to consider the natural habitat of eel as the watercourses from the river mouth to a height of 800 m in basins with little slopes and to 600 m in those of greater slopes, assuming that there were no natural obstacles in levels below these heights. For the internal basins (without EMP in the 1st phase, see Section 2.3), data on surface water layer has been used with a series of technical criteria provided by the Hydrographic Confederations. The autonomous communities with EMP in the 1st phase have defined a more detailed estimate of their habitat, which may mean that the inland habitat area is underestimated compared with the coastal one. The **current habitat** was quantified as the previous one, but only taking into account the habitat before the first artificial impassable obstacle.

Table 34. Approaches used by the Spanish autonomies to determine the 3Bs.

	B ₀	B _{CURRENT}	B _{BEST}
ES_Basq	Area production rate (20 kg /ha)	Extrapolation of area production rate (surveys)	
ES_Nava	Area production rate (20 kg /ha)	Extrapolation of area production rate (surveys)	
ES_Cant	Apply a conversion factor to B _{current}	Extrapolation of area production rate (surveys)	
ES_Astu	Apply a conversion factor to B _{current}	Extrapolation of area production rate (surveys)	
ES_Gali	Surveys	Surveys	
ES_Anda	Area production rate (20 kg /ha)	Extrapolation of area production rate (surveys)	B _{current} + A
ES-Murc	Apply a conversion factor to B _{current}	Based on fishery data and surveys (Martinez Baños, 2010)	
ES_Cast	Area production rate (20 kg /ha)	No current production	
ES_Vale	Area production rate (20 kg /ha)	Area production rate from Rhone	
ES_Cata	Area production rate (20 kg /ha)	Extrapolation of area production rate (surveys)	
ES_Bale	Apply a conversion factor to B _{current}	Based on fishery data and surveys (Cardona <i>et al.</i> , 2002)	
ES_inner	Area production rate (20 kg /ha)	No current production, inaccessible habitat	

In the initial version of the EMP (2010), an average pristine productivity of 20 kg/ha was assumed in the internal basins (without EMP in the 1st phase, see Section 2.3) in the inland water areas and 50 kg/ha in transitional waters (ICES, 2001). The autonomous communities with EMP in the 1st phase took a different approach, based on the information available that best matches their specific environmental and ecological conditions (Table 217). A more detailed explanation might be found in the EMP of each EMU. Some of the regions have improved their estimations in the 2015 post-evaluation report: they have obtained new current productivity values and they have calculated historic values applying a conversion factor (Tables 35 and 36).

14.2 Summary

14.2.1 Stock indicators

In this section the indicators as reported in the Spanish EMP post-evaluation report (2015) are compiled.

The pristine escapement estimations (Table 35) have been improved compared to the previous report; on the one hand, Asturias, Galicia and Murcia have improved their productivity estimations, and on the other hand, Galicia has recalculated the pristine area.

Table 35. Pristine escapement and wetted areas according to the Spanish EMP 2015 post-evaluation report.

	B₀ (KG)	WETTED AREA (HA)		
		Freshwater	Transitional/lagoons	Total
ES_Basq	245040	1434	2616	4050
ES_Nava	5448	272	0	272
ES_Cant	9680	1936	NC	1936
ES_Astu	63495	2437	1337	3774
ES_Gali	110700	2813	2722	5535
ES_Anda	5562526	25377	101100	126477
ES_Murc	21900	219	13500	13719
ES_Cast	23488	1174	0	1174
ES_Vale	698026	12499	5718	18217
ES_Cata	364607	7011	2884	9895
ES_Bale	330883	0	4253	4253
ES_inner	2420205	66868	0	66868
TOTAL	9855999	122040	134130	256170

Estimations of B_{curr} , both before and after EMP plan have been improved also (Table 36); more concretely Asturias, Galicia and Murcia have improved their productivity estimations, and on the other hand Andalusia has recalculated the pristine area. An increase in B_{curr} has been observed since the EMP was implemented; however, although there is a great variability among Spanish EMUs in B_{lim} , this indicator is still well above the 40% target limit when the whole Spanish area is considered (Table 35).

Table 36. Current escapement and wetted areas according to the Spanish EMP 2015 post-evaluation report.

Año	pre-EMP	B_{CURR} (KG)		WETTED AREA (HA)		
		2011	2014	Freshwater	Transitional/lagoons	Total
ES_Basq	12215	129164	126869	1375	2616	3991
ES_Nava	ND	2346	2142	231	NP	231
ES_Cant	6433	1976	1259	615	NC	615
ES_Astu	ND	12584	27492	1254	1337	2591
ES_Gali	15199	ND	24889	1826	2722	4548
ES_Andal	ND	ND	141479	11060	49706	60766
ES_Murc	7031	3382	13510	0	13500	13500
ES_Cast	0	0	0	0	NP	0
ES_Vale	385175	385175	385175	912	5718	6630
ES_Cata	168943	ND	ND	2683	2884	5567
ES_Bale	216540	220561	220561	0	4253	4253
ES_inner	0	0	0	0	0	0
TOTAL	811536	755188	943376	19956	82736	102692

Table 37. Temporal evolution of the B_{curr}/B₀ relation in the Spanish EMP 2015 post-evaluation report.

Año	B_{CURR}/B₀ (%)		
	pre-EMP	2011	2014
ES_Basq	5,0	52.7	51.8
ES_Nava	ND	43.1	39.3
ES_Cant	66.5	20.4	13.0
ES_Astu	ND	19.8	43.3
ES_Gali	13.7	ND	22.5
ES_Andal	ND	ND	2.5
ES_Murc	32.1	15.4	61.7
ES_Cast	0.0	0.0	0.0
ES_Vale	55.2	55.2	55.2
ES_Cata	46.3	ND	ND
ES_Bale	65.4	66.7	66.7
ES_inner	0.0	0.0	0.0
TOTAL	8.2	7.7	9.6

Among the main anthropogenic mortalities in Spain only fishery has been estimated for all the regions, and only Asturias and Galicia have estimated that corresponding to Hydropower. In this way, B_{best} is underestimated since it has been obtained adding the underestimated mortalities to B_{curr}.

Table 38. Temporal evolution of B_{best} relation in the Spanish EMP 2015 post-evaluation report.

Año	BBEST (KG)		
	pre-EMP	2011	2014
ES_Basq	12215	238398	239334
ES_Nava	ND	ND	ND
ES_Cant	6433	28063	36575
ES_Astu	ND	58247	43782
ES_Gali	52697	ND	52021
ES_Anda	ND	ND	334601
ES_Murc	46890	32770	47387
ES_Cast	ND	0	0
ES_Vale	408080	422688	406875
ES_Cata	620157	ND	ND
ES_Bale	219470	222662	220871
ES_inner	ND	0	0
TOTAL	1365946	1002828	1381446

Table 39. Summary of stock indicators, mortality rates and targets according to the Spanish EMP 2015 post-evaluation report.

	B_0	B_{CURR}	B_{BEST}	ΣF	ΣH	ΣA
ES_Basq	245040	126869	239334	0.635	ND	0.635
ES_Nava	5448	2142	ND	ND	ND	0.000
ES_Cant	9680	1259	36575	3.369	ND	3.369
ES_Astu	63495	27492	43782	0.464	0.001	0.465
ES_Gali	110700	24889	52021	0.718	0.019	0.737
ES_Anda	5562526	141479	334601	0.861	0.000	0.861
ES_Murc	21900	13510	47387	1.255	0.000	1.255
ES_Cast	23488	0	0	NP	NP	NP
ES_Vale	698026	385175	406875	0.055	0.000	0.055
ES_Cata	364607	ND	ND	ND	ND	ND
ES_Bale	330883	220561	220871	0.001	ND	0.001
ES_inner	2420205	0	0	NP	NP	NP
TOTAL	9855999	943376	1381446	0.475	0000	0.475

14.2.2 Habitat coverage

In Spain the lakes are very small and located at high altitudes; thus they have not been assessed. Coastal waters have not been assessed neither (see Tables 37 and 38).

14.2.3 Anthropogenic mortality

The available information is shown in Tables 40, 41 and 42.

Table 40. Catches (in SEE) and fishing mortality rates in professional fishery according to the Spanish EMP 2015 post-evaluation report.

	PRE-EMP		2011		2014	
	SEE (kg)	ΣF	SEE (kg)	ΣF	SEE (kg)	ΣF
ES_Basq	NP	NP	NP	NP	NP	NP
ES_Nava	NP	NP	NP	NP	NP	NP
ES_Cant	NC	ND	NC	ND	2234	0.2130
ES_Astu	61808	ND	46750	1.5508	16996	0.4810
ES-Gali	36691	1.2166	NC	ND	26427	0.7180
ES_Anda	210034	ND	145758	0.7082	172613	0.7975
ES-Murc	39863	1.8976	29388	2.2710	33877	1.2550
ES_Cast	NP	NP	NP	NP	NP	NP
ES_Vale	23023	0.0581	37347	0.0925	21580	0.0545
ES_Cata	451214	1.3004	146534	0.6250	153942	0.6480
ES_Bale	NP	NP	NP	NP	NP	NP
ES_inner	NP	NP	NP	NP	NP	NP
Total	822633	0.699	405777	0.409	426932	0.354

Table 41. Catches (in SEE) and fishing mortality rates in recreational fishery according to the Spanish EMP 2015 post-evaluation report.

	PRE-EMP		2011		2014	
	SEE (kg)	ΣF	SEE (kg)	ΣF	SEE (kg)	ΣF
ES_Basq	NC	ND	109234	0.6129	112465	0.6347
ES_Nava	NC	ND	NP	NP	NP	NP
ES_Cant	NC	ND	NC	ND	33081	3.1560
ES_Astu	NP	NP	NP	NP	NP	NP
ES-Gali	NC	ND	NP	NP	NP	NP
ES_Anda	NC	ND	NC	ND	NC	ND
ES-Murc	NP	NP	NP	NP	NP	NP
ES_Cast	NP	NP	NP	NP	NP	NP
ES_Vale	NC	ND	244	0.0006	218	0.0006
ES_Cata	NP	NP	NP	NP	NP	NP
ES_Bale	2930	0.0134	1968	0.0088	310	0.0014
ES_inner	NP	NP	NP	NP	NP	NP
Total	2930	0.002	111445	0.112	146074	0.121

Table 42. Non-fishery mortality indicators according to the Spanish EMP 2015 post-evaluation report.

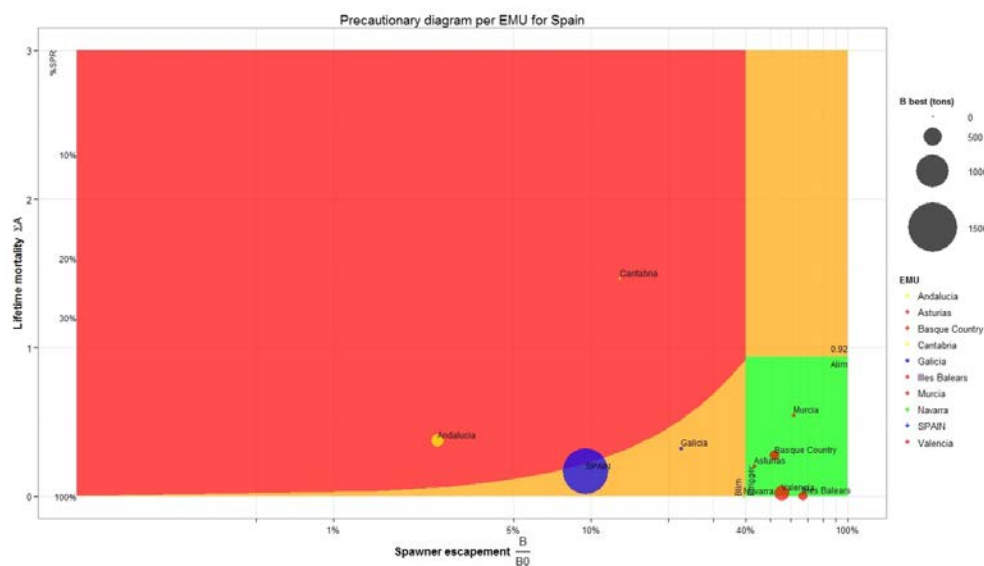
	ENTRAINMENT AND MORTALITY AT WATER INTAKES (INCLUDES HYDROPOWER FACILITIES)						HABITAT QUANTITY AND QUALITY INCREASE						STOCKING					
	SEE	ΣH'x'	SEE	ΣH'x'	SEE	ΣH'x'	SEE	ΣH'x'	SEE	ΣH'x'	SEE	ΣH'x'	SEE	ΣH'x'	SEE	ΣH'x'	SEE	ΣH'x'
	pre-EMP		2011		2014		pre-EMP		2011		2014		pre-EMP		2011		2014	
ES_Basq	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ES_Nava	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NP	NP	NP	NP	NP	NP
ES_Cant	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ES_Astu	ND	ND	ND	ND	31	0.0009	ND	ND	ND	ND	ND	ND	0	0.0000	0	0.0000	ND	ND
ES_Gali	807	0.0270	NC	NC	705	0.0192	ND	ND	ND	ND	0	0.0000	NP	NP	NP	NP	NP	NP
ES_Andal	ND	ND	ND	ND	ND	ND	0	0	0	0	0	0	0	0	0	0	3	0.0000
ES_Murc	0	0	0	0	0	0	NP	NP	NP	NP	NP	NP	0	0	0	0	0	0
ES_Cast	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
ES_Vale	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	118	-0.0003	78	-0.0002	97	-0.0003
ES_Cata	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ES_Bale	0	0	0	0	0	0	NP	NP	NP	NP	NP	NP	0	0	0	0	0	0
ES_inner	0	0	0	0	0	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOTAL	807	0.001	0	0.0000	736	0.001	0	0	0	0	0		118	-0.0001	78	-0.0005	100	-0.0001

Table 43. Mortality indicators according to the Spanish EMP 2015 post-evaluation report.

	ΣF			ΣH			ΣA		
	pre-EMP	2011	2014	pre-EMP	2011	2014	pre-EMP	2011	2014
ES_Basq	ND	0.613	0.635	ND	ND	ND	ND	0.613	0.635
ES_Nava	ND	ND	ND	ND	ND	ND	ND	ND	ND
ES_Cant	ND	ND	3.369	ND	ND	ND	ND	ND	3.369
ES_Astu	1.557	1.551	0.465	ND	ND	0.001	ND	1.551	0.465
ES_Gali	1.217	ND	0.718	0.027	ND	0.019	1.244	ND	0.737
ES_Anda	ND	ND	0.861	0.000	0.000	0.000	ND	ND	0.861
ES_Murc	1.897	2.270	1.255	0.000	0.000	0.000	1.898	2.271	1.255
ES_Cast	NP	NP	NP	NP	NP	NP	NP	NP	NP
ES_Vale	0.058	0.093	0.055	0.000	0.000	0.000	0.058	0.093	0.055
ES_Cata	1.300	ND	ND	ND	ND	ND	1.300	ND	ND
ES_Bale	0.013	0.009	0.001	ND	ND	ND	0.013	0.009	0.001
ES_inner	NP	NP	NP	NP	NP	NP	NP	NP	NP
TOTAL	0.702	0.522	0.475	0.001	0.000	0.001	0.702	0.522	0.475

14.2.4 Precautionary diagram

According to the post-evaluation report B_{current} escapement in Spain is 13% of the pristine one. However, eel population status varies greatly among the different EMUs (Figure 6), ranging from the 0% to the 61.7 of the target (see Table39).

**Figure 6. Modified Precautionary Diagram (ICES 2012).**

14.3 Summary data on glass eel

Table 44. Overview of glass eel data in Spain. Updated and modified data are shown in bold. NC: Not compiled. NR: Not recorded.

	PRE-EMP						2011						2014					
	Catches (kg)	Stocking (kg)	Human consumption (kg)	for consumption (kg)	Catches (kg)	Stocking (kg)	Human consumption (kg)	for consumption (kg)	Catches (kg)	Stocking (kg)	Human consumption (kg)	for consumption (kg)	Catches (kg)	Stocking (kg)	Human consumption (kg)	for consumption (kg)	Catches (kg)	Stocking (kg)
ES_Basq	1090	0	1090	0	376	0	376	0	2406	0	2406	0						
ES_Nava	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP						
ES_Cant	NC	NC	NC	NC	58	5	0	0	540	0	0	0						
ES_Astu	2273	6	2267	0	2067	8	2059	0	5820	0	5820	0						
ES-Gali	NC	NC	NC	NC	NP	NP	NP	NP	NP	NP	NP	NP						
ES_Anda	NC	0	NC	NC	4	4	NC	NC	38	38	NC	NC						
ES-Murc	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP						
ES_Cast	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP						
ES_Vale	257	45	NC	NC	262	55	NC	NC	185	46	NC	NC						
ES_Cata	1238	NC	NC	NC	1426	NC	NC	NC	3648	NC	NC	NC						
ES_Bale	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP						
ES_inner	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP						

15 Eel research in Spain in 2015

The following papers have been published during 2015:

- Aranburu A., Díaz E., Briand C. 2015. Glass eel recruitment and exploitation in a South European estuary (Oria, Bay of Biscay). ICES Journal of Marine Science; doi:10.1093/icesjms/fsv116.
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Vílchez M.C., Santangeli, S., Maradonna, F., Gioacchini, G., Verdenelli, C., Gallego V., Peñaranda D.S., Tveiten H., Pérez L., O. Carnevali, Asturiano J.F. 2015. Effect of the probiotic *Lactobacillus rhamnosus* on the expression of genes involved in European eel spermatogenesis. *Theriogenology*. 84: 1321–1331, 10.1016/j.theriogenology. (2015).07.011.

16 Overview, conclusions and recommendations

As mentioned above, in Spain, each autonomous government is in charge of the control, regulation and management of eel fishery and population. The only information that is compiled routinely corresponds to fishery. In addition to that, each autonomous region has its own methodology to compile fishery data. In this way, the assessment of the general eel status in Spain is a very complicated task. Apart from the present report and the management plan, there is not any global study or sampling program to compile information (fishery data, biological information, etc.) in Spain in order to give a national overview of eel situation. Similarly, there are some research projects going on in Spain, but there is not any that includes researchers from different regions.

All the above mentioned, makes a very complicated task to compile the data required in the report, and also, the one necessary to be able to make a proper assessment of the eel population

In this way, it is essential to compile eel data as required by the DCF. Additionally, the different autonomous regions should coordinate their data collection and management and research plans. Thus, it is recommended to **create a Spanish eel group**, including autonomic administrations, RBDs, and researchers. Also, in those RBDs that extend over different autonomous regions, the different local administrations should make an effort to coordinate their work in the basin, concerning both management and research.

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Report on the eel stock and fishery in Sweden 2014/2015

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Reporting Period: This report was completed in November 2015, and contains data up to 2014 and some provisional data for 2015.

Contributors to the report: NP

2 Introduction

2.1 Eel Management Units

Sweden consists of only one Eel Management Unit, covering almost the whole country except the mountainous region in the north and northwest where eels are rare or do not occur.

2.2 Ecoregions

Two ecoregions are concerned, namely the North Sea and the Baltic Sea. However, since the fishery for eels along the Swedish West Coast was closed in spring 2012, the North Sea ecoregion now refers to Öresund only. Öresund is the strait between Sweden and Denmark where most silver eels from all over the Baltic have to pass when leaving for the North Sea and the Atlantic Ocean.

2.3 Type of marine eel fisheries

In the Baltic there are two main types of eel fisheries. One is the traditional fishery with large fixed traps (poundnets) along the “Eel Coast”, where silver eels are the target species. The other type of fishery also uses big poundnets, but targets several species including cod, perch, pike, flounder, etc. depending on the site and abundance of different species.

2.4 Freshwater eel fisheries

Finally, there is an eel fishery also in a number (ca. 20) of inland lakes. Also this fishery is mainly done using poundnets and targets more species than eels. Pike perch is one of the most important species in this context and has become the main species in many fisheries.

3 Time-series data

3.1 Recruitment

3.1.1 Glass eel recruitment

3.1.1.1 Commercial

There is no fishery for glass eels in Sweden. The reasons are twofold as there has never been any interest for such small eels and the fact that high minimum legal sizes preclude fishing for glass eels.

3.1.1.2 Recreational

See above.

3.1.1.3 Fishery-independent

The abundance of glass eels (truly unpigmented) in the open sea (Kattegat and Skagerrak) are surveyed by trawling with either an Isaacs–Kidd Midwater trawl (IKMT) or with a modified Methot–Isaacs–Kidd Midwater trawl (MIKT). The former trawl is used in a fixed position in the intake canal for cooling water to the condensers at the Ringhals Nuclear Power Station (e.g. Westerberg, 1998 a & b). The latter method is used from RV Argos during ICES-International Young Fish Survey (Hagström and Wickström, 1990), (since 1993 part of the International Bottom Trawl Survey (IBTS Quarter 1). RV Argos is now scrapped and this survey is now run from Danish RV Dana. When the glass eels have settled they and larger eels can be monitored on soft and shallow bottoms using a “Drop Trap” technique (Westerberg *et al.*, 1993; ICES, 2009). This was successfully done during a number of years, and an attempt was made to restart similar series, extending over a considerable stretch of the West Coast. From all three methods recruitment-series could be compiled and two of them are shown below.

Recruitment of glass eel (truly unpigmented) to the Swedish West Coast is monitored at the intake of cooling water to the nuclear power plant at Ringhals in the Kattegat (Figure SE. 1 and Table SE. 1). The sampling at Ringhals is performed twice weekly in February–April, using a modified Isaacs–Kidd Midwater trawl (IKMT). The trawl is fixed in the current of incoming cooling water, fishing passively during entire nights. Sampling depends on the operation of the power plant and changes in the strength of the current may occur.

The arrival of the glass eels to the sampling site varies between years, probably as a consequence of hydrographical conditions, but the peak in abundance normally occurs in late March to early April. Abundance has decreased by 92% if the recent three years are compared to the peak in 1981–1983. The sampling depends on the operation of the power plant, i.e. the amount of seawater needed for cooling. In 2015 the seawater current at the sampling site was reduced to zero during the historical peak of the glass eel season from late March through April. Sampling was then moved to an alternative intake channel a few hundred meters SW along the same shoreline. For a short period sampling could be performed simultaneously at both sites, indicating reasonable performance at the new site. The annual glass eel index was adjusted for different levels of water current by multiplying by a factor 2 when only one out of the two reactors was operation at each site. Corrections like this were done in several years with similar situations. The true relationship between current and glass eel catchability is not known.

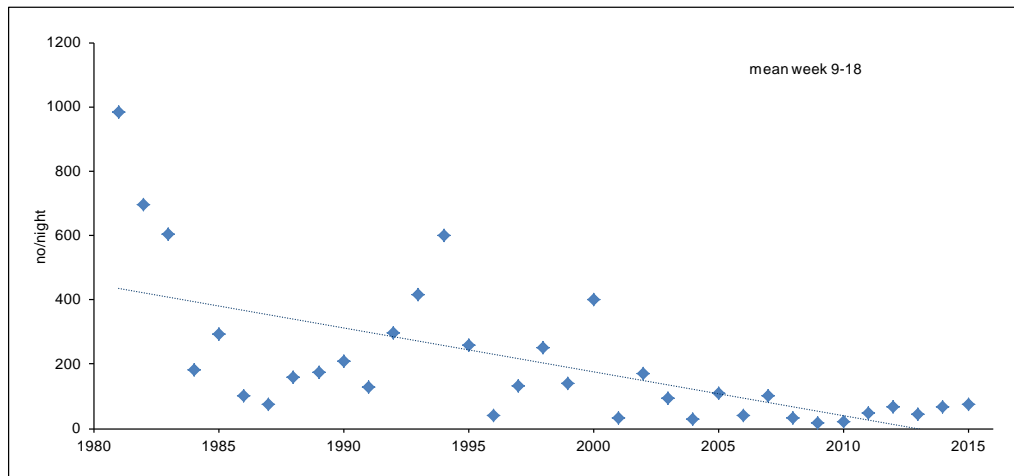


Figure SE. 1. Time-trend in glass eel recruitment at the Ringhals nuclear power plant on the Swedish Kattegat coast.

Table SE. 1. Annual indices of glass eel recruitment at the intake canal for cooling water to reactors 1 and 2 at the Ringhals nuclear power plant. Weekly means (n/night) of numbers of glass eels collected with a modified Isaacs–Kidd Midwater trawl during March and April (weeks 9–18). Data were corrected for variations in water flow. Historical values were corrected and updated in March 2013.

week no	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
3	3													1			
4								16			1				0		
5	7							8		14	15	17	30	5	4	0	0
6								26		25	13	53	45	7	10	0	1
7								6		21	9	80	331	4	39	0	21
8	22							33		54	3			8	46	11	3
9	187					3		34	322	174	3	151	55	3	157	0	64
10	199	23				2		76	351	127	15	444	118	7	211	4	319
11	250	123	497	166		3		18	122		83	346	130	575	314	13	207
12	378	896	600	272	13	17	4	15	101		40	442	535	377	537	24	25
13	2265	1186	250	115	129	1	0	68	274	237	104	530	495	1348	312	57	40
14	2093	1259	442	171	0	3	39	141	115	331	130	142	403	1165	590	32	73
15	1849		1103	212	828			133	568	63	268	390	281	540	1079	67	121
16			872		449			130	393	40	113	239	134	527	584	60	69
17	804		450	162	330		5	120			182	436	934	262	76	53	41
18	827					675	215				117	52					217
mean 9-18	983	697	602	183	291	101	75	159	173	208	130	296	415	600	258	41	131
1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	0																
	0	74	2	27	6		20	0	10					0		0	
3	0	142	0	86	5	1	12	2	42	8	1		0	0	4	2,5	26
9	8	193	3	154	2	2	57	3	4	27	0	0	1	0	1	7,5	45
	8	115	8	327	5	0	13	2	7	17	2	0	0	0	13	7	28
	58	344	5	117	5	1	15	6	11	10	3	1	1	12	8	17	50
	114	377	3	200	10	3	10	2	29	31	2	2	3	8	51	52,5	58
	68	533	22	366	44	3	39	1	81	114	3	4	4	94	17	40	71
270	149	214	24	530	53	18	161	13	382	38	15	9	34	299	15	140	136
397	2	479	16	59	185	35	153	17	186	30	36	4	37	89	17	102	113
422	296	942	22	185	192	65	161	55	101	43	37	34	62	27	109	129	16
	355	178	45	184	151	55	201	97	191	26	25	24	161	29	67	45	76
181	75	299	25	53	74	90	284	132	20	13	23	91	51	48	91	83	211
191	133	257	128	8	180	18	66	62	18	3	11	23	66	10	44	49	31
37				9	46	8	10	36	7	3	0	28			6	28	5
	250	139	402	32	171	94	29	110	42	102	31	15	22	47	68	42	69
																	76

From surveys at sea, glass eels are caught in fine-meshed trawls together with e.g. sprat and herring larvae. One earlier series based on the use of an IKMT was abandoned in 1989, but replaced by a MIKT series. Glass eels have always been a bycatch in these surveys and the catches are very low. Cpue from this latter series is given in glass eels caught per hour of oblique trawling. Each tow lasts for about 20 minutes (Figure SE. 2).

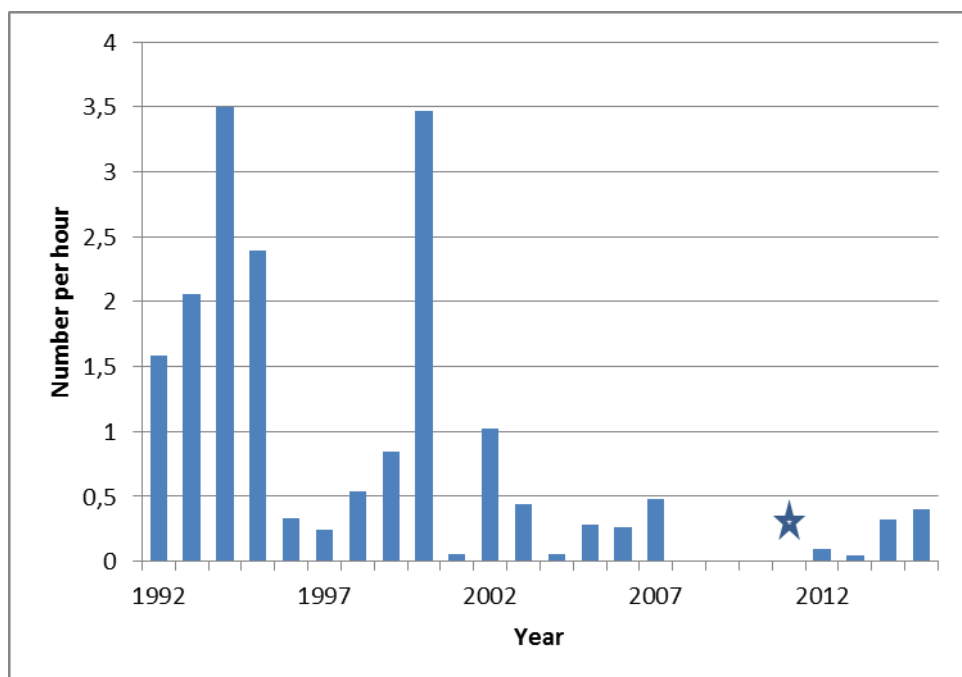


Figure SE. 2. Catch of glass eels by a modified Methot-Isaacs-Kidd Midwater trawl (MIKT) in the Skagerrak-Kattegat 1992–2015. Data expressed as total numbers per hour of haul. No glass eels were caught in 2008, 2009 and 2010. In 2011 there was no sampling due to technical problems.

3.1.2 Yellow eel recruitment

3.1.2.1 Commercial

NP, see above.

3.1.2.2 Recreational

NP, see above.

3.1.2.3 Fishery-independent

The recruitment of small yellow eels are since a long time monitored at a number of sites along the coasts of Sweden. The ascending eels are caught in eel passes connected to a storage box from where the catch is measured before being transported and released upstream. This procedure is often regulated in a judgement from the Water Rights Court. The dataserie are presented below standardised to a common mean. In River Viskan the recruits are dominated by young of the year (YOY) elvers, i.e. they arrived as glass eels to the neighbouring sea earlier the same year. Also in River Lagan the proportion of YOY is quite high, but in the remaining rivers, there are mixes of several age groups and sizes. In the northernmost rivers (still equipped with traps), Motala ström and Dalälven, ascending eels between 35 and 45 cm are common.

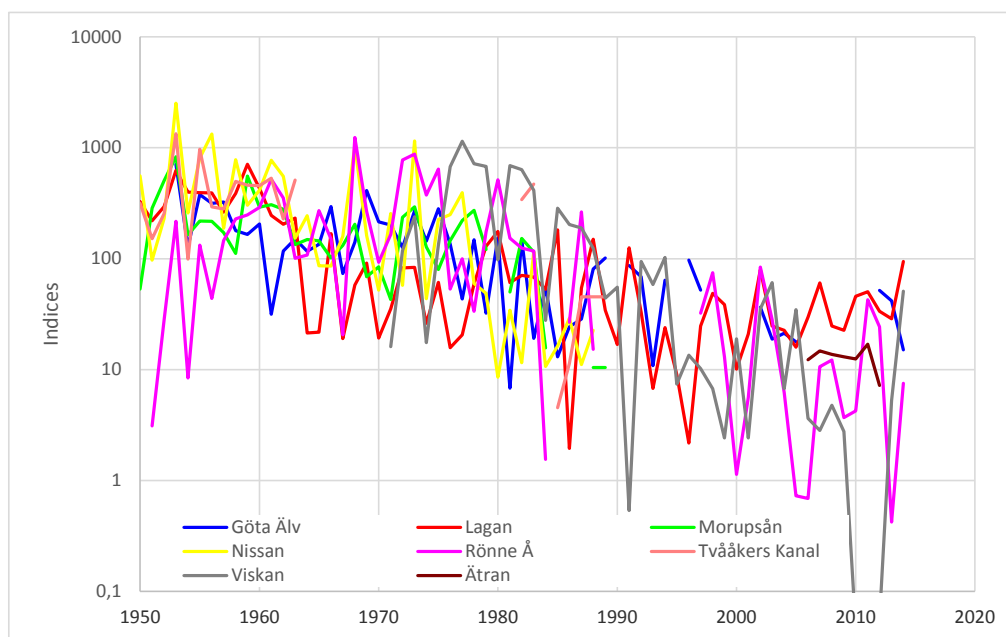


Figure SE. 3. Ascending young eels in eight rivers facing west (standardized data on a logarithmic scale).

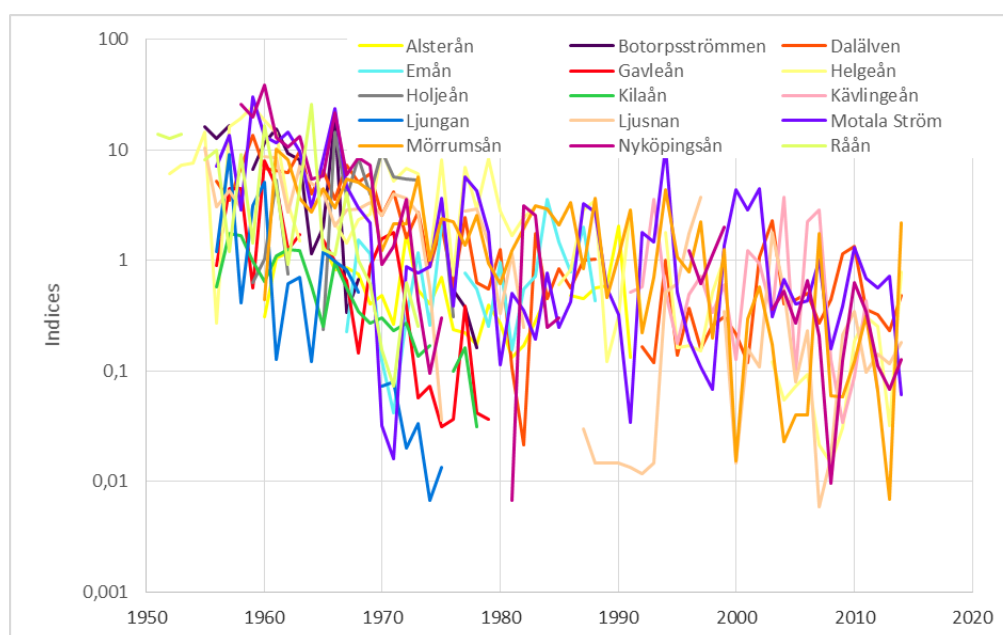


Figure SE. 4. Ascending young eels in 15 rivers facing east (standardized data on a logarithmic scale).

3.2 Yellow eel landings

3.2.1 Commercial

Most eel fisheries are today targeting silver eels, even if some large yellow eels (>700 mm) now and then are sold together with the silver ones. An earlier fishery, mainly targeting yellow eels along the Swedish West Coast was closed in spring 2012.

3.2.2 Recreational

Recreational fishing for eels is normally not allowed. Besides, the high minimum legal size (in most cases 700 mm) precludes most fisheries for yellow eels.

3.3 Silver eel landings

3.3.1 Commercial

See above.

3.3.2 Recreational

Recreational fishery for eel is generally not allowed (with few exceptions). There is still a small fishery using a traditional, coghill-like fishing gear ("lana") in some upstream sites, but their catch is not known. Their fishing rights often refer to time-honoured rights.

3.4 Aquaculture production

3.4.1 Seed supply

In 2015, 672 kg of glass eels were purchased from River Severn in the UK.

3.4.2 Production

Of the 672 kg glass eels:

	KG	NUMBER
Restocking Sweden	544.3	1 832 524
Restocking Finland	30.3	102 000
Farming in Sweden	77,2	259 931
Mortality	20,2	68 051

The production for consumption purposes in 2014 was 64 tons.

3.5 Stocking

3.5.1 Amount stocked

In 2015 the glass eels originated from the Severn Eel Management Unit in the UK.

Eels are stocked in nature after 8–10 weeks in quarantine at aquaculture conditions. They are then about one gramme each when stocked.

	kg	number
Restocking in Sweden	544.3 kg (as glass eels)	1 832 524 individuals
Restocking in Finland	30.3 kg (as glass eels)	102 000 individuals

3.5.1.1 Stocked in Sweden

YEAR	NOS OF 1 GR EELS (PRE-GROWN)		
	Freshwater	Coast	Sum
2013	1 985 984	671 600	2 657 584
2014	2 054 432	898 611	2 953 043
2015	944 474	888 050	1 832 524

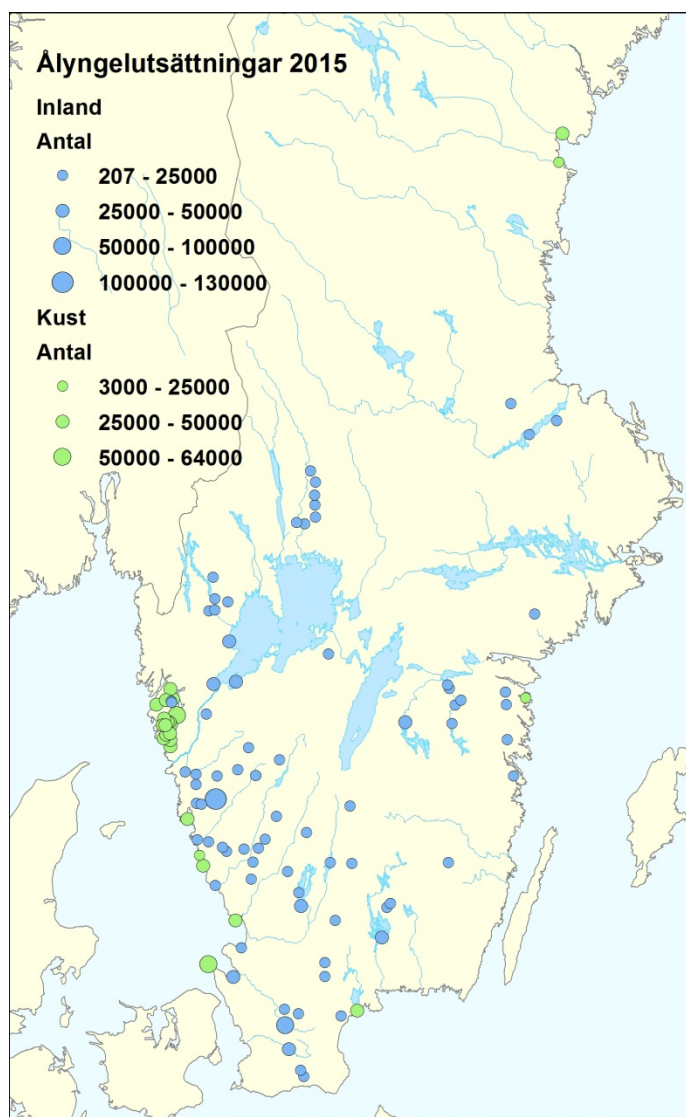


Figure SE. 5. Distribution of stocked eels in 2015.

3.5.2 Catch of eel <12 cm and proportion retained for restocking

NP.

3.5.3 Reconstructed time-series on stocking

Table SE. 2. Stocking of cultured and wild eel in country since 1984 (*after ca. ten weeks in quarantine the eels are ca 1 g each).

Year	LOCAL SOURCE					FOREIGN SOURCE				
	Glass eel (n)	Quarantined Glass (n)	Wild Yellow (n)	On-grown cultured (n)	Total	Glass eel (n)	Quarantined* Glass (n)	Wild Yellow (n)	On-grown cultured (n)	Total GEE (n)
2013							2 657 584			2 898 116
2014							2 953 043			3 220 316
2015							1 832 524			1 998 382

3.6 Trade in eel

Sweden are “exporting” and “importing” eels to a number of countries within the EU. Data are given in tons and Euros, respectively.

Table SE. 3. Quantities of exported and imported eels in tons.

EXPORT	BELGIUM	DENMARK	ESTONIA	THE NETHERLANDS	POLAND	GERMANY	FRANCE	LATVIA	FINLAND	SUM
2014	2	17	14	3	10	84	3	3	1	138
2013	2	13	9	17	1	88	1	0	1	132
Import										
2014	0	5	0	1	0	3	1	0	0	10
2013	1	4	0	13	0	5	0	0	0	23

Table SE. 4. Values of export and import in Euro.

EXPORT	BELGIUM	DENMARK	ESTONIA	THE NETHERLANDS	POLAND	GERMANY	FRANCE	LATVIA	FINLAND	SUM
2014	17 076	179 463	124 260	35 119	101 707	1 148 736	32 005	26 098	35 656	1 700 121
2013	15 895	170 227	120 716	141 337	10 955	1 262 579	16 002	0	56 814	1 794 525
Import										
2014	0	62 721	0	18 043	0	106 540	859	0	0	188 163
2013	7 303	62 399	0	150 143	0	155 191	20 513	0	0	395 549

4 Fishing capacity

4.1 Glass eel

NP.

4.2 Yellow eel

NP as most eels caught are silver eels or close to that stage.

4.3 Silver eel

Today's system only allows fisherman with a special “eel permit” to fish for eels. This is the present rule in freshwater as well as in the sea. In short, fishermen who do not

use their permit for a year or so, will not have their permit prolonged. The permits are personal and cannot be transferred to other persons or companies. Neither is it allowed to increase the gear effort initially applied for, nor to exceed the number of fishing days or the maximum catch of 8 tons per fisherman.

The numbers of permits are given below, separated in freshwater and marine fishers. However, it is not known if the full allowed effort is actually utilized.

Table SE. 5. Number of “eel permits” issued by the responsible agency.

YEAR	TOTAL	COASTAL	COASTAL & FRESHWATER	FRESHWATER
2007	434	NA	NA	NA
2008	408	336	3	69
2009	389	317	2	70
2010	389	317	2	70
2011	365	289	3	73
2012	251	180	2	69
2013	251	180	2	69
2014	236	169	2	65
2015	223	159	1	63

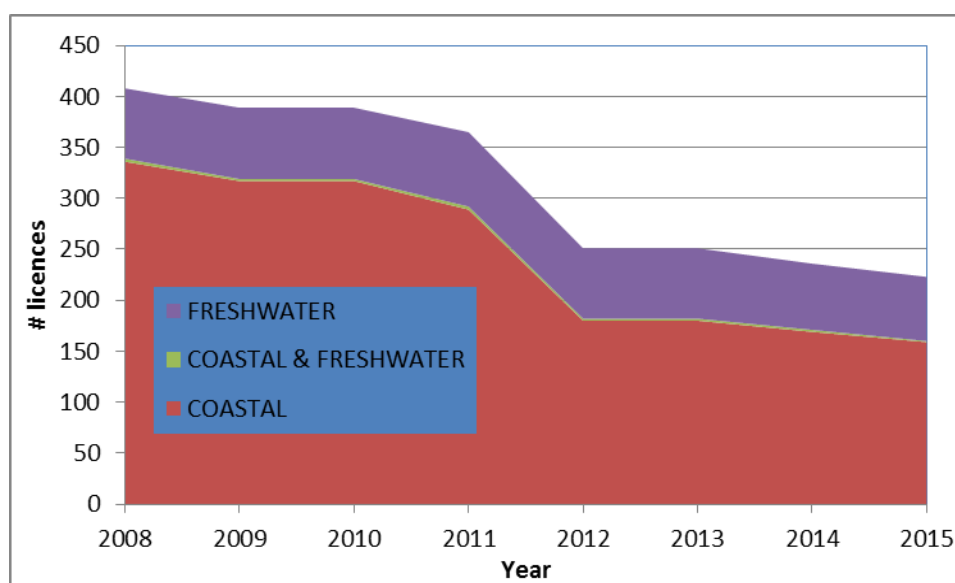


Figure SE. 6. Number of “eel permits” issued by the responsible agency.

4.4 Marine fishery

See above.

5 Fishing effort

5.1 Glass eel

NP.

5.2 Yellow eel

NP as most eels caught are silver eels or close to the silver stage.

5.3 Silver eel

Effort statistics from the Swedish eel fishery are scarce and often of doubtful quality. There are some local or regional information, gathered in industrial monitoring programmes. In a 20 km section of classic fishing grounds on the Baltic coast, the total annual effort decreased by over 80% if the period before 1975 is compared with recent years (Figure SE. 7). The reasons behind this development is probably a combination of competition for a declining resource, low profits and not the least that fishers leave their profession with old age, and no sons or daughters inheriting their fisheries. Licences cannot be transferred between fishers, not even within a family. This trend is probably representative for vast areas of the Baltic coast including Öresund (SD 23) (Andersson *et al.*, 2012).

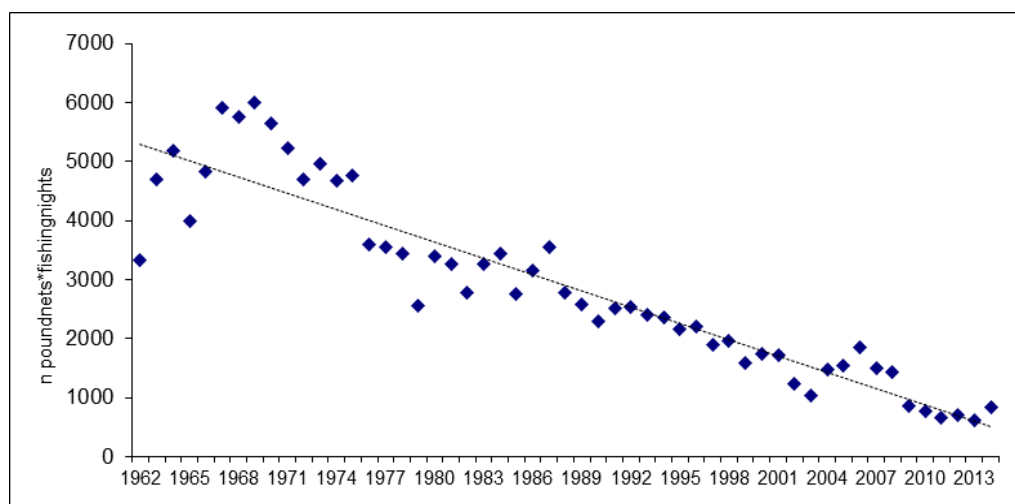


Figure SE. 7. Fishing effort in a poundnet fishery north of Oskarshamn on the Baltic coast.

5.4 Marine fishery

See above.

6 Catches and landings

6.1 Glass eel

NP.

6.2 Yellow eel

NP as most eels caught are silver eels or close to the silver stage.

6.3 Silver eel

6.3.1 Freshwater fishery

Table SE. 6. Landings of eel from freshwater lakes.

YEAR	MÄLAREN	HJÄLMAREN	VÄNERN	SMALLER LAKES*	TOTAL
1962			8		8
1963			9		9
1964	2		10		12
1965	2		9		11
1966	2	1	10		13
1967	2	1	12		15
1968	1	2	15		18
1969	1	3	14		18
1970	2	2	14		18
1971	3	2	14		19
1972	4	3	13		20
1973	4	4	12		20
1974	5	3	12		20
1975	8	5	16		29
1976	6	5	11		22
1977	8	6	14		28
1978	7	6	9		22
1979	8	6	8		22
1980	13	9	10		32
1981	13	9	11		33
1982	15	12	11		38
1983	17	10	12		39
1984	18	11	13		42
1985	20	11	19		50
1986	18	12	17	45	92
1987	22	11	17	38	88
1988	28	19	23	66	136
1989	21	16	19	53	109
1990	28	29	22	49	128
1991	35	25	23	49	132
1992	30	27	19	56	132
1993	31	28	19	51	129
1994	43	35	22	71	171
1995	36	24	19	48	127
1996	35	23	17	33	108
1997	43	30	25	45	143
1998	31	19	21	41	112
1999	44	30	26	40	140
2000	38	20	22	34	114
2001	38	23	25	32	118

YEAR	MÄLAREN	HJÄLMAREN	VÄNERN	SMALLER LAKES*	TOTAL
2002	34	18	22	29	103
2003	31	16	23	26	96
2004	38	18	23	28	107
2005	42	18	21	29	110
2006	45	21	21	36	123
2007	41	20	19	31	111
2008	47	23	22	20	112
2009	47	14	14	21	96
2010	49	18	14	27	108
2011	42	17	11	15	85
2012	51	13	15	21	100
2013	46	11	20	25	102
2014	49	8	17	36	110

*catch from smaller lakes were not reported on until 1986.

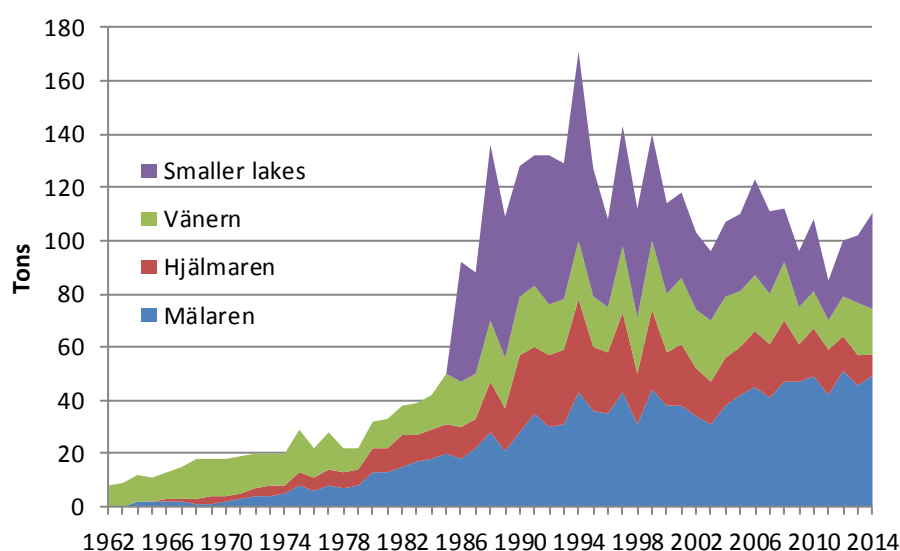


Figure SE. 8. Landings of eel from freshwater lakes (catch from smaller lakes were not reported on until 1986).

6.4 Marine fishery

Total eel catches reported to the logbook system averaged 446 tons in 1999–2014. As the system allows reports of undefined eel catches, the life-stage composition is not exactly known. Before 2005 the shares of silver and yellow eel were equal and the undefined part was small (3%). Silver eel proportions tend to increase in 2005–2007 as an increase in landings was recorded in the Baltic proper after 2004. During 2012–2014 the proportion of silver eels varied between 88 and 89%.

The Baltic eel fishery is strongly dominated by a poundnet fishery for silver eel. Until 2005, reporting logbooks for fishing on private waters was not mandatory (private ownership of fishing rights is common in both inland waters and along the coast). This implies that catches in the Baltic Sea silver eel fishery were underestimated. The degree of underestimation is not known. In addition, the new legislation requiring

licence for eel fishing in 2007 has probably reduced underestimation of catches. In 2009–2011 approximately 70% of the landings were silver eel, mainly due to a reduction of yellow eel landings. The closure of the West Coast fishery in 2012 makes the silver eel dominance almost total.

Logbooks contain information on a daily basis on catches (kg), gears used (number and type) and the fishing time (hours). In the journals information is given on a monthly basis with catches (kg), and effort (number of gears*days). Both types of data are stored by the Swedish Agency for Marine and Water management. The Baltic Proper and the Kattegat-Skagerrak area strongly dominate the landings until 2011 but the share for Kattegat and Skagerrak decreases in recent year to be reduced to close to zero after the fishery was banned in most of these areas in 2012 (Figure SE.9). A significant decline in the total landings is seen in 2007–2014 (linear regression, $p < 0.01$) and for the first time in modern history, the Swedish eel landings from the sea fisheries were below 300 tons in 2012. The sum of landings from all coastal areas in 2014 reached 210 tons. Recreational fishery is prohibited since 2007.

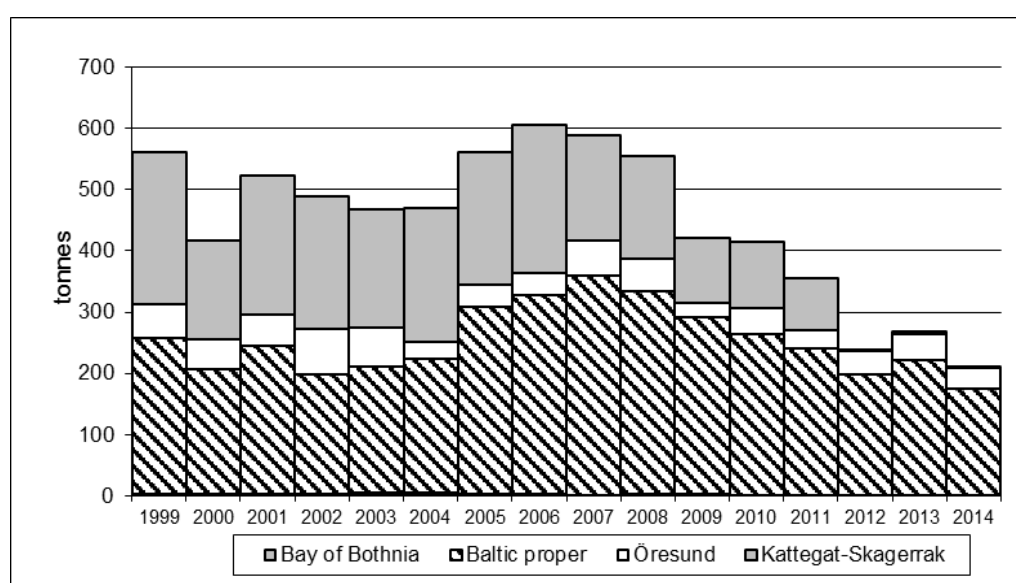


Figure SE. 9. Total commercial landings in coastal fishery by main basin.

Table SE. 7. Total commercial landings in coastal fishery by main basin.

	KATTEGAT-SKAGERRAK	ÖRESUND	BALTIC PROPER	BAY OF BOTHNIA	GRAND TOTAL
1999	247	56	254	3	560
2000	161	48	204	3	417
2001	228	49	243	3	523
2002	217	73	196	3	489
2003	194	62	208	4	467
2004	219	27	219	4	470
2005	215	37	304	4	561
2006	240	37	324	4	605
2007	172	58	358	1	589
2008	168	52	331	3	554
2009	108	22	289	3	422
2010	108	43	262	2	415
2011	84	31	238	2	355
2012	0	37	197	2	236
2013	4	43	220	1	268
2014	0	34	175	1	210
average	158	45	256	3	446

In addition to the more recent logbook system, there is the traditional, long series of eel landings based on a sales note system. These two systems give deviating data in most years, not always in a predictable way.

Table SE. 8. Landings of eel based on registered sales notes.

YEAR	SOUTH COAST	EAST COAST	WEST COAST	LAKES	TOTAL
1986	479	138	234	92	943
1987	439	119	250	89	897
1988	532	190	304	136	1162
1989	447	132	264	109	952
1990	452	119	242	129	942
1991	486	181	285	132	1084
1992	534	162	352	132	1180
1993	550	93	438	129	1210
1994	654	98	630	171	1553
1995	444	79	555	127	1205
1996	564	67	406	97	1134
1997	546	181	204	142	1073
1998	318	50	165	112	645
1999	339	69	186	140	734
2000	286	39	123	113	561
2001	107	123	195	118	543
2002	126	183	222	102	633
2003	115	145	209	96	565
2004	84	134	227	106	551
2005	119	187	211	111	628
2006	125	195	227	123	670
2007	126	178	153	111	568
2008	110	116	156	113	495
2009	63	127	101	97	388
2010	101	99	109	108	417
2011	68	85	82	85	320
2012	61	94	8	100	263
2013	96	96	0	102	294
2014	59	79	0	110	248

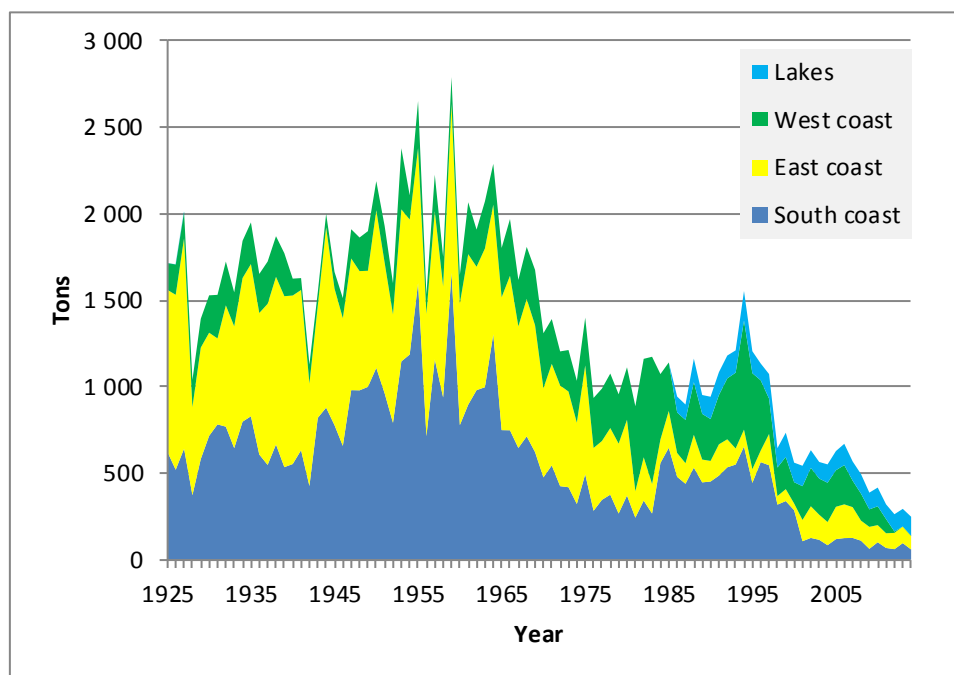


Figure SE. 10. Landings of eel based on registered sales notes.

6.5 Recreational fishery

As a recreational fishery is not allowed in Sweden since 2007, there are no data. There is however, a small fishery allowed far upstream in some river systems referring to time-honoured rights, but data are not available.

6.6 Bycatch, underreporting, illegal activities

We are not aware of any substantial bycatch of eel in fisheries targeting other species.

There are probably both some underreported catches of eel as well as illegal fishing, but there are no data available. However, it is assumed to be quite small as the awareness of the poor stock status in combination with a requirement to report any substantial sales, makes it difficult to make profit out of an illegal eel fishery. However, the Swedish Agency for Marine and Water Management recently reported to the government on seized fykenets and imperfect reporting of eels sold.

7 Catch per unit of effort

7.1 Glass eel

NP.

7.2 Yellow eel

NP, see below.

7.3 Silver eel

NP, as most eels, if not all, caught are silver eels or at a size and stage close to silver.

7.4 Marine fishery

Fishermen in the central Baltic have provided detailed records of their catches for several decades, as part of a monitoring programme related to the nuclear power plant in Oskarshamn. On one site in southern Östergötland archipelago (Figure SE. 11), no change in the catch of yellow or silver eel per unit of effort has been observed since the mid-1970s, though the fishing effort after 1990 was considerably lower than before and decreasing. The highest silver eel cpue of the entire time-series was reported in 2012–2014. Effort was more stable over the years on the site in northern Kalmar County. In 2012–2014 effort was reduced significantly, possibly due to fishing regulations. As in Östergötland silver eel cpue was on a historically high level in these years. No significant change in yellow eel catch occurred in northern Kalmar County, but cpue of silver eel have increased on a long term. This might be related to an increased focus on silver eel in recent years and to imposed regulations of the period open for fishing. The very high cpue in N Kalmar 2012–2014 is partly an effect of a late start and a shorter fishing period. No such change took place in S Östergötland.

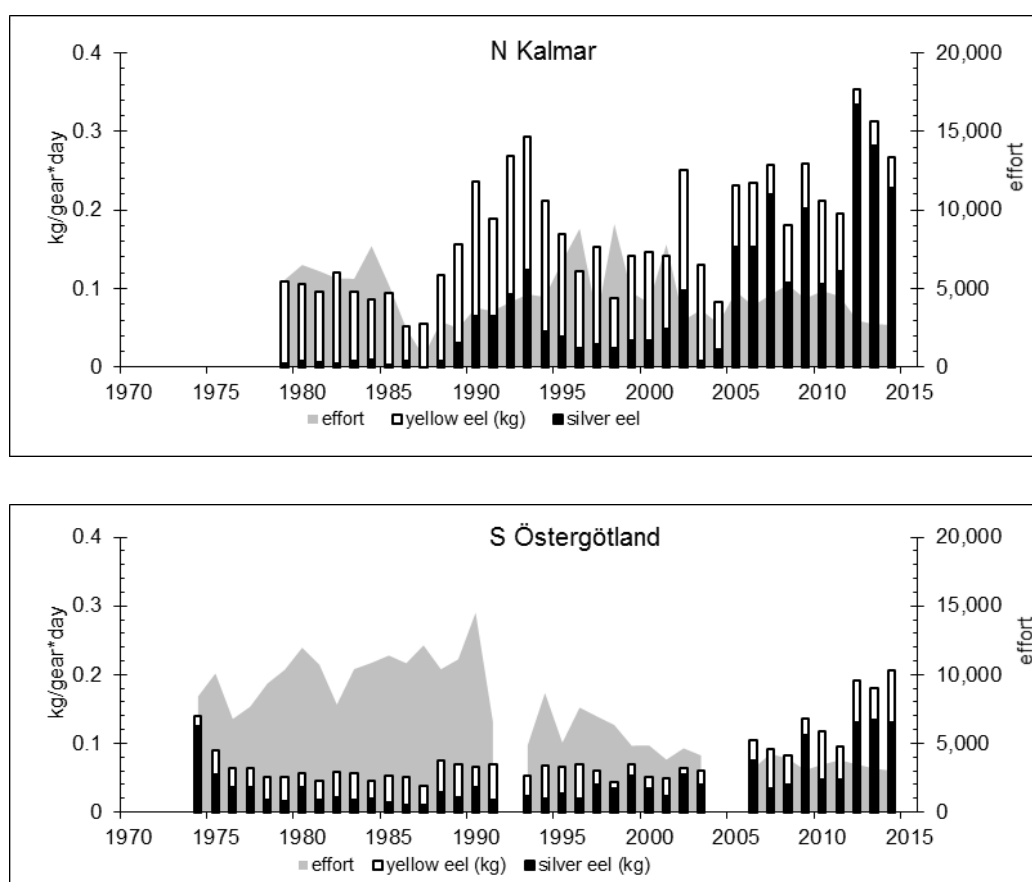


Figure SE. 11. Catch per unit of effort for yellow and silver eel, and total annual fishing effort, in fisheries with (small) fykenets in two areas in the central Baltic.

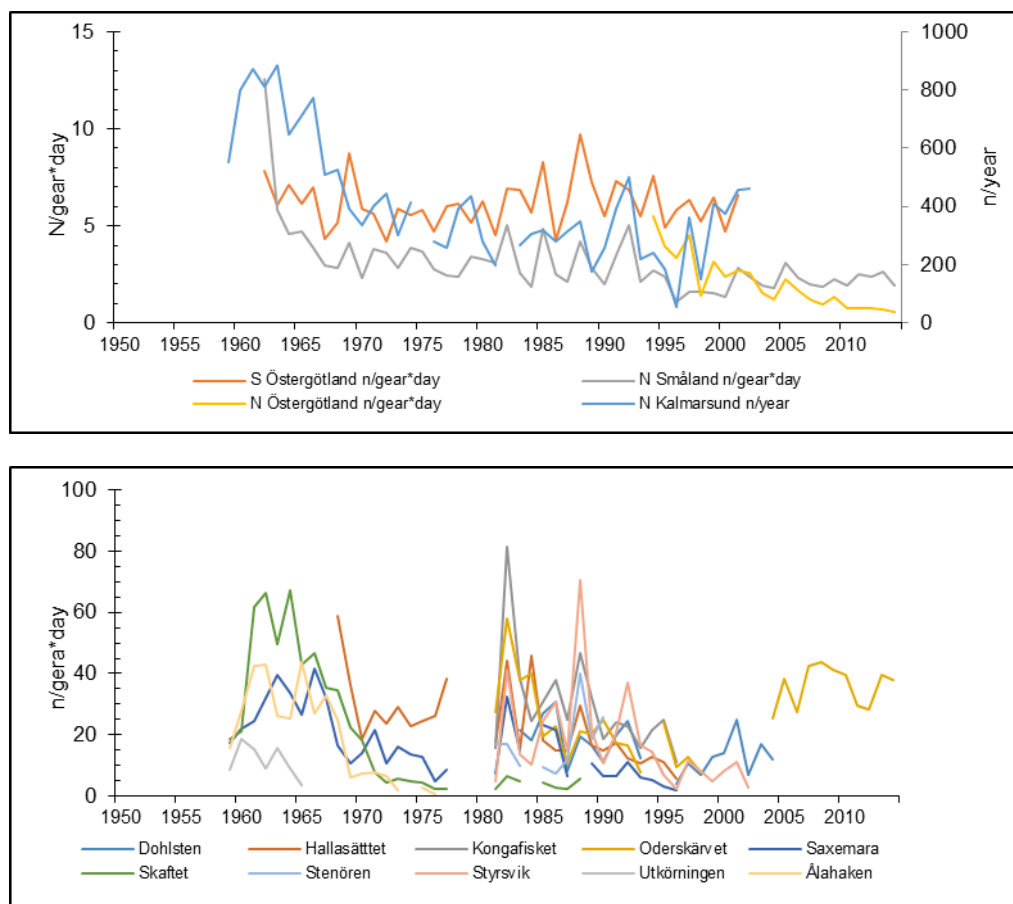


Figure SE. 12. Catch per unit of effort in the poundnet fishery for silver eel at four sites in the central Baltic (top) and ten sites in Hanöbukten (below).

The catch per unit of effort for the poundnet fishery on silver eel in the central Baltic has declined considerably in the 1960s (Figure SE. 12), but stabilized thereafter. One of the sites remained on a stable level the last twenty years, the other one showed a decreasing cpue in the same period. Two of the series ceased around 2000, and the same happened to most of the series in Hanöbukten in the 1990s. In recent years, however, some of the original series resumed, and catches at these sites have been relatively high recently, compared to the 1980s. Note however, that the data only represent part of the poundnet fishery in this area.

8 Other anthropogenic and environmental impacts

There is a programme running, aiming at a reduction in hydropower induced mortalities from assumed high levels down to less than 60% in total (looking at Sweden as one management unit). However, no relevant data besides what is presented in chapter 13 are available yet.

Glass eel mortality is part of the effect monitoring at the nuclear power plant at Ringhals on the Kattegat coast, which also provides recruitment data described above. Survival is estimated to 90% as the glass eels pass through the power plant (Andersson *et al.*, 2011; Bryhn, 2012). Yellow and silver eel mortality is monitored annually at the nuclear power plants, Forsmark and Oskarshamn in the Baltic Sea. Data can be supplied on demand by SLU Aqua.

9 Scientific surveys of the stock

9.1 Recruitment surveys, glass eel (includes yellow eel in Scandinavia)

Electrofishing has been done annually at many sites in running water all over Sweden for a long time period. Though abundance of salmonids by tradition has got most attention, data on eel occurrence and abundance are accumulating. The Swedish Electrofishing Register (SERS) probably offers good opportunities to monitor the recruitment of young eels to many sites not monitored in any other way. Within DCF this network of electrofishing sites was increased with other eight eel specific sites. So far SERS has not been used for any comprehensive studies related to eels specifically.

9.2 Stock surveys, yellow eel

The coastal fish communities on the Swedish West Coast are monitored by standardized fishing with fykenets in shallow water (2–5 m). Yellow eel was among the dominating fish species in August most years. The trend for the longest time-series from Vendelsö in central Kattegat is significantly positive (Figure SE. 13). No trend exists in the other long time-series from Barsebäck in the Öresund. After relatively low catches before and around 2010, catches increased again towards 2014 and fell back again in 2015, probably due to a cold spring and summer. The cpue in 2014 was the highest ever recorded since 1998 in Fjällbacka and since 2002 in Stenungsund. Catches were historically high also in Barsebäck and Vendelsö. High seawater temperature at least partly explains the results in 2014. The temperature at Vendelsö in 2014 is not representative for the other areas as the fishing period in that area was delayed due to strong winds. The interannual variations in cpue were influenced by water temperature at the time of sampling. Cpue at Vendelsö and at Barsebäck was positively correlated with seawater temperature at Vendelsö in the period with available data (1988–2014) (Vendelsö $p < 0.01$, $r^2 = 0.27$; Barsebäck $p < 0.05$, $r^2 = 0.16$). However, no time-trend in temperature was observed for this period.

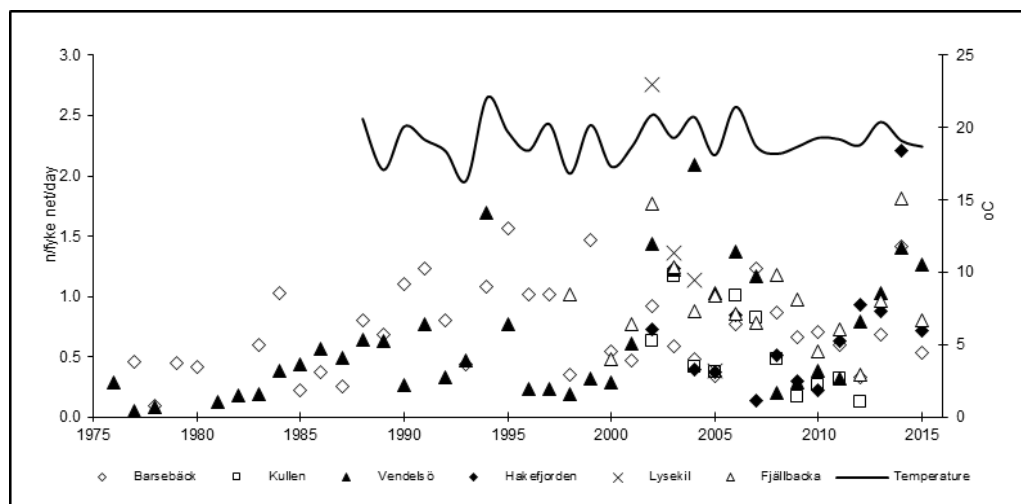


Figure SE. 13. Time-trend in the yellow eel catches in coastal fish monitoring with fykenets in August on the Swedish West Coast. Annual mean water temperature at the fishing gears is presented for the Vendelsö area in central Kattegat.

An introduced stock of marked eels is monitored since 1997. The eels were stocked as 1 g elvers in Lake Mälaren 1997 and have been monitored annually using paired fykenets since then. As they were marked with Alizarin Complexone before being

stocked they are easily distinguished from the natural stock at this site and we have accumulated a great quantity of data on growth, sex ratio, size at silvering, etc. (Figure 14). We are also following the prevalence of *Anguillicola crassus* in this introduced stock (Figure 15). The stocked eels have now dominated the catch at this site during the last eleven years. During the last few years the proportion of silver eels has increased, indicating the eels are reaching maturity after some 18 years in the lake.

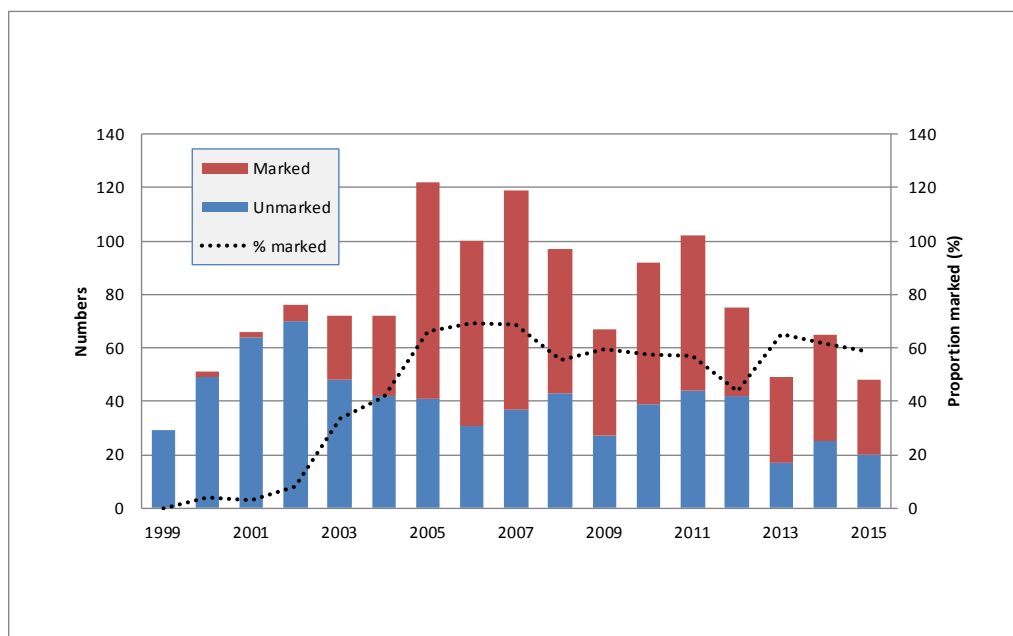


Figure SE. 14. Catch and proportion of marked eels at a site in Lake Mälaren.

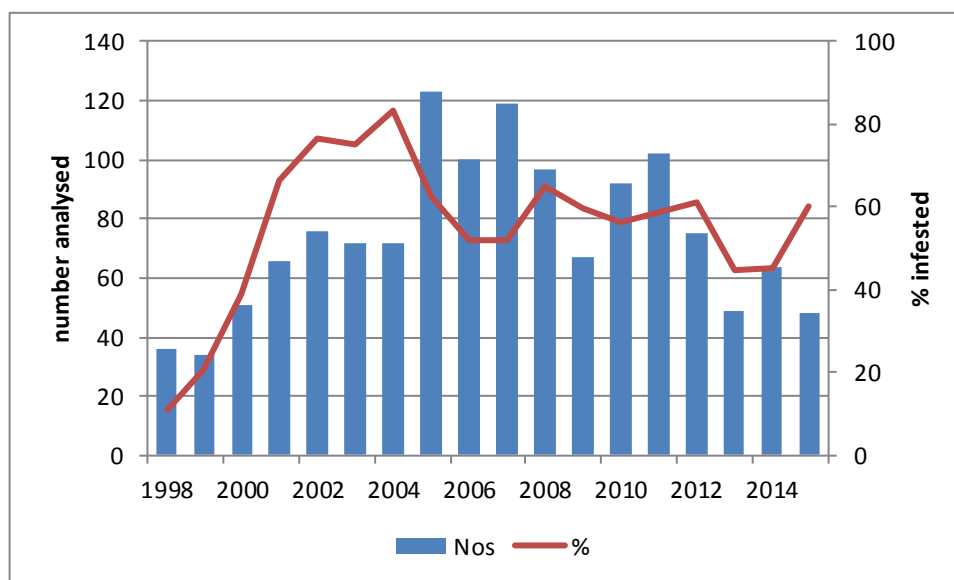


Figure SE. 15. Prevalence of *Anguillicola crassus* in eels from one site in Lake Mälaren.

9.3 Silver eel

9.3.1 A revived traditional eel tagging series from the Baltic Sea

In the Nordic region tagging experiments started in 1903 and the objective in the first taggings was to gain general information on the migration direction and routes taken

(Sjöberg, 2015). Since then thousands of eels have been tagged mostly with silver plates and Carlin tags. Recaptures of tagged eel were relatively scarce in the early 1900s, probably because fish tagging were a new phenomenon and the fishers were unaware of the ongoing experiments. In addition, the fishery was not as extensive as it became later. In 1958 Swedish eel landings from the Baltic Sea reached an all-time high of more than 2500 tons of silver eel. This was also reflected in the recapture rate (Figure 16). After this, catches decreased and so did the recapture rates. However, a bit unsynchronized since the intensity of the fishery started to decrease somewhat later, in the early 1970s (Andersson *et al.*, 2012). Since 2012, tagging has continued with the same method as before (Figure 17 and Table 9). It has become an important part within the EU's data collection programs (EC No 665/2008), and is a useful tool to estimate the fisheries impact on spawners leaving the Baltic Sea region (Dekker, 2015).

Table SE. 9. Tagging experiments within the DCF program between 2012 and 2014. Total number of released eels, recaptures and the national distribution among the recaptured eels.

RELEASE PLACE	YEAR OF RELEASE	NR TAGGED	RECAPTURES %	RECAPTURES NR	SWEDEN	DENMARK	POLAND	GERMANY
Bylehamn	2012	150	3	4	2	2	0	0
Vinö	2012	120	9	11	9	2	0	0
Sandhamn	2012	150	9	14	8	4	1	1
Gävle	2013	34	9	3	1	2	0	0
Bråviken	2013	150	2	3	1	1	0	1
Rumpeboden	2013	150	14	21	17	4	0	0
Yxlö	2014	150	6	9	9	0	0	0
Birkö	2014	300	6	19	16	3	0	0
Svartö	2014	150	7	10	6	4	0	0

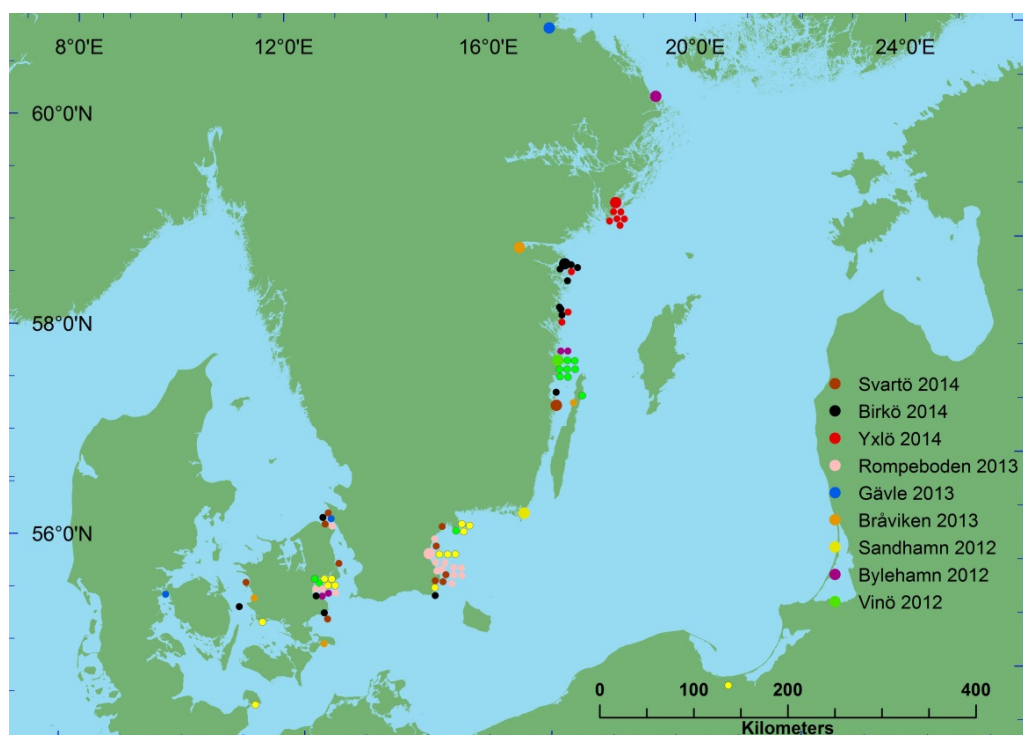


Figure SE. 16. Recaptures from tagged eels within the DCF program made along the Swedish east coast 2012–2014. (Some recaptures may be hidden behind each other. For exact recapture numbers see Table 9).

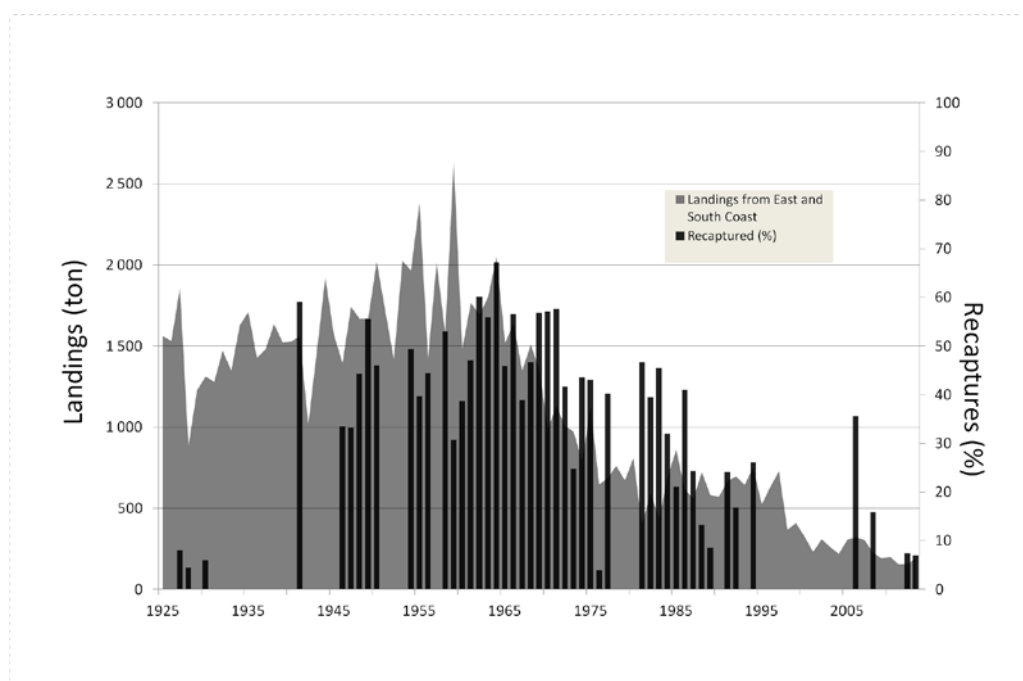


Figure SE. 17. Landings from the Swedish eel fishery on the East and South Coast (grey area). Recaptures from tagged eels made in Sweden and Denmark are given with black bars. More than 90% of the recaptures were made in the Swedish fishery at the East and South coast (after Sjöberg, 2015).

9.3.2 Tag loss in silver eels

To study the tag loss in silver eels tagged with Carlin tags (as used in the experiments mentioned above) eels from Lake Ymsen were tagged with both PIT-tags and Carlin tags in 2012. Since then all eels handled from that lake were scanned for PIT-tags and any sign of lost tags were noted. So far, exactly 50% were recaptured and among the recaptured eels only one had (partly) lost its tag.

9.3.3 Growth and production from a stocked eel population

In another study a stock of eels was introduced 1989 as YOY eels in to Lake Fardume träsk (Wickström *et al.*, 1996). The eels produced in this lake have been followed since stocking, mainly as number of silver eels descending from the lake. The sampling intensity has unfortunately been thinned out, but there is still a significant run of silver eels from the lake. In June 2015, the average length in silver eels was 84 cm to compare with 77 cm in June 2010, i.e. five years earlier. In most years all eels leave the lake during spring, probably due to a low or absent flow in late summer and early spring.

10 Data collected for the DCF

Since 2010, when DCF sampling in freshwater commenced, until 2014 a total of 2808 commercially fished eels were sampled, representing six lakes and nine sites. The sampling regime is to sample 125 eels from each site in four lakes at the time, i.e. 750 eels per year (as two of the lakes are represented by two sites each). The samples are stratified over time to represent the early, mid and late season, respectively. Length, weight, eyes and pectoral fins are measured. Stage in all eels is determined using both the Pankhurst eye index and the Durif silver index (Pankhurst, 1982; Durif *et al.*, 2005). The prevalence and intensity of the swimbladder parasite, *Anguillicola crassus* is examined macroscopically in all eels.

The plan is to change lake or sites within lakes after some years in order to improve the coverage of the whole inland fishery for eel.

Eels from the current year, 2015 are still being processed, but in 2014, 679 eels in total were sampled (as there were some deviations in the program).

In addition also the recruitment is monitored as DCF has allowed increasing the number of sites that are electro-fished in Sweden. DCF contributes with eel data from sites in eight rivers.

The tagging study described above is also done within the national DCF-programme. The main aim is to estimate the fishing mortality in the migrating silver eels stock along the Baltic coast. This is normally done annually at three different sites that are changed every year.

Table SE. 10. Summary of the DCF monitoring implementation per EMU in 2014.

DATA	RIVER	LAKES	ESTUARIES	LAGOONS	COASTAL & MARINE
No. of production / escapement surveys ¹	1				3
No. of recruitment time-series surveys ²	8				2
No. fished aged	256	727			1446
No. of fished sexed	34	679			1459
No. of fish examined for parasites	256	679			1458
No. of fish examined for contaminants	0	0			0
No. of non-fishery mortality studies ³	NP	NP			NP
Socio-economic survey	NP	NP			NP

¹ Surveys to estimate B_{best} and/or $B_{current}$ [These should include WFD surveys where the data are being used to estimate production and/or escapement of eel].

² Fishery-independent surveys.

³ Studies to determine ΣH for non-fisheries anthropogenic impacts, such as hydropower, barriers, predation, etc.

11 Life history and other biological information

11.1 Growth, silvering and mortality

von Bertalanffy parameters: L_{inf} , K , t_0

NP (in silver eels)

L_{50} = the length at which 50% of the population has silvered (my interpretation of 50% maturity)

NR

Length and age at silvering

NR

Fecundity

NR

Weight-at-age

NR

Length–weight relationship

$W = 2,87 * 10^{-6} * L^{2,95}$ (based on 678 eels from 2014)

Table SE. 11. Size, age and parasites in freshwater eels (DCF).

Lake	N	Mean Length (std)	Mean Weight (std)	Mean Age (std)	K	A. CRASSUS Prevalence	A. CRASSUS Intensity	Note
Hjälmarén								
2010	125	876 (65)	1566 (361)	16.1 (2.9)	0.23	61.6	4.0 (4.7)	
2011	111	882 (70)	1552 (361)	15.7 (2.9)	0.22	53.2	3.6 (4.3)	
2012	127	893 (65)	1633 (377)	15.4 (2.2)	0.23	62.2	2.9 (5.3)	
2013	127	907 (79)	1697 (477)	14.3 (2.9)	0.22	68.5	2.9 (2.3)	
Mälaren								
Galten 2010	125	748 (46)	846 (153)	16.7 (2.5)	0.20	79.8	3.7 (3.4)	
Galten 2011	125	766 (37)	939 (135)	17.2 (2.3)	0.21	84	4.6 (4.4)	
Galten 2012	125	777 (48)	989 (181)	17.5 (2.2)	0.21	83.2	4.0 (5.6)	
Galten 2013	125	791 (54)	1003 (202)	16.8 (1.8)	0.22	83.2	4.1 (3.6)	
Galten 2014	110	803 (48)	1036 (185)	20,7 (2,5)	0,20	86,4	3,7 (3,2)	
Gisselfjärden 2014								
62	814 (59)	1110 (246)	17.3 (2.7)	0,20	79,0	4,6 (5,1)		
Granfjärden 2014								
64	798 (61)	1003 (271)	16.5 (2.6)	0,20	85,9	6,3 (12,4)		
Prästfjärden 2010								
129	825 (76)	1315 (390)	18.7 (2.9)	0.23	82.9	6.1 (4.9)		
Prästfjärden 2011	127	807 (78)	1183 (375)	17.7 (2.5)	0.22	85	5.5 (5.1)	
Prästfjärden 2012	126	835 (67)	1298 (349)	18.2 (3.2)	0.22	74.6	5.3 (6.2)	
Prästfjärden 2013	124	825 (67)	1252 (355)	16.5 (2.3)	0.22	74.6	6.3 (6.5)	
Ringsjön								
2011	124	678 (64)	620 (183)	16.1 (3.3)	0.19	79	12.8 (14.4)	
2013	127	699 (47)	667 (155)	15.7 (1.8)	0.20	87.4	13.6 (15.0)	
Roxen								

LAKE	N	MEAN LENGTH (STD)	MEAN WEIGHT (STD)	MEAN AGE (STD)	K	A. CRASSUS PREVALENCE	A. CRASSUS INTENSITY	NOTE
2014	88	887 (67)	1466 (366)	15,8 (2,0)	0,21	78,4	10,0 (18,5)	
Vombsjön								
2014	124	764 (65)	957 (273)	15.3 (2.3)	0,21	82,3	10,9 (16,9)	
Vänern								
South 2010	129	783 (61)	1016 (301)	12.8 (3.1)	0.21	81.4	8.6 (8.3)	
South 2011	131	823 (75)	1158 (362)	16.0 (4.8)	0.20	79.2	7.1 (7.3)	
South 2012	122	826 (63)	1206 (315)	17.0 (3.9)	0.21	79.5	7.6 (8.9)	
South 2013	125	853 (59)	1380 (322)	16.4 (2.9)	0.22	80.8	8.4 (12.6)	I max = 97. I median = 4.0
South 2014	106	817 (70)	1172 (329)	15.0 (2.1)	0,21	72,6	8,6 (10,9)	
North 2010	126	784 (72)	1019 (334)	15.3 (3.2)	0.20	81	6.0 (6.2)	
North 2011	126	779 (77)	950 (323)	16.6 (3.4)	0.19	89.7	8.3 (8.8)	
North 2012	125	818 (62)	1145 (272)	16.9 (2.6)	0.21	71.2	4.9 (6.8)	
North 2013						80.6	7.5 (18.3)	I max = 167. I median = 3.0
	124	834 (56)	1263 (296)	16.1 (2.6)	0.22			
North 2014	124	851 (61)	1318 (283)	17.0 (1.9)	0,21	74,2	6,1 (10,0)	

11.2 Parasites and pathogens

The prevalence of swimbladder parasite *Anguillicola crassus* has been monitored in samples taken from commercial catches, in freshwaters and coastal areas. The prevalence in yellow eel until 2011 was generally lower in marine areas along the West Coast, on average 6% in Skagerrak and 12% in the southern Kattegat, while close to 50% of the yellow eels had parasites in both Baltic areas (Figure SE. 17). Sampling ceased in central Baltic (SD 27) after 2011, due to small landings. In 2012–2014 prevalence was higher in SD20, probably due to a large proportion of samples close to an estuary (Figure SE. 19). Silver eels were less infected in general, and differences between sites were smaller (Figure SE. 20). In inland lakes, prevalence was generally much higher (79–83%), although “only” 61% of eels in Lake Hjälmaren were infected in 2010–2014.

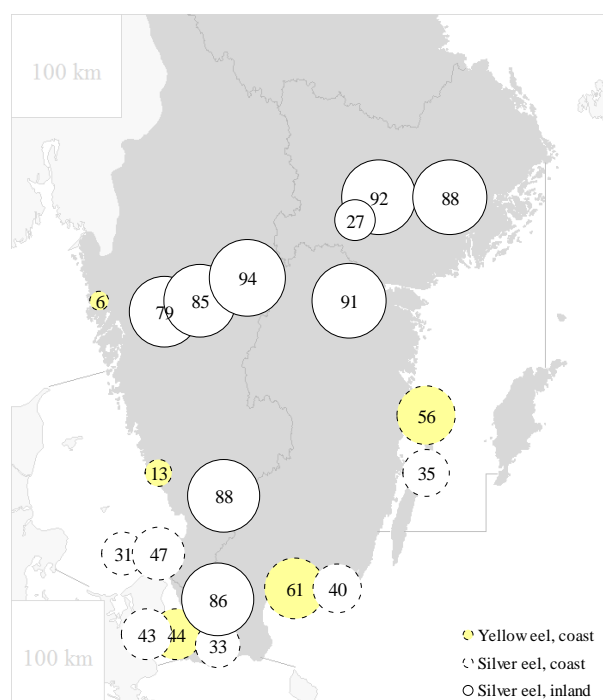


Figure SE. 18. Prevalence (%) of the swimbladder parasite *A. crassus* in yellow and silver eel, in the 2000s.

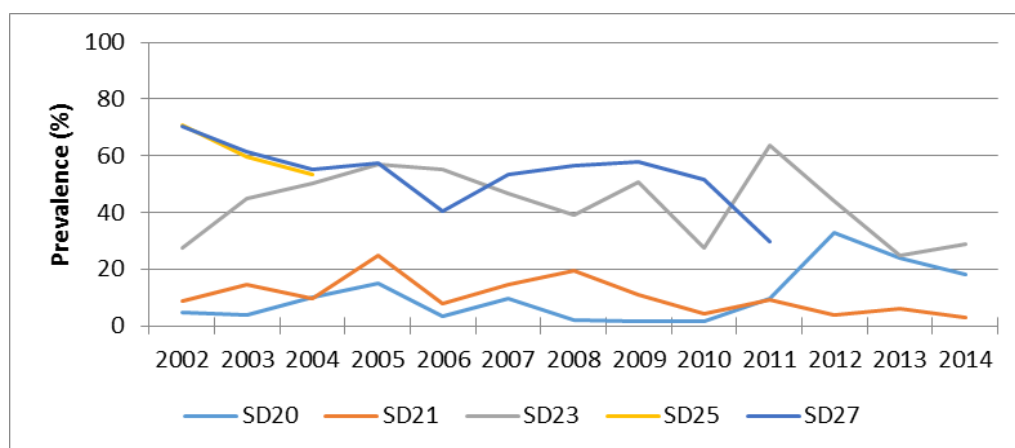


Figure SE. 19. Time-trends in prevalence of *A. crassus* in yellow eels in Swedish coastal areas (ICES Subdivisions 20, 21, 23, 25 and 27).

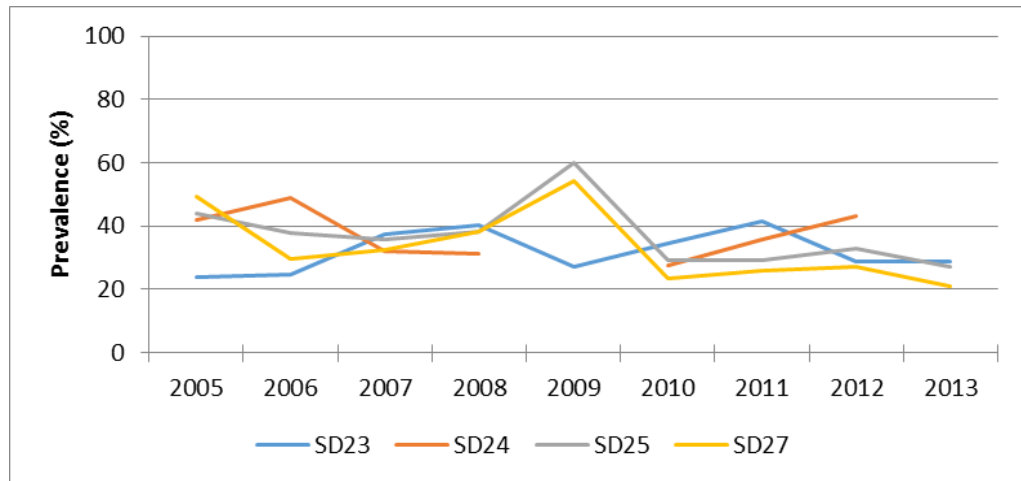


Figure SE. 20. Time-trends in prevalence of *A. crassus* in silver eels in Swedish coastal areas (ICES Subdivisions 23, 24, 25 and 27).

11.3 Contaminants

NP.

11.4 Predators

NP.

12 Other sampling

NP.

13 Stock assessment

13.1 Method summary

This section summarises the assessment made in spring 2015.

13.2 Local stock assessment

According to the Swedish Eel Management Plan, the whole Swedish national territory constitutes a single management unit. Several management actions, however, and most of the anthropogenic impacts differ between geographical areas: inland waters and coastal areas are contrasted and West Coast vs. Baltic Coast (east and south). Anthropogenic impacts include barriers for immigrating recruits, restocking, yellow and silver eel fisheries, hydro-power related mortality, Trap & Transport of young recruits and of maturing silver eels, etc.

The assessment in Dekker (2012) is broken down along geographical lines, also taking into account the differences in impacts, resulting in four blocks, with little interaction in-between.

- 1) West Coast – natural recruitment and restocking, fishery on yellow eel. The Swedish EMP presents an assessment, based on catch curve analysis. By 2012, fishing restrictions have been implemented, including a reduction in effort and a raise in minimum size. In the years 2009–2012, the stock is expected to have declined (trend in recruitment) and recovered (reduced impacts), but in 2012, these effects will have had only little effect yet. The

West Coast fishery being closed as of spring 2012, Dekker (2012) made a rather simple re-assessment: assuming that the stock remained almost stable, fishing mortality and landings were assumed to have developed proportionally. In 2015, however, three years have passed since the closure of the fishery (recovery), and the last available data are from 2006 (nine years ago). In the absence of follow-up monitoring (no priority with the funding agency), no new assessment has been made; no new indicators are given. A major problem arises in the calculation of B_0 . Between the 1950s and the 2000s, catches rose and then declined, to end close to the starting level. It is unclear, whether the 1950s stock was equally abundant as today's (implying equal fishing impact) or if the stock declined proportionally to recruitment (implying a very low impact in the 1950s). Depending on that assumption, B_0 comes at either 1154 ton or 11 540 ton; B_{current} is either 1% or 1‰ of B_0 ; A_{lim} is either 0.0230 or 0.0023. This uncertainty on B_0 , however, appears to be almost irrelevant; to come within sustainable limits, a major reduction in fishing impact is required and the fishery has been closed as of spring 2012.

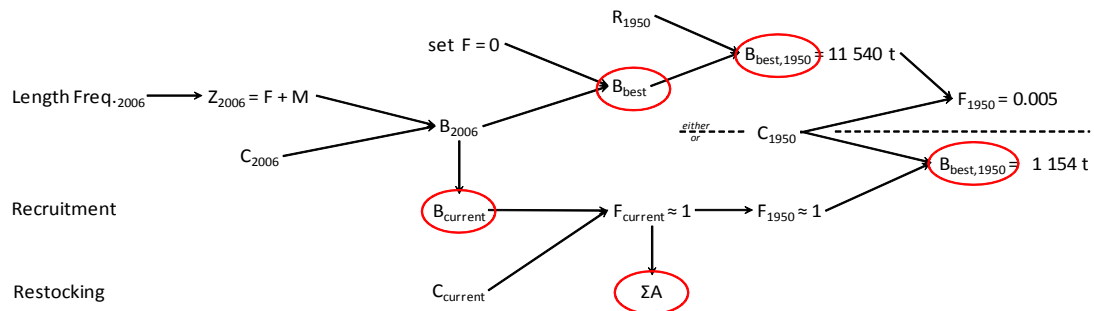


Figure SE. 21. Dependencies between data and estimates for the West Coast.

- 2) Inland waters – for the inland eel stock, a brand new assessment has been made. Starting with estimates of natural recruitment (trend analysis of trap catches) and databases on restocking and assisted migration, a reconstruction is made of the corresponding amount (biomass, numbers) of silver eel produced in inland waters, which is time and location-specific (the place and time of release, known growth and age, guesstimated natural mortality). For each reconstructed batch of silver eel in each year, the amount caught by the fishery is deduced. For the remaining silver eel, the route towards the sea is deduced from GIS maps, and the mortality due to the hydropower stations on this route calculated. Only limited ground-truth information exists, to verify the result (electrofishing in rivers, while most restocking was done in lakes), but that ground-truth has not been applied yet. . Surprisingly, actually observed landings derived from past restocking indicate that natural mortality M must have been extremely low (5–10%), much below conventional estimates (15–20%). In the absence of independent verification, estimates is presented for $M=0.10$.

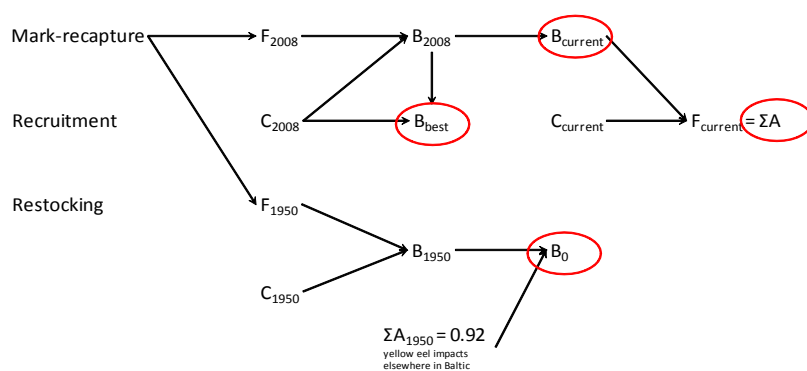


Figure SE. 23. Dependencies between data and estimates for the Baltic coast.

13.2.1 Estimate of B_0

Table SE. 12. Reference period for B_0 .

EMU_code	B_0 (<i>tons</i>)	Reference time period	Whether or not changed from value reported last year (Y/N)
SE-West	1154 – 11540	1950-2010	N
SE-Inland	595 or 300 (with, without restocking)	Varies by year, if restocking is included	Y
T&T	n/a	n/a	n/a
Baltic coast	12,500	1950s	N

13.3 Summary data

13.3.1 Stock indicators and targets

The following indicators are taken from Dekker (2015).

EMUCODE	INDICATOR BIOMASS (T)			MORTALITY (RATE)		TARGET			
	B ₀	B _{best}	B _{curr}	ΣA	ΣF	ΣH	Source	Biomass (t)	ΣA (rate)
SE-West				0	0	0	EMP		
							EU Reg		
							WGEEL		
SE-inland+*	595	330	91	1.29	0.38	0.96	EMP		
							EU Reg		
							WGEEL		
SE-Inland- **	300	35	10	1.29	0.38	0.96	EMP		
							EU-Reg		
							WGEEL		
Baltic coast	12500	3770	3557	0.02	0.02		EMP		
							EU Reg		
							WGEEL		
T&T			19						

*with stocked eels included.

**with stocked eels excluded.

13.3.2 Habitat coverage

EMU CODE	RIVER		LAKE		ESTUARY		LAGOON		COASTAL	
	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)
SE	NP	NP	3 926 246	NP	NP	NP	NP	NP	1 194 606	NP

13.3.3 Impact

None of the assessments allows to split the assessed impacts by habitat type.

A = assessed, MI = not assessed, minor, MA = not assessed major, AB = impact absent.

EMU CODE	HABITAT	FISH COM	FISH REC	HYDRO & PUMPS	BARRIERS	RESTOCKING	PREDATORS	INDIRECT IMPACTS
XY_abdc	Riv	A/MI/ MA/AB						
	Lak							
	Est							
	Lag							
	Coa							
	All							

EMU CODE	STAGE	FISH COM	FISH REC	HYDRO & PUMPS	BARRIERS	RESTOCKING	PREDATORS	INDIRECT IMPACTS
XY_abdc	Glass							
	Yellow							
	Silver							
	Silver EQ							

13.3.4 Precautionary diagram

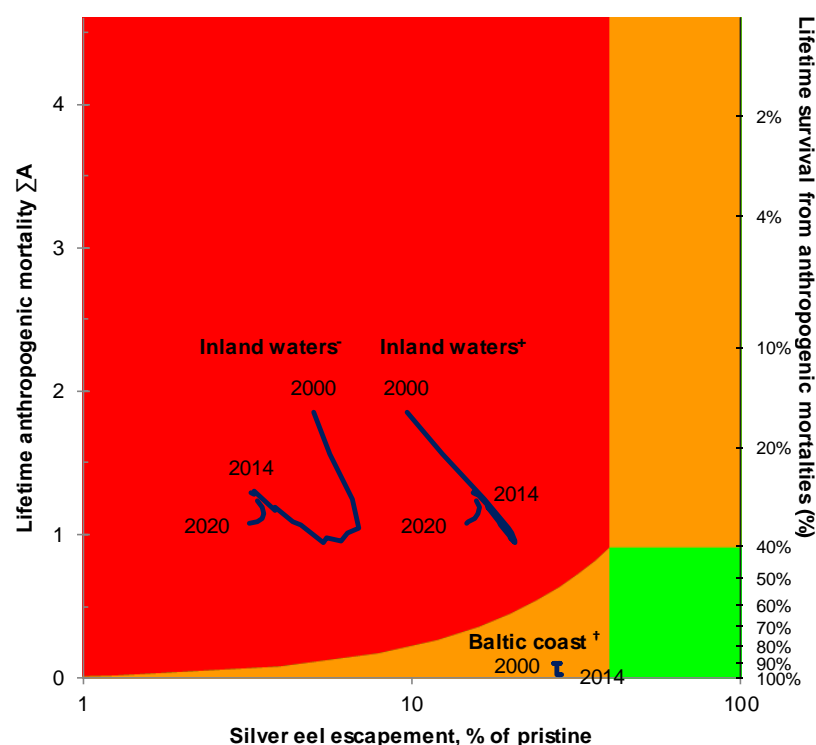


Figure SE. 24. Precautionary Diagram for the Swedish eel stock in inland waters and along the Baltic coast. For the west coast, no stock indicators are currently available. For inland waters, the true mortality is shown (not interpreting restocking as compensating for other mortalities), giving separate curves for the current biomass with or without the contribution from restocking, %SSB+ resp. %SSB-.

[†] For the Baltic coast, only the impact of the Swedish silver eel fishery is included; impacts in other life stages, in other areas/countries, are not.

13.3.5 Management measures

EMU CODE	ACTION TYPE	ACTION	LIFE STAGE	PLANNED	OUTCOME
SE_Inla	Com Fish	Restricted	Silver	Yes	Yes
SE_West		Closed	Yellow	No	Yes
SE_East		Restricted	Silver	Yes	Yes
SE_Inla	Rec Fish	Closed	Silver	Yes	Yes
SE_West		Closed	Yellow	Yes	Yes
SE_East		Closed	Silver	Yes	Yes
SE_Inla	Hydropower & Pumps		Silver	Yes	Partially
SE_West			NP	NP	NP
SE_East			NP	NP	NP
SE_Inla	Restocking		Elvers	Yes	Yes
SE_West			Elvers	Yes	Yes
SE_East			Elvers	Yes	Yes
SE_Inla	Other	Studies	Silver	No	Partially
SE_West		Studies	Yellow	No	Partially
SE_East		Studies	Silver	No	Partially

13.4 Summary data on glass eel

	QUANTITIES		
	2013	2014	2015
caught in the commercial fishery	NP	NP	NP
exported to Asia	0	0	0
used in stocking	910 kg	1008 kg	574.6 kg 1 934 524 #
used in aquaculture for consumption	390 kg	358 kg	77.2 kg
consumed direct	0	0	0
mortalities		34 kg	20.2 kg 68 051 #

14 Sampling intensity and precision

NP.

15 Standardisation and harmonisation of methodology**15.1 Survey techniques**

NP.

15.2 Sampling commercial catches

NP.

15.3 Sampling

NP.

15.4 Age analysis

NP.

15.5 Life stages

NP.

15.6 Sex determinations

NP.

15.7 Data quality issues

NP.

16 Overview, conclusions and recommendations**17 Literature references**

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Report on the eel stock and fishery in Turkey 2014/2015

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Reporting Period: This report was completed in November 2015, and contains data up to 2014 and some provisional data for 2015.

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2 Introduction

Turkey's coasts are in two ecoregions; the western and southern parts of Turkey are in the Aegean-Levantine Seas and the northern part is in the Black Sea ecoregions. In Turkey the European eel is found in nearly all freshwater, from lagoons and small creeks to rivers which flow into these coasts. However, the fisheries of this species is concentrated in some particular lagoons and estuaries in Mediterranean and Aegean Sea.

The main European Eel habitats are recorded by some documents (Geldiay and Balık, 1996; Oray, 1987; Küçük and İkiz, 2004; İkiz *et al.*, 1998; Koca 2001, Yalçın and Kuçuk, 2002; Onaran, 2006; Ozdemir *et al.*, 2007). In addition to these documents the possible habitats of eels are listed below:

1) In the Aegean-Levantine Ecoregion:

- Mediterranean
 - Hatay
 - Rivers: Asi River
 - Adana
 - Lagoons: Ömer Gölü, Yapı Gölü, Darboğaz gölü, Ağyatan (Hurma), Akyatan and Tuzla
 - Rivers: Seyhan and Ceyhan
 - Mersin
 - Lagoons: Akgöl, Paradeniz, Dipsiz Dalyanı
 - Rivers and streams: Göksu, Berdan (Tarsus), Anamur (Dragon), Lamos (Limonlu), Efrenk, Alata, Mezitli, Bakır, Sipahi, Dece, Gilindires, Kargıcak
 - Antalya
 - Lagoons: Gelemiş gölü, Beymelek lagün gölü
 - Rivers: Manavgat, Köprüçay, Eşen, Aksu, Düden, Dim, Gazipaşa, Alara, Alakır, Karpuz, Kargı, Korkuteli, Karaman
- Aegean Sea
 - Edirne
 - Lagoons: Taşaltı gölü, Dalyan, Bücürmene, Karagöl, Vakuf Tuzla gölü, Tuzla gölü

- Rivers: Meriç
 - Çanakkale
 - Lagoons: Kavak, Anafarta Tuz gölü, Tuz gölü, Gökçeada, Kumkale Lagün, Diremli azmağı, Gülpınar
 - Rivers: small creeks
 - Balıkesir
 - Lagoons: Çıkırcı Dalyanı, Alibey dalyanı, Uzungöl
 - Rivers: small creeks
 - İzmir
 - Lagoons: Dalyan Gölü, Zeytindağ Dalyan, Homa-Kırdeniz, Raufpaşa Dalyanı, Çakalburnu Dalyanı, Gebekilise Gölü
 - Rivers: Küçük Menderes, Gediz (This river rises in Kütahya flows through Uşak, Manisa), Bakırçay
 - Aydın
 - Lagoons: Karine gölü, Arapça Lagünü, Karaca Dalyanı, Bölme Dalyanı, Kabahayıt Dalyanı, Bafa gölü
 - Rivers: Büyük Menderes (This river also passes Afyon, Uşak, Denizli provinces)
 - Muğla
 - Lagoons: Güllük dalyanı, Tuzla Lagünü, Köyceğiz Gölü
 - Rivers: Dalaman, Eşen, Büyük Menderes
 - Marmara Sea
 - İstanbul Küçükçekmece and Tuzla lagoons
 - Yalova Hersek lagoon
 - Bursa Arapçiftliği and Dalyan+Poyraz lagoons
 - Balıkesir Yarıntı, Tahir, Tuzluazmak lagoons, Susurluk and Gönen streams
 - Çanakkale Hoyrat , Karabiga Gölleri, Çardak, Çatal Azmak lagoons
- 2) In the Black Sea ecoregion:
- Black Sea: Sinop Küçük boğaz lagoon

The annual catches of eels has dramatically decreased after 1997–1998 in every location of Turkey. After these years there is no record of eels from Black Sea location. In Turkey the fisheries were traditional or small-scale fisheries until 1970s. With the developing of technology, the industrial fisheries which have broad negative effects of coastal communities and heavy impact on the marine environment, took place the artisanal fisheries. However, the eel fisheries are mainly based on fykenet and the industrial fishing is not the main reason of this dramatic declines. In recreational means, fishermen use hooklines for hunting European Eel. Number of recreational fishermen involved in eel fishery is unknown. No glass eel fisheries in any other habitats and no collection of glass eels for aquaculture in Turkey. Only larger than 50 cm in length, probably silver eels, are allowed to catch. Ministry of Food, Agriculture and Livestock is responsible for the regulation of fishery affairs. The general directorate of fishery and aquaculture collect and record data on the annual catchment of eels as tonnes and the price of eels per kg.

3 Time-series data

3.1 Recruitment series and associated effort

3.1.1 Glass eel

There is no glass eel catch, commercial, recreational and fishery-independent in Turkey.

3.1.1.1 Commercial

No available data.

3.1.1.2 Recreational

No available data.

3.1.1.3 Fishery-independent

No available data.

3.1.2 Yellow eel recruitment

3.1.2.1 Commercial

No available data.

3.1.2.2 Recreational

No available data.

3.1.2.3 Fishery-independent

No available data.

3.2 Yellow eel landings

The management of fishery regulation allow only catches in larger than 50 cm in length from beginning 1984. It means that all the catch data represent the silver eels.

3.2.1 Commercial

No available data.

3.2.2 Recreational

No available data.

3.3 Silver eel landings

Data are collected for both yellow and silver eels combined. The Turkish National Statistical Institute assesses the annual eel catch as tons per year using the data collected by the Republic of Turkey Ministry of Food, Agriculture and Livestock (RTMFAL). The data are collected by a questionnaire with fishery cooperatives, fishery producers and aquaculture enterprises. The officers from the each districts of RTMFAL collect data every three months and send these data to RTMFAL. After 2013, "Certificate of Origin" (CO) is used by the owner of the fishing vessel or cooperatives for the eels harvested. COs are recorded to Fisheries Information System. Sales notes are issued by the companies which intend to export eel to the EU or third

countries. CITES certificate is issued by RTMFAL. This system will serve more reliable data collection about catching of eels.

3.3.1 Commercial

The MADES system collects data on commercial eel landings. According to Turkish Statistical Institute the time-series data on European eel (larger than 50 cm in length) is seen in Figure 3.2.1. The regular data are recorded from 1994. However, annual production of eel in Turkey in the period from 1973 to 1981 was recorded as between 224 and 588 tons (Oray, 1987; TUIK 2013, 2015). Adana, Antalya and Muğla have the rivers including with the most dense eel population (Table 3.1).

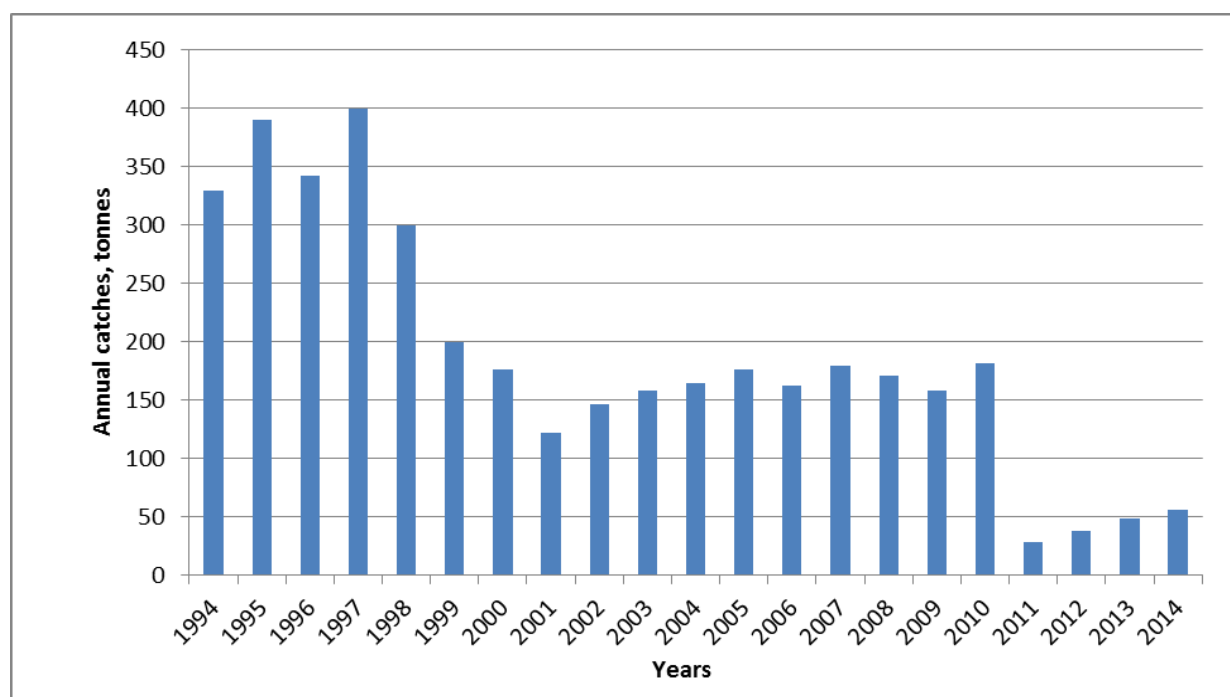


Figure 3.2.1. Annual catches of European eel in Turkey.

Table 3.1. The annual catch of eels in different localities (TUIK, 2013; TUIK, 2015).

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Adıyaman	30	35	30	16	18							10	14	12	12		1	1	2
Kahramanmaraş	6	12	10	5	3														
Osmaniye						13	5	5	7	6	5	8	5	6	6		1	2	3
Hatay	12	14	10	6	4	3	3	4	3	7	15	14	12	11	11		1	1,5	1
Adana	140	150	100	70	65	25	23	25	29	39	29	27	25	23	27	0,7	3	3	5
Mersin	7	8	6	4	6	7	11	13	11	22	15	12	9	8	8	0,9	3	3	3
Antalya	24	30	20	14	10	6	9	10	15	18	16	15	13	11	11	0,2	2	3	3
Isparta				2	1	1			2										
Muğla	58	64	65	49	45	40	47	48	47	32	34	37	35	33	39	4,1	5	13	13
Aydın	20	25	20	12	8	2	17	18	17	21	21	32	37	35	43	9,1	8	7,5	9
Denizli																0,8	1		
İzmir	10	14	12	6	5	9	13	14	12	15	13	13	12	10	13	1,8	4	2	2
Manisa	14	18		6	4	3													
Çanakkale	5	8	6	4	4	11	19	21	22	16	13	10	7	7	9	10,7	8	10,2	12
Edirne	5	10	6	4	3	2					1	1	2	2	3		1	2	3
İstanbul	2	4																	
Kocaeli				1															
Sinop	6	8	4																
Tokat			11																

Black Sea Region and
Record discontinued

3.3.2 Recreational

No available data.

3.4 Aquaculture production

No aquaculture production in Turkey.

3.4.1 Seed supply

No seed supply.

3.4.2 Production

No aquaculture production in Turkey.

3.5 Stocking

No stocking in Turkey.

3.5.1 Amount stocked

No aquaculture production in Turkey.

3.5.2 Catch of eel <12 cm and proportion retained for restocking

Catch of eel <50 cm is forbidden in Turkey.

3.6 Trade in eel

The exported European eel has decreased dramatically since the listing of the species in CITES in 2009. 420 kg in 2009. The exported amount of eels are:

- 14 866 kg in 2010;
- 4500 kg in 2011;
- 380 kg in 2012;
- 0 kg in 2013;
- 0 kg in 2014.

This amount of export leads losses of benefits and effects negatively the fishermen who provide their livelihood by hunting these fish. In order to respect the right of these fishermen, the governmental officers from RTMFAL things that the amount to be exported eel should be increase in a reasonable amount but not zero.

4 Fishing capacity

No available data.

4.1 Glass eel

No glass eel fisheries in Turkey.

4.2 Yellow eel

No available data.

4.3 Silver eel

4.4 Marine fishery

All the fisheries are in Estuarine and freshwaters.

5 Fishing effort

Fykenet is principle fishing gear for commercial fishing. The type and number of the nets are not recorded. Therefore, there is not any fishing effort in order to measure the fishing effort for eels.

5.1 Glass eel

No glass eel fisheries in Turkey.

5.2 Yellow eel

No available data.

5.3 Silver eel

No available data.

5.4 Marine fishery

All the eels fishery are in freshwater and estuaries.

6 Catches and landings

Because of restriction in eel size (allowed only longer than 50 cm in length), the annual collected catch data can be assumed as the silver stage of eel in Turkey. Fykenet is the principle fishing gear in commercial catches and hook is used in recreational fishing. All the catches are transported to the market alive, so catches and landings data are assumed the same in Turkey.

6.1 Glass eel

No glass eel fisheries in Turkey.

6.2 Yellow eel

No available data.

6.3 Silver eel

The total catches of Turkey has dramatically decreased after 1997 and 2010. The main reason for this second decline could be the obligatory used quota of EC regulation. The export of European eel is forbidden since 2010. In Turkey most of the landed eel is exported to European countries. After this regulation total catches of eel might have decreased (Figure 6.1). The downward trend in annual catches of eels are more or less the similar in different locations. Adana (Yumurtalık) and Muğla (Köyceğiz) take place important part in the landings of eel in Turkey (Figure 6.2).

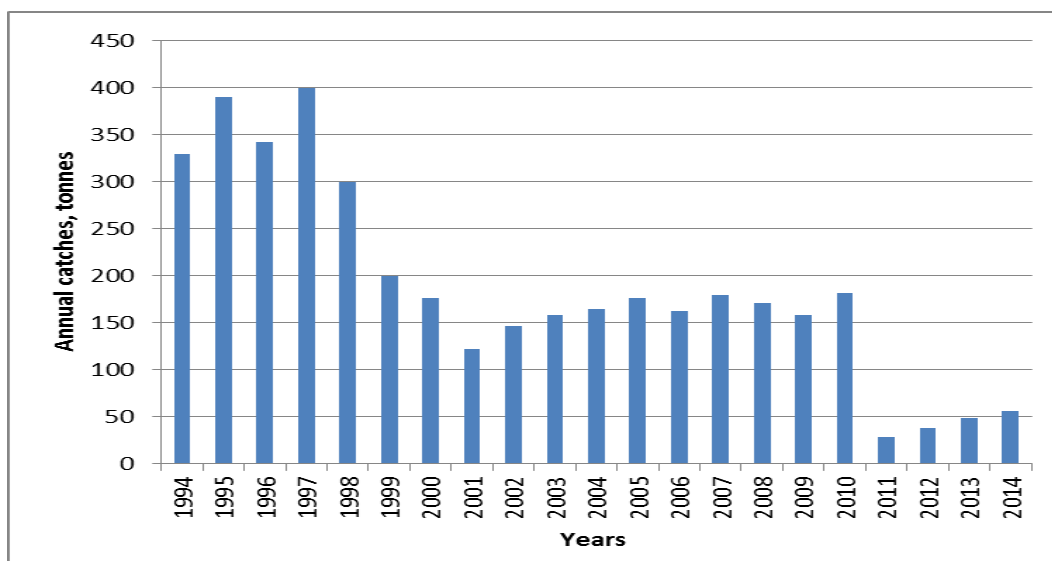


Figure 6.1. The annual catches of eel in Turkey.

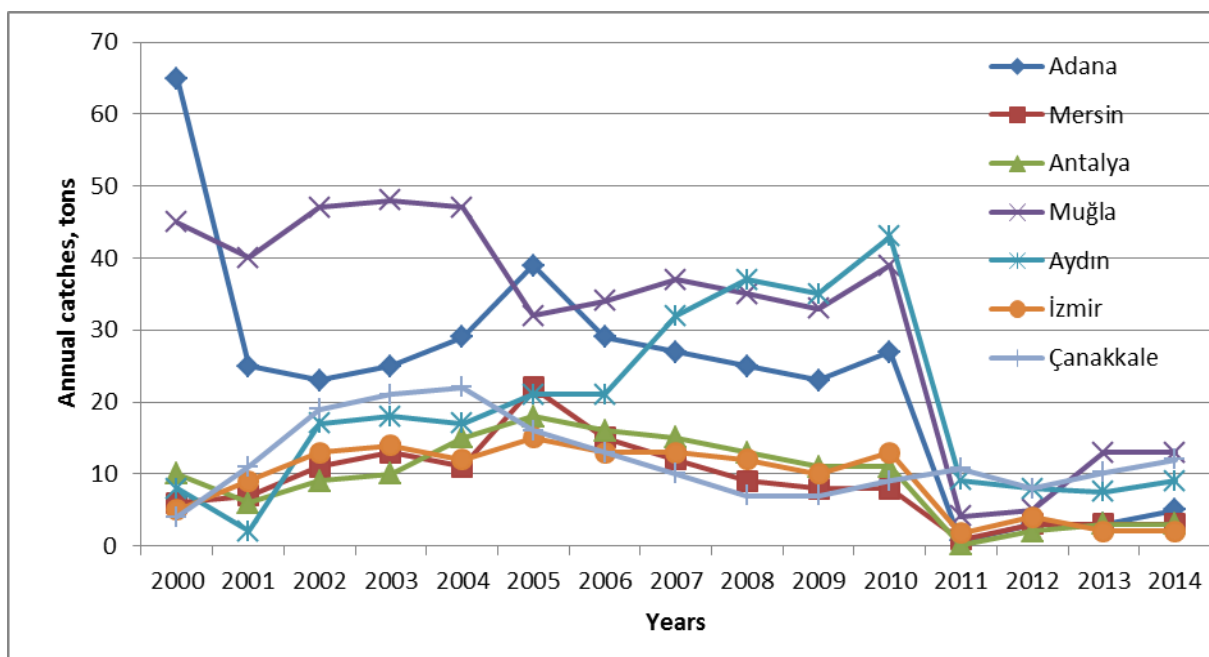


Figure 6.2. The annual catches of eels in different cities of Turkey.

6.4 Marine fishery

All the eel fishery are made in freshwater and estuaries. No eel fishery on marine area.

7 Catch per unit of effort

No available data.

7.1 Glass eel**7.2 Yellow eel****7.3 Silver eel****7.4 Marine fishery****8 Other anthropogenic impacts**

There are some data on habitat degradation. Aksungur *et al.* (2011) discussed the negative impacts of dam barriers on migration animals. Üçüncü and Altındağ (2012) also focused on the dam barriers in Turkey. They indicated that most dams have not any passageway and even if there is passageway on the dams, it does not work effectively. Yalçın Özdilek *et al.* (2015) also indicated the negative impact of dams on the migratory animals such as *A. anguilla* in along the river system. However, there is not direct quantitative record on the effects of dams on particularly eels.

9 Scientific surveys of the stock

No available data.

10 Catch composition by age and length

No available data.

11 Other biological sampling**11.1 Growth, silvering and mortality****Asi River, Hatay**

There are limited data on the growth parameters of European eel. Yalçın Özdilek *et al.* (2006) recorded the von Bertalanffy parameters in the River Asi, which is in the Hatay (Table 11.1). Eels in the River Asi grow fast and mean growth rate was at about 13 cm per year for the modal age group and 9 cm averaged over all observations. Temperature is the main factor driving to growth. Since these fastest growing stocks will be of major significance for overall dynamics of the whole population.

Table 11.1. The growth parameters calculated from von Bertalanffy equation in Asi River (Yalçın Özdilek *et al.*, 2006).

	L_{∞}	W_{∞}	K	T0	PHI PRIME (°)
Females	73.73	881.65	0.38406	0.486	3.32
Males	63.05	631.22	0.27547	-0.767	3.04
Both	67.57	730.74	0.37377	-0.108	3.23

11.1.1 Length and weight and growth**Asi River**

The weight-length relationships were reported as $W = 0.0007L^{3.27}$ ($n = 315$, $r^2 = 0.96$), $W = 0.001L^{3.20}$ ($n = 90$, $r^2 = 0.95$) and $W = 0.001L^{3.17}$ ($n = 34$, $r^2 = 0.90$) for all samples, females, and males, respectively (Yalçın Özdilek *et al.*, 2006). Otolith reading indicated age ranged from one to 18 years. Modal age was three (26%) in females, two (39%) in

males, and three (38%) in combined specimens. The female ratio is 0.73. Otolith readings indicates that the yellow eels spent their entire yellow eel stage in freshwater and did not return to salt water after they recruited to the River Asi (Lin *et al.*, 2011). The condition factors were recorded as 0.22 ± 0.15 and 0.20 ± 0.04 for females and males respectively (Yalçın Özdilek and Solak, 2007).

Göksu Delta, Mersin

The mean body weight and length of migration female silver eels were recorded 890.27 g and 72.90 cm respectively and in female yellow eels mean total body length was measured 57.45 cm and mean body weight 384.86 g in the Göksu Delta/Mersin (Rad *et al.*, 2013). Some life-history parameters recorded from the same location is given in Table 11.2 (Rad *et al.*, 2013).

Table 11.2. Mean values (\pm standard deviations) of morphological-biometric parameters and indices of migrating female silver and yellow eels from Göksu Delta, Mersin (Rad *et al.*, 2013).

TRAITS	YELLOW EELS		MIGRATING SILVER EEL	
	N	Mean \pm SD	N	Mean \pm SD
Total length (cm)	38	57.45 \pm 5.83	18	72.90 \pm 4.88
Body weight (g)	38	384.66	18	890.27 \pm 192.23
Gonad weight (g)	38	2.43 \pm 2.81	18	15.82 \pm 3.73
Liver weight (g)	38	7.32 \pm 5.18	18	12.01 \pm 3.17
Eye index (IE)	38	6.07 \pm 1.54	18	8.42 \pm 1.80
Fin index (IF)	38	4.91 \pm 0.34	18	5.02 \pm 0.9
Gonado-somatik indeks, IG (%)	38	0.59 \pm 0.47	18	1.78 \pm 0.29
Hepato-somatik indeks, IL (%)	38	1.54 \pm 0.89	18	1.37 \pm 0.27
Condition factor, K	38	0.18 \pm 0.041	18	0.22 \pm 0.032

Karamenderes River, Çanakkale

During 2014 survey 96,7% and 3,3% of *A. anguilla* population is yellow and silver in Karamenderes, Çanakkale, respectively. The mean weights and total length of silver and yellow eels were recorded as 110.2 g \pm 14.4 and 38.96 cm \pm 1.1, 138,5 g \pm 64.8 and 42.24 cm \pm 7.36. Females were dominant in the yellow eels (M:F ratio is 0.58), silvers (only 3.3% of all population) were males (MSc Thesis of İnci Balkan, unpublished data).

11.2 Parasites and pathogens

Anguillicola crassus is a common pathogenic swimbladder parasite in the eels. Genç *et al.* (2005) recorded that 78% of the eels were infected by this parasites in Ceyhan River. Comparing to this ratio the eels in the Asi River (22,6%) are less infested (Yalçın Özdilek and Solak, 2007).

11.3 Contaminants

The heavy metal contamination is the other anthropogenic impact on eels. Yılmaz (2009) indicated that Pb, Zn and Cd concentrations in edible parts of *A. anguilla* were higher than the Turkish Food Codex, European Units and World Health Organisation limits for human consumption in Köyceğiz, Muğla.

11.4 Predators

No available data.

12 Other sampling

No available data.

13 Stock assessment**13.1 Local stock assessment**

No available data.

13.2 International stock assessment

No available data.

13.2.1 Habitat

The eels are found in all the wetted habitats (lacustrine, riverine, transitional & lagoon and coastal). However, commercial fishing is focused on the lagoons.

13.2.2 Silver eel production***13.2.2.1 Historic production***

No available data.

13.2.2.2 Current production

No available data.

13.2.2.3 Current escapement

No available data.

13.2.3 Impacts

No available data.

13.2.3.1 Stocking requirement eels <20 cm

No glass eel fisheries.

13.2.3.2 Summary data on glass eel

No glass eel fisheries.

13.2.3.3 Data quality issues

No glass eel fisheries.

14 Sampling intensity and precision

No available data.

15 Standardisation and harmonisation of methodology

15.1 Survey techniques

15.2 Sampling commercial catches

15.3 Sampling

15.4 Age analysis

15.5 Life stages

15.6 Sex determinations

16 Overview, conclusions and recommendations

Turkey has just integrated in this working group. There is big gap on data on European Eel such as life-history traits, recruitment, landings, the fish stock and management. Turkey has many eel habitats and the high growth rate might be important for the whole eel stock. The landings data from Turkey indicate that as seen on the other subpopulations, the eel population is also decreasing in Turkey too. Particularly there are two important dramatic decrease in annual catch data. One is the 31% decrease in 1998 and the other is 16% decrease in 2010. Decrease in the annual catch data may partly be explained by restriction on the export quota which may affect the commercial fishing capacity. Because the most of the catches were exported the European countries, lots of fishermen may give up fishing efforts after quota regulation. The annual commercial catching data not indicate the real stock. Unfortunately there are many gaps in eel fish and fishery biology in Turkey. Therefore, urgent reliable and usable data should be collected via a monitoring programme and an effective management plan should be improved in Turkey.

GFCM has started a pilot action in order to assess the present stocks for particularly the limited data all for Mediterranean countries. Turkey has taken a part in this action with limited data and the results are very arguable. However, this intention has triggered the Turkish scientists to start doing something on eel biology, fishery, monitoring and conservation activities. A Turkish scientist has group come together and produced some projects and actions about collecting minimum reliable data for assessment and for presenting country reports in the next years. Of course the year's data are insufficient to assess real eel fishery assessment; however it will be beginning and a basic action. The Turkish government intends to improve any other activities on conservation and sustainable fisheries of this species.

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Report on the eel stock and fishery in United Kingdom 2014/2015

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Reporting Period: This report was completed in November 2015, and contains data up to 2014 and some provisional data for 2015.

2 Introduction

2.1 UK overview

Eel are widespread throughout estuaries, rivers and lakes of the UK, with the possible exception of the upper reaches of some rivers, particularly in Scotland, due to difficulties of access.

There are eleven Eel Management Plans (EMPs) for England and Wales, including one shared with Scotland, one for the remainder of Scotland, and three in Northern Ireland including one shared with the Republic of Ireland (Figure 1). Most of the UK EMPs have been set at the River Basin District (RBD) level, as defined under the Water Framework Directive. The RBDs in Northern Ireland deviate slightly from those defined for the WFD, owing to their transboundary nature. The North Western International EMP is a transboundary plan with the Republic of Ireland.



Table 1. The ICES ecoregions into which the UK RBDs (EMUs) drain.

EMU CODE	ICES ECOREGION	RIVER BASIN DISTRICT (RBD)
GB_Sco	Celtic Sea & North Sea	Scotland
GB_Neag	Celtic Sea	Neagh Bann
GB_NorE	Celtic Sea	Northeastern
GB_NW*	Celtic Sea	Northwestern
GB_Nort	North Sea	Northumbria
GB_Humb	North Sea	Humber
GB_Angl	North Sea	Anglian
GB_Tham	North Sea	Thames
GB_SouE	North Sea	Southeast
GB_SouW	Celtic Sea	Southwest
GB_Seve	Celtic Sea	Severn
GB_Wale	Celtic Sea	Western Wales
GB_De	Celtic Sea	Dee
GB_NorW	Celtic Sea	Northwest
GB_Solw	Celtic Sea & North Sea	Solway-Tweed

* International EMU shared with Ireland.

2.2 England and Wales

Responsibility for the management of eel fisheries rests with the Environment Agency in England and with Natural Resources Wales in Wales. All fishing for eel requires authorisation, which is subject to standard national conditions that control seasons, methods, apply geographic restrictions and other measures to protect bycatch species. The Environment Agency, under formal agreement, issues authorisations on behalf of Natural Resources Wales for those fisheries operating in Wales.

Standard conditions allow the use of four instrument types for eel fishing: permanently fixed traps (e.g. weir or rack traps and 'putts'); moveable or temporary nets or traps without leaders or wings and with a maximum diameter of less than 75 cm; moveable or temporary nets or traps with leaders or wings with a maximum diameter of less than 100 cm (usually fykenets); and elver (glass eel) dipnets. Recreational angling is permitted using rod-and-line but all rod-caught eels must be returned alive to the waters from where they were caught. Appendix 1 in the 2007 UK report provides a summary description of netting and trapping methods used to catch eels in England and Wales.

Conditions also stipulate that all eel (apart from glass eel) less than 300 mm in length must be returned to the water, that no part of any net, wing or leader shall be made of a mesh greater than 36 mm stretched mesh, and that monofilament material is prohibited (except for an elver dipnet or fishing with rod-and-line). It is also a requirement that nets set in tidal waters should not dry out, unless they are checked just before they do so, and that nets should not cover more than half the width of the watercourse, or should not be set closer than 30 m apart (apart from in still waters and tidal waters). All fykenets must be fitted with an otter guard (a 100 mm square mesh hard plastic frame, fitted in the mouth of the first trap, to prevent otters becoming trapped in the nets). No fishing is allowed within 10 m upstream or downstream of any obstruction. Elver dipnets must be used singly, by hand and without the use nets,

chains, or boats. Small wingless traps and winged traps (fykes) can be used across the whole of England and Wales unless local byelaw restrictions apply.

Since 2010, the yellow and silver eel fisheries have been limited to those individuals who were already licensed, and these individuals are limited to the number of nets that they can apply for based on previous effort. Applications from newcomers are considered, but only for scientific studies, stock monitoring or for personal consumption. Thus, commercial fishing is effectively capped to existing fisherman who can use up to a maximum number of nets.

The glass eel fishery is restricted to two zones: in parts of South Wales and Southwest England, and in parts of Northwest England.

Every authorized instrument must carry an identity tag issued by the Environment Agency and it is a legal requirement that all eel and elver fishermen submit a catch return. The Environment Agency, under formal agreement, collates catch return information on behalf of Natural Resources Wales. Eel fishers are required to give details of the number of days they have fished, the location and type of water fished, the total weight of eel caught and retained or a statement that no eel have been caught. Annual eel and elver net authorization sales and catches are summarized by instrument type for England and Wales and reported in the "Salmonid and Freshwater Fisheries Statistics for England and Wales" series (www.environment-agency.gov.uk/research/library/publications/33945.aspx).

2.3 Scotland

Eel fisheries have never been regulated in Scotland, and the last known fishery closed in 2005. Legislation was introduced in 2009 requiring anyone wishing to fish for eel in Scotland by any method must obtain a licence from the Scottish ministers.

2.4 Northern Ireland

Lough Neagh in Northern Ireland is the largest freshwater lake in the UK. Prior to 1983, estimates of annual recruitment of glass eel to the Lough consistently exceeded 6 million and averaged in excess of 11 million (based on a mean weight of 3000 glass eel per kg). Productivity is such that the Lough sustains a large population of yellow eel and produces many silver eels that migrate via the out-flowing Lower River Bann.

The system sustains the largest remaining commercial wild eel fishery in Europe, producing 16.3% of total EU landings and supplying 3.4% of the entire EU market (wild-caught + aquaculture) in 2013. Fishing rights to all eel life stages are owned by the Lough Neagh Fishermen's Co-operative Society (LNFCS). The fishery is managed to enable the capture of approximately 250–350 t of yellow eel and 75–100 t of silver eels annually, with an escapement of silver eels at least equivalent to the catch of silvers. Whilst it is illegal to fish for glass eels in N. Ireland, provision is made whereby LNFCS staff are allowed to catch glass eels using dragnets below a river-spanning sluice gate, which creates a barrier to upstream juvenile eel migration, for onward placement into L. Neagh. Elvers are also trapped at the same location and placed into the Lough.

The yellow eel fishery (May–September, five days a week) supports 80–90 boats each with a crew of two men using draftnets and baited longlines. Eels are collected and marketed centrally by the cooperative. Silver eels are caught in weirs in the Lower River Bann. Profit from the less labour-intensive silver eel fishery sustains the management of the whole cooperative venture, providing working capital for policing,

marketing and stocking activity and an out of season bonus payment for yellow eel fishermen at Christmas.

Natural recruitment has been supplemented since 1984 by the purchase of glass eel from outside the RBD. Approximately 106.5 million (35.5 t) additional glass eel have been stocked by the LNFCs. Reviews on the fishery, its history and operation can be found in Kennedy (1999) and Rosell *et al.* (2005).

The cross-border Erne system is comparable in size to L. Neagh and produced a fishery yield in the region of 33 t of eels per year. Within N. Ireland, Upper and Lower Lough Erne sustained a small-scale yellow eel fishery, which was closed in 2010 under the terms of the NWIRDB Eel Management Plan (EMP). There has been no commercial silver eel fishery on the Erne since 2001, but a trap and truck conservation silver eel fishery was instigated in 2009. Elvers are trapped at the mouth of the River Erne using ladders placed at the base of the hydroelectric facility that spans the Erne, and trucked upstream into the Erne lake system. A comprehensive study into the structure, composition and biology of the eel fisheries on the Erne was conducted by Matthews *et al.* (2001).

Overall policy responsibility for the supervision and protection of eel fisheries in Northern Ireland, and for the establishment and development of those fisheries rests with the Department of Culture, Arts and Leisure (DCAL). The Agri-Food and Biosciences Institute for N Ireland (AFBI) are employed by DCAL to provide the scientific basis for eel management in Northern Ireland.

3 Time-series data

3.1 Recruitment

3.1.1 Glass eel recruitment

3.1.1.1 Commercial

England & Wales

The glass eel fisheries of England and Wales are prosecuted by hand-held dipnets, in estuaries draining into the Bristol Channel, in particular from the Rivers Severn, Wye and Parrett, with smaller fisheries elsewhere, such as that in Morecambe Bay, Cumbria.

Those authorized to fish for glass eel in England and Wales are obliged to report their annual catch by weight, effort in terms of days and gears fished, location and water type (coastal, river, still water). Catches reported to the Environment Agency have historically been aggregated and reported to the WG as the catch for England and Wales. In addition to these catch returns, annual trade statistics from Her Majesty's Revenue & Customs (HMRC) provided an alternative indication of catches, for the period 1979–2006. Trade reports did not discriminate by eel size or stage, and therefore a procedure was developed to estimate glass eel trade into and out of the UK, and hence net export trade; see the 2010/2011 UK Country report for further details. Comparison between the catch reported to the EA and the net exports HMRC data for 1979–2006 suggested a significant but variable level of underreporting to the Agency, by between five and 15 times.

In 2009, legislation was introduced to improve the traceability of eel caught, such that there are now three sources of data:

- 1) Catch returns to the Agency;

- 2) The quantity of glass eel bought by the dealers from the fishermen (consignment notes);
- 3) The quantity of glass eel exported from the UK or stocked within the UK.

Updating the provisional data reported to WGEEL in the UK Country Report 2013/2014 (2014: Table 2), the final catch reported to the Environment Agency for 2014 was 11.91 t of glass eel. The quantity of glass eel bought by the dealers was 11.6 t, and 12.3 t was exported or used internally (within UK), the difference between these figures normally represents the apparent loss (mortality or weight loss) between capture and sale by dealer, however for the 2014 reporting 2014, this figure had an gain of plus 6.0% by weight. This apparent gain, can be explained by the fact that approximately 600 kg of the fish caught, were donated by the fishermen for domestic restocking (effectively trap and transport) in England. These fish were received by the elver stations, but not declared as part of the consignment notes (because they were not exported).

For 2015, the provisional data (as of 28th October) of catch reported to the Environment Agency is 2.80 t, the quantity bought by the dealers was 2.8 t, and 2.7 t was exported or used internally (within UK), representing a loss (mortality and shrinkage) of 3.6% by weight.

Table 2 also presents data for catch per unit of effort (cpue) based on catch (kg) and effort (days fished) returns to the Environment Agency (see Table 33 for regional data). Though underreporting of catch and effort are recognized, the consistency in the data collection over the time period (2005–2015) allows an evaluation of the trend in stock over this time period. Over the last five years, there has been an increase in glass eel recruitment from the low of 2009 (0.29 t), to a forty-fold catch increase reported for 2014 (11.91 t), which was the best elver catch reporting year since 1996. These figures are thought to reflect a true increase in the availability of glass eel to the fishery. However, with the exception of the harvest of 2014, the catch of UK glass eel remains at the very low levels compared to those reported in the late 1990s (Table 2).

Table 2. Time-series of 'UK' glass eel commercial fishery catches reported to Environment Agency and predecessor Agencies, and as estimated from HMRC net export trade reports to 2006 and then consignment notes at first sale reported to the Environment from 2009 onwards. 'n/a' = no data available. * Note that the 2015 reported catch is provisional, as of 28 October 2015.

YEAR	CATCH REPORTS TO AGENCY (T)	HMRC NETT TRADE	DEALERS PURCHASE (T) 2009 ONWARDS	CPUE (KG/DAY)
		(TO 2006) OR CONSIGNMENT NOTES (T)		AGENCY RETURNS 2005 ONWARDS
1972	16.7	n/a		
1973	28.2	n/a		
1974	57.5	n/a		
1975	10.5	n/a		
1976	13.1	n/a		
1977	38.6	n/a		
1978	61.2	n/a		
1979	67	40.1		
1980	40.1	32.8		
1981	36.9	n/a		
1982	48	30.4		
1983	16.9	6.2		
1984	25	29		
1985	20	18.6		
1986	19	15.5		
1987	21.3	17.7		
1988	21.4	23.1		
1989	20.6	13.5		
1990	20.9	16		
1991	1.1	7.8		
1992	5	17.7		
1993	5.73	20.9		
1994	9.5	22.3		
1995	11.9	n/a		
1996	18.8	23.9		
1997	8.7	16.2		
1998	11.2	20.1		
1999	n/a	18		
2000	n/a	7.6		
2001	0.809	5.4		
2002	0.521	5.1		
2003	1.715	10		
2004	0.97	14.4		
2005	1.701	8.8		0.26
2006	1.274	8.2		0.12
2007	2.07	n/a		0.29
2008	0.816	n/a		0.13
2009	0.29	0.45	0.45	0.06

YEAR	CATCH REPORTS TO AGENCY (T)	HMRC NETT TRADE (TO 2006) OR CONSIGNMENT NOTES (T)		DEALERS PURCHASE (T) 2009 ONWARDS	CPUE (KG/DAY) AGENCY RETURNS 2005 ONWARDS
2010	1.24	1.72	1.89		0.37
2011	2.24	3.28	3.64		0.31
2012	2.77	3.61	3.82		0.29
2013	5.91	7.79	8.66		0.65
2014	11.91	12.3	11.6		1.98
2015*	2.80	2.7	2.8		0.43

Regional indices for England and Wales

Catches are now reported per “nearest waterbody” and, as such, new time-series are being developed reporting catches to basin or more likely River Basin District (Table 3).

Table 3. Commercial catches (kg) of glass eel from England and Wales RBDs reported to the EA, 2005 to 2014. Note that the 2013 catches are updated from the provisional data reported in the 2013 report, the *2015 catches are provisional (as of 28th October 2015), and that no glass eel fisheries operate in the other RBDs, i.e. Northumbria, Humber, Anglian, Thames and Solway-Tweed.

YEAR	NORTHWEST	DEE	WEST WALES	SEVERN	SOUTHWEST	SOUTHEAST
2005	166.2	39.0	87	784.8	626.5	0
2006	116.1	5.5	37	631.3	482.7	1.5
2007	200.0	6.3	26	1172.5	669.0	0
2008	91.6	2.0	3.8	370.7	348.6	0
2009	19.6	0.5	0	76.8	194.5	0
2010	30.3	4.8	1.1	531.7	756.5	0
2011	75.8	12.9	2.5	897.5	1249.8	0
2012	35.8	16.9	0.0	1151.5	1568.7	0
2013	81.0	14.8	23.3	2693.0	3095.0	0
2014	1.38	0	33.9	6125.9	5610.8	0
2015*	105.9	17	0	1299.6	1382.2	0

Scotland and Northern Ireland

There are no commercial glass eel fisheries in Northern Ireland or Scotland.

3.1.1.2 Recreational

There are no recreational fisheries for glass eel in the UK.

3.1.1.3 Fishery-independent

Fisheries-independent data are available for two sites: Leighton Moss (North West RBD) and Brownhill (GB_Angl), and these are shown in Figure 2 and Table 4, respectively. Leighton Moss is at Lat: 54.16814N, Long 2.80107E), and Brownhill is at Lat: 52.335134N Long: 0.008595E

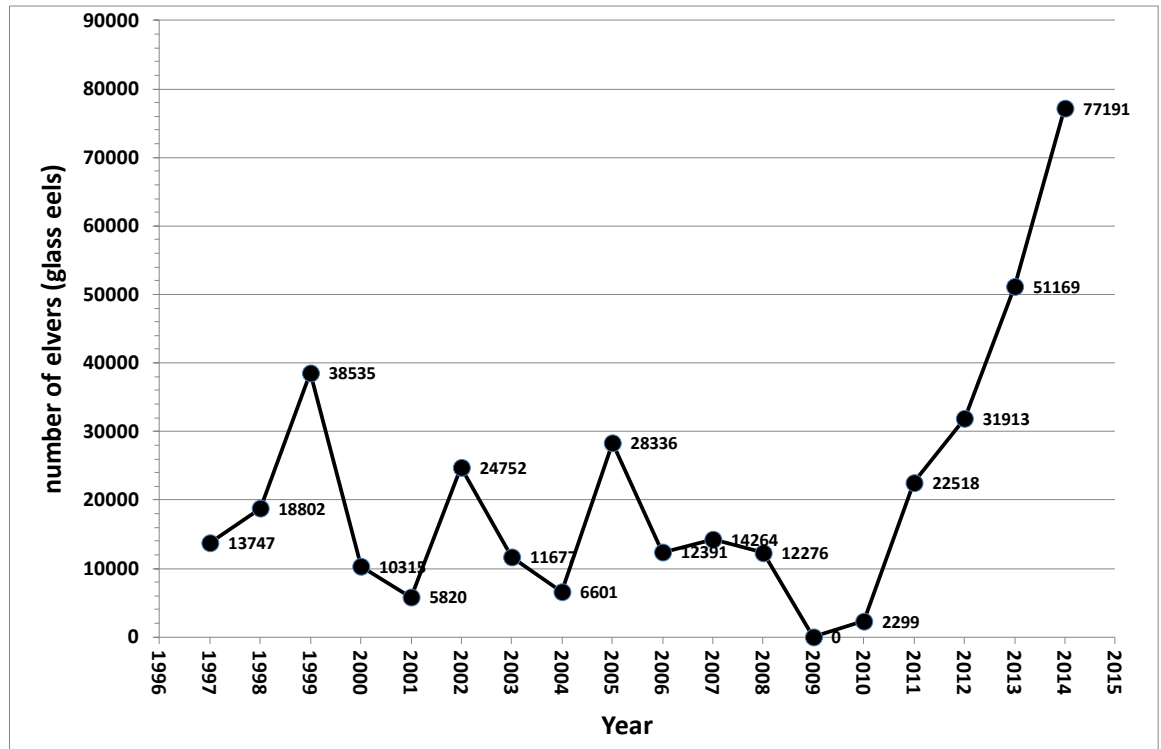


Figure 2. Trend in the number of glass eel counted at Leighton Moss (GB_NorW) between 1997 and 2014, there was no count in 2009.

The number of glass eel counted at Brownhill on the River Great Ouse (GB_Angl) between 2011 and 2015 (Table 4). In 2012 the trap was not operational for a long period due to summer flooding; the catching chamber was completely flooded out.

Table 4. The number of glass eel (<80 mm) counted at Brownhill on the River Great Ouse (GB_Angl) between 2011 and 2015 (as of October 22nd 2015). *2012 represents a partial count.

YEAR	GLASS / PIGMENTED <80 MM
2011	5175
2012*	24
2013	36 908
2014	633
2015	476

For two sites in the Thames EMU (GB_Tham) the trend in the number of glass eel is shown in Figures 3 and 4.

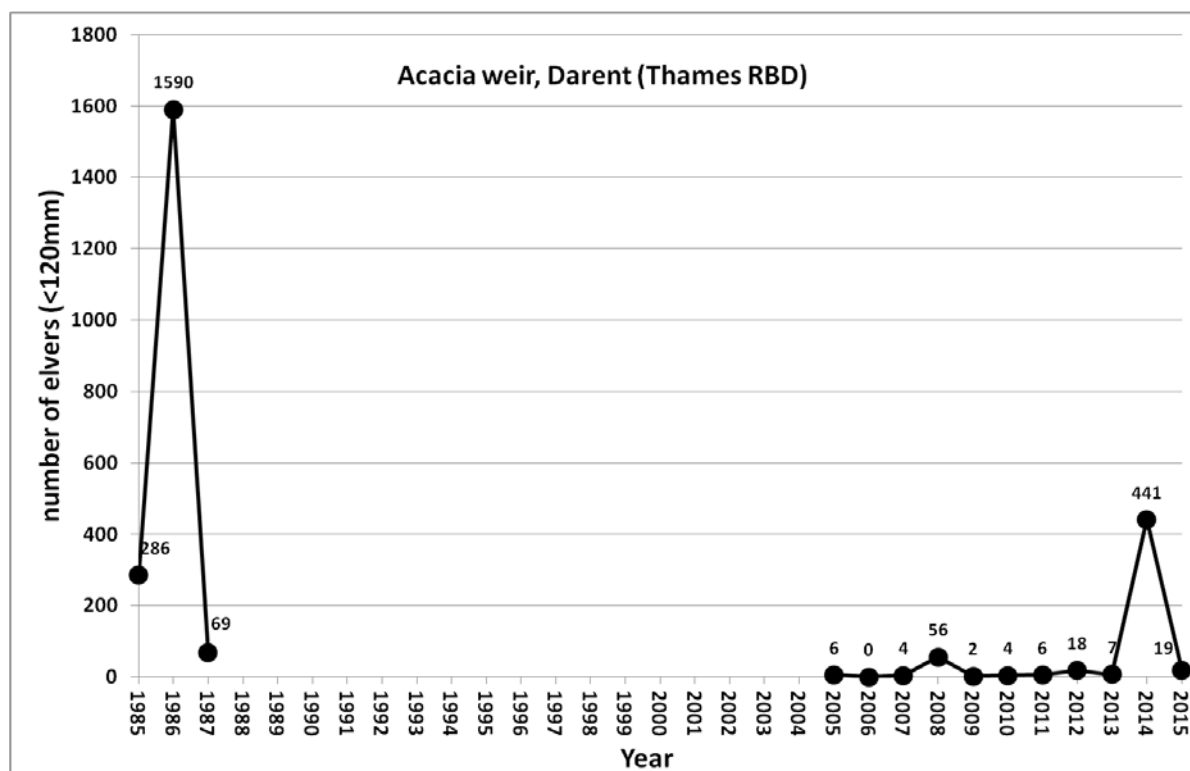


Figure 3 Time-series of glass eel counts on the River Darent (GB_Tham).

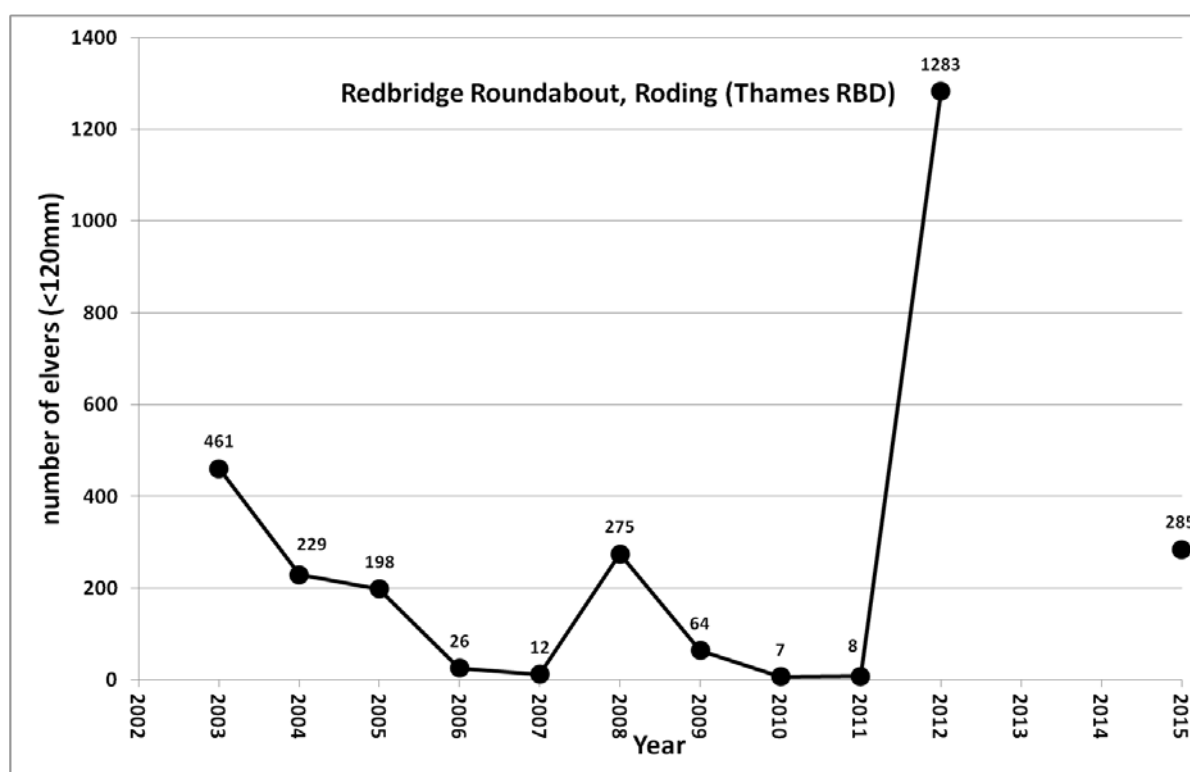


Figure 4. Time-series of glass eel counts on the Roding (GB_Tham).

Scotland

A time-series for glass eels ascending the Shieldaig River in Wester Ross, using pin-hole traps fishing from March to July inclusive was instituted in 2014. Table 5.

Table 5. Number of ascending elvers at the mouth of the Shildaig River, GB_Sco.

YEAR	UNPIGMENTED EELS <80 MM	
	Number	Mean length (mm)
2014	176	70
2015	46	70

Northern Ireland

The LNFCS catch glass eels using dragnets with an area of 0.94 m², fished below a river-spanning sluice gate, which creates a barrier to upstream juvenile eel migration on the River Bann. A record of total catch per night is recorded, but not catch per individual net. These, and elvers trapped at the same location, are transported upstream to be stocked into the Lough. These catches provide a time-series of 'natural' recruitment into the Lough (Table 6). Recruitment had shown an overall downward trend to only 16 kg (approximately 48 000 glass eel) in 2011, which was the lowest catch on record. The catch has increased over the following three years and recorded as to 189.3 kg, 384 kg and 698.5 kg respectively by 2014. However in 2015 recruitment fell to 306 kg. As previously noted and reported last year, elvers were once again captured in September while migrating silver eels were also found leaving the Bann.

Table 6. Glass eel recruitment to the River Bann, Northern Ireland, 1960 to 2015.

YEAR	NATURAL ELVER RUN (KG)	YEAR	NATURAL ELVER RUN (KG)	YEAR	NATURAL ELVER RUN (KG)
1960	7408.55	1979	2088.8	1998	1283.33
1961	4938.69	1980	2485.93	1999	1344.93
1962	6740.46	1981	3022.6	2000	562.8
1963	9076.7	1982	3853.73	2001	315
1964	3136.92	1983	242	2002	1091.53
1965	3801	1984	1533.93	2003	1155.93
1966	6183	1985	556.73	2004	334.6
1967	1898.77	1986	1848.47	2005	930
1968	2524.9	1987	1682.8	2006	456
1969	4008.3	1988	2647.4	2007	444
1970	3991.63	1989	1567.53	2008	24
1971	4157.07	1990	2293.2	2009	158
1972	2905.27	1991	676.67	2010	68
1973	2524.2	1992	977.67	2011	16
1974	5859.47	1993	1524.6	2012	189.3
1975	4637.27	1994	1249.27	2013	384
1976	2919.93	1995	1402.8	2014	698
1977	6442.8	1996	2667.93	2015	306
1978	5034.4	1997	2532.6		

The elver run to the River Erne is monitored by capture at a box at the foot of the dam of Cathaleens Fall hydropower station (at tidal head) and transported to upper and lower Lough Erne. This RBD is transboundary between Northern Ireland and the Republic of Ireland. The glass eel fishery operates in the Republic of Ireland, but upstream transport of that catch is distributed to both countries. The elver run to the

Erne was 73.0 kg in 2011, 132.1 kg in 2012, 219.7 kg in 2013, 659.4 in 2014 and 712.5 in 2015. The full time-series index of glass eel recruitment to this basin is reported in the Republic of Ireland Country Report.

3.1.2 Yellow eel recruitment

3.1.2.1 Commercial

There are no commercial fisheries for larger 'yellow' eel recruits, and therefore no time-series data.

3.1.2.2 Recreational

There are no recreational fisheries for larger 'yellow' eel recruits, and therefore no time-series data.

3.1.2.3 Fishery-independent

The number of yellow eels counted at Brownhill on the River Great Ouse (GB_Angl) (lat/lng: 52.335444, 0.008360) between 2011 and 2015 (Table 7). In 2012 the trap was not operational for a long period due to summer flooding; the catching chamber was completely flooded out.

Table 7. The number of yellow eels counted at Brownhill on the River Great Ouse (GB_Angl) between 2011 and 2015 (as of October 22nd 2015). *2012 represents a partial count.

YEAR	ELVER 81-120 MM	YELLOW EEL >121 MM
2011	21 331	23 690
2012*	560	54
2013	139 531	734
2014	24101	219
2015	79168	1077

The numbers of yellow eel migrating upstream past Greylake on the River Parrett (GB_SouW), 11.7 km upstream from tidal influence are recorded annually (Figure 5).

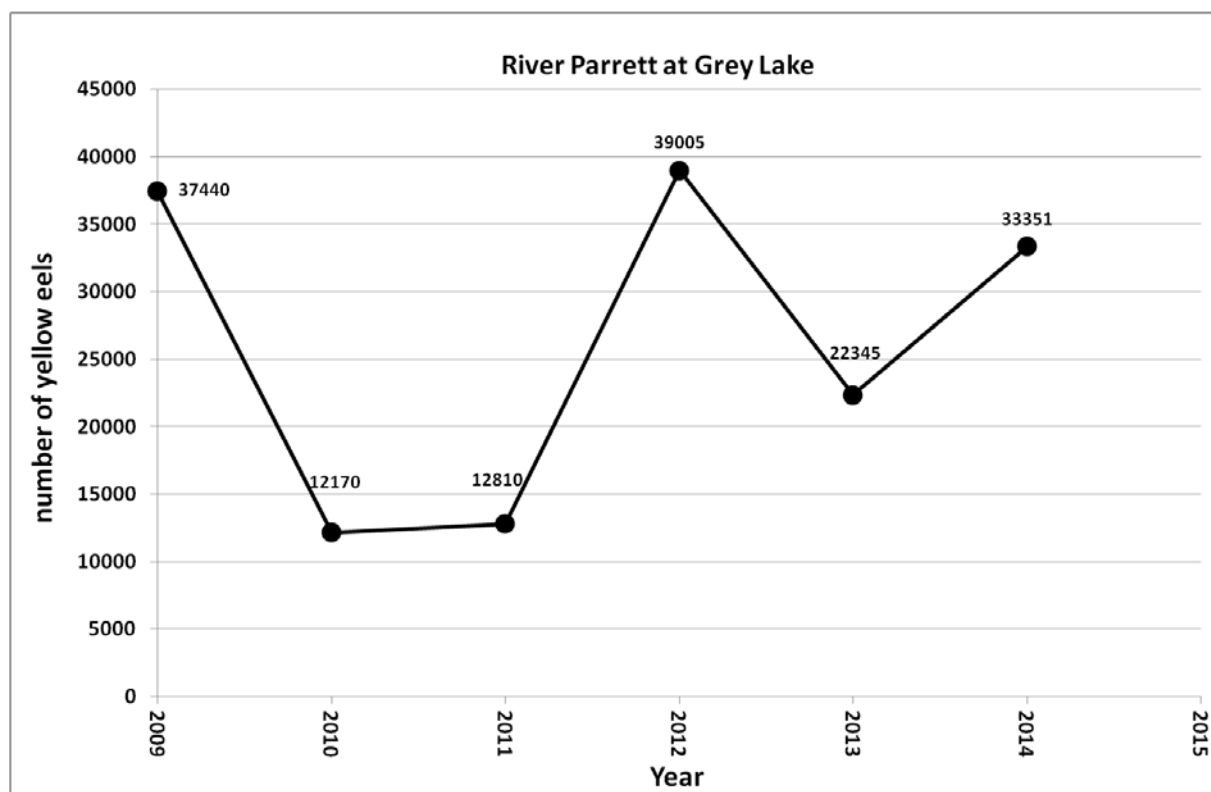


Figure 5. Time-series of yellow eel counts on the River Parrett at Greylake (GB_SouW).

Scotland

A short time-series is available of yellow eel recruitment from the mainstem River Dee into a single small catchment in northeast Scotland, the Girnock Burn. An upstream trap approximately 50 km from the sea catches upstream migrating yellow eels (length range 96–254 mm) and these are manually counted. There is uncertainty about how representative these counts are of the total upstream migration, because although there is a substantial barrier to migration at the site, eels can find alternative routes upstream. The annual counts of upstream migrants, and mean length, are presented in Table 8, the 2015 count is the lowest on record.

Table 8. Yellow eel recruitment to the Girnock Burn, a tributary of the River Dee, GB_Sco, from 2008 to 2012.

YEAR	COUNT	MEAN LENGTH (MM)
2008	572	156
2009	370	155
2010	89	156
2011	48	158
2012	273	158
2013	181	154
2014	276	159
2015	23	149

Northern Ireland

There are no fishery-independent yellow eel recruitment data.

3.2 Yellow eel landings

3.2.1 Commercial

The yellow and silver eel catches reported to the Environment Agency have historically been reported to the WG as a single catch for England and Wales. Since 2005, catches have been recorded according to the “nearest water body” and reported separately for yellow and silver eels (Tables 9 a and b).

Table 9a. Commercial catch (t) of yellow eel for Northumbria, Humber Anglian, Thames, South-east and Southwest RBDs 2005–2014.

YEAR	NORTHUMBRIA	HUMBER	ANGLIAN	THAMES	SE	SW
2005	0.005	1.295	13.065	7.175	0.406	3.787
2006	0.001	1.160	6.282	5.688	3.069	6.788
2007	0.000	2.138	3.739	6.963	1.807	2.019
2008	0.000	1.429	9.903	5.548	0.602	6.626
2009	0.045	0.411	6.616	4.745	7.029	2.546
2010	0.060	3.033	10.708	5.655	1.432	2.722
2011	0.000	4.857	16.478	6.082	1.879	3.792
2012	0.000	3.267	15.335	1.815	2.116	5.966
2013	0.000	3.865	9.351	3.991	0.286	8.688
2014	0.000	2.811	16.875	3.222	0.284	10.117

Table 9b. Commercial catch (t) of yellow eel for Severn, West Wales Dee Northwest and Solway RBDs, together with the total for England and Wales, 2005–2014.

YEAR	SEVERN	WEST WALES	DEE	NORTHWEST	SOLWAY TWEED	TOTAL
2005	0.565	0.240	0.034	1.619	0.000	28.191
2006	0.170	0.475	0.028	1.250	0.000	24.911
2007	0.068	0.273	0.023	0.211	0.000	17.240
2008	0.027	0.118	0.642	0.474	0.000	25.369
2009	0.000	0.022	0.070	0.114	0.000	21.598
2010	0.150	0.345	0.053	0.150	0.000	24.309
2011	0.350	0.252	1.082	1.477	0.000	36.248
2012	0.000	0.647	0.478	2.972	0.000	32.596
2013	0.000	0.100	0.152	0.669	0.000	27.102
2014	0.000	0.000	0.455	0.087	0.00	33.850

Scotland

There are no commercial fisheries for yellow eel in Scotland.

Northern Ireland

The supplementary stocking of glass eel and the operation of a market driven quota system for yellow eel fishing in Lough Neagh means that the yellow eel catch data are not suitable as an index time-series of yellow eel production. However, the catch data are useful for scientific understanding of eel production processes.

3.2.2 Recreational

There is no recreational time-series and no recreational fisheries targeting eel in the UK. Recreational taking of eels is prohibited without a licence in Scotland, and no licences have been issued. A bye-law to the Northern Ireland Fisheries Act 2010 prohibits the recreational taking of eels.

3.3 Silver eel landings

3.3.1 Commercial

The silver eel catches reported to the Environment Agency have historically been reported to the WG as a single catch for England and Wales. Since 2005, catches have been recorded according to the “nearest water body” (Tables 10 a and b).

Table 10a. Commercial catch (t) of silver eel for Northumbria, Humber Anglian, Thames, South-east and Southwest RBDs 2005–2014.

YEAR	NORTHUMBRIA	HUMBER	ANGLIAN	THAMES	SE	SW
2005	0.00	0.24	6.66	1.07	3.59	1.89
2006	0.00	0.32	2.42	0.97	4.10	1.90
2007	0.00	2.19	0.20	0.48	2.62	0.23
2008	0.09	0.86	1.97	0.40	1.65	0.55
2009	0.01	0.11	0.59	0.12	3.20	0.30
2010	0.00	0.20	0.74	0.07	0.82	0.17
2011	0.00	0.26	2.01	0.51	0.69	0.07
2012	0.00	1.63	2.98	0.20	0.65	0.53
2013	0.00	0.26	2.49	0.31	1.99	0.95
2014	0.00	0.480	1.483	0.384	0.975	1.167

Table 10b. Commercial catch (t) of silver eel for Severn, West Wales Dee Northwest and Solway RBDs, together with the total for England and Wales, 2005–2014.

YEAR	SEVERN	WEST WALES	DEE	NORTHWEST	SOLWAY TWEED	TOTAL
2005	0.40	0.01	0.01	0.20	0.00	14.07
2006	0.15	0.03	0.01	1.10	0.00	11.00
2007	0.12	0.14	0.01	0.09	0.00	6.08
2008	0.12	0.01	0.02	0.26	0.00	5.94
2009	1.22	0.04	0.01	0.08	0.00	5.69
2010	0.10	0.01	0.02	0.07	0.00	2.20
2011	0.38	0.01	0.12	0.27	0.00	4.32
2012	0.00	0.00	0.00	0.46	0.00	6.45
2013	0.00	0.00	0.03	0.11	0.00	6.13
2014	0.00	0.00	0.03	0.28	0.00	4.545

Scotland

There are no commercial fisheries for silver eel in Scotland.

Northern Ireland

The supplementary stocking of glass eel in Lough Neagh means that the silver eel catch data are not suitable as an index time-series of unassisted silver eel production, for present purposes. However, the catch data are useful for scientific understanding of eel production processes.

On the Erne system in the North Western International RBD, the trap and truck conservation fishery over the last five years caught approximately 19 t in 2010, 25.3 t in 2011, 29.6 t in 2012, 39.3 t in 2013 and 48.6 t in 2014.

3.4 Aquaculture production

3.4.1 Seed supply

There is no eel aquaculture in the UK.

3.4.2 Production

There is no eel aquaculture in the UK.

3.5 Stocking

3.5.1 Amount stocked

There is limited stocking undertaken in England and Wales all of which is using glass eel (Table 11) obtained from either Severn or Southwest RBD. The method in which the Environment Agency tracks the movement of fish stocks has changed. The Environment Agency's new live fish movement scheme was introduced in January 2015 with the enactment of The Keeping and Introduction of Fish (England and River Esk Catchment Area) Regulations 2015. This legislation replaced the previous controls under Section 30 of the 1975 Salmon and Freshwater Fisheries Act.

Table 11. Quantity of glass eel (kg) stocked between 2009–2015 in EMUs of England and Wales (data source: Section 30 consents).

YEAR	HUMBER	ANGLIAN	THAMES	SE	SOUTHWEST	SEVERN	WW	NW	TOTAL
2009	18.5	4.6							23.1
2010	38.0	15.2				0.4			53.6
2011		11.3	0.0			38.8			50.1
2012	10.0	1.5	3.2		5	21.5			41.2
2013	3.0	9.8	2.00		12.9	37.0	1.0		65.7
2014	3.8		14.0	7.5	8.7	21.5		0.03	55.6
2015	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Scotland

There has been no recorded stocking of eel in Scotland.

Northern Ireland

Recruitment of glass eel and elver to Lough Neagh has been supplemented by stocking of purchased glass eel since 1984 (Table 12), and these eel have been sourced from the UK glass eel fishery. However, in 2010 the 996 kg of glass eel purchased from UK Glass Eel Ltd originated from fisheries in San Sebastian, Spain and the west coast of France: no glass eels from UK waters were purchased. In 2011 and 2012, glass eel from UK and French sources were stocked into Lough Neagh though all were purchased from UK Glass Eels Ltd. In 2013 and 2014 1866 kg and 2680 kg respectively of entirely UK sourced glass eels were stocked into L. Neagh. Due to availability issues and lower European glass eel harvests stocking in 2015 fell to 604 kg from the River Severn.

Glass eel are not routinely quarantined before stocking into Lough Neagh, but arrive from UK Glass Eels Ltd with a Veterinary Health certificate. However, following the recent purchases from outside the UK, 1 kg of each new delivery is held in tanks and survival rates monitored for several weeks.

In 2014, for the first time ever, the River Lagan in the NERBD was stocked with 20 kg of glass eel purchased by the LNFCS from UK Glass Eels Ltd. This was not repeated in 2015 due to lack of glass eels and availability timings.

2014 was also the first time that glass eel going into Lough Neagh (and the River Lagan) were marked using Strontium Chloride.

Table 12. Weight (kg) of glass eel stocked into Lough Neagh, 1984 to 2015.

YEAR	GLASS EEL (KG)	YEAR	GLASS EEL (KG)
1984	1334.67	2001	0
1985	3638.51	2002	1007
1986	5935.16	2003	1368.03
1987	4584.07	2004	427.09
1988	2107	2005	718.67
1989	0	2006	330
1990	0	2007	1000
1991	0	2008	428
1992	785.87	2009	215
1993	0	2010	996
1994	771.87	2011	1035
1995	686	2012	1300
1996	33.19	2013	1866
1997	70.47	2014	2680
1998	17.27	2015	604
1999	1200		
2000	150.33		

2.5.2 Catch of eel <12 cm and proportion retained for restocking

There are no long-term time-series of data on restocking. The catch is that reported in Section 3.1.1.1 (Table 2), but there are historic issues of underreporting the catch which mean that it is not appropriate to derive a proportion stocked from this historical catch data. New measures to accurately record catch and proportion retained for stocking have been implemented as part of the EMPs.

Confirmed data for 2014, shows that 11.6 t of UK caught glass eels were bought by dealers, of which 31.0% were subsequently used in stocking, 63.0% for aquaculture and 7.0% for direct consumption (Table 13). Provisional data for 2015 show the 2.8 t of UK caught glass eels were purchased by dealers, and that 73% were used for stocking and 27% for aquaculture.

Table 13. Percentage of glass eel caught in the UK and used for stocking, aquaculture or direct consumption. [Note these percentages may not add up to 100% because of mortality and weight loss after capture].

	2009	2010	2011	2012	2013	2014	2015
Stocking	100	53.8	43.9	84.7	72.6	62.9	73.0
Aquaculture	0	36.5	45.3	10.5	27.4	28.2	27.0
Direct Consumption	0	0	0	0	0	6.7	0

The destinations and tonnages of glass eel caught in the UK are shown in Table 14.

Table 14. The destination and tonnages of glass eel caught in the UK.

	2009	2010	2011	2012	2013	2014	2015
Belgium					4		
Czech Republic			30	76	470	594	0.032
Denmark		200	515	400		400	0.250
Estonia			307	90	480	420	0.250
France						863	0.100
Germany		97	882	384	470	1199	0.323
Greece			411		1005	650	0.040
Latvia			100	343	15	483	
Lithuania					180	330	
Netherlands		1288	593	100	1620	2232	0.350
Poland				120	95	15	0.005
Slovakia		85	80				
Spain						500	
Sweden	205			1200	1300	1400	0.697
UK	240	54	366	921	2151	3300	2.719

3.5.3 Reconstructed time-series on stocking

England and Wales

There is limited stocking undertaken in England and Wales all of which is using wild glass eel (Table 15) obtained from either Severn or Southwest EMU.

Table 15. The quantity of glass eel stocked (kg) in England & Wales, 2009–2015.

YEAR	HUMBER	ANGLIAN	THAMES	SE	SOUTHWEST	SEVERN	WW	NW	TOTAL
2009	18.5	4.6							23.1
2010	38.0	15.2				0.4			53.6
2011		11.3	0.0			38.8			50.1
2012	10.0	1.5	3.2		5	21.5			41.2
2013	3.0	9.8	2.00		12.9	37.0	1.0		65.7
2014	3.8		14.0	7.5	8.7	21.5		0.03	55.6
2015	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Scotland

There is no stocking taking place in Scotland.

Northern Ireland

Table 16. Reconstructed time-series of eel stocking (kg) in Northern Ireland.

Year	LOCAL SOURCE				FOREIGN SOURCE			
	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured
1984	1334.67				0			
1985	3638.51				0			
1986	5935.16				0			
1987	4584.07				0			
1988	2107				0			
1989	0				0			
1990	0				0			
1991	0				0			
1992	785.87				0			
1993	0				0			
1994	771.87				0			
1995	686				0			
1996	33.19				0			
1997	70.47				0			
1998	17.27				0			
1999	1200				0			
2000	150.33				0			
2001	0				0			
2002	1007				0			
2003	1368.03				0			
2004	427.09				0			
2005	718.67				0			
2006	330				0			
2007	1000				0			
2008	428				0			
2009	215				0			
2010	0				996			
2011	321				714			
2012	900				400			
2013	1866				0			
2014	2700				0			
2015	604				0			

3.6 Trade in eel

In the UK glass eel are obtained from five EMUs (Southwest, Severn, West Wales, Dee and Northwest) these are treated as one group for the purpose of exports / destinations (Table 17).

Table 17. The quantities (kg) and destinations of glass eel caught in the UK, 2009–2015.

	2009	2010	2011	2012	2013	2014	2015
Belgium					4		32
Czech Republic			30	76	470	594	250
Denmark		200	515	400		400	250
Estonia			307	90	480	420	100
France						863	323
Germany		97	882	384	470	1199	40
Greece			411		1005	650	
Latvia			100	343	15	483	
Lithuania					180	330	350
Netherlands		1288	593	100	1620	2232	5
Poland				120	95	15	
Slovakia		85	80				
Spain						500	697
Sweden	205			1200	1300	1400	2719
UK	240	54	366	921	2151	3300	32

Scotland

There are no commercial glass eel fisheries in Scotland.

Northern Ireland

There are no commercial glass eel fisheries in N. Ireland.

3.6.1 Yellow eel

There are no commercial yellow eel fisheries in the northeast or northwestern International RBDs.

The Neagh/Bann RBD contains a yellow eel fishery, bulk of the catch destined for the Netherlands, and small amount to UK (London) (Table 18).

Market Value: to maintain our scientific independence and impartiality we are prohibited from enquiring about commercial values of catches.

Table 18. Catches of yellow eel in the Lough Neagh fishery, Northern Ireland, from 1965 to 2014 (catches rounded to nearest 1000 kg, 2005 onwards). Note that a daily quota system operates per boat in this fishery.

YEAR	YELLOW EEL CATCH (KG)	YEAR	YELLOW EEL CATCH (KG)
1965	236759.1	1990	613231.8
1966	284772.7	1991	578868.2
1967	327281.8	1992	533240.9
1968	382327.3	1993	535150
1969	368677.3	1994	597418.2
1970	516504.5	1995	659050
1971	610909.1	1996	594045.5
1972	509090.9	1997	554750
1973	562481.8	1998	531968.2
1974	587904.5	1999	556213.6
1975	576354.5	2000	486595.5
1976	481886.4	2001	451309.1
1977	455350	2002	432313.6
1978	544695.5	2003	413763.6
1979	702609.1	2004	363522.7
1980	668945.5	2005	317800
1981	681545.5	2006	242000
1982	705759.1	2007	351000
1983	662709.1	2008	290000
1984	807672.7	2009	345000
1985	616668.2	2010	337000
1986	522359.1	2011	342000
1987	503777.3	2012	302000
1988	503236.4	2013	321000
1989	643395.5	2014	292000

3.6.2 Silver eel

There are no commercial silver eel fisheries in the northeast or northwestern International RBDs.

Neagh/Bann RBD contains two silver eel fisheries, bulk of the catch destined for the Netherlands, and small amount to UK (London) (Table 19). 2014 was the lowest catch on record.

Table 19. Catches of silver eel in the River Bann flowing from Lough Neagh, Northern Ireland, from 1965 to 2014(catches rounded to nearest 1000 kg, 2005 onwards).

YEAR	SILVER EEL CATCH (KG)	YEAR	SILVER EEL CATCH (KG)
1965	329563.6	1990	123600
1966	332800	1991	121381.8
1967	242727.3	1992	148036.4
1968	204618.2	1993	90327.27
1969	238327.3	1994	95200
1970	237345.5	1995	138581.8
1971	233309.1	1996	112290.9
1972	124945.5	1997	109418.2
1973	162400	1998	104545.5
1974	178872.7	1999	113054.5
1975	187527.3	2000	101963.6
1976	144872.7	2001	84000
1977	236690.9	2002	95963.64
1978	280727.3	2003	114327.3
1979	341163.6	2004	99636.36
1980	245272.7	2005	117000
1981	228690.9	2006	104000
1982	209890.9	2007	76000
1983	203636.4	2008	78000
1984	165890.9	2009	88000
1985	135054.5	2010	97000
1986	129854.5	2011	73000
1987	121345.5	2012	74000
1988	150981.8	2013	72000
1989	152436.4	2014	66000

4 Fishing capacity

4.1 Glass eel

England & Wales

Since 2005, glass eel fishermen have been required to annually report the number of days fished as part of their catch return, and these data are being used to develop time-series of fishing effort (Table 22). Over the time period there has been no glass eel fishing in the following RBDs; Northumbria, Thames and Solway Tweed.

Table 20. Numbers of dipnet fishing licences sold or authorised by the Environment Agency or predecessors for commercial fishing for glass eel in England and Wales, 1980 to 2015.

YEAR	AGENCY DIPNET LICENCES	YEAR	AGENCY DIPNET LICENCES/AUTHORISATIONS
1980	1367	1998	2480
1981	1303	1999	2207
1982	1288	2000	2100
1983	1537	2001	838
1984	1192	2002	899
1985	1026	2003	922
1986	917	2004	957
1987	1162	2005	812
1988	918	2006	719
1989	1087	2007	705
1990	1169	2008	656
1991	960	2009	484
1992	969	2010	369
1993	1000	2011	446
1994	1058	2012	489
1995	1530	2013	482
1996	1682	2014	492
1997	2450	2015	528

Scotland

There are no fisheries for glass eel in Scotland.

Northern Ireland

The capture of glass eel and elvers is prohibited in Northern Ireland, except under licence from the Department of Culture, Arts and Leisure (DCAL) to help with up-stream migration past in-river obstacles on the River Bann.

4.2 Yellow eel

England & Wales

Since 2010, authorizations for yellow and silver eel fisheries have been limited to those individuals who were already licensed, and these individuals are limited to the number of nets that they can apply for based on previous effort. Applications from newcomers are considered, but only for scientific studies, stock monitoring or for personal consumption. Thus, commercial fishing is effectively capped to existing fisherman who can use up to a maximum number of nets.

No distinction is made between fishing for yellow or silver eels in the authorizations and most gears, with the exception of fixed traps on weirs, can be used to catch either stage. Therefore, fishing capacity in England and Wales is reported as licences/authorisations sold for commercial fishing for yellow and silver eels combined (Table 21).

Table 21. Numbers of yellow/silver eel fishing licences/authorizations sold by the Environment Agency, 1983 to 2015. Note that licences/authorizations are for gears and not per person but the number of licensees are available for 2009 onwards. *The 2015 data are provisional (as of October 22nd 2015).

YEAR	AGENCY LICENCE SALES	NUMBER OF LICENSEES	YEAR	AGENCY LICENCE/AUTHORISATION SALES	NUMBER OF LICENSEES
1983	1523		2000	n/a	
1984	2085		2001	1991	
1985	2624		2002	1992	
1986	1994		2003	1831	
1987	2168		2004	1600	
1988	2443		2005	2369	
1989	2041		2006	2679	
1990	1589		2007	2818	
1991	1704		2008	2799	202
1992	1724		2009	3120	215
1993	1859		2010	2970	167
1994	2647		2011	2777	130
1995	2648		2012	2939	124
1996	2752		2013	2599	95
1997	2602		2014	2534	86
1998	1825		2015*	2007	100
1999	1670				

Scotland

In Scotland, historic commercial fisheries for yellow eels were largely based in low-lying productive lochs, the eels being sold mainly to local smokehouses. There is no tradition of eel consumption in Scotland. During the 1960s–1970s, eel catches in Scotland were estimated at around 10–40 t per annum. In 1989, 17 eel fisheries were operating, with catches ranging from 0.25 to 10.76 t (total: 23 t) (I. McLaren, Marine Scotland (Science), unpublished data). Correspondence with proprietors of eel fisheries in 2003 indicated a catch of less than 2–3 t per annum, chiefly yellow eels. The last known fishery closed in 2005. Since January 2009, a licence has been required to conduct any form of eel fishing. No licences have been granted to date (November 2015).

Northern Ireland

In Northern Ireland, longlines and draftnets are authorised fishing instruments for yellow eels (the 2007 UK Report: Appendix 1 provides a description of netting and trapping methods). The use of fykenets as a fishing engine for catching eels was banned in 2010 under the terms of all EMPs in Northern Ireland.

There are no eel fisheries in the northeast or northwestern International RBDs.

Neagh/Bann RBD

Lough Neagh/River Bann comprises a 400 km² lake-based system, which produces all of the commercial eel harvest in Northern Ireland.

Eel fishing on Lough Neagh is controlled by the LNFCS who licence the fishery to 180 fishermen, though in 2014 this number has ranged from 140 to 194 fishermen operating at different times during the fishing season. Around 1990, there were 200 boats (400 fishermen) fishing the Lough, but this number has steadily declined to the present day number of 80 to 90 boats as a result of an ageing fisher population, availability of alternative employment and falling market prices for eel. Boat size on L. Neagh is restricted to 8.6 m long and 2.7 m wide. Information on licence applications, number of boats, fishing activity, recruitment to the fishery and the catch of yellow and silver eels from L. Neagh is collected and maintained by the LNFCS with several aspects of these data spanning over 50 years. This information is made available to DCAL and AFBI for scientific analysis and the provision of management advice.

Thirty percent of the Lough Neagh yellow eel catch is derived from draftnets, the other 70% from longline fishing using a maximum of 1200 standard sized hooks baited with earthworms, fish fry or the larvae of the flour beetle (meal worm). The fishery is run on a market-driven quota-based system (usually 50 kg per boat per day) and a record is kept of each individual boat's daily (Monday–Friday) catch, though this normally just records “quota achieved”. New technologies such as hydraulic draftnet haulers have been introduced over the last 20 years, thereby reducing the labour needed in the fishery or enabling fishermen to fish for longer if required. Recently fishermen have begun commenting on difficulties in “making quota” both in terms of time and effort.

4.3 Silver eel

England & Wales

See Section 4.2 for silver eel fishing capacity in England and Wales.

Scotland

Correspondence with proprietors of eel fisheries in 2003 indicated a catch of silver eel less than 100 kg, mostly from traps in mill races. Although there are few comprehensive records, data for one silver eel fishery show a 90% decline in catches between the early 1990s and 2002, although a yellow eel fishery was established in the upstream loch during the same period. The last known commercial silver eel fishery in Scotland ceased operation in late 2005. Since January 2009, a licence has been required to conduct any form of eel fishing. No licence applications for commercial fishing have been received to date (November 2015).

Northern Ireland

Northeast RBD

There are no silver eel fisheries in this RBD.

Northwestern International RBD

There are no silver eel fisheries in this RBD. The fisheries using large coghill nets at fixed weirs on Lower Lough Erne have been suspended since 2005, and closed since 2010 as part of the implementation of the EMP for this RBD.

Neagh/Bann RBD

Silver eel from Lough Neagh were caught in the River Bann using coghill nets fished on three weirs at two locations, but from 2012 the LNFCS reduced this to two weirs as

an additional conservation measure. The number of coghill nets fished depends on weather and river flow conditions, and normally ranges from 2–4 nets per fishing night. The record of nightly catch is estimated at the time (though rarely accurate). True daily catch is only obtained if the catch is processed and sold the following day. Otherwise, catches are retained in tanks and sold as and when market conditions are more favourable. Therefore, a 'single' catch sale record may be a total for several nights fishing.

4.4 Marine fishery

England & Wales

In England and Wales, the Environment Agency authorisations extend to targeted eel fishing in the coastal waters of RBDs. There are some authorised fisheries operating off the Anglian and south coast of England, but these are not distinguished from inland fisheries in terms of fishing capacity (see Section 4.2). Eel are occasionally landed as a bycatch by marine registered vessels, but these vessels are not reported here as a fishing capacity.

Scotland

There are no marine fisheries for eel in Scotland.

Northern Ireland

There are no marine fisheries for eel in Northern Ireland.

5 Fishing effort

5.1 Glass eel

England and Wales

Since 2005, glass eel fishermen have been required to annually report the number of days fished as part of their catch return, and these data are being used to develop time-series of fishing effort (Table 22). Over the time period there has been no glass eel fishing in the following EMUs; Northumbria, Thames and Solway Tweed.

Table 22. Commercial glass eel fishing effort reported to the Environment Agency as days (nights) fished by RBD, for 2005 to 2015. * Note that the 2015 data are provisional (up to October 28th 2015).

YEAR	HUMBER	ANGLIAN	SOUTHEAST	SOUTHWEST	SEVERN	WEST WALES	DEE	NORTHWEST
2005		92		1876	4508	20		172
2006	36	60	15	6065	4574	35	29	193
2007		3		2440	4560	26	33	204
2008				2064	4060	18	10	194
2009			16	1344	3020	16	14	142
2010				1178	2271	22	14	82
2011				3141	3903	14	23	95
2012				4026	5390	9	32	108
2013				4301	4660	17	12	101
2014				9371	8306	7	0	153
2015*				8032	10297		39	266

Scotland

There are no glass eel fisheries in Scotland.

Northern Ireland

There are no glass eel fisheries in Northern Ireland.

5.2 Yellow eel

Since 2005, yellow and silver eel fishers are now required to annually report the number of days fished as part of their catch return, and these data allow the development of a time-series of fishing effort, which is the number of codends multiplied by the number of nights fished and summed for the entire fishing season. Note that there is no separation of effort into that targeting yellow vs. silver eel.

Table 23. Total effort (number of codends*number of nights fished) deployed fishing for yellow and silver eel in England and Wales between 2009 and 2014, by EMU.

YEAR	NORTHUMBRIA	HUMBER	ANGLIAN	THAMES	SOUTHEAST	SOUTHWEST	SEVERN	WEST WALES	DEE	NORTHWEST	SOLWAY	TWEED	ENGLAND & WALES
2005	84	13078	56565	21998	4451	17379	2207	590	152	4989	0		121493
2006	29	10306	32721	28689	12140	25755	190	2770	134	5383	0		118117
2007	0	5826	24673	35745	20720	14475	1057	534	116	0	0		103146
2008	186	17898	54163	24811	13296	28999	185	186	5102	5909	0		150735
2009	168	16157	41561	13610	30277	11494	5330	2458	210	548	0		121813
2010	66	6991	52358	13940	7898	17728	366	331	144	533	0		100355
2011	0	19346	99418	18305	6783	17483	1980	557	5184	14604	0		183660
2012	0	17380	83572	10267	19315	27885	0	5703	4423	27574	0		196119
2013	0	24545	75430	21796	13381	48437	10	302	884	9305	0		194090
2014	0	83317	32865	55697	46800	37542	0	0	99844	13806	0		369871

Scotland

There are no yellow eel fisheries in Scotland.

Northern Ireland

Fishing effort in Lough Neagh is only represented as capacity, which is reported in Section 4.2.

5.3 Silver eel

England & Wales

See Section 5.2.

Scotland

There are no silver eel fisheries in Scotland.

Northern Ireland

Silver eel fishing effort at the outflow of Lough Neagh is only represented as capacity, which is reported in Section 4.3.

5.4 Marine fishery

Not applicable; see Section 4.4.

6 Catches and landings

6.1 Glass eel

England & Wales

Across England and Wales, the glass eel catch is only reported by weight, so number or length–frequency data are not available. The annual catch reported to the Environment Agency is presented in Table 2.

The final catch reported to the Environment Agency for 2014 was 11.91 t of glass eel. The quantity of glass eel bought by the dealers was 11.6 t, and 12.3 t was exported or used internally (within UK). The apparent discrepancies between the 2014 reported catch and dealer returns were explained in Section 3.1.1.1.

For 2015, the provisional data (as of 28th October) of catch reported to the Environment Agency is 2.80 t, the quantity bought by the dealers was 2.8 t, and 2.7 t was exported or used internally (within UK), representing a loss (mortality and shrinkage) of 3.6% by weight.

The catch of glass eel by RBD is shown in Table 24 and that reported by dealers for 2014–2015 is shown in Table 25.

Table 24. Commercial catch (kg) of glass eel reported to the Environment Agency, for 2005 to 2015.

YEAR	HUMBER	ANGLIAN	SOUTHEAST	SOUTHWEST	SEVERN	WEST WALES	DEE	NORTHWEST
2005	0.0	0.0	0.0	626.5	784.8	87.0	39.0	166.2
2006	0.0	0.0	1.5	482.7	631.3	37.0	5.5	116.1
2007	0.0	0.0	0.0	669.0	1172.5	26.0	6.3	200.0
2008	0.0	0.0	0.0	348.6	370.7	3.8	2.0	91.6
2009	0.0	0.0	0.0	194.5	76.8	0.0	0.5	19.6
2010	0.0	0.0	0.0	756.5	531.7	1.1	4.8	30.3
2011	0.0	0.0	0.0	1249.8	897.5	2.5	12.9	75.8
2012	0.0	0.0	0.0	1568.7	1151.5	0.0	16.9	35.8
2013	0.0	0.0	0.0	3095.0	2693.0	23.3	14.8	81.5
2014	0.0	0.0	0.0	5281.0	5541.0	8.0	0.0	138.0
2015*	0.0	0.0	0.0	1382.2	1299.6	0	17	105.9

* Note that the 2015 data are provisional (October 28th 2015).

Table 25. The catch of glass eel (kg) by EMU in England & Wales (dealer returns).

YEAR	NORTHWEST	SEVERN	SOUTHWEST	TOTAL
2013	47	4559	4053	8659
2014		5594	12652	7058
2015	89	1176	1567	6

Scotland

There are no commercial glass eel fisheries in Scotland.

Northern Ireland

There are no commercial glass eel fisheries in Northern Ireland.

6.2 Yellow eel

England & Wales

Across England and Wales, yellow eel catch is only reported by weight, so number or length–frequency data are not available.

Prior to 2005, catches were only reported as 'yellow and/or silver eel' and therefore it was not possible to separate catches by stage. Since 2005, licensees have been required to report separate catch returns for yellow and silver eels, and these data are available from 2007 (Table 26).

The reported yellow eel catch for 2014 was 33.85 t, a marginal increase of 1.9% compared to the previous year, 2013 (33.23 t), and almost identical with the average annual catch over the past five years, 2009–2013 (33.33 t). The catch by RBD is shown in Table 28.

Table 26. Time-series of yellow and silver eel catches (t) for England and Wales reported to the Environment Agency or predecessor agencies, and derived from HMRC trade data. n/a = data not available.

Year	HMRC NETT EXPORT (t)	AGENCY RETURNS (t)		
	Yellow + Silver	Yellow + Silver	Yellow	Silver
1979	162			
1980	196			
1981	229			
1982	273			
1983	270			
1984	283			
1985	283			
1986	274			
1987	381	60.41		
1988	456	280.58		
1989	376	80.63		
1990	277	48.74		
1991	358	38.26		
1992	234	35.63		
1993	232	46.62		
1994	384	86.79		
1995	514	103.76		
1996	540	100.51		
1997	526	68.04		
1998	306	58.31		
1999	294	n/a		
2000	113	n/a		
2001	207	48.62		
2002	122	24.06		
2003	46	25.44		
2004	171	9.58		
2005	110	42.26	28.19	14.07
2006	62	35.91	24.91	11.00
2007	n/a	23.32	17.24	6.08
2008	n/a	31.31	25.37	5.94
2009	n/a	27.29	21.60	5.69

	HMRC NETT EXPORT (T)	AGENCY RETURNS (T)		
2010	n/a	26.50	24.31	2.20
2011	n/a	40.56	36.25	4.32
2012	n/a	39.05	32.60	6.45
2013	n/a	33.23	27.10	6.13
2014	n/a	38.4	33.85	4.55

Scotland

There are no commercial yellow eel fisheries in Scotland.

Northern Ireland

There are no eel fisheries in the northeast or northwestern International RBDs.

Neagh/Bann RBD

Yellow eel catches in L. Neagh in 2013 amounted to 292 t, continuing the general downward trend since the late 1990s (Table 27), associated with reducing effort in the yellow eel fishery as a function of falling boat numbers (Section 4.2). This is a significant cause of the long-term decline in catches and a response to alternative work/low prices available for yellow eels, rather than declining stocks. Catches per boat per day in the longline and draftnet fisheries continue to meet daily quotas imposed by the cooperative, implying that sufficient stocks are maintained for the reduced number of boats fishing in the Lough, but fishermen have commented that it takes longer to catch their quota (Section 4.2). Such comments were more frequent in 2014 and in the light that boat numbers have remained somewhat comparable to recent years this increase in effort is likely a reflection of stock decreases as a consequence of historic recruitment. Provisional data for 2015 (though likely to be accurate given the submission date of this ICES report) is a catch of 251 t, the lowest since 1965.

Table 27. Catches of yellow eel in the Lough Neagh fishery, Northern Ireland, from 1965 to 2014 (catches rounded to nearest 1000 kg, 2005 onwards). Note that a daily quota system operates per boat in this fishery.

YEAR	YELLOW EEL CATCH (KG)	YEAR	YELLOW EEL CATCH (KG)
1965	236759.1	1990	613231.8
1966	284772.7	1991	578868.2
1967	327281.8	1992	533240.9
1968	382327.3	1993	535150
1969	368677.3	1994	597418.2
1970	516504.5	1995	659050
1971	610909.1	1996	594045.5
1972	509090.9	1997	554750
1973	562481.8	1998	531968.2
1974	587904.5	1999	556213.6
1975	576354.5	2000	486595.5
1976	481886.4	2001	451309.1
1977	455350	2002	432313.6
1978	544695.5	2003	413763.6
1979	702609.1	2004	363522.7
1980	668945.5	2005	317800
1981	681545.5	2006	242000
1982	705759.1	2007	351000
1983	662709.1	2008	290000
1984	807672.7	2009	345000
1985	616668.2	2010	337000
1986	522359.1	2011	342000
1987	503777.3	2012	302000
1988	503236.4	2013	321000
1989	643395.5	2014	292000

6.3 Silver eel

England & Wales

Across England and Wales, the silver eel catch is only reported by weight, so number or length–frequency data are not available.

Since 2005, licensees have been required to report separate catch returns for yellow and silver eels, and these data are available from 2007 (Table 28).

The reported silver eel catch for 2014 was 4.454 t, a decrease of 27.3% compared to 2013, but only 10.2% less than the average annual catch 2009–2013 (4.958 t). The catch by RBD is shown in Table 29.

Table 28. Declared catch (t) of yellow eel for England and Wales by RBD.

YEAR	NORTHUMBRIA	HUMBER	ANGLIAN	THAMES	SOUTHEAST	SOUTHWEST	SEVERN	WEST WALES	DEE	NORTHWEST	SOLWAY TWEED	ENGLAND & WALES
2005	0.005	1.295	13.065	7.175	0.406	3.787	0.565	0.240	0.034	1.619	0.000	28.191
2006	0.001	1.160	6.282	5.688	3.069	6.788	0.170	0.475	0.028	1.250	0.000	24.911
2007	0.000	2.138	3.739	6.963	1.807	2.019	0.068	0.273	0.023	0.211	0.000	17.240
2008	0.000	1.429	9.903	5.548	0.602	6.626	0.027	0.118	0.642	0.474	0.000	25.369
2009	0.045	0.411	6.616	4.745	7.029	2.546	0.000	0.022	0.070	0.114	0.000	21.598
2010	0.060	3.033	10.708	5.655	1.432	2.722	0.150	0.345	0.053	0.150	0.000	24.309
2011	0.000	4.857	16.478	6.082	1.879	3.792	0.350	0.252	1.082	1.477	0.000	36.248
2012	0.000	3.267	15.335	1.815	2.116	5.966	0.000	0.647	0.478	2.972	0.000	32.596
2013	0.000	3.865	9.351	3.991	0.286	8.688	0.000	0.100	0.152	0.669	0.000	27.102
2014	0.000	2.811	16.875	3.222	0.284	10.117	0.000	0.000	0.455	0.087	0.000	33.850

Table 29. Declared catch (t) of silver eel for England and Wales by RBD.

YEAR	NORTHUMBRIA	HUMBER	ANGLIAN	THAMES	SOUTHEAST	SOUTHWEST	SEVERN	WEST WALES	DEE	NORTHWEST	SOLWAY TWEED	ENGLAND & WALES
2005	0.000	0.243	6.659	1.067	3.594	1.886	0.396	0.010	0.010	0.202	0.000	14.065
2006	0.000	0.323	2.417	0.971	4.104	1.896	0.146	0.031	0.006	1.103	0.000	10.996
2007	0.000	2.188	0.198	0.484	2.621	0.228	0.124	0.140	0.009	0.085	0.000	6.077
2008	0.090	0.865	1.974	0.404	1.650	0.552	0.117	0.010	0.015	0.263	0.000	5.941
2009	0.010	0.110	0.592	0.119	3.198	0.303	1.224	0.043	0.014	0.080	0.000	5.691
2010	0.000	0.199	0.739	0.067	0.823	0.172	0.100	0.009	0.015	0.072	0.000	2.195
2011	0.000	0.257	2.006	0.513	0.694	0.068	0.380	0.009	0.119	0.270	0.000	4.315
2012	0.000	1.627	2.980	0.200	0.650	0.533	0.000	0.000	0.000	0.462	0.000	6.452
2013	0.000	0.259	2.486	0.308	1.991	0.950	0.000	0.000	0.031	0.105	0.000	6.130
2014	0.000	0.480	1.483	0.384	0.975	1.167	0.000	0.000	0.030	0.280	0.00	4.545

Scotland

There are no commercial silver eel fisheries in Scotland.

Northern Ireland

There are no commercial silver eel fisheries in the northeast or northwestern International RBDs.

Neagh/Bann RBD

Silver eel catches in L. Neagh in 2014 totalled 66 t, and is the new lowest silver eel catch on record (Table 30).

Table 30. Catches of silver eel in the River Bann flowing from Lough Neagh, Northern Ireland, from 1965 to 2014(catches rounded to nearest 1000 kg, 2005 onwards).

YEAR	SILVER EEL CATCH (KG)	YEAR	SILVER EEL CATCH (KG)
1965	329563.6	1990	123600
1966	332800	1991	121381.8
1967	242727.3	1992	148036.4
1968	204618.2	1993	90327.27
1969	238327.3	1994	95200
1970	237345.5	1995	138581.8
1971	233309.1	1996	112290.9
1972	124945.5	1997	109418.2
1973	162400	1998	104545.5
1974	178872.7	1999	113054.5
1975	187527.3	2000	101963.6
1976	144872.7	2001	84000
1977	236690.9	2002	95963.64
1978	280727.3	2003	114327.3
1979	341163.6	2004	99636.36
1980	245272.7	2005	117000
1981	228690.9	2006	104000
1982	209890.9	2007	76000
1983	203636.4	2008	78000
1984	165890.9	2009	88000
1985	135054.5	2010	97000
1986	129854.5	2011	73000
1987	121345.5	2012	74000
1988	150981.8	2013	72000
1989	152436.4	2014	66000

6.4 Marine fishery

There are no marine fisheries targeting eel outside the EMUs in the UK.

6.5 Recreational fishery

In England and Wales any eel caught on rod and line (the only recreational fishing that catches eel) must be returned to the same water with as little damage as possible. There is no requirement for anglers to report catches and effort for rod caught eel. The mortality from catch and release has therefore been treated as part of natural mortality as any further management action to reduce catch and release mortality is not considered feasible.

A similar approach is in place in Northern Ireland.

In Scotland all recreational fishing for eel has been illegal since 2009, unless by licence from Scottish ministers: no licences have been granted (November 2015).

6.6 Bycatch, underreporting, illegal activities

Table 31. Estimation of underreported catches in the UK, per EMU and Stage.

[illegible]

Table 32. Existence of illegal activities, its causes and the quantity of seizures they have caused in the UK.

Year	EMU	GLASS EEL			YELLOW EEL			SILVER EEL			COMBINED (Y + S)		
		Y/N/?	Seizures (kg)	Cause	Y/N/?	Seizures (kg)	Cause	Y/N/?	Seizures (kg)	Cause	Y/N/?	Seizures (kg)	Cause
2013	GBNW*	N	0	-	N	0	-	N	0	-	N	0	-
	GBNoE	N	0	-	N	0	-	N	0	-	N	0	-
	GBNea	N	0	-	N	0	-	N	0	-	N	0	-
	EMU_d												
	EMU_e												
2014	GB_Sco	N	0	-	N	0	-	N	0	-	N	0	-
	GBNW*	N	0	-	N	0	-	N	0	-	N	0	-
	GBNoE	N	0	-	N	0	-	N	0	-	N	0	-
	GBNea	N	0	-	N	0	-	N	0	-	N	0	-
	EMU_d												
	EMU_e												
	GB_Sco	N	0	-	N	0	-	N	0	-	N	0	-

7 Catch per unit of effort

7.1 Glass eel

England & Wales

The overall (2015 provisional) cpue for glass eel was 0.151 kg/day, which was 75.5% lower than in 2014 (0.615 kg/day) and only about a third (37.2%) of the five year mean (2010–2014) of 0.406 kg/day. For the two main fishery areas, the Southwest and Severn RBD fishery the cpue for 2014 showed a decrease of 81.1% and 69.5% respectively. The data for 2015 are provisional.

Over the time period since 2004 there has been no glass eel fishing in the following RBDs: Northumbria, Humber Anglian and Solway Tweed.

Table 33. Cpue (kg/day) for glass eel fisheries by EMU of England and Wales based on catch and effort returns to the Environment Agency. The 2015* data are provisional as of 28th October 2015.

YEAR	SOUTHEAST	SOUTHWEST	SEVERN	WEST WALES	DEE	NORTHWEST	OVERALL
2005	0.0	0.334	0.174	4.350	0.0	0.966	0.256
2006	0.100	0.080	0.138	1.057	0.190	0.602	0.116
2007	0.0	0.274	0.257	1.000	0.191	0.980	0.285
2008	0.0	0.169	0.091	0.211	0.200	0.472	0.129
2009	0.0	0.145	0.025	0.000	0.036	0.138	0.064
2010	0.0	0.642	0.234	0.051	0.343	0.370	0.371
2011	0.0	0.398	0.230	0.179	0.561	0.798	0.312
2012	0.0	0.390	0.214	0.000	0.528	0.331	0.290
2013	0.0	0.720	0.578	1.368	1.234	0.807	0.650
2014*	0.0	0.564	0.667	1.143	0.000	0.902	0.615
2015	0.0	0.172	0.126	0.0	0.436	0.398	0.151

Scotland

There are no glass eel fisheries in Scotland.

Northern Ireland

There is no commercial fishing for glass eel in Northern Ireland. No standardised cpue data are available for glass eel fishing on the River Bann, which is for local assisted migration purposes only.

7.2 Yellow eel

England & Wales

As it is not possible to differentiate between fishing effort targeting yellow vs. silver eel in England and Wales, it is not possible to derive cpue separately for either stage. Therefore, the cpue for the combined yellow-silver eel fishery is reported in Table 28, both per RBD and for the fishery as a whole.

The cpue for the national yellow and silver eel fishery for 2014 was 0.1.04 which is 39.3% lower than that reported in 2013 (0.171 kg per trap per day), and 51.9% lower

compared to the cpue for the past five years from 2009 and 2010 (0.216 kg per trap per day), (Table 29).

Scotland

There are no yellow eel fisheries in Scotland.

Northern Ireland

A market driven quota-based catch management system, combined with varying boat numbers on L. Neagh (on an almost daily basis) means it is impossible to calculate an accurate cpue for the yellow eel fishery. However a comparison of catch against average boat numbers produces a mean catch of 2830.1 kg boat⁻¹ in 2006–2008 and 3788.9 kg boat⁻¹ in 2009–2011, (increase of 33.9%). Analysis of the Lough Neagh data reveals no relationship between cpue and time-lagged input stock density. This is most likely because (i) two different gears are operated (nets and baited longlines) with very different catch vs. effort limitations and with catch reported as a combined daily catch for both gear types, and (ii) there is a variable market related daily cap on the amount of eel that fishermen are allowed to catch.

However, for the first time since the 1960s two fykenet surveys were carried out on L. Neagh during summer of 2013. Using 30 fykenets nightly over five nights, the cpue for eel caught ranged from 1.5–2.3 eel and were deemed essentially useless given the known catch of eels from L. Neagh. The surveys were repeated in 2014 yielding similar useless results with cpue ranging from 0.9–3.4 eel. The exact cause of these anomalies is as yet unclear but may be a function of bottom topography and very soft muds and as a result a standard fykenet sinks through it.

7.3 Silver eel

England & Wales

Effort data for the silver eel fishery are reported in combination with the yellow eel fishery (see Section 7.2 and Table 34).

Table 34. Cpue (kg/trap-day) of combined yellow and silver eel fisheries in England & Wales by EMU [based on catch and effort returns to the Environment Agency].

YEAR	NORTHUMBRIA	HUMBER	ANGLIAN	THAMES	SOUTHEAST	SOUTHWEST	SEVERN	WEST WALES	DEE	NORTHWEST	SOLWAY TWEED	ENGLAND & WALES
2005	0.063	0.118	0.349	0.375	0.899	0.326	0.435	0.423	0.289	0.365	0.000	0.348
2006	0.034	0.144	0.266	0.232	0.591	0.337	1.663	0.182	0.256	0.437	0.000	0.304
2007	0.000	0.743	0.160	0.208	0.214	0.155	0.181	0.773	0.276	0.000	0.000	0.226
2008	0.484	0.128	0.219	0.240	0.169	0.248	0.778	0.688	0.129	0.125	0.000	0.208
2009	0.327	0.032	0.173	0.357	0.338	0.248	0.230	0.026	0.398	0.354	0.000	0.224
2010	0.909	0.462	0.219	0.410	0.286	0.163	0.683	1.069	0.472	0.416	0.000	0.264
2011	0.000	0.264	0.186	0.360	0.379	0.221	0.369	0.468	0.232	0.120	0.000	0.221
2012	0.000	0.282	0.219	0.196	0.143	0.233	0.000	0.113	0.108	0.125	0.000	0.199
2013	0.000	0.168	0.157	0.197	0.170	0.199	0.000	0.331	0.207	0.083	0.000	0.171
2014	0.000	0.039	0.559	0.065	0.027	0.301	0.000	0.000	0.005	0.027	0.000	0.104

Scotland

There are no silver eel fisheries in Scotland.

Northern Ireland

There are no commercial silver eel fisheries in the east or northwestern International RBDs.

Given that a night's catch from the silver eel fishery in the River Bann may not be marketed the next day, but is combined with several nights' capture (with this reported at the time of sale as the "catch"), it is difficult to calculate a cpue for the silver eel fishery that would provide a meaningful indicator of stock abundance. However, attempts were made to analyse catch by number of nights in 2013 (as had been attempted for 2012) but as outlined previously proved to be very difficult as the processing (and thus access for analysis) was dictated by market demands.

7.4 Marine fishery

There are no marine fisheries targeting eel outside the EMUs in the UK.

8 Other anthropogenic and environmental impacts

The level of impact has been reported in Section 13.2.3, at present there have been no estimates of the impact of the management measures on mortality.

9 Scientific surveys of the stock

9.1 Recruitment surveys for glass eel

Although there are several scientific surveys to qualify recruitment time-series, there are no scientific surveys to quantify total capture of glass eel recruitment in the UK.

9.2 Yellow eel stock surveys

England and Wales

Avon re-survey

A fykenet survey was undertaken on the River (at Sabines), the stretch had been fished previously in 1996, 2000, 2006 and again in 2012–2014. The results from the survey are shown in Table 35. The survey was undertaken over a four week period in summer (July/August), similar to the timing in previous years. There is evidence of a decline in catch over the ten year period from 1996–2006, with an increase in 2012–2014.

The 2014 survey showed a rise in the population, apparently above that of 1996 level. However much of that (2014) weight was made up of silver females (unlike previous years). As these eels are migratory, one has to treat the results with caution as these eels were probably passing through. Numbers of yellow eels were slightly down but the presence of elvers was evident throughout and in very large numbers, although that cannot be qualified statistically. The traps were possibly more efficient as the survey was carried four weeks earlier than previous surveys (July 15th–August 15th). This site was not surveyed in 2015.

Table 35. Total catch of yellow and silver eel per ten codends between 1996 and 2014 on the river Avon, GB_Seve EMU, (Roger Castle pers. comm.).

YEAR	CATCH (KG)
1996	50
2000	28
2006	12
2012	30
2013	37
2014	62
2015	No data

Scotland

Since 2008, the Scottish Environment Protection Agency (SEPA) has undertaken routine electrofishing surveys for all fish species, including eels. In 2008, 48 sites were fished, eels were present at 39 sites (80%), and three of the nine sites where they were not found may have been affected by natural barriers to migration. This suggests that the SFCC data significantly overestimates the number of sites at which eels are absent. Minimum density of eels estimated from three pass electrofishings at the 39 sites where they were found ranged from 0.3–23.7 eels per 100 m², giving a mean minimum density across the RBD of 6.7 eels per 100 m² (or 5.4 eels per 100 m² including those sites from which eels were absent).

A further eleven electrofishing sites above the Girnock and Baddoch traps are fished annually by Marine Scotland Science.

The other site monitored by Marine Scotland - Science is the Allt Coire nan Con Burn, which is situated in the Strontian region of western Scotland and drains into the River Polloch, an inflow to Loch Shiel. The catchment covers 790 ha and its altitude falls from 756 m to 10 m at the sampling point, where the river is 5–6 m wide and features riffle interspersed with glides which can be deep. Riparian vegetation at the sampling sites is predominantly mature deciduous woodland. Annual electrofishing surveys show no clear evidence of declines in yellow eel densities since 1992 (Adams *et al.*, 2012).

Data from eel capture on trash screens of a pumping station (1982–2003) on Loch Lomond found no evidence of a decline in yellow eels (Adams *et al.*, 2012)

Northern Ireland

Northeast RBD

Eel are known to be present throughout this RBD but there are limited scientific data. Three lakes in this region have been selected as potential fish monitoring sites in the trial implementation phase of the Water Framework Directive. These lakes were sampled with a standardised (CEN) gillnetting method supplemented with fykenets specifically for eel. Yellow eel populations are present in every lake examined thus far, though there were significant differences between two of these sites in length and age distribution.

A PhD research project carried out an intensive sampling programme in regions of the Northeast RBD using fykenets. Results have been incorporated into the reviewed EMP for this RBD in 2012. This PhD will be published and release in 2016.

Northwestern International RBD

A recent intensive fykenet survey into the yellow eel population of Lower Lough Erne was completed summer 2014. The results of this survey were compared with those of the Erne Eel Enhancement Programme (Matthews *et al.*, 2001) and viewed against the closure of the yellow eel fishery in this RBD in July 2010. Cpue levels had risen from both the EEEP research and the recent 2011 study, reflecting the impact of the commercial yellow eel fishery closure.

Neagh/Bann RBD

Eel are sampled regularly as part of a long-term research programme which investigates all life stages throughout the year. Yellow eel catches are sampled weekly over 20 weeks (from May to September). A sample of 20 eels is chosen to reflect all size ranges caught, and analysed for age and length. In addition, the entire, ungraded landing of two fishing crew on one day each month is sampled, usually comprising 400–600 eels captured by longline and a similar number by draftnet, to enable comparison between methods. Every eel is measured for length and the total catch recorded.

Preliminary analysis indicates that a larger proportion of small eels (<40 cm) are captured by draftnets (34%, compared to 21.4% on longlines), whereas more of the larger eels (>60 cm) are taken on longlines. Furthermore, there was significant variation in the numbers of small eels captured by long lining dependent upon bait type (earthworms caught more) and hook size (larger hook caught fewer small eels).

For the first time in 50 years, permission to carry out a fykenet survey on Lough Neagh was granted by the LNFCS in summer 2013. This survey was repeated twice in 2014 and the results from are discussed in Section 7.2.

In 2014 a new Queens University PhD funded directly by the LNFCS began examining all aspects of the biology of the Male eel based on L. Neagh.

<http://www.afbini.gov.uk/index/news/news-releases/news-releases-archive-2014.htm?newsid=26679>.

In 2015 a Danish research group working in association with the Agri-Food and Biosciences Institute (AFBI) and the Lough Neagh Fishermen's Co-operative (LNFCS) are to use Lough Neagh eels in breeding trials in an attempt to complete the full European eel life cycle in captivity for the first time.

<http://www.afbini.gov.uk/index/news/news-releases.htm?newsid=29616>

The LNFCS have also funded research at AFBI's Veterinary Sciences Laboratories on the health status of Lough Neagh eel, examining the presence of a range of eel viruses.

9.3 Silver eel

England and Wales

Silver eel movement and behaviour in estuarine environments

Piper, A.

In collaboration with Cefas, an array of 14 acoustic receivers has been deployed in the Stour estuary, Suffolk. This will allow tagged silver eel movements to be monitored to the estuary mouth (19 km downstream from the Stour tidal limit). These data will

enhance knowledge of eel movements through the estuary and indicate the influence of tide cycles. Secondly, it is hoped that these data, combined with freshwater movement data, will allow investigation into the influence of recent freshwater history such as delay at structures or passage through HP turbines on the estuarine movements of eel.

Piper, A.T., Wright, R.M., Walker, A.M. and Kemp, P.S. 2013. Escapement, route choice, barrier passage and entrainment of seaward migrating European eel, *Anguilla anguilla*, within a highly regulated lowland river. *Ecol. Eng.* 57, 88–96.

Fluvial disconnectivity can have important impacts on fish populations, including hindering movement between habitats required for different ontogenic stages. Recruitment of the European eel (*Anguilla anguilla*) has reduced by over 90% since the early 1980s, in part due to the effect of riverine barriers on its catadromous migration. There is a legislative requirement to restore free passage, increase habitat availability, and limit anthropogenic losses at intakes to aid eel recovery and good ecological status; necessitating an improved understanding of underlying processes. Escapement, route choice, delay at structures, and entrainment at water abstraction points of downstream migrating silver eels were examined using acoustic and Passive Integrated Transponder (PIT) telemetry in the heavily regulated lower river Stour, UK. Downstream migrating adult eel ($n = 69$) were trapped approximately 10 km upstream of the tidal limit, surgically implanted with an acoustic transducer and PIT transponder, and released between October and December in 2009 and 2010. Movements of tagged individuals were monitored by a linear array of 19 fixed acoustic receivers extending from the release site, through the last 9.2 km of the freshwater catchment. Three groups of water control structures, two water abstraction intakes and several possible routes of migration are present in the reach. Seventy six and 65% of tagged eels escaped from the study reach in 2009 and 2010, respectively. Entrainment at a single intake was the principal cause of loss and positively related to rapid increases in abstraction while eels were in the vicinity of the intake. Route choice into the estuary was dependent on discharge over a large intertidal weir; opening regimes of a tidal gate at the termination of the alternative channel; and abstraction rate at a nearby water intake. Long delays (up to 68.5 days) and recurrent behaviour were associated with several structures in the study reach; high variability between individuals reflected the management of spill at weirs. Potential scenarios for minimising entrainment and delay through integrated management of water level control structures and abstraction rates are discussed.

Piper, A.T., Manes, C., Siniscalchi, F., Kemp, P.S. Marion, A and Wright, R. 2015. Response of seaward-migrating European eel (*Anguilla anguilla*) to manipulated flowfields. *Proceedings of the Royal Society B*. DOI: 10.1098/rspb.2015.1098.

Anthropogenic structures (e.g. weirs and dams) fragment river networks and restrict the movement of migratory fish. Poor understanding of behavioural response to hydrodynamic cues at structures currently limits the development of effective barrier mitigation measures. This study aimed to assess the effect of flow constriction and associated flow patterns on eel behaviour during downstream migration. In a field experiment, we tracked the movements of 40 tagged adult European eels (*Anguilla anguilla*) through the forebay of a redundant hydropower intake under two manipulated hydrodynamic treatments. Interrogation of fish trajectories in relation to measured and modelled water velocities provided new insights into behaviour, fundamental for developing passage technologies for this endangered species.

Eels rarely followed direct routes through the site. Initially, fish aligned with streamlines near the channel banks and approached the intake semi-passively. A switch to

more energetically costly avoidance behaviours occurred on encountering constricted flow, prior to physical contact with structures. Under high water velocity gradients, fish then tended to escape rapidly back upstream, whereas exploratory 'search' behaviour was common when acceleration was low. This study highlights the importance of hydrodynamics in informing eel behaviour. This offers potential to develop behavioural guidance, improve fish passage solutions and enhance traditional physical screening.

Piper, A.T., Svendsen, J. C., Wright, R.M and Kemp, P.S. In press. Movement patterns of seaward migrating European eel (*Anguilla anguilla*) at a complex of riverine barriers: implications for conservation. *Ecology of Freshwater Fish*. 2015.

River infrastructure such as weirs and hydropower stations commonly present migrating fish with multiple potential passage routes. Knowledge of the cues fish use to navigate such environments is required to protect migrants from hazardous areas and guide them towards safe passage; however, this is currently lacking for many species. Employing high-resolution positioning telemetry, this study examined movements of downstream migrating adult European eel, *Anguilla anguilla*, as they encountered a complex of water control structures in one location on the River Stour, southern England. The distribution of eels across five potential routes of passage differed from that predicted based on proportion of discharge alone. Certain routes were consistently avoided, even when the majority of flow passed through them. Passage distribution was partially explained by avoidance in the vicinity of a floating debris boom. Movement paths were non-randomly distributed across the forebay and eels moved predominantly within a zone 2–4 m from the channel walls. Understanding of avoidance and structure orientation exhibited by eels will help advance effective guidance and downstream passage solutions for adults.

G.V. Wright, R.M. Wright and P.S. Kemp. 2015. Impact of Tide Gates on the Migration of Adult European Eels, *Anguilla anguilla* [Estuaries and Coasts](#) November 2015, Volume 38, [Issue 6](#), pp 2031–2043.

Tide gates form a temporal barrier to fish migration, closing during the flood tide and opening during the ebb, primarily for flood prevention and land reclamation. Their impact on downstream adult migration of the critically endangered European eel, *Anguilla anguilla*, is unknown. The River Stiffkey, UK, has three top-hung tide gates (one counterbalanced, two not) through which it discharges into the North Sea. Adult eels of silver appearance (n = 118) were caught between 0.5 and 6.0 km upstream from the tide gates in Autumn 2011 and implanted with 23 mm half-duplex passive integrated transponder (PIT) tags. Tagged individuals were detected by PIT antennae located near the tide gates. Of the eels tagged, 80 were detected actively migrating downstream to the gates. Escapement past the gates was 98.3%. Speed of migration was slower near the gates than for an unimpeded upstream reach and was positively and negatively related to mean degree of gate opening and mean light intensity, respectively. When the largest gate was modified through installation of an orifice intended to improve upstream passage of sea trout and juvenile eels, downstream migration was more rapid when it was operating. However, video analysis revealed that eels did not pass through the orifice, meaning that faster migration may have been a result of the gates being open on more occasions when eels initially approached them, or the lower tides and upstream saline intrusion that occurred during these periods. Top-hung tide gates in the River Stiffkey delayed eel migration, potentially increasing the risk of predation and energy expenditure immediately prior to a 5000–6000 km migration to spawning grounds in the Sargasso Sea.

Scotland

Downstream migrating silver eels have been trapped at three sites in Scotland: the Girnock Burn and Baddoch Burn (two adjacent tributaries of the river Dee, emptying ultimately into the North Sea), and the Shildaig (an entire small catchment on the western seaboard). The biomass of migrating silver eels for each available year have been converted to area production rates (kg/ha) and are reported in Table 36.

Table 36. Silver eel escapement from three catchments in Scotland (kg.ha⁻¹).

YEAR	GIRNOCK	BADDOCH	SHILDAIG	YEAR	GIRNOCK	BADDOCH	SHILDAIG
1966	0.53	-	-	1991	-	-	-
1967	0.44	-	-	1992	-	-	-
1968	1.42	-	-	1993	-	-	-
1969	1.02	-	-	1994	-	-	-
1970	0.86	-	-	1995	-	-	-
1971	1.25	-	-	1996	-	-	-
1972	0.84	-	-	1997	-	-	-
1973	1.59	-	-	1998	-	-	-
1974	1.07	-	-	1999	-	-	0.57
1975	2.23	-	-	2000	-	-	-
1976	1.91	-	-	2001	-	-	-
1977	1.42	-	-	2002	-	-	0.69
1978	1.25	-	-	2003	1.05	-	0.51
1979	1.07	-	-	2004	-	-	-
1980	0.61	-	-	2005	0.86	-	-
1981	1.02	-	-	2006	-	0.32	1.59
1982	-	-	-	2007	0.51	0.35	0.63
1983	-	-	-	2008	0.42	0.57	0.55
1984	-	-	-	2009	0.44	0.53	1
1985	-	-	-	2010	-	0.1	0.53
1986	-	-	-	2011	0.30	0.47	0.38
1987	-	-	-	2012	0.78	0.45	0.43
1988	-	-	-	2013	0.44	0.34	0.61
1989	-	-	-	2014	0.23	0.66	1.87
1990				2015*	0.36*	0.08*	1.10*

*2015 data are provisional.

Northern Ireland

Northeast RBD

No current surveys of silver eels.

Northwestern International RBD

Surveys on the migrating silver eel stock on the Erne system began in 2009, as an integral component of a conservation fishery designed to trap and transport silver eels

around hydropower plants within this RBD. The results of this survey work are presented in the National Report of Ireland.

Neagh/Bann RBD

Samples of ten eel chosen to reflect all size ranges in the catch are removed every week over a 12 week period and analysed for age and length. At weekly intervals the previous night's haul is measured for length. The number analysed can vary widely but on average covers at least 400 fish within a nights catch of >1 t. In addition the weekly silver eel samples are also analysed for length, weight, fat content, sex, prevalence and intensity of *Anguillicola crassus*, stomach contents, and gastrointestinal endohelminths. Sex ratio of the silver eel population is also examined by counting the numbers of individuals contained in the graded (depending upon size) 15 kg boxes. The fishery records the number of boxes of small (male) and large (female) eels sold, and from this the sex ratio and number of silver eels can be estimated.

10 Data collected for the DCF

Provide summary information on the monitoring of eel by EMU in the current year.

England & Wales

Recruitment surveys were undertaken at a number of sites, the details of which are reported in Sections 3.1.1.3 and 3.1.2.3.

In 2014 monitoring of yellow eel was undertaken on ten rivers at a total of 94 sites, Table Z, (these sites are in addition to the ones used for WFD assessment) and is used to assess the biomass of silver eel escaping from each eel management unit (equivalent to a River Basin District), as required by the EU Eel Regulation (1100/2007), using SMEPII. These data (B_{best}) have yet to be processed, but previous years' data are summarised in Section 13.2.1. At each site the following data are collected; number and size (mm) of each eel, together with the site's dimensions (length and average width).

Table 37. Eel specific monitoring carried out during in England & Wales EMUs in 2014.

EMU	RIVER	NUMBER OF SITES
GB_Angl	Suffolk Stour	10
GB_Humb	Ure/Ouse	10
GB_NorW	Gowy	9
GB_NorW	Bela	8
GB_NorW	Ribble	10
GB_Nort	Coquet	10
GB_Seve	Severn	12
GB_Seve	Usk	6
GB_Wale	Wnion (Mawdach)	10
GB_SouW	Fowey	9

Scotland

No data on eels are collected under the DCF in Scotland, because Scotland is not in receipt of any DCF money for work with eels.

Table 38. Summary of the DCF monitoring implementation for Scotland RBD (GB_Sco).

DATA	RIVER	LAKES	ESTUARIES	LAGOONS	COASTAL & MARINE
No. of production / escapement surveys ¹	0	0	0	0	0
No. of recruitment time-series surveys ²	0	0	0	0	0
No. fished aged	0	0	0	0	0
No. of fished sexed	0	0	0	0	0
No. of fish examined for parasites	0	0	0	0	0
No. of fish examined for contaminants	0	0	0	0	0
No. of non-fishery mortality studies ³	0	0	0	0	0
Socio-economic survey	0	0	0	0	0

¹ Surveys to estimate B_{best} and/or $B_{current}$ [These should include WFD surveys where the data are being used to estimate production and/or escapement of eel].

² Fishery-independent surveys.

³ Studies to determine ΣH for non-fisheries anthropogenic impacts, such as hydropower, barriers, predation, etc.

Northern Ireland

Table 39. Summary of the DCF monitoring implementation in Northeastern RBD.

DATA	RIVER	LAKES	ESTUARIES	LAGOONS	COASTAL & MARINE
No. of production / escapement surveys ¹		5			
No. of recruitment time-series surveys ²		2			
No. fished aged		130			
No. of fished sexed		130			
No. of fish examined for parasites		130			
No. of fish examined for contaminants		0			
No. of non-fishery mortality studies ³		0			
Socio-economic survey		0			

Table 40. Summary of the DCF monitoring implementation in Northwestern RBD.

DATA	RIVER	LAKES	ESTUARIES	LAGOONS	COASTAL & MARINE
No. of production / escapement surveys ¹		0			
No. of recruitment time-series surveys ²		1			
No. fished aged		0			
No. of fished sexed		0			
No. of fish examined for parasites		0			
No. of fish examined for contaminants		0			
No. of non-fishery mortality studies ³		0			
Socio-economic survey		0			

Table 41. Summary of the DCF monitoring implementation in Neagh Bann RBD.

DATA	RIVER	LAKES	ESTUARIES	LAGOONS	COASTAL & MARINE
No. of production / escapement surveys ¹		1			
No. of recruitment time-series surveys ²		1			
No. fished aged		320			
No. of fished sexed		320			
No. of fish examined for parasites		320			
No. of fish examined for contaminants		20			
No. of non-fishery mortality studies ³		0			
Socio-economic survey		0			

In addition to the glass eel sampling at the River Bann, other sampling is undertaken at several coastal sites: the Foyle Estuary, the River Lagan (Belfast), River Quoile (Strangford Lough) and Carlingford Lough Estuary. A new glass eel monitoring site was established at Strangford Lough to replace the River Quoile site in 2012 and is now part of an anticipated longer term monitoring programme for this EMU.

In Lough Neagh, the glass eel/elvers are monitored for the presence of *Anguillicoloides crassus*, and the weekly samples of yellow eels are also examined for length, weight, fat content, sex, age, stomach contents, the prevalence and intensity of *A. crassus*, and gastrointestinal endohelminths. The undersized yellow eels (<40 cm long) captured via longline are returned to the Lough at the point of capture with hooks in place. Every month 100 undersized eels are sampled at the fishery, their hook location recorded and in conjunction with analysis of the catch composition, attempts are made to quantify possible losses to the fishery through hook mortality.

The weekly silver eel samples are also analysed for length, weight, fat content, sex, age, stomach contents, the prevalence and intensity of *A. crassus*, and gastrointestinal endohelminths. Sex ratio of the silver eel population is also estimated by counting the numbers of individuals contained in the graded 15 kg boxes which the fishery then sell. Eels are graded as small (males) and large (females), based on a length–sex key derived from previous sampling. Sex ratios in the silver eels in 2004 to 2005 were numerically close to 1:1, but changed in 2006 and 2007 to 63% and 62% females (Table 42). However, in 2008, 2009 and 2010, this trend has reverted to close to 1:1 (48, 52 and 47% females) and remains similar into 2014. Taking account of differing sizes and weights of males and females, 74% of the recorded silver eel biomass is now female.

Table 42. Biological characteristics of silver eels emigrating from Lough Neagh. Note: mean ages of males and females for 2005 and 2006 have been revised in light of additional data.*age data to be QA verified.

year	MALES				FEMALES			
	%	mean L (cm)	mean Wt (g)	Age	%	mean L (cm)	mean Wt (g)	Age
1927	0				100		567	
1943	27				73			
1946	40				60			
1956	61				39			
1957	62				38			
1965	10		180		90		330	
2004	51	40.6	122	11	49	58.6	386	18
2005	52	41.4	126	11.4	48	58.1	393	18.2
2006	37	40.1	117	11.3	63	59.5	368	18.7
2007	38	40.2	121	11	62	62.3	370	n/a
2008	52	40.3	122	n/a	48	59.5	367	n/a
2009	54	40.9	128	n/a	46	61.7	378	n/a
2010	54	40.1	117	12.3	46	56.7	365	17.8
2011	57	40.2	118	14.7*	43	61.4	375	20.1*
2012	54	38.4	117	13.9*	46	61.2	396	19.6*
2013	51	41.1	125	12.8	49	61.4	372	18.6
2014	53	39.6	120	n/a	47	58.1	342	n/a

11 Life history and other biological information

11.1 Growth, silvering and mortality

von Bertalanffy parameters: Linf, K, t0

L50 = the length at which 50% of the population has silvered (my interpretation of 50% maturity)

Length and age at silvering

Fecundity

Weight-at-age

Length–weight relationship

Scotland

Individual growth rates of PIT tagged eels are measured by Marine Scotland Science in two tributaries of the River Dee. To date, growth rates for eels with more than a season between capture and recapture have ranged from 0.8 to 35.2 mm.yr⁻¹, with mean \pm s.e growth of 8.85 ± 0.62 mm.yr⁻¹ (n = 78). On the Baddoch, the range of growth rates was 0.0–14.5 mm.yr⁻¹, with mean \pm s.e growth rates of 6.36 ± 0.84 mm.yr⁻¹ (n = 26). These may be the lowest growth rates ever reported for the European eel.

Since 2008, yellow eel recruitment into the Girnock Burn has been assessed by Marine Scotland, using an eel pass. Eels are measured, weighed, and most are individually marked, either using PIT tags or VIE elastomer. Mean size of these ascending yellow eels is ca 157 mm (see Section 3.1.2), ranging from 96–254 mm.

Eel otoliths (ca 100 pairs) have been collected (by SEPA) and read (by Marine Scotland Science) from a number of sites around Scotland, but these data are not available. Historical data are available for age (estimated from otoliths) and length composition at a variety of sites in Scotland from a survey conducted in the early 1970s (Williamson, 1975).

Some Fisheries Trusts collect data on the length of eels captured during routine electrofishing surveys targeted at salmonids (1136 eels were measured between 1996 and 2008). Lochaber Fisheries Trust conducted an eel specific survey in 2010, and data are available at

[http://www.lochaberfish.org.uk/cust_images/Lochaber_eel_report_2010\[1\].pdf](http://www.lochaberfish.org.uk/cust_images/Lochaber_eel_report_2010[1].pdf)

11.2 Parasites and pathogens

England & Wales

- Detection of *Herpesvirus anguillae* during two mortality investigations of wild European eel in England: implications for fishery management

Herpesvirus anguillae (HVA) was detected during disease investigations of European eel, *Anguilla anguilla* L. at two stillwater fisheries in central England. These represent the first records of HVA from UK eels. Both mortalities were eel specific and took place during August 2009 and July 2010 at water temperatures between 17 and 19.4°C. Pathological changes consistent with HVA infection included haemorrhaging in the fins, skin lesions and necrosis within the gills and liver. Transmission electron microscopy revealed active virion replication within the gill tissue. An initial assessment of risk is presented, indicating that HVA represents a high disease risk to UK eel stocks. However, further studies are required to establish the distribution of HVA before a reliable assessment of impact may be obtained. Until then, the detection of HVA holds important implications for eel conservation and management, in particular eel stocking activity.

Armitage, J., Hewlett, N. R., Twigg, M., Lewin, N. C., Reading, A. J., Williams, C. F., Aprahamian, M., Way, K., Feist, S. W. and Peeler, E. J. 2014. Detection of *Herpesvirus anguillae* during two mortality investigations of wild European eel in England: implications for fishery management. *Fisheries Management and Ecology*, 2014, 21, 1–12. European eel health and disease investigations

Eel health and diseases in England and Wales are monitored through mortality investigations, targeted surveillance and screening of eels prior to re-stocking.

Since 2013, two eel-specific mortalities have been reported from still water fisheries in England. Field investigations and detailed post-mortem examinations confirmed the

primary cause for these losses to be Anguillid herpesvirus 1 (AngHV-1). These events, combined with previous outbreaks reported in 2009 and 2010 (Armitage *et al.*, 2013), bring the total number of mortalities associated with this virus in England to four.

All four outbreaks of AngHV-1 have involved large eels, measuring between 70 and 120 cm in length. These fish had estimated ages of between 17 and 29 years and many eel examined showed morphological characteristics of silvering. Affected eels were lethargic and unresponsive with signs of external haemorrhaging, skin lesions and severe gill necrosis. Histopathological examinations revealed marked necrosis, haemorrhage and inflammatory changes within the gills, kidney, skin, liver and spleen.

Post mortality sampling suggested that up to 70% of the eel populations were lost from these waters. It is proposed that the onset of silvering, with associated physiological changes and migration pressure, were triggers for these disease events, which so far have all occurred in still waters with barriers to escapement. Further sampling is underway to assess the prevalence, persistence and impact of the virus within these waters.

Since 2011, efforts have been made to establish the distribution of AngHV-1 in wild eels in England and Wales. This collaborative study between the Environment Agency and Cefas, has involved taking blood samples from live eels captured and returned during routine monitoring activities. To date, 685 eels, from 36 rivers in eleven RBDs have been tested for antibodies to AngHV-1. An additional 429 glass eels have been tested, from 14 sites in five RBDs. This work has confirmed that AngHV-1 has a relatively widespread distribution, but exists at a low prevalence (~5%) in most of the rivers sampled. This work will help inform existing disease risk assessments for this virus. Efforts are also underway to assess the presence and distribution of other eel viruses in England.

Since 2013, yellow eel from two rivers and glass eels from three rivers have been screened for parasites and disease prior to movement/stocking. *Anguillicola crassus* was found in all of the yellow eel samples at a prevalence of between 50 and 93%. Within these populations mean intensity of infection ranged from six to seven parasites respectively. Of the glass eels examined, only one of the samples revealed infections of *A. crassus*, at a prevalence of 37% and intensity of 1–7 nematodes (mean 2.4). These data are consistent with historic surveys of this nematode, now widely distributed throughout England and Wales. It is thought that a small number of catchments and some isolated rivers in North Wales and Northern England remain either sparsely infected or tentatively free of the parasite. No other parasites or diseases of concern were recorded during these examinations.

- Collaborative studies

A number of collaborative projects are underway to progress understanding of European eel health interactions. This includes development of a standardised protocol to harmonise assessments of eel spawner quality and maximise retrieval of data from UK monitoring activities (Lewin *et al.*, 2014).

A study in collaboration with Southampton and Cardiff Universities was also conducted to assess the influence of parasites on the behaviour and passage of silver eels in freshwater. This involved observations of 150 silver eels in response to a range of flow regimes within flume facilities. It has been shown that infections of *A. crassus* alters the behaviour of silver eels, causing avoidance of high flow velocities, in turn delaying downstream migration (Newbold *et al.*, in press). This could have important implications for eel passage, escapement and eel spawner quality.

The effect of *Anguillicola crassus*, *Pseudodactylogyrus bini* and *Pseudodactylogyrus anguillae* infection on the behaviour of downstream migrating adult European eels *Anguilla anguilla* as they encountered accelerating water velocity, common at engineered structures where flow is constricted (e.g. weirs and bypass systems), was evaluated in an experimental flume. The probability of reacting to, and rejecting, the velocity gradient was positively related to *A. crassus* larval, adult and total abundance. High abundance of *Pseudodactylogyrus* spp. reduced this effect, but *A. crassus* was the strongest parasitic factor associated with fish behaviour, and abundance was positively related to delay in downstream passage. Delayed downstream migration at hydraulic gradients associated with riverine anthropogenic structures could result in additional energetic expenditure for migrating *A. anguilla* already challenged by *A. crassus* infection (Newbold *et al.*, 2015).

References

- Lewin, N.C. Reading, A.J. Hockley, F.A. Cable, J. Turnbull, J.T. Davies, G.D. Feist, S.W. Evans, D. Belpaire, C. Walker, A.M. Way, K. Kemp, P.S. Aprahamian, M.W. Haenen, O.L.M. Hoole, D. Dufour, S. Hickley, P. and Williams, C.F. 2014. Silver Service: A Standard Protocol for Eel Health Examinations. Poster presentation, European Association of Fish Pathologists (EAFP), UK Meeting, Keele, 15–16 September 2014.
- Newbold, L.R., Hockley, F.A., Williams, C.F., Cable, J., A. J. Reading, Auchterlonie, N., and Kemp, P.S. Relationship between European eel *Anguilla Anguilla* infection with non-native parasites and swimming behaviour on encountering accelerating flow. *Journal of Fish Biology* 86, (5) 2015.

Scotland

No new data.

N Ireland

The LNFCS have funded research at AFBI's Veterinary Sciences Laboratories to examine the health status of Lough Neagh eel, by screening for the presence of a range of eel viruses currently believed to have negative impacts on the stock such as EVEX and HVA. The proposed project and Innovation voucher application aims to develop molecular assays to detect the presence of Eel Virus European (EVE), Eel virus European X (EVEX) and Herpes virus Anguillae (HVA).

Anguillicola crassus is now considered to be ubiquitous throughout Northern Ireland.

11.3 Contaminants

Scotland

A comparison of recent lipid and pollutant levels in Scottish yellow eel tissue with data from 1980 has recently been published (Oliver *et al.*, 2015)

References

- Oliver IW, Macgregor K, Godfrey JD, Harris, L and Duguid, A. 2015. Lipid increases in European eel (*Anguilla anguilla*) in Scotland 1986–2008: an assessment of physical parameters and the influence of organic pollutants. *Environmental Science and Pollution Research*, **22**, 7519–7528.

N Ireland

Samples of yellow eels have recently been submitted by the LNFCS for contaminant analysis as part of their commercial output licence. These data will be made available to WGEEL and ICES. Corroborative laboratory analyses examining fat content against that measured by fish fat meter have also been undertaken throughout the 2014 and 2015 fishing seasons. These data will also be made available to WGEEL and ICES in due course.

11.4 Predators

No new information is available on eel predation this year. The historic information, albeit limited, on predation levels in UK eels has been reviewed in recent UK reports.

12 Other sampling

England & Wales

Piper, A.T., Wright, R.M. and Kemp, P.S. 2012. The influence of attraction flow on upstream passage of European eel (*Anguilla anguilla*) at intertidal barriers. *Ecol. Eng.* 44, 329–336.

River structures can delay or prevent upstream migration of the critically endangered European eel *Anguilla anguilla* (L.). Eel ladders are frequently installed to mitigate for the impacts of barriers. There has been little quantitative testing to optimise attraction to pass facilities. The effect of plunging and streaming flow on pass efficiency was tested within field trials using four eel ladders at an intertidal weir with little seaward freshwater discharge. Eel passage was twofold higher in the presence of plunging flow. Water temperature and height of tide were also significant factors influencing daily catch. A strong 'edge effect' influenced route choice, with greatest catches in traps positioned at the channel sides. Route choice was related to body size with largest size classes (>121 mm) mostly passing towards the centre of the channel. The findings show that simple manipulation of hydrodynamic conditions at the entrance to upstream eel passes can improve passage efficiency for both juvenile and adult life stages.

Vowles, A.S., Eakins, L.R., Piper, A.T., Kerr, J.R. and Kemp, P. 2013. Developing Realistic Fish Passage Criteria: An Ecohydraulics Approach. *Ecohydraulics: An Integrated Approach*, 143–156. (Book Chapter).

Assessing the influence of low-head hydropower (Archimedes screw), Larinier and elver passes on up and downstream fish passage

Piper, A.

The EC Renewables Directive 2009 (2009/28/EC) is driving an increase in low-head hydropower schemes across Europe; however the impacts of such installations on the movement and behaviour of fish are poorly understood.

A field investigation on the River Stour, Suffolk, commenced autumn 2012, focuses on a low-head hydropower installation at Flatford Mill. The site comprises several structures including an Archimedes screw turbine, Larinier fish pass, two elver passes and multiple water level control weirs. PIT telemetry, acoustic telemetry and DID-SON sonar camera are being employed to monitor fish movement, behaviour and route choice. Fish were captured, PIT tagged and released up and downstream of the study site during the period April to October 2013 (n= 228 upstream; n=223 downstream). In March 2014 a further 261 individuals were tagged and further capture and tagging sessions are planned April–August 2014. Up and downstream fish move-

ments through the site will be continuously monitored over the period January 2013 to September 2014. Concurrent with this, water level and flow via each of the structures will be recorded using depth loggers and fixed side-looking ADCP telemetry. These data will be supplemented with hydrodynamic mapping upstream and downstream of the structures over a range of flow conditions using a raft mounted downward facing ADCP.

In addition, actively migrating silver eel were captured by fykenetting in autumn 2013, tagged with acoustic transponders and released 5 km upstream of the site ($n=67$). A network of acoustic receivers deployed throughout the downstream freshwater reach and into the estuary (see below) will track eel movements past a series of cross-channel structures, including those at Flatford Mill. The use of DIDSON at Flatford Mill will record fine-scale eel behaviour in the vicinity of the Archimedes screw and Larinier fish pass. This work follows a previous study of eel escapement and route choice through the same reach in 2009 and 2010, prior to installation of the hydropower scheme and fish passes (Piper *et al.*, 2012); hence the current study will enable quantitative assessment of the impacts of the hydropower installation on eel. Analysis of movement and passage data from autumn/ winter 2013 is still underway, but early indications show the negative influence of power generation regimes on the delay and energy expenditure of seaward migrating eel.

This work will demonstrate the efficacy of low head hydropower and associated passage facilities at providing safe passage routes for multiple species and life stages of migrating fish under a range of flow scenarios. Findings will provide valuable information for river managers that increasingly need to balance the growing demand to develop low-head hydropower with maintaining and improving free passage for all fish species.

Assessing the efficiency of acoustic behavioural guidance for deterring silver eel from water intakes

Piper, A.

European eel are particularly susceptible to damage and mortality at hydropower and water abstraction intakes. Mitigating for the negative impacts of such structures is a key focus of EU legislation (1100/2007/EC) aimed to restore declining eels stocks.

Field investigations on the River Stour, Dorset, aim to establish the efficacy of infrasound at deterring silver eel from water abstraction and hydropower intakes. The study site comprises an intake channel originally built to divert river flow to two turbines (now redundant). During November 2013, sub-metre fish positioning telemetry (HTI) was used to monitor the movements and fine-scale behaviour of tagged silver eel ($n = 60$) on the approach to the intake during six nights (batches of ten fish per night) with the infrasound source (12 Hz) alternately in 'on' and 'off' modes. The fine control of water levels afforded at the site enables hydrodynamic parameters to be kept constant throughout the study period.

The study generates eel swim paths (± 0.5 m positioning accuracy) on the approach to the intake and infrasound deterrent. This will enable quantification of deterrent/passage success, movement metrics (e.g. swim speed, tortuosity, etc.), and fine-scale behavioural changes in response to the infrasound source. Detailed flow mapping, using an ADCP, and infrasound mapping, using a pair of hydrophones, will enable interrogation of eel tracks in relation to stimuli within the site.

This work is conducted in response to the recent urgent drive to develop novel behavioural devices as an alternative to traditional mechanical screens for the mitiga-

tion of negative impacts of water resource infrastructure on eel populations. Early stage analysis from the winter 2013 study has indicated some downstream migrating silver eel react to 12 Hz infrasound within a nearfield detection distance to the infrasound device. The labour intensive nature of processing fine scale acoustic telemetry data means it will not be possible to quantify the true efficacy of this device for several months. On completion of the work, findings will be immediately disseminated nationally to the Environment Agency.

Piper, A. T., Wright, R. M., Walker, A. M. and Kemp, P. S. 2013. Escapement, route choice, barrier passage and entrainment of seaward migrating European eel, *Anguilla anguilla*, within a highly regulated lowland river. *Ecological Engineering*, 57, 88–96.

Assessing the impact of hydropower and riverine structures on silver eel migration, River Stour Suffolk

Piper, A.

The efficacy of low head hydropower and associated passage facilities at providing safe passage routes for migrating fish is poorly understood and requires investigation in terms of current impact, with the objective to identify optimal passage criteria. To achieve this, it is necessary to address knowledge gaps in fish responses to abiotic stimuli, and passage efficiency at a range of typical structures and conditions.

Building on previous (pre-and-post turbine installation) eel movement data. Seaward migrating adult eels will be captured and tagged (PIT and Acoustic) upstream of a complex of river structures including Archimedes Hydropower turbine, Larinier fishpass, elver passes and sluice gates on the river Stour, Suffolk. Subsequent fish movements will be monitored at fixed logging stations and via manual tracking. An ARIS sonar camera and conventional underwater filming techniques will also be employed to assess fine-scale behaviour.

This work will demonstrate the impact and efficacy of low-head hydropower and associated facilities at providing safe downstream passage routes for adult eel under a range of scenarios and help inform best practice guidance for future installations and management.

Additionally, fixed receiver monitoring stations will be situated to record fish movements past a number of other structures and abstraction intakes through the freshwater catchment and estuary. These data will provide additional insight into freshwater escapement rate, and elucidate on barrier impacts and movement patterns of eel; all of which are deemed knowledge gaps requiring attention under current eel management plans.

Datasets will also enable more robust analysis of the survival and energetic consequences for individuals that have and have not passed through the hydropower facilities.

Silver eel trap-and-transport feasibility study

Piper, A.

Large drinking water reservoirs have been identified by the Environment Agency as waterbodies likely to hold significant stocks of European eel. In many cases, disconnection from river and estuary systems prevents mature adult eels from contributing to the wider eel population by completing their oceanic spawning migration. Trap-and-transport has been proposed as a more feasible and cost-effective method

of facilitating adult spawning migration than provision of permanent connectivity between reservoirs and rivers using fishways.

The feasibility of trap-and-transport for enhancing adult eel spawning stock is poorly understood, with particular knowledge gaps in the viability of adult eels translocated from disconnected still waters to contribute to the breeding population i.e. will such individuals migrate.

Before a long-term trap-and-transport programme is undertaken, there is a need to establish the viability and efficacy of this technique.

A telemetry study to track the movement of tagged adult eel captured from a disconnected reservoir and translocated to the Suffolk Stour river/estuary system will provide an evidence base for management decisions regarding future implementation of trap-and-transport.

The use of acoustic telemetry will enable tracking of a subsample of tagged, translocated eel through the lower river Stour and Stour estuary. Concurrent tracking of silver eel captured directly from the river Stour will allow comparison between the two groups.

Understanding eel and trout movement in relation to obstructions in an East Anglian chalk stream

Piper, A.

Little is known about eel and trout populations and movement in small East Anglian chalk streams. Such information is required to fulfil obligations under the Water Framework Directive, Eel Management Plans and The Eels (E&W) Regulations 2009 and will, in a wider context, contribute to guidance for the enhancement of eel and trout passage at structures.

A PIT tagging study will focus on the impact of structures such as flow gauging weirs and tidal flaps on the movements of eels and trout in the River Stiffkey, Norfolk. Intensive electrofishing will be conducted to capture fish, a representative sample of both species will be PIT tagged and released. PIT telemetry arrays will enable monitoring of fish movement, both up and downstream, over four flow-gauging weirs and past modified (pet flap) and unmodified tidal flaps. At each of the PIT detection stations, additional monitoring of water level, flow and temperature will be conducted. These data will allow quantification of the impact of low-head structures, and associated environmental parameters, on fish movement within and between freshwater and estuarine environments.

Efficiency of vertical oriented bristle passes for upstream moving European eel (*Anguilla anguilla*) at an experimental Crump weir

Kerr, J., Karageorgopoulos, P and Kemp, P.

When head difference was at its greatest (230 mm) (High Velocity regime) and velocity was high (max: 2.43 m s⁻¹) the upstream passage of large eel was severely hindered (passage success: 17.2%), and for the eel that did pass, delay was long. The addition of bristle passes, under these conditions, increased passage success to 76.5% and reduced delay. As such, the addition of bristle passes considerably improved the passage of European eel when hydraulic conditions restricted movement.

The new configuration of bristle pass tested in this study represents a cost-effective, easy to install, non-mechanical, low-maintenance and hydraulically unobtrusive (En-

vironment Agency, 2010) alternative to conventional fish passes at low-head structures.

We recommend that new methods for reducing habitat fragmentation continue to be researched, but suggest that in the absence of a better alternative the configuration of bristle pass tested in this study represents a good short-term solution to improve habitat connectivity for European eel at low-head barriers.

Efficiency of “Eel Tiles” for upstream migrating glass eel (*Anguilla anguilla*) ascending as experimental Crump weir

Vowles, A. Don, A. Karageorgopoulos, P and Kemp, P.

“Eel tiles” may provide a cost-effective solution for mitigating barriers to juvenile eel migration. However, as eels were observed bursting upstream in a single attempt resting locations may be required on longer/larger barriers. Passage efficiency increased from 0% to an average of 66.9% per trial when the weir was modified with eel tiles. Higher passage efficiencies were attained for smaller (58.7%) rather than larger (41.3% study configuration).

Northern Ireland

In 2014 a new Queens University PhD funded directly by the LNFCS began examining all aspects of the biology of the Male eel based on L. Neagh.

<http://www.afbini.gov.uk/index/news/news-releases/news-releases-archive-2014.htm?newsid=26679>

The LNFCS have also funded research at AFBI’s Veterinary Sciences Laboratories on the health status of Lough Neagh eel, examining the presence of a range of eel viruses. This work required the sampling of 150 eels, covering juvenile eel, yellow eels through to male and female silver eels.

In 2015 a Danish research group working in association with the Agri-Food and Biosciences Institute (AFBI) and the Lough Neagh Fishermen’s Co-operative (LNFCS) are to use Lough Neagh eels in breeding trials in an attempt to complete the full European eel life cycle in captivity for the first time. A sample of broodstock composed of 100 male and 80 female silver eels were removed and relocated to the new facility in Denmark for the ongoing work.

<http://www.afbini.gov.uk/index/news/news-releases.htm?newsid=29616>

13 Stock assessment

13.1 Method summary

England and Wales

Silver eel production

Silver eel production is based on yellow eel electric fishing surveys and production estimated using the SMEP II model. The numbers of potential silver eel emigrants arising from the yellow eel population in the survey year, is estimated from the abundance and length distribution of those eels considered to be long enough to have a probability >0 of becoming silver eels in that year. The biomass of silver eels is estimated from the numbers-at-length using a length–weight relationship derived from

data for over 16 000 eels sampled throughout England and Wales (Arahamian *et al.*, 2007; Walker *et al.*, 2013).

Fishery impact

To estimate fishing mortality rate, the yellow and glass eel catches were first converted to silver eel equivalents. The biomass of yellow eel caught was considered to be the equivalent of the potential silver eel escapement as the instantaneous mortality rate of 0.139 yr⁻¹ (Dekker, 2000) approximated to the instantaneous growth rate of 0.2 yr⁻¹ (Arahamian, 1986).

For the glass eel catch, 1 kg of glass eel was considered equivalent to 59.4 kg of silver eel, based on the instantaneous mortality of 0.00915 day⁻¹ for the first 50 days post-settlement and there after a mortality of 0.139 yr⁻¹, a 50:50 sex ratio with males maturing at 12 (@90 g) and females at 18 years (@570 g) (Arahamian, 1988).

Non-fishery anthropogenic impact

Tidal flaps/gates, pumping stations, surface water abstraction points and hydropower facilities were assessed for their impact on eel. Over the last three years, there has not been any substantial change in the infrastructure or methods of operating at the sites associated with these factors which would reduce eel mortality, and no reduction was specified in the EMPs.

Tidal flaps/gates

A total of 1048 tidal sluices exist within England and Wales. A study was undertaken to produce a nationally consistent, prioritised list of tidal outfall structures in England and Wales where upstream and/or downstream fish passage is adversely affected (HIFI, unpublished). The decision of which sluices to assess was initially made on the basis of channel width, with the narrowest watercourses (those <5 m wide) rejected because these are unlikely to provide large quantities of habitat for eel (even if channel length is long). This reduced the number of structures from 1048 to 449. These 449 were prioritised based on (1) fish stock status; (2) passage efficiency; (3) channel length; (4) channel width and (5) habitat quality.

An initial assessment of the impact on eel production was estimated for the top 106 of the prioritised tidal structures. Assuming that all the area upstream of the tidal gates/flaps is lost production the total loss in terms of silver eel biomass was derived from total wetted area upstream * B_{best} production (kg/ha) in that RBD. In the absence of site-specific information on impacts, a conservative approach was taken to assume total loss of eel production upstream of the top 10% of tidal structures, and no loss of production from the remainder. This assessment will likely be revised as and when further information becomes available.

Pumping stations

In England and Wales, there are 321 pumping stations identified as having the greatest potential to impact on eel, based on: 1) distance from head of tide (shorter distance = greater impact) and 2) the predicted presence of eel.

To estimate the impact it has been assumed that all the area upstream of the pumping station is lost to eel production. The total annual loss in terms of silver eel biomass is derived from wetted area upstream * B_{best} production (kg/ha) for the relevant RBD.

Surface water abstraction sites

Surface water is abstracted at 29 863 sites in England and Wales. Those sites with the greatest potential to impact on eel were identified using the following criteria: distance from head of tide, size of the abstraction, predicted presence of eel, the sensitivity of the waterbody to abstraction; and were quality assured by consultation. 772 sites were identified as posing the greatest threat to eel.

A study of eel entrainment and mortality has been carried out at twelve surface water abstraction sites. The average number of eel entrained at these twelve sites was 627 eel per year, with the average age of those eel being two years (~150 mm). The equivalent in terms of silver eel biomass is estimated to be 0.03 kg per entrained eel. This equates to 18.81 kg per year entrained per abstraction.

Hydropower facilities

In England and Wales, there are 212 hydropower facilities in operation (Figure 2.9) affecting 11 158 ha of eel producing habitat. The impact of each hydropower facility is estimated according to the B_{best} production (kg/ha) for the relevant RBD, the area of habitat upstream, the presence or absence of screens (preventing eel entrainment) and the type of turbine. For those sites with screens, the proportion of eel entering the turbine(s) was assumed to be zero if the spacing between the bars/mesh was <15 mm, 50% if the spacing was between 16–29 mm and 100% if >30 mm: 27.6% of hydropower schemes (excluding Archimedes screws) are adequately screened to prevent the entrainment of eel (i.e. spacing was <15 mm). The estimates of turbine mortality were taken from the WGEEL 2011 report and were; Archimedes screw 0%, Francis Turbine 32%, Kaplan turbine 38%. All hydropower facilities have some form of bypass channel that provides an alternative route for fish around the turbine. On this basis, it has been assumed that approximately 50% of the silver eels produced upstream of a turbine will become entrained therein.

On those river systems where there is more than one hydro facility, the loss of production from the upstream turbine(s) has been accounted for in estimating the potential impact of turbines further downstream, i.e. the cumulative impact of all turbines has been calculated.

Scotland

Stock assessment methods have been developed for the Scotland RBD, based on quantification of upstream and downstream counts of eel at traps on three rivers. The estimates of B_0 , B_{current} and B_{best} rely heavily on the extrapolation of data from small study areas to the RBD as a whole, with the inherent possibility of bias. To derive an estimate of current production and anthropogenic mortality for the RBD from the available data has required a number of assumptions; these have tended to be precautionary in nature (i.e. likely to underestimate current production and overestimate current anthropogenic mortality (see Scotland RBD EMP 2010 for details). Some of these precautionary assumptions could be tested, and the production/mortality estimates adjusted accordingly, if resources become available.

Scotland RBD EMP is available at:
<http://www.gov.scot/Resource/Doc/295194/0118349.pdf>

From 2013, and following the methods used in England and Wales, Scotland has adopted the inclusion of a silver eel production estimate for transitional waters based on the simplistic assumption that this is equivalent to silver eel production in the lowland rivers and lochs of Scotland (<240 m). Pristine production for transitional

waters is assumed to be equivalent to pristine production in Scottish freshwaters during the reference period. For this reason, the inclusion of transitional waters has no effect on modelled silver eel output as a percentage of pristine output. However, because anthropogenic mortality is assumed to be zero in transitional waters, as there are no fisheries, the inclusion of transitional waters leads to a substantial reduction in the estimate of the value of ΣA for GB_Sco.

13.1.1 Estimate of B_0

England and Wales

Estimation of B_0

The 2015 triennial UK Eel Management Plan (EMP) progress report has an updated methodology for the calculation on historical biomass (B_0). The improved model now better reflects the actual state of eels stocks in rivers. Although the basic life history model used for compliance calculations has not changed, some of the assumptions and key datasets used within the model have significantly changed (for more details on the methodology, see annex A in the 2015 UK EMP report).

The 2015 UK EMP report can be accessed via the following link: http://sciencesearch.defra.gov.uk/Document.aspx?Document=12571_UKEMP2015report.pdf

Such changes to the model include better estimates of the historical biomass baseline (B_0) figures for each specific River Basin District (= Eel Management Units) in England & Wales. In the past, due to the limited data available, the first reports used a universal baseline figure for all RBDs ($16.25 \text{ kg} \cdot \text{ha}^{-1}$) based on data from the Dee RBD. As different catchments have variable habitat conditions and hence eel carrying capacities, this led to under and overestimates of baseline values in earlier reports. In this current report, eight out of the eleven EMPs now have higher B_0 estimates compared to the previous ICES 2013 Technical Review update report methodology.

Other model changes includes the use of an additional 33 Eel index Rivers (total 44), the previously report only used 11 index rivers. This has led to data quality improvements in current year best estimates of stock biomass (B_{best}). In the UK EMP 2015 report, estimates of anthropogenic impacts and hence derivation of B_{current} from B_{best} have been revised by the application of a new analysis quantifying the losses due to barriers to eel migration. The B_0 estimates have been revised by the inclusion of the new method to take account of the impact of barriers during the reference period. Although our model has been improved, the confidence limits around the biomass estimates are inherently wide.

Table 43. Reference period for B_0 .

EMU_CODE	B_0 (KG/HA)	REFERENCE TIME PERIOD	WHETHER OR NOT CHANGED FROM VALUE REPORTED LAST YEAR (Y/N)
GB_Nort	5.16	1983–1986	Y
GB_Humb	2.38	1983–1986	Y
GB_Angl	6.27	1983–1986	Y
GB_Tham	5.88	1983–1986	Y
GB_SouE	10.60	1983–1986	Y
GB_SouW	37.03	1977–1990	Y
GB_Seve	11.98	1983	Y
GB_Wale	16.18	1977–1990	Y
GB_Deer	45.02	1984	Y
GB_NorW	18.50	1977–1990	Y
GB_Solw	16.84	1977–1990	Y

Scotland

Estimation of B_0

Pristine escapement, B_0 , was estimated via three different methods: one based on historical measures of escapement from the Girnock Burn 1967–1980; one based on reference to a similar habitat elsewhere (Burrishoole data); and one based on the Irish Catchment Geology model. Details are presented in the Scotland RBD EMP (<http://www.gov.scot/Resource/Doc/295194/0118349.pdf>).

All three yielded broadly similar results, and accordingly the mean value for pristine escapement of the three methods was adopted as B_0 . Since the EMP was published the estimate of B_0 has been slightly increased to take account of trap efficiency in one of the estimated methods. From 2013 estimated production from transitional waters was included in the estimate (on the assumption of parity of production from fresh-water and transitional water habitats, as per England & Wales. Further details can be found in the UK [2015 EMP progress report to the EC](#).

Table 44. Estimate of B_0 for Scotland RBD.

EMUCODE	B_0 (KG/HA)	REFERENCE TIME PERIOD
GB_Sco	1.25	<1980s

Northern Ireland

The estimate of pristine escapement from the Northeast RBD was calculated with reference to the ecology and hydrology of similar systems (option c Article 5 of the Regulation) as described in Section 2.4.1 of the EMP. Current escapement is unknown and not monitored as there are no fisheries in this RBD, and escapement assessments were not an original feature of the terms of this EMP, but all rivers and upland lakes which are suitable for eel have been assessed as having no barriers to migration. As such under adequate recruitment levels and an adherence to the criteria laid down in the Northeast RBD EMP, this RBD should reach or better the 40% target naturally.

An annual mark-recapture programme of silver eel emigrating from Lough Neagh was initiated in October 2003, to estimate silver eel escapement (B_{current}) past the weir fishery, which is subject to a trap-free gap in the river channel, a three-month fishing season (some silver eel movement occurs outside this season), and inefficient fishing when river flows are very high. Recaptures occur both during the year of release and at least one or even two years afterwards. To date, 5823 silver eels have been tagged and maximum estimates of escapement, based on the proportion of recaptured Floy™ tagged eels, range from 38% to 85% during 2003 to 2013 (Table 46). No tagging was undertaken in 2007 due to the sporadic nature of the silver eel run. The Neagh/Bann estimate of B_{best} is derived from a known history of natural recruitment plus enhancement stocking, time lagged for known growth rates of silver eel; the current fishery management arrangements significantly contribute to outputs of this system.

The assessment methods for the Northwestern International RBD are detailed in the original EMP (Section 8; Action 2a). Stock assessment was carried out on the Erne as part of the Erne Eel Enhancement Programme which ended in 2001 (Matthews *et al.*, 2001).

Table 45. Estimate of B₀ for Northern Ireland RBDs. (Note GBNW* Transboundary NW IRBD with Ireland will be in Ireland report also).

EMUCODE	B ₀ (KG/HA)	REFERENCE TIME PERIOD
GBNW*	136	<1980s
GB NoE	4	
GB Nea	500	

Table 46. Results of mark–recapture estimation of silver eel escapement from the Lough Neagh silver eel fishery 2003–2014.

RECAPTURES								
Year	No. tagged	Toome	Kilrea	Carry over to catch (T+1, T+2y)	Total	Rate (%)	Total annual silver catch (t)	Max. possible escapement estimate (t)
2003	189	33	7	7	47	24.9	114	343
2004	838	302	15	4	321	38.3	99	159.4
2005	792	118	0	7	125	15.8	117	623
2006	700	197	1	2	199	28.4	104	262
2007	0	no tagging due to sporadic nature of silver eel run.					76	
2008	950	193	18		211	22.2	76	266.2
2009	486	187	0	1	188	38.8	85	134.1
2010	491	167	14	0	181	36.9	97	165.9
2011	474	82	64	3	149	31.4	73	159.5
2012	452	65	19	2	86	19.0	74	315.9
2013	451	74	19	3	96	21.2	72	267.6
2014	956	139	57	3	196	20.5	66	253.2
							11 yr mean	268.2
							1stEMPmean	153.2
							2nd EMP mean	278.9
							TARGET	200.0

13.2 Summary data

13.2.1 Stock indicators and Targets

England and Wales

The stock indicators for RBDs in England and Wales for 2015 are shown in Table 47. These have been revised since the last report via recent data collated in the UK EMP 2015 progress report.

Table 47. Stock indicators for England & Wales EMUs, 2013, the source of the material is Tables 2 & 3 of UK EMP 2015 progress report to ICES. Biomass targets = $0.4 \cdot B_0$ and ΣA is = 0.92 if ' B_{current}/B_0 ' >40%, or $0.92 \cdot B_{\text{current}}/(40\% \cdot B_0)$ if ' B_{current}/B_0 ' <40%.

EMUCODE	INDICATOR	BIOMASS (T)		MORTALITY (RATE)			TARGET		
		B_0	B_{best}	B_{curr}	ΣA	ΣF	ΣH	Source	ΣA (rate)
GB_Nort	60.876	9.577	4.478	0.76	0.00	0.76	WGEEL	24.3504	0.169
GB_Humb	137.859	137.859	43.147	1.16	0.05	1.11	WGEEL	55.1436	0.720
GB_Angl	341.084	171.573	94.596	0.60	0.09	0.50	WGEEL	136.4336	0.638
GB_Tham	251.699	162.444	51.581	1.15	0.04	1.10	WGEEL	100.6796	0.471
GB_SouE	121.340	75.622	50.807	0.40	0.04	0.36	WGEEL	48.536	0.92
GB_SouW	1327.684	319.248	22.767	2.64	2.52	0.12	WGEEL	531.0736	0.039
GB_Seve	899.687	383.532	83.264	1.53	1.20	0.32	WGEEL	359.8748	0.213
GB_Wale	429.944	37.231	27.277	0.31	0.07	0.24	WGEEL	171.9776	0.146
GB_Dece	636.166	53.223	31.958	0.51	0.04	0.47	WGEEL	254.4664	0.116
GB_NorW	865.449	25.350	5.781	1.48	0.59	0.88	WGEEL	346.1796	0.015
GB_Solw	1473.755	38.885	29.925	0.26	0.00	0.26	WGEEL	589.502	0.047

Scotland

Table 48. Stock indicators for the Scotland RBD for 2014.

EMUCODE	BIOMASS (T)			MORTALITY (RATE)			TARGET		
	B_0	B_{best}	B_{curr}	ΣA	ΣF	ΣH	Source	Biomass (t)	ΣA (rate)
GB_Sco	267.7	454.2	375.8	0.190	0	0.190	WGEEL	107.1	0.92

Northern Ireland

Table 49. Stock indicators for Northern Ireland RBDs 2013. (Note GBNW* Transboundary NWIRBD with Ireland will be in Ireland report also).

EMUCODE	BIOMASS (T)			MORTALITY (RATE)			TARGET		
	B_0	B_{best}	B_{curr}	ΣA	ΣF	ΣH	Source	Biomass (t)	ΣA (rate)
GBNW*	136	54.3	51.5	0.05	0.0	0.05	WGEEL	54.3	0.87
GB NoE	4			0.0	0.0	0.0	WGEEL	1.6	0.0
GB Nea	500	582	154.6	1.33	1.33	0.00	WGEEL	200.0	0.71

13.2.2 Habitat coverage

England and Wales

Table 50. The areas of habitat used in the assessment to determine B_0 , $B_{current}$ and B_{best} for EMU in England and Wales. N/A indicates not applicable.

EMU CODE	RIVER		LAKE		ESTUARY		LAGOON		COASTAL	
	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)
GB_Nort	5760	Y	3599	Y	2457	Y	0	N/A	70461	N
GB_Humb	15305	Y	9743	Y	32805	Y	0	N/A	32885	N
GB_Angl	12048	Y	9539	Y	32786	Y	0	N/A	225599	N
GB_Tham	34	Y	9162	Y	33615	Y	0	N/A	4268	N
GB_SouE	3954	Y	2061	Y	5428	Y	0	N/A	171207	N
GB_SouW	9798	Y	2621	Y	23431	Y	0	N/A	349787	N
GB_Seve	14372	Y	6157	Y	54542	Y	0	N/A	0	N/A
GB_Wale	8824	Y	4271	Y	13475	Y	0	N/A	433095	N
GB_Dece	1579	Y	1623	Y	10928	Y	0	N/A	0	N/A
GB_NorW	9076	Y	9780	Y	27927	Y	0	N/A	151109	N
GB_Solw	10933	Y	6760	Y	69803	Y	0	N/A	191300	N

Scotland

The wetted area of rivers and lakes in the Scotland RBD were calculated from UK Ordnance Survey Master Maps, scales 1:10 000 and 1:1250. Below a certain channel width (defined as normal winter flow width) the digital network represents channels as a single dimensional line, which thus provides no data on the width of river channels. On 1:10 000 scale maps this occurs nominally on channels below 5 m in width; at the 1:1250 scale, it is for channels below 1 m. To provide a reasonable measure of the true extent of water area represented by all non-determined widths of channels, these were attributed 1 m width. In some cases this will overestimate and in others underestimate the true width and hence wetted areas.

An area of the WFD defined transitional waters, combining estuarine and lagoon waters, was also calculated in GIS, with a value of 60 502 ha.

Table 51. The areas of habitat used in the assessment to determine B_0 , $B_{current}$ and B_{best} in the Scotland RBD.

EMU CODE	RIVER		LAKE		ESTUARY		LAGOON		COASTAL	
	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)
GB_Sco	138 557	Y	48 104	Y	60 502	Y	0	Y	4 589 412	N

Northern Ireland

Table 52. The areas of habitat used in the assessment to determine B_0 , $B_{current}$ and B_{best} in the EMUs of Northern Ireland.

EMU CODE	RIVER		LAKE		ESTUARY		LAGOON		COASTAL	
	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)	Area (ha)	A'd Y/N)
GB_Neag	0	N	40 000	Y	0	N	0	N/A	0	N
GB_NorE	0	N	5000	Y	0	N	0	N/A	0	N

13.2.3 Impact

England and Wales

The following impacts have been assessed for all RBDs in England and Wales; commercial fisheries, tidal gates, pumping stations, surface water abstractions and hydro-power installations. Since the last report, a new assessment of the impacts of other man-made obstructions has been completed (Table 53), and this barrier assessment methodology is detailed in Annex A of the UK EMP 2015 report. The impact of the recreational fishery, predators and contaminants and parasites is treated as part of natural mortality.

Table 53. England and Wales: An overview of the assessed impacts per habitat type or for 'All' habitats where the assessment is applied across all relevant habitats. Barriers includes habitat loss. Indirect impacts are anthropogenic impacts on the ecosystem but only indirectly on eel (e.g. eutrophication). A = assessed, MI = not assessed, minor, MA = not assessed major, AB = impact absent.

EMU CODE	HABITAT	FISH COM	FISH REC	BARRIERS			RESTOCKING	PREDATORS	INDIRECT IMPACTS
				HYDRO & PUMPS	(ALL INCLUDING TIDAL)				
GB_Nort	Riv	A	MA	A	A	M1	MI	MI	
	Lak	A	MA	A	A	MI	MI	MI	
	Est	A	MA	A	A	MI	MI	MI	
	Lag	AB	AB	AB	AB	AB	AB	AB	
	Coa	AB	AB	AB	AB	AB	AB	AB	
	All	A	MA	A	A	MI	MI	MI	
GB_Humb	Riv	A	MA	A	A	MI	MI	MI	
	Lak	A	MA	A	A	MI	MI	MI	
	Est	A	MA	A	A	MI	MI	MI	
	Lag	AB	AB	AB	AB	AB	AB	AB	
	Coa	AB	AB	AB	AB	AB	AB	AB	
	All	A	MA	A	A	MI	MI	MI	
GB_Angl	Riv	A	MA	A	A	MI	MI	MI	
	Lak	A	MA	A	A	MI	MI	MI	
	Est	A	MA	A	A	MI	MI	MI	
	Lag	AB	AB	AB	AB	AB	AB	AB	
	Coa	AB	AB	AB	AB	AB	AB	AB	
	All	A	MA	A	A	MI	MI	MI	
GB_Tham	Riv	A	MA	A	A	MI	MI	MI	
	Lak	A	MA	A	A	MI	MI	MI	
	Est	A	MA	A	A	MI	MI	MI	
	Lag	AB	AB	AB	AB	AB	AB	AB	
	Coa	AB	AB	AB	AB	AB	AB	AB	
	All	A	MA	A	A	MI	MI	MI	
GB_SouE	Riv	A	MA	A	A	MI	MI	MI	
	Lak	A	MA	A	A	MI	MI	MI	
	Est	A	MA	A	A	MI	MI	MI	
	Lag	AB	AB	AB	AB	AB	AB	AB	
	Coa	AB	AB	AB	AB	AB	AB	AB	
	All	A	MA	A	A	MI	MI	MI	
GB_SouW	Riv	A	MA	A	A	MI	MI	MI	
	Lak	A	MA	A	A	MI	MI	MI	
	Est	A	MA	A	A	MI	MI	MI	
	Lag	AB	AB	AB	AB	AB	AB	AB	
	Coa	AB	AB	AB	AB	AB	AB	AB	
	All	A	MA	A	A	MI	MI	MI	
GB_Seve	Riv	A	MA	A	A	MI	MI	MI	

EMU CODE	HABITAT	FISH COM	FISH REC	HYDRO & PUMPS	BARRIERS (ALL INCLUDING TIDAL)		RESTOCKING	PREDATORS	INDIRECT IMPACTS
	Lak	A	MA	A	A		MI	MI	MI
	Est	A	MA	A	A		MI	MI	MI
	Lag	AB	AB	AB	AB		AB	AB	AB
	Coa	AB	AB	AB	AB		AB	AB	AB
	All	A	MA	A	A		MI	MI	MI
GB_Wale	Riv	A	MA	A	A		MI	MI	MI
	Lak	A	MA	A	A		MI	MI	MI
	Est	A	MA	A	A		MI	MI	MI
	Lag	AB	AB	AB	AB		AB	AB	AB
	Coa	AB	AB	AB	AB		AB	AB	AB
	All	A	MA	A	A		MI	MI	MI
	Riv	A	MA	A	A		MI	MI	MI
	Lak	A	MA	A	A		MI	MI	MI
	Est	A	MA	A	A		MI	MI	MI
	Lag	AB	AB	AB	AB		AB	AB	AB
GB_Deer	Coa	AB	AB	AB	AB		AB	AB	AB
	All	A	MA	A	A		MI	MI	MI
	Riv	A	MA	A	A		MI	MI	MI
	Lak	A	MA	A	A		MI	MI	MI
	Est	A	MA	A	A		MI	MI	MI
	Lag	AB	AB	AB	AB		AB	AB	AB
	Coa	AB	AB	AB	AB		AB	AB	AB
	All	A	MA	A	A		MI	MI	MI
	Riv	A	MA	A	A		MI	MI	MI
	Lak	A	MA	A	A		MI	MI	MI
GB_NorW	Est	A	MA	A	A		MI	MI	MI
	Lag	AB	AB	AB	AB		AB	AB	AB
	Coa	AB	AB	AB	AB		AB	AB	AB
	All	A	MA	A	A		MI	MI	MI
	Riv	A	MA	A	A		MI	MI	MI
	Lak	A	MA	A	A		MI	MI	MI
	Est	A	MA	A	A		MI	MI	MI
	Lag	AB	AB	AB	AB		AB	AB	AB
	Coa	AB	AB	AB	AB		AB	AB	AB
	All	A	MA	A	A		MI	MI	MI
GB_Solw	Riv	A	MA	A	A		MI	MI	MI
	Lak	A	MA	A	A		MI	MI	MI
	Est	A	MA	A	A		MI	MI	MI
	Lag	AB	AB	AB	AB		AB	AB	AB
	Coa	AB	AB	AB	AB		AB	AB	AB
	All	A	MA	A	A		MI	MI	MI

The estimated loss in tonnes from fishing, hydropower, surface water abstractions and pumping stations (recorded under Hydro & Pumps) and from barriers (including tidal) is presented in Table 53.

Table 54. England and Wales: The loss in tonnes (t) for each impact per developmental stage (mean 2009–2011) or MI = not assessed, minor, MA = not assessed major, AB = impact absent. Recreational fishing loss has been included as part of natural mortality.

EMU CODE	STAGE	FISH COM	FISH REC	HYDRO & PUMPS	BARRIERS (INCLUDING TIDAL)	RESTOCKING	PREDATORS	INDIRECT IMPACTS
GB_Nort	Glass			MI		MI	MI	MI/MA
	Yellow					MI	MI	MI/MA
	Silver	2.539	0	9.629	13.794	0.139	MI	MI/MA
	Silver EQ			MI		MI	MI	MI/MA
GB_Humb	Glass			MI		MI	MI	MI/MA
	Yellow					MI	MI	MI/MA
	Silver	123.738	0	20.007	12.056	0.257	MI	MI/MA
	Silver EQ			MI		MI	MI	MI/MA
GB_Angl	Glass			MI		MI	MI	MI/MA
	Yellow					MI	MI	MI/MA
	Silver	94.142	0	2.065	63.980	1.380	MI	MI/MA
	Silver EQ			MI		MI	MI	MI/MA
GB_Tham	Glass			MI		MI	MI	MI/MA
	Yellow					MI	MI	MI/MA
	Silver	0.846	0	3.252	4.785	0.000	MI	MI/MA
	Silver EQ			MI		MI	MI	MI/MA
GB_SouE	Glass			MI		MI	MI	MI/MA
	Yellow					MI	MI	MI/MA
	Silver	1.504	0	2.378	17.455	0.000	MI	MI/MA
	Silver EQ			MI		MI	MI	MI/MA
GB_SouW	Glass			MI		MI	MI	MI/MA
	Yellow					MI	MI	MI/MA
	Silver	5.806	0	9.124	4.458	0.000	MI	MI/MA
	Silver EQ			MI		MI	MI	MI/MA
GB_Seve	Glass			MI		MI	MI	MI/MA
	Yellow					MI	MI	MI/MA
	Silver	0	0	0.121	8.844	0.000	MI	MI/MA
	Silver EQ			MI		MI	MI	MI/MA
GB_Wale	Glass					MI	MI	MI/MA
	Yellow	2.539	0	9.629	13.794	0.139	MI	MI/MA
	Silver			MI		MI	MI	MI/MA
	Silver EQ			MI		MI	MI	MI/MA
GB_Dece	Glass					MI	MI	MI/MA

	Yellow	123.738	0	20.007	12.056	0.257	MI	MI/MA
	Silver			MI		MI	MI	MI/MA
	Silver EQ			MI		MI	MI	MI/MA
GB_NorW	Glass					MI	MI	MI/MA
	Yellow	94.142	0	2.065	63.980	1.380	MI	MI/MA
	Silver			MI		MI	MI	MI/MA
	Silver EQ			MI		MI	MI	MI/MA
GB_Solw	Glass					MI	MI	MI/MA
	Yellow	0.846	0	3.252	4.785	0.000	MI	MI/MA
	Silver			MI		MI	MI	MI/MA
	Silver EQ			MI		MI	MI	MI/MA

Scotland

Table 55. Scotland RBD: an overview of the assessed impacts per habitat type or for 'All' habitats where the assessment is applied across all relevant habitats. Barriers includes habitat loss. Indirect impacts are anthropogenic impacts on the ecosystem but only indirectly on eel (e.g. eutrophication). A = assessed, MI = not assessed, minor, MA = not assessed major, AB = impact absent.

EMU CODE	HABITAT	FISH COM	FISH REC	HYDRO & PUMPS	BARRIERS (TIDAL)	RESTOCKING	PREDATORS	INDIRECT IMPACTS
GB_Sco	Riv	AB	AB	A	A	AB	A	MI
	Lak	AB	AB	A	A	AB	A	MI
	Est	AB	AB	A	A	AB	na	na
	Lag	AB	AB	A	A	AB	na	na
	Coa	AB	AB	A	A	AB	na	na
	All	AB	AB	A	A	AB	MI	MI

Table 56. Scotland RBD: the loss in tonnes (t) for each impact per developmental stage (2011) or MI = not assessed, minor, MA = not assessed major, AB = impact absent.

EMU CODE	STAGE	FISH COM	FISH REC	HYDRO & PUMPS	BARRIERS (TIDAL)	RESTOCKING	PREDATORS	INDIRECT IMPACTS
GB_Sco	Glass	0.000	0	MA	MA	AB	MI	MI/MA
	Yellow	0.000	0	MA	MA	AB	MI	MI/MA
	Silver	0.000	0	2.363	15.726	AB	MI	MI/MA
	Silver EQ	0.000	0	2.363	15.726	AB	MI	MI/MA

Northern Ireland

Table 57. Northern Ireland: an overview of the assessed impacts per habitat type or for 'All' habitats where the assessment is applied across all relevant habitats. Barriers includes habitat loss. Indirect impacts are anthropogenic impacts on the ecosystem but only indirectly on eel (e.g. eutrophication). A = assessed, MI = not assessed, minor, MA = not assessed major, AB = impact absent.

EMU CODE	HABITAT	FISH COM	FISH REC	HYDRO & PUMPS	BARRIERS (TIDAL)	RESTOCKING	PREDATORS	INDIRECT IMPACTS
GB_Neag	Riv	AB	AB	A	A	AB	MI	MI
	Lak	AB	AB	AB	A	A	MI	MI
	Est	MI	MI	AB	AB	na	na	na
	Lag	na	na	na	na	na	na	na
	Coa	MI	AB	AB	AB	AB	na	na
GB_NorE	Riv	AB	AB	A	A	na	MI	MI
	Lak	AB	AB	AB	A	na	MI	MI
	Est	MI	MI	AB	AB	na	na	na
	Lag	na	na	na	na	na	na	na
	Coa	MI	AB	AB	AB	AB	na	na

Table 58. Northern Ireland (only GB Neagh is included due to the presence of commercial fishery): the loss in tonnes (t) for each impact per developmental stage (2014) or MI = not assessed, minor, MA = not assessed major, AB = impact absent.

EMU CODE	STAGE	FISH COM	FISH REC	HYDRO & PUMPS	BARRIERS (TIDAL)	RE STOCKING	PREDATORS	INDIRECT IMPACTS
GB_Neag	Glass	0.000	0	AB	MA	na	MI	MI/MA
	Yellow	292	0	AB	AB	MI	MI	MI/MA
	Silver	66	0	AB	AB	MI	MI	MI/MA
	Silver EQ	358	0	AB	AB	MI	MI	MI/MA

13.2.4 Precautionary diagram

(Include graph(s)).

Not available at this time.

13.2.5 Management measures

England and Wales

An updated list of management measures became available in June 2015 within the publication of the 2015 UK EMP progress report. In summary (Table 58), actions in this period have delivered:

- Introduction of 100% catch and release for eel by angling;
- Close season for net and trap fishing for eel;
- Limits on the geographical extent of the eel fishery;
- Creation of no fishing areas;
- Restrictions on eel fishing methods and gear
- A programme of eel specific monitoring for all eel life stages;
- 328 new eel passes restoring access to over 4200 ha of river habitat;
- Legislation providing new powers to require passes and screening to protect eel (UK Eel Regulation 2009);
- Raised awareness and widespread engagement with key stakeholder groups, including Water Companies, Internal Drainage Boards (IDBs), Power Generation and, Hydro-Power sector representatives.

In January 2010, the Eels (England and Wales) Regulations, 2009 Statutory Instrument came into force. This legislation was specifically developed to facilitate the implementation of Council Regulation (EC) No 1100/2007 in England and Wales. The legislation makes provisions to monitor exploitation, imposed a temporary close season on fishing for eels, enabled some control on the fishery and makes provision to protect the passage of eels. Much time and effort has been (and will continue to be) dedicated to the implementation of these Regulations.

Table 59. Summary of management measures taken in England and Wales between 2009 and 2013.

EMU CODE	ACTION TYPE	ACTION	LIFE STAGE	PLANNED	OUTCOME
GB_Nort	Com Fish	Com Fish	Com Fish	Com Fish	Com Fish
	Com Fish	Com Fish	Com Fish	Com Fish	Com Fish
	Com Fish	Com Fish	Com Fish	Com Fish	Com Fish
	Com Fish	Com Fish	Com Fish	Com Fish	Com Fish
	Com Fish	Com Fish	Com Fish	Com Fish	Com Fish
GB_Humb	Com Fish	Controlled through legislation	All	Implemented fully	Increase catch
	Rec Fish	Catch & Release	All	Implemented fully	Not measured
	Hydropower & Pumps	High priority sites screened	All	2015-20121	Not measured
	Restocking 2011–2013 total (kg)	17	GE	Implemented fully	Not measured
	Eel pass	29	All	Implemented fully	Not measured
GB_Angl	Com Fish	Controlled through legislation	All	Implemented fully	Increase catch
	Rec Fish	Catch & Release	All	Implemented fully	Not measured
	Hydropower & Pumps	High priority sites screened	All	2015-20121	Not measured
	Restocking 2011–2013 total (kg)	25.9	GE	Implemented fully	Not measured
	Eel pass	45	All	Implemented fully	Not measured
GB_Tham	Com Fish	Controlled through legislation	All	Implemented fully	Decrease catch
	Rec Fish	Catch & Release	All	Implemented fully	Not measured
	Hydropower & Pumps	High priority sites screened	All	2015-20121	Not measured
	Restocking 2011–2013 total (kg)	3.21	GE	Implemented fully	Not measured
	Eel pass	35	All	Implemented fully	Not measured
GB_SouE	Com Fish	Controlled through legislation	All	Implemented fully	Increase catch
	Rec Fish	Catch & Release	All	Implemented fully	Not measured

EMU CODE	ACTION TYPE	ACTION	LIFE STAGE	PLANNED	OUTCOME
	Hydropower & Pumps	High priority sites screened	All	2015–2021	Not measured
	Restocking 2011–2013 total (kg)	7	GE	Implemented fully	Not measured
	Eel pass	31	All	Implemented fully	Not measured
GB_SouW	Com Fish	Controlled through legislation	All	Implemented fully	Increase catch
	Rec Fish	Catch & Release	All	Implemented fully	Not measured
	Hydropower & Pumps	High priority sites screened	All	2015–2021	Not measured
	Restocking 2011–2013 total (kg)	13.49	GE	Implemented fully	Not measured
	Eel pass	40	All	Implemented fully	Not measured
GB_Seve	Com Fish	Controlled through legislation	All	Implemented fully	Decrease catch
	Rec Fish	Catch & Release	All	Implemented fully	Not measured
	Hydropower & Pumps	High priority sites screened	All	2015–2021	Not measured
	Restocking 2011–2013 total (kg)	69.68	GE	Implemented fully	Not measured
	Eel pass	54	All	Implemented fully	Not measured
GB_Wale	Com Fish	Controlled through legislation	All	Implemented fully	Decrease catch
	Rec Fish	Catch & Release	All	Implemented fully	Not measured
	Hydropower & Pumps	High priority sites screened	All	2015–2021	Not measured
	Restocking 2011–2013 total (kg)	0	GE	Implemented fully	Not measured
	Eel pass	22			
GB_Deer	Com Fish	Controlled through legislation	All	Implemented fully	Increase catch
	Rec Fish	Catch & Release	All	Implemented fully	Not measured
	Hydropower & Pumps	High priority sites screened	All	2015–2021	Not measured
	Restocking 2011–2013 total (kg)	0	GE	Implemented fully	Not measured
	Eel pass	4	All	Implemented fully	Not measured

EMU CODE	ACTION TYPE	ACTION	LIFE STAGE	PLANNED	OUTCOME
GB_NorW	Com Fish	Controlled through legislation	All	Implemented fully	Decrease catch
	Rec Fish	Catch & Release	All	Implemented fully	Not measured
	Hydropower & Pumps	High priority sites screened	All	2015–2021	Not measured
	Restocking 2011–2013 total (kg)	0	GE	Implemented fully	Not measured
	Eel pass	54	All	Implemented fully	Not measured
GB_Solw	Com Fish	Controlled through legislation	All	Implemented fully	No change
	Rec Fish	Catch & Release	All	Implemented fully	Not measured
	Hydropower & Pumps	High priority sites screened	All	2015–2021	Not measured
	Restocking (kg)	0	GE	Implemented fully	Not measured
	Eel pass	3	All	Implemented fully	Not measured

Scotland

Table 60. Summary of management measures in Scotland 2009–present.

EMU CODE	ACTION TYPE	ACTION	LIFE STAGE	PLANNED	OUTCOME
GB_Sco	Com Fish	Controlled through legislation	All	Implemented fully	Zero legal fishing
	Rec Fish	Controlled through legislation	All	Implemented fully	Not measured
	Hydropower & Pumps	Regulations for new licences	All	Implemented fully	Not measured

Northern Ireland

Table 61. Summary of management measures in Northern Ireland, 2009 to present.

EMU CODE	ACTION TYPE	ACTION	LIFE STAGE	PLANNED	OUTCOME
GB_Neag	Com Fish	Controlled through legislation	All	Implemented fully	No change
	Rec Fish	Controlled through legislation Catch & Release	All	Implemented fully	Not measured
	Hydropower & Pumps	Regulations for new licences	All	Implemented fully	Not measured
	Restocking (kg)	5414	GE	Implemented fully	Target unachieved
GB_NorE	Com Fish	Absent Controlled through legislation	All	Implemented fully	No change
	Rec Fish	Controlled through legislation Catch & Release	All	Implemented fully	Not measured
	Hydropower & Pumps	Regulations for new licences	All	Implemented fully	Not measured
	Restocking (kg)	20	GE	Implemented fully	Target unachieved

13.3 Summary data on glass eel

Quantities caught in the commercial fishery

exported to Asia

used in stocking

used in aquaculture for consumption

consumed direct

mortalities

England and Wales

Table 62. Quantities of glass eel caught in the UK between 2009 and 2015, as reported to Environment Agency and predecessor Agencies, and as estimated from HMRC nett export trade reports. 'n/a' = no data available. * Note that the 2015 reported catch is provisional, as of 28th October 2015.

YEAR	CATCH REPORTS TO AGENCY (T)	CONSIGNMENT NOTES (T)	DEALERS PURCHASE (T) 2009 ONWARDS	LOSS (MORTALITY AND WEIGHT LOSS) PERCENT
2009	0.29	0.45	0.45	0.0
2010	1.24	1.72	1.89	9.0
2011	2.24	3.28	3.64	9.9
2012	2.77	3.61	3.82	5.5
2013	5.91	7.79	8.66	10.0
2014	10.97	12.39	12.66	2.1
2015*	2.80	2.7	2.8	-3.6

For 2014, the confirmed data reported to the Environment Agency was 11.91 t, the quantity bought by the dealers was 12.3 t, and 11.6 t was exported or used internally (within UK), representing a loss (mortality and shrinkage) of plus 6.0 by weight. Provisional figures for 2015 have been described in Section 3.1.1.1 (Table 2), as has the reason why we have an apparent “positive mortality” figure for 2014.

The fate of the confirmed 2014 and provisional 2015 glass eels have been described in Section 2.5.2 (Table 13) and further summarized in (Table 63).

Table 63. Percentage of glass eel caught in the UK and used for stocking, aquaculture or direct consumption. [Note these percentages may not add up to 100% because of mortality and weight loss after capture]. *2015 Provisional data (as of 28th October 2015).

	2009	2010	2011	2012	2013	2014*	2015
Stocking	100	53.8	43.9	84.7	72.6	31.0	73.0
Aquaculture	0	36.5	45.3	10.5	27.4	63.0	27.0
Direct Consumption	0	0	0	0	0	7.0	0

*provisional data.

The quantities (kg) and destinations of glass eel caught in the UK are shown in Table 64.

Table 64. The quantities (kg) and destinations of glass eel caught in the UK between 2009 and 2015.
***2015 Provisional data (as of 28th October 2015).**

	2009	2010	2011	2012	2013	2014	2015*
Belgium					4		0
Czech Republic			30	76	470	594	32
Denmark		200	515	400		400	250
Estonia			307	90	480	420	250
France						863	100
Germany		97	882	384	470	1199	323
Greece			411		1005	650	40
Latvia			100	343	15	483	0
Lithuania					180	330	0
Netherlands		1288	593	100	1620	2232	350
Poland				120	95	15	5
Slovakia		85	80				0
Spain						500	0
Sweden	205			1200	1300	1400	697
UK	240	54	366	921	2151	3300	2719

Scotland

No data on glass eel because there are no commercial glass eel fisheries.

Northern Ireland

No data on glass eel because there are no commercial glass eel fisheries.

14 Sampling intensity and precision

No new information available. Refer to previous UK Country Reports.

15 Standardisation and harmonisation of methodology

15.1 Survey techniques

England & Wales

Knights *et al.* (2001) provided recommendations for design of monitoring programmes to detect spatial and temporal changes in population status, including those on electrofishing method. The Environment Agency has two standard work instructions in relation to eel, for eel-specific electrofishing surveys in rivers and for fykenetting.

Baldwin and Aprahamian (2012) undertook an evaluation of electric fishing for assessment of resident eel in rivers. Electric fishing is the sampling method of choice in smaller rivers and can be very efficient at optimal conditions. There are, however, widely held assumptions about the efficiency of electric fishing for eel which suggest that it is difficult, if not impossible, to get accurate population estimates from electric fishing surveys. Relationships between efficiency of eel capture by electric fishing and survey method were examined. Data from over 2000 routine electric fishing surveys carried out by the UK Environment Agency were used. Catch efficiencies (CE)

were compared for surveys targeted at salmonid, coarse fish (multispecies) or eel (mean CE 0.575, 0.569, 0.605 respectively), and different size ranges of eel. Eel catch efficiency was compared with that for other species. The assumption that surveys targeted at multiple species or salmonids invariably underrepresent eel is not supported by this study. The results from eel specific surveys examined in this study did not demonstrate any significant advantage over multispecies or salmonid surveys in terms of catch efficiency.

Scotland

No information.

Northern Ireland

No information.

15.2 Sampling commercial catches

Scotland

No commercial catches are reported.

Northern Ireland

Methods described above. No Quality Assurance is undertaken within the sampling of the commercial catches.

15.3 Sampling

England & Wales

Monitoring Eel Population, Environment Agency Eel Manual for details see:- <http://publications.environment-agency.gov.uk/PDF/GEHO0411BTQF-E-E.pdf>

Scotland

No information.

Northern Ireland

No information.

15.4 Age analysis

England & Wales

Ages reported in Knights *et al.* (2001) were quality assured by the Environment Agency's National Fisheries Laboratory at Bampton. A similar QA method was employed by Bark *et al.* (2007). Age analyses currently being conducted on otoliths using the cutting and burning method (as per ICES Eel Ageing Workshops held in Bordeaux in 2009 and 2011), or sectioning and staining where the otoliths are used for microchemistry analyses.

Scotland

Age analyses currently being conducted on otoliths deploy the cracking and burning method (as per ICES Eel Ageing Workshops held in Bordeaux in 2009 and 2011).

Northern Ireland

Age analysis is performed on yellow and silver eels sampled from the Lough Neagh fisheries and other samples collected from the GB_NorW during yellow eel surveys using the grinding and polishing technique. The results have been quality assured against burning and cracking of sister otoliths performed at the Marine Institute laboratories in Newport. Results to date indicate that on Neagh commercially sold mean yellow eel age of 14.7 years, male silvers twelve years and female silvers 18 years. These findings and the methodologies by which they were calculated were corroborated during the ICES Eel Ageing Workshop held in Bordeaux in 2009.

15.5 Life stages

Scotland

No information available.

Northern Ireland

All life stages on Lough Neagh are studied. Glass eels and yellow eels are periodically examined from those systems listed previously and as part of NS Share work.

In GB_NorE EMU only glass eel are annually monitored. Periodically as part of yellow eel stock assessments in the GB NorW IRBD samples of a minimum 100 yellow eels will be intensively analysed.

For Northern Ireland in general, no analysis of glass eel developmental stage is undertaken. The difference between yellow eel and silver eel is determined by gross morphology, aided by length and time of year and was originally under the guidance of senior fisheries scientists and in the company of experienced fishermen.

15.6 Sex determinations

Scotland

No information available.

Northern Ireland

The correct gender assignment was originally under the guidance of senior fisheries scientists and is based on *in situ* macroscopic examination.

15.7 Data quality issues

Scotland

No information available.

16 Overview, conclusions and recommendations

17 Literature references

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