Report on the eel stock, fishery, and other impacts in:

Poland

2023

Note to the reader – this document accompanies a series of spreadsheet tables that provide the bulk of the data in a format most suitable for the working practices of WGEEL. Summaries of these data are provided in this document.

Authors

Tomasz Nermer, National Marine Fisheries Research Institute (NMFRI), Poland. nermer@mir.gdynia.pl;

Katarzyna Nadolna –Ałtyn, National Marine Fisheries Research Institute (NMFRI), Poland.. knadolna@mir.gdynia.pl;

Rafał Bernaś, National Inland Fisheries Research Institute (NIFRI), Poland. rber@infish.com.pl

Reporting Period: This report was completed in September 2024, and contains data up to 2023

Contents

1 Summary of national and international stock status indicators

1.1 Escapement biomass and mortality rates

Table 1.1.1 Stock indicators of silver eel escapement, biomass and mortality rates, and assessed habitat area.

Year	EMU_code	Assessed Area (ha)	B_0 (kg)	B_{curr} (kg)	B_{best} (kg)	Bcurr/B_0 (%)	∑F	∑H	∑A
2011	PL_Oder	152 100	1204000	1148403	215000	1,79	0,73	0,29	1,02
2012	PL_Oder	152 100	1204000	762004	215000	1,19	0,87	0,29	1,15
2013	PL_Oder	152 100	1204000	681601	215000	1,06	1,08	0,29	1,37
2014	PL_Oder	152 100	1204000	638108	215000	0,99	0,98	0,29	1,27
2015	PL_Oder	152 100	1204000	572321	215000	0,89	0,78	0,29	1,07
2016	PL_Oder	152 100	1204000	509559	215000	0,79	1,00	0,29	1,29
2017	PL_Oder	152 100	1204000	484544	215000	0,75	1,11	0,29	1,40
2018	PL_Oder	152 100	1204000	463508	215000	0,72	0,81	0,29	1,10
2019	PL_Oder	152 100	1204000	513103	215000	0,80	0,75	0,29	1,04
2020	PL_Oder	152 100	1204000	568241	215000	0,89	0,52	0,29	0,81
2021	PL_Oder	152 100	1204000	685456	215000	1,07	0,47	0,29	0,76
2022	PL_Oder	152 100	1204000	804446	215000	1,25	0,52	0,29	0,81
2023	PL_Oder	152 100	1204000	884673	215000	1,38	0,59	0,29	0,88
2011	PL_Vist	252 600	4713000	4560423	841000	1,81	0,34	0,29	0,63
2012	PL_Vist	252 600	4713000	3126381	841000	1,24	0,31	0,29	0,60
2013	PL_Vist	252 600	4713000	2805302	841000	1,12	0,47	0,29	0,76
2014	PL_Vist	252 600	4713000	2403862	841000	0,96	0,33	0,29	0,62
2015	PL_Vist	252 600	4713000	2250683	841000	0,90	0,44	0,29	0,73
2016	PL_Vist	252 600	4713000	1978955	841000	0,79	0,69	0,29	0,97
2017	PL_Vist	252 600	4713000	1764076	841000	0,70	0,65	0,29	0,94
2018	PL_Vist	252 600	4713000	1680029	841000	0,67	0,49	0,29	0,78
2019	PL_Vist	252 600	4713000	1764679	841000	0,70	0,44	0,29	0,73
2020	PL_Vist	252 600	4713000	1858080	841000	0,74	0,26	0,29	0,55
2021	PL_Vist	252 600	4713000	1906167	841000	0,76	0,35	0,29	0,64
2022	PL_Vist	252 600	4713000	2113097	841000	0,84	0,48	0,29	0,77
2023	PL_Vist	252 600	4713000	2268814	841000	0,90	0,37	0,29	0,66

Key:

EMU_code = Eel Management Unit code (see Table 2 for list of codes); B_0 = the amount of silver eel biomass that would have existed if no anthropogenic influences had impacted the stock (kg); B_{curr} = the amount of silver eel biomass that currently escapes to the sea to spawn (in the assessment year) (kg); B_{best} = the amount of silver eel biomass that would have existed if no anthropogenic influences had impacted the current stock (kg); ∑F = mortality due to fishing, summed over the age groups in the stock (rate); ∑H = anthropogenic mortality excluding the fishery, summed over the age groups in the stock (rate); ∑A = all anthropogenic mortality summed over the age groups in the stock (rate); Assessed area (ha) = combined area total (ha) of transitional and inland waters.

1.2 Recruitment time series

Data from Polish rivers are not used by WGEEL to determine the level of natural recruitment. The decreasing number of glass eel reaching Europe and intense catches of them suggest that currently far fewer fish are ascending the rivers of the southern Baltic than did so in the past. Additionally, their further migration in rivers is significantly hampered by river degradation and barriers. The vast majority of lakes in Poland that are primary eel production areas are inaccessible to ascending eels.

Natural recruitment plays a minor role in population formation. Monitoring of eel occurrence being currently performed on rivers flowing directly into the Baltic Sea has confirmed small numbers of ascending eel fry.

In 2012-2023, monitoring points on the Slupia and Lupawa rivers found eels with lengths ranging from 8 to 40 cm, with an average length of 14 cm. The number of fry ranged from a few to about 1,600 per year, with by far the most caught in a trap located on the Slupia River. The origin of these fish is not clear, especially since intensive stocking of glass eels and ongrown eels is underway in the Baltic Sea catchment basins. Research carried out in 2015-2016 (Nermer 2022) showed that among the adult eels living in the waters of the Vistula Lagoon, no individuals from natural recruitment were found. A historical source (Kaj and Walczak 1953) indicates that millions of eel individuals were recruited in the post-war years of the 20th century, and were moved artificially up river basins, above the barriers already present in large numbers in northern Poland at that time.

2 Overview of the national stock and its management

2.1 Describe the eel stock and its management

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 km^2. Dams in the Vistula and Oder rivers and in many of their tributaries prevent migrations of eel and other fish species.

Eel fisheries has 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

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.

In mid-2024, Poland sent a new version of the Plan to the Commission, which provides many significant changes.

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.

These EMUs include the following river basins, running waters, and maritime waters: Oder (Odra) EMU and Vistula EMU.

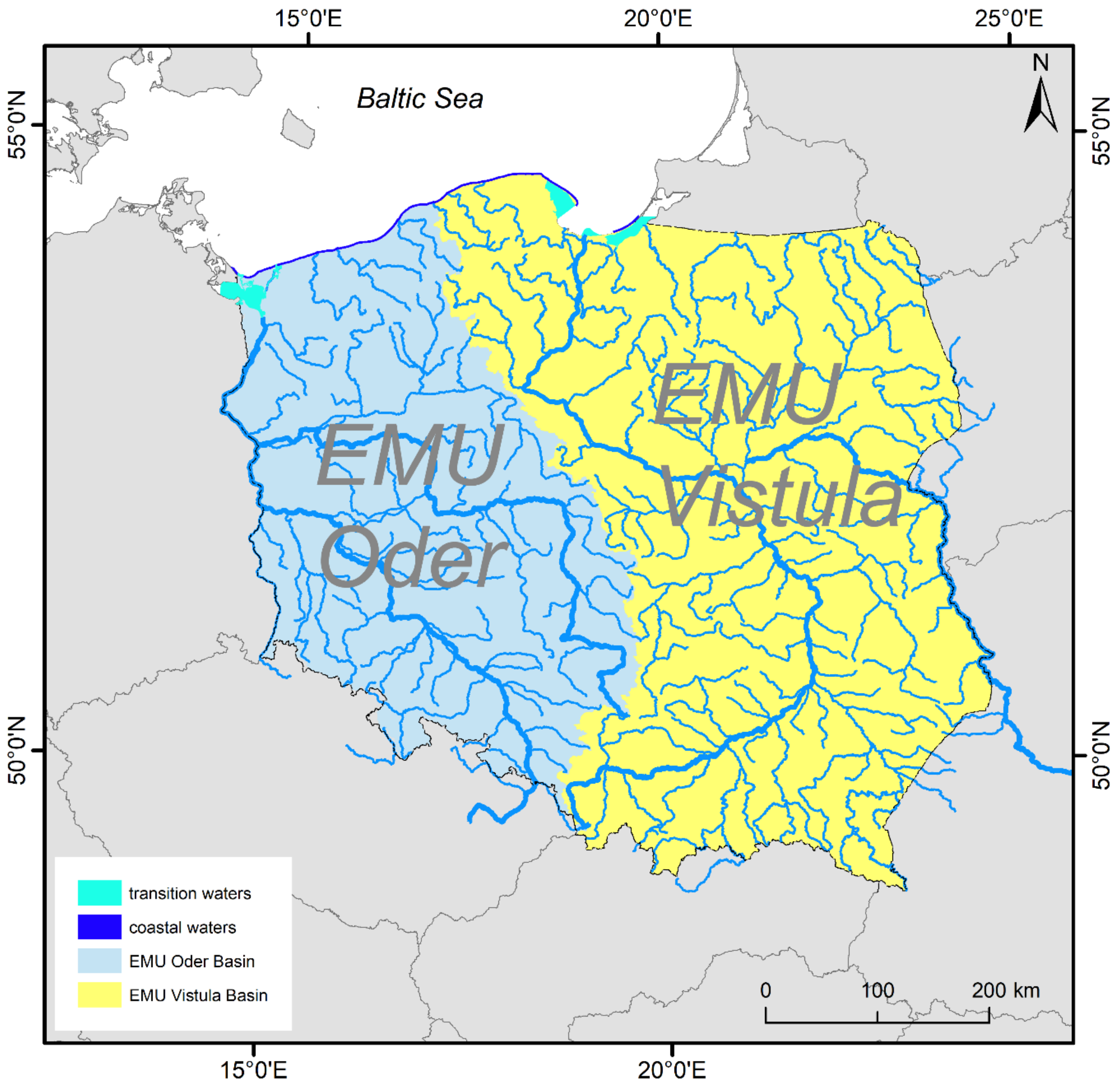

Figure 2.1.1 EMUs in Poland according to the Polish EMP.

The major elements and measures of the Polish EMP (2010) 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 ongrown eels <20 cm, respectively;

make migration routes passable – removing barriers, building passes, closing hydroelectric 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).

2.2 Significant changes since last report

The 2024 model uses many new or updated data compared to previous implementations. New escapement, biomass and mortality rates. New habitat description and quantity. Updated chapter 5.4 Diseases, Parasites & Pathogens or Contaminants.

3 Impacts on the national stock

3.1 Fisheries

3.1.1 Glass eel fisheries

Not applicable

3.1.2 Yellow eel fisheries

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). Data is presented as total landings.

Table 3.1.2. Commercial catches (kg) of eel fin Poland reported from 2005 to 2022

Year	PL_ODER	PL_VIST
2005	90338	129572
2006	73797	110651
2007	74900	105800
2008	68400	91300
2009	74400	86200
2010	76100	97100
2011	54800	64000
2012	51300	68000
2013	67400	70000
2014	45700	71100
2015	35432	66991
2016	45749	92645
2017	64459	108159
2018	70851	75639
2019	64301	103233
2020	44414	59218
2021	49179	77422
2022	56081	101718
2023	60039	82746

3.1.3 Silver eel fisheries

Data is presented as total landings (see above)

3.2 Restocking

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.. 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 and marine waters in 2011–2023 was determined using data obtained from the users of fisheries districts and from Inland Fisheries Institute database.

Table 3.2.1 Restocking (indiv.) of ongrown eels x reported from 2005 to 2023

Year	PL_ODER	PL_VIST
2005	220000	520000
2006	354000	563900
2007	475604	919281
2008	530107	988611
2009	462070	938142
2010	426148	865210
2011	1098671	1574303
2012	753458	993975
2013	1308936	2170066
2014	1511058	783554
2015	401475	3225676
2016	761125	745611
2017	842045	967905
2018	950324	1486504
2019	420000	560000
2020	313000	636554
2021	1034303	786875
2022	1693088	2675424
2023	708880	756955

3.3 Aquaculture

Table 3.3.1 Production of eels and reported from 2015 to 2022

Year	Production(kg)
2015	600
2016	981
2017	2810
2018	3090
2019	ND
2020	61083
2021	7840
2022	45070

3.4 Entrainment

On Polish rivers there are tens of thousands of barriers of varying kinds. Their influence on eel migration is highly varied: practically every one of them to some degree makes it difficult for eel to move upstream; not all, however, constitute a hindrance for eel moving downstream. The barriers' influence depends on a range of factors, the main one of which is the purpose of the construction, and, in particular, whether water is used to produce electricity, for irrigation, in water supply, for ponds, etc., whether the water is used in its entirety, or whether it is possible for the eel to avoid machinery (turbines, pumps, etc.), which, in turn, depends on individual configurations of technology. The influence also depends on whether - if the eel can avoid the machinery - they are exposed to the risk of injury from falls, changes in pressure, etc. The worst, in this respect, are without doubt water-powered electricity generating facilities. In Poland there are around 600 of them, and their number has grown in recent years. Mortality among eel navigating the barrier of an electricity generating facility depends on the possibility for the eel of avoiding the turbines, on the size of the eel themselves, on the type and size of a given turbine, and the height of a given barrage. Mortality rises with the size of the eel; it is greater in Francis turbines than in Kaplan ones; and it is greater in smaller turbines. Smaller electricity generating facilities often have Francis turbines; however, it seems that eel have more chance of voiding a turbine in larger electricity generating facilities. It is also worth recalling that when passing through turbines eel are subject to much more serious injuries than, for example, salmon smelt. At the same time, it is only from 24% of the surfaces of lakes, which are the basic environment and site of natural eel production that eel can swim to the sea without encountering a water-powered generating station. From as much as 63% of those surfaces they have to deal with at least two power stations. Based on results A variable, often significant, part of the eel after release does not swim downstream, but quite the reverse swims upstream (up the facility's reservoir). This was observed both in spring and in fall experiments. On the Narew River (Zegrzyński Reservoir) in 2012, of 30 eel 20 swam upstream, including nine that went as far as the reservoir backwater. Twelve of them (40% of all eel) did not pass the dam up to the end of the experiment, which is over a period of two and a half months. In 2013, the percentage of such eel was 32%. On the Słupia in Słupsk this was 18%, in Kondradowo 96%, in Krzynia 23%, on the Drawa in Kamienna 16%, and on the Radunia in Rutki 100%. Partly this may be a result of stress induced by capture, transport, marking, and release. At several places the eel are too big to get through the grates protecting the turbine inflows. Many eel, however, do not go near the inflow, but immediately swim upstream, several reaching the river above the reservoir. This phenomenon is described in the literature: barriers and reservoirs can prevent eel migration, sometimes forever. It is difficult to assess to what degree this is attributable to the eel natural impulse, and to what degree to the method employed in the research. Certainly, however, the limit on downstream movement placed on silver eel by barriers is not restricted to the injuries eel may suffer in passing through the turbines of a power station.

The Polish Eel Management Plan (PEMP) assumes an improvement in the conditions of downstream migration, and makes the success of the plan dependent on such improvement, and designates it as a fundamental course of action.

3.5 Habitat Quantity and Quality

The natural habitats of the eel in Poland are rivers, lakes, transitional waters and coastal marine waters.

Poland lies in the catchment area of three seas: the Baltic Sea - 99.7% of Poland's area, the Black Sea (the Dniester and Danube basins) and the North Sea (the Elbe basin). The largest river is the Vistula. Its catchment area covers 55.7% of Poland's area. The other major river is the Oder (33.9%). The area drained by coastal rivers occupies 9.3%.

It was assumed that the potential habitat of the eel is the entire width of the river channel. The average width of rivers of each type was calculated from measurements made during ichthyological monitoring of rivers at 1,073 sites.

Table 3.5.1 Length of rivers of particular abiotic type that are eel habitat

Abiotic types of rivers	Oder River EMUs (km)	Vistula River EMUs (km)
Transformed watercourse	1067	1832
Sandy-clay lowland river	3308	4880
Lowland gravel river	1639	1792
Great lowland river	1280	1697
Estuarine river under the influence of salt water	49	49
River in a peaty valley	763	1663
River connecting lakes	2342	3741

Lakes occupy about 0.8-0.9% of Poland's total area, counting bodies of water with an area of more than 1 hectare there are a total of 7085, while the total area is estimated at about 281 thousand hectares.

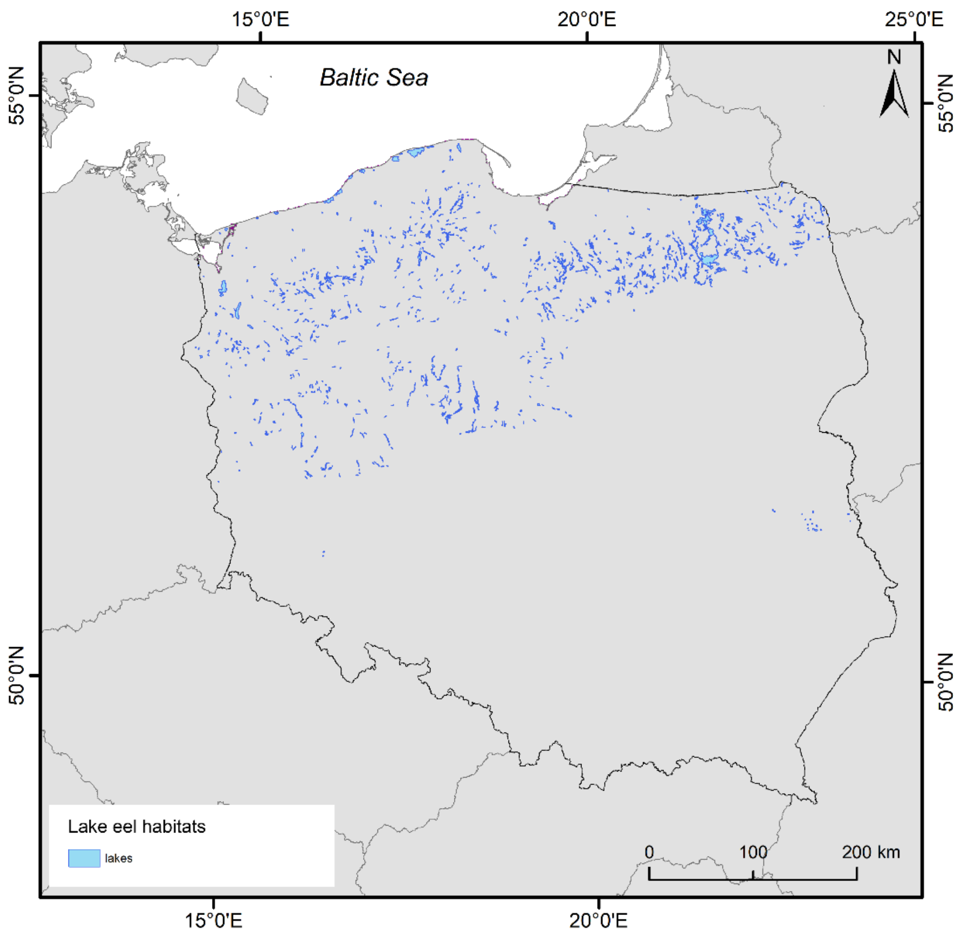

Figure 3.5.1 Lake districts in Poland that are eel habitats

Transitional waters are surface waters located in or near estuaries, which, due to their proximity to saline waters, show partial salinity while remaining within the range of significant freshwater influences. Of importance for the occurrence of eel are, defined according to the Water Directive, the basins of the Szczecin Lagoon, including the Kamienski Lagoon, the Dziwna River, the Swina River, Lake Nowowarpienskie and Wicko, as well as the Vistula Lagoon (lagoon type with silty and sandy substrate), the Outer Puck Bay (bay type with clay and silty substrate) and the Puck Lagoon (lagoon type with sandy and silty substrate).

Coastal waters include the area of surface waters from the shoreline, the outer limit of which is a distance of one nautical mile on the seaward side, counting from the baseline. The ICES 24 coastal zone is the Pomeranian Bay, which is part of the Oder estuary. This basin is characterized by variable hydrochemical conditions caused by the interaction of inland and marine waters. The coastal zone of ICES 25 and 26 is a relatively homogeneous coastal zone environment with a sandy bottom exposed to strong wind and wave action, and locally occurring upwelling (lifting of cold water masses from the depths towards the shore in summer). In addition, there are cliff shores and stretches of spit-like shores in these areas.

A summary of the estimated areas of waters of each type that are potential eel habitats is presented in Table 1.

Table 1.5.1 Area of potential eel habitats(km2)

	Lakes	Rivers	Transitional waters	Marine waters	Total
Oder EMUs	611	235	482	193	1521
Vistula EMUs	997	575	725	229	2526

Eels migrating through rivers encounter numerous obstacles on their way (Figure). Most of them are the result of hydrotechnical development of watercourses. These include various types of weirs, dams and water intakes.

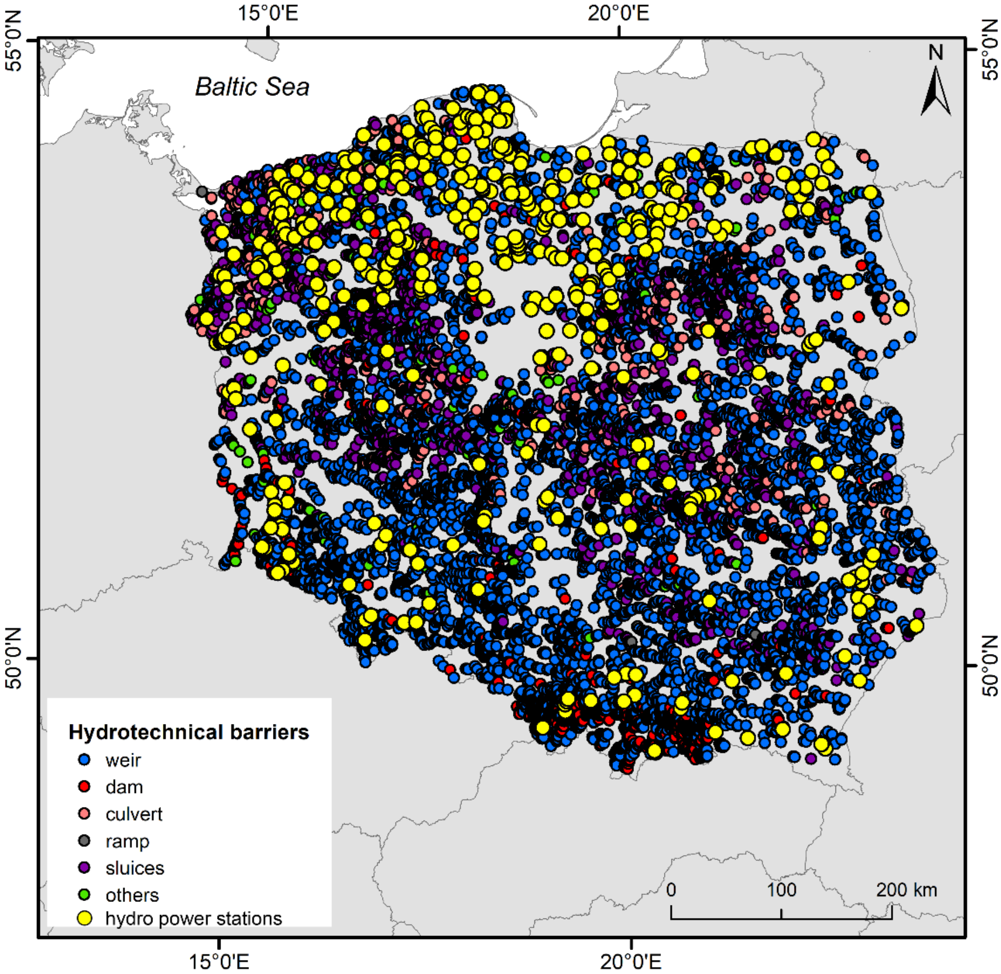

Figure 3.5.2 Hydrotechnical structures in Poland

3.6 Other impacts

No new data available.

4 National stock assessment

4.1 Description of Method

The stock dynamics of eel in both RBDs was estimated using a version of the CAGEAN model (Deriso et al., 1985). The model was originally fitted to data covering the period of 1960–2011. There were many gaps in the age structure data, and for some data only approximate or assumed values were available, so the model was fitted using simplified assumptions. The available data included:

– fishery and recreational catches covering whole period;

– stocking numbers covering whole period;

– age structure and weight-at-age for several years, but in most years these data were not ava-ilable and the best age and weight data are from 2006;

– cormorant eel predation.

In the CAGEAN model fishing mortality (F) was separated into year effect (fishing mortality at reference age in a year) and age effect (selection). Until 2005, data for estimating year effect in F were too scarce, the F is presented as a time-dependent polynomial of the 7th degree, and coefficients of this polynomial were estimated in the model. Since 2006, F can be calculated for each year as age data are available. Cormorant predation mortality was included, but it appeared to be low (usually well below 0.1). Recruitment to the model was assumed as proportional to recruit-ment indices estimated using GLM by WGEEL (ICES, 2017) and the coefficient of proportionality (Ralfa) was estimated in the model. Selection was estimated at ages 3–6, at others it was assu-med at 1. Another parameter was Zini, which was total mortality used to estimate initial stock numbers (in 1960) from average recruitment at the beginning of the simulation period.

The model was fitted by minimizing the sum of squared residuals between observed and modelled catches and observed and modelled catch-at-age in those years in which age distribu-tion was available. The residuals were determined from logged values. Details of the model were presented in the 2008 Polish eel management plan. The inverse of variance weighting was applied to weight terms of the total sum of squared residuals. Estimated fishing mortality and Ralfa were inversely correlated, and there was relatively little information in the data for selecting the most representative estimate of Ralfa. Thus, the model was run for series of Ralfa values, and as a representative for eel dynamics the Ralfa selected was that at which the minimized sum of squ-ared residuals showed low changes, while the total mortality was relatively close to the mortality estimates from the catch curve. Otherwise, the minimizing procedure tended to select high Ralfa and produced unrealistically low fishing mortality.

The 2024 model uses many new or updated data compared to previous implementations, including:

a) new recruitment abundance rates derived from the GLM analysis and presented in the 2023 WGEEL Report were used;
b) the analysis includes new data on catches, stocking and age structure of catches for 2021-2023;
c) the model was fitted to total catches, catches in pieces by age, and average fishing mortality estimated from the catch curve;
d) new natural mortality rates have been applied, generally lower than those previously used;
e) using new data on the sexual maturity of eels, in previous assessments assumed sexual maturity at 12-15 years (for 12 years it was 50%), according to the current data, a significant number of eels at the age of 8-9 are already sexually mature;
f) new mortality rates due to hydrotechnical obstacles have been applied, we now assume that this mortality is 25%, previously assumed 40-55% mortality due to hydrotechnical obstacles.

4.1.1 Data collection

During 2015–2016 the eel monitoring was conducted exclusively in marine and transitional waters, based on the requirements of Council Regulation (EC) No 199/2008. The monitoring program was based on the collection of catch and biological data, such as length, age, weight, and state of gonads.

Since 2010 WGEEL has been indicating the need of an assessment of biomass and mortality indicators in management as well as scientific reference points to ultimately result in a scientific advice framework that works in line with the ICES precautionary approach (RCM Baltic 2016). The sampling design had to provide relevant data for biomass assessment to WGEEL to perform the approach for international stock assessment.

As required by Commission Implementing Decision (EU) 2016/1251 of 12 July 2016, data collection for two Polish EMUs (Oder and Vistula) from 2017 onwards must consist of:

- catch quantities derived from inland and marine commercial fisheries (logbooks and official statistical questionnaires) biological variables – age, length, weight, sex, and life stage.
- abundance of recruits – catch data obtained on eel ladders set in Pomeranian rivers, data on stocking from statistical questionnaires and resellers.
- abundance of the standing stock – calculated by mathematical modelling, supplemented by data from scientific non selective fyke nets set in lagoons and electrofishing in lakes.
- number of emigrating silver eels will be calculated by mathematical modelling.

The stock dynamics of eel for both EMUs is estimated using a version of CAGEAN model (Deriso et al., 1985), described in the Polish Eel Management Plan. Data was delivered to WGEEL annually.

4.1.2 Analysis

Eel Model is described in paragraph 4.1.

4.1.3 Reporting

Results of DCF sampling are stored in the international database - FishFrame. Data needed by WGEEL were sent to stock coordinator.

4.1.4 Data quality issues and how they are being addressed

Data collection in coastal and transitional waters meets quality requirements of the DCF. From 2019 onwards NMFRI and IFI will put more effort into quality aspects including better spatial coverage of freshwater samples, cross reading of otoliths, incorporating new data into the eel model.

4.2 Trends in Assessment results

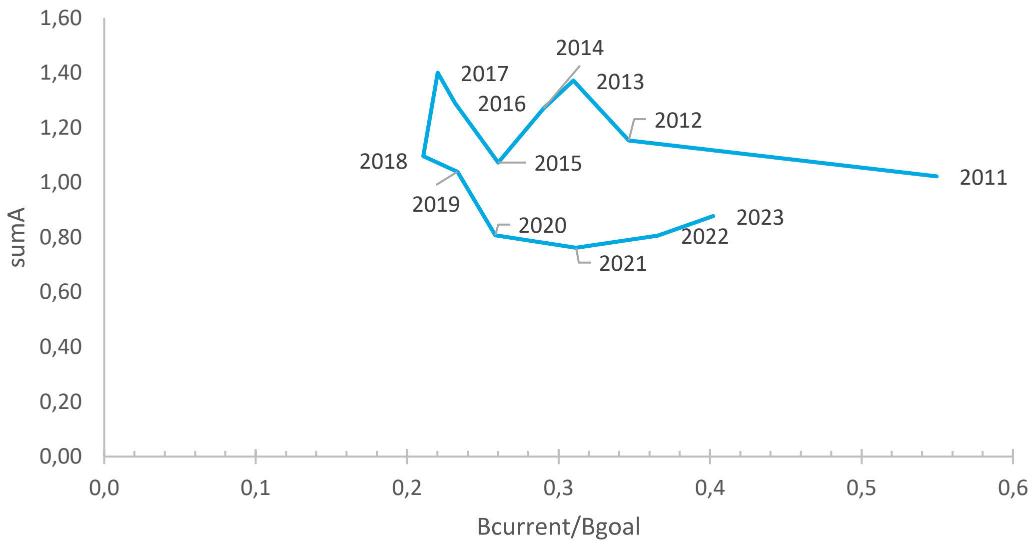

Fig. 4.2.1 Lifetime anthropogenic mortality (sumA) plotted against the ratio of spawning biomass (Bcurrent) to goal (Bgoal) from 2011-2023 for the Oder EMUs

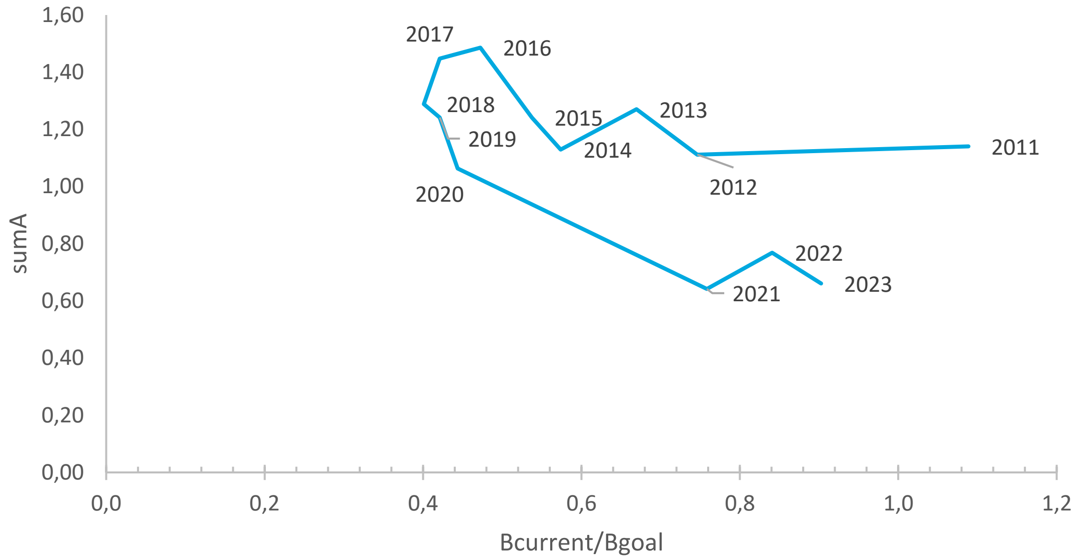

Fig. 4.2.2 Lifetime anthropogenic mortality (sumA) plotted against the ratio of spawning biomass (Bcurrent) to goal (Bgoal) from 2011 to 2023 for the Vistula EMUs

5 Other data collection for eel

5.1 Yellow eel abundance surveys

Routine electrofishing surveys are conducted every year in Pomeranian rivers to estimate abundance of salmon and see 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 this dataset is considered to be low. In the new EU – MAP Work Plan Poland inserted abundance survey. The 2018 results showed that electrofishing is not effective in lakes due to the low eel abundance. For this reason, non-selective scientific fyke-nets have also been used to estimate CPUE trend.

Research on the Vistula Lagoon has been conducted in the period from May 1 to October 30. A total of 290 eels were caught with a total weight of 110 kg. The distribution of the length of the eel caught is presented in the figure

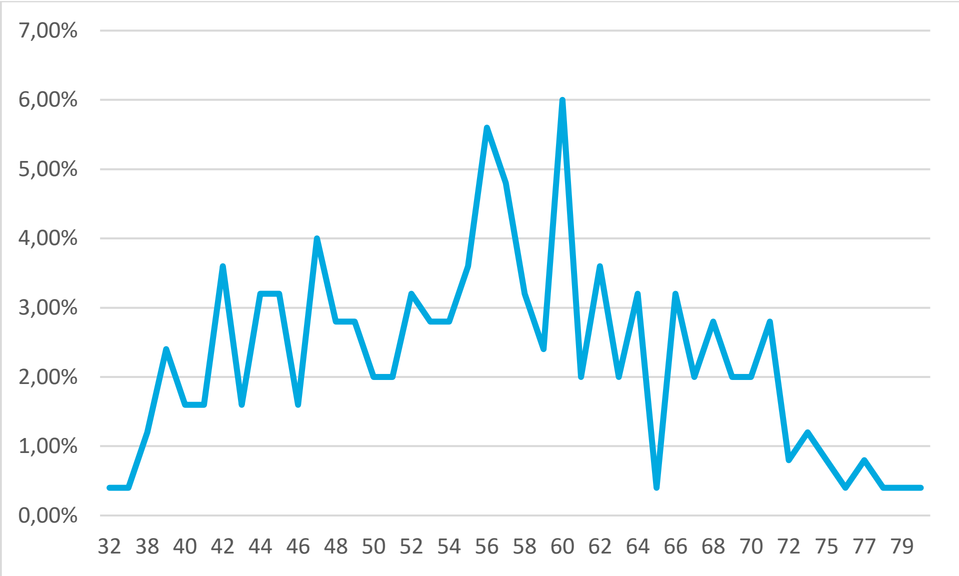

Fig. 5.1.1 Length distribution of eels caught in the Vistula Lagoon in non-selective fyke net.

More than half eels (70%) measured more than protective size (50 cm). Compared to 2017 (1.5 indiv/day/fyke), CPUE dropped to 0.8 indiv /day. The reason may be the systematic removal of fish by commercial/recreational fishery.

5.2 Silver eel escapement surveys

Tagging if 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 has 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 the Copenhagen. Tags were also found by consumers during standard processing.

Currently no silver eels surveys is being performed. The number of emigrating silver eels is calculated using mathematical models.

5.3 Life history parameters

Data is collected according to EU – MAP requirements and includes standard analysis of length, age (from sectioned otoliths), and maturity stage (silvering index). During 2015–2018 more than 2000 eel from commercial fisheries were collected and analysed. On the basis of biological analyses, the age structure of eel was identified, and then it was used in a mathematical model that permitted calculating biomass and mortality indicators. In 2018 age data from inland waters was also included.

In inland waters age groups ranging from 6 to 26 in the Oder EMU, and from 4 to 33 in the Vistula EMU were identified. The most abundant fish were from age groups 12–14 in the Oder EMU (30% of the total frequency) and from age groups 16–18 in the Vistula EMU (30% of the frequency). Both EMUs were characterized by quite numerous individuals from age groups 14+, for which 100% silvering was assumed.

The age structure in transitional waters differed and age groups 4–8 dominated. The biomass in these basins is supplemented regularly by intense stocking, the eel have good living conditions, and the growth rate is higher than in inland waters.

5.4 Diseases, Parasites & Pathogens or Contaminants

Studies in eels caught from inland waters between 2010 and 2021 showed the presence of *Aeromonas hydrophila, Photobacterium damsela, Chrysoemonas luteola, Citrobacter freudi,* and *Pseudomonas aeruginosa* (Siwicki et al. 2021).

Virological studies have found EVEX, VHSV, IHNV, IPNV, SVCV (Siwicki et al. 2021). In 2015, eel herpesvirus type 1 (AngHV-1) was found only in fish from the Oder River basin (5% of the studied population). In 2016, the presence of this virus was detected in 20% of fish from the Oder River basin and 5% of fish from the Vistula River basin. No clinical or anatomopathological changes were noted in fish infected with this virus, but changes in activity in the immunological parameters determined (Siwicki et al. 2017). In contrast, the presence of AngHV-1 was demonstrated in eels from the Vistula Lagoon in samples collected in 2014 (Stachnik and Nermer 2015).

An increase in the presence of the nematode *A. crassus* has been demonstrated (Siwicki et al. 2021). Further studies have shown that the presence of these parasites negatively affects basic parameters assessing fish condition (Terech-Majewska et al. 2013 and 2015). The occurrence of *A. crassus* nematodes in eels caught in the Gulf of Gdansk was recorded as early as 1988, and at that time the extensiveness of the infestation was 63.3-75% (Rolbiecki and Rokicki 2005), and in 2000-2002 it was at 73.6-76.2% (Rolbiecki and Rokicki 2005). Since 2014, the NMFRI in Gdynia has been conducting regular surveys of the level of infestation of European eels with *A. crassus* nematodes (Figure 5.4.1). Fish are caught in the Szczecin Lagoon and the Vistula Lagoon. In 2014-2023, a total of more than 5,600 eels were subjected to ichthyological and parasitological analyses, and more than 55% of these fish were infected with *A. crassus* nematodes. The average extensiveness of eel infestation with this parasite varied over the years: a decreasing trend was observed between 2014 and 2020, and an increasing trend of infestation has been maintained since 2020 (Figure 1). In total, more than 25,000 nematodes were captured, which is an average of more than 8 parasites per infected fish. The intensity of infestation varied between 1 and 95 nematodes per fish. A relationship was observed between the intensity of infestation and the length of the fish studied: more parasites were recorded in larger/older fish. This, in turn, is linked to intensive foraging, and therefore greater exposure to parasite infection by eating large amounts of infested food. Differences were also observed in the trends of changes in the infestation of eels with *A. crassus* nematodes depending on the study region (Figure 1 and Figure 5.4.1). In the Vistula Lagoon, a decrease in the extensiveness of the infestation was observed from 2014 (about nearly 80%) to 2020 (about 30%), followed by a reversal of the trend (Figure 1). In contrast, in the Szczecin Lagoon, there was an increase in infestation to about 80% in 2015, a sharp decline to about 50% in 2016, and then an increasing trend in infestation (Figure 5.4.3).

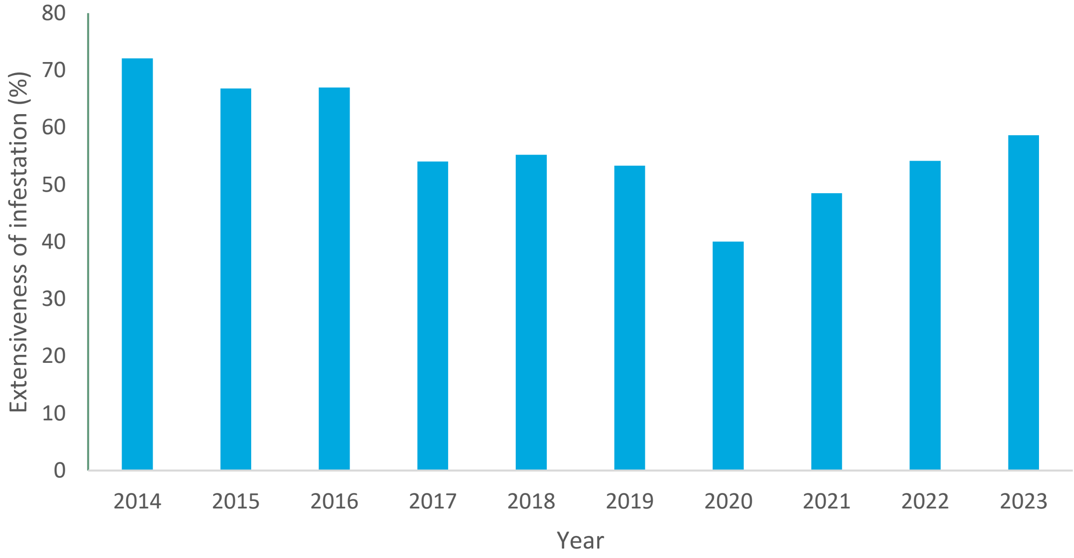

Figure 5.4.1 Average extensiveness of infestation of European eels with *A. crassus* nematodes (based on NMFRI studies)

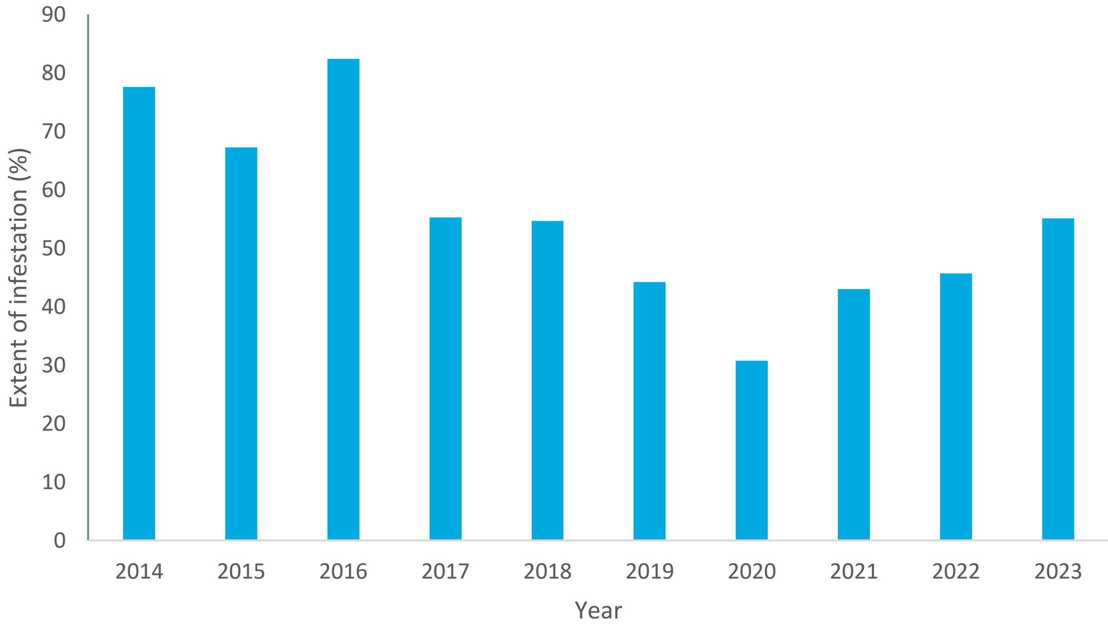

Figure 1 Average extensiveness of infestation of European eels with *A. crassus* nematodes from the Vistula Lagoon (based on NMFRI studies)

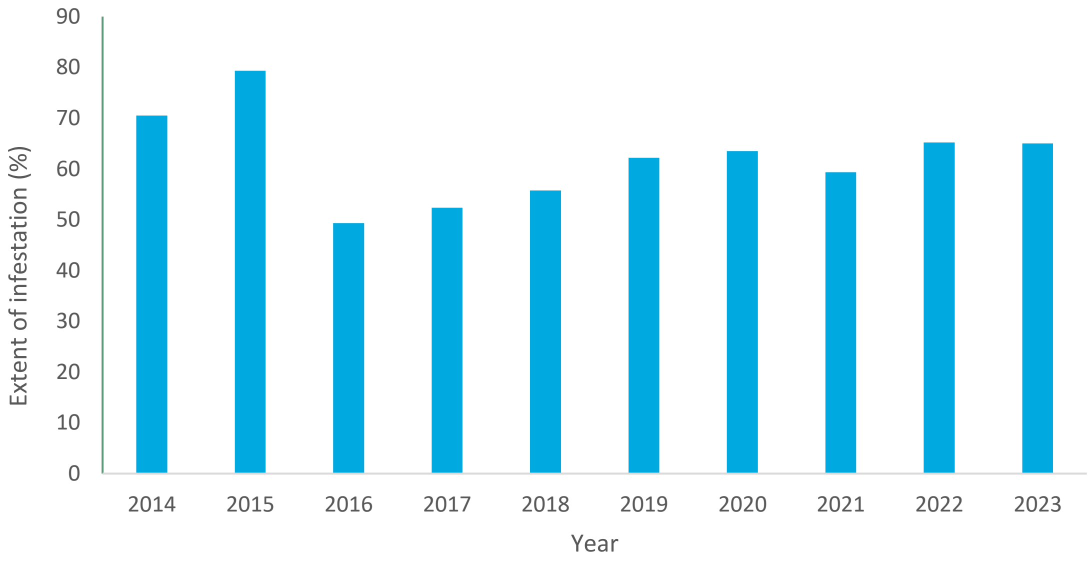

Figure 5.4.3 Average extensiveness of infestation of European eels with *A. crassus* nematodes from the Szczecin Lagoon (based on NMFRI studies)

The eels surveyed by the SSIFI between 2010 and 2021 showed no changes indicative of disease processes. In addition, microbiological, immunological and biochemical tests indicated good and very good condition and health status of the examined fish (Siwicki et al. 2021). The increasing incidence of eel herpesvirus type 1 (AngHV-1) remains a concern. Dangerous for the health of individuals, as well as the entire population, is the increase in eel nematode *A. crassus* infestation, observed in recent years in the NMFRI studies. Given the dynamics of the spread of pathogens in the environment, it is necessary to continue monitoring the health status of eels.

6 New Information

No data available

7 References

Bush,A.O., Lafferty,K.D., Lotz,J.M., ShostakA.W. (1997) Parasitology Meets Ecology on Its Own Terms: Margoliset al. Revisited The Journal of Parasitology 83, 575-583.

Deriso R.B., Quinn II T.J., Neal P.R.1985 Catch-age analysis with auxiliary information. Can. J. Fish. Aquat. Sci. 42: 815-824.

Kaj J., Walczak J. 1953 Ascending eel in the coastal rivers of Western Pomerania. An attempt to determine the stocking inventory. Yearbooks of Agricultural Sciences. 67-B-I: 123-139.

Koops,H., Hartmann,F. (1989) Anguillicola infestations in Germany and in German eel imports. Journal of Applied Ichthyology 1, 41-45.

Nermer T. 2022. Management of the European eel *Anguilla Anguilla* (L.) In transitional waters on the example of the Vistula Lagoon. PhD thesis. IRS Olsztyn.

Rolbiecki,L, Rokicki,J (2005) Anguillicola crassus analien nematode species from the swim bladder of eel (Anguilla Anguilla) in the polish zone of the southern Baltic and in the waters of northern Poland. Oceanological and Hydrobiological Studies Vol.XXXIV(1):121-136.

Siwicki A.K., Achulz P., Kaczorek E, Robak S., Małaczewska J., Wójcik R. 2017. Immunopathogenesis of herpesviruses: Influence of Anguillid herpesvirus (AngHV-1) on cellular defense mechanisms in European eel (*Anguilla anguilla*). 18th International Conference on Diseases of Fish and Shellfish. Belfast, 04-08.09.2017, 077-P, 295.

Siwicki A.K., Robak S., Kazuń B., Kazuń K., Schulz P., Terech-Majewska E. 2021. Health and fitness status of eels in Polish waters - current state of knowledge. Annals of Fisheries 4: 16-22.

Stachnik M., Nermer T. 2015. The presence of viral pathogens in European eel population from Vistula Lagoon (Baltic Sea). 17th International Conference on Diseases of Fish and Shellfish, 7-11.09.2015, Las Palmas, Gran Canaria, Spain.

Terech-Majewska E., Robak S., Szczucińska E., Zembrzuska M., Siwicki A.K. 2013. The cellular immunity defense of European eel (*Anguilla Anguilla*) during nematode *Anguillicoides crassus* invasiae. 16th International Conference on Diseases of Fish and Shellfish, Tampere, Finland. EAFP Bulletin, P-158, 404.

Terech-Majewska E., Schulz P., Siwicki A.K. 2015 Influence of nematode *Anguillicoides crassus* infection on the cellular and humoral innate immunity in European eel (*Anguilla anguilla* L.). Centr. Eur J Immunol 40: 127-131.