ICES WKTRUTTA REPORT 2013

SCICOM Steering Group on Ecosystem Functions

ICES CM 2013/SSGEF:15

Ref. WGBAST, WGRECORDS, SCICOM

Report of the Workshop on Sea Trout (WKTRUTTA)

12–14 November 2013

ICES Headquarters, Copenhagen, Denmark

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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Recommended format for purposes of citation:

ICES. 2013. Report of the Workshop on Sea Trout (WKTRUTTA), 12–14 November 2013, ICES Headquarters, Copenhagen, Denmark. ICES CM 2013/SSGEF:15. 243 pp.
https://doi.org/10.17895/ices.pub.8833

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Executive Summary

The Workshop on Sea Trout (WKTRUTTA) was held in Copenhagen, 12–14 November 2013, to review recent sea trout research, assessment methods and to recommend how these might improve future fisheries management.

Sea trout, the anadromous (sea-migratory) form of brown trout (*Salmo trutta*) are common around the ICES area and increasingly the focus for European funding for applied fisheries research. Concerns over stock declines in areas where marine mixed stock fisheries prevail such as the Baltic, have brought about international collaborations and some developments in stock assessment. In spite of the Baltic situation, sea trout have traditionally been secondary to the Atlantic salmon, in part because of the lack of perceived need for ICES scale collaboration. This is changing as recent Interreg-funded research has shown that sea trout distribution in the sea does in fact expose them to many forms of threat in regions and countries other than the immediate location of their natal rivers. The extent of this exchange remains to be fully described.

New developments and changing environmental priorities have made it necessary to explicitly position sea trout in relation to, for example, the Water Framework Directive, the emergence of the Ecosystem Approach, the onset of Marine Spatial Planning and the increasing concern over climate change impacts on marine and freshwater biota. As an anadromous fish that occupies primarily coastal zones during its marine phase, the sea trout bridges environmental and fishery concerns across freshwater, transitional and marine habitats. This unique characteristic brings challenges for science, assessment and management, which have previously lacked cohesion across these connected ecosystems. However, it also brings opportunities as a platform on which to develop more cohesive, integrated science and management across environments within one species. These developments justified an updated review of sea trout research and its application.

The WKTRUTTA sessions were organised to match the four Terms of Reference.

Progress in research covering a number of items was presented and discussed. The life – history session included discussions on anadromy, implications of partial migration for stocks structuring and assessment, and the self-reinforcing occurrence of anadromy through high fecundity and density effects. It was concluded that progress in life-history modelling has been limited until very recently due to its demanding nature, which requires high quality data usually available only from index rivers. Nevertheless the approach was regard as important and valuable because it addresses the underlying processes governing the incidence and abundance of sea trout. Growth and related metabolic states, reflecting feeding opportunity during the juvenile phase, is most likely the most important determinant of life history tactic in trout. Genetic influences are likely to be important, but at the moment information on these and interactions with environmental factors is sparse, reflecting a research need. A number of recent projects, workshops and study groups on sea trout were summarized and their recommendations for priority freshwater and marine research collated. Key methods to study migration in in estuarine, coastal and marine environments and their application both recently and historically were reviewed and discussed. These indicate sea trout migration to be, at least in part, determined by currents, availability of food and nutritional status of individual fish, but studies have also indicated genetic influence. New knowledge was highlighted on the genetic structure

of trout populations in rivers of several sea areas (around the British Isles, the North Sea and in the Baltic Sea).

Recent studies on climate change conclude that the effects are unpredictable, potentially being both positive and negative, but are likely to influence sea trout populations. Some changes have already been observed, indicating prolonged growth seasons, increased growth and changed smolt age. The basis for predicting effects from climate change are better for the freshwater phase, than in the sea. Surprisingly, there are no reported temperature/growth models for trout in marine environments,

The principal threats and knowledge gaps for sea trout were summarized and discussed. Examples were presented and a list of threats and associated research suggestions was produced. The priority of threats varied between regions, but with that caveat, serious threats to sea trout were reported from marine fisheries, marine farming of salmon and barriers in freshwater. In addition emerging but incompletely understood risks came from renewable energy structures such as tidal lagoons and barriers. Climate change, at sea and in freshwater, is a generic but unpredictable threat acting through direct effects on growth and survival and indirectly via changing life histories, prey, predators and invasive species..

The workshop found that the marine phase is the part of sea trout life history having the largest knowledge gaps and extends to a very wide area. Understanding of marine survival threats is closely linked to the research into migration and behaviour. Present interpretation and understanding of the marine related mortality factors may also be compromised by uncertainties arising from the freshwater phase acting through life history optimisation.

A regular assessment programme covering a larger area is only found in the Baltic Sea area, where it was recently implemented, The assessment is based on a model using juvenile densities being related to habitat quality and taking into account climatic conditions. It was suggested to test this approach in other regions.

Biological Reference Points (BRP) are lacking for sea trout but were seen as an important unfulfilled development and various options were discussed. Previous practice for salmon and eel stocks might be appropriate, some following models using stock-recruitment approaches others based on juvenile carrying capacity. The limited availability of stock-recruitment relationship for sea trout is a constraint. However BRPs, in their broadest sense, provide a unifying theme across much of applied management-orientated assessment and it is recommended that a workshop, focussed on BRPs be promoted over the next two years.

Juvenile trout densities and adult immigrating sea trout are monitored to some extent in all countries with sea trout populations. Young trout (sea trout cannot be distinguished from residents at this stage) are monitored by electrofishing in more or less extensive programmes. Smolt numbers are monitored at varying levels of precision in at least 36 rivers. In-river adult runs are monitored in many countries through rod catch recording, with varying degrees of effectiveness. The workshop was aware of 15 index rivers monitoring both smolt numbers and adult spawners. The monitoring is in many countries carried out by several different institutions and for varied purposes, making complete national overviews of status not readily available.

Information on genetic population structure of trout was presented for populations in rivers entering the Irish Sea, Celtic Sea, English Channel, North Sea, Baltic Sea and the Skagerrak. Substantial progress was also reported in deploying genetic methods in elucidating the distribution and extent of migrations of trout in open and estuarine European waters.

The role of small coastal streams should be evaluated because it is believed that these might be sources of recruitment to marine stocks and to adjacent rivers as well as sources of genetic diversity for trout. However they are usually low priorities for environmental protection.

Scale reading (for determining age, growth and reproductive schedules) is potentially very useful for stock assessment and population dynamics, yet it is contentious practice due to the difficulties of consistency and reliability in sampling and interpretation, which are particularly acute in sea trout. A working group to better describe and resolve these issues is recommended.

The application of the ecosystem approach to sea trout assessment and management was considered and found to be particularly relevant due to the species' dependence upon multiple environments. The types of data needed for implementing the ecosystem approach to fisheries and ecosystem assessment was listed.

Spatial conflicts in sea areas were discussed and summarized. Spatial conflicts, including catch in fisheries (both distant and local - which has in some places been demonstrated to threaten populations with extinction), aquaculture, renewable energy constructions, tidal and thermal barriers, light pollution and water quality were discussed. Only rarely are sea trout included in marine spatial planning.

The Terms of Reference requested specifically recommendations on sea trout assessment for the Data Collection Framework (DFC). The Workshop advised as follows.

- Data should be consistently collected on the number and weight of all sea trout caught and fishing effort, separated by commercial and recreational fisheries, the location of the fishery (freshwater, coastal, sea), and whether the stocks are wild or reared.
- Data for evaluating the economic and social value of commercial and recreational sea trout fishing should be collected and evaluated. The specific details of the sampling should be agreed between countries at a regional level.
- Simulations (management strategy evaluations) should be employed to evaluate the impact of different data collection approaches on assessments/management. This process should be targeted to end–user (e.g. ICES) needs and types of assessments involved.
- The need for sampling of sea trout under DC-MAP should be evaluated by the Regional Coordination Meetings, if end-users raise a specific need.
- Both in the Atlantic and Baltic areas there is a need for more index river studies to describe population life history characteristics and dynamics. The geographical coverage of index rivers should be evaluated to assess its representativeness of rivers or stock types and, where relevant, the establishment of additional rivers should be promoted.

Terms of Reference and agenda

1) To review and report on progress with research and investigations on sea trout since the last international sea trout meeting in 2004 with emphasis on inputs which might be used by WGBAST who are developing sea trout assessments. The review should include biological knowledge and relevance to existing management practices including: population genetics, migratory routes, anadromous / non-anadromous population interactions, habitat preferences and life history understanding.

2) To identify remaining critical knowledge gaps for research prioritisation on potential threats to sea trout populations including: cumulative impact of migratory barriers, marine survival issues and climate change.

3) To review alternative assessment methodologies and appropriate scales and make recommendations for the DCF.

4) To identify potential spatial conflicts for sea trout life history in marine and estuarine locations

	DAY 1 12TH NOV		
Time	**Item**	**Presenters**	**Chairperson**
0930 - 0950	Welcome, aims, ICES context, programme, etc.		Stig Pedersen
	SESSION 1 (TOR1) "RESEARCH PROGRESS" **30mins each**		
0950 - 1020	1.1 Life history understanding	Nigel Milner & Antenas Kontautas	
1020 - 1050	1.2 Anadromous / non-anadromous population interactions	Johan Höjesjö & Sophie Launey	
1050 - 1110	**BREAK - coffee**		
1110 - 1140	1.2 Freshwater phase habitat preferences / ecology / behaviour	Ronald Campbell & Philippe Gaudin	
1140 - 1210	1.3 Migration routes, behaviour at sea (swimming depths, ...)	Barry Bendall & for reporting: Piotr Debowski + Harry Hantke + Harry Strehlow	
1210 - 1240	1.5 Population genetics	Phil McGinnity & Dorte Bekkevold	
1240 - 1340	**LUNCH**		
1340 - 1410	1.6 Climate impacts	Ian Davidson & Marie Nevoux	
1410 - 1440	1.7 Other (sweep up & session discussion)		
1440 - 1500	**BREAK - coffee**		

	SESSION 2 (ToR2) "GAPS IN KNOWLEDGE OF THREATS TO SEA TROUT"		Alistair Maltby
1500 - 1530	2.1 Freshwater survival and production (e.g. cumulative impacts of barriers, habitat alterations)	Johan Ostergren & Kim Aarestrup	
1530 - 1600	2.2 Marine survival issues	Kim Aarestrup & Jan G. Davidsen	
1600 - 1630	2.3 Climate change	Ian Davidson	
1630 - 1715	2.4 Other (sweep up and session discussion)		
	CLOSE		
	DAY 2 13th Nov		
	SESSION 3 (ToR 3) "ALTERNATIVE ASSESMENT METHODS, SCALES AND RECOMMENDATIONS"		Nigel Milner
0900 - 0930	3.1 Overview of assessment and status in the Baltic Area (WGBAST)	Stig Pedersen & Johan Östergren	
0930 - 1000	3.2 Overview of assessment and status in France and Spain	Gilles Euzenat & Pablo Caballero	
1000 - 1030	3.3 Overview of assessment and status in British Isles	Ian Davidson & Phil McGinnity	
1030 - 1050	**BREAK**		
1050 - 1130	3.4 Overview of assessment and status in Norway, Sweden, Denmark and Germany	Johan Östergren, Jan Davidsen, Christoph Petereit & Stig Pedersen	
1130 – 1200	3.5 Turning assessment into management (priorities, uncertainties, feasibilities)	Ronald Campbell & Wojciech Pelczarski	
1200 - 1230	3.6 Freshwater Asessessment,	Johan Höjesjö	
1230 - 1300	3.7 marine and adult assessment. Age determination	Gilles Euzemat & Harry Strehlow	
1250 - 1400	**LUNCH**		
1400 – 1440	3.8 Genetics (+ short presentation by Marja-Liisa Koljonen, FI)	Jamie Stevens & Phil McGinnity	
1440 - 1510	3.9 Linking with wider ecosystem assessments	Nigel Milner & Bruce Stockley	
1510 - 1540	**BREAK**		
1540 - 1610	3.10 Population modelling, Biological Reference Points (BRPs) – management and data needs, scale of modelling	Ted Potter & Ross Gardiner	
1610 - 1700	3.10 Other and sweep up		

	DAY 3 14th Nov		
	SESSION 4 (ToR 4) "SPATIAL CONFLICTS, MARINE AND ESTUARINE"	Region specific discussion under headings (see note)	Ted Potter
0900-1200	Discussion under headings: ➢ By catch in marine fisheries ➢ Sea Trout and regulatory processes ➢ Salmonid mixed stock fisheries ➢ Offshore renewable energy (wind, tidal, wave etc) ➢ Barriers to FW entry (incl. tidal barriers), port development etc ➢ Aquaculture ➢ Other coastal developments		
1200-1300	Sum up, discuss actions, agree on roles and time tables for report drafting		Nigel Milner & Stig Pedersen
1300	**CLOSE**		

Introduction

This is the report of the ICES Workshop on Sea Trout (WKTRUTTA) held in Copenhagen, 12–14 November 2013, to review recent sea trout research, assessment methods and to recommend how these might improve future fisheries management.

Sea trout are the anadromous migratory form of the brown trout (*Salmo trutta*), which go to sea to feed and mature as adults prior to return to spawn in their natal rivers. The previous geographically extensive overview of sea trout fisheries and biology for ICES was in 1994 by the Study Group on Anadromous Trout (ICES, 1994). Since then interest in the species has greatly increased with growing awareness of its contribution to fisheries, to biodiversity and the sea trout's potential as an indicator of aquatic ecosystem health. An international symposium in Cardiff in 2004 brought together much of what was known at the time (Harris & Milner, 2006) and led to the setting up of Interreg-funded programmes on sea trout in the North Sea, the English Channel and the Irish Sea. These are now coming to fruition. In the Baltic, where marine sea trout fisheries are particularly important, overviews have been carried out on status and specific threats to sea trout (Heinimaa *et al.* 2007; Pedersen *et al.* 2012). Baltic sea trout have been increasingly in focus in the ICES context (e.g. ICES 2013), leading to an innovative assessment methodology being developed by an ICES Study Group (ICES 2011). Furthermore, new developments and shifts in environmental priorities have made it necessary to position sea trout in relation to, for example, the Water Framework Directive, the emergence of the Ecosystem Approach, the onset of Marine Spatial Planning and the increasing concern over climate change impacts on marine and freshwater biota. As an anadromous fish that occupies primarily coastal zones during its marine phase, the sea trout bridges environmental and fishery concerns across freshwater, transitional and marine habitats. This unique characteristic brings challenges for science, assessment and management, which have previously lacked cohesion across these connected ecosystems. However, it also brings opportunities as a platform on which to develop more cohesive, integrated science and management across environments within one species.

Following all these developments in research and progress in the assessment of sea trout it was felt appropriate to reassess stock status and to evaluate the application of the new research to better management, across the ICES area. This led to the setting up of WKTRUTTA and the workshop reported here, held at ICES headquarter in Copenhagen 12-14 November 2013.

1 Research progress

1.1 Introduction

Progress in sea trout research over their natural range has not been summarized since a symposium in 2004 (Harris & Milner 2006). However, a number of more recent specialist reviews have included aspects of sea trout ecology, such as climate impacts (Graham and Harrod 2009, Elliot and Elliott 2010, Jonson and Jonsson 2009a) and effects of river flows (Thorstad *et al.*, 2008, Milner *et al.*, 2012). In this chapter recent progress in studies reported or ongoing mainly since 2004 are summarized.

1.2 Life History Understanding

1.2.1 Introduction

This session addressed the key questions: can we apply life history (LH) approaches to sea trout management, are they feasible and what research has emerged since 2004. The rationale for these approaches is set out, recent progress is outlined and some future research areas relevant to the workshop aims are proposed. There are overlaps in the rationale with Section 1.2 (interaction between anadromous and non-anadromous forms), but this section focuses on the life history modelling aspects and assessment implications.

1.2.2 Rationale and topic overview

Life history (LH) strategies vary in brown trout from resident to anadromous. Both forms may exist in sympatry, but sex linked such that a higher proportion of females are migrants; consequently the majority of residents in partially migrating (*sensu* Chapman *et al.*, 2012) populations are male. The presence and extent of "sea trout" (the anadromous form of brown trout, *S.trutta*) is dependent upon the size of the anadromous contingent (*cf* Chapman *et al.*, 2012) and their life history choices (e.g. migrate/not migrate; mature /not mature) affect the properties of sea trout fisheries (location, abundance, size composition, seasonal timing). Thus description and analysis of life histories using, typically, life table and matrix projection models, offers a means to describe and understand sea trout populations and their response to environmental or fishing pressures (*cf* Hutchings and Jones, 1998; Marschall *et al.*,1998; Hutchings, 2002); and are essential if process-based modelling of populations is the aim. The distinction was noted between populations (the group of interbreeding individuals, being the level where the LH processes operate) and stocks (the management unit) each of which often comprise multiple populations. This distinction is an issue for developing, parameterising and applying life history models and for appropriate monitoring and assessment. The LH approach and its practical application is still comparatively rare for salmonids, possibly because of the complexities of partial migration and resulting difficulties in gathering appropriate population data and model parameterization (Fergusson *et al.*, 2008). However, this does not detract from the potential benefits and a reappraisal in the light of new information is warranted.

Anadromy is a threshold quantitative trait (Jonsson and Jonsson, 1993; Ferguson, 2006), influenced by a combination of genetic and environmental factors. Environmental factors are thought to act by determining the growth trajectory in the early juvenile stage, possibly through feeding opportunity. This somehow triggers a response by which fish with higher metabolic rate and growth capacity that is not met by the energy supply of its freshwater environment tend to migrate (Cucherousset *et* *al.*, 2005; Olsson *et al.*, 2006; Wysujack *et al.*, 2009; Dodson *et al.*, 2013; Davidsen *et al.* submitted). Lipid metabolic status appears to be an important part of this mechanism, with demonstrable differences in lipid reserves of anadromous and resident juveniles (Boel *et al.* in press). Section 1.2 considers these aspects in more detail.

The presumption from classical life history theory is that migration to sea offers greater reproductive fitness benefits to female trout through the increased fecundity that arises from faster growth on the high lipid/protein diet potentially available in the sea (e.g. sandeel or sprat). However this is only advantageous if the benefits (in terms of life time fitness, e.g. R_0, net reproductive rate) outweigh the costs of enhanced mortality or reduced fertility caused by migration to varied environments (e.g. through predation, energy demands, hypo-hypertonic environment shift). The anadromous/resident life history "choice" is therefore based on a risks-benefits trade-off and the factors affecting these are probably some combination of genes and environmental factors in freshwater and at sea. The former (freshwater) being ambient factors to which juveniles would be exposed and therefore might be responsive through reaction norms (e.g. competition, temperature, productivity, flow variation etc), and the latter (at sea) being factors that previous generations (so are these maternal effects only?) will have experienced (e.g. migration distance and energy demands, predation risk, marine productivity and feeding opportunity); (Jonsson and Jonsson, 2006). The freshwater factors appear to involve a combination of continuous variation in liability (i.e. the propensity to migrate) coupled with a threshold for liability, exceedance of which determines if fish migrate or not. Age-specific growth rate appears to be a convenient surrogate for liability which may comprise a range of metabolic and hormonal changes (Dodson *et al.*, 2013).

In addition to the initial freshwater-sea migration, further life history choices are made at sea; the principal one being the time to mature for the first time and return to fresh water, which might occur in first post-smolt year, or after 1 or 2 sea winters. This has an effect on total life time egg deposition through survival/fertility schedules (fitness, e.g. R_0) (Hutchings and Jones, 1998; Hutchings, 2002) and also on the size distribution of fisheries; therefore it is important for both population dynamics (rate of increase and stability) and for fisheries performance (catch and value). Maturation and the river return decisions may be related to growth in the first post-smolt year and possibly to freshwater growth.

One (age-structured) life history analytical approach is shown as a conceptual model in Figure 1.2.2.1 The variables are analysed through life history tables (Table 1.2.2.1 gives a simple example based on the River Dee North Wales) to derive net reproductive rate (R_0) and instantaneous rate of population increase (r) and then taken into matrix projection models that enable prediction of the population structure and response to differing environmental factors, comparison of populations and their potential resilience to pressures.

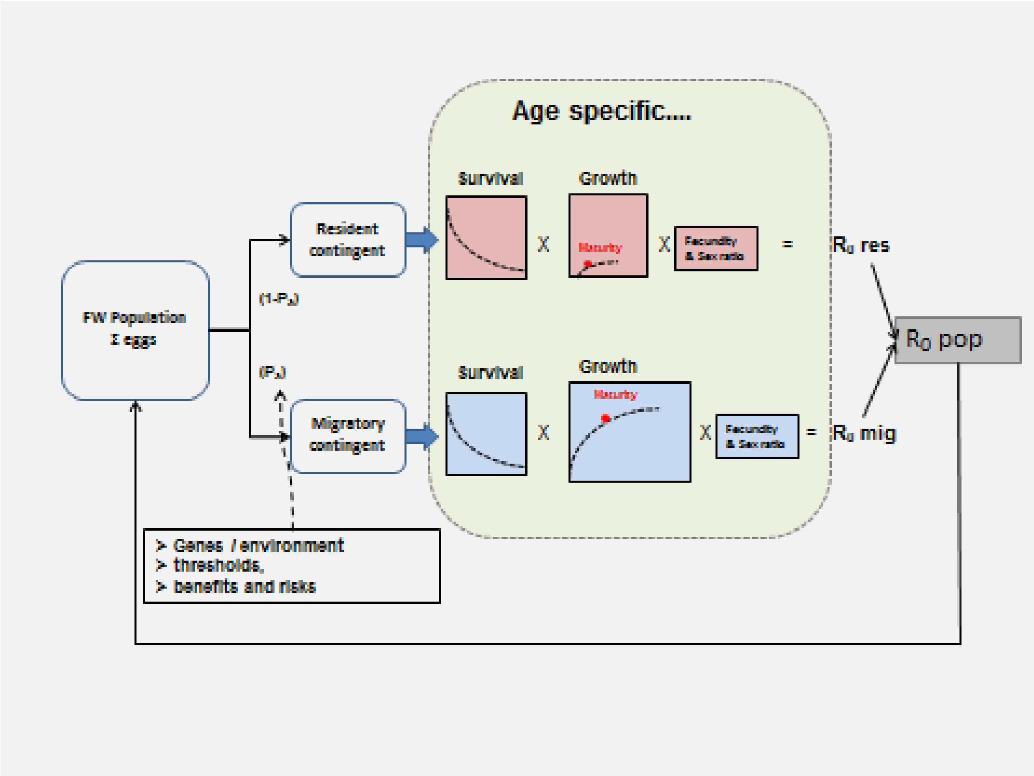


Figure 1.2.2.1 Outline conceptual model of age-specific life table analysis in partially migrating trout population with resident and anadromous contingents. P_a, the probability of becoming anadromous, is hypothesied to be related to genetics and environmental factors (e.g. temp, growth, productivity) and to site features (physical carrying capacity, distance from sea, gradient and accessibility), which variously influence juvenile metabolism and growth energetics, and migration risks through energy demands and predation. R_0 is the net reproductive rate the mean number of female offspring produced per female over her lifetime, derived from the life table. (ex Celtic Sea Trout Project).

Table 1.2.2.1 Example life table for sea trout in Welsh Dee. Nx= numbers at age x, lx = survival to age x, Px = proportion surviving between ages x and (x+1), mx= fertility at age x (product of maturity x fecundity); the other columns are used to calculate r, the instantaneous rate of population increase (see for example Gotelli, 2008).

Age (x)	Nx	lx	Px	mx	lx.mx	x.lx.mx	e-rx.lx.mx	x.e-rx.lx.mx
0	2283908.6	1.00000	0.01	0.00	0.00	0.00	0.00000	0.00000
1	22839.086	0.01000	0.40	0.00	0.00	0.00	0.00000	0.00000
2	9135.6345	0.00400	0.19	117.36	0.47	0.94	0.37924	0.75847
3	1756.9499	0.00077	0.33	508.94	0.39	1.17	0.28427	0.85281
4	572.52684	0.00025	0.24	1206.67	0.30	1.21	0.19740	0.78961
5	134.91708	0.00006	0.49	2171.45	0.13	0.64	0.07524	0.37620
6	65.439874	0.00003	0.29	2680.93	0.08	0.46	0.04050	0.24298
7	19.208507	0.00001	0.81	2938.54	0.02	0.17	0.01171	0.08197
8	15.540726	0.00001	0.15	3207.00	0.02	0.17	0.00929	0.07435
9	2.3913043	0.00000	0.00	3638.85	0.00	0.03	0.00146	0.01313
10	0	0.00000		3603.24	0.00	0.00	0.00000	0.00000
11	1.7391304	0.00000	0.00	3789.85	0.00	0.03	0.00089	0.00982
SUM=					1.42	4.84	1.00000	3.19933

1.2.3 Discussion points from the meeting

- Due to partial migration and the difficulties of distinguishing and enumerating at least two population contingents (sea migrant and residents), life table (LT) construction is difficult for brown trout. Assumptions have to be made about egg-smolt survival, proportion of .0+ returns (and their maturity status) and rod exploitation rate. Reaction norms (the phenotypic expressions of genotypes across an environmental range) determine how the effects of environmental factors affect trait (e.g. timing of anadromy) expression; but are difficult to describe.
- The "population" identified for LT analysis needs to be discrete and to experience identifiable environmental factors. This is a scale problem e.g. a trout "population" in small sub-catchment might experience the same conditions, but fish from a whole large catchment probably will not. Unfortunately, most adult sampling and assessment data is obtained at large scale (e.g. a whole river putative "population"), so the spatial resolution doesn't lend itself directly to LT processes, if they operate as outlined above. Therefore detecting say growth responses to freshwater environmental variation acting at less than catchment scale is unlikely in fish sampled as a notionally homogeneous catchment "population". However, if fish could be reliable assigned to freshwater locations through genetics or micro-chemistry (see 1.6 and 1.8), that might offer a way to use the traits data for individual fish; this is currently impracticable.
- Reaction norms (RN) present a significant sampling problem. We tend look at variation in LH between "populations" (in fact only between river meta-populations, see above); but these are empirical relationships – interesting, but not the same as within population (same genome) variance of true reaction norms. Johan Ostergren (JÖ) suggested that eco-genetic models (Thériault *et al.*, 2008; Frank and Baret, 2012; Piou and Prévost, 2012; Östergren *et al.*, in prep) might be suitable for investigating growth, smoltification and maturation, but acknowledged that the sampling issue remains. He gave an example where RNs for smolt size at age, might be evident at between-tributary level.
- Age-specific tables may be more demanding of data than stage- or size-specific ones. Weight-based models may be better. JÖ suggested that size-based mortality functions in Individual Based Models (IBMs) gave better (more realistic) model outcomes.
- A specific lack is the absence of temperature-growth models for adult trout in sea water. Models effective for younger freshwater trout (e.g. Elliott *et al.*, 1997), appear not to work well for trout in the sea (L'Abée-Lund *et al.*, 1989); but compensatory growth might make this a difficult undertaking (Jonsson and Jonsson, 2011).
- Can we include density-dependence in LH projection models for sea trout? This has been done for salmon, (Milner, unpublished in EIA models for tidal barrage impacts), but lose the interpretation of eigenvalues in the model outputs. JÖ considered this was feasible using IB eco-genetic models.
- Is the partial migration problem as big as commonly thought, given the dominance of migratory contingent to egg deposition? Might we assume for practical assessment purposes that anadromy always dominates if it is

present? There is no direct evidence in this, but simple modelling (Celtic Sea Trout Project - CSTP) shows that due to size-related fecundity small increases in anadromy force the system further towards anadromy, other factors being equal. An important question is: are there examples of genuinely sympatric female anadromous / resident trout? Anecdotally from the workshop it appears so, but nothing is published; and if so does frequency-dependent selection apply then? No answer to this one came from the group.

- Data needed to support the development of models and the application of the LH approach are quite explicit. Unbiased age- or size- or stage- structured estimates are essential prerequisites for survivorship terms, as is information on maturation, sex ratio, fecundity. Ideally information on the relative proportions and composition of migrant / non-migrant contingents is needed too, but there may be acceptable assumptions in many situations (see previous point). Index rivers, ideally over a gradient of river types and regions, have an important role in providing some of these data to complement and calibrate data for routinely, less intensively assessed rivers.
- For completeness it should be noted that sensitivity analysis would form an essential part of the LH approach and model development.

1.2.4 Conclusions

- Progress in this research area for sea trout has been limited, perhaps reflecting the difficulty in its application to a partially migrating fish species, the difficulty being related to the extent of anadromy in a trout population. In spite of that it was agreed that life history tactics and traits are fundamental determinants of sea trout stock size, structure, timing and consequently of fisheries composition and value.
- A process-based life-history approach offers major benefits for understanding how sea trout respond to environmental, genetic and other pressures (e.g. fishing mortality). However, it is particularly complex in sea trout due to partial migration and the resulting difficulties of population sampling, model structure and parameterisation.
- The feasibility of life history based approaches has improved recently, and individual based eco-genetic models seem likely to be an important part of this approach.
- Some concern was expressed that the life cycles of sea trout might be too variable between, or even within, catchments to warrant the approach; but until very recently the systematic gathering of life history trait data to test this has been limited (although good data have been reported for Norway).
- Sensitivity analysis has a vital role in determining which parameters are the most critical for assessment.
- The data required for applying the LH approach need to come through a combination of routine assessment and index rivers, unbiased estimates of age and size structure are essential if the benefits of LH approaches are to be realised. They and the basic data to derive fertility (maturation, sex ratios and fecundity), provide a further purpose and a framework for the design of monitoring and assessment programmes. Such data are of use even

if the LH approach cannot be fully implemented, because they offer a biological process-driven basis to assessment.

1.3 Interactions between anadromous and non-anadromous trout

1.3.1 Rationale and topic overview

Brown trout is probably one of the most phenotypically plastic salmonid species and can adapt to a number of different conditions ranging from landlocked populations in small streams, genuine freshwater populations that migrates to larger lakes and sea run populations. In addition, most populations consist of both migratory and resident life history forms living in sympatry. There are numerous studies examining the factors that determines and triggers anadromy in brown trout, which most likely consists of a combination of environmental and genetical factors (Chapman *et al.* 2012, Dodson *et al.* 2013 and references within these).

Each individual is faced with a trade-off between benefits and cost of migration compared with residency (e.g. Jonsson 2006). Generally it is believed that individual variation in migratory behaviour is controlled by developmental thresholds (e.g. Dodson *et al.* 2013) and most studies argue that factors such as size, growth opportunity, growth rate body energy content during the first two years determines their choice of life history (e.g. Bohlin *et al.* 1995, Olson *et al.* 2006, O'Neal *et al.* 2011, Cucherousset *et al.* 2005, Boel *et al.* in press, Davidsen *et al.* submitted) . It is suggested that present size (Bohlin *et al.*, 1995) independent of age might be a trigger for migratory behaviour (Acolas *et al.* 2012). The distance to the sea is another factor that decreases the willingness to migrate as reflected in the study by Bohlin *et al.* (2001) where the proportion of migratory fish decreased with the altitude.

In most European countries the resident part of the population almost exclusively consists of resident males that may breed with large migrant females as sneakers. The presumption is that migration to sea offers greater reproductive fitness benefits to female trout through the increased fecundity that arises from faster growth on the high lipid/protein diet potentially available in the sea. By using stable isotopes, Acolas *et al.* (2008) demonstrated that freshwater residents displayed a constant increase in ova size with enrichment (15N), suggesting an investment in larger ova. In contrast, anadromous females had smaller ova compared with freshwater-resident females of the same size and achieved higher fecundity as they grew bigger supporting the idea of a continuum of reproductive traits for freshwater-resident females whereas anadromous females clearly show a break with this continuum. Acolas *et al.* (2008) argue that this major dissimilarity could be explained by the difference in growing environment. Mapping and inventory of the distribution of anadromous trout in catchments will be an important step in understanding what environmental factors influence anadromy, in addition to being valuable in devising freshwater assessment strategies.

The genetic basis influencing anadromy are less understood and evidence of intraspecific genetic divergence of migratory tactics is so far uncommon (Pettersson, *et al.*, 2001; Dodson *et al.*, 2013) and inherited variation in migratory behaviour among populations has only been detected in relatively few and older studies (Elliott 1989, Skrochowska 1969). This could be explained by the fact that both life histories generally spawn at the same sites where small resident sneaker males are believed to share their genes with larger migratory females. However, if female competition for oviposition sites results in spawning segregation of alternative phenotypes there is potential for genetic differentiation (e.g. Dodson *et al.*, 2013). This is also supported in the study of Charles *et al.* (2006) using a combination of stable isotope analyses and microsatellite DNA where they concluded that a high level of gene flow exists between the two morphs when anadromous adults have access to the spawning grounds of residents. In agreement, studies using telemetry in small streams on the west coast of Sweden suggests that migratory and resident individuals utilizes different part of the stream during spawning with a smaller overlap in home range compared to the months prior spawning (Höjesjö *et al.* in prep).

With the use of more advanced genetic tools it could be possible to tease apart the effect of environmental vs. parental effects in the future. Juvenile brown trout have been shown to differ in their metabolic rate / energy demands (Burton *et al.* 2011) which have been suggested to have a genetic less flexible basis influencing their boldness and risk-taking behaviour. If so, this could explain why individuals with higher metabolic rate and growth capacity that is not met by the energy supply of its freshwater environment tend to migrate (Cucherousset *et al.*, 2005; Olsson *et al.*, 2006; Wysujack *et al.*, 2009). However, different gene expressions during the ontogenetic development might also mask any genetic differentiation and future research is definitely needed.

1.3.2 Conclusions

Growth, based on the feeding opportunity during the first two years in the stream, is most likely the most important and reliable cue for determining life history tactic in trout. The genetical influence needs more research but most studies suggest a large degree of gene flow between the morphs, at least under circumstances when anadromous and resident individuals share spawning grounds.

1.3.3 Recommendations for future research

- Better knowledge on the long term and possibly fluctuating fitness of these competing life histories;
- Spawning behaviour in sympatric populations;
- Genetic basis for anadromous / resident tactics and behaviours using new molecular tools;
- Factors controlling spatial patterns of anadromy and the extent of partially migrating population within catchments;
- Mapping the distribution of anadromous trout in catchments is recommended as a step towards understanding factors influencing anadromy.

1.4 Freshwater Phase: Habitat Preferences, Ecology, Behaviour

1.4.1 Introduction

This is a wide ranging research area, subject to a number of recent and continuing programmes that in some cases included all aspects of sea trout research, including the marine phase, leading to some overlap with other sections, but they are listed here for completeness. The workshop identified three key recent reviews, outlined recent or continuing programmes, summarized these and identified priorities for the future focusing on the session freshwater issues.

1.4.2 Recent reviews of research including freshwater phase

2011 ICES Study Group on Data Requirements and Assessment Needs for Baltic Sea trout (SGBALANST). St. Petersburg, (ICES) [*Summary (1) below*]

2011 Sea trout Workshop, Bangor, (Atlantic Salmon Trust, Feb 2011 - AST). [*Summary (2) below*]

2012 Small Streams Workshops in (a), Carlingford 2012, (Integrated Aquatic Resources Management Between Ireland, North Ireland and Scotland - IBIS & Atlantic Salmon Trust, Nov 2012) and (b) York 2013 (Institute of Fisheries Management (2012) - IFM with others). The first focused on trout, the second on all fish species [*Summary (3) below*]

Summaries of the outputs of these are given below.

SGBALANST (ICES 2008, 2009, 2011). This group compared the various ways electric-fishing surveys were made and how the habitat was assessed at survey sites in the countries around the Baltic. They evaluated the need for joint assessment and compared national field habitat survey methods. Criteria for juvenile and spawning habitats were established and a common habitat classification system was devised, testing it by predicting juvenile densities from habitat criteria, and finally constructed a model for assessment in the Baltic area. Good relationships were found between 0+ trout and substrate size, velocity, average depth, slope, shade and stream width combined.

The recommendations from the SGBALANST workshop

- identification of factors depressing stocks,
- rating of relative importance of these factors,
- identification of mitigation methods and
- establishment of sea trout Index Rivers for the Baltic (see sections 3.7 and 3.8).

AST Bangor Sea trout Workshop. This brought together sea trout workers across the British Isles. It was a meta-analysis of eight recent or continuing programmes that included work on the freshwater phase of sea trout and were wholly or partly based in the UK. These were: Anglian Rivers Project, Celtic Sea trout Programme, Living North Sea, Moray Firth Sea trout Project, South Coast Sea trout Project, DEFRA Commissioned Research Programme, Atlantic Aquatic Resource Conservation Project and the Salmon Catchment Management Programme (Northern Ireland).

The workshop report considered five topic areas: management priorities, stock structure and composition, habitat requirements, monitoring and assessment methods and key threats, with the aim of identifying research priorities.

Recommendations from the AST workshop

- A comprehensive programme, provisionally titled *Life History Optimisation in Trout in a Changing Environment*, should be developed, to explore the factors that influence the life history strategies that trout adopt, together with the ways that climate change might affect them.
- A programme of research on the utilisation of estuaries, inter-tidal and coastal habitats by sea trout at all life stages should be developed.

- More attention should be given to the significance of small streams for sea trout production. In particular, research is needed to quantify the contribution small streams make to sea trout recruitment. There is also a need to identify both actual and potential sea trout spawning streams.
- Priority should be given to improving the monitoring and assessment of sea trout stocks, and of habitats.
- A seminar or workshop, attended by the appropriate experts, be organised to take forward work on the economic, social and ecosystems services value of sea trout and sea trout fisheries, including the development of quantitative indicators.
- There is a clear need for further research into the practicality of setting biological reference points and into alternative indicators for use in stock assessment.
- Existing and prospective projects on individual streams that could contribute to research on anadromy, such as an evaluation of existing material from the Tadnoll brook (River Frome), should be identified and carried forward.
- The possibility of developing comprehensive sea trout population models, incorporating life history aspects as well as conventional population dynamics processes should be explored.
- A GIS-supported inventory of sea trout rivers should be developed, with supporting information on the size of the resource, and once the system is operational it should be taken up throughout the British Isles.
- The conservation status of trout is assessed within the overall assessment of Good Ecological Status (GES) under the Water Framework Directive should be clarified.

IBIS/AST/IFM Small Streams Workshops. These meetings focused on the environmental state of small streams in the British Isles and their role in supporting fisheries (including sea trout) and their management. The main points and conclusions, relating to trout, are outlined below.

- First order (<3m wide) streams constitute a very significant proportion (50–60%) of the total length of typical rivers, although a much smaller proportion (10–20%) of the wetted area.
- In mixed populations surveyed in many Scandinavian and European countries trout are more abundant than salmon on stream <5m wide. Salmon prefer streams with a width of more than 2.5m; the minimum size used by trout appeared to be 0.8m, with streams of only 1 metre wide used by large sea trout for spawning.
- Juvenile trout tend to show a preference for habitat that lies close to banks, corresponding to a higher proportion of the stream area in narrower channels.
- In very small streams 0+ trout fry move downstream early; this is essential in seasonally intermittently flowing streams such as winterbournes (small tributaries in groundwater water fed chalk rivers).
- On the island of Gotland 0+ trout fry move into brackish water, and elsewhere they may make use of pools and lake littoral zones.
- Evidence from Burrishoole, Ireland, shows that juvenile fish, particularly in older age classes, move progressively downstream from spawning areas

throughout the year. Nevertheless, quite small streams may also contain small resident trout .

- More research is needed into the role and importance of small coastal streams in contributing to sea trout numbers at sea;
- The linkages between primary and secondary (macroinvertebrates) and fish production in small streams needs to be quantified.
- More research is needed on the movement of immature salmon and trout, within and out of small streams.
- There is a need to improve our understanding of the complexity of interactions between fish communities in small streams, including interactions between separate populations of the same species & variation in spawning locations, in terms of access, competition between and within species and food availability.

1.4.3 Recent or continuing programmes including freshwater research

Programmes that are specifically concerned with sea trout or have significant sea trout component are summarized in Table 1.4.1, and their geographic coverage is indicated in Figure 1.4.1. Most of these have also a strong marine element. In addition, the workshop recognised that there are many other studies in progress which are generating data and information on the freshwater phase, but are not formally presented as coordinated programmes. In some cases, rather than being research-orientated, the programmes have a strong focus on supporting sea trout fishing tourism through fisheries management (habitat improvement and barrier removal), for example the Danish Fyn project (http://www.seatrout.dk/nc/english.html).

Table 1.4.1 Summary of research topics covered in extant or recently concluded sea trout programmes.

TABLE 1	JUVENILES					SMOLTS	ADULTS					
PROGRAMME	Habitat Problems & Restoration	Identification of limiting factors	Electric fishing surveys	Juvenile Habitat Characterisation & Optima	Alien spp impacts	Migration / Predation	Ensure / Improve access from sea	Tagging for Exploitation rate & Movements	Fish Counters for ST	Catch Records Database / Fishery Analyses	Upstream Migration Behaviour	Spawning Counts & Habitat
Anglian Rivers Sea trout project	*	*					*					
Celtic Sea trout Programme (CSTP)			*	*						*		*
Living North Sea (LNS)			*			*	*	*	*		*	
Moray Firth ST Initiative	*						*	*		*		
South Coast ST Project	*	*					*					
DEFRA Research Programme					*							

Atlantic Aquatic Res Cons Prog. (AARC)	*					*	*		*	*	*	
Salmonid Catchment Man Prog (N. Ireland).		*	*									
Sea trout **Fyn**	*	*					*	*				
Baltic ST Study Group				*								
ST at Sea (Western Sweden)			*	*		*		*			*	
Marine Migrations of ST (Central Norway)			*			*		*				*
TOTAL	**5**	**4**	**5**	**3**	**1**	**4**	**6**	**5**	**2**	**3**	**3**	**2**

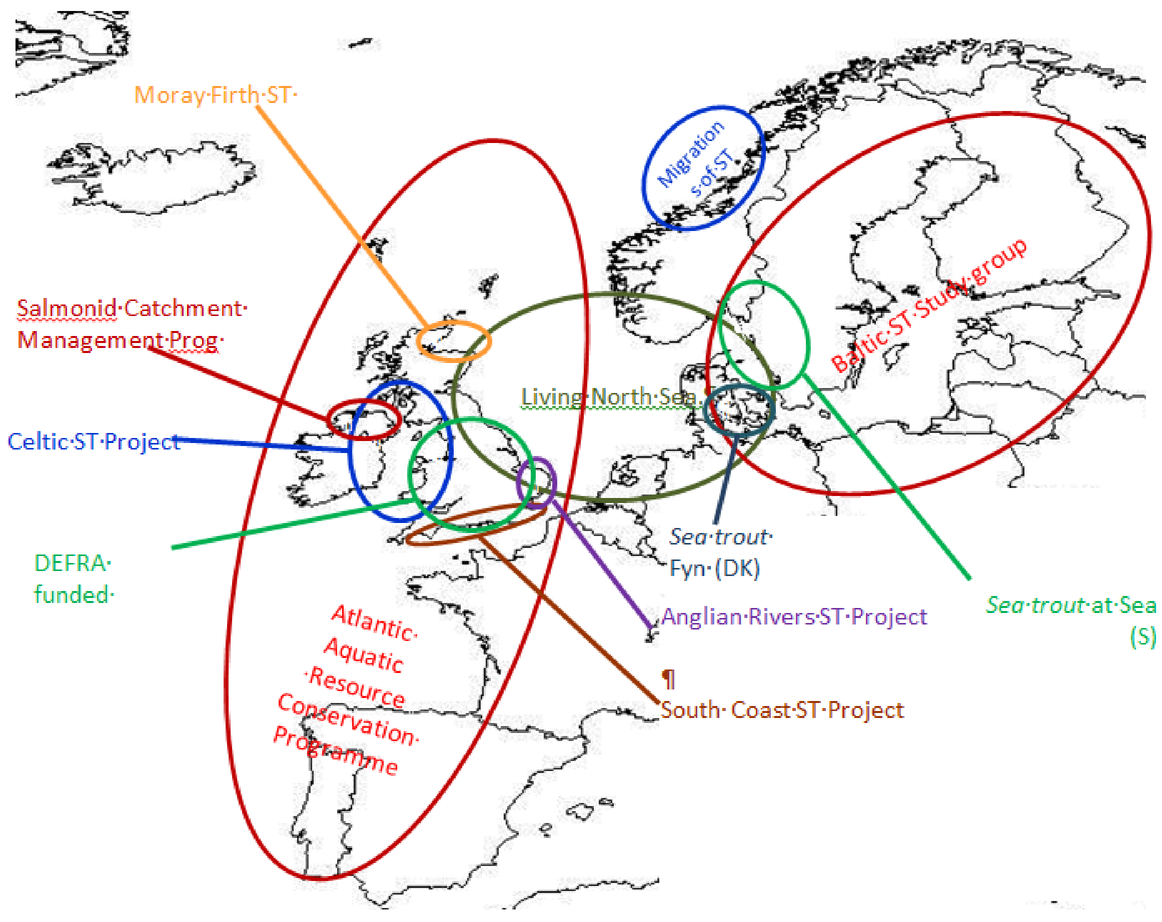


Figure 1.4.1 Location of principal sea trout research programmes.

1.4.4. Priorities for the future

Table 1.4.1 shows that while the habitat requirements and management needs of juveniles have been well-studied, other aspects of the freshwater phase seem to be less well covered, and the workshop identified the following priorities:

- Downstream migration of smolts: Those studies that have been made of the downstream migration have shown very significant rates of mortality, up to 80%. Such rates could be limiting factors for some populations, especially as they are apparently linked with the effect of in-stream structures and lotic areas in increasing rates of predation. More such studies need to be made in order to assess how widespread such problems are for sea trout.
- Upstream migratory behaviour of sea trout through main channels and then how they access their final spawning streams. The flows and migration cues for these are better known for salmon but as sea trout use smaller channels, there could be important differences. There appears to be no information on how the upstream migratory behaviour of sea trout relates to catches in freshwater fisheries, though such fisheries are a major source of data.
- Exploitation rates by freshwater rod fisheries and the factors affecting those, such as river flow and fishing effort. In many countries there is a need for better recording of catches in such fisheries to support such studies.
- The actual and potential impact of alien species on sea trout juveniles. Signal crayfish, for example, are spreading through sea trout rivers in the British Isles, many of which have never supported populations of even native crayfish before.
- Inter-specific competition, particularly with salmon, and the intra-specific relationship between the anadromous and non-anadromous forms of trout (see 1.2). Possibly the most significant issue for sea trout work in the future is the determination of this relationship and the factors that affect it: genetic influences; geographical / topographical location; trophic conditions, habitat variables and others.

1.5 Migratory routes and behaviour

1.5.1 Context and progress

Dispersal of sea trout through their life cycle is vital for the maintenance of populations by enabling fish to move to the sea in order to feed and mature in optimal habitats and then to return to their natal stream to reproduce. Although barriers are of crucial significance to the upstream and downstream migration of sea trout in freshwater (e.g. Thorstad *et al.*, 2008; Aarestrup and Koed, 2003) the workshop focused discussion on migration in estuarine, coastal and marine environments.

The group discussed the different technologies and methodologies that provide information on this aspect of sea trout biology and briefly touched on some of the results (and their value) coming from both historical and recent investigations. The different methodologies discussed are summarised in Table 1.5.1.

Table 1.5.1 Summary of methodologies used and key discussion points

METHODOLOGY	KEY POINTS (INCL PROS & CONS)	HISTORICAL (>10YRS) USE	CURRENT (<10YRS) & FUTURE USE
External mark recapture (floy tags, carlin tags)	Simple and effective methodology that enables easy identification of individual fish. Requires recapture - reliant on fishery and reporting Suitability for pre-smolt? Possible vector for infection? Useful secondary marker	Number of studies across EU, but many in grey literature	Some small scale tagging (e.g. UK LNS, France, Finland, Poland) – no coordinated programme
Internal mark/recapture (micro tags, PIT tags)	Relatively low cost Tags require “scanning” to detect therefore reliant on recovery programme Requires recapture - reliant on fishery and reporting Useful secondary marker Suitable for almost all life stages Tag life not compromised by battery	UK North East Coast investigations mid 1980-mid 1990’s	Limited tagging (e.g. DK) - no coordinated programme
Acoustic tracking – active monitoring	Requires constant contact with fish Invasive tagging procedure Labour and cost intensive Usually tracking single fish Detailed fine-scale behaviour Short tag life (high ping rate reduces battery life) Expensive tag	Some limited coastal and fjord tracking (UK, Norway), but tracks relatively short	Limited coastal tracking (mainly in fjords Could have application for further coastal/fjord/loch studies and possibly detailed movement studies around structures (e.g. tidal energy schemes)
Acoustic tracking – passive receivers	Requires deployment of receiver network and recovery of data (usually by recovering receivers) Invasive tagging procedure Coded tags allow multiple fish to be detected Fish located in FW and sea	Historical work mainly in estuaries and fjord systems	Several studies in estuaries/ lochs & fjords (all life stages) as well as in rivers (smolts) Recent study detected smolts in the North Sea (LNS, UK) Continually developing technology will provide many opportunities for future

	Provide multiple location fixes Tag life relatively short for smolt-sized tags Can be used to obtain fine scale positioning data Tags can incorporate sensors (e.g. depth, temp) Expensive tag		investigations
Genetic studies – determine river of origin from sea-caught fish	Fish do not require any previous "tagging" Results dependent on strength of baseline Useful for analysis of catch (MSF's etc.)	Sea migration, analysis of sub-populations, determination of origin (DK),	Several recent studies have focused on sea trout genetics (LNS, CSTP, AARC). Lots of scope for future studies, but a need to coordinate methods – see genetics report
Echo sounder data	Possibility of looking at population-scale movements at a fixed site where other technologies (e.g. conventional counters) are unsuitable	none	Used in salmon streams (Finland and Ireland) and trialled at tidal barrage (UK). Requires refinement
Archival Data storage Tags (DST's) – including Satellite tags	Continuous time series data on temp, depth, salinity experiences – providing key information on thermal /salinity preferences, feeding ecology etc. DST's Requires recovery of tag, but value of data is not dependent on recovery location Sat tags do not require recovery, but generally lower resolution data Invasive procedure Not currently suitable for smolts Expensive tag	none	Recent studies (LNS DK/UK) highlighting the value of this data and as technology develops (small tag size for smolts will be a critical development).
Migration scenario modelling	Using hydro-dynamic modelling to investigate possible migration routes accounting for parameters such as currents, random swimming behaviour and directed movements relative to temp and depth Model requires "ground-truthing" with known biological data (form other tracking technologies)	none	Current investigation under CSTP

Stable isotope analysis	Understand feeding locations based on stable isotope "signatures" of fish compared to environmental reference map Methods can also reveal other info on diet (relevant to wider food web studies) Fish do not require any previous "tagging" Fish do not need to be caught in sea	None	Recent LNS study revealed possible feeding locations of individual fish in North Sea. Promising technology.

The group agreed that the biology and ecology of sea trout in the sea is poorly understood. Recent research programmes based on genetics, microchemistry, isotopic and telemetry studies have improved our knowledge in this area (Ruzzante *et al.* 2004, Living North Sea project report in press and see section 1.8). However, much more research and refinement of techniques is required before we can address some of the specific management questions related to potential impacts such as renewable energy and fisheries (see section 4). In a recent review in the context of marine renewables off Scotland (Malcolm *et al.*, 2010) concluded that there was very little information available on migration routes, timing, swimming depths and behaviour of post-smolt and adult sea trout at sea.

The extent of marine migration in sea trout is variable. Although it is believed to be mostly local (<100km), some marine migration appears to be extensive and fixed, for example the long distance movement of sea trout from rivers in North East England and South East Scotland around the North Sea (see refs in Malcolm *et al., op cit*). This is believed to be influenced by residual current patterns and recent provisional results from the Irish Sea (CSTP) indicate that sea trout migrations there might also be partly dependent upon residual currents, presumable mediated in some way by the sea trout search for food supply, as this is a feeding migration. Genetics may also be involved and a study in the Kattegat area indicates genetic influence on the spawning migration (Pedersen *et al.* 2006). In line with the observations supporting an opportunistic migration at sea, by which the extent of migration might be influenced by the availability of prey, i.e. the distance of migration and not only the direction. Observations on Baltic salmon have shown that they may halt their post-smolt feeding migration if they come across abundant food supply (0+ herring); (Ikonen and Parmanne 1992). Such behaviour might also apply to sea trout and, coupled with the variable need for winter habitat, explain some of the variety they display in coastal migration (Degerman *et al.*, 2012; del Viguerra *et al.*, in press). Migration distance has also been found to be related to the energy content in migrating salmon smolt; smolts with lower energy content were found to migrate shorter distances (Boel *et al. in press*).

A study on the swimming depth of returning adult sea trout in an English estuary, revealed a general tendency for migration in the upper water column (typically ~1m depth) with frequent deeper dives (>3m) believed to be associated with the halocline (Barry Bendall, *pers. comm.*). Rikardsen *et al.* (2007) reported sea trout in coastal waters spending most of their time at depths <3m. Very recent studies of sea trout migration using Data Storage Tags have revealed highly varying behaviour patterns where sea trout from one population regularly performed deep dives, while trout from some other populations seem to show no deep dives and average swimming depths of just a few metres (del Villa-Guerra *in press*, Harry Hantke *pers. comm.*). A study from 2013 using depth sensing acoustic tags indicated a shift in swimming depth with greater depths during the day than during night (Davidsen *et al.* in prep.).

The group considered some of the potential pressures on sea trout populations once they leave the freshwater river and discussed how data on migratory routes and behaviour could help identify impacts and also provide the knowledge to mitigate further impacts. Such pressures (which may be inter-related) include:

- Fishery exploitation
- Food web dynamics (incl. prey availability and predation)
- Construction and maintenance of harbours and ports
- Climate change

- Renewable energy schemes (tidal stream arrays, barrages, lagoons, wind farms), in both construction and operational phases

1.5.2 Conclusions

- The group agreed that data on the behaviour and migratory routes of sea trout provides essential information for the purposes of managing sea trout stocks and the impacts upon them.
- It is uncertain to what extent migration is opportunistic or genetically determined.
- Each methodology provided useful data in its own right, but that it was the integration of different approaches that would generate the most meaningful data.
- To this end, it was important that future research activities are coordinated across disciplines and where appropriate between countries to ensure the maximum benefit.

1.6 Genetics

1.6.1 Progress outline

Information on genetic population structure of trout (*Salmo trutta*) was presented for populations in rivers entering the Irish Sea, Celtic Sea, English Channel, North Sea, Baltic Sea and the Skagerrak (southern Norway). This information has come primarily (but not exclusively) from the findings generated by three European Union funded projects: the Celtic Sea Trout Project (CSTP), the Atlantic Aquatic Resources Conservation project (AARC) and the Living North Sea project (LNS), and for the Baltic Sea the Healthy fish stocks – indicator of successful river basin management project (HEALFISH); (Koljonen *et al.*, 2013) and the Rivers and fish (RIFCI)..

New knowledge was highlighted on the genetic structure of trout populations in rivers of this area of northern Europe and, by inference, the evolutionary significant diversity of these genetic resources as a potential surrogate for the sustainability and resilience of the species, especially within the context of anthropogenically-mediated stressors. Substantial progress was also reported in deploying genetic methods in elucidating the distribution and extent of migrations of trout in open and estuarine European waters. These data were considered to be of critical management importance, both from the perspective of conserving and protecting threatened elements of biodiversity, and in managing fisheries, particularly where mixed stocks are known or anticipated.

Potential for international (interceptory) fisheries was recognised and, consequently, a requirement for management on a trans-European basis was emphasised. Genetic methods offer excellent potential to elucidate coarse level behaviours in the marine environment (the marine biology of the sea trout is recognised as an important knowledge gap), which allows for the recovery of population specific information from all fish sampled in the sea, in contrast to physical tagging methods which are confined to only those samples that can be recovered with a readable tag. There is considerable complementarity between modern physical tagging techniques and genetic techniques; the former has advantages in revealing fine-level behaviours, such as direction and extent of migration routes, swimming depths, feeding behaviours etc. However, discussions at the meeting revealed a number of vital areas, which require investment and further investigation. Principal among these was the necessity to understand how the stocking of cultured fish affects stock dynamics (demography) and the genetic structure and integrity of components of the species' biodiversity.

1.6.2 Recommendations

- Recent investigations suggest long distance migration and dispersal of many sea trout in European waters. The preparation of an international baseline for the genetic assignment to river and region of origin of sea trout caught at sea both for the Atlantic and Baltic Sea coastlines would allow further resolution of sea trout distributions and movements in the seas around Europe;
- Efforts should be made to extend and standardise the existing genetic baselines (currently principally microsatellite-based); standardisation of the genetic markers (loci) used (microsatellite, SNPs) is essential to facilitate future Europe-wide research on fish movements and migrations, and fisheries management. We anticipate this may require a pan-European, inter-laboratory calibration project;
- Methodologies to improve assignment stringency, including feasibility and implementation of the new (universal) marker systems, e.g. SNPs (addressing cost considerations), should be undertaken;
- The sequencing of entire sea trout and brown trout genomes to facilitate genomic studies targeted at determining the genetic basis of anadromy should be supported; such genomes will allow direct assessment of the genetic basis of anadromy and related life-history traits (by genomic comparisons), whilst also providing a solid framework for a broad range of future genetic-based studies on different aspects of trout biology and ecology;
- Assessment of the impact of sea trout stocking, and the contribution of cultured fish to fisheries and their potential impacts on the genetic integrity of wild sea trout populations, particularly with respect to the long-term resilience and natural productivity, is required;
- Assessment of mixed stock fisheries at the European level. This encompasses both a need to assess European mixed stock fisheries using genetic methods and to assess the utility and robustness of genetic methods for analysis of European mixed stock fisheries;
- Assessing the extent of anthropogenic influences (fisheries, climate, disease - pathogens/parasites, introgression with cultured fish) on the evolutionary trajectories of natural trout populations will be an essential component of future research efforts;
- Investigate the utility of genetic methods in providing estimates of effective population size (N_e), number of breeders (N_b) etc., which are relevant to assessing achievement of biological reference points, such as conservation limits, and in a possible complementary role to long-term census techniques;
- Integration of brown trout and sea trout genetic data, including inclusion of hatchery stocks into genetic baselines to facilitate identification of escapees and assessment of genetic introgression from farmed trout into natural populations;
- Distinguishing between genetic information required for addressing conservation questions and fisheries management questions;

- Identifying how geneticists can improve communication of the statistical framework associated with assignment based on genetic information.

1.7 Climate impacts

1.7.1 Climate change – causes and projections

Climate change can be defined as measurable and long term change in the state of the climate (e.g. weather patterns and associated variables such as temperature and precipitation) as a result of natural processes or human activity (or both). In turn, environmental changes linked to climate change have consequences for biological systems, including fisheries.

Evidence for recent warming of the climate system is unequivocal (IPPC, 2007). For example, 11 (out of 12) years from the recent period 1995-2006 have been among the twelve warmest years in the instrumental record of global surface temperature (since 1850). Temperature increases have been widespread across the globe – including at northern latitudes where brown trout (*Salmo trutta*, L) in their anadromous and non-anadromous forms are present. Indeed, IPPC (2007) noted that temperature increases have tended to be greater at higher northern latitudes. Recent developments in climate modelling (e.g. IPPC, 2007 and UKCP09, 2010) have resulted in more probabilistic projections of future climate change scenarios for inland and marine environments and better tools to facilitate impact assessment studies and decision making on climate change adaptation. Modelling continues to provide strong evidence that anthropogenic emissions of greenhouse gases (GHGs) post the industrial age (principally carbon dioxide and methane) have been the main cause of rising global average temperatures since the mid-20th century.

If GHG emissions are unchecked then further warming is likely – inducing changes in the global climate system in this century larger than those observed in the last. Such changes are likely to have wide ranging and adverse consequences for many terrestrial and aquatic ecosystems - hence global efforts to reduce carbon dioxide and other GHG emissions. However, even if GHG emissions were to remain at year 2000 levels, further warming (of about 0.1°C per decade) would be expected because of inertia in the climate system (IPPC, 2007).

The main scenario for climate change in northern Europe *[and North America]* in the near future is for milder, wetter and stormier winters, warmer and drier summers, and more frequent periods of extreme weather e.g. floods and droughts (IPCC, 2007). Climate change effects are likely to be stronger over land than over the ocean, with potentially greater consequences for freshwater compared to marine life stages.

1.7.2 Impacts on salmonids

For salmonids in Europe – principally the Atlantic salmon (*Salmo salar*, L) and the brown trout (*Salmo trutta*, L), including the anadromous sea trout - there have been a number of recent reviews of the likely effects of climate change on these species. Graham and Harrod (2009), for example, examined the implications of climate change for freshwater and marine species in the British Isles, including a detailed review of Atlantic salmon as an anadromous species. Jonsson and Jonsson (2009a) focused solely on Atlantic salmon and brown trout and particularly the effects of temperature and flow on these species. Elliott and Elliott (2010) specifically reviewed the temperature requirements of Atlantic salmon and brown trout in the context of climate change but also included the Arctic char (*Salvelinus alpinus*, L) in their review. It is apparent from these reviews that the response of any one species to climate change, and in particular to changes in temperature and flow (and associated factors), will be complex and difficult to predict (Graham and Harrod, 2009). Species may be affected at all levels e.g. individual, population and ecosystem, at freshwater and marine stages, and in direct and indirect ways with positive and negative outcomes.

Studies into climate change impacts on salmonids have ranged from examination of specific issues (e.g. temperature effects; Elliott and Elliott, 2010) to catchment scale investigations, (e.g. the Burrishoole study; Fealy *et al.*, 2010) and whole lifecycle modeling (e.g. Piou and Prevost, 2013).

Even for variables such as temperature, where responses (e.g. in terms of thermal limits for survival, feeding and freshwater growth) are relatively well understood (Solomon and Lightfoot, 2008; Elliott and Elliot, 2010), the picture is a complex one. To illustrate this; Table 1.7.1 below – extracted from Jonsson and Jonsson (2009a) indicates the range of life-stage responses to increased temperature for Atlantic salmon and brown trout. Non-linear responses to environmental change (such as thresholds or bell-shaped relationships) are important here. For example, populations could show increased or decreased growth rates in response to increased temperature depending on whether such increases resulted in temperatures above or below the optimum for growth.

Table 1.7.1. Summary of responses by life stages of *Salmo salar* and *Salmo trutta* to increased environmental temperature based on available literature (From Jonsson and Jonsson, 2009b).

Character	Eggs	Embryos	Alevins	Parr	Smolts	Post-smolts subadults	Adults
Number	-						+/-
Size	+		+/-		-/+		-
Developmental rate		+/-	+/-	+/-	+	+	+
Food consumption				+/-		+/-	
Growth efficiency				+/-		+/-	
Day activity				+	+	+	
Time in season of migration					+		+
Time in season of spawning				-			-
Mortality		-/+	-/+	+	-/+	+	+

+, increase or earlier; -, decrease or later; +/-, maximum at intermediate value; -/+, minimum at intermediate value

Provisional temperature-growth modelling on the Welsh Dee (England and Wales; Davidson and Cove 2010) showed significant associations between observed and predicted lengths of autumn trout (and salmon) fry at a sub-catchment level (e.g. Figure 1.7.1) – improving on weaker relationships evident at the whole catchment scale (Davidson *et al.* 2006). Strong relationships between temperature and growth of salmon fry in a French coastal stream were reported by Bal *et al.* (2011). However other factors – namely population density (Figure 1.7.2) and nutrient status of the water body (M. Nevoux pers. comm.) may be more influential in terms of the growth rate of juvenile Atlantic salmon than temperature (Figure 1.7.2). This suggests that climate linked forecasts of future changes in growth rate, based on temperature alone, may be overly simplistic. In this particular case, the population is considered highly vulnerable not only because it is located toward the southern extreme of the distribution range and facing climatic conditions at the limits of thermal tolerance, but also because of strong anthropogenic pressures on freshwater ecosystems in this densely populated region. Indeed, anthropogenic activities may mask, interfere with or override climate impacts on salmonid population dynamics, in such circumstances.

Salmonids, including *Salmo trutta*, seem to show little intraspecific variation to support hypotheses for thermal adaptation, except, perhaps, in very cold rivers (Elliot and Elliot, 2010). Most variation observed appears to be due to phenotypic plasticity – perhaps the more advantageous evolutionary response than genetic fixation to life in environments where temperatures can vary considerably both spatially and temporally (Jonsson *et al.*, 2001; Forseth *et al.*, 2009; Jonsson & Jonsson, 2009a.)

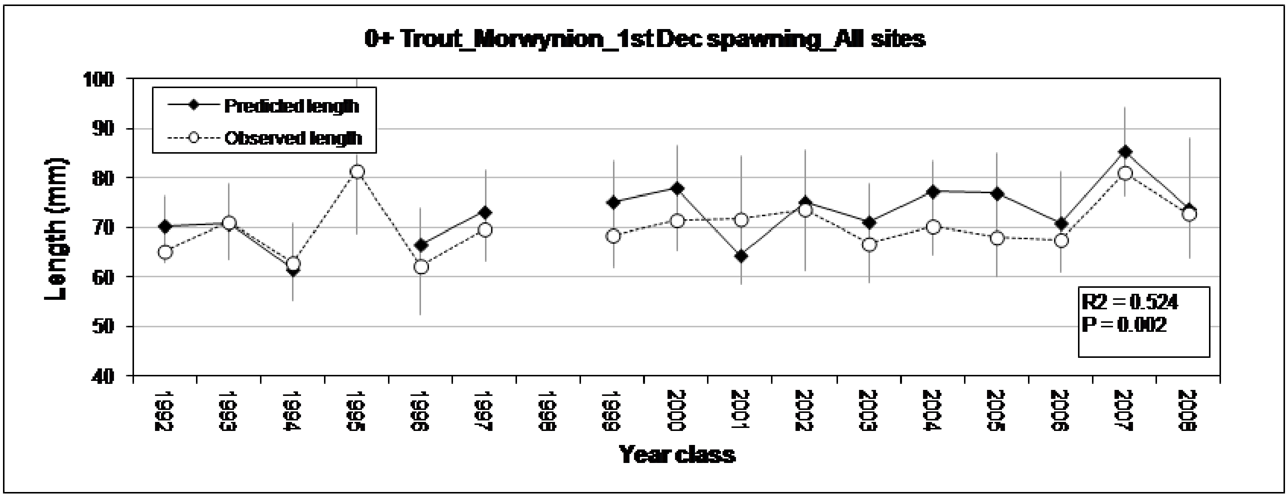


Figure 1.7.1. Relationship between observed and temperature predicted mean lengths of autumn 0+ trout fry on the Morwynion sub-catchment, River Dee, North Wales.

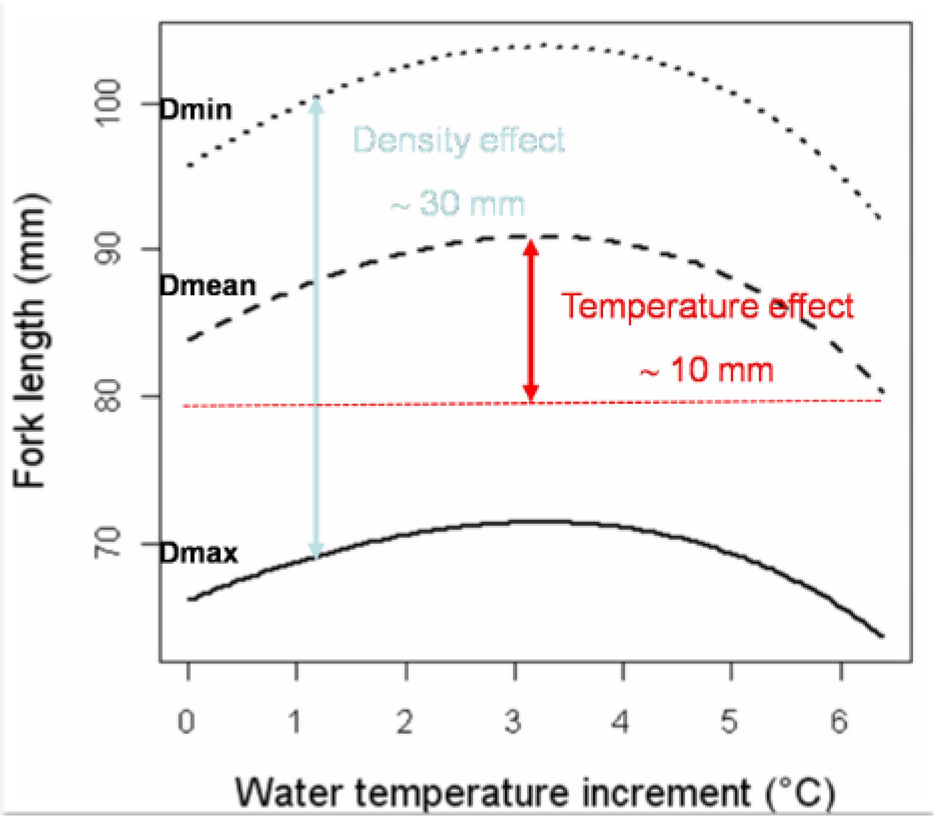
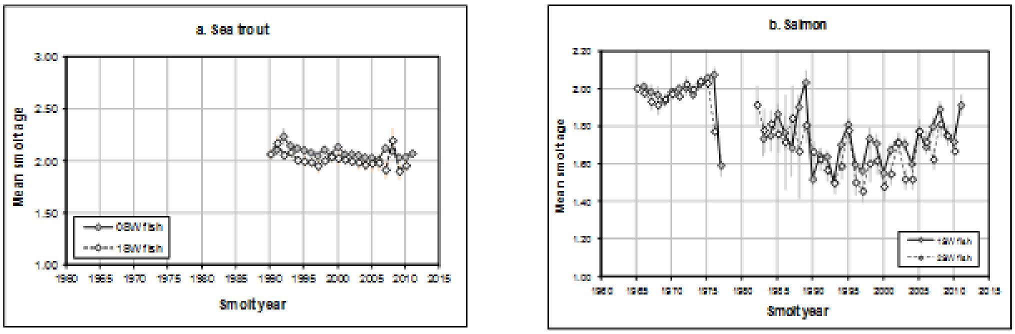


Figure 1.7.2. Modelled influence of temperature and density on growth of 0+ salmon fry in a French coastal stream [After Bal *et al.*, 2011).

Recent decline changes in the mean smolt age of salmon on some Scottish rivers (R. Campbell pers com) may be linked to improved juvenile growth rates in warmer conditions. These changes have led to a shift in the focus of electrofishing surveys from parr to fry as, for example, any increase in the number of fish emigrating as one year-old smolts is likely to mean that relatively fewer 1+ parr would be present to sample in summer, leaving the fry stage as the most consistent indicator of spawner/pre-smolt abundance. The change in smolt age may potentially change the smolt productivity of a river.

In a Norwegian small stream brown trout were found to compensate for increased temperatures by density regulated growth (Bærum *et al.* 2013). Annual variations in the mean smolt ages of salmon and sea trout on the Welsh Dee (based on adult scale readings) have shown markedly different patterns in recent years (Figure 1.7.3). This contrasting response from two closely related sympatric species with similar physiological requirements, including thermal preferences, suggests that different factors are at play. It also illustrates the value of monitoring programmes targeting both species on the same river because of the additional ecological insight this can provide.

Temperature and other climate related changes are likely to be just as important to sea trout (and salmon) in the marine phase of the life cycle as in the freshwater. However, understanding of the marine phase is far less complete; for example there appear to be no temperature-growth models applicable to sea trout in the sea.



a) b)

Figure 1.7.3 Annual variation in the mean smolt age of sea trout (a) and salmon (b) on the River Dee, North Wales (ages determined from adult scale readings).

Jonsson and Jonsson (2009 b) examined environmental influences on the marine growth and survival of sea trout on the River Imsa. For different components of the run, they found strong associations between sea survival and a number of factors including the timing of the smolt migration, marine growth rates and the North Atlantic Oscillation Index. Tentative associations between sea surface temperature and both post-smolt growth rates and smolt-to-adult return rates were described from studies on the Tamar and Welsh Dee (England and Wales) and highlight the probable influence (direct or indirect) of temperature in the marine phase (Davidson and Hillman pers com). Locally prolonged growth seasons have been observed in the Kattegat and southern Baltic in recent years (S. Pedersen *pers. comm.*). The workshop noted that while there are some tentative empirical relationships, it was not aware of any reported temperature/growth models (*cf* Elliott's freshwater model) for trout in the marine environment.

Evidence from the Welsh Dee of a link between sea trout size differences at the (S2) smolt stage and maturation, with larger smolts tending to spawn at age .0+ as opposed to age .1+, indicates that factors influencing freshwater (pre-smolt) growth could have consequences for marine life-history (aside from the influence of factors purely associated with a changing marine environment), (see S1.1). An improved understanding of freshwater and marine environmental influences on survival, abundance, maturation and timing of migration, including the interplay between these factors, would help fisheries managers to anticipate and better protect fluctuating stock levels. Jonsson and Jonsson (2009a) note that partly anadromous species such as *Salmo trutta*, populations, will possibly exhibit progressively less anadromous behaviour if, over time, environmental changes mean that the benefits of remaining in freshwater systems outweigh the advantages of migrating to coastal areas for summer feeding.

While little work has been done to examine the implications, for sea trout, of a changing marine environment; in the case of salmon, the SALSEA programme has seen significant research in this area (Hansen *et al.*, 2012). The main focus of the latter has been on the migratory behaviour and marine ecology of salmon in the North Atlantic, and less so on inshore waters likely to be important to sea trout. Nevertheless, research describing changes in the marine environment/ecosystem (e.g. Beaugrand and Reid, 2012) and the biological responses of salmon to these and freshwater environmental changes (e.g. Russell *et al.* 2012; Todd *et al.*, 2012), should help inform judgment as to the likely ecological consequences for sea trout exposed to similar pressures. That said, many of the recent studies described in Section 1.4 include significant focus on the ecology and behaviour of sea trout in the marine (as well as the freshwater) environment and should add considerably to our understanding as to how sea trout are likely to respond to environmental changes at sea.

1.7.3 Management response to climate change

The high level management response to avoid the more extreme projections associated with climate warming involves global efforts to reduce GHG emissions (IPPC, 2007). In Europe and other parts of the developed world this has resulted in a proliferation of initiatives to introduce renewable energy schemes, some of which e.g. riverine hydropower schemes and estuarine/marine tidal and offshore windfarm schemes pose real or potential threats to migratory species, including sea trout and salmon. The issue of renewable schemes and their impact is dealt with in other sections of this report e.g. 'migration routes' (Section 1.5); 'freshwater survival and production' (Section 2.2) and specifically, 'marine spatial conflicts marine' (Section 4).

Even if GHG emissions are held close to current levels the inertia in the climate system will mean that global temperatures are still expected to rise (as described above), so forms of mitigation other than control GHG emissions are likely to be required. Graham and Harrod (2009) note that climate change presents a further potential stress on fish already subject to various natural and anthropogenic stressors. Attempting to alleviate these other stresses – as agencies responsible for environmental management commonly do (e.g. via better land and water resource management, control of pollution, regulation of fisheries, improved access for migratory fish, etc.) will help to maximise the resilience of individual populations to any adverse effects of climate change. On this theme, Maltby (2010) identified the importance of river restoration schemes to rectify historic and sometimes overlooked anthropogenic impacts which could lessen the resilience of salmonid populations to the increased stressors associated with climate change. He highlighted the success of restoration schemes in the Pacific Northwest as an example to European fisheries managers, and points out that in the former, salmonids with similar environmental requirements are found over a wide geographical range (almost as far south as Mexico). This indicates that, with appropriate river basin management, even salmonid populations toward the southern end of the European range might withstand the adverse effects of climate change. Phenological and phenotypic changes in stocks in response to environmental change may also require appropriate modifications to fisheries regulations. For example, in Brittany, France, changes in the size of adult Atlantic salmon and their time of return has resulted in recent revisions to fishery size limits and proposed amendments to season dates.

In reviewing the management implications of the SALSEA programme, Hansen *et al.* (2012) recognised that freshwater habitats are more amenable to management than marine habitats. On this basis, aiming to maximise the production of healthy wild smolts is likely to be the best management option for countering any adverse changes in the marine environment. To meet this aim in the face of climate change, and the uncertain challenges that might bring for freshwater and marine habitats, will require a long-term, adaptive and evidence based approach to management where options are evaluated and refined and best practice shared (Environment Agency 2010, Orr, 2010).

However, it was noted that in the case of (sea) trout with their complex and apparently flexible life histories, the species might adapt to climate change through adjustment in the proportion of anadromy. But the direction or extent of this critically important shift cannot, at the moment, be predicted with confidence. Better understanding of life history response to environmental change is needed.

1.7.4 Conclusions and Recommendations

- Evidence for recent warming of the climate system appears unequivocal with anthropogenic emissions of greenhouse gases (GHGs) likely to have been the main cause of rising global average temperatures since the mid-20th century.
- Climate modelling for northern Europe indicates that near-term changes in weather patterns will lead to milder, wetter and stormier winters, warmer and drier summers, and more frequent periods of extreme weather e.g. floods and droughts. Effects are likely to be stronger over land than over the ocean, with potentially greater consequences for freshwater compared to marine life stages.
- A number recent reviews/studies have explored the implications of climate change for native European salmonids – principally Atlantic salmon and brown trout. From these, it is evident that responses to factors such as changes in temperature and flow will be complex and difficult to predict. Species may be affected at all levels e.g. individual, population and ecosystem, at freshwater and marine stages, and in direct and indirect ways with positive and negative outcomes.
- Management responses to climate change may bring costs as well as benefits for salmonids. For example the need to reduce GHG emissions has led to a proliferation of initiatives to introduce renewable energy schemes, some of which e.g. riverine hydropower schemes and estuarine/marine tidal and offshore wind farm schemes pose real or potential threats to migratory species, including sea trout and salmon (e.g. see Section 4 for more details).
- Climate change presents a further potential stress on fish already subject to various natural and anthropogenic stressors. Attempting to alleviate these other stresses – through sustained, improved and adaptive environmental management appears the best strategy to help to maximise the resilience of individual populations to any adverse effects of climate change.
- Knowledge gaps and research needs in relation to climate change are examined in Section 2.4.

1.8 Hard structure chemistry

Studies in the microchemistry and radioisotope ratios of scales and otoliths have proved to be of increasing value for the study of feeding and trophic levels of sea trout, their natal origins and their distribution at sea and in freshwater (McCarthy and Waldron, 2000; Ramsay *et al.*, 2011, 2012; Veinott *et al.*, 2012; McCarthy *et al.*, in prep). The microchemical methods are contingent upon adequate resolution in the background geo- and hydro-chemistries of the environment; but in the Irish Sea for example this has proved to be sufficient for distinguishing and successfully assigning adult fish to natal regions (McCarthy *et al.* in prep, CSTP report). The radioisotope methods (C and N) are well established for salmon (Kennedy *et al.*, 2005), but have not yet been applied to sea trout in the sea. An important new sea trout application arising within the CSTP was the use of strontium ratios to validate the interpretation of scale structures, in which using conventional scale reading it can otherwise be hard to distinguish between marine and freshwater checks.

1.9 Sea Trout Research Progress – Conclusions

Sea trout research has increased significantly since 2004, across several topics, principally genetics, processes governing anadromy, marine movements and ecology. General freshwater trout (*Salmo trutta*) orientated research, applicable equally to "sea trout", has been extensive, focusing on growth and freshwater habitat relationships. The developments in incorporation of habitat for Baltic assessment purposes have been especially significant (Section 3).

Anadromy, a trait first evident in freshwater, has expression through biology and behaviours in freshwater (growth-maturation/smolting) and in the sea (growth-maturation and return migration). The latter is far less well described and understood, but both are necessary to understand how life histories are regulated by genes and environment and how they might respond to changing environmental pressures. Traditionally the marine and freshwater phases are studied separately, often with separate funding. Therefore, perhaps the biggest gap remains the difficult area of linking the separate topics together into a coherent synthesis of anadromy and population dynamics in trout and an explanation of why sea trout productivity varies over space and time. Given the international, universal nature of this need and the desirability of working across wide environmental gradients to reveal better the mechanisms, it might be a topic where some international collaborative activity would be beneficial. It is noted that early proposals along these lines are being prepared (Javier Lobon-Cervia and John Piccolo, pers. comm.).

The specific research recommendations are listed under their respective sections, but there appears to be a more general research funding issue as outlined below. A distinction is sometimes made between research that aims to support fisheries management and that which is more academically directed: this dichotomy is particularly evident in the sea trout (brown trout) context. Many of the on-going or recent large scale programmes have been driven by the applied needs of fisheries management, to solve issues like the location and composition of mixed stock fisheries, assessment needs and the passage problems of fish at barriers. This has proved a successful, if short term, way to obtain EU or government funding, which naturally seeks to maximise socioeconomic and community returns. But this route is less successful for other research into questions that are important for sea trout, such as the evolutionary significance of anadromy, demo-genetic modelling, or the application of life history theory to population dynamics and forecasting. These are certainly fundamental to better management in the long run, but are not attractive to applied funders and are not apparently of interest to pure science (for want of a better term) funders. They seem to be regarded as Cinderella academic subjects and ways need to be found to present them more robustly if progress is to be made. The degree to which this is a problem varies and the university sector, which would probably be the ones to develop these areas, seems to have more success in securing funding in some countries (Scandinavia) than in others (British Isles). In any event the linkage between applied and academic research needs to be strengthened if the benefits are to be realised.

2 Gaps in knowledge about threats to sea trout

2.1 Introduction

The workshop identified and ranked the knowledge gaps in understanding of the principle threats to sea trout across marine and freshwater environments. Threats include environmental factors and impacts of fishing. The wide distribution and high potential value of the stocks makes understanding and mitigating these impacts important in order to optimise the Bio Economy (http://ec.europa.eu/research/bioeconomy/) and the Blue Growth (http://ec.europa.eu/dgs/maritimeaffairs_fisheries/consultations/blue_growth/index_en.htm).

2.2 Freshwater survival and production

2.2.1 Overview of issues

In the freshwater environment there are numerous threats to sea trout through impacts on migration, survival and production. Habitat fragmentation and its converse, connectivity, are of clear importance to the anadromous trout. Thus obstruction and delay to fish passage from various kinds of barriers was regarded as the top threat. Man-made barriers are the primary concern, including dams (for water supply, flood prevention, HEP), historic mills and fish farms. In England and Wales a review of barriers in rivers with potential for low head hydro power generation identified 26,000 sites, of which 12,000 were classified as having high environmental sensitivity on a range of criteria including presence of migratory salmonids (AMEC, 2009). Elsewhere, the expansion of hydropower schemes offers major challenges whose effects, especially cumulative ones, have been identified (Aarestrup *et al.* 2003; Östergren and Rivinoja 2008; Calles and Greenberg 2009; Kemp and O´Hanley, 2010). Solutions to new barriers can lie in the application of robust environmental statements coupled with good weir and fish pass design; but often the legal powers to deal with historical barriers are ineffective or non-existent. Both individual and cumulative effects of manmade barriers can be very high (>80%; Aarestrup *et al.*. in prep). Most research on effects of barriers for salmonid fish has been done on salmon (see reviews by Thorstad *et al.* 2008; Marschall *et al.* 2011; Milner 2008; Milner *et al.*, 2012).

Environmental impacts through the many often combined effects of agriculture, forestry, urbanisation and historical channelisation have also decreased sea trout production (e.g. Armstrong *et al.*, 2003; Hendry *et al.*, 2003; Nilsson *et al.* 2005) through habitat carrying capacity or reduction in survival. National and European environmental legislation such as the Water Framework Directive have led to improvements, although much remains to be done (Hering *et al.*, 2010).

The effects of factors such as changing nutrient status, water temperature, or population density that might influence feeding and growth are of potential significance for brown trout because they could have direct effects on smolting, and vice versa; changes in smolt age can result in increased habitat available to younger ages resulting in overall increase in smolt production. Such mechanisms have been postulated for salmon and sea trout (Davidson and Cove, 2010) and processes linking feeding, metabolic rate, growth and smolting have been demonstrated for trout experimentally and in the field (Forseth *et al.*, 1999, Wysujack *et al.*, 2009; Olsson, *et al.*, 2006). Three questions then arise. First, how stable is the migratory tendency in trout? This has not been formally reported; it appears to be comparatively stable in a given river, on the basis of catch variance, but catch data usually lack the resolution and precision to properly evaluate this: smolt counts would be far better. Second, given the demonstrably significant response of anadromy to feeding opportunity, how temporally stable is the suite of environmental factors that control trophic webs and biomass production in rivers? Third, what might be the relative roles of environment and genetic factor in controlling anadromy in the face of changing environments? These are key questions in determining how sea trout will respond to environmental pressures in freshwater. Moreover, they require an ecosystem-based approach to their investigation (see section 3.6).

Habitat management for streams is now a well-described remedial activity with many reviews and descriptions of best practice (e.g. Gore, 1985; Hendry *et al.*, 2003; O'Grady, 2006; Kemp, 2010). Overall, schemes to enhance habitat complexity appear to work (Smokorowski and Pratt, 2007), but there have been some contrasting results (e.g. Pretty *et al.*, 2003). Unfortunately effective monitoring of restoration projects is rare, although it can provide new insight into survival and production in the freshwater environment. Some examples are restoration of streams cleaned for log-floating in Northern Sweden and habitat enhancements on spawning grounds targeting sea trout (Nilsson *et al.*, 2005; Palm *et al.* 2007). Stocking was also nominated as a potential threat to stocks if carried out incorrectly.

2.2.2 Conclusions

For sea trout, the priority knowledge gaps identified by the workshop regarding the freshwater phase were:

- The scale and consequences of delayed downstream and upstream migration caused by barriers singly and in combination on contrasting rivers; including how dependent are the effects upon spatial location of barriers in the catchment?
- The effects of flow regime variation on migration in contrasting river types, fish size and maturity status.
- Basic knowledge about spatial and temporal variance in trout production in different types of habitats and streams.
- Long term effectiveness of habitat restoration at contrasting scales (site, reach, catchment) of production and what is relevant specifically to sea trout.
- Winter survival, habitat availability and habitat selection.
- Wider effects (e.g. biodiversity) when restoring habitat targeting sea trout.
- Stocking effects (genetic and ecological) at the population level.

2.3 Marine survival and migration

2.3.1 Overview of issues

The marine phase is the part of sea trout life history considered to have the largest knowledge gaps and spatially extends to a very wide area. Marine survival threats are closely linked to the research into migration and behaviour (S1.5). The knowledge gaps cover even apparently simple biological metrics such as survival and marine residence time, as well as return rates of maiden and repeat spawners. The widespread occurrence of numerous populations all over Europe and the inherently large life history variation both within and amongst populations adds to the complexity in the species. This makes an EU and wider scale approach necessary to generate an overview and wider understanding of the species.

Current traditional methods such as Carlin tagging and scale reading provides insufficient detail and sometimes confusing knowledge to describe and understand the marine life of sea trout. To gain more knowledge on the species new methods available such as telemetry, chemical fingerprints (scale, otoliths) and genetics or a combination of those provides the best alternative to fill the knowledge gaps. These methods hold promise for identifying specific migration patterns, feeding places, alternative marine life histories and origin as well as broader survival issues.

The principal threats were seen to arise through climate change to marine ecosystems, offshore and inshore renewable energy developments, particularly those that might present barriers to migration such as tidal lagoons or barrages, harbour developments and fishing (directed fisheries, by-catch and illegal).

2.3.2 Conclusions

Priority knowledge gaps for the marine phase identified by the group were:

- Descriptions of behaviour and survival, (post-smolt phase, maiden fish and kelts) and their response to environmental and biotic factors, particularly prey and predator status;
- Marine life history variation, particularly the timing of maturation, the differential survival of sea-resident maidens and spawners, proportions and the fate of returning whitling (n.0+);
- Marine migration. Where do they go at sea and when? Maps of marine migration routes and feeding locations would be useful in order to evaluate specific risks for spatial planning purposes;
- Determinants of migration. The influence of environmental and trophic factor and specific navigation and orientation cues vs the inherent genetic traits;
- The extent and significance of temporary and true (reproductive) straying;
- Response to undersea electromagnetic fields;
- Possible negative interactions between sea trout and aquaculture (e.g. impact from sea lice and diseases).

2.4 Climate change

2.4.1 Overview of issues

As set out in Section 1.6 much of the literature on climate has focused on salmon, and in spite of the biological similarities caution in extrapolation between salmon and trout is required because their responses to thermal stress in terms of growth and potential smolt output can be different. Improved climate modelling has provided a more detailed (if uncertain) picture as to how climate warming might affect freshwater and marine environments, particularly in relation to temperature increases and river flow patterns. In summary in addition to overall warming climate will become variable, with greater extremes. However, associated changes e.g. in freshwater (dissolved oxygen, pH, invasive species, pathogens) and in marine ecosystems (prey predators) are more difficult to predict. Our understanding of how salmonids will be affected by climate related changes is good in some areas but weak in others. For example, in the freshwater phase, growth responses to temperature are well understood; however there is far less certainty about the consequences of that for the incidence of anadromy, smolt age, size and survival. River flow requirements of sea trout are a further knowledge gap. In the estuarine and marine phase knowledge is less complete, e.g. in areas such as migration, feeding and predation or factors affecting specific processes such as growth and maturation. There are no growth models that apply to adult sea trout in saline environments on high lipid diets. This severely limits interpretation of marine climate change effects on sea trout population dynamics. The impacts of climate change at the population or ecosystem level remain highly uncertain and part of this is due to the still limited understanding of life history responses to environmental change.

Better use could be made of the network of monitored rivers and their latitudinal spread to improve ecological understanding and track the potential responses of populations to climate related effects. Links between individual, population and community level responses need to be better understood (e.g. density dependent processes and trophic interactions). Eco-evolutionary approaches should also be considered as rapid evolution may affect individual/population adaptation and resilience to environmental change.

The focus of management should be on protecting and improving freshwater, estuarine and (where feasible) marine environments e.g. to reduce stressors – climate linked or otherwise, and to maximise wild smolt production and resilience. An adaptive and evidence based approach to management should be adopted to identify and share best practice.

2.4.2 Conclusions

Priority research topics are:

1) Models of life history trait responses (growth, maturation, survival, fertility, dispersal) in freshwater and at sea to changing temperatures and productivity;

2) Better description (i.e. spatial and temporal resolution) of climate induced environmental change;

3) Adaptive capacity (phenotypic and genetic) of trout to climate induced change;

4) Better coordination of international index river facilities to present wider geographical coverage.

2.5 Overall conclusions on knowledge gaps about threats to sea trout

Gaps in knowledge about threats to sea trout are significant, but noticeably less than ten years ago. The progress in understanding anadromy, marine distribution, stock structuring and behaviour have given an improving scientific base to sea trout threat management, although there is still much to do (Section 1). Knowledge about threats in the sea was regarded as the top priority. The traditional environmental threats in freshwater have been mainly identified as being: obstructions to passage, poor water quality, altered flow regimes and habitat destruction. Resolutions of these are mostly matters of general aquatic environmental management and (sea) trout are simply part of that biota benefitting from the wider activity. The importance of small coastal streams should be noted because it is believed that these might be sources of recruitment and genetic diversity for trout, yet they are usually low priorities for environmental protection. The knowledge gap therefore lies in establishing exactly how important they are in regional scale population dynamics and biodiversity. The base activity to resolve this is the mapping of sea trout distribution and their habitats. Such a GIS based inventory of resources is a critical step that links with much other freshwater stream management.

Barriers remain a special issue for sea trout (and other diadromous species) and the knowledge gaps include understanding the extent of partial obstructions and the benefits that might arise from their removal. These topics involve understanding population structuring, spatial distribution and capacity to recolonize. Environmental threats in the sea have been less obvious historically, but over-fishing has been and continues to be a major issue in some locations. The principal knowledge gaps here lie in quantifying the movements (timing and distribution), the extent of population mixing of sea trout in the sea, the true extent of exploitation from good quality assessment data and the significance of that against biological reference points (See S.3.7).

Concern over climate change is now all pervading with potentially serious consequences for sea trout through shifts in their ecosystems and life history responses in freshwater and at sea, the effects of which at population level cannot yet be predicted because of weak assessment and limited progress on life history modelling. The top present day threats specific to sea trout (hence excludes the universally important topic of freshwater habitat change and destruction) are listed below (Table 2.5.1) with their priority research questions.

Table 2.5.1. Summary of principal threats and research needs for sea trout.

HABITAT	THREAT	PRIORITY RESEARCH NEEDS
Marine / estuarine	Climate change	Feeding, growth and maturation responses to marine ecosystem change (temperature, prey and predators). Changes in growth and smoltification age and resulting effect on different trout life stages.
	Coastal renewable energy development	Migration routes, speed and behavioural response to construction and operational phases.
	Overfishing	Incidence of mixed stocks. Evaluation of fishing mortality. Stock BRP development.
	Predation	Size selective effects on natural mortality.
Freshwater	Coastal streams (and all small vulnerable habitat)	Spatial GIS-based inventory of potential sea trout habitats and fish distribution.
	Barriers	Responses of (1) smolts and (2) adults to physical and hydraulic factors at individual and multiple barriers. Predation risks and changes in mortality rates.
	Flow regime	Migration behaviour and speed in relation to natural and altered flow regimes in contrasting river types. Effect of delayed passage eon adult maturation and reproductive fitness.
Overall	Climate change	Metabolic, growth and smolting responses to climate and biological productivity. Genetic basis to phenotypic responses.

	Any impact on survival, fertility or dispersal patterns	Population models that incorporate partial migration responses and other life history traits, in order to predict population size and composition change. Demo-genetic models to describe the interaction between genes and environment in response to environmental change. Appropriate monitoring and assessment.

3 Alternative assessment methods

3.1 Introduction

In all countries represented sea trout have historically taken second place to salmon in national fishery assessment programmes. In most countries freshwater juvenile electrofishing surveys have been focused on salmon and, while there is considerable overlap, the two species can have very different distributions at the extremities of habitat types (for example sea trout use of very small tributaries or coastal streams). The particular assessment problems of partial migration (see sections 1.1 and 1.2) are acute in trout. In the adult phase the species have very different river entry patterns and repeat spawning schedules, making age structure an especially important feature for sea trout. Therefore it is appropriate to set out the specific assessment needs for sea trout, and to explore the use of emerging technologies or adaptation of existing methods to improve assessment. To set the context the section starts with an outline of current methods in hand in the participating countries and an overview of current stock status.

3.2 Current assessment practice overview and summary of stocks status

3.2.1 Overview of assessment current methods

The status of trout populations is to some degree assessed or monitored in all the European countries included in this survey, however with highly variable intensity.

A description of the information provided from each country (region) is collected in Annex 2.

An assessment model covering a larger region has been implemented in the Baltic area, being the only larger area with general assessment (ICES 2011). This model is based on available data of trout densities at sites relative to habitat quality, derived from a combination of habitat score values for each of the variables stream width, slope, depth, substrate, shade and velocity. Recruitment status for trout populations in different areas also considers geographical variation such as differences in temperature.

An overview of monitoring methods and the extent to which these are exercised is found in Table 3.2.1. Information provided in the table only indicates that some activity occurs or has taken place providing at least some relevant information. The fact that information is or has been collected does not imply that data-sets are coherent.

Table 3.2.1. Overview of sea trout monitoring methods in European countries participating in the WKTRUTTA workshop and in 6 additional countries.

Abbreviations:

Parr density - Data collected: D: Density, H: Habitat variables, I Index, W: Water quality observation

Adult immigration – Methods: A: Automatic counter, T: Trap, RC: Rod Catch, V: Video, SP: Count of spawning pits, VC: Visual count, CC: Commercial catch, MR: Mark-recapture, BS: Brood-stock fisheries.

Smolt emigration: P: Project based – time limited.

COUNTRY	0+ / PARR DENSITY	DATA COLLECTED	NO. RIVERS MONITORED	NO. SITES	FREQUENCY Ann: Ann, ROL: Rol	ADULT IMMIGRATION ASSESED	METHOD	NO. RIVERS	SEA CATCH INFO. COLLECT-ED	SMOLT EMIGRATION	NO. RIVERS	NO. INDEX RIVERS
England & Wales	YES	D H	ca 70	3400	Ann, Rol 6 yr	YES	A, T	6	x	x	2	4
Scotland	YES	D (H)	ca. 300	ca 9200	Ann , Rol	YES	RC	> 400	x	x		
Ireland	YES	D	125		Ann	YES	A, T, CC, RC	ca 23	x	x	2	1
N Ireland	YES	D (I)	6		Ann	YES	A, RC	5	x			
Spain	YES	D	11	182	Ann	YES	T, MR	4		x	2	2
France	YES	D	?	?	Ann	YES	V T MR	17	x	x	2	1
Netherlands	NO					YES	T	1		P	1	
Germany	YES	D H	46	> 118	Project, Ann	YES	V, SP	ca 23	x			
Denmark	YES	D H	ca 400	ca 5800	Ann, Rol 5-9 yr	YES	SP, RC	ca 10	x	P	1	0

Norway	YES	D H	> 100	> 400	Ann, Project	YES	T, V, A, VC, RC, SP, VC, MR	> 140	x	x	> 10	3
Sweden	YES	D H	> 50	> 150	Ann	YES	A, T, RC, V, CC, MR, BS	> 15	x	x	7	4
Finland	YES	D H	13	> 200	Ann, Rol 3-5 yr	YES	A, RC	1	x	x	1	
Russia	YES	D H	31	48	Ann, Rol 3 yr	NO				x	1	
Estonia	YES	D H	73	39	Ann	YES	SP	1	x	x	1	
Latvia	YES	D	3	35	Ann	NO			x	x	1	
Lithuania	YES	D H W	10	94-102	Ann, Rol 3 yr	YES	SP, RC, CC	8	x	x	3	1
Poland	YES	D H	8	17-23	Ann	YES	A, SP, RC	9	x			
Iceland	YES	D (H)	32	150	Ann, Rol 3 - 5 yr	YES	A, RC, CC	2		P		
Belgium	YES	D	1	20	Rol 3 yr	YES	T	5	x			

The most widespread monitoring method in the countries participating and 5 additional countries where information has been gathered is determination of young fish densities by electrofishing.

In a majority of countries habitat information is also collected on the sampling sites . Regular monitoring of densities of parr (0+ and older) by electric fishing selected sites occurs in all countries except one where naturally occurring trout has become extinct. Monitoring is in most cases annual, but in some countries over 2–7 year continuous cycle.

The intensity of monitoring parr densities varies between countries and the duration of routine collections of densities also varies. The number of rivers monitored varies from covering all rivers, almost all rivers, principal rivers, rivers with salmon to just a sample of rivers, and this is reflected in the number of sites. There are several different purposes of monitoring juveniles: to monitor the ecological status of rivers; to merely follow trout populations or to maximize production; or, combinations of these. In general habitat data are collected from the sites of electric fishing or in a few cases from the entire river system.

The run of adult spawners into rivers is surveyed in fewer countries in fewer rivers than juveniles, varying much between countries. Surveillance is in many cases continuous, using variously permanent traps, automatic fish counters or video installations. In time limited projects antennae registering entry or (PIT) tagged fish. In one country the spawning population is estimated in several rivers by visual count from the river bank or from drifting divers. In other cases an estimate of the spawning run is obtained indirectly by count of spawning redds in selected rivers, or spawning population may be estimated as an index from catch reports.

The magnitude of the smolt emigration is determined in selected rivers where traps are operated routinely in a few rivers in most of the countries, and time limited in projects in others. The number of rivers included varies between 1 and 10 per country and the duration of trap operation also varies considerably, some having very long time series (50 years in one country and 45 in another).

Index rivers (where the smolt emigration is monitored concomitantly with enumeration of spawners) are found in at least six countries (from 2014) in a varying number of rivers.

Catches offer information on (a) stock status (if the relationship between catch and stock is sufficiently robust) and (b) fishery performance *per se*. Catch of sea trout in recreational fisheries in rivers is monitored in the majority of the countries and in four countries together with fishing effort. The extent of monitoring varies from a few rivers to complete catch reporting by log-book. Commercial catch of sea trout in rivers occurs only in few rivers in Iceland and catch data are collected.

Data on the magnitude of the recreational catch of sea trout (both rod and line and with fixed gear) in the sea is collected in just a few countries.

Trout is deliberately targeted only in a few countries in the commercial fishery, and caught as by-catch widely. As part of the commercial harvest they are usually entered in official landing statistics.

3.2.2 Summary of sea trout stocks status

Detailed descriptions of the status together with supplementary information on a country basis is found in Annex 3.

In the **Baltic Sea area** trout populations are either poor or very poor in the North and East (in the far north even threatened from extinction), however with an indication of a positive trend in Sweden and Estonia. In the North the poor status is caused by over exploitation due to fisheries directed at other species, while it in the Eastern area it is believed to be due to poaching in rivers.

In **England and Wales** there are 60+ principal rivers with sea trout (and salmon), and many more (100's) of smaller coastal streams, most of which produce sea trout. Trout populations are monitored as part of general fish stream surveys by electric fishing annually, although the return frequency to individual sites may be several years in most cases, driven by WFD *de minimus* requirements. The main aim is to follow the spatial and temporal stability of juvenile populations. Habitat (HABSCORE) surveys are also conducted (but less frequently than fish surveys) to account for between-site variation in abundances attributable to habitat features, and to provide measures of life-stage abundances relative to expected levels under pristine conditions. Numbers of returning spawners are monitored by resistivity counters / traps on six rivers with associated biological sampling (e.g. to collect data on age and size composition, etc.) on four of these rivers (the latter are termed 'Index rivers'). Rod and net catch statistics are collected on all rivers where these fisheries exist; the former in particular serve as the main indicators of the abundance and composition of returning adult fish in the absence of run enumeration by counters or traps..

Stock trends, mostly indexed by rod catches, are variable around the country in part reflecting local circumstances such as long term recovery from historic pollution. However, it is evident that catch patterns between rivers show a good degree of synchrony - indicating that common external factors are also influencing abundance to a significant degree (see Annex 3; Section 2). In most cases stocks are lower than before 1989/1990 when a widespread reduction occurred. A wide range of limiting factors is reported, but particularly common are the effects of barriers to migration, low flows, habitat loss and siltation. These and related issues are being identified and addressed through the WFD assessments and associated River Basin Management Plans.

Most river systems in **Scotland** contain at least some sea trout, but they vary from ones with only a few sea trout to ones with many. The main data which has been used in Scotland for the assessment of sea trout populations is the comprehensive set of catch data which has been collected from salmon and sea trout fishing owners and tenants since 1952 (see the assessment and monitoring table). The latest information available is the 2012 information. A large decline in net effort has resulted in net catches now being of limited use for stock assessment, and the rod catches now form the main general basis of stock assessment. The decline in net fishing has been largely driven by changes in the salmon netting industry, as in the vast majority of cases salmon is the primary target species for these fisheries. Total rod catches of sea trout for Scotland as a whole have declined over much of the period since 1952. This may indicate low numbers of fish both entering fresh water and spawning. Although catches have shown a slight increase since 2008, total reported rod catch in 2012 was the fifth lowest in the 61-year time series. However, the overall rod catch pattern masks considerable local variability illustrated by the relative strength of the 2012 rod catch. All mainland regions in the west of Scotland reported rod catches which were within the lowest eleven recorded for their region over the period 1952 to 2012. The reported catch in the Moray Firth and North East regions were, similarly, the lowest and fifth lowest respectively over the same period. Catches in the East and North regions in 2012 were, on the other hand, both among the top ten catches recorded within their respective regions, while the catch recorded in the Outer Hebrides was close to the mid-point in the time series.

Sea trout stock size at any time will reflect spawning numbers in the previous generation, the survival of juveniles in fresh water and the marine survival. There are likely to be a number of factors driving the trends in sea trout catches seen around Scotland, and these factors are likely to vary between areas. One of the most controversial factors is the impact of fish farms, and in particular any link with sea lice, on sea trout on the west coast. While there is increasing scientific evidence for a detrimental effect of sea lice connected with fish farms on sea trout populations, the magnitude of any such impact in relation to overall mortality levels is not known. It is also clear that areas without salmon farms, such as the Moray Firth, have also had poor recent catches.

In **Ireland** sea trout occur in the majority of coastal rivers/streams and sea trout rod catch is reported by fisheries inspectors, fisheries owners and managers from 60+ of the larger systems. Nationally, a notable decline occurred in rod catch over the period 2002–2007, after which catches increased in the majority of fishery districts. Numbers of returning spawners have been monitored on over 20 rivers since 2005 by resistivity counters. Stock trends are variable. Two index rivers on the west coast use traps to monitor smolts /returning adults (Burrishoole River) and smolts/surviving kelts (Erriff system). Land use practices such as drainage, damage to small tributaries, afforestation, barriers to migration, inadequate water quality have all contributed to recent declines in many fisheries, but declines in populations cannot be explained in all rivers. In the Connemara district in Western Ireland, highly regarded for its sea trout fisheries, rod catches were stable during the 1970s and 1980s but collapsed in 1988/1989. Since 1990 there has been a progressive limited improvement in rod catch in this specific area, but catches declined again in 2002 to 2004 period and have not recovered to the levels prior to the 1988/1989 period. The collapse in western fisheries over the 1989/1990 period was linked to sea lice (*Lepeophtheirus salmonis* Krøyer) infestation from marine salmon farms.

Trout parr population densities are monitored by electric fishing as part of general annual monitoring but, because a large proportion of these populations remain in freshwater as resident trout, these density statistics are not used to monitor sea trout populations.

In **Northern Ireland** the abundance of juvenile 0+ trout in coastal sea trout producing streams varies across the region and the most recent survey in 12 coastal rivers indicated an average density for 0+ age class fish of 31 trout/100 m^2 in 2011. In general juvenile densities were higher in the rivers located in the south east portion of N.Ireland (36 trout/100 m^2). Two rivers in Northern Ireland. The Glendun (north east) river showed a negative trend between 2002-11 across the time series whilst one in south west indicated a more cyclical pattern of abundance. In one in this area catches indicate an increased spawning run.

In **Spain** sea trout are found only in the north and North-West, in streams with outlet into the Cantabrian Sea (Bay of Biscay) or the Atlantic Ocean. Sea trout are found in at least 48 larger or medium sized, and in a number of smaller streams. Densities of juveniles in three streams is fluctuating, but without indication of change over time during the period 1995–2011, with average values between 3.4 and 10.9 parr $100m^{-2}$. Adult run shows a decreasing trend in three traps and increasing in one trap. Monitoring adult run is also partly possible by reported catches, however this is influenced by changes in minimum legal sizes. During the period 1996–2010, having comparable data, population lows were apparent in 1998 and 2007 and maximum in 2001/2002 (min approx. 1000, max. approx. 3000). Items constraining populations include water and habitat quality, including erosion of sand from river banks, exploitation at sea, migration barriers.

In **France** the largest number of sea trout rivers are found in the north along the English Channel and around Brittany, but trout are found all along the Atlantic coast to the very south of France. Densities of parr are in general not available (observations have started recently in Brittany). The best data available comes from an index river in North-West France providing both smolt estimates and adult abundance. Adult returns were stable until 1996/1997. At this time the adult run increased with more than 30% on average. Concomitant with this change the average size of spawners decreased. The increase in spawners was followed by a 25% increase in production of smolts.

In the **Netherlands** sea trout are not able to complete their life cycle; however some natural spawning by resident trout has been observed in a couple of rivers. Otherwise trout populations are the result of release of fish. Obstruction of migration routes has been specifically damaging to the survival of migratory fish species. In order to facilitate drainage, security against flooding, land reclamation, navigation and impounding, lateral barriers in river systems are found in tens of thousands in the Netherlands

In **Germany** in the federal state Mecklenburg-Vorpommern at least nine rivers contain a self-recruiting wild sea trout population, while it is still uncertain to which extent wild populations are found in Schleswig – Holstein. However, some rivers have been found to produce 0+ trout. The extent is currently being investigated. Clogging of spawning nests by sand and clay is suggested (and being investigated) as one reason for the possible absence of wild trout populations.

In **Denmark** the number of sea trout streams was 406 in 2012 having increased from 176 in 1960, and the densities of 0+ trout has increased significantly from the 1980s to 2010's. The overall average densities of 0+ trout during recent years was 53 $100m^{-2}$, with large regional differences mainly due to habitat and water quality. Currently it is estimated that the natural smolt production is about 600 000, having increased from some 200 000 in the 1980's. The reason for this progress was initially improvement in water quality, followed by improved accessibility and restoration of spawning possibilities (addition of gravel). Also fishing restrictions being implemented during the time period have improved the situation for sea trout, particularly in the sea. Recently the increase in production (at least in the Baltic area) has slowed down, possibly because most of the easier (smaller scale) mitigating actions have been implemented. The current production is still much below the potential, populations being limited by heavy sediment erosion and transport, existing barriers, areas with slow flowing water upstream barriers that have actually being opened, but where water is still stemmed. Also artificial lakes, constructed in the lower part of streams in order to remove nitrogen results in severe losses of smolt, as does avian (Cormarant - *Phalacrocorax carbo sinensis*) predation.

In **Norway** trout populations are doing better in the north and south, compared to the western and central part. 1168 streams have wild populations and from these about 100 are threatened or vulnerable. 28 stocks have been lost. During the last two decades, the catches in Norwegian rivers have, except for the northernmost areas, declined by 23–66 %. Also sea catches have been reduced (possibly due to changes in legislation). Reasons for the decrease are not clear, but infection with sea lice (*Lepeophtheirus salmonis*) are likely to influence populations negatively locally.

In **Sweden** many populations in the North have been lost and/or declined due to hydro power development, historical log floating and fishing. Recently, Northern populations are increasing while a negative trend is observed in the middle and in the south. The reason for the decline in the South is probably complex involving factors like climate, artificial structures like barriers and man-made lakes, canalization and acid deposits. A huge number of barriers remains to be improved, both for trout and fauna passage in general.

In **Finland** there are only 14 rivers with original populations (25 % of the number 100 years ago). The decline has been caused mainly by construction of hydro power installations and dredging for log driving and prevention of flooding. In addition acidic conditions and sedimentation as affected populations. Fishing has had (and still has) a huge and regionally devastating effect on populations in a (mostly recreational fishery) targeting other species, catching the sea trout at a young stage.

The remaining original sea trout populations are in Finland since 2010 considered critically endangered on the Red List of Finnish Species.

In **Russia** (Sct. Petersburg area) more than 40 rivers have wild populations of sea trout. Most of these have very low densities of sea trout 0+ and parr, mainly due to poaching in the rivers. In Russia catching sea trout is illegal. In the Kaliningrad area nine rivers have sea trout populations. Populations in this area are below populations in the Sct. Petersburg area, but information is scarce. Major causes for this are nutrient and sediment load, low flow during summer and poor water quality.

In **Estonia** wild trout populations are found in 60 rivers and in additionally 40 rivers occasional reproduction may take place. In rivers with outlet into the Baltic sea populations have increased during the last decade (probably due to reduced fishery in the sea, in the estuary and reduced poaching in rivers). In rivers with outlet into the Gulf of Finland populations are more stable, but still much below carrying capacity. In general populations are affected by occasional low water conditions during summer and artificial barriers and to some extent also by beaver dams.

In **Latvia** sea trout are found in 15 larger rivers and potentially all small streams hold trout populations. Fifty to 100 streams could potentially hold trout populations. A major problem is man-made barriers making accessibility impossible to approx. 60 % of the area potentially useable to sea trout. Overall populations seem to be stable, but information is scarce and the situation is uncertain.

In **Lithuania** wild and mixed stocks of sea trout are found in many of the tributaries of the larger rivers. Wild sea-trout populations are known in 10 rivers basins The stocks are original and self-sustaining wild populations. In surveys conducted at 104 sites, the average in 2012 was approx. 13 0+ and older parr 100 m-2. Smolt production was estimated to be 44 900 in 2012. Sea-trout population is stronger in Western Lithuania – the Minija River catchment. In recent years smolt production increased in Eastern part of Lithuania river catchments. In general trout populations are limited by some pollution, sedimentation and in some places accessibility due to man-made barriers

In **Poland** only one original wild stock of sea trout is left, all other rivers hold either mixed wild and reared or reared trout populations. In six rivers (18 sites) average densities of naturally spawned 0+ trout was in recent years around 50 $100m^{-2}$.

Spawning run is monitored in one sea trout river with runs between approximately 3500 and 7000 sea trout.

One major problem to the wild sea trout populations in Poland is the presence of dams built for hydro power production en the early 20th century. In the large Vistula river a dam blocking the upper part of the river was erected in the 1960s.

In **Iceland** the densities of trout juveniles varies considerably between years and in recent years a reduction has been observed. The largest populations of sea trout is in the south-east. However, in this area populations have been decreasing in recent years, while they seem to increase in the north and north-west (derived from catches).

Wounds from sea lamprey (*Petromyzon marinus)* have been observed only in recent years especially in south Iceland, where up to 30% of the spawning population is found to have wounds. It is not clear whether the sea lamprey causes increased sea trout mortality. Also limiting the populations locally is manmade drought by water transfer, causing total dry weeks in one year, in one river.

3.3 Freshwater assessment

3.3.1 Overview of issues

The status of trout populations in fresh water is frequently assessed and monitored using standardized electrofishing in streams, and this type of monitoring is implemented in practically all the countries reporting here (section 3.2.1); (Bohlin *et al.* 1989). Usually, reference sections are visited in consecutive years to provide data on density which are comparable between years. To get a more accurate assessment of the population there is a need to categorize and divide the whole stream into proportions (areas) of suitable habitats for spawners and 0+ fish; and older fish. The overall density of trout within each year class can then be extrapolated using models, which incorporate habitat specific densities of trout assessed within each discrete habitat type. One of the most frequently used methods to define habitat in streams is HABSCORE, used in England and Wales, which is based on a series of empirical statistical models relating population size of five salmonid species /age combinations to observed habitat variables at site and catchment scale (e.g. Milner *et al.*, 1998). Another method, PHABSIM (The Physical HABitat SIMulation) can be used to assess and improve river habitats (Bovee, 1982; Milhous *et al.* 1989; Elliott *et al.*, 1996, Dunbar *et al.* 2002). This model quantifies the availability of different habitat types using Weighted Usable Area (WUA) at different discharges and incorporates the suitability of each habitat to species / age preferences for depth, velocity and substrate. These suitability values (HSI) are then used to create habitat utilization indices that quantify the relative suitability for all habitat variables (e.g. Bovee 1986; Moir *et al.* 2005). PHABSIM and others in the suite of IFIM (Instream Incremental Flow Methodology) (Dunbar *et al.*, 2002; Armstrong and Nislow, 2012) are primarily used for impact assessments rather than routine population assessment.

Previously, ICES (2011) have suggested that Index Rivers could be established in Baltic streams with sufficient annual monitoring of recruitment (electro-fishing surveys) and numbers of migrating smolts (trapping). Stock parameters could then be transferred to rivers without these data based on a habitat classification system (see section 3.7 below). This model has now been further developed and is being tested in Sweden. Like the model described in ICES (2011) this model classifies suitable habitats (in relation to depth, substrate, velocity and foliage cover) into four different categories of habitat. In the model, the trout densities in each of four categories have a fixed proportional relationship with each other with the best habitat category used as a reference with maximum (100 %) densities of trout. Densities in all categories of habitat can then be calculated, even if empirical data are only available from one category of habitat. This model then adds assessments of migration mortality, degree of smoltification, age structure at fishing sites and winter mortality; First, predicted winter mortality (50–70 % for 1+) and degree of smoltification (90 % for 1+) are brought in to the model which yields an estimation of produced smolts within each category of habitat. A migration mortality of 0–50 % per km depending on habitat quality and flow characteristics is then added (Nilsson *et al.* 2010, Halldén *et al.* 2005, Figure 3.3.1). A mortality of 50% is rare but has been reported as smolts migrate through wetlands with high number of avian predators and/or pike, but high mortalities are not uncommon (Aarestrup *et al.* 2014). However, good evidence on whether the relationships used are valid is rare and some conflicting results have been reported. In Sweden, there are only data available from four rivers where smolt traps have been put up in order to validate the model. In the River Ävarån which has the longest data set, smolt production has been quantified using a smolt trap in eight years. In five of these years, the average deviation from those predicted by the model was 16 % (median values) whereas the model overestimated the actual production (between 90 and 360 %). In contrast, data from River Himleån in Sweden where a similar smolt trap were used over two years resulted in an underestimation of the actual production of 18 and 19 % respectively (Aldvén *et al.*in press).

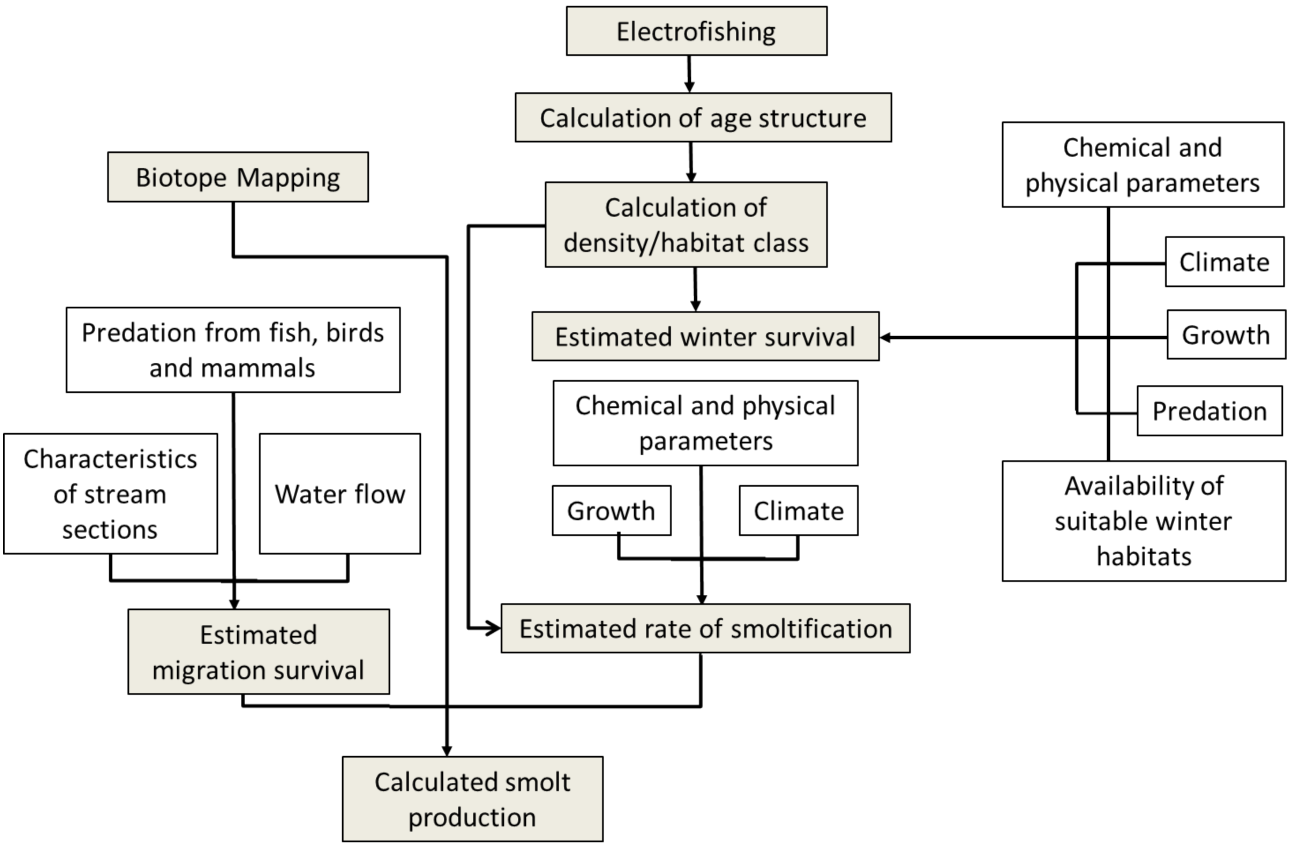


Figure 3.3.1. Schematic description of a possible model on how to calculate smolt production. Grey boxes refers to different investigations or calculations within the model whereas white boxes are factors affecting the outcome of the assessments (Modified after Nilsson *et al.* 2010).

Because the distribution of sea trout in catchments is not random, but influenced in part by distance from the sea and local productivity, freshwater assessment needs to be designed with these factors in mind. Better understanding of these relationships will be of value in assessment and methods to evaluate the incidence of anadromy. Various methods including morphometrics, the use of isotopic ratios and carotenoid pigments may offer procedures, (Kazakov & Kozlov 1985; Debowski *et al.* 1999; Bagliniere *et al.* 2001) if they can be undertaken on sufficient scale at reasonable cost.

3.3.2 Conclusions

Only in the Baltic a regular assessment programme covering a larger area has recently implemented, using a model based on juvenile densities related to habitat quality and taking into account climatic conditions. This model could potentially be used in other areas in Europe.

To test this approach on a wider scale it is important that the methods used for assessing densities (electrofishing, habitat scoring) are well defined and standardized both within and between countries in Europe, which needs to be confirmed. Depending on results of a first test other variables could be taken into consideration (Nilsson *et al.* 2010).

National monitoring is mostly by evaluation of parr densities, often collected together with information on habitat quality.in many countries data are collected by several institutions and data are not always readily available, or not publicly accessible. Information on the spawning run is (or has been) also collected to some extent as well as information on the smolt run.

Further verification of the model should be done in index streams, and maximal potential densities should be estimated from independent sites.

A comprehensive inventory of stream habitat, evaluated by appropriate measures of habitat quality for trout, appears to be lacking in most countries, but is an essential prerequisite for survey design, assessing freshwater stocks and the scale of freshwater environmental impacts.

3.3.3 Recommendations

- It is recommended that the Baltic model is tested in different parts of Europe.
- Data from freshwater monitoring programmes should be collected and stored in a uniform way in order to facilitate national and international cooperation.
- The geographical distribution of index rivers and rivers with high quality of enumeration of adult immigration and smolt emigration should be mapped including descriptions of river types and the coverage of individual rivers (if the entire river is not monitored). In areas with poor or no coverage establishing additional index rivers should be promoted.
- In all countries with existing data, information on fry densities, resulting smolt escapement and sea survival should be collected and evaluated.

3.4 Marine Phase and Adult Assessment

3.4.1 Introduction

This section deals with the assessment of adult sea trout populations during their marine phase, which comprises three broad categories:

1) The post-smolt stage – from smolting up to the time when .0+ maidens first return (approximately June – October, with regional variation). During which time it is thought that, like salmon, entry to the new marine environment presents particular survival risks for sea trout and mortality is correspondingly high.

2) Fish remaining at sea to return as maiden fish after 1, 2 or more sea winters.

3) Post spawners recovering and feeding before returning to spawn.

Each group has particular characteristics of maturation, growth and survival. The assessment is made difficult because the fish are well-dispersed, compared to freshwater, and there is no knowledge about how the different groups are differentially dispersed, if indeed they are. The two principal windows on adults are:

1) sampling in marine fisheries, which is very partial and selective and,

2) sampling fish returning to rivers by combinations of estuary nets (increasingly rare, and suffer from mixed stocks to varying degrees), in-river rod fisheries and by fixed traps or counters.

Clearly marine and freshwater methods are both biased in their sampling of the overall adult population and need to be combined in some way to provide data suitable for population dynamics and modelling, if that is the eventual aim. Moreover, the direct enumeration of catches is not sufficient because of the complex ways in which catch in both environments are related to stock. Only traps provide robust data, but only on spawners; as implied above they fail to sample the fish remaining at sea. Therefore new methods, enhancements to existing methods or additional information on fish behaviour and migrations that aids interpretation are necessary.

As noted in Sections 1.5 and 2.3 Post-smolt and adult survival and behaviour in the sea are little known for sea trout (Aarestrup *et al.* 2014, Drenner *et al.* 2012, Jonsson & Jonsson 2009b, Thorstad *et al.* 2006, Kallio-Nyberg *et al.* 2007, Kallio-Nyberg *et al.* 2006, Dieperink *et al.* 2001, Pedersen and Rasmussen 2000, Fahy 1978; Milner *et al.* 2006; Malcolm *et al.* 2012). More knowledge exists on the adult immigration into spawning rivers (Aarestrup & Jepsen 1998, Östergren *et al.* 2012, Östergren *et al.* 2011, Debowski *et al.* 2011, Svendsen *et al.* 2011, Kristensen *et al.* 2011, Moore *et al.* 2012, Davidsen *et al.* in prep.). From this, combined with information on fry density and smolt numbers sea survival can be calculated and a stock-recruit relationship be determined (Cowx and Fraser 2002).

Data on the size of the adult immigration is (or has been) to some extent determined in almost all countries (not in Russia) in at least one or a few rivers in each country. In areas sea catches may be used as an index for the development in the size of the spawning population. Irrespective of the methods used in collecting data for assessment, it is important that wild fish can be recognised from released.

3.4.2 Overview of methods

An overview of the methods used in different countries is found in Table 3.2.1. and Annex 2 with more detailed information from individual countries.

Freshwater

The highest quality of information on adult immigration is obtained from **traps** catching all adult sea trout migrating upstream (Cowx and Fraser 2002). This method enables collection of essential assessment data such as: size (length, weight) of the fish, age composition and growth (through scale sampling and age determination), sex composition, certain determination of species, possibly determination of strain (a population of sea trout belonging to a single river system) through sampling of tissues and genetic analysis. If the traps are operated continuously information on run time will also be available. A drawback in trap catch as method is handling stress and delay in migration, if not operated continuously.

Combined with determination of the smolt emigration (***index rivers***) sea survival can be determined and important information about the influence from *inter alia* environmental factors, effect from changes in the fishing pattern and gear types etc. With this information stock-recruit relationsships can be determined. Traps are operated in at least six countries and in total about 15 index rivers with sea trout are found in Europe, but the geographical coverage varies and has not been mapped.

A valuable alternative to trapping migrants is **automatic counters** (including automatic video registration and hydroacoustic devices) being operated in a varying number of rivers in 9 countries. Compared to traps, automatic counters provides precise information on numbers, no biological data (scales, tissue) and less precise information on sizes of the individual fish, and unless cameras are installed uncertain determination of species.

Direct enumeration of immigrants in the lower part of a larger river system does not provide information on (possible) subpopulations within individual rivers.

Visual counts may provide good estimates on numbers and approximate sizes of the adult sea trout, provided the conditions are adequate – such as clear water.

The methods mentioned so far all have the advantage of being operated by trained personnel providing complete data for assessment.

Less certain estimates on adult population are collected in the majority of countries from **river catches** (mostly recreational rod and line catch). The catch may, if the fishing effort is also known, or at least stable between years, provide an index on the spawning population. Combined with a mark-recapture program an estimate of the actual number of spawners can be obtained (used in one river in Spain). The method depends on sufficient and accurate reporting, which is customary in some places and doubtful or uncertain in others. In most cases catch in the recreational fishery is believed to be underestimated. If properly organized biological samples may be obtained this way, but drawbacks are *inter alia* selective sampling (if the catch does not represent the actual population), varying sampling from different parts of a river system and no information from rivers without fishing, and variation in the fraction of the population being caught at different fish densities (Milner *et al.*, 2002, Peterman and Steer 1981).

Also **count of spawning pits (redds)** provides an index of the spawning run when done under suitable conditions. It is often imprecise due to practicalities of observation, sampling stratification problems, confusion with salmon redds, and uncertainty over the number of redds and eggs per redd. (see Walker and Bayliss, 2006, and references therein).

Integrated in-river assessment, combing data from traps, counters, rod fisheries and redd counting as available, should in theory offer more robust assessment of the spawning stocks and might be used to calibrate catch-based methods in rivers where that is the only available data. Early attempts found substantial variation between rivers (Shields *et al.* 2006), making transfer of relationships impracticable, but it has yet to be fully tested for sea trout.

Marine catches

Sea trout catches in coastal or offshore fisheries are sometimes available (see section3.2 and Appendices) and might be suitable as population indices, but require far more detailed information on the stratification, type and level of effort in the fisheries than is normally available. The issue of mixed stocks is acute, but data from physical tagging or increasingly from genetics are starting to provide insights into populations mixing to support assessment.

In general there has been a decline in commercial sea catch due to reduced coastal fisheries, limiting the availability and possibility of obtaining information of sea trout at sea. At the same time it is known that in some areas by far the larger part of sea catches are taken in the recreational fishery, where detailed information is scarce and uncertain.

In the south east Baltic a larger scale commercial fishery targeting sea trout takes place, and accurate information on both effort and catch is available, theoretically providing the basis for using sea catch in assessment. Unfortunately this is not possible at the moment because catch statistics has for a number of years have been unreliable because part of the salmon catch has been reported as sea trout due to quota restrictions. Potentially the catch and effort data could in future provide good information population strength in the area.

Overall estimates of present day population strength, compared to historic levels could potentially be obtained by comparison of present-day to historic catches. Comparison is, however, likely to be rather uncertain due to for example changes in the gear used, effort and changes in the fishery pattern.

It should be noted that in addition to their usefulness (or not!) for stock assessment, marine catches have essential value in their own right as indices of fisheries performance. Therefore shortcomings in the assessment role should not be taken as a reason to reduce catch recording. Catch data are essential and the innovations needed lie in better ways to stratify the sampling, to record fishing effort and to subsample the biological characteristics of the catch. No new approaches to these were offered at the workshop.

Scale sampling and reading (for determining age, growth and reproductive schedules) was discussed only briefly, but it was agreed that this is a major issue for sea trout assessment. Scale reading has been the foundation of data on stock age composition, maturation and spawning schedules and growth, information vital for stock assessment and population dynamics. The issue is that scale reading is a subjective activity for sea trout especially (due to their complex life cycles and varying behaviours) and that inaccuracies or biases can arise between workers or shift over time, even with skilled practitioners. This is a sensitive subject, some people felt their reading and procedures were quite adequate, other were less confident; but in a recent UK context when fish from many different rivers were studied (CSTP), it was apparent from testing that inconsistences were common even amongst experts. If scale sampling is in fact inherently unreliable or unacceptably so, then the extent and implications of this need to be described and understood. If it is simply a matter of better training and application of protocols, including new computer image analytical methods then that needs to be recognised and initiated. If however the problems are not resolvable then question need to be asked about its role in routine assessment and alternative options explored (e.g. size- structure analysis, see section 1.2). Further work on this topic is recommended.

Conclusions

- Because the adult sea trout are exploited in fisheries, catches are the most universally available form of stock index in the sea and in rivers.
- Because adult sea trout are partitioned between the sea and freshwater, with the former comprising maturing fish and the later comprising spawners, sampling in both environments is biased; therefore some means of combining them is necessary if the aim is to obtain full age-specific population data.
- Catch data in both environments (but in the sea far more so) have several limitations for stock assessment, related to fish distribution, sampling stratification, lack of detail on fisheries, methods, effort and distribution. However, catch data are universally available and therefore still offer considerable potential, if the complementary information could be made available. Moreover catches have value in their own right as indices if fishery performance.
- Therefore a focus on and enhancement, where necessary, of catch data is strongly recommended The enhancements refer to the quality of data and the type which should include biological data appropriate to stock assessment and fishing effort and environmental data that contributes to explanation of catch variance.
- Marine fisheries are mainly commercial nets although recreational net fisheries and rod catch are extensive in the Baltic and Kattegat area, but no new approaches to their use were presented at the workshop. However important new understanding is emerging form genetics research that should complement catch assessments, but this has yet to be fully achieved.
- The number of marine sea trout fisheries is declining so these options are reducing.
- In freshwater, extra sampling is available through traps, counters (although these are only on comparatively few rivers) and red counting (which is even less common). The advance that might be made here is to combine these multiple methods through robust statistical modelling to develop integrated assessments that might be transferable to rivers where only catches are available.
- It was noted that catch data and recording give opportunities for stronger engagement and collaboration with stakeholders in the fisheries.

- Scale reading, a foundation of much sea trout life history knowledge and assessment, may be less informative than sometimes believed and requires a structured appraisal and evaluation in order to propose ways forward.
- In some areas it is not possible to distinguish between wild and released trout, because released fish are not fin clipped or otherwise marked. This is due to either legal prohibition of fin clipping, for economic reasons or because the information is not used in assessment.

Recommendations

- Mapping of sea trout exploitation, or at least fishing activity, in principal sea areas would help to stratify that sampling and to inform Marine Spatial Planning (section 4).
- Information on migration and behaviour at sea should be increased to improve interpretation of marine catch data. Collection of quantitative information in both commercial and recreational catches in both sea and freshwater, with as much detail on position (in freshwater river, area), gear, effort, size of fish and collection of scales should be established where not existing and increased where appropriate.
- The combination of information from sea catches and on migratory patterns should be investigated, using information already available.
- It is recommended that development of integrated modelling for assessment of multiple freshwater sampling methods (rods, traps, counters, red counting) is commissioned on contrasting (in stock and environmental features) test rivers to establish protocols and applications for use elsewhere.
- An overview of behavioural and migration studies from tagging and genetics and microchemistry should be produced, in order to reveal areas with insufficient coverage and the amount of information already available. In areas (sea types) with insufficient coverage examinations should be promoted.
- It is recommended that scale sampling and reading are subject to review and critical evaluation in order to test its strengths, expose shortcoming and to propose improvements or alternative approaches. A working group is proposed as a constructive way to progress this.
- It is recommended that fin-clipping of artificially released fish, should be carried out or reviewed in all relevant areas to test and assess its usefulness. The aim is to distinguish between wild and hatchery stock for wild stock assessment.

3.5 Genetics

3.5.1 Introduction to topic

Information on genetic population structure of trout was presented for populations in rivers entering the Irish Sea, Celtic Sea, English Channel, North Sea, Baltic Sea and the Skagerrak (southern Norway). This information has come primarily from the findings generated by three European Union funded projects: the Celtic Sea trout Project (CSTP), the Atlantic Aquatic Resources Conservation project (AARC) and the Living North Sea project (LNS).

New knowledge was highlighted on the genetic structure of trout populations in rivers of this area of northern Europe and, by inference, the evolutionary significant diversity of these genetic resources as a potential surrogate for the sustainability and resilience of the species, especially within the context of anthropogenically-mediated stressors. Substantial progress was also reported in deploying genetic methods in elucidating the distribution and extent of migrations of trout in open and estuarine European waters. These data were considered to be of critical management importance, both from the perspective of conserving and protecting threatened elements of biodiversity, and in managing fisheries, particularly where mixed stocks are known/anticipated. Potential for international (interceptory) fisheries was recognised and, consequently, a requirement for management on a trans-European basis was emphasised. Genetic methods offer excellent potential to elucidate coarse level behaviours in the marine environment (the marine biology of the sea trout is recognised as an important knowledge gap), which allows for the recovery of population specific information from all fish sampled in the sea, in contrast to physical tagging genetic methods which are confined to only those samples that can be recovered with a readable tag. There is considerable complementarity between modern physical tagging techniques and genetic techniques; the former has advantages in revealing fine-level behaviours, such as direction and extent of migration routes, swimming depths, feeding behaviours etc. However, discussions at the meeting revealed a number of vital areas, which require investment and further investigation. Principal among these was the necessity to understand how the stocking of cultured fish affects stock dynamics (demography) and the genetic structure and integrity of components of the species' biodiversity.

3.5.2 Recommendations

- Recent investigations suggest long distance migration and dispersal of many sea trout in European waters. The preparation of an international baseline for the genetic assignment to river and region of origin of sea trout caught at sea would allow further resolution of sea trout distributions and movements in the seas around Europe;
- Efforts should be made to extend and standardise the existing genetic baselines (currently principally microsatellite-based); standardisation of the genetic markers (loci) used (microsatellite, SNPs) is essential to facilitate future Europe-wide research on fish movements and migrations, and fisheries management. We anticipate this may require a pan-European, inter-laboratory calibration project;
- Methodologies to improve assignment stringency, including feasibility and implementation of the new (universal) marker systems, e.g. SNPs (addressing cost considerations), should be undertaken;
- The sequencing of entire sea trout and brown trout genomes to facilitate genomic studies targeted at determining the genetic basis of anadromy should be supported; such genomes will allow direct assessment of the genetic basis of anadromy and related life-history traits (by genomic comparisons), whilst also providing a solid framework for a broad range of future genetic-based studies on different aspects of trout biology and ecology;
- Assessment of the impact of sea trout stocking, and the contribution of cultured fish to fisheries and their potential impacts on the genetic integrity of wild sea trout populations, particularly with respect to the long-term resilience and natural productivity, is required;

- Assessment of mixed stock fisheries at the European level. This encompasses both a need to assess European mixed stock fisheries using genetic methods and to assess the utility and robustness of genetic methods for analysis of European mixed stock fisheries;
- Assessing the extent of anthropogenic influences (fisheries, climate, disease - pathogens/parasites, introgression with cultured fish) on the evolutionary trajectories of natural trout populations will be an essential component of future research efforts;
- Investigate the utility of genetic methods in providing estimates of effective population size (N_e), number of breeders (N_b) etc., which are relevant to assessing achievement of biological reference points, such as conservation limits, and in a possible complementary role to long-term census techniques;
- Integration of brown trout and sea trout genetic data, including inclusion of hatchery stocks into genetic baselines to facilitate identification of escapees and assessment of genetic introgression from farmed trout into natural populations;
- Distinguishing between genetic information required for addressing conservation questions and fisheries management questions;
- Identifying how geneticists can improve communication of the statistical framework associated with assignments based on genetic information.

3.6 The Ecosystem Approach: linking sea trout with Ecosystem Assessments

3.6.1 The Ecosystem Approach to Fisheries and Ecosystem Assessment

This section considered the following questions in the sea trout context: what is the ecosystem approach, what is its relevance; what types of data might be appropriate for ecosystem assessment and what advice can the Group offer for its further development? The Group was aware of the deliberations of other ICES groups acting in this topic area, e.g. ICES 2012 and sought to make its discussion relevant to those. The focus was on marine ecosystems, but the crucial additional importance of the freshwater dimension for sea trout was emphasised.

The Ecosystem Approach to Fisheries (EAF, *sensu* FAO, 2003) has numerous definitions but its essential elements comprise:

- a holistic view and understanding of ecosystem function and emergent properties;
- seeks the maintenance and protection of ecosystem health and the sustainable use of resources;
- includes the human dimension, e.g. participation, rights, ownership, development, shared decisions;
- incorporates risk assessment into target setting and decision-making and
- applies adaptive management in its implementation.

Ecosystem Assessment (EA), also known as integrated Ecosystem Assessment (IEA) is an essential step in delivering the EAF, but has data requirements that extend and complement those of conventional single or multiple species fisheries assessment.

Relevance to sea trout. In freshwater, as juveniles and adult trout, brown trout display territorial behaviours and occupy lotic and lentic ecosystems. After migration through estuaries to sea post-smolt and adult sea trout become part of the marine pelagic and benthic ecosystems. Therefore to maintain sea trout life cycle and population fitness, the freshwater and marine ecosystems are contiguous and integral. The migratory habits of sea trout expose them to multiple ecosystems and contrasting environmental conditions as they move between freshwater, estuarine and marine habitats. Thus there are potentially many ecosystem assessments relevant to sea trout conservation and fisheries management. The EAF can involve the impacts of fishing on ecosystems and/ or the impacts of ecosystems on sea trout stocks and fisheries. The former was not regarded as very significant for sea trout, compared with other marine fisheries, because the fishing methods are believed to be environmentally benign and gear is rarely lost. However, it was recognised that there might be some aspects of local importance and this cannot be ruled out of management considerations. The latter links are of more significance and are outlined below.

The lack of reference conditions and of management aims for ecosystems was noted. In the absence of these it is not yet clear how the EAF would actually be applied. One scientific application lies in identifying food web sensitivities, based on the importance and resilience of trophic links (see for example the Ecopath with Ecosim models (Lees and Mackinson 2007) sea trout were thought likely to exert relatively minor impacts on other components of marine ecosystems, by virtue of their modest total biomass; but because of their dependency on high lipid diets to realise the benefits of marine life, they could be influenced by other trophic levels.

3.6.2 Ecosystem data and indicators for sea trout

In their marine phase sea trout have similar ecosystem linkages and dependencies as other pelagic organisms in coastal and offshore waters. The benefits of anadromy involve the rapid growth potential offered by large habitats and abundant high protein lipid piscivorous food sources (e.g. sandeel and sprat), offset by risks of migration costs and new environmental, pathogens and predation risks. Therefore processes governing habitat connectivity, biological productivity and community structures are of particular importance for sea trout. It was reported in discussion that in the still comparatively few studies on sea trout in the sea there was a distinct lack of data on the abundance and population dynamics of sea trout, prey and predators. In a rare example, Lees and Mackinson (2007) included sea trout in an Ecopath ecosystem assessment of the Irish Sea. Necessarily they had to use provisional estimates of sea trout abundance. More recent abundance data have suggested that sea trout biomass may have been underestimated by 50% (CSTP in prep.).

Limited data suggest an association between lower trophic levels and sea trout. In a study in the southern part of the North Sea a relation between sea trout year class strength and the level of primary production as indicated by plankton levels has been observed. If this relation is valid it might contribute to the understanding of sea trout population dynamics in general

(http://www.northsearegion.eu/files/repository/20131129170058_LNSSeaTroutPlan.pdf).

Briefly, the types of data (and potential indicators) needed for implementing the EAF for sea trout were listed by the workshop and included:

- sea trout spatial distribution: biotope preferences and availability;

- sea trout populations size, structure and biomass productivity;
- prey and predator abundance, population dynamics and distribution;
- key competitors;
- nutrient load and runoff, zooplankton, chlorophyll;
- Temperature;
- NAO and related indicators of climate change;
- By-catch (see section 4.2);
- fishery properties (nature, participation, regulations, governance);
- marine nutrient subsidies to FW.

3.6.3 Sea trout as bioindicators

The role of sea trout as a potential bioindicators species was briefly discussed, without reaching a conclusion. Whilst the ubiquity of trout, its occupancy of multiple habitats, its phenotypic responsiveness to environmental variation and its extensive background of research appear to make it an ideal species, some people considered that its phenotypic plasticity made sea trout less suitable. These ideas need to be tested and demonstrated through case studies.

3.6.4 Conclusions

- It was agreed that the Ecosystem Approach to fisheries (EAF) is an important emerging paradigm, that Ecosystem Assessment (EA) is an essential step in applying the EAF and that EA complements but does not replace conventional single species management.
- To clarify a common misconception, Ecosystem Services analysis (UK NEA, 2011) is a different concept from the EA, but in combination offers one of the novel ecosystem related routes by which overall decisions might be made.
- In the absence of clear objectives and reference points it is not yet clear how the EAF would actually be applied to management, but this is likely to change as understanding and knowledge of this topic increases. Progress in these areas might be made by a workshop format to test scenarios through case studies where some progress has already been made (e.g. Irish Sea, Baltic) and by collaboration with other ICES EA developments.
- It was also agreed that to apply the EAF to sea trout it was essential to consider the interaction between marine and resident components in Ecosystem Assessments. Marine subsidies could be important in low nutrient status streams.
- There was disagreement on the potential of sea trout as an ecosystem bioindicator species, but the idea has potential for testing through case study.

3.7 Population modelling and Biological Reference Points (BRPs)

3.7.1 Population models

Population models provide a means to describe the relationships between the different life stages in a population and the response of the population to changing external pressures. They therefore provide the best scientific basis for making management decisions. Population specific models may be developed to describe the dynamics of a particular population based on counts or estimates of the numbers of individuals at different life stages collected over a period of years. Simulation models, on the other hand, may be used to investigate the dynamics of hypothetical populations under different scenarios; these models may be parameterised using data from several specific population studies or using hypothetical values.

Both types of model may be used to investigate the effects of changing environmental and anthropogenic factors on populations and may thereby provide a basis for forecasting population responses, prioritising conservation actions and managing exploitation. The Workshop noted the importance of modelling work but recognised the difficulty of collecting the baseline data to develop and run such models. It was also noted that genetic data on population differentiation may be an important input to such modelling work. The Workshop was aware of only four studies in which long time series of data had been collected on sea trout for whole river systems; three are in the Atlantic, the Burrishoole in western Ireland, the Bresle in northern France and the Dee in North Wales; and one is in the Baltic, the Åvaån, Sweden. Stock-Recruitment (S-R) relationships have been developed for three of these. It was also reported that population models are currently being developed for the River Minho (border river Spain - Portugal), the River Bresle (Brittany France) and a 'typical trout stream' in the Baltic. No examples were provided of development work on models to forecast sea trout population size.

3.7.2 Assessing fish stocks

The status of a fish stock is generally assessed by comparing an estimate or index of the stock numbers at any time with one or more reference levels, often referred to as Biological Reference Points (BRP). While a wide range of different BRPs has been defined for different purposes (ICES 1997), they generally fall into two broad categories, targets and limits (FAO, 1995; Garcia, 1996). A target is a point to aim at, and a target reference point therefore represents a desirable state, and may, for example, provide the basis for setting a quota. A limit, on the other hand, defines a lower threshold which, ideally, should not be crossed. Limit reference points are therefore used to demarcate undesirable stock levels or levels of fishing activity, and the ultimate objective when managing stocks and regulating fisheries is to ensure that there is a high probability that the undesirable levels are avoided. Both limit and target BRPs are ideally based upon a detailed understanding of the population dynamics of the species or stock in question.

ICES has established principles for setting BRPs for two diadromous species, Atlantic salmon (*Salmo salar*) and European eel (*Anguilla anguilla*), and these may provide a basis for setting BRPs for sea trout. In the case of Atlantic salmon, the North Atlantic Salmon Conservation Organisation (NASCO) has agreed that conservation limits and management targets should be set for each river stock and that stocks should be maintained above the conservation limits (CL) by the use of the management targets (MT) (NASCO 1998). ICES and NASCO currently define the CL for salmon as the stock size that is expected to generate maximum sustainable yield in the long term (i.e. S_{MSY}) (ICES 2013) as derived from an adult-to-adult S-R relationship (Ricker, 1975; ICES, 1993). In the Baltic ICES defines the CL for salmon is to reach a certain level of smolt production in relation to the maximum potential smolt production – the carrying capacity - on a river by river basis (ICES 2013). Management objectives may be defined in terms of the probability that the CL is being or will be exceeded. Thus annual estimates of the numbers of returning spawners or the egg deposition can be compared with the reference level to determine the stock status, and forecasts of stock numbers can be compared with the reference level to set fisheries regulations (ICES, 2013).

ICES (1998) advised that CLs should ideally be set for individual rivers based on long time-series of stock and recruitment data. The best S/R relationship would be derived from data collected over a long time period using multiple traps or counters to provide information on individual populations, but in practice data is normally collected on whole river stocks, but this is still a costly procedure and so it is only practical to collect such data for a very small proportion of rivers. It is therefore necessary to transport data from 'donor' rivers (index rivers), where BRPs have been established, to rivers without these data. The approaches used rely on estimating suitable habitat types by various methods and applying target egg deposition rates derived from known S-R relationships.

An alternative procedure has been adopted for eel. The European eel is a single panmictic stock for which there is no good S-R relationship. The BRP for eel has therefore been based upon a predetermined percentage of the pristine spawning stock biomass (B_0). The pristine spawning stock biomass is the stable population size that would be expected to arise if all fishing pressures and other anthropogenic impacts were removed. This has now been enshrined in EU legislation such that member states are required to ensure that silver eel escapement exceeds 40% of B_0 for each Eel Management Unit. The approach therefore depends upon using habitat based population models to estimate the pristine spawning stock biomass for each River Basin District. Estimates of the annual silver eel escapement are then compared with this figure.

3.7.3 BRPs for sea trout

The Workshop was not aware of any examples of BRPs being developed for sea trout stocks (except parr densities at specific habitat qualities used in the Baltic) or used in making management decisions. In most countries, management decisions are made on the basis of trends in catches. This carries risks because changes in catches do not always reflect changes in stock abundance. In England and Wales, the status of sea trout stocks is assessed using the trend in the rod catch per unit effort over recent years. While this may provide a better indication of the trend in stock abundance, it still fails to assess the status of different stocks against a common standard.

Ideally, BRPs for sea trout would be established using similar principles to those that have been adopted for salmon. This methodology would require S-R relationships for index river stocks that can be transported to other rivers. However, in view of the great complexity and variability of the sea trout life-cycle, it may be more difficult to transport BRPs reliably and there may be a need to a greater number of index studies to fully understand the factors affecting sea trout population dynamics.

S-R relationships, based in adult and juvenile (smolt) assessments are reported for only two complete river systems in the Atlantic area, the Burrishoole in western Ireland and the Bresle in northern France (Figure 3.7.3.1), and one in the Baltic, the Åvaån, Sweden. The classic study on the Black Brows Beck (Elliott and Elliott, 2006) is based on a small stream and while appropriate for that might not be applicable to whole large river systems. A number of additional sites have been proposed for Index River studies in the Baltic (ICES, 2011), but it will be at least one to two decades before data from these sites will provide sufficient stock and recruit data to define the S-R relationships. In the Atlantic two additional rivers on which long term sea trout data are collected that should be suitable for establishing S-R relationship are the Dee, North Wales (since 1991) (see Annex3) and the Tamar, South West England (since 1996). An overview of countries with index streams is found in Table 3.2.1.

A number of characteristics are known to vary significantly between river stocks including the proportion of the river stock that is anadromous, the average age at first maturation, and the average number of spawning events. These and other stock characteristics are also affected by the freshwater habitat (e.g. proportions of riverine and lacustrine habitat) and the coastal marine habitat. As a result, S-R relationships for Index Rivers may only provide a suitable basis for setting BRPs in a limited number of other rivers with similar characteristics or in the same area. Index rivers distributed in different sea areas will provide essential information on marine life history such as sea survival, growth and age at return.

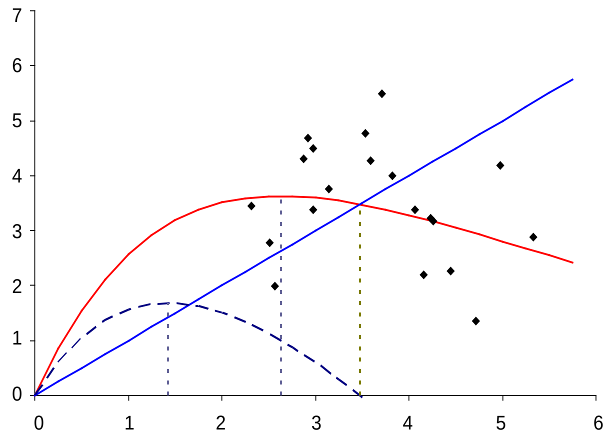


Figure 3.7.3.1. Stock-recruitment relationship for the sea trout stock of the River Bresle, France. Solid blue line = replacement line. Red line = Ricker S-R relationship. Dashed blue line = yield curve (adapted from Euzenat *et al.*, 2006).

Information was presented to the Workshop on attempts to develop pseudo-S-R relationships based on catch data, where other stock parameters such as age composition are known. Figure 3.7.3.2 shows an example of a S-R relationship based on catch data for the river Tweed, Scotland. In this case rod catch for any year is plotted as an indicator of recruitment against the rod catch four years earlier as an indicator of stock, using catch data for the years 1952–2011. This assumes a life cycle of four years – two freshwater years, and fish returning as spawn as 1+ sea winter fish which would commonly be the case with Tweed fish. While this appears to demonstrate a S-R relationship, much of the apparent relationship stems from a trend of increasing reported catches over the time series, which may reflect changes in exploitation rates (e.g. caused by changing fishery regulations or rod effort) and catch reporting rates, or a trend in in sea survival, rather than being driven by a S-R process. A similar type of curve, but based on trap data, which are more robust that catches, has been derived for the River Dee in North Wales (See Annex 3).

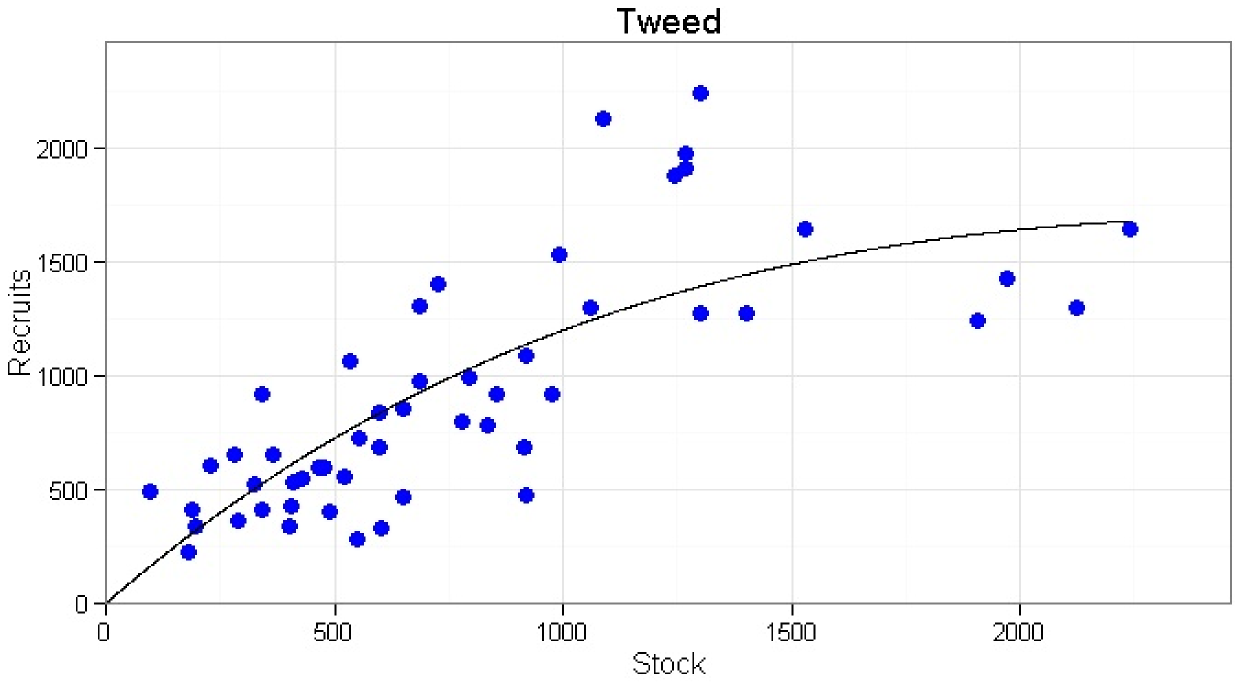


Figure 3.7.3.2. Stock-recruitment relationship for the sea trout stock of the River Tweed, Scotland based on rod catches as an index of population levels. A Ricker curve has been fitted..

An alternative solution that may be more practical and which would not require the collection of long time series of population data would be to adopt the principles used for European eel. This would require determination of the pristine stock size for each river and setting BRPs as a proportion of these values. However, defining the pristine stock size in all catchments will depend on developing habitat models that can be transported between systems.

Various studies were reported to the Workshop on the relationship between available habitat and estimates of population size. For rivers in Wales, there is a correlation between mean annual catch (as a surrogate for population size) and catchment area, although the relationship is less good than for salmon (Figure 3.7.3.3). Similar analyses have been undertaken for Scottish rivers based on the District sea trout catches and the area of accessible running water (Figure 3.7.3.4) but these show little indication of a relationship for sea trout, in contrast to salmon. It was suggested that this may be because sea trout habitat use is controlled by other factors and so they use a varying proportion of accessible running water (smaller tributaries), whereas salmon saturate it the main river and medium sized tributaries.

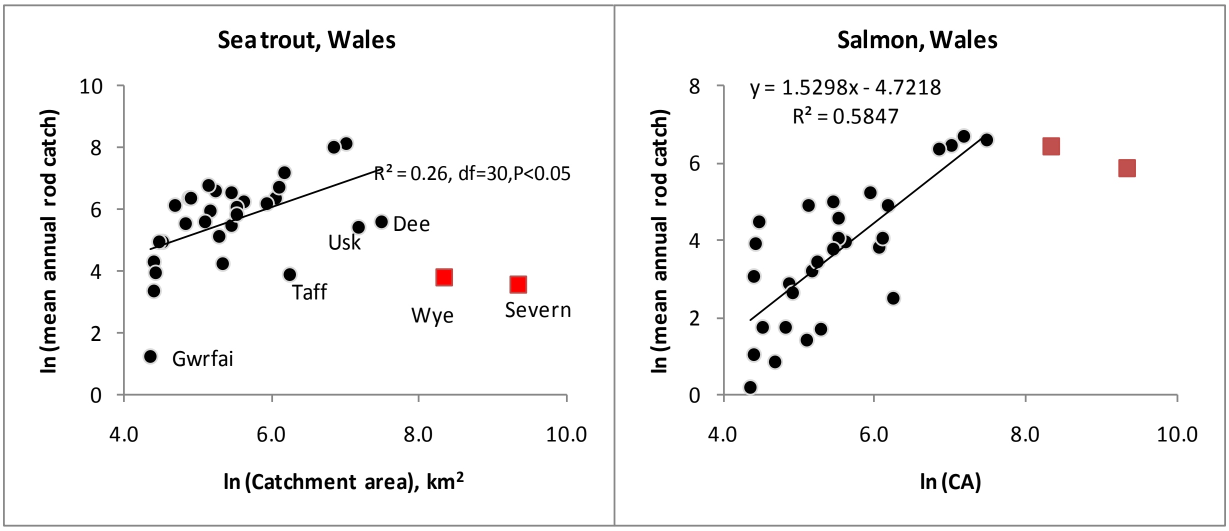


Figure 3.7.3.3. Relationship between log of the mean annual catch (2003–2007) and log of the catchment area for sea trout (LH panel) and salmon (RH panel) in Welsh rivers. Rivers Wye and Severn highlight in red because they are large rivers with very small sea trout populations.

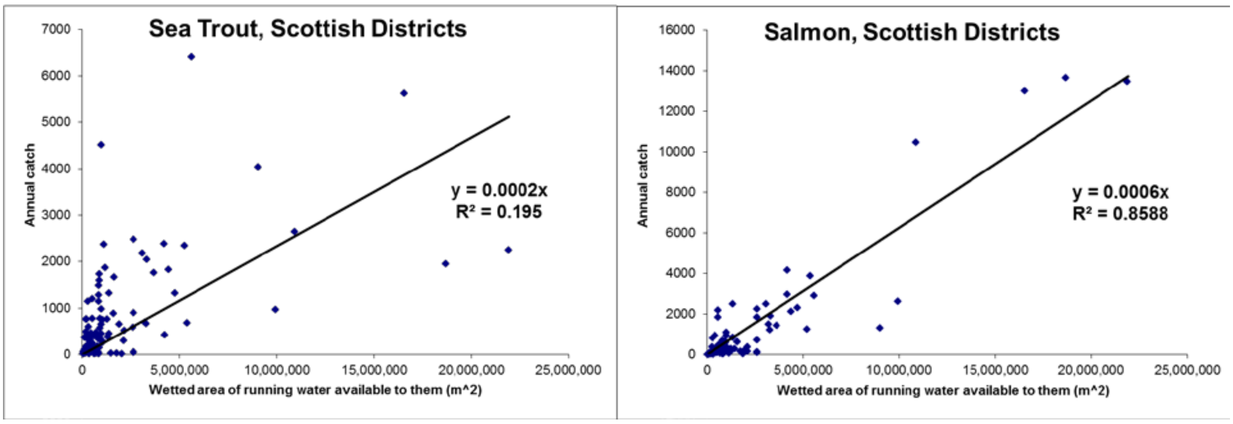


Figure 3.7.3.4. Relationship between median top ten annual district rod catch (essentially mean of 5th & 6th highest catches) for sea trout and salmon over the period 1952–2011 against wetted area of running water available to them in Scottish Districts.

More detailed habitat models have been developed for sea trout stocks in the Baltic (Section 3.2). ICES (2011) noted that index rivers for sea trout could be established in Baltic streams with existing annual monitoring of recruitment (electro-fishing surveys), and counting of smolts and spawners (trapping and redd counts). Stock parameters for the Index River could then be transferred to rivers without these data based on a habitat classification system. Electrofishing data for sampled sites were compared between countries, and the suitability of each of the following six environmental factors for evaluating habitat quality for trout parr was determined (Table 3.6.3.2):

- stream wetted width
- slope of investigated section (estimated from maps)
- water velocity
- average/dominating depth
- dominating substratum
- shade

The suitability ranged from 0 to 2 for each factor, with 2 indicating the highest habitat quality. Smaller streams, with a slope of 0.5–3% and a bottom substrate dominated by gravel and small stones (approx. 20–200 mm) were regarded as having high macro-habitat quality (Table 3.7.3.1). A bottom substrate dominated by fine particles (<0.2 mm) was considered a bad habitat (habitat score=0), whereas sand (0.2–2 mm) or coarse stones and boulders (>200 mm) was given a habitat score of 1. The water velocity is normally only estimated, and not actually measured, in the field. Suggested classes are slow/still (<0.2 m/s), moderate (0.2–0.7 m/s) and fast (>0.7 m/s).

Table 3.7.3.1. Suggested habitat scores for the six common field descriptors of habitat quality (from ICES, 2011).

	---Habitat score---		
	0	1	2
Wetted width of stream (m)	>10	6-10	<6
Slope (%) of section	<0.2 & >8	0.2–0.5 & 3–8	>0.5-<3
Water velocity class	Slow/still	Fast	Moderate
Average/dominating depth (m)	>0.5	0.3–0.5	<0.3
Dominating substratum	Fine	Large stones, boulders or sand	Gravel-Stone
Shade (%)	<10%	10–20	>20

The trout macrohabitat score system has been tested on southern Swedish coastal streams (from the county of Uppsala to Skåne) with a catchment area less than 1000 km^2 (ICES 2011). The trout macrohabitat score (THS) was calculated for 3213 fishing occasions. The abundance of trout parr (all ages) was closely related to the habitat score (Figure 3.7.3.5, ANOVA $F_{10,3202DCF}$=80, p<0.001). The approach has provided similar results for streams in other countries (Denmark, Estonia and Germany (Schleswig – Holstein)). Such relationships could be used to transfer BRPs between rivers (as for salmon) or to provide information on pristine stock conditions as for eel. The Workshop recommended that this approach should be tested on sea trout stocks in the Atlantic area and fully evaluated as a means for setting BRPs.

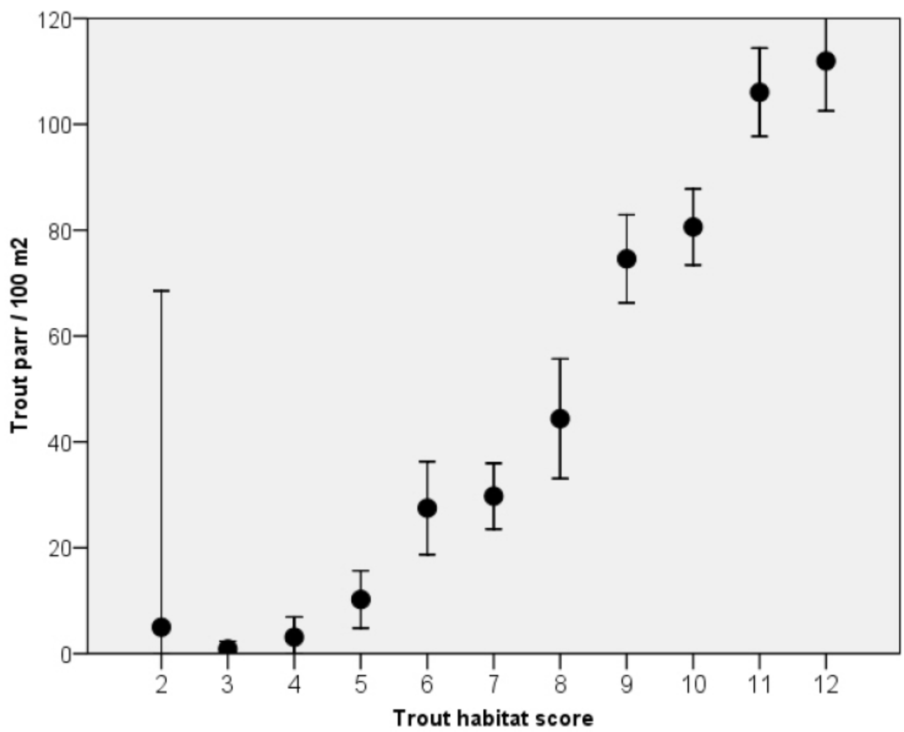


Figure 3.7.3.5 Average abundance of trout parr (±95% confidence interval) for each trout macro-habitat score class (n=3213 fishing occasions from southern Sweden); (from ICES 2011).

3.8 Integration of data collection to support assessments

The Workshop discussed the requirements for the collection of biological and economic data on sea trout under the EU Data Collection Framework (DCF) and the revised Data Collection-Multi Annual Plan (DC-MAP) for 2014-2020. Council Regulation (EC) No 199/2008 (dated 25 February 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*") sets out a Community framework (the DCF) for the collection, management and use of data for the purpose of establishing a solid basis for scientific analyses of fisheries and for providing the formulation of sound scientific advice for the implementation of the Common Fisheries Policy. Since 2008 the DCF has included a requirement to collect data on Atlantic salmon, European eel and, in the Baltic, sea trout. However, the specified data requirements have not reflected the data used in the annual ICES assessments.

As part of the current reform of the Common Fisheries Policy (CFP), the DCF is being reviewed and updated. The new Data Collection - Multi Annual Plan (DC-MAP) will require Member States to collect biological, environmental, technical, and socio-economic data, manage them and make them available to end users. The data shall in particular enable the assessment of:

a) the state of exploited marine biological resources;

b) the level of fishing and the impact that fishing activities have on the marine biological resources and on the marine ecosystems, and

c) socio-economic performance of the fisheries, aquaculture and processing sectors within and outside Union waters.

In this context 'marine biological resources' means available and accessible living marine aquatic species, including anadromous and catadromous species during their marine life.

In view of the proposed changes to the data collection systems, ICES established the Workshop on Eel and Salmon DCF data (WKESDCF) to consider the data required to conduct the ICES assessments of eel and salmon for the EU and NASCO (ICES 2012a). The Workshop made extensive recommendations for data collection programmes covering all stocks, in both marine and freshwater environments and including the operation of various Index and Monitored River programmes. Although WKESDCF did not consider sea trout, many of its recommendations are likely to be relevant. A second ICES group, the Working Group on Recreational Fisheries Surveys (WGRFS) (ICES 2012b), also noted that sea trout should be included in the new DC-MAP according to the principle that (1) the recreational fishery has a potential important impact on the population dynamics and (2) it is of strong socio-economic importance.

The Workshop supported the view that data on sea trout should continue to be collected for all fisheries in both freshwater and the sea in the Baltic area and noted that the specific data requirements should be reviewed. Where the commercial and/or recreational fisheries include a large proportion of young fish, the numerical catch could be large although the catch weight is small. Accordingly, the Workshop recommends the collection of data on the number and weight of all sea trout caught, separated by commercial and recreational fisheries, the location of the fishery (freshwater, coastal, sea), and whether the stocks are wild or reared. The Workshop also highlighted the importance of collecting data for evaluating the economic and social value of commercial & recreational sea trout fishing.

The specific details of the sampling such as periodicity of sampling (e.g. annual or three yearly) and sea areas should be agreed between countries at a regional level. Simulations (management strategy evaluations) should be employed to evaluate the impact of different data collection approaches on assessments/management. Where there is high inter-annual variability, annual data at low precision may provide better information than intermittent higher-precision data. This process should be targeted to end–user (e.g. ICES) needs and types of assessments involved (need for stock assessment methods that can deal with intermittent data, for years with no data).

The Workshop noted the general paucity of data on sea trout stocks in the Atlantic area including knowledge on the socio-economic value of the species and the need both in the Atlantic and Baltic for more index river studies to describe population dynamics. However, the case for including sea trout under DC-MAP for waters outside the Baltic Sea is not clear because there is currently no requirement to conduct an international assessment or provide fishery management advice for sea trout in these areas for the EU or any other customer. There is limited knowledge of the extent to which sea trout from one country are exploited in the coastal waters of neighbouring states. However marine fisheries are extensive in the Baltic and the potential for mixed stock fisheries appears to be quite high in some other areas given the recent genetic results on stock distributions at sea, even if the existing fisheries are low intensity because of regulations. The Workshop noted concerns that by-catches may be a problem in some areas. The Workshop therefore considered that although there is in general limited immediate requirement for sampling of sea trout under DC-MAP, this should be evaluated by the Regional Coordination Meetings.

3.9 Overall Conclusions and Recommendations

- Alternative and emerging assessment methods proved to be a large and complex subject, because it requires a description, update and reappraisal of existing methods which are in a continual state of development. Conclusions and recommendations pertaining to each topic are listed under the appropriate headings.
- Improving assessment should remain priority work for sea trout, integrating between the resident and anadromous forms.
- Development of BRPs is a common ambition across most of the participating countries and the various approaches reflect the variety of facilities for data acquisition and policy drivers. The notion of BRPs requires clarity on its application and management aims, and on priorities for assessment data and is therefore is a unifying theme.
- There is much ongoing work on new techniques in genetics, juvenile-habiat related assessment, marine ecology and in life history understanding, all of which will advance assessment. It is recommended that a workshop focused on BRPs be promoted within the next two years in order to pull together and compare the approaches.

4 SPATIAL CONFLICTS

4.1 Introduction

The Working Group was asked to identify potential spatial conflicts for sea trout life history in marine and estuarine locations (to include by catch issues and potential impacts of renewable energy developments). These were discussed in the context of factors in coastal waters affecting sea trout (including marine fisheries, directed fisheries for sea trout, renewable energy generation and aquaculture) and activities creating barriers to movements into freshwater. The Working Group also briefly considered the current position of sea trout in marine spatial planning processes.

4.2 By-catch in marine fisheries

By-catch is the inadvertent capture of a species in fisheries targeted at other species. Mortality can be significant through deliberate or accidental retention of sea trout either legally or illegally, or by post-release mortality. This is a spatial planning issue because the migrations of sea trout in estuarine, coastal or offshore waters are likely to bring them within the range of marine fisheries both targeted or as by-catch. Evaluation of by-catch as a risk factor is therefore dependent upon information on sea trout movement (timing and location), the location and timing of the fisheries and the methods they employ. Around the ICES area information on movements is sparse and data on by-catches is limited and of varying quality, although good data are available in parts of the Baltic.

A broad distinction can be made between the Baltic and the Atlantic / North Sea areas. In the Baltic there is a substantial commercial coastal and offshore fishery for Atlantic salmon, whitefish and other species using methods that also take sea trout. Landings are not recorded at all in Russia, where catch of sea trout by any means is prohibited. Moreover, unlike in the Atlantic, there is a substantial recreational fishery using nets, traps and rods, for which landing records are not be complete. Although sea trout catch is only known with significant uncertainty in some places, in others it is known to be extensive, such as the north Baltic where it threatens the local populations with extinction (ICES 2009).

In the North Sea, extensive inshore commercial fisheries on continental coasts may take sea trout (e.g. on the Dutch / Belgian coasts and in the Wadden Sea, seines and stake nets are believed to regularly take sea trout). On the UK coast, there are directed inshore net fisheries for salmon and sea trout (e.g. NE England drift and fixed trapping nets) and eastern Scotland (bag and stake nets), but fishing for these species in coastal waters is illegal in many other areas.

All around the UK coast, particularly on the south and west coasts, there are significant inshore net fisheries (seine and gill net) for bass and to lesser extents other species, such as mullet and sand eel. Sea trout are taken in these, although the numbers are not known and it is illegal to retain the fish. In a number of countries angling for sea trout in fresh or saltwater requires a rod licence and in some countries compulsory catch reporting; but in the newly emerging, still small, salt water sea trout fishery, these conditions may not be widely recognised or adhered to.

Off the French and Spanish coasts, there are also coastal, boat and shore-based net fisheries that undoubtedly take sea trout although their retention is illegal; but no records are available, because commercial catches are not systematically recorded.

On the Irish coast, drift net and coastal fisheries for salmonids are now closed, but some catch is recorded in the inshore fisheries and as elsewhere illegal by-catch in fisheries for other species is likely.

To conclude, professional sea fisheries targeting sea trout are mainly confined to parts of the Baltic Sea, while by-catch of sea trout in non-targeted fisheries occurs in most countries to a varying degree. National legislations regulating the fisheries vary between countries regarding minimum legal size or in some countries a complete ban of retention of the fish. Recreational fishing, either with rod and line or semi-professional gear also varies considerably, apparently being much more common in the Baltic area compared to all other areas.

4.3 Mixed stock fisheries

Sea trout show fairly precise homing to spawn in their natal streams and, as in Atlantic salmon, this has resulted in the groups of fish originating in different rivers or streams becoming genetically distinct and often adapted to survive and reproduce in the conditions that they face there. They may therefore differ from fish originating in other rivers and tributaries which have become adapted to a different set of conditions. These sub-groups comprise genetically distinct '**populations**', however, in most instances it is not possible to demarcate clear population boundaries within a river, and managing fisheries at this level of detail would be very complex. Thus, while there is a need to protect the sustainability of these units, the primary management unit used for regulating fishing and reporting statistics is generally taken to be the '**river stock**', comprising all fish originating from eggs laid within the river. Fisheries that exploit sea trout or salmon from more than one river stock are often referred to as 'mixed stock fisheries' (MSFs); (Koljonen *et al.*, 2013).

These fisheries pose particular problems for management because it is difficult to determine the levels of exploitation on each individual stock. This has been recognised for salmon, and many MSFs have been closed in recent years. While salmon undertake much longer marine migrations than sea trout, they are only caught in coastal waters on their homeward spawning migration. Sea trout, however, probably spend much of the marine phase of their life-cycle in coastal waters and may regularly move in and out of different estuaries and even visit other rivers (Degerman *et al.* 2012).

Sea trout have also been recorded in deep water areas in the Skagerrak and off the west coast of Ireland. This behaviour may expose them to a greater range of directed mixed stock fishing over a wider geographical range. For example, sea trout from north-east England may be caught all-round the North Seas, and fish from northern France appear to make directed migrations into the southern North Sea, and also in the Baltic area many stocks have been found to have long-migrating components. Notably, and in contrast to salmon, for sea trout there is suspected to be more exploratory straying into non-natal estuaries and rivers (e.g. Degerman *et al.*, 2012); this increases the extent of mixed stock exploitation.

However, while sea trout are known to migrate variable distances from their rivers of origin there is in general relatively little known of their migration routes and distributions. Within the Baltic, management of MSFs is further complicated by the presence of large numbers of sea trout released for ranching and mitigation purposes which are mixed with wild stocks.

The basis of the reported higher level of straying between estuaries (compared with salmon) is poorly understood, and many questions remain to be addressed concerning its extent and seasonality. Studies in Norway suggest that sea trout may enter estuaries to feed and remain there for extended periods, and there have also been suggestions that sea trout may move into estuaries when sea temperatures get too low (Thomsen *et al.* 2007). Genetic analysis is now providing a means to investigate stock mixing in greater detail, and genetic baselines have been developed in a number of areas (e.g. Irish/Celtic Sea; SW England; North Sea; Baltic). These studies are beginning to reveal information on the greater extent of mixing in coastal waters compared to estuaries (e.g. River Tweed) and differences in the distribution of fish of different ages (e.g. Irish Sea). Particular impediments to obtaining more reliable data are the problems of obtaining marine samples of sea trout and the difficulty of obtaining reliable information on sea trout catches in non-directed coastal fisheries.

4.4 Marine renewable energy

Across Europe there are demanding targets for renewable energy generation. For countries with significant areas of sea under their jurisdiction, these targets are likely to be met in substantial proportion, from marine developments, particularly power generation from offshore wind, offshore wave, tidal stream and tidal lagoons and tidal barrages. Some of the planned developments are very large.

There is a need to assess the risk that such developments pose to populations of fish, including sea trout. The key questions in risk assessment for sea trout are:

1) are there mechanisms by which the developments could impact on fish populations, either directly or by affecting prey fish.
2) will the distribution of sea trout in space and time result in these developments impacting on them, and
3) what would be the resilience of the sea trout populations to any impacts?

Table 4.4.1 summarises the main concerns for sea trout, where they occur in the proximity of the main types of power generation. The area in which sea trout could be affected will vary. Underwater noise generated when very large piles are being driven to support large wind turbines might be detectable by fish and potentially affect behaviour over substantial distances, whereas damage from collisions or near collisions with underwater structures would present a risk in the immediate vicinity of the structures. It was noted that offshore wind farms may also have benefits as offshore reefs of refugia for fish (Hoffman *et al.* 2000; Leonhard, *et al.* 2011).

Table 4.4.1 Concerns with respect to sea trout, when they are present, for the main types of marine renewables development, with a tentative indication of the highest priority (+++) to the lowest priority (+) for risk assessment of each type of development. Less significant concerns for particular types of development are left blank.

Main concerns in relation to fish for each type of development	Possible mitigations	Offshore wind arrays	Wave arrays	Tidal stream arrays	Tidal range / barrage
Noise during construction (for example from impact pile driving, dredging activities for gravity bases) causing injury or	soft start piling and bubble curtains in some situations, timing of work	+++		+ (often the bed underlying tidal streams is not suitable for impact pile driving)	+++

effects on feeding or migratory behaviour for example.					
EMF from underwater generators, interconnector cables and export cables during operation causing effects on feeding or migratory behaviour for example.	Cable burial (or armouring where that is not possible); horizontal drilling for connection to shore	++	++ As cables may be close to the surface	+	
Effects on water quality for example caused by dredging activities for gravity bases, during construction, either directly impacting on fish welfare, or causing changes in feeding or migratory behaviour for example.	Timing of work, choice of method, and awareness of substrate conditions and any hotspots for locations for sea trout when deciding on locations for substrate dredging or dumping.	++			++
Change in habitat / loss of habitat				+ (by affecting hydrography)	+++
Physical inference of structures with migration to and from rivers	Provision of effective fish passes		+		+++
Underwater noise or other disturbance during operation		+	+++	+	+
Collision with underwater turbines	In the case of tidal stream arrays, turbine design and location and in the case of turbines associated with barrages, screening and diversion of migrating or other fish which might get entrained.			+++	

In England Wales and in Scotland sea trout are taken into account in risk assessment of renewable energy developments. There is a need for better information on the distribution of sea trout in space and time during their marine phase, including the depth distribution of the sea trout and what drivers determine this. Various people at the workshop made it clear that although more information on the marine distribution of sea trout is needed for risk assessment, some useful information has already been collected which is not yet readily accessible, so that there will be value in both new studies and insuring that information from work already carried out becomes accessible. Swimming depth can be important in determining the risk posed to sea trout or other fish. The information which is available indicates that near surface waters are often used. However, more information would be useful and Marine Scotland (Scottish Government) has recently commissioned an Icelandic company, Laxfiskar, to extract, collate and analyse data on the swimming depth of sea trout at sea which was obtained in the course of studies on tagged sea trout in Icelandic waters. The study will give overall proportions of time spent at different depths, and insights into the factors determining swimming depth. A report is to be submitted to Marine Scotland by the end of March 2014.

There is also a need to know more about how sea trout will interact with the developments. For example issues such as how they might respond to electromagnetic fields are still unresolved. Larger wind, wave and tidal stream developments are generally phased with smaller start up phases planned to build up to larger phases in the future. The assessment of later phases will therefore be able to make use of information obtained in monitoring and investigations during the start-up phases. This assumes such work is properly designed and adequately funded. Although information of use to risk assessment can sometimes be produced from tank studies and modelling, robust risk assessment will require that data is also obtained in the field. This is likely to be demanding and expensive and integrating studies across different receptor species is important. There was some discussion about who should be responsible for the studies and their resourcing, and the need to prioritise and collaborate. It was noted also that some of the habitat change caused by these developments might be beneficial by for example providing structural diversity and protection in open sea areas (see above).

4.5 Marine aquaculture

The potential for the spatial conflict between aquaculture and sea trout is dominated by consideration of net pen salmon farming in the sea, although salmon are also bred in captivity for stock enhancement and ocean ranching purposes. The production of juvenile salmon for farming in freshwater also has considerable potential for interaction with sea trout where they co-occur in the same river systems. However, here we concentrate on marine net pen culture.

Atlantic salmon grown in sea cages have the potential, even while the fish remain *in situ* within cages, to impact negatively on sea trout populations, principally through the transmission of pathogens, particularly the sea louse *L. salmonis* (see reviews by Costelloe, 2009; Torrissen *et al.* 2013). When salmon escape they also pose additional ecological and genetic risks to wild sea trout. Ecologically escapes attract predators, compete for mates, their progeny will compete for food and space resources in the river and escaped adults can continue to be a source of infection. Genetically, directly mediated through inter-species hybridisation between salmon and trout (Youngson *et al.* 1993; Hindar & Balstad, 1994), and indirectly via the potential for disease mediated evolution as has been found previously reflected in signatures in changes in immune response genes (e.g. Coughlan *et al.* 2006), escaped salmon can impact negatively on wild sea trout populations.,

Spatial conflict between aquaculture and wild sea trout is primarily a problem for Norwegian, Scottish and Irish sea trout populations where the farming industry is largely concentrated. The level of associated risk ranges from profound quantitative changes in life history affecting the productivity and nature of the species e.g. in terms of their propensity to migrate to the sea to the extirpation of wild populations. The potential severity of impacts related to either sea lice infestation or escapes into sea trout bearing rivers, can be either aggravated or ameliorated by the location of the farm, and will be a function of a multitude of spatially determined factors. These include obvious things such as the proximity of the farms to sea trout rivers and feeding areas; the size and concentration of the farms in a given location; the numbers of fish; the age of the fish in the farms; the management of the farms in respect of lice treatments e.g. fallowing regimes, separation of generations, use of parasiticides. The geography and hydrography of the farm sites will also have an important bearing on the level of interaction between the farm and local sea trout populations e.g. degree of shelter; tidal water exchange; salinity; tidal current velocity and direction; current gyres, surface currents; wind direction; surrounding landscape such as wave sheltered coastal inlets versus exposed sites; freshwater river volumes; sea bed topography. The population specific behaviours such as the timing of sea trout entry into the sea, the tendency to either feed in the inter-tidal area or to forage in the open sea, will influence their exposure to sea lice. In respect of genetic interactions frequency of escapes, volume of escapes, distribution of local sea trout populations; the risk of escapes being a function of the exposure of the location being farmed. Furthermore, in addition to the sea trout themselves as a year round reservoir population of lice, the river or region specific timing of adult wild salmon returns will affect lice transmission rates from the wild to the farm.

The planning for and the locating of marine salmon farms to avoid or at least minimise impacts on sea trout and the resolution of spatial conflict, must be cognisant of the potential of all of the above factors and how they are influenced by biology and geography. Unfortunately most of these factors are poorly parameterized and to resolve this will require a substantially increased knowledge base to provide accurate environmental impact assessments. This is proving difficult within the context of contemporary environments, but must also be capable of assessing the degree of spatial interactions for future marine conditions. For example, projected climate regimes suggest increases in freshwater and sea temperature, which will perturb growing seasons and will likely increase the pathogenicity of disease causing organisms; this in conjunction with increasing resistance of lice to parasiticidal treatments. At the same time predicted climate change mediated increases in the frequency, duration and magnitude of storm events will lead to increases in escapes through physical damage of cages, but will also limit the areas where salmon can be grown and a retreat into more sheltered areas and hence will bring them further into contact with sea trout producing rivers.

There is an array of relatively new methods for understanding the migratory behaviour and biology of the sea trout, assessing environmental risk, identifying spatial aspects of conflict, establishing carrying capacity for specific economic activities and assessing potential for restoration of compromised or lost diversity. These include the following (many of these techniques and approaches were developed within previous EU research programs).

- Instrumented rivers and estuaries (listening stations) for the tracking of fish in both freshwater and marine elements of the sea trout ecosystem;
- Radio, acoustic and data storage tags;
- Trapping infrastructure for the tagging and retrieval of tagged fish;
- Electronic fish counters;
- Microchemistry and isotopic profiling for elucidation of feeding strategies;
- Image analysis for extraction of life history information from archive and contemporary scales
- Genetic techniques for individual population identification;
- Genetic techniques for the determining the molecular basis for key life history traits;
- Genetic techniques for the recovery of biodiversity information from archive tissue collections;
- Laboratory and hatchery facilities for the manipulation of food, temperature and light important for the resolution of biological responses to climate change.

In Scotland an ongoing project monitors the prevalence of lice infestation in relation to fish farm locations (Managing Interactions Aquaculture Project - MIAP) (http://www.rafts.org.uk/managing-interactions-aquaculture-project-sea-trout-monitoring-project-regional-report-2012/).

Conclusions and Recommendations

- an excellent summary of future research needs in respect of how sea lice emanating from salmon farms interact with wild salmonids is provided in the supplementary annex provided in Costelloe *et al.* (2009); these include a recommendation for the further study of the biology of *Lepeophtheirus salmonis* in the plankton including behaviour, transmission and dispersal models; understanding the relationships between farm production and lice; distribution on hosts; elucidation of population demographic parameters.
- a retrospective assessment of level of past impacts as window to determining the future problems and as a way of identifying elements of ecosystem and biological diversity, for determining approaches for ecosystem and restoration and establishing a carrying capacity for the pursuance of economic activity at levels that are sympathetic to the natural resource;
- the development of methodologies to redress (restoration/replacement/recue) past impacts to ecosystem and sea trout population and life history diversity;
- to develop a risk identification and risk management framework by understanding the biology of the sea trout, determining its ecosystem requirements and determining its interaction with other components of the ecosystem including physical and biological (competitors, pathogens, parasites) and alterations of the ecosystem following development for economic activity;
- an assessment of how the ecosystem and the sea trout within, might respond (productivity, life histories) to projected levels of climate change;

- further work into the identification of novel treatments for the management of lice on farms which are not injurious to broader ecosystem services;
- the development of methods designed to improve accuracy of operational tools for use in spatial planning and decision support regarding the identification and location of sites most suitable for aquaculture activity and those areas that should be designated as marine protected areas.
- an exploration of new advances in molecular biology and technologies such as e DNA to elucidate ecosystem interactions between the farms and wild salmonids.

4.6 Estuarial barriers

On at least two occasions during their life cycle, the interface between freshwater and tidal waters serves as a significant bottleneck to the migration of sea trout populations. It is therefore important that fish are allowed to move freely between these environments. Barriers can cause a delay or even totally prevent movement (including by causing direct mortality) between habitats; alter patterns of behaviour; cause physiological stress; and increase the transfer of pathogens and predation risk.

Physical structures are the commonest form of barrier and typically consist of weirs, barrages, locks, hydropower turbines – including artificial lakes created by stemming the water (Berg 1987, Prignon *et al.* 1999, Rivinoja 2005, Jepsen *et al.* 1998, Thorstad *et al.* 2008, Aarestrup and Koed 2003) and flood defense structures such as tidal flap gates. Artificial structures such as barrages generally create an unnatural abrupt transition from saline to freshwater as well as removing the natural tidal cues which may stimulate upstream migration. Additional environmental impacts of physical structures can include poor water quality due to reduced tidal wash out and artificial lakes constructed to remove nutrients (Kristensen *et al.*, 2014). Even relatively small physical structures are likely to delay migration. Data on the impact of physical structures on freshwater entry by adult sea trout exist from studies conducted in the UK and also on immature trout (including smolt escapement) at tidal flaps. Mitigating the impacts of physical structures should ideally be considered during the design of the structure. Retrofitting fish passage solutions or by adapting management protocols to maximise migration opportunities can be disruptive and very expensive[5]. However, artificial structure such as barrages generally create an unnatural abrupt transition from saline to freshwater as well as removing the natural tidal cues which may stimulate upstream migration. The most appropriate solution is likely to be very site specific and robust data from which to help develop the optimal solution is generally lacking.

Thermal barriers or abrupt changes in temperature may also delay or deter movement of sea trout. Data from a tracking study on the River Tyne revealed that temperature played an important role in regulating the time taken to enter freshwater. However there is comparatively little data on the impacts of abrupt temperature changes on migration from such sources as energy plant cooling water. Migration through lakes or slow flowing parts of rivers, rapidly warming up during sun-lit conditions may interrupt migration if temperatures above 13 C are encountered (Whelan *et al.* 1993)

Underwater sound might affect sea trout migration and impacts from construction activities (e.g. piling) is of growing concern. Although there is very little data from which to draw robust conclusions some does exist from noise sources in the estuary that provide mixed results. A study in Aberdeen harbour (UK), a busy commercial port with a significant sea trout and salmon run, showed than any effects of quay construction working including piling could not be detected against background variation. An experiment conducted in Southampton Water based on observations of caged trout also revealed no impact, while a study on the River Tyne revealed anecdotal evidence for a reduction in successful freshwater entry (salmon and sea trout combined) when exposed to piling activity. Noise from sources close to the freshwater/estuary interface may have the greatest impact but such data are currently lacking.

Another potential delay to the movement of sea trout is poor ***water quality***. Low levels of dissolved oxygen have been shown to play a role in regulating freshwater entry and to be a direct cause of mortality at the tidal limit on the River Tyne. However, there is very little information on the effect of sub-lethal changes in water quality and specific pollutants/contaminants on freshwater entry. This is due both to an insufficient monitoring from which to carry out an assessment and the difficulty in distinguishing the impacts of individual pollutants/contaminants.

Studies conducted in the UK have shown that ***light pollution*** from artificial night light can disrupt the migratory behaviour of salmon smolts (Riley *et al.* 2012) and it is therefore conceivable that the same impacts would persist for sea trout moving in either direction at the tidal interface – particularly if this is in conjunction with a physical barrier.

Flow is often considered to be the major factor in determining freshwater entry of salmon and low flow clearly deters migration especially in small rivers or shallow reaches. The impacts of low flow (on movement in both directions) are likely to be exacerbated by other conditions including the presence of physical structures and other metrics of water quality. Recent work has highlighted that it is not just the physical properties of flow *per se* that have an important role in regulating freshwater entry, but the sensory stimuli contained within the flow may be important. This has important implications in regulated rivers, or indeed in rivers with a common estuary. Flow is undoubtedly an attractant and flow from sources other than that originating from the intended migratory route (e.g. those from hydro outlets) can exert delay on freshwater entry. The impacts of alternative flow sources can be severe if fish repeatedly try to ascend impassable structures.

4.7 Sea trout in the Marine Spatial Planning process

Planning of many activities within estuaries and the sea is subject to well established regulatory processes. The group discussion however concluded that advice specific to sea trout was not fully implemented in these regulatory processes. Consideration given to diadromous species in Marine Spatial Planning (MSP) is very varied, with attention given to Atlantic salmon, but much less to sea trout. Sea trout are not covered under the EU Habitats Directive, but some countries have conservation legislation to protect sea trout. Wild sea trout are listed as endangered in Finland which has led to a catch and release policy for anglers and an increased minimum size limit (50cm to 60cm) for sea trout caught as by-catch in the important whitefish fishery. In Polish waters, the protection of seals under the Habitat Directive is having a detrimental effect as they are believed to have serious impacts on sea trout stocks.

In Scotland sea trout have a high profile and receive attention in MSP in areas where they occur. Consultation is ongoing for Scotland's first National Marine Plan(http://www.scotland.gov.uk/Publications/2013/07/9185/0)Other countries felt that they found out about planned wind farms and marine developments too late in planning process or that planned projects were so economically important that they would go ahead regardless of the impacts on species such as sea trout. It was felt that sea trout get little protection in Germany, partly because they have very limited salmon stocks and so sea trout are not afforded any benefit that may be derived from consideration given to salmon in the planning process.

The Marine Strategy Framework Directive (MSFD) establishes a protocol by which EU member States are required to take necessary measures to achieve or maintain Good Environmental Status (GES) in the marine environment by 2020. The directive aims to protect Europe's marine waters by applying an ecosystem-based approach to the management of human activities, while enabling the sustainable use of marine goods and services for present and future generations.

4.8 Conclusions and recommendations

- Spatial conflicts with other anthropogenic activities are very evident for sea trout because of their migration through multiple freshwater, transitional and marine habitats.
- All of the risks discussed (by-catch, mixed fisheries, renewable energy, aquaculture and estuarial barriers) are potential hazards and are subject to various controls that should fall within spatial planning processes; but in practice this is variable between the activities and between states. Sea trout are actually, or could be, taken into account under Environmental Impact Assessment, where this process is formally carried out (e.g. for renewable energy engineering developments). Their lower conservation status, compared with salmon remains a constraint.
- The ability to propose and implement effective controls as part of the Marine Spatial Planning process and to manage them in the marine environment is constrained by limited understanding and knowledge about the migrations, mixing and marine ecology of sea trout. This situation has been improving recently in some areas with better information, but remains a priority for study.
- The Ecosystem Approach is being employed in some areas and sea trout have been included in ecosystem analysis, although the data and process understanding are still weak. The Ecosystem Approach has yet to deliver a strong decision-making protocol, but development of the approach is welcomed.
- It is recommended that the studies on the effects of local and distant fisheries as well as mixed stock fisheries are promoted.
- It is recommended that the effect from installations such as tidal barriers and renewable energy installations are studied in order to gain knowledge on specific types of development, where experiences may be used in future planning processes.
- In areas where sea trout populations are at critically low levels national (and where this is relevant) international actions, should be taken in order conserve biological variation.

5 Principal Conclusions and Recommendations

5.1 Conclusions

1) Progress in research in the life history (LH) approach has been limited and parameterization was identified as an important and difficult problem, very demanding of good quality data

2) Increase in the understanding of environment variables influencing life history variation could be improved by mapping the distribution of anadromy in freshwater.

3) Anadromy in trout is most likely determined by a combination of environmental and genetic factors, the former being increasingly well-described and thought to act through metabolism and juvenile growth. However the role of genetics and interaction with environment is still poorly understood.

4) The factors determining marine feeding migration and distance are poorly understood, but are variable between locations and thought to be some combination of residual currents, opportunistic feeding, nutritional status of the fish and genetics.

5) In several sea areas, recent information on genetic population structures of sea trout stocks indicated clear differences in rivers of origin and therefore evidence of mixing during their sea migrations.

6) The effects of climate changes on sea trout are difficult to predict. They potentially will influence history and population dynamics by increasing variables like growth (up to some maximum, thereafter growth will decline) and by altering a number of variables acting at different life stages, to change the timing of events such as maturation, spawning and smolt migration. The lack of marine temperature /growth models for adult sea trout was noted.

7) The use of hard structure chemistry has proven useable as a tool of increasing value in the study of feeding and trophic levels of sea trout, their natal origins and their distribution at sea.

8) The workshop identified and ranked the knowledge gaps in understanding of the principle threats to sea trout across marine and freshwater environments, including climatic effects. Threats include environmental factors and impacts of fishing. The marine phase is the part of sea trout life history considered to have the largest knowledge gaps.

9) Regular assessment involving several countries is only performed in the Baltic Sea area.

10) A regular monitoring of young sea trout occurs with varying intensity (number of streams covered, duration between monitoring occasions and number of sites monitored) is widespread. Also monitoring of adults is performed to some extent, while data on smolt numbers are collected more rarely. In total the workshop is aware of 15 index rivers.

11) Monitoring adult sea trout is widespread, but with large variation in intensity and quality of data between countries.

12) Novel information on genetic population structure of trout was presented for populations in rivers entering the Irish Sea, Celtic Sea, English Channel,

North Sea, Baltic Sea and the Skagerrak. Substantial progress was reported in deploying genetic methods in elucidating the distribution and extent of migrations of trout in open and estuarine European waters.

13) Stock-recruit relationships has been developed for sea trout in three water systems with long time series of smolt production and spawning number, and they are being developed in three additional rivers.

14) The most serious spatial conflict problems in the sea were considered to be catch in local (sea- and freshwater) and distant fisheries, and sea based salmon aquaculture. In addition, threats from port developments were noted and emerging risks seen in structures such as tidal lagoons and barriers for renewable energy generation.

5.2 Recommendations for ToR 3 (To review alternative assessment methodologies and appropriate scales & make recommendations for the DCF).

1) The Workshop recommends the collection of data on the number and weight of all sea trout caught and fishing effort separated by commercial and recreational fisheries, the location of the fishery (freshwater, coastal, sea), and whether the stocks are wild or reared.

2) Data for evaluating the economic and social value of commercial & recreational sea trout fishing should be collected and evaluated. The specific details of the sampling should be agreed between countries at a regional level.

3) Simulations (management strategy evaluations) should be employed to evaluate the impact of different data collection approaches on assessments/management. This process should be targeted to end–user (e.g. ICES) needs and types of assessments involved.

4) The need for sampling of sea trout under DC-MAP should be evaluated by the Regional Coordination Meetings if end-users raise a specific need.

5) Both in the Atlantic and Baltic areas there is a need for more index river studies to describe population dynamics and to support the development of options for Biological Reference Points. An inventory of index rivers should be prepared; the geographical cover of index rivers should be evaluated, and, where relevant, the establishment of additional rivers should be promoted.

6) Scale reading (for determining age, growth and breeding schedules) is potentially very useful for stock assessment and population dynamics, yet it is contentious practice due to the difficulties of consistency and reliability in sampling and interpretation, which are particularly acute in sea trout. A working group to fully assess and resolve these issues is recommended.

7) It is recommended that a workshop focussed on BRPs be promoted within the next two years in order to pull together and compare the approaches.

5.3 General recommendations

The workshop recommended that:

1) On a national basis information on 1) parr densities after the density regulation phase , 2) smolt output and 3) number of returning spawners should be collected from existing information or generated from new studies, in

order to establish knowledge on the range of river production and population dynamics. This information, its systematic presentation and international availability is essential to progress population modelling for stock and environmental impact assessment.

2) Studies on marine life history variation, particularly the timing of maturation, the differential survival of sea-resident maidens and spawners, proportions and the fate of returning whitling (n.0+) should be promoted.

3) Understanding on marine migration should be enhanced to quantify the proportions and timing of sea trout exchange between marine zones. Maps of marine migration routes and feeding locations are needed in order to evaluate specific risks for spatial planning purposes.

4) Determinants of marine migration direction and distance should be investigated to understand the roles of genetics and environment, particularly feeding opportunity.

5) Future research activities on migration behaviour at sea should be coordinated across disciplines and where appropriate between countries and with similar studies on other species to ensure the maximum benefit.

6) The extent and significance of temporary and true (reproductive) straying needs to be evaluated.

7) The role of small coastal streams in sustaining sea trout should be evaluated because it is believed that these are collectively important sources of recruitment and genetic diversity for trout, yet they are usually low priorities for environmental protection.

8) The distribution of anadromy in freshwater should be mapped, combined with analysis of environment variables as a step towards understanding factors influencing anadromy and the spatial distribution of spawning anadromous adults.

9) Studies on the effect of native and invasive fish species on sea trout populations should be promoted.

10) Efforts should be made to extend and standardise the existing genetic baselines

11) Better use should be made of the network of monitored (index) rivers and their latitudinal spread to improve ecological understanding and track the potential responses of populations to climate related effects. The geographical distribution of index rivers and rivers with high quality of enumeration of adult immigration and smolt emigration should be mapped. In areas with poor or no coverage establishing additional index rivers should be promoted.

12) Modelling of life history trait responses (growth, maturation, survival, fertility, dispersal) in freshwater and at sea to changing temperatures and productivity should be promoted, and used to guide priorities in data collection in selected locations.

13) The adaptive capacity of trout (phenotypic and genetic) to climate induced change should be studied.

14) Methods for setting Biological Reference Points for sea trout stock assessment should be further explored and developed. This should include testing of the Baltic assessment model should be tested in different parts of Europe to evaluate it under contrasting environments

15) Information on migration and behaviour at sea should be increased to improve interpretation of marine catch data. Collection of quantitative information in both commercial and recreational catches in both sea and freshwater, with as much detailed on position (in freshwater river, area), gear, effort, size of fish and collection of scales should be established where not existing, and increased where necessary. The combination of information from sea catches and on migratory patterns should be investigated, using information already available.

16) An overview of behavioural and migration knowledge should be established including knowledge from tagging studies, genetics and microchemistry. In areas (sea types) with insufficient knowledge examinations should be promoted.

17) An international baseline for the genetic assignment to river and region of origin of sea trout caught at sea should be developed to allow further resolution of sea trout distributions and movements

18) The effect from renewable energy installations specifically tidal lagoons and barriers and wind farms should be studied in order to gain knowledge on minimising threats from specific types of development, to more effectively carry out environmental impact assessments and to advise on planning proposals.

19) In areas where sea trout populations are threatened from reaching critically low levels national, and where relevant, international actions, should be taken in order conserve biological variation.

20) Methods are developed to improve accuracy of the identification and location of sites most suitable for aquaculture activity.

21) New advances in molecular biology and technologies such as e DNA are explored to elucidate ecosystem interactions between the fish-farms and wild salmonids.

22) Status of sea trout populations in different parts of Europe and their exposure to spatially dispersed threats should be assessed on national basis and evaluated to see if there is a need for international / regional assessment.

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Annex 2: Overview of monitoring and assessment activities.

1. Assessment in the Baltic area

Introduction

Sea trout has been included in assessment work in the ICES Working Group on Salmon and Trout (WGBAST) at least since the 1980'ies; however in the early years merely focusing on tagging experiments, comparison of releases of different strains in new areas and performance of hatchery fish. In more recent years tagging experiments have been evaluated as well as directly observed densities in nursery streams.

In 1994 (ICES 1994) it was clearly stated that populations had a poor status in the northern part of the Baltic Area (Gulf of Bothnia) in both Sweden and Finland, as well as in Poland. The main threat at the time was overexploitation, but also habitat and environmental problems were significant. Since 1997 the WGBAST has expressed continuous concern on the status of sea trout populations (ICES 1997; e.g. ICES 2013).

By 2006 an increased interest in the situation for the sea trout in the Baltic Area was confirmed by an international meeting in Kotka, Finland, focusing exclusively on this subject (Heinimaa & Pakarinen 2007), and in ICES context where the Study Group on Data Requirements and Assessment Needs for Baltic Sea trout (SGBALANST) was established at the ICES Annual Science Conference.

The SGBALANST working group was active until 2011 and produced three reports (ICES 2008, 2009 and 2011). In the last report the study group presented a suggestion on an assessment method used in WGBAST since 2012.

In addition, the status of sea trout populations was analyzed by HELCOM (2011) providing an overall and country specific overview of the status of populations around the Baltic. Furthermore, a workshop in Helsinki, 2011 (Pedersen *et al.* 2012), focused on recent developments in Baltic sea trout populations and possible management issues.

Baltic assessment method presently used

The model presently used is presented in ICES (2011). It is based on available data of trout densities at sites with good habitat and water quality. Initially an index of habitat quality was established, trout habitat score (THS). It is based on six variables. For each of the habitat variables, habitat score values were determined based on preference curves and expert opinions (Table 1).

The following data were available for electrofishing sites from all countries around the Baltic (some missing for one or more countries): Stream width, Slope (missing for some countries), Depth, Substrate, Shade, Velocity

Habitat score values used are presented in Table 1.1.1

Table 1.1.1. Habitat score values for separate variables used in the THS (trout habitat score) in the Baltic trout assessment.

	---------------------------------------Habitat score------------------------------------		
	0	1	2
Wetted width of stream (m)	>10	6-10	<6
Slope (%) of section	<0,2 & >8	0,2-0,5 & 3-8	>0,5-<3
Water velocity class	Slow/still	Fast	Moderate
Average/dominating depth (m)	>0,5	0,3-0,5	<0,3
Dominating substratum	Fine	Large stones, boulders or sand	Gravel-Stone
Shade (%)	<10%	10-20	>20

The THS was then constructed as a simple addition of all the individual scores of the six descriptors for each site:

THS = width + slope + velocity + depth + substrate + shade

The results of these for three countries are presented in Figures 1.1.1–1.1.3.

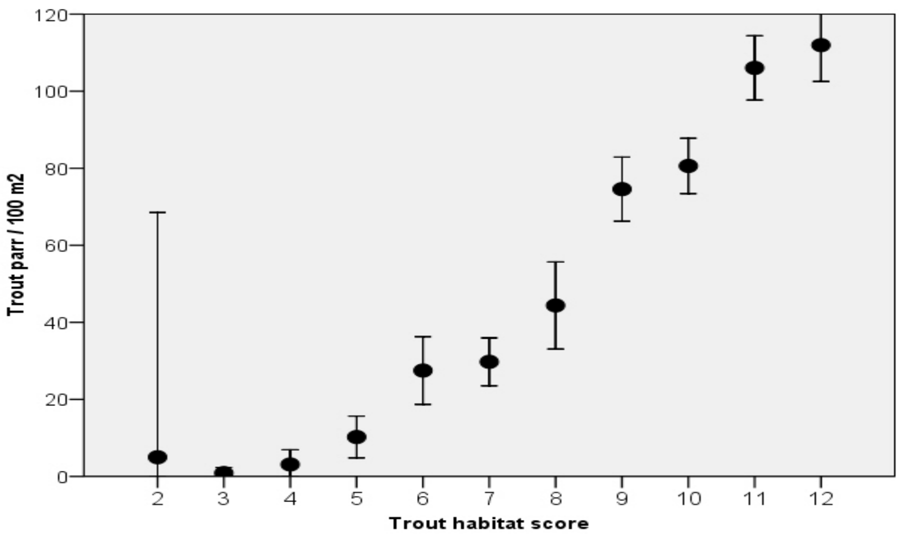

Figure 1.1.1. Trout densities (averages and 95% c.i.) at different Trout Habitat Score values in Sweden.

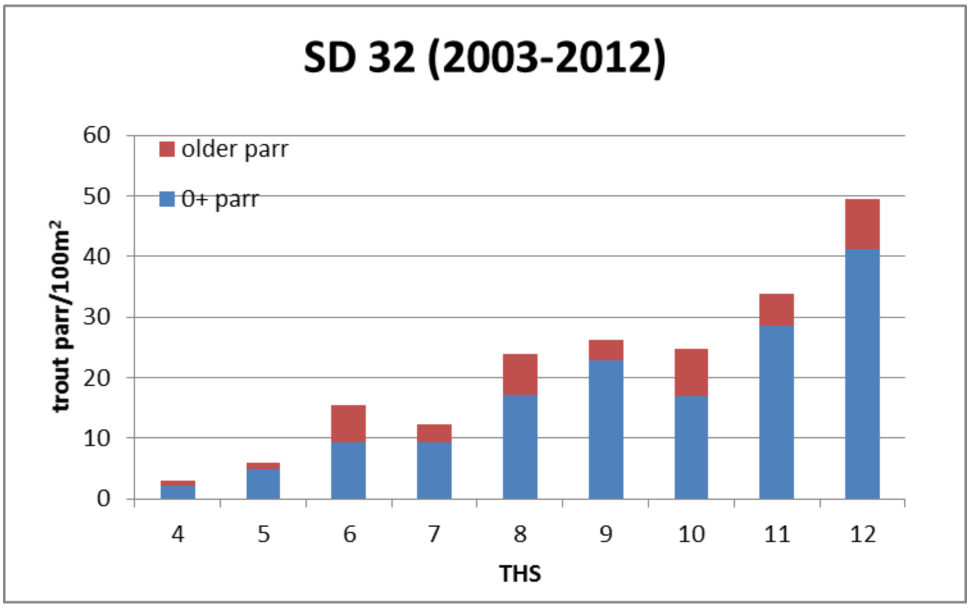

Figure 1.1.2. Trout densities at different Trout Habitat Score values in Estonia.

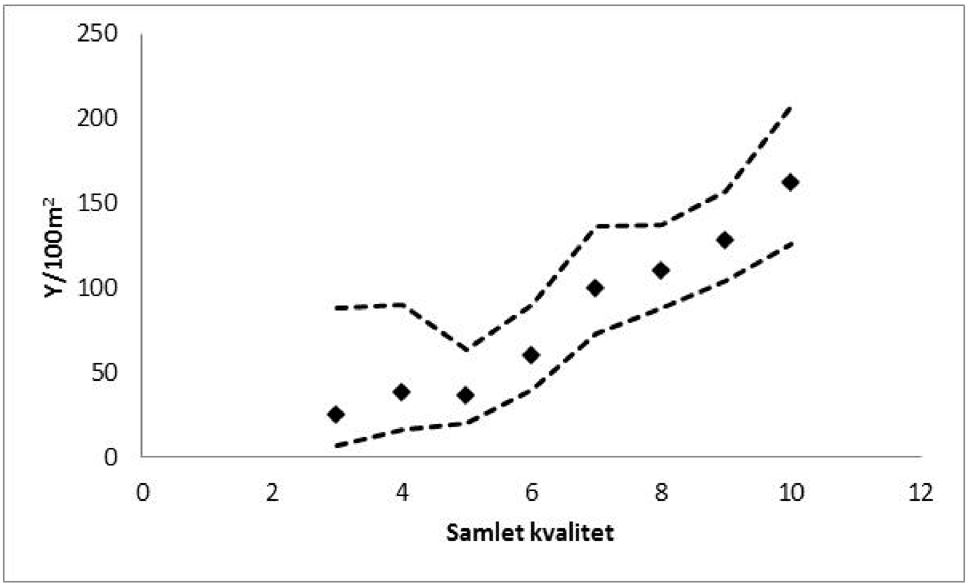

Figure 1.1.3. Trout densities at different Trout Habitat Score values in Denmark.

The different Trout Habitat Scores were originally recommended to be combined into 4 combined THS (ICES 2011):

0 = THS <6

1 = THS 6-8

2 = THS 9-10

3 = THS 11-12

if slope is included or

0 = THS <4

1 = THS 5-6

2 = THS 7-8

3 = THS 9-10

if slope is omitted.

Using THS sites with high habitat quality was identified and used to produce a model of expected trout densities at sites with high/good habitat. Densities of sea trout parr depend on climate and the size of the river (op. cit.). Using these factors the effect of different climate and catchment size was accounted for. Only rivers with good water quality and good habitat as reported by the members of SGBALANST were selected for modelling. Only data from the period 2000–2008 were used as this period was available from all members that had electrofishing data. Further, only stable populations were used, i.e. those with a CV (Coefficient of variation) below 50% (calculated from log10-transformed river averages of trout parr abundance different years). This was done to eliminate rivers with large fluctuations, e.g. some rivers in the Gulf of Finland that had limited ascent of spawners in the autumn of 2002 due to low water flow. Data from ICES subdivision 31 was not used as it was the opinion of the Finnish and Swedish delegates that these stocks were extremely small, well below carrying capacity. A few rivers with stocking of parr were included as it was suggested that the stocking was done to levels that were not above carrying capacity. Using the resulting simple model, the abundance of parr in rivers with good ecological conditions and stable populations could be predicted from latitude and catchment size class, but with only 32.5% explained variation. Parr abundance (Log10) at these sites could be described using multiple linear regression ($r2=0,542$, Anova; $F2,66=41,2$, $p<0,001$):

*Parr (log10) = 1,890-(1,153+Wetted width (log10))+(0,079*Aver. air temperature)*

The observed abundance for each river and year was divided by the predicted abundance and expressed as percentage; recruitment status. Rivers with abundance as predicted would then get a recruitment status of 100%, and rivers with a lower abundance than predicted would have lower percentages. It must be stressed that a recruitment status of 100% does not mean that a maximum production of recruits is present. It is mere an index of what was the best production in rivers with good habitat during 2000–2008.

The relative status is calculated by comparing average observed density to average densities at sites with optimal quality within the same Subdivision (Figure 1.1.4 from ICES 2013). A value of 100 represents the 'expected' density in that area.

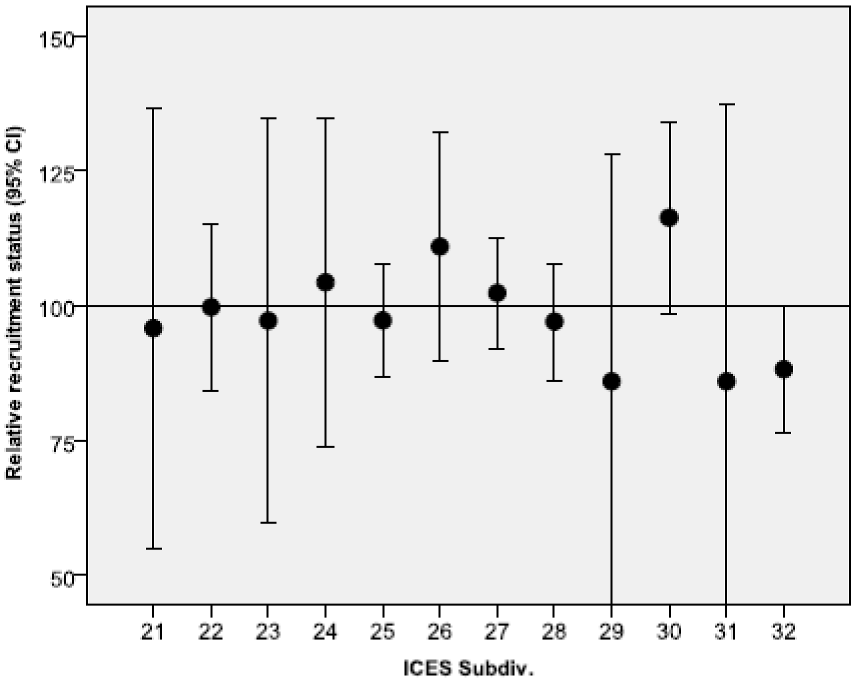

Figure 1.1.4. The relative recruitment status (averages and 95% c.i.) for trout in different ICES Subdivisions in the Baltic area.

The relative recruitment for each are may for practical purposes be grouped into larger assessment areas consisting of several geographically close ICES Subdivisions (Figure 3.1.5 – ICES 2013).

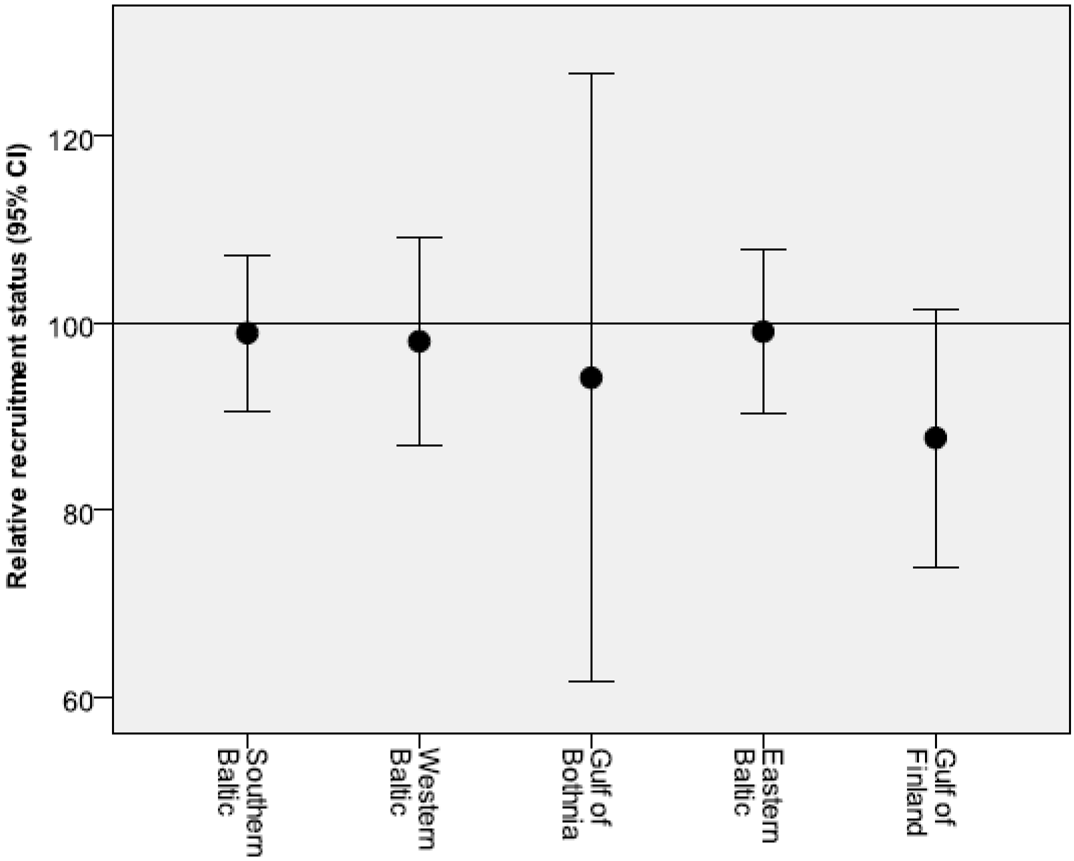

Figure 1.1.5. Average relative recruitment status ((observed parr abundance/predicted abundance)*100, averages and 95% c.i.) for different parts of the Baltic Sea.

The development trend in an area may then be calculated using the average Pearson *r* (trend in parr abundance during 2000–2011), demonstrated in Figure 1.1.6 (ICES 2013) for different assessment units in the Baltic.

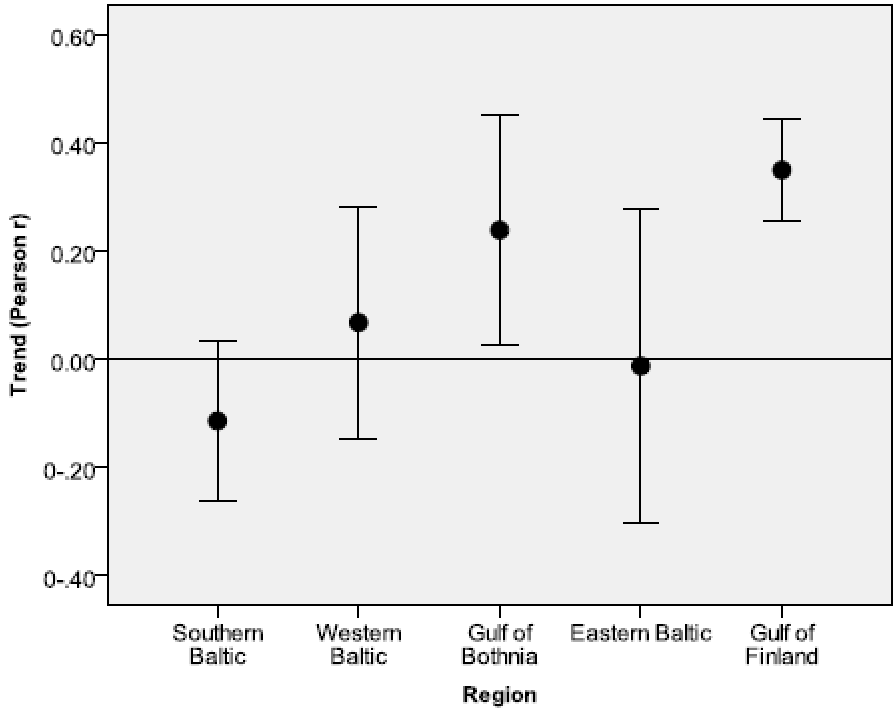

Figure 1.1.6. Average Pearson *r* (trend in parr abundance during 2000–2011, averages and 95% c.i.) for different parts of the Baltic Sea.

2. Assessment overview by country

2.1. England & Wales

COUNTRY	ENGLAND AND WALES
REGION	All country
INSTITUTION(S) MONITORING	Environment Agency (EA) (All rivers in England and Wales to April 2013; England and Welsh border rivers, April 2013 onward.) Natural Resources Wales (NRW) (Wales and English border rivers, April 2013 onward.) [Note: Common approach to monitoring by both organizations - as set out below.]
PURPOSE OF MONITORING	Adult stock and fishery assessment and regulation of fisheries. Assessment of juvenile distribution and abundance - principally via electrofishing surveys to evaluate status at a site/sub-catchment scale (e.g. for Water Framework Directive evaluation of 'Ecological Status').
WHERE IS MONITORED1)	1. All licenced net (coastal and estuarine) and rod (in-river) fisheries. 2. All main 'principal' sea trout and salmon rivers (~70).
ITEMS MONITORED2)	Net catch returns by licensee (e.g. 31 fisheries; 45 gears; 274 licences in 2012). Includes data on (i) catch (number and date of fish caught; individual fish weight; carcass tag number1; killed or released); (ii) fishing effort (hours1/tides fished; days fished; licences issued); (iii) location fished (fishery/river) and (iv) method (gear type). [1Variables collected since carcass tag/logbook scheme was introduced in 2009. Other variables collected from licence return pre-2009.] Rod catch returns by licensee (note licence covers all rivers; e.g ~26K annual and ~9K short term licences in 2012). Includes data on (i) catch2 (number and date of fish caught; individual fish weight; killed or released); (ii) fishing effort3 (days fished per river; licences issued – not river specific); (iii) location fished (river) and (iv) method (fly/spin/bait). [2Option to report combined catches of small sea trout (<~0.5kg). 3No distinction between salmon and sea trout angling effort, but periodic surveys (1996 and

	2006) provide some information on the effort spilt.] Juvenile electrofishing (EF) surveys - quantitative (netted) and semi-quantitative (un-netted) sites 30-50m long. Rolling programme of annual/biannual temporal (~400 sites) and 6-yearly spatial surveys (~3,000 sites). Includes data on (i) catch (number caught; fish length; fish age - from length/scales) and (ii) site features (location; site length/width/area; habitat features – 'HabScore'). Resistivity fish counts – main river counters with supporting information to provide Returning Stock Estimates (RSEs). Sea trout RSEs available on 5 rivers (Tyne; Tamar; Fowey; Lune and Kent) from resistivity counts. [RSEs obtained from one river (Dee) from trapping and mark-recapture (see below).] Data includes daily/monthly/annual run estimates [indication of fish size from counter signal strength]. Adult (upstream) traps - main river partial traps for provision of biological information [and RSEs by mark-recapture in the case of the Dee above]. Trapping co-located with resistivity fish counters on the 'index rivers' (Tyne,Tamar, Dee and Lune) [biological information on the Tyne is obtained from rod fishery and broodstock sampling]. Trapping on some other systems (e.g. Tees, Taff; Tawe and Caldew). Data on individual fish details includes: date caught; length; weight; river age (from scales); sea age (from length/scales); sex (from external features); general condition (e.g. parasites/disease). Smolt traps - main river/tributary partial traps. Provision of return rate and run estimates from mark-recapture. Trapping on two 'Index rivers' (Tamar and Dee). Data include (i) individual fish details (date caught; length; weight; river age – from scales); (ii) smolt run estimates and return rates (latter by maiden sea age group).
QUALITY OF DATA	Data quality is generally good with collection methods consistent over many years. For example, single national angling licence return system has been in place since 1993 (separate regional schemes before then); overall, the declared catch from this scheme is estimated to represent ~90% of the total catch (although reporting rates may vary, by an unknown amount, from river to river). EF survey sites are biased to reaches accessible to Atlantic salmon and sea trout, so non-anadromous brown trout may be under-represented in samples. Similarly, the angling licence system for non-anadromous brown trout (unlike the system for salmon and sea trout described above) does not include a catch return, so no information is routinely collected on the catches of these fish. The status of this component is largely unknown on most rivers.
OTHER / REMARKS	
REFERENCES / PUBLICATIONS	Environment Agency (2003) National Trout and Grayling Fisheries Strategy – see: http://www.environment-agency.gov.uk/research/library/publications/113643.aspx Environment Agency (2012) Index River monitoring for salmon and sea trout. Environment Agency (2013) Salmonid and Freshwater Fisheries Statistics for England and Wales, 2012 – see: http://www.environment-agency.gov.uk/research/library/publications/148591.aspx
ACCESSIBILITY OF DATA	Data available on request.
REPORTED BY (INSTITUTION, NAME)	Natural Resources Wales, Ian Davidson

2.2. Scotland

COUNTRY	SCOTLAND
REGION	United Kingdom
INSTITUTION(S) MONITORING	1. Marine Scotland Science (MSS) (Scottish Government) 2. Local Fisheries Trusts (FTs) 3. Scottish Environment Protection Agency (SEPA)
PURPOSE OF MONITORING	1 MS, 2 FTs. Monitoring status of populations 3 SEPA. Waterbody classification under the Water Framework Directive.
WHERE IS MONITORED[1)]	1. MSS. Streams, catch statistics (all types of water with fisheries). All Scotland. 2 FTs. Streams, some netting in coastal waters. In local areas each FT is responsible for (FTs cover most of Scotland) 3. All Scotland.
ITEMS MONITORED[2)]	1. MS Sea trout catches across the whole of Scotland (since 1952). Freshwater. Trout 0+ and parr as part of survey work on sites mainly monitored for their salmon. Some long term datasets, notably for a site on the Shelligan Burn, Perthshire, which has been visited at least annually since 1966, with within year sampling for some years. Some information from traps operated primarily for salmon. 2. FTs Extensive electrofishing information with accompanying habitat information from sites on streams since 1997. Data from survey netting in coastal waters in some parts of Scotland. Some information from traps, some on tributaries used primarily by sea trout. 3. SEPA This is a relatively new, but potentially important, dataset.
QUALITY OF DATA	MS. The catch survey operates on a statutory basis with information successfully obtained from a high proportion of the rod and net fisheries operating. The data is believed to provide a good index of the actual catches. There is little information on the exploitation rates of sea trout in Scotland by netting by rod and net in different parts of Scotland in different months to allow conversion into absolute numbers and no attempt is made to do this. A large decline in net effort has resulted in the net catches now being of limited use for stock assessment, and the rod catches now form the main basis for stock assessment. Data on rod effort is not collected as part of the statutory survey. The electrofishing and habitat information collected by all the parties is of a high standard. Since 1997 the survey work by FTs has been co-ordinated by the Scottish Fisheries Co-ordination Centre which the Trusts are members of. There is a comprehensive set of sampling protocols and training programmes and the information is held in a single database with information at a local level shared between parties which have agreed to this.
OTHER / REMARKS	
REFERENCES / PUBLICATIONS	Annual statistical reports on the catch survey.
ACCESSIBILITY OF DATA	
REPORTED BY (INSTITUTION, NAME)	Ross Gardiner, Marine Scotland, Ronald Campbell, Fisheries Trusts, SEPA

2.3. Ireland

COUNTRY	IRELAND
REGION	All fishery Districts
INSTITUTION(S) MONITORING	Inland Fisheries Ireland, Marine Institute
PURPOSE OF MONITORING	Statutory salmon logbook returns require sea trout >40cm also to be recorded in rod and commercial fisheries. Two rivers, Burrishoole and Erriff (National Index Catchment) have long-term monitoring of sea trout stocks (traps/counters).
WHERE IS MONITORED[1)]	All commercial salmon fisheries and selected rod fisheries (approx 62 rivers). Sea trout are monitored in about 20 fish counters monitoring upstream sea trout runs.
ITEMS MONITORED[2)]	<u>Monitoring in freshwater:</u> 0+ Density / parr densities (method, time, frequency, intensity, duration of observation) Approx 125 of Irelands 140 salmon rivers have been electro-fished since 2008 to assess salmon fry density. O+ and parr trout are encountered in the shallow riffle sites fished and recorded in this programme over the July to September period. Smolt number (method e.g.: traps with complete catch, traps with partial catch, derived from density, duration of observations, ….), Sea trout smolt and kelt numbers are available from two traps (Burrishoole & Erriff) since 1969 and 1984 respectively and over the 1991- 2011 period in traps in two Connemara fisheries. Spawner number (method: trap with total catch, trap with partial catch, derived from catch (rod, professional, Catch Per Unit Effort, camera total Total upstream sea trout runs are available from the Burrishoole and from two Connemara fisheries (1991-2011). Upstream sea trout numbers are available from about 20 rivers with fish counters since 2005. Baseline biological data on sea trout populations at sea have been recently undertaken through the Celtic Sea Trout Project.
QUALITY OF DATA	Commercial sea trout catch is accurately recorded. Rod fishery sea trout catch is underestimated for fish >40 cm and poorly recorded for smaller sea trout. The catchment wide electro-fishing programme undertaken annually by IFI in different rivers concentrates on shallow gravel/riffle sites for o+ salmon fry. Trout fry are also captured and some parr. This programme underestimates the density of 0+ trout fry as trout spawn earlier in the season and may have migrated from shallow riffle sites by the start of the programme in July. The Water Framework Directive monitoring programme does monitor surveillance sites for all fish species and provides good quality data on juvenile trout density. There is a difficulty in determining whether juvenile trout are the progeny of resident or migratory fish.
OTHER / REMARKS	
REFERENCES / PUBLICATIONS	Anon. (1995). Report of the Sea Trout Working Group, 1994, Department of the Marine, Dublin, 254pp. Gargan, P.G., Tully, O., & Poole. R 2003. The Relationship Between Sea Lice Infestation, Sea Lice Production And Sea Trout Survival In Ireland, 1992-2001. In: Salmon on the Edge (ed. D. Mills), pp. 119-135. Blackwell Science, Oxford, UK. Gargan, P.G., Poole, R, & Forde, G. (2006). A Review of the Status of Irish Sea trout Stocks.In G.S.Harris and N.J. Milner. Sea Trout: Biology, Conservation and Management. Fishing News Books, Blackwells Scientific Publications, Oxford, UK. pp 25-44. Gargan, P.G., Roche, W.K., Forde, G.P. and Ferguson, A. (2006) Characteristics of sea trout (Salmo trutta L.) stocks from the Owengowla and Invermore Fisheries, Western Ireland, and Recent Trends in Marine Survival. In G.S.Harris and N.J. Milner. Sea

	Trout: Biology, Conservation and Management. Fishing News Books, Blackwells Scientific Publications, Oxford, UK. 60-75. Mills C.P.R, Piggins D.J. & Cross T.F. (1986). Influence of stock levels, fishing effort and environmental factors on anglers' catches of Atlantic salmon, *Salmo salar* L., and sea trout, *Salmo trutta* L. *Aquaculture & Fisheries Management*, 17, 289-297. Poole, W.R., Dillane, M., deEyto, E, Rogan, G. & Whelan, K. (this meeting). Chracteristics of the Burrishoole sea trout population: census, marine survival, enhancement and stock recruitment, 1971-2003. Paper presented to the 1st International Symposium on the Conservation and Management of Sea Trout. Poole, W.R., Whelan, K.F., Dillane, M.G., Cooke, D.J. & Matthews, M. (1996). The performance of sea trout, *Salmo trutta* l., stocks from the Burrishoole system western Ireland, 1970-1994. Fisheries Management & Ecology, 3 (1). 73-92. TULLY, O. GARGAN,P.G., POOLE,W.R., and WHELAN, K.F. (1999). Spatial and temporal variation in the infestation of sea trout (*Salmo trutta* L.) by the caligid copepod *Lepeophtheirus salmonis* (Kroyer) in relation to sources of infestation in Ireland. Parasitology, 119, 41-51. Whelan, K.F., and Poole, W.R. 1996. The Sea Trout Collapse, 1989-92. *In* The Conservation of Aquatic Systems, pp 101-110. *Edited by* J.D. Reynolds. Proceedings of seminar held on 18-19th February, 1993. Royal Irish Academy, Dublin. 194 pp.
ACCESSIBILITY OF DATA	Commercial, rod catch data accessible, Juvenile catchment wide electro-fishing trout data available, WFD monitoring data available. Long term monitoring data on Burrishoole published, Long term monitoring data in Erriff being prepared for publication.
REPORTED BY (INSTITUTION, NAME)	Inland Fisheries Ireland ; Since 2010 Inland Fisheries Ireland is the state agency responsible for the protection, management and conservation of Ireland's sea trout fisheries.

2.4. North Ireland

COUNTRY	**UK (NORTHERN IRELAND)**
REGION	Northern Ireland and Cross-Border Foyle and Carlingford areas
INSTITUTION(S) MONITORING	AFBI, DCAL, Loughs Agency.
PURPOSE OF MONITORING	Fulfillment of salmonid conservation/monitoring programmes. Often trout information is collected as a by-product of salmon monitoring.
WHERE IS MONITORED[1)]	*Sea Fishery Areas in Northern Ireland.* DCAL fishery area – Commercial sea trout catches. *All Riverine Fishery Areas in Northern Ireland.* DCAL fishery area – Recreational sea trout catches. Loughs Agency fishery area – Recreational sea trout catches. *Monitored Sea Trout Rivers in Northern Ireland.* Shimna River (AFBI/DCAL) Moneycarragh River (AFBI/DCAL) Glendun River (AFBI/DCAL) Faughan River (Loughs Agency) Roe River (Loughs Agency) BurnDennett (Loughs Agency)
ITEMS MONITORED[2)]	*Sea Trout Catches (Commercial & Recreational).* Commercial and recreational sea trout catches are monitored through carcass tagging and logbook schemes which are operational in both fishery areas in Northern Ireland (DCAL area and Loughs Agency area).

	Shimna River - 0+ Density (Semi-quantitative electric fishing - 5 minutes); 1+ Density (Depletion electric fishing 1 site); Adult abundance (Resistivity fish counter); CPUE index (Derived from recreational fishers). Moneycarragh River - 0+ Density (Semi-quantitative electric fishing - 5 minutes). Glendun River - 0+ Density (Semi-quantitative); 1+ Density (Depletion electric fishing 1 site); Adults (Resistivity fish counter). Faughan River - 0+ Density (Semi-quantitative); Adults (Resistivity fish counter). Roe River - 0+ Density (Semi-quantitative); Adults (Resistivity fish counter). BurnDennett - 0+ Density (Semi-quantitative)
QUALITY OF DATA	*Sea Trout Catches.* The carcass tagging and logbook schemes in both N. Ireland fishery areas are similar in that only larger sea trout must be tagged and recorded (>50cm in the DCAL area and >40cm in the Loughs Agency area). There is currently no requirement to tag and log sea trout above the statutory minimum retention size and under the statutory tagging size, as such the carcass tagging derived catch data is limited to the larger/older component of stocks. *0+ Density.* All the rivers mentioned above are subject to annual electric fishing surveys employing a semi-quantitative (SQ) technique developed locally (Crozier & Kennedy, 1994). Typically SQ sites are sited through-out each catchment to sample the entire range of nursery habitats available to migratory salmonids. A relative index of abundance (No. 0+ 5 $mins^{-1}$) is generated for each river in each year, and since sites and techniques are standard between years, a comparative time series of 0+ abundance is available for each monitored river. Most of the catchments listed above currently have time series of around 10 years in duration. *1+ Density.* Several long term monitoring sites (Shimna & Glendun River) are conducted on coastal sea trout rivers in Northern Ireland using depletion electric fishing techniques. Abundance estimates (no. m^{-2}) are available for these sites, however, time series are variable and range from 3-10 years. *Adult abundance in Rivers.* The Shimna, Glendun, Roe, Faughan and Foyle all take runs of adult sea trout and have fish counters monitored by Aquantic 2100C resistivity fish counters. All facilities have CCTV validation. The counters typically have electrode spacing set at c. 45-55cm, which was designed for detection of adult salmon. Larger sea trout are counted at each site but the smaller size component (particularly finnock) of each stock are variably detected and thus under-represented in the count; a shortcoming for full stock assessment on these rivers.
OTHER / REMARKS	Adult and smolt trapping facilities have been operational on the River Bush in Northern Ireland since 1974 and provide the basis of many long term databases describing population dynamics of Atlantic salmon. The Bush River tends not to produce sea trout with the annual smolt run often less than 50-100 individuals (in contrast to 10,000-25,000 salmon smolts) and few returning adult sea run trout. The River Bush trout stock tend to complete their lifecycle within freshwater and as such the river does not provide an index of local sea trout population dynamics. The Shimna River was included as a sampling river during the recent Celtic Sea Trout project. Additional data will be available from this river on a range of biological

	characteristics including size, age and genetic structure during 2010-12. The Loughs Agency have two PhD's ongoing to report in 2015 and 2016 on sea trout (www.loughs-agency.org/ibis)
REFERENCES / PUBLICATIONS	Crozier W.W. & Kennedy G.J.A. (1994) Application of semi-quantitative electrofishing to juvenile salmonid stock surveys. *Journal of Fish Biology* 45, 159–164. McLeish J. (2012) The impact of predation on the Atlantic salmon (Salmo salar) and Brown trout (Salmo trutta) stocks of the Lough Foyle Catchment – A Bioenergetics Modelling Apllication, IBIS Rport (www.loughs-agency.org/ibis
ACCESSIBILITY OF DATA	Sea Trout data not generally published.
REPORTED BY (INSTITUTION, NAME)	AFBI, Loughs Agency.

2.5. Spain

COUNTRY	**SPAIN**
REGION	North and North West Area Autonomies Communities: Navarra, Basque Country, Cantabria, Asturias and Galicia
INSTITUTION(S) MONITORING	Xunta de Galicia (Dirección Xeral de Conservación da Natureza) Gobierno de Navarra (Dirección General de Medio Ambiente y Agua)
PURPOSE OF MONITORING	Monitoring status of brown trout and salmon populations
WHERE IS MONITORED[1)]	Streams and catch statistics
ITEMS MONITORED[2)]	Xunta de Galicia (only freshwater): Trap operation: in three regular upstream traps since 1993 (Ximonde Trap at Ulla River) and since 1997 (Bora Trap at Lérez River and Freixa Trap at Tea River-Tributary of Miño River). Ximonde and Freixa Traps also operate with smolt trap but number of smolt trap is not yet calculated properly. Adult and kelt data are register every day of the year in Ximonde and Bora traps, in Freixa Trap mark recapture methods allow the estimation of the sea trout run. 0+ densities, parr densities (electrofishing, late summer – early autumn, routinely at 120 sites in salmons and sea trout area fished every year since 1996, routinely at 52 sites in brown trout area every year since 2000. Fish data collected together with habitat data. Official Catch Series since 1995 is available, due to that Galician Freshwater Law published in 1992, made obligatory to declare all sea trout caught. Gobierno de Navarra (Dirección General de Medio Ambiente y Agua) Trap operation: in one regular upstream traps since 1992 (Bera Trap) in the only salmon/sea trout river of this Conmunity. Adult data are register every day of the yaer. At the Bidasoa River, 0+ densities, parr densities (electrofishing, late summer – early autumn, routinely at 1 site in sea trout area fished every year since 1992, routinely at 9 sites in brown trout area every year since 1992 also. Fish data collected together with habitat data. Since 2011 is obligatory to declare all sea trout caught in the Bidasoa River.
QUALITY OF DATA	Most frequently electrofishing data have good quality. Official catch statistics from Galician Recreational Fishery is underestimated because it depends on the active participation of anglers and the number of water bailiff on each river, but in some river the information is rather reliable of the catch extent.
OTHER / REMARKS	Xunta de Galicia: Gobierno de Navarra:
REFERENCES / PUBLICATIONS	

ACCESSIBILITY OF DATA	
REPORTED BY (INSTITUTION, NAME)	

2.6. France

COUNTRY	FR (France)
REGION	All regions run alongside Channel and Atlantic seas
INSTITUTION(S) INVOLVED 1- State, 2-région or subregion, 3-local a-Public, b- corporates, c-NGOs	Index rivers : ONEMA[a1] (r. Bresle and r. Oir) and INRA[a1] (r. Oir, Scorff, Nivelle) Other rivers : Associations[b2] for Conservation, Restoration and Management of Diadromous Fish, ACRMDF and similar (local Federation of Anglers[b3])
OBJECTIVE	Fulfillment of migratory fish conservation/restoration programs. *Trout information can be a by-product of first and priority salmon program*
WHAT & WHERE	**CATCHES** - Sea : logbook schemes for vessels > 12m. Managed by Administration for Maritime Affairs [a1], IFREMER[a1] and RBSFA[b2,] (Regional Board of Sea Fisheries and Aquaculture) - no scheme for vessels < 12 m.... Annual report for no commercial fixed nets in some areas as Upper Normandy (East Channel) : no report obligation for no commercial boats. - Estuary : logbook schemes for sea fishermen, same organization. Compulsory report for river netsmen to ONEMA . Voluntary report to ONEMA for rods. - River: compulsory report to ONEMA for rods. **POPULATIONS** **Monitored rivers** (only adult counting, without evaluation) East : Rhine river (Saumon Rhin [b2]) North-West : Seine river (Seinenormig[b2]) – Touques, Orne and Vire rivers (Anglers federation of Calvados[3b]) West : Elorn and Aulne rivers (Anglers Fédération of Finistère[b3], Bretagne Grands Migrateurs[b2]) Central : Loire and Allier rivers, Creuse and Vienne rivers (Logrami[b2])- Charente river (Basin organization of Charente river[abc3]) South-West : Dordogne and Garonne rivers (Migado[b2]) – Oloron, Pau et Nive rivers (Migradour[b2]) **Index rivers (adult and smolt census, trapping, with assessment)** North-West : Bresle river (ONEMA[a1]) West : Oir river (ONEMA[a1], INRA[a1])- Scorff river (INRA[a1]) South-West : Nivelle river (INRA[a1])
METHODS	**CATCHES** Commercial. - sea : no carcass tagging, logbook schemes for vessels > 1O m, only monthly reporting for vessels <10m, annual reporting for fixed nets recreational in NW (Upper-Normandy). - estuary : no carcass tagging , logbook for netsmen in lower river. Legal size : 35 cm (50 cm for salmon) No season period Recreational

	- sea : no report scheme for recreational boats (authorized to use 50 m trammel and lines) and sport fisheries. - estuary : similar to river - river : no carcass tagging, voluntary report for rods (contrary to salmon) Legal size : 35 cm (50 cm for salmon) Season period : variable according to areas. NW : 26 avril-26 october (similar salmon). 30 days extra time in october. 30' before sunrise- 2 hours after sunset. W : 9 mars – 15 june or 31 july for PHM fish ; 16 june or 1 july to 15 oct. for grilse fish. Days limit in some rivers for PHM period SW : 8 march- 31 july and 1 august – 7 september – 21 sept or 15 october (depending on river)). Day extra time as in NW – No days limitation as for salmon POPULATIONS Juvenile abundance No scheme to provide proxy of density by semi-quantitative 5' electric fishing on X sites. Just started in West (Brittany). Contrary to salmon. By-producted information on trout by salmon scheme for 15 years (in South West for example) Smolt abundance Trapping with assessment in Bresle, Oir and Scorff rivers, smolt production derived from electric fishing survey in Nivelle river. Adult abundance Gross video counts on monitored rivers, without correcting... Trap counts in index rivers with estimation No use of catches declared by rods due to very low reporting and unreliability
	CATCHES Coast & estuary : only first data processing of catches by commercial drift nets at sea and in estuary, limited and deferred access, relative confidentiality…. No data processing for fixed nets in Upper-Normandy. River : processing of data and access for some nets in SW rivers and rods in sea trout rivers everywhere Low or no control of reporting everywhere, even in river… **POPULATIONS** Juvenile 0+ abundance : no time series in monitored and index rivers. Contrary to salmon with series of around 15 years in duration. Issue of reliability of 5' sampling for sea trout, relative efficiency in deeper riffles and flats and no relationship between indices and densities, except in SW ; matter of distinction between residency vs anadromy types. Smolt abundance : 32 years series in Bresle, Oir, Nivelle Adult abundance : id
OTHER / REMARKS	
REFERENCES / PUBLICATIONS	Rare publications, grey literature : reports

AVAILABILITY OF DATA	Data not published, except in some annual activity reports ; information gathered for this workshop
REPORTED BY (INSTITUTION, NAME)	ONEMA-Dast, G. EUZENAT & F. FOURNEL, Field station of Eu

2.7. Netherlands

For information on the Netherlands see Annex 3.

2.8. Germany

COUNTRY	Germany
REGION	German Federal States Schleswig-Holstein (SH) and Mecklenburg-Vorpommern (MV) primarily covering the Baltic Sea waters
INSTITUTION(S) MONITORING	GEOMAR – Helmholtz Centre for Ocean Research Kiel (Research Centre) Verein Fisch & Umwelt Mecklenburg Vorpommern (F&U MV; registered Association) State Office for Agriculture, Food safety and Fisheries (LALLF MV) with subcontractors (NAWA, F&U MV etc) State Office for Agriculture, Environment and Rural Area (LLUR SH) with subcontractors Verein für Salmoniden und Gewässerschutz MV (VSG MV; Association for Salmonides and freshwater protection) Thünen-Institute of Baltic Sea Fisheries (TI-OF), Rostock; SH & MV)
PURPOSE OF MONITORING	GEOMAR: Sea Trout Parr Habitat Index (SH) Monitoring status of trout and salmon populations F&U MV: Spawner counts to determinate magnitude of spawning run, Marine Distribution LALLF MV: Fry stocking success control LLUR SH: Monitoring ecological status (e.g. quality determination for European Water Framework Directive) VSG MV: Spawning redd counts (MV) TI-OF: Evaluation of marine fishing mortality in the Baltic Sea (recreational and commercial fishery)
WHERE IS MONITORED[1)]	GEOMAR: rivers and tributaries, Baltic Sea (SH) F&U MV: selected Mecklenburg river and tributaries (Hellbach System) LALLF MV: stocked and formerly stocked rivers and tributaries (MV) LLUR SH: rivers and tributaries SH Verein für Salmoniden und Gewässerschutz MV: selected streams and rivers in MV (also some Elbe river tributaries - North Sea) TI-OF: Coastal and shorebased recreational and commercial fisheries in the western Baltic Sea (SD 22 & SD 24)
ITEMS MONITORED[2)]	GEOMAR (SH): LLUR (SH) LALLF (MV): VSG (MV) F&U (MV) TI-OF (SH & MV) Freshwater: (1. SH): Current pilot study, 0+ densities, parr densities (electrofishing, late summer to

	autumn, started 2013 according WGBAST Parr Habitat Score Method, 27 running water bodies 118 fished stations). Fish data collected together with habitat data (Parr Habitat Score) and water quality observations. First inventory according THS for SH – final results expected in 2014. Collection of genetic samples planned for 2014 (BALTIC SEA). (2. SH): Coordinated by LLUR Department Running Water Ecology (for EU WFWD purpose: sites selected for environmental surveillance). Electrofishing: abundance and length frequency measurements of fish (also trout) including habitat data and water quality observation (BALTIC SEA and NORTH SEA) (3. MV): 0+ densities, parr densities, since 2002 ongoing (electrofishing, spring (winter mortality) and autumn (0+ survival) in fry -stocked or formerly stocked systems (~25 rivers and tributaries since 2002, to date 13 rivers remained in stocking program) (4.MV): 21 rivers/tributaries are monitored for number of spawning redds and associated criteria (e.g. area, potential age used) since 2010 ongoing 2014 (BALTIC SEA and single Elbe river tributaries to NORTH SEA) (5. MV): Sea trout spawner counts using videomonitoring systems since 2010 (ongoing) in Hellbach, Tarnewitzer Bach and Peetzer Bach. Pit tagging of adult spawners caught in the Hellbach. Extension to three more rivers planned for 2014. (BALTIC SEA) Brackish/marine area: (5. MV): pilot tagging study with Data Storage Tags on fish from Hellbach System to follow Sea Trout marine distribution and migration behavior (2010-2011). BALTIC SEA (6. SH & MV): pilot study since 2013 (ongoing) to quantify marine recreational catches and efforts (using a telephone-diary survey approach). Since 2013, collection of scale (ageing) and tissue (genetics) samples from fish caught in the marine recreational fisheries. BALTIC SEA (5. & 6. SH & MV): pilot study started in 2013 to evaluate the socio-economic value of the German recreational sea trout fishery in the Baltic Sea (6. SH & MV): pilot study planned in 2014 to verify German commercial sea trout catches in the Baltic Sea
QUALITY OF DATA	The ICES WGBAST methodology is only followed in SH to evaluate the parr status. No comparison has been performed yet among electrofishing activities in SH and MV. Official catch statistics have unknown quality (potentially unreported catches) and do not include any discard information. Marine recreational catch estimates will be available in 2015.
OTHER / REMARKS	LLUR SH: Department Fisheries and the Federal Sport Angling Association (LSFV SH); Scientific studies by universities e.g. Kiel and Hamburg (Diploma, Doctoral theses): Quality of spawning red pilot study performed in the river system Stör (NORTH SEA) →2013; only very few redds sampled, egg survival possible Reproduction success of Salmonids by determination of spawning redd quality (NORTH SEA, Kiel Kanal, BALTIC SEA)→1987/88; 2002; 2004-2007 (pilot studies in selected rivers, Studies reported low oxygenation of redds and accordingly low egg survival potential) Early study in 1970th on smoltification age, growth rates, marine distribution and population size of sea trout in the Farver Au (BALTIC SEA) and the Rantzau (NORTH SEA) using different methods like electrofishing, scale analyses, tagging, mark and recapture. Pilot study analyzing the PCB/Dioxin/Furane concentration of adult and juvenile sea trout caught in selected stream in MV (BALTIC SEA) Concerning Baltic Sea sea trout: No index rivers are found and are very unlikely to be established. No smolt traps are operated.
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	characteristics of salmon and sea trout spawning habitats in Germany – a contribution to river ecology. Zeitschrift für Geomorphologie 53(3): S. 319-334. Dirksmeyer, J., Meyer, E.I., Brunotte, E. (2011): Haben Lachs und Meerforelle in Deutschland wieder eine Chance? Bewertung der Sedimentzusammensetzung und Sauerstoffversorgung im Bereich der Laichplätze. Zeitschrift für Geomorphologie (Supplementary Issues) 55(3): S. 77-86. Gehlhaar, C.E. (1972): Beiträge zur Biologie der Meerforelle (*Salmo trutta f. trutta* L.) in Schleswig-Holstein unter besonderer Berücksichtigung der Farver Au und der Rantzau. Doktorarbeit aus dem Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei zu Hamburg und dem Institut für Meereskunde an der Christian-Albrechts-Universität zu Kiel, S. 1-109. (in German) Gehlhaar, C.E. (1974): Untersuchungen über Alter und Wachstum von Meerforellen in der Farver Au und der Rantzau. Schriften des Naturwissenschaftlichen Verbandes Schleswig-Holstein 44: S. 107-126 (in German, English Summary) Hantke, H., Laatz, M. (2007): Untersuchungen des Laicherbestandes der Meerforelle des Hellbaches während des Projektzeitraumes 2004 bis 2006. Fischerei und Fischmarkt Mecklenburg-Vorpommern 2007 (3): S.25-34. (in German) Hantke, H., Krüger, O.W., Laatz, M. (2007/2008): Erste zusammenfassende Ergebnisse zum Pilotprojekt – automatische Langzeitregistrierung von Meerforellen im Salmonidengewässer Hellbach. In: Jahresberichte Verein Fisch und Umwelt Mecklenburg-Vorpommern 2007/2008, S. 57-80. (in German) Hantke, H. (2008): Automatische Erfassung von Meerforellen im Hellbach – Ein Methodenkomplex zur Bestandsschätzung. Fisch und Fischerei in Mecklenburg-Vorpommern 5: S. 40-44. (in German) Hantke, H. (2010): Erste zusammenfassende Ergebnisse der Markierung von Meerforellen mit DST-GPS Tags zur Ermittlung der horizontalen und vertikalen Wanderungen im Bereich der Ostsee. In: Jahresberichte Verein Fisch und Umwelt Mecklenburg-Vorpommern 2009/2010, S. 53-73. (In German) Hantke, H., Jennerich, H.-J., Schulz, N. (2011): Optimierung des Bestandsmanagements für Meerforellen (*Salmo trutta trutta* L.) in den Küstengewässern Mecklenburg-Vorpommerns durch Ermittlung vertikaler und horizontaler Wanderbewegungen. In: Beiträge zur Fischerei, Mitteilung der Landesforschungsanstalt für Landwirtschaft und Fischerei MV, Heft 45: S. 1-11. (in German) Hantke, H. (2012): Sea Trout in Germany. In: Pedersen, P., Heinimaa, P., Pakarinen, T. (2012): Workshop on Baltic Sea Trout. DTU Aqua Report No 248-2012, S. 77-85. Hantke, H., Lorenz, T., Krüger, O.W., Blume, W., Gentzen, B. (2013): Entwicklung einer Methode zur Bestandsschätzung der Meerforelle (*Salmo trutta trutta* L.) auf Grundlage videooptischer Zählungen in ausgewählten Fließgewässern unter Einbeziehung von Gewässerstrukturdaten. Jahresbericht Verein Fisch und Umwelt Mecklenburg-Vorpommern e.V., in press (in German) Hantke, H. (2013): Chapter 6: Sea Trout. In: Verband Deutscher Sportfischer e.V. Fisch des Jahres 2013 – die Forelle; ISBN 978-3-9812032-5-7. S. 36-49 (in German). Hartmann, U. (1987): Ökologische Untersuchung zur Fortpflanzungsbiologie einiger Fischarten in der Stör. Diplomarbeit, Universität Hamburg, S. 1-82. (in German) Hartmann, U. (1988): Probleme der Eientwicklung der Meerforelle in der Stör – Vorschläge zu einer Lösung. Arbeiten des Deutschen-Fischerei Verbandes 46: S. 72-94. (in German) Heller, T. (2013): Ermittlung und Einschätzung der Dioxin und PCB Gehalte der Meerforelle (*Salmo trutta*) in Mecklenburg Vorpommern. Diploma Thesis, University Zittau/Görlitz S. 1-64. (in German, unpublished) Lill, D.R., Schaarschmidt, T., Mitschke, V. (2004): Meerforellenbesatz in kleinen Ostseezuflüssen Mecklenburg-Vorpommerns 2002/2003. Fischerei & Fischmarkt in Mecklenburg-Vorpommern 01/2004, S. 4-10. (in German) Meyer, E., Dierksmeyer, J., Kaschek, N., Pöpperl, R. (2008): Evaluierung des Reproduktionserfolges von Großsalmoniden in Besatzgewässern Schleswig-Holsteins im Rahmen der Erfolgskontrolle von Fischarten Hilfsmaßnahmen. Endbericht, S. 1-52, Studie im Auftrag von: Amt für ländliche Räume Kiel als obere Fischereibehörde Schleswig-Holsteins. (in German, unpublished)

	Oberdörffer, P. (2002): Untersuchungen zum Reproduktionserfolg von Forellen in Zuflüssen des Nord-Ostsee-Kanals. Abschlussbericht 2002, Universität Hamburg, Institut für Fischereiwissenschaft und Hydrobiologie, S. 1-75. (in German, unpublished) Petereit, C., Reusch, T. B. H., Dierking, J. and Hahn, A. (2013) *Literaturrecherche, Aus- und Bewertung der Datenbasis zur Meerforelle (Salmo trutta trutta L.) : Grundlage für ein Projekt zur Optimierung des Meerforellenmanagements in Schleswig-Holstein* GEOMAR Report, N. Ser. 010 . GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel, Kiel, 158 pp. DOI 10.3289/GEOMAR_REP_NS_10_2013 (in German) Weltersbach, S., Strehlow, H., Petereit, C. (2013): National report Germany 2012 ICES WGBAST. Contributions to WGBAST report 2013, 12p.
ACCESSIBILITY OF DATA	Most data are not publicly accessible
REPORTED BY (INSTITUTION, NAME)	GEOMAR, Christoph Petereit TI-OF, Simon Weltersbach F&U, Harry Hantke

2.9. Denmark

COUNTRY	DENMARK
REGION	All country
INSTITUTION(S) MONITORING	DTU Aqua (National Institute of Aquatic resources) Danish Nature Agency (National Environmental Authorities - DEA)
PURPOSE OF MONITORING	DTU Aqua: Monitoring status of trout and salmon populations DEA: Monitoring ecological status (e.g. quality determination for European Water Framework)
WHERE IS MONITORED[1)]	DTU Aqua: Streams and tributaries, occasionally sea DEA: Streams and tributaries
ITEMS MONITORED[2)]	DTU Aqua: Freshwater: a) 0+ densities, parr densities (electrofishing, late summer – early autumn, routinely at 12 sites fished every year, and routinely at approx. 5000 sites over 7-9 year cycle, covers all trout streams, continuously in larger streams since 1960'ies, all streams since approx. 1990). Fish data are collected together with habitat data and water quality observations. b) Locally count of spawning pits (by angler associations, every year, continuously in recent years) c) Locally statistics on angler's catch (by angler associations, every year) d) recreational catches (both sea and freshwater, telephone interviews, annually since 2010) Derived information: Smolt production is calculated from densities of parr using fixed 0+/parr to smolt survival rates DTU Aqua: Sea: a) Professional catches by weight (fishery statistics, routinely) b) Recreational catches (both sea and freshwater, telephone interviews, annually) DEA: Freshwater: 0+ densities, parr densities (electrofishing, late summer –early autumn, routinely at 16 sites fished every year, routinely at additionally 799 sites fished over 7 year period, sites

	selected for environmental surveillance). Information on habitat, invertebrates and water quality are collected from same sites. Anglers catch data are available from a number of streams (mandatory reporting in recent years in salmon rivers, voluntary reporting in sea trout streams)
QUALITY OF DATA	All electrofishing data have good quality (reliable data on both fish number and size (length)), count of spawning pits are possibly incorrect and underestimates spawning run but may be used as index of spawning run, catch statistics from anglers in freshwater are in most rivers likely to be underestimated, official catch statistics has unknown quality but does not include caught fish being released again, catch statistics from telephone interview has unknown quality.
OTHER / REMARKS	DTU Aqua: Additional monitoring: Smolt number and emigration time + sea survival (smolt trap, as part of time limited projects, occasionally) Smolt emigration time and survival during emigration, including survival through lakes + sea survival (electronic tags with automatic registration in stream + Spawning run and immigration time (electronic tags, as part of time limited projects, occasionally) Migration and behavior at sea (returns from traditional tagging / electronic tags, occasionally) Sea survival (electronic tags with automatic registration near outlet to sea The number of sites fished every year is limited to only 28 (reducing the reliability of observations on following general trends in population development). No index rivers are found and are very unlikely to be established. No permanent smolt traps are operated.
REFERENCES / PUBLICATIONS	Most recent monitoring reports from DTU Aqua including trout densitieas are found here: http://www.fiskepleje.dk/Vandloeb/udsaetning/oerred
ACCESSIBILITY OF DATA	Data are publicly accessible through http://internet.miljoeportal.dk/Sider/Forside.aspx
REPORTED BY (INSTITUTION, NAME)	DTU Aqua, Stig Pedersen

2.10. Norway

COUNTRY	NORWAY
REGION	All country
INSTITUTION(S) MONITORING	Norwegian Institute of Nature Research (NINA) Norwegian Institute of Water Research (NIVA) Norwegian University of Science and Technology (NTNU) Uni Research AS (University of Bergen) Some smaller private companies No overall co-ordination
PURPOSE OF MONITORING	All institutions monitor ecological status (e.g. quality determination for European water Framework Three reference rivers with wolf traps (two from 2014) monitor all up- and downstream stream migrations of sea trout.
WHERE IS MONITORED[1)]	Streams, tributaries and occasionally sea
ITEMS MONITORED[2)]	Freshwater: 0+ and par densities (electrofishing, late summer – early autumn). The surveys are often parts of impact assessments or monitoring programs in watercourses regulated by hydropower. Further, surveys may be conducted in order to monitor ecological status of individual streams or rivers. The smolt runs are monitored by wolf traps in the index rivers or occasionally (typically in a period of 1-5 years) by rotary screw traps, PIT tag antennas, submerged

	video cameras or other temporarily installations. Returning adults are counted by wolf traps in the index rivers or occasionally (typically in a period of 1-5 years) by PIT tag antennas, submerged video cameras or other temporarily installations. Many fish ways have automatic fish counters or a trap which is emptied (and the numbers of fish counted) on a daily basis Spawners (sea trout and salmon) are counted in many salmon rivers (visual observation by foot or from drifting divers in larger rivers) Spawning grounds (sea trout and salmon) are counted in many salmon rivers (visual observation by foot, from boats or by drifting divers) Reports from recreational (underreported; especially in smaller water courses with no or poor administration of the fishery licenses) and professional fisheries (obligatory to report) Sea: Reports from professional fisheries (obligatory to report) Locally, different kinds of traps are used in the sea to recapture smolts during their seaward migration or to capture returning adults. The traps are mainly intended for Atlantic salmon but may capture sea trout as well. Some studies on seaward migrations and habitat use have been conducted (acoustic telemetry, pit tags, traditional tags)
QUALITY OF DATA	All electrofishing data have generally good quality (reliable data on both fish number and size (length)). Count of spawning pits are possibly incorrect and underestimates spawning run but may be used as index of spawning run Catch statistics from anglers in freshwater are likely to be underestimated Official catch statistics has unknown quality. From 2009 have numbers of caught fish being released again being recorded. Sea catches are only reported from fishermen registered in "Sjøfangstregisteret ". Data from the wolf traps holds a good quality; however data from the fish counters differs in quality. Highest quality is typically obtained from whose traps with a submerged video camera installed.
OTHER / REMARKS	A recent report from Norwegian Institute of Nature Research suggest a national monitoring system in Norway. The report is in Norwegian but with an english summary www.miljodirektoratet.no/no/Publikasjoner/Publikasjoner-fra-DirNat/Oppdragsrapporter/Forslag-til-overvakingssystem-for-sjoorret/
REFERENCES / PUBLICATIONS	Monitoring reports including trout densities from the different research institutions are found here: www.nina.no/ninaenglish/Publications.aspx www.niva.no/en/rapporter/sok www.ntnu.no/vitenskapsmuseet/publikasjoner www.miljo.uni.no/?page_id=56
ACCESSIBILITY OF DATA	Data obtained from monitoring of ecological status in streams and rivers can be found here: http://vannmiljo.miljodirektoratet.no/
REPORTED BY (INSTITUTION, NAME)	NTNU University Museum, Jan Grimsrud Davidsen

2.11. Sweden

COUNTRY	SWEDEN
REGION	All country
INSTITUTION(S) MONITORING	SLU (Swedish University of Agricultural Sciences) County Administration Boards (CAB)
PURPOSE OF MONITORING	SLU: Monitoring and status of trout and salmon populations, SLU is monitoring for the EU DCF (Data Collection Framework) covering the Baltic Sea, Swedish west coast not included in DCF. CAB: Monitoring ecological status (e.g. quality determination for European Water

	Framework, effects of liming and habitat restoration)
WHERE IS MONITORED[1)]	SLU: Streams and tributaries, occasionally sea CAB: Streams and tributaries
ITEMS MONITORED[2)]	SLU: Freshwater: a) Four salmon index rivers (within DCF) in the Baltic Sea reporting abundance of parr, smolt counts (by traps, including age), and number of ascending adults on a yearly basis also for sea trout. Age reading of smolts. b) Count of upstream migrating adults in >10 rivers and streams (by fish counters in fish ladders, normally VAKI, some manually operated traps) c) Additionally information on smolt numbers in at least three rivers. d) All electrofishing data (0+ densities, parr densities in late summer – early autumn) performed in Sweden are collected, quality checked and stored in an open database; Swedish Electrofishing e) RegiSter (SERS) containing >15000 fishing occasions with sea trout since 1951. Continuously monitoring since 1978 in some streams. Fish data collected together with habitat data and water quality observations. Sea: a) Professional catches by weight (fishery statistics, routinely), for the Baltic also length and occasionally age from scale reading (within DCF). b) Recreational catches, discard, unreported catch estimates (both sea and freshwater, telephone interviews, annually) CAB: Freshwater: Continously performing electrofishing and at some rivers monitoring of ascending adults. Report results to SERS.
QUALITY OF DATA	All electrofishing data are quality checked and stored in a national open database (SERS). These data have good quality (reliable data on both fish number and size (length)). Fish counts of ascending adults are mostly covering the entire river, however in some rivers only part of the river is monitored (counter high upstream) leading to underestimates of number of spawners. Smolt counts are associated with insecurity in estimates and possibly biased at high water flows. Catch statistics from anglers in freshwater are likely to be underestimated, official catch statistics has unknown quality but does not include caught fish being released again, catch statistics from telephone interview has unknown quality.
OTHER / REMARKS	SLU: • The DCF program also monitor releases of hatchery produced and released sea trout, and recaptures of carlin-tagged fish. Information presented by ICES WGBAST. All hatchery reared fish in Sweden are adipose fin clipped. • A model for estimating freshwater production using habitat is under development. • Spawning run and smolt run time (electronic tags, as part of time limited projects, occasionally). • Migration and behavior at sea (returns from traditional tagging / electronic tags, occasionally). • Migration, behaviour and survival at hydroelectric power plants occasionally (electronic/telemetry tags). • Hybrids of salmon and sea trout monitored in special project (River Mörrumsån). • Some studies of genetic Mixed Stock Analysis (MSA) of commercial catch exsits (population level). Potential rivers to add as specific sea trout index rivers have been identified.

	No complete data-set for calculating stock-recruitment relationships exists.
REFERENCES / PUBLICATIONS	Most recent monitoring reports from SLU including trout densities are found at; www.ices.dk and www.slu.se
ACCESSIBILITY OF DATA	SERS is an open database: http://www.slu.se/elfiskeregistret
REPORTED BY (INSTITUTION, NAME)	SLU Aqua, Johan Östergren & Erik Degerman

2.12. Finland

COUNTRY	FINLAND
REGION	All country
INSTITUTION(S) MONITORING	FGFRI (Finnish Game and Fisheries Research Institute)
PURPOSE OF MONITORING	Monitoring status of trout and salmon populations
WHERE IS MONITORED[1)]	Rivers and tributaries, returns from tagged smolts, catch statistics from the sea fisheries and some river fisheries
ITEMS MONITORED[2)]	Freshwater: a) 0+ densities, parr densities (electrofishing, late summer – early autumn, in 11 Baltic rivers routinely at approx. 150 sites fished every year and at approx. 110 sites over 3-5 year cycle. In 2 north Atlantic river systems parr densities are monitored routinely at about 50 sites and at 20-40 sites over 3-5 year cycle. The monitoring covers all remaining original sea trout rivers and is performed continuously in larger streams since 1970's and in all streams since 1990´s). Information on habitat is collected from the same sites. b) Local statistics on angler's catch (every year in 4 rivers) c) National recreational catches (both sea and freshwater, postal enquiry every other year) Sea: a) Commercial catches by weight (fishery statistics, routinely) b) Recreational catches (both sea and freshwater, postal enquiry every other year)
QUALITY OF DATA	All electrofishing data have good quality (reliable data on both fish number and size (length)), covers all relevant sea trout rivers, catch statistics from professional sea fishery have good quality, catch statistics from the recreational sea and freshwater fishery have significant uncertainty.
OTHER / REMARKS	Additional monitoring: a) Smolt number and emigration time + sea survival in the Tornionjoki river (smolt trap, occasionally in favourable flow conditions in spring) b) Migration, behavior at sea and sea survival (returns from traditional tagging of stocked smolts, but also wild smolts of the Tornionjoki river) c) 1-3 index rivers have been proposed but monitoring has not been established An EU-founded project ECOKNOWS is studying the harvest rates and escapement of two Gulf of Bothnia sea trout rivers
REFERENCES / PUBLICATIONS	Most recent monitoring reports including trout densities are found http://www.rktl.fi/kala/kalavarat/itameren_lohi_taimen/meritaimen/ ICES WGBAST 2013
ACCESSIBILITY OF DATA	Data are publicly accessible
REPORTED BY (INSTITUTION, NAME)	FGFRI, Eero Jutila, Atso Romakkaniemi, Tapani Pakarinen

2.14. Estonia

COUNTRY	ESTONIA
REGION	All region
INSTITUTION(S) MONITORING	University of Tartu, Estonian Marine Institute
PURPOSE OF MONITORING	Monitoring status of trout and salmon populations
WHERE IS MONITORED[1)]	Rivers and streams, occasionally sea
ITEMS MONITORED[2)]	Freshwater: • Parr densities (electrofishing, late summer – early autumn, routinely at about 100 sites fished every year. Fish data collected together with habitat data. • Annual smolt abundance estimates gathered from one river Sea: • Professional catches by weight (fishery statistics, routinely) • Recreational catches (both sea and freshwater)
QUALITY OF DATA	All electrofishing and smolt count data have good quality (reliable data on both fish number and size (length), catch statistics are likely to be underestimated, official catch statistics has unknown
OTHER / REMARKS	Spawner counting in one river will commence in y. 2014.
REFERENCES / PUBLICATIONS	Recent monitoring reports from University of Tartu, Estonian Marine Institute including trout and salmon densities are found here: http://www.envir.ee/2110
ACCESSIBILITY OF DATA	Reports are publicly accessible
REPORTED BY (INSTITUTION, NAME)	Martin Kesler (University of Tartu, Estonian Marine Institute)

2.15. Latvia

COUNTRY	LATVIA
REGION	All country
INSTITUTION(S) MONITORING	BIOR (Institute of Food safety, animal health and environment)
PURPOSE OF MONITORING	1.Monitoring status of trout and salmon populations 2.Monitoring ecological status (e.g. quality determination for European Water Framework)
WHERE IS MONITORED[1)]	Streams and tributaries Biological data collection form coastal fisheries
ITEMS MONITORED[2)]	Freshwater: • Parr densities (electrofishing, late summer – early autumn, routinely at 35 sites fished every year in 3 wild salmon spawning rivers and 5 tributaries. • Direct smolt count in the river Salaca by trap (April- end of May) • Recreational catches (both sea and freshwater) • Professional catches by weight and numbers (fishery statistics, routinely) • Biological sampling of ~200- 300 adult fish • Age reading of smolts, adults
QUALITY OF DATA	All electrofishing data have good quality (reliable data on both fish number and size (length)). Smolt count carried out with same method from 1964, good quality.
OTHER / REMARKS	Some electrofishing carried out in rivers not accessible for migratory fish
REFERENCES / PUBLICATIONS	Monitoring results in 2006-2008 (in Latvian): http://biodiv.lvgma.gov.lv/fol302307/fol038572/fol577030

ACCESSIBILITY OF DATA	Data are not publicly accessible
REPORTED BY (INSTITUTION, NAME)	BIOR, Janis Birzaks

2.16. Lithuania

COUNTRY	Lithuania
REGION	All country
INSTITUTION(S) MONITORING	Klaipeda University (Western part of Lithuania) Lithuanian Nature Research Center (Eastern part of Lithuania)
PURPOSE OF MONITORING	Monitoring status of salmonids populations Monitoring ecological status (Lithuanian index of rivers ecological status, e.g. quality determination for European Water Framework)
WHERE IS MONITORED[1)]	Streams and tributaries
ITEMS MONITORED[2)]	Freshwater: • 0+ densities, parr densities (electrofishing, late summer – early autumn, routinely at 76 sampling sities each year from 1998, 25 sampling sities – over cycle 3 years, 3 smolt traps, spawners monitoring in Curonian lagoon by gillnets, releases control – (about 30 sites each year), reds counting – from 1998 in 6 river catchments. Fish data collected together with habitat data and water quality observations. • recreational catches – information from licenses used for angling (freshwater, from 2012). • commercial catches (Curonian lagoon and Baltic coastal fishery). More less correct information from 1998. Derived information: Smolt production is calculated from densities of parr using fixed 0+/parr to smolt survival rates.
QUALITY OF DATA	All electrofishing data have good quality (reliable data on both fish number, body weight and size (length)), count of spawning reds are possibly incorrect and sometimes underestimates spawning run but may be used as index of spawning intensity, catch statistics from anglers in freshwater is only in starting position and should be not correct, official catch statistics in Curronian lagoon is quit correct b ut in Baltic coast – the quality is unknown.
OTHER / REMARKS	Klaipeda university additional monitoring: Genetical structure of stoks and impact of releases to natural populations (on project basis) Reproduction ecology of trout in streams NRC additional monitoring: Spawning run and immigration time (electronic tags, as part of time limited projects, occasionally) Juvenils anatomy and physiology in hatchery The Minija river is as index river for sea trout in Lithuania.
REFERENCES / PUBLICATIONS	Yearly monitoring reports drafts including trout densities in lithuanian language are found here: http://gamta.lt/cms/index?rubricId=47f04440-d850-4c12-9fd5- A couple of scientific publications was published in different scientific journals.
ACCESSIBILITY OF DATA	Data are not publicly accessible
REPORTED BY (INSTITUTION, NAME)	Klaipeda university, Antanas Kontautas

2.17. Poland

COUNTRY	POLAND
REGION	All country
INSTITUTION(S) MONITORING	1) Inland Fisheries Institute (IFI) 2) National Marine Fisheries Research Institute (NMFRI)
PURPOSE OF MONITORING	1) Monitoring status of sea trout and salmon populations 2) Monitoring commercial catch of sea trout and salmon and their status of biological parameters (length, weight, age)
WHERE IS MONITORED[1)]	1) Rivers, streams and tributaries 2) Polish EEZ
ITEMS MONITORED[2)]	1. IFI: a) 0+ and >0+ parr densities (electrofishing autumn, 6 river systems, 23 sites - 10 since 2004). b) Spawning intensity: count of spawning redds in 8 river systems, the longest set since 1996. c) Number of spawners: count of fish by counters in one river since 2006. d) Migration: smolt tagging with Carlin tags since 60ties. 2. NMFRI: a) Sea and coast – routinely, commercial and recreational catch by numbers, weight and effort from logbooks, monthly fisher's reports, self-sampling and interviews. b) Vistula and Pomeranian river – commercial and other catch by numbers and weight – from tenants of waters and from Polish Angler's Association, in cooperation with IFI.
QUALITY OF DATA	All electrofishing data have good quality but sites are located on the best stretches and don't represent typical conditions. In some rivers redds counting depends strongly on hydro and meteorological conditions. Very low return of tags since end of 80ties. Official commercial fishery statistics has unknown quality. Offshore statistics is frequently overestimated due to misreporting salmon as a sea trout. Coastal and recreational catch has unknown quality and is likely to be underestimated. All sources do not include caught fish being released again.
OTHER / REMARKS	
REFERENCES / PUBLICATIONS	IFI: Actual data haven't been published. NMFRI: Yearly reports of research are published in Annual NMFRI Reports of Research
ACCESSIBILITY OF DATA	Data are not publicly accessible
REPORTED BY (INSTITUTION, NAME)	IFI: Piotr Dębowski NMFRI: Wojciech Pelczarski

2.18. Iceland

COUNTRY	ICELAND
REGION	Iceland
INSTITUTION(S) MONITORING	Institute of Freshwater Fisheries (Veidimalastofnun)
PURPOSE OF MONITORING	Monitoring of the status and ecology of freshwater fish populations Monitoring 2 sea trout populations
WHERE IS MONITORED[1)]	In several rivers and specifically for sea trout in two rivers where sea trout are the dominating fish spices

ITEMS MONITORED[2)]	Monitoring in freshwater: 0+ / parr densities of salmonids (Atlantic salmon, brown trout and Arctic char) are collected annually in approx. 30 rivers on approx.. 150 sites. 0+/parr densities and growth in two sea trout rivers on 13 sites + returning adults (automatic fish counter – since 1996) Smolt migration (timing and size) has been studied in time limited projects in a few rivers Recreational catch in rivers (logbook with information on date, location, sex, length, weight, C&R, bait) Commercial catch in rivers, nets and seins, (recordings on gear, catch and weight)
QUALITY OF DATA	Electrofishing data on density as an index are reliable for estimating changes over time. Data series form 1986- Recreational catch statistics is accurate with information on individual fish.The logbook has a tradition since 1946 and recorded on electronic form since 1974 Commercial catch data in few glacial rivers collected annually by correspondence
OTHER / REMARKS	Scale samples collected of adult fish from several rivers Migration studies by telemetry (radio tags and DST) in two rivers The influence of volcanic eruptions on freshwater fish
REFERENCES / PUBLICATIONS	Antonsson, Th. and Jóhannsson M. 2012. Life history traits of sea trout in two Icelandic rivers. ICEL. AGRIC. SCI. 25: 67-78. Gudjónsson, Th. 1993. Marking and tagging of sea trout (Salmo trutta L.) in the river. Úlfarsá, southwest Iceland. ICES CM 1993/M:12: 6 pp. Jóhannsson, M. and Einarsson, S.M. 1993. Anadromous brown trout (Salmo trutta L.) populations in southern Iceland. - ICES C.M. 1993/M:11: 12 pp. Jóhannsson M., Gudjonsson S. and Bjornsson, E. 2001. Migration behavior of brown trout, Salmo trutta, in River Grenlaekur in south eastern Iceland. IN: Proceedings of The Second Nordic International Symposium on Freshwater Fish Migration and Fish Passage. Evaluation and Development. (R. Kamula and A. Laine eds.) University of Oulu, Finland: 61-64. Pereira, A.M., Jónsson, B., Jóhannsson, M., Robalo, J.I., Almada, V.C. 2012. Icelandic lampreys (Petromyzon marinus): where do they come from. Ichthyological Research: 59(1): 83-85. Sturlaugsson, J. and Jóhannsson, M. 1996. Migratory pattern of wild sea trout (Salmo trutta L.) in SE-Iceland recorded by data storage tags. ICES. C. M. 1996/M:5: 16 pp. Sturlaugsson, J. and Jóhannsson, M. 1998. Sea migration of anadromous brown trout (Salmo trutta L.) recorded by data storage tags. ICES. C.M. 1998/N: 23. (Abstract). Annual Reports on catch statistics from the Institute of Freshwater Fisheries http://www.veidimal.is/Files/Skra_0062466.pdf Several research reports (in Icelandic) http://www.veidimal.is/default.asp?sid_id=23836&tId=15&sbmt=4&qsr
ACCESSIBILITY OF DATA	Data stored of Institute of Freshwater Fisheries data bases.
REPORTED BY (INSTITUTION, NAME)	Institute of Freshwater Fisheries, Austurvegur 3-5, IS 800 Selfoss ,Iceland, Magnús Jóhannsson, (magnus.johannsson@veidimal.is) Catch statistics: Gudni Gudbergsson, (gudni.gudbergsson@veidimal.is)

2.19. Belgium

COUNTRY	BELGIUM
REGION	All country
INSTITUTION(S) MONITORING	SPW, Public Service of Wallonia University of Liège, Laboratory of Fish Demography and Hydroecology INBO, Research Institute for Nature and Forest
PURPOSE OF MONITORING	• Scientific Monitoring of Fish Passes, but not only focused on sea trout. Traps are run all year (15 year time period covered for onefish pass). • Monitoring fish populations by electric fishing, but not only focused on sea trout. Monitoring in a rolling 3 year cycle • Fish Biotelemetry • Artificial reproduction, farming and river restocking
WHERE IS MONITORED[1)]	• River Meuse and tributaries (Fish passes & monitoring populations) • River Meuse and Ourthe (Biotelemetry) • Fish farming of the SPW in Erezée (Belgian Ardenne) and restocking in the river Meuse Basin (Artificial reproduction)
	• Fish Biodiversity, fish biomass, periodicity of capture, size classes, abundance over years. • Fish Biodiversity, fish biomass, size classes, abundance over years, fish integrity indices. • Impact of obstacles, efficiency of fish-passes, distance of migration, localization of potential spawning areas.
QUALITY OF DATA	1) High quality, 20 years of history of captures in some fish-passes 2) High quality, but captures of sea trout are scarce during electric fishing 3) Good quality, but just a few sea trout were radio-tagged
OTHER / REMARKS	
REFERENCES / PUBLICATIONS	Reports and publications of the University and SPW available at: http://orbi.ulg.ac.be/simple-search?query=ovidio
ACCESSIBILITY OF DATA	Partly accessible in some reports and publications
REPORTED BY (INSTITUTION, NAME)	ROLLIN Xavier, Direction Generale Operationelle De L'agriculture, De ressouces Naturelle et De L'environnement, Service De la Peche, Avenue Prince de Liège 15 - 5100 Jambes. Dr Michaël OVIDIO, Faculté des Sciences, Département de Biologie, Ecologie, Evolution. Laboratoire de Démographie des Poissons et d'Hydroécologie (LDPH), 10 Chemin de la Justice, B-4500 Tihange. Belgique.

Annex 3: Status of sea trout populations

1. Status in the Baltic area

Introduction

Using the assessment model for the Baltic area the observed abundance for each river and year is divided by the predicted abundance and expressed as percentage giving the recruitment status. Rivers with abundance as predicted gets a recruitment status of 100%, and rivers with a lower abundance than predicted lower percentages.

The relative status is calculated by comparing average observed density to average densities at sites with optimal quality within the same Subdivision (Figure 1.1 from ICES 2013). A value of 100 represents the 'expected' density in that area.

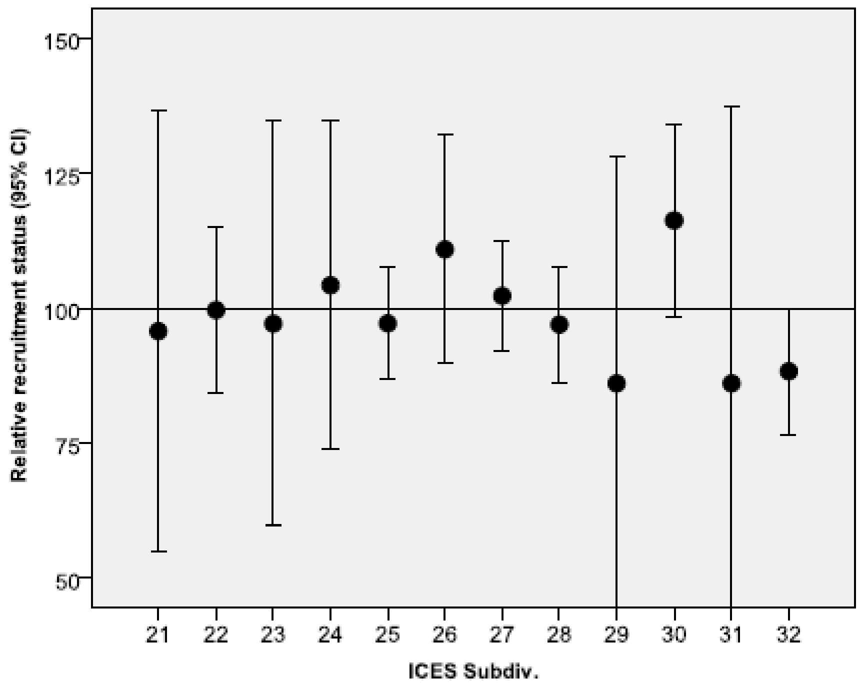


Figure 1.1. The relative recruitment status (averages and 95% c.i.) for trout in different ICES Subdivisions in the Baltic area.

The relative recruitment for each are may for practical purposes be grouped into larger assessment areas consisting of several geographically close ICES Subdivisions (Figure 1.2 – ICES 2013).

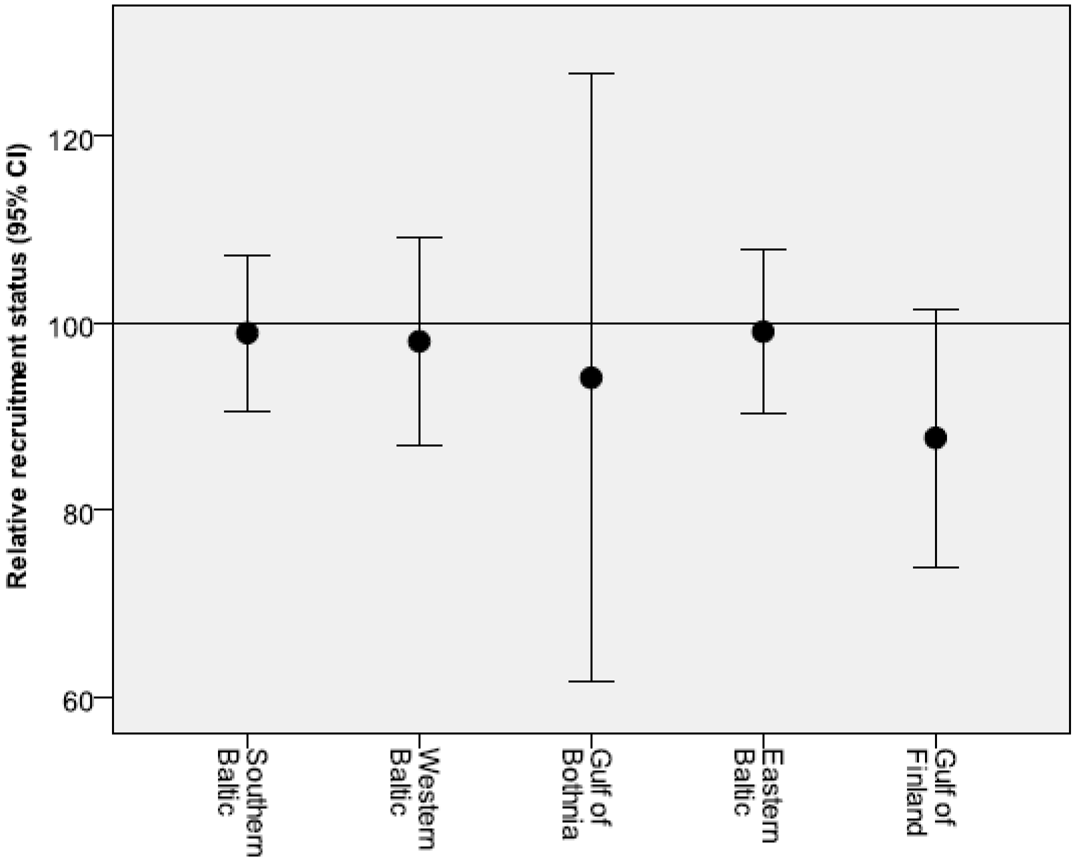


Figure 1.2. Average relative recruitment status ((observed parr abundance/predicted abundance)*100, averages and 95% c.i.) for different parts of the Baltic Sea.

The development trend in each (using the average Pearson *r* - trend in parr abundance during 2000–2011), is presented in Figure 1.3 (ICES 2013) for different assessment units in the Baltic.

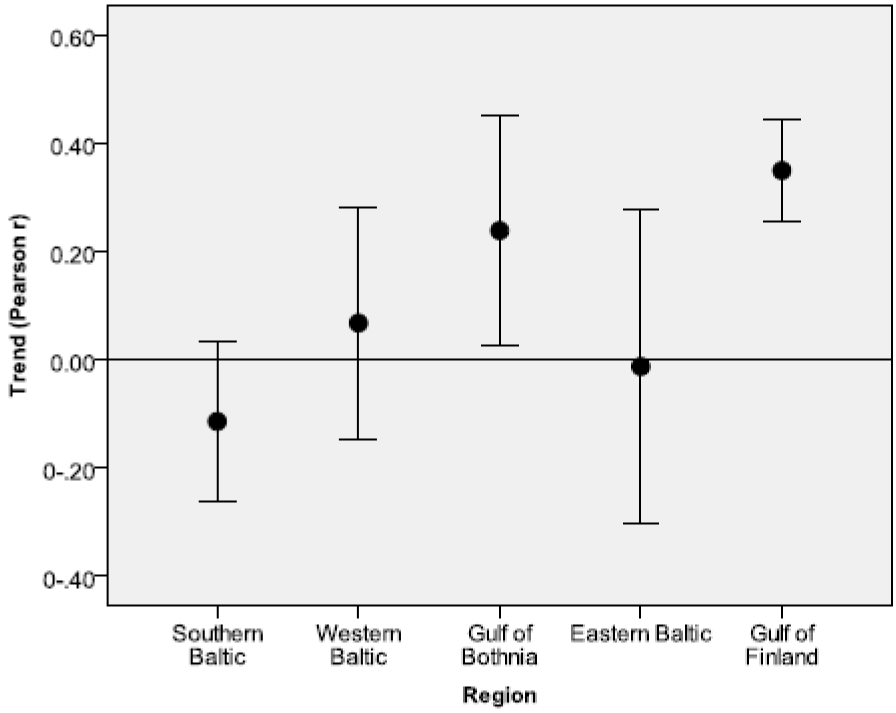


Figure 1.3. Average Pearson *r* (trend in parr abundance during 2000–2011, averages and 95% c.i.) for different parts of the Baltic Sea.

The status of populations of sea trout in the Baltic area is in some areas very poor.

Populations in especially the North (Bothnian Bay) are considered to be at the risk of extinction, due to capture of post-smolts and young age classes of sea trout as bycatch in fisheries targeting other species. Also trout populations further South and East (Bothnian Sea and partly in Gulf of Finland) are in poor status due over exploitation. The situation is particularly severe in Finland.

A positive tendency in parr densities is observed in Estonia and Sweden (in the Bothnian Sea area), probably reflecting management changes in these countries.

Russian populations show a poor and decreasing trend probably mainly due to illegal fishing in rivers (poaching).

Trout populations in the Main Basin area in general have a better status compared to the northern and eastern areas. In the central part of the southern Baltic, a negative trend was observed for streams included in the assessment but parr densities are still reasonable.

Even if it is not evident from *average* den-sities of parr, that seem to be close to optimal, 299 trout populations were estimated to be below 50% of potential smolt production capacity in the Baltic (HELCOM, 2011); 100 in Sweden, 50 in Estonia, 50 in Denmark and close to 50 in Russia.

2.1. England & Wales

STATUS OF AND TREND IN DEVELOPMENT IN SEA TROUT POPULATIONS & SEA TROUT CATCHES IN ENGLAND AND WALES

General status for, and development in populations since 1994 in your country (If relevant separate descriptions for different parts of the country). Relevant information could include: 0+ / parr densities, Smolt numbers, Spawner numbers (or proxy, e.g. spawning pits etc.)

Around 70 ‘principal’ sea trout (and salmon) rivers in England and Wales (E&W) support at least moderate sized rod fisheries, and in some cases net fisheries (Figure 1). Most of these rivers are located on the west coast where, generally, .0+ sea trout feature strongly in returning populations. In contrast, east coast populations contain few .0+ fish but a more significant .1+ or older maiden component. The biological characteristics of sea trout from these rivers have been well described by Solomon (1995) and Harris (2002).

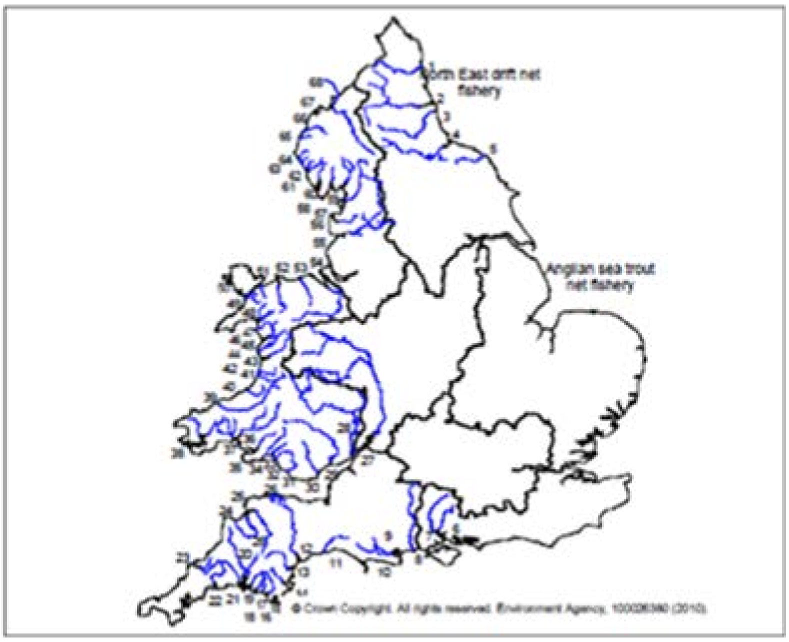
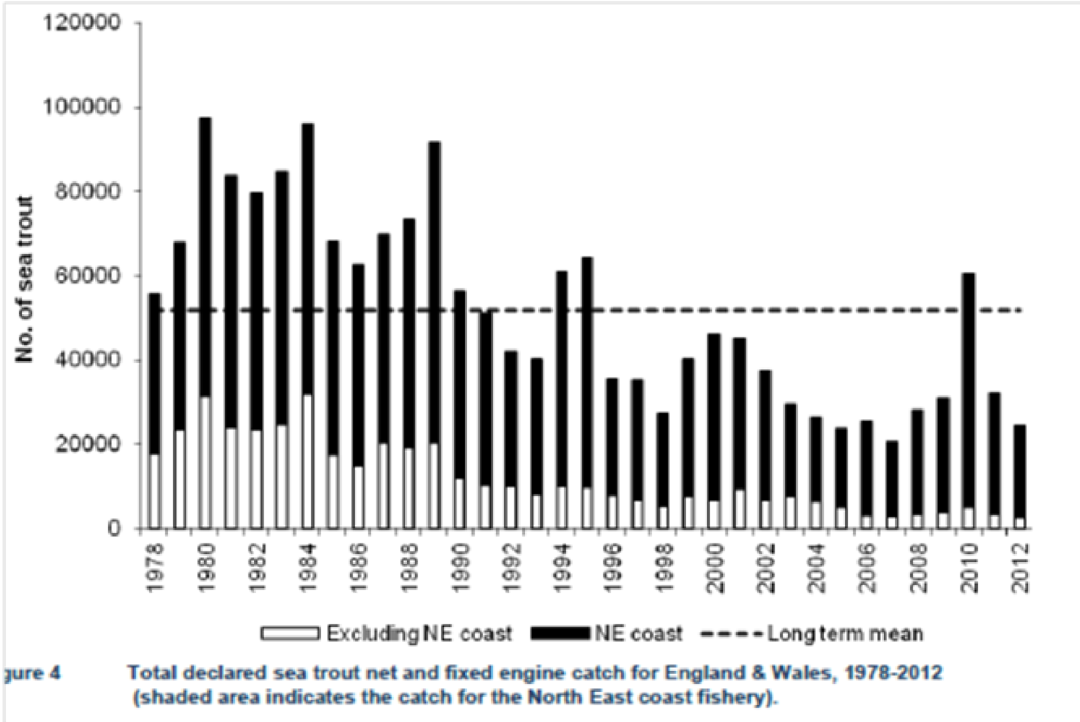


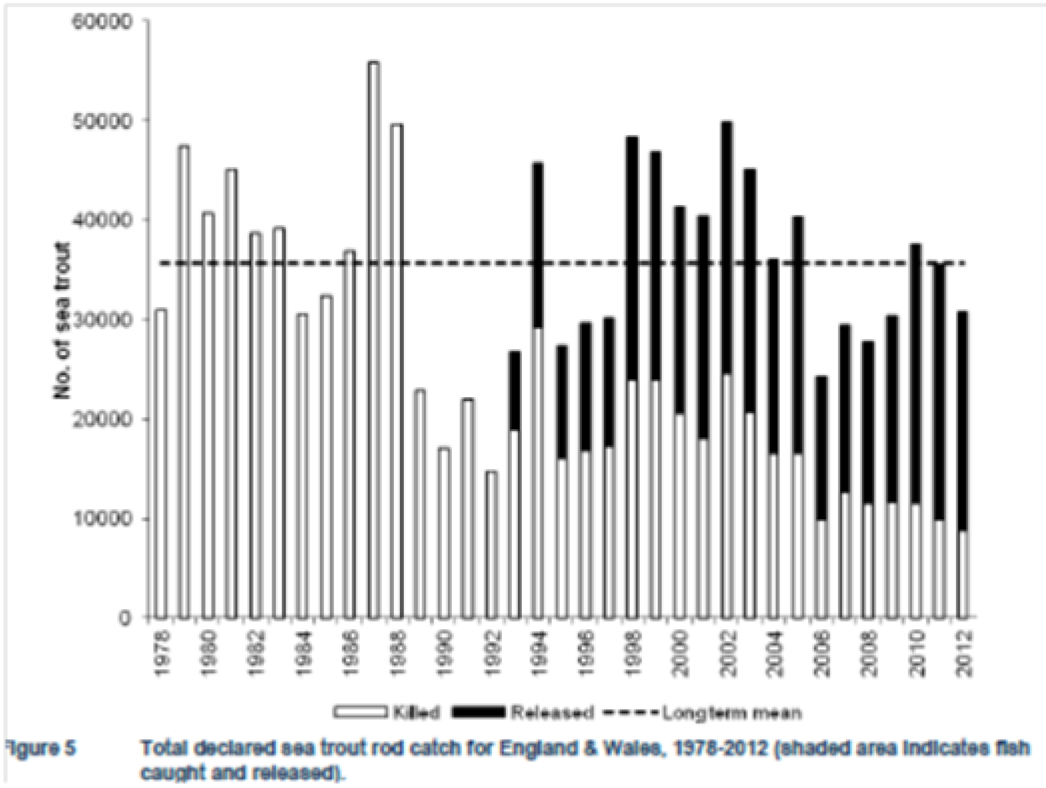
Figure 1. Principal sea trout (and salmon) rivers in England and Wales.

Catch statistics and fishery assessments

Declared 5-year mean catches of sea trout by all net and rod fisheries in E&W for the period to 2011 were 34 241 and 32 114, respectively (Environment Agency, 2013). An average of 64% of rod caught sea trout in this period were released. Time series of declared net and rod catches for the past ~30 years are shown in Figure 2.



a)



b)

Figure 2. Declared sea trout (a) net and (b) rod catches for England and Wales, 1978–2012.

Sea trout stock assessment in E&W is less developed than for salmon. For example, unlike salmon, no Conservation Limits and related compliance procedures exist for sea trout and, at present, there is no requirement to report these or other stock assessment criteria nationally or internationally. That said, the value of developing 'biological reference points' (BRPS) for sea trout has been recognized and options reviewed (Thornton, 2008), and opportunities for progressing this area are being explored. Outputs from recent EU funded research initiatives focusing, to different degrees, on sea trout in E&W e.g. the Celtic Sea Trout; Living North Seas and Atlantic ARC programmes (referred to elsewhere in this report), should help inform the development of new approaches to sea trout stock assessment. For example, from the Celtic Sea Trout Programme, N. Milner (pers com) described the coherent patterns evident in sea trout rod catch data collected within E&W and between Irish Sea jurisdictions (Figure 3). This indicates that catch data, despite some of the weaknesses and inconsistencies in the way they are collected, may well provide useful indicators of stock abundance from which underlying influences might be further explored (e.g. marine environmental factors). *[See also Section 3.7 on 'population modelling and BRPs'.]*

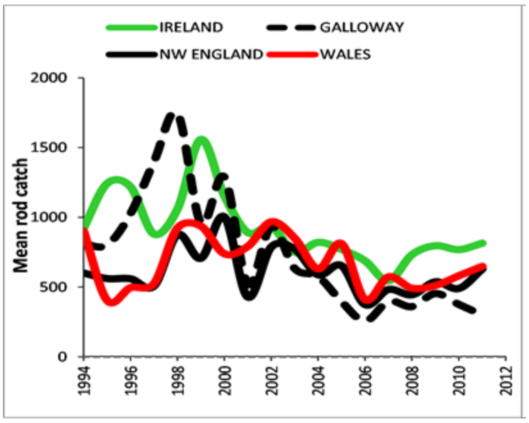


Figure 3. Coherence in sea trout rod catch patterns from the Irish Sea region.

Aside from the reporting of catch statistics in E&W, methods have been employed to examine the annual performance of individual rod fisheries (i) by comparing the mean catch per licence day from the latest 3-year period with the previous 10-year mean and (ii) by examining the trend in catch per licence day over the latest decade (e.g. the River Tyne in Figure 4). These two measures are used to provide an indicator of stock status for management purposes. However, there are clear weaknesses in this approach, not least that the benchmark decade mean catch is a changing one and has no link to any biological optimum.

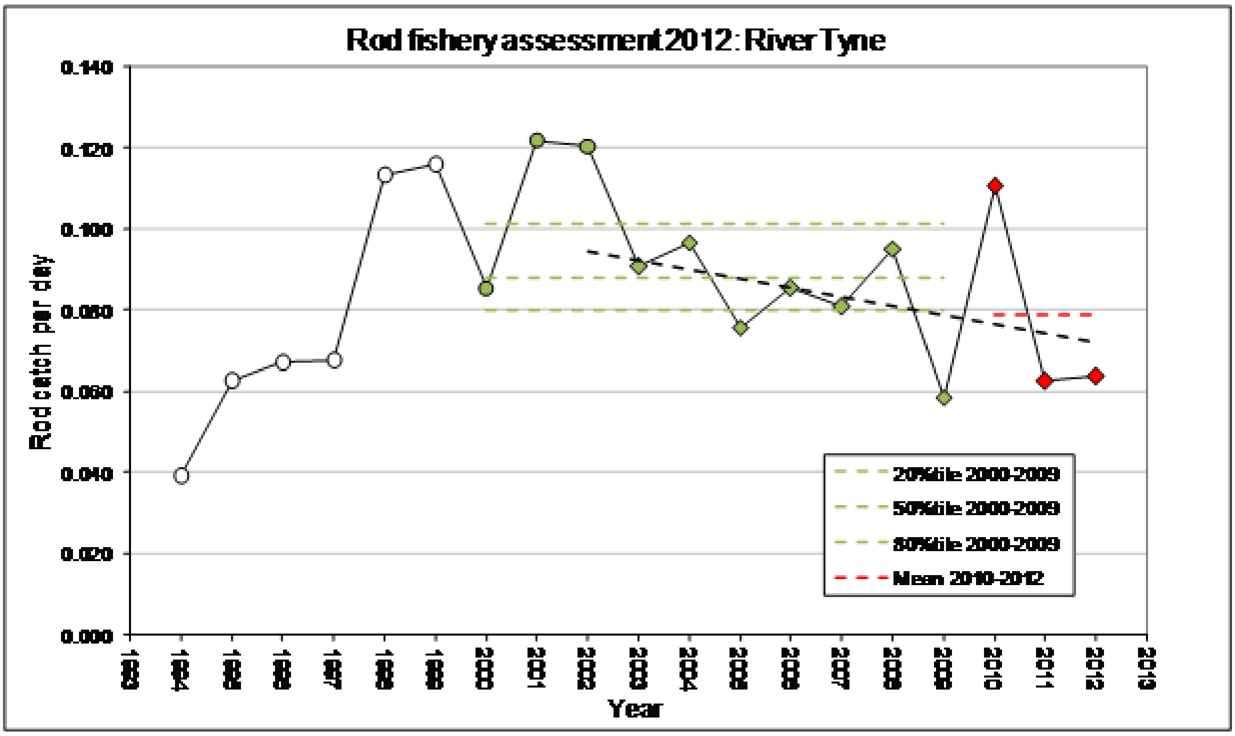


Figure 4. Catch per licence day assessment of sea trout rod fishery performance on the River Tyne, 2012

Juvenile monitoring

Annual electrofishing surveys are carried out on the principal sea trout and salmon rivers to track the spatial and temporal stability of juvenile salmonid populations and, primarily, as part of the assessment of the 'Ecological Status' of Water Bodies for the EU Water Framework Directive. In the case of the latter, the FCS2 (Fisheries Classification 2) model is used to compare observed fish abundance with reference conditions based on the physical characteristics of each reach. A similar model - HabScore (Milner *et al.* 1998) – is also used in E&W used to assess habitat quality and compare observed with expected fish abundance on a site by site basis.

Returning Stock Estimates (RSEs) and Index River monitoring

Sea trout RSEs - from resistivity fish counters or trapping and mark-recapture - are available for 6 rivers in E&W (out of 10 rivers also producing RSEs for salmon); namely the Tyne, Tamar, Fowey, Dee, Lune and Kent. Four of these rivers are classed as 'Index Rivers' (Tyne, Tamar, Dee and Lune) because of associated trapping or the equivalent sampling programmes to collect biological information, e.g. on age and size composition, sex, general condition, etc. On two of the Index Rivers (Tamar and Dee) smolt trapping and tagging programmes are used to evaluate return rates (back to adult) and estimate smolt output.

The broad purpose of these more intensive monitoring programmes is to develop understanding of sea trout stock and fishery processes on a few rivers in order to inform and improve the wider management of this species. Applications range from a general overview of patterns and trends in adult returns (Figure 5), to the development of stock-recruitment relationships (Figure 6).

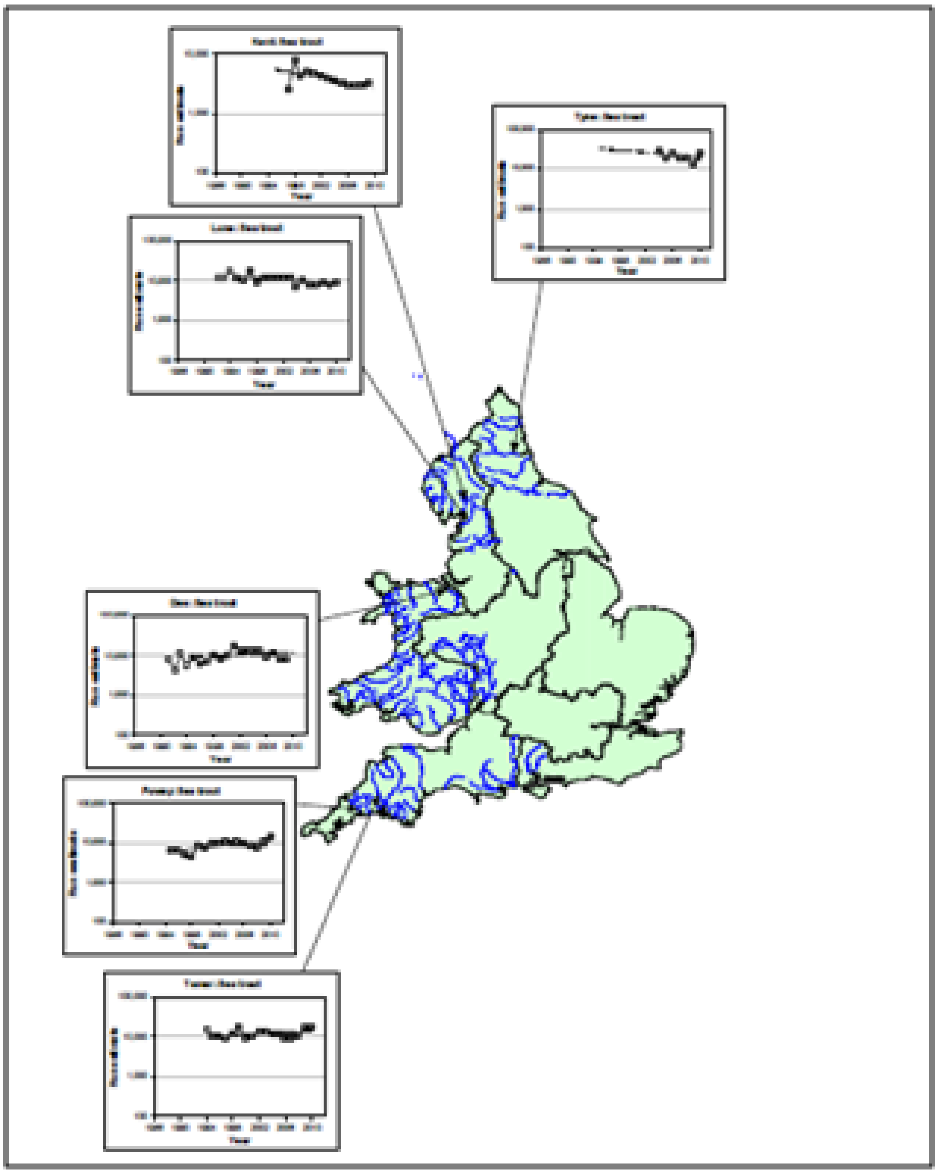


Figure 5. Time-series of sea trout RSEs for river sin England and Wales.

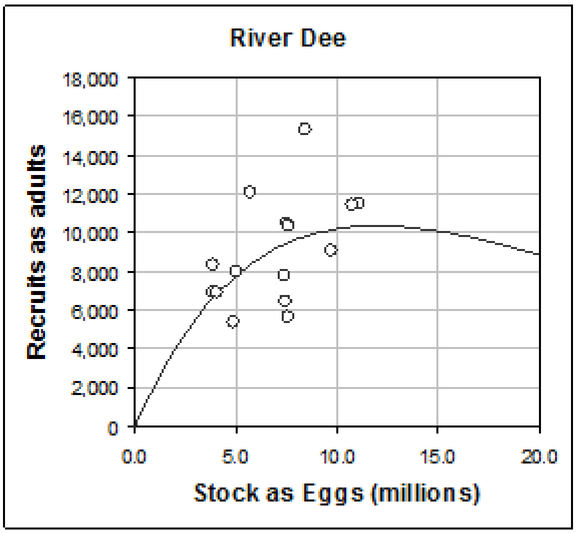


Figure 6. Provisional egg-to-adult Ricker stock-recruitment curve fitted to sea trout data from the Welsh Dee.

References

Environment Agency (2013) Salmonid and freshwater fisheries statistics for England and Wales, 2012. Version 1, November 2013.

http://www.environment-agency.gov.uk/research/library/publications/148591.aspx

Milner, N.J., Wyatt, R.J. and Broad, K. (1998) HabScore – applications and future developments of related models. Aquatic Conservation: Marine and Freshwater Ecosystems, 8: 633-644.

Harris,G.S. (2002) Sea trout stock descriptions: The structure and composition of adult sea trout stocks from 16 rivers in England and Wales. Environment Agency, Bristol. R&D Technical Report W224, 93pp.

Solomon, D.J. (1995) Sea trout stocks in England and Wales. R&D Report 25, National Rivers Authority, Bristol, 102 pp.

Thornton, L.(2008) Evaluating options for sea trout and brown trout biological reference points. Environment Agency, Science Report SC060070. ISBN: 978-1-84432-934-2.

2.2. Scotland

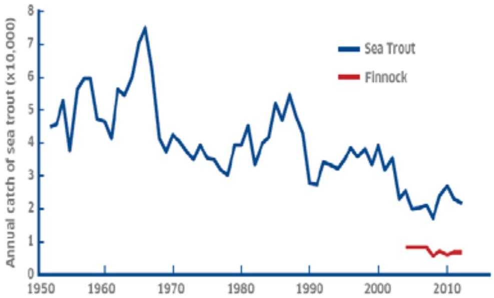
STATUS OF AND TREND IN DEVELOPMENT IN SEA TROUT POPULATIONS & SEA TROUT CATCHES

General status for, and development in populations since 1994 in your country (If relevant separate descriptions for different parts of the country). Relevant information could include: 0+ / parr densities, Smolt numbers, Spawner numbers (or proxy, e.g. spawning pits etc.)

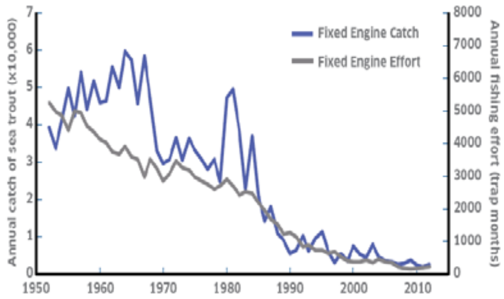
There are about 400 salmon rivers in Scotland (NASCO rivers database). Most of these contain at least some sea trout, but they vary from ones with only a few sea trout to ones with many. Often the sea trout are localized within the river systems, with freshwater resident populations predominating elsewhere. There are many small coastal streams which contain sea trout which are not included in the salmon river total. It is often mainly female fish which migrate to sea, with the male fish remaining in fresh water.

As noted in ICES (1994), the main data which has been used in Scotland for the assessment of sea trout populations is the comprehensive set of catch data which has been collected from salmon and sea trout fishing owners and tenants since 1952 (see the assessment and monitoring table). The website from which these statistics can be reached is http://www.scotland.gov.uk/Topics/marine/science/Publications/stats/SalmonSeaTroutCatches. It should be noted that angling catches are given in two different data series, for fish retained (killed) and fish released.

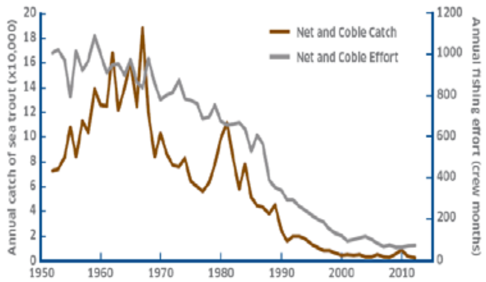
The most recent data is for 2012 and provisional 2013 data should become available in April 2014.



Scottish rod catch. Finnock = sea trout which have spent less than one year at sea before making their first return to fresh water (also known as whitling or blacktails).



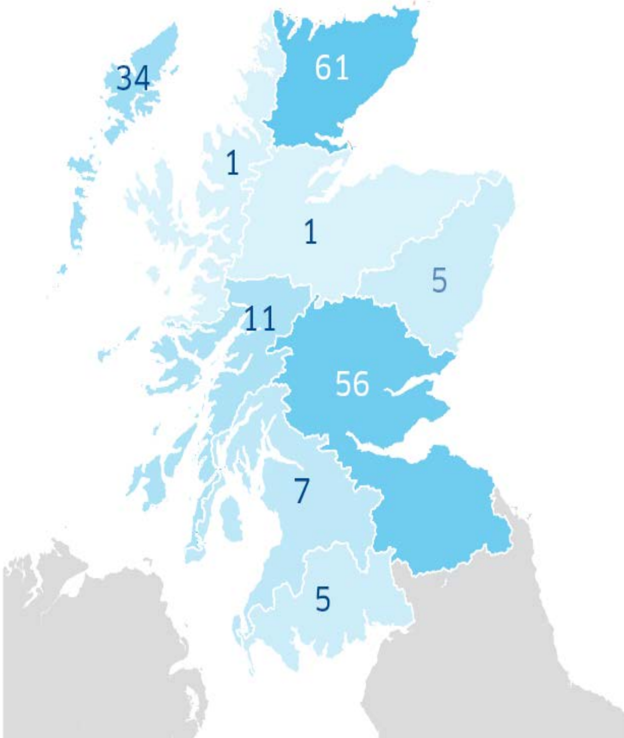
Total catch by fixed engines and effort in trap-months. These fisheries operate along the coast outwith estuaries.



Total catch by net and coble and effort in crew-months. These fisheries mainly operate within river estuaries.

A large decline in net effort has resulted in net catches now being of limited use for stock assessment, and the rod catches now form the main general basis of stock assessment. The decline in net fishing has been largely driven by changes in the salmon netting industry, as in the vast majority of cases salmon is the primary target species for these fisheries.

Total rod catches of sea trout for Scotland as a whole have declined over much of the period since 1952. This may indicate low numbers of fish both entering fresh water and spawning. Although catches have shown a slight increase since 2008, total reported rod catch in 2012 was the fifth lowest in the 61-year time series. However, the overall rod catch pattern masks considerable local variability. The map below shows how the 2012 catch in each Scottish region ranks in the whole time series of catches for the region.



KEY

Each reporting region has 61 years of data, and the number shows the rank of the 2012 catches in its series: 1 = the lowest catch in 61 years and 61 the highest.

Relative strength of the 2012 rod catch among regions.

There are clear differences among geographic regions in the relative strength of the 2012 rod catch. All mainland regions in the west of Scotland reported catches which were within the lowest eleven recorded for their region over the period 1952 to 2012 (1 west, 11, 7 & 5 on the map above). The reported catch in the Moray Firth (1) and North East regions (5) were, similarly, the lowest and fifth lowest respectively over the same period. Catches in the East (56) and North regions (61) in 2012 were, on the other hand, both among the top ten catches recorded within their respective regions, while the catch recorded in the Outer Hebrides was close to the mid-point in the time series.

What are the principal reasons for any changes in the status of sea trout populations in your country in recent years?

Sea trout stock size at any time will reflect spawning numbers in the previous generation, the survival of juveniles in fresh water and the marine survival. The concordance in the fine scale structure in the time series in different parts of Scotland would indicate that common factors are often operating, although the differences in trends indicate that there are important local differences. Although more information is needed, there are known to be important differences in the marine phases of Scottish sea trout in different parts of Scotland. These are not always restricted to local coasts. There is some evidence that those from rivers in the south west of Scotland can migrate south into the Irish Sea, while there is extensive tagging and genetic evidence that shows that a major component of the sea trout of the Tweed district (in the south east) make a long migration south to the Dutch and Frisian coasts and that some of these stay at sea for a second year and migrate up the west Jutland coast as far as the Skaggerak.

There are likely to be a number of factors driving the trends in sea trout catches seen around Scotland, and these factors are likely to vary between areas. One of the most controversial factors is the impact of fish farms, and in particular any link with sea lice, on sea trout on the west coast. While there is increasing scientific evidence for a detrimental effect of sea lice connected with fish farms on sea trout populations (e.g. Middlemas *et al.* 2010, 2013), the magnitude of any such impact in relation to overall mortality levels is not known. It is also clear that areas without salmon farms, such as the Moray Firth, have also had poor recent catches - a special joint programme of investigation is being made here by the local Fisheries Trusts (The Moray Firth Trout Initiative http://www.morayfirthtrout.org/).

There has been much work over the past 20 years to remove or ease obstacles to salmon migration and this will have benefitted sea trout as well. No new obstacles are known to have reduced sea trout spawning area in recent years. There is very little stocking of sea trout in Scotland, so it is not a factor.

Are sea trout caught commercially in your country? If yes, are they the primary target in this fishery?

If yes what type of fishery (professional gear at sea, fixed gear in freshwater) and what is the magnitude in number or tons?

If no, what monitoring and evaluations are there on by-catch?

What measures are in place to ensure that commercial catch-reports are made?

Yes. However, they are not generally the primary target, which is salmon.

Fixed engines are used along the coast outwith estuaries. Net and coble is generally used within estuaries.

The total catch is now low – 5115 sea trout caught by net in 2012. The websites giving the 2012 catch data for these fisheries are:-
Net and Coble ("Sweep Netting", "Draught Netting):

http://www.scotland.gov.uk/Resource/0043/00434045.xlsx

Fixed Engine, coastal netting ("Stake Netting") :

http://www.scotland.gov.uk/Resource/0043/00434048.xlsx

The owners of commercial net fisheries have been legally required to report their catches to the government since 1952

Data on the annual catches by net over the period 1952 to 2012 are given in Figures ** and **.

Are sea trout caught in recreational fisheries?

If yes what type of fishery (fixed gear at sea, fixed gear in freshwater, rod and line at sea, rod and line in freshwater) and, if known, what is the magnitude in number or weight for last 5 years (or more, if appropriate)?

What measures are in place to ensure that recreational catch-reports are made?

Yes. Rod and line in fresh water and in river estuaries. Some rod and line fishing along the coast, especially in the Orkney Islands and the Hebrides.

The web sites for the 2012 angling catches of sea trout are:-

Sea-trout killed in rod fisheries:

http://www.scotland.gov.uk/Resource/0043/00434047.xlsx

Sea-trout caught & released by rod fisheries:

http://www.scotland.gov.uk/Resource/0043/00434046.xlsx

Approximately 30-40% of the sea trout caught by anglers are released.

Data on the annual catches by rod and line over the period 1952 to 2012 are given in Figure **.

The owners of salmon and sea trout fishing rights have been legally required to report their catches to the government since 1952

There is no recreational netting for sea trout in Scotland.

Are sea trout caught illegally? If yes, what type(s) of fishery, and what is the extent (if known)?

There is still some illegal netting of sea trout both in rivers and on the coasts. Each District Fishery Board has a force of water bailiffs who are responsible for policing their rivers. It is difficult to assess the level of illegal catches, but it is certainly in decline, partly through improved enforcement action and partly through general, cultural, change with less interest in, and less ability to undertake, such "countryside" activities. The collapse in the price of salmon through increased supply from the salmon farming industry and a statutory ban on the sale of rod caught salmon and sea trout have largely removed the economic incentive for poaching and large-scale commercial poachers have moved on to other, more profitable, criminal activities.

References

Middlemas, S.J., Raffell, J.A., Hay, D.W., Hatton-Ellis, M. and Armstrong, J.D. (2010). Temporal and spatial patterns of sea lice levels on sea trout in western Scotland in relation to fish farm production cycles. Biology Letters 6, 548-551.

Middlemas, S.J., Fryer, R.J., Tullett, D. and Armstrong, J.D. (2013). Relationship between sea lice levels on sea trout and fish farm activity in western Scotland. Fisheries Management and Ecology 20, 68-74.

3. Ireland

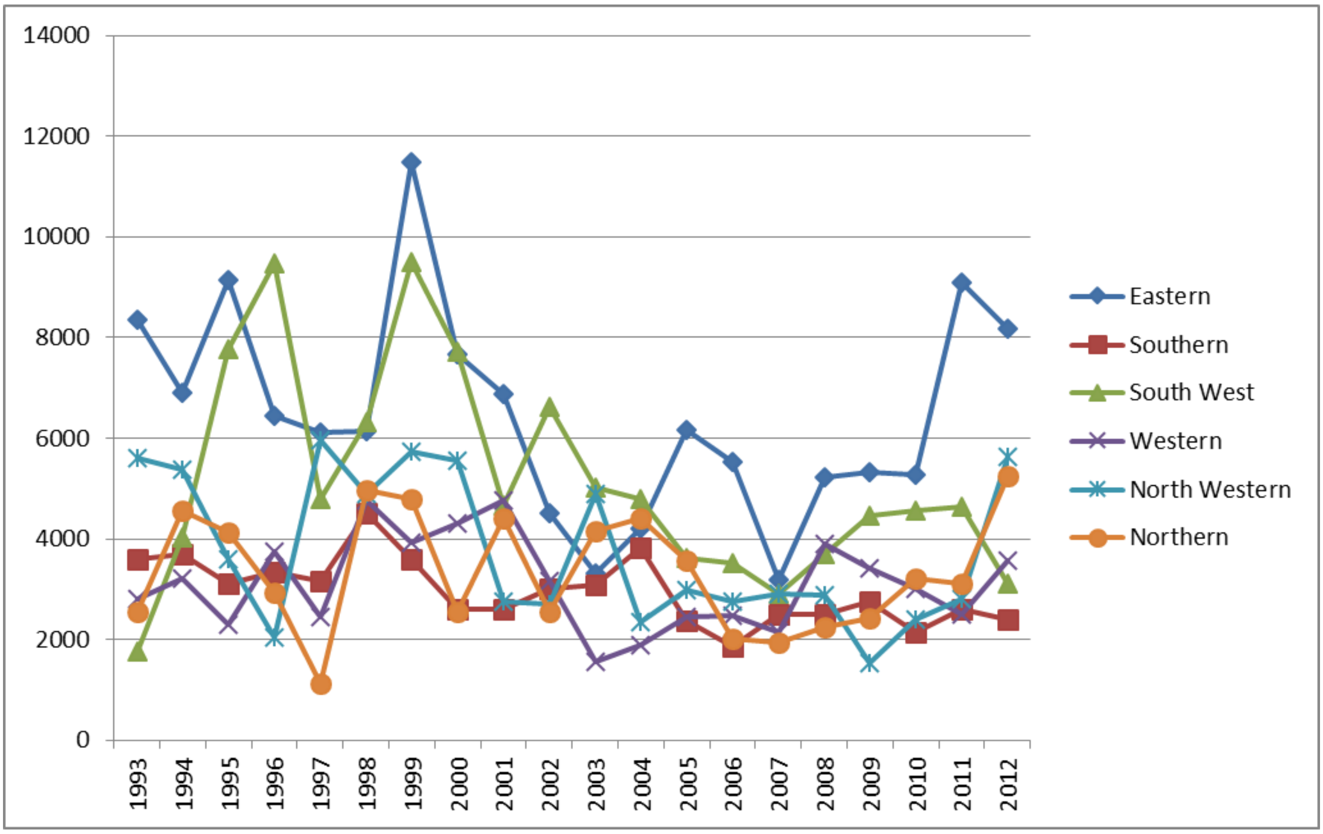
STATUS OF AND TREND IN DEVELOPMENT IN SEA TROUT POPULATIONS & SEA TROUT CATCHES in Ireland

P. Gargan etc.

General status for, and development in populations since 1994 in your country (If relevant separate descriptions for different parts of the country). Relevant information could include: 0+ / parr densities, Smolt numbers, Spawner numbers (or proxy, e.g. spawning pits etc.)

The general status of sea trout stocks In Ireland over the period 1989–2003 is described in detail in Gargan *et al.* 2006. A review of the Status of Irish sea trout stocks Gargan, P.G., Poole, R, & Forde, G. (2006). In G.S.Harris and N.J. Milner. Sea Trout: Biology, Conservation and Management. Fishing News Books, Blackwells Scientific Publications, Oxford, UK. pp 25-44. PDF Attached.

Since 1993, rod catch data has been collected on 62 key fisheries on a fishery district basis. There was a noticeable decline in rod catch over the 2002–2007 period, after which catches have increased in most fishery districts.



Selected Sea trout rod catch by fishery District in Ireland 1993–2012.

Little information is available specifically on juvenile sea trout as electro-fishing surveys monitor juvenile trout data and this data may include fish that may be migratory or non-migratory.

There are two principal monitored index rivers based on operation of total traps: 1. the Burrishoole river, which has reported all upstream adult fish entering the river and all smolts leaving the river since 1969; 2. the Glendavock river at Tawnyard on the Erriff catchment, where a spring smolt count (including measurements of size and run time) has been undertaken along with counts of surviving kelts since 1984. There are also some data available for two Connemara rivers (Owengowla and Invermore over the 1991–2012 period.

There are over twenty resistivity and Vaki infra-red fish counters with video verification which provide adult sea trout census data delivering accurate numbers of sea trout with accompanying information on run time and size. Most of these installations were established only recently (since 2005) and were commissioned to enhance the salmon management programme. The value of these facilities for sea trout stock assessment will increase substantially with extension of the time series.

What are the principal reasons for any changes in the status of sea trout populations in your country in recent years?

Sea trout stocks have been reported to be declining in a number of historically important fisheries such as the Feale in the south west and the Owenmore in the north west. No clear indication is available for the cause of these apparent declines and the sea trout stock has shown recent indications of recovery in both fisheries. Generally land use practices such as drainage, damage to small tributaries, afforestation, barriers to migration, inadequate water quality have all contributed to recent declines. A new management strategy where many rivers are closed to salmon harvest or closed completely to salmon angling has resulted in reduced effort and resultant reduced declared sea trout rod catches.

Are sea trout caught commercially in your country? If yes, are they the primary target in this fishery?

If yes what type of fishery (professional gear at sea, fixed gear in freshwater) and what is the magnitude in number or tons?

If no, what monitoring and evaluations are there on by-catch?

What measures are in place to ensure that commercial catch-reports are made?

Data is collected through the salmon tagging and logbook scheme on all sea trout >40cm captured in commercial and angling fisheries. Salmon are the target species. Sea trout, particularly larger sea trout were captured in significant numbers in the offshore drift net fishery up to 2006. This fishery has ceased to operate since 2006. Inshore draft net and other inshore fisheries target salmon and the mesh sizes permitted are designed to allow sea trout escape. Therefore the scale of sea trout capture in inshore commercial fisheries does not reflect the sea trout stock in those areas. There is no targeted commercial fishery for sea trout.

	Drift	Draft	Other	Angling	Total Harvest
2001	1,787	2,192	246	1,066	5,291
2002	874	1,083	126	1,464	3,547
2003	712	1,024	203	997	2,936
2004	640	929	78	519	2,166
2005	279	535	50	770	1,634
2006	116	311	47	543	1,017
2007	N/A	34	N/A	331	365
2008	N/A	59	N/A	448	507
2009	N/A	35	10	455	500
2010	N/A	67	N/A	368	435

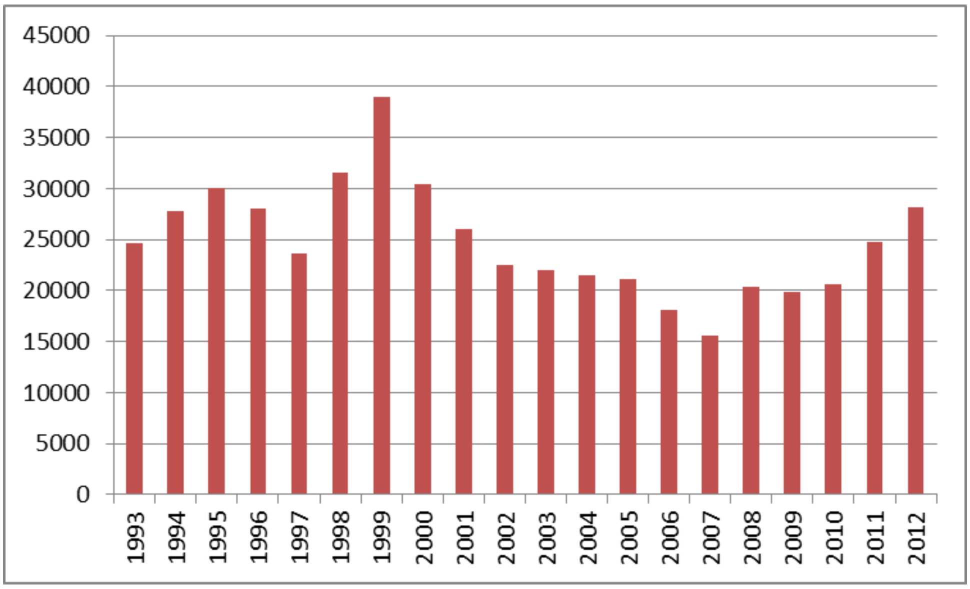
Total sea trout harvest of sea trout >40cm over the 2001–2010 period.

Are sea trout caught in recreational fisheries?

If yes what type of fishery (fixed gear at sea, fixed gear in freshwater, rod and line at sea, rod and line in freshwater) and, if known, what is the magnitude in number or weight for last 5 years (or more, if appropriate)?

What measures are in place to ensure that recreational catch-reports are made?

Sea trout are only captured by rod and line in recreational fisheries. The graph below sets out the number of sea trout captured in freshwater in selected fisheries nationally. Approximately 50% more sea trout are captured but not reported in the national statistics. The average weight of the rod catch is approx. 0.5kg. Sea trout are also captured by shore anglers in the sea but catches are less than those in freshwater. There is only a need to report sea trout caught by rod and line >40cm in Ireland and many rod caught sea trout go unreported. The systematic reporting and collection of recreational sea trout catches, which includes sea trout that are less than 40cm should be undertaken and the possibility of recorded all rod caught sea trout in angling logbooks is currently being investigated.



Sea trout rod catch in freshwater reported by Fishery inspectors in selected fisheries.

Are sea trout caught illegally? If yes, what type(s) of fishery, and what is the extent (if known)?

Sea trout are caught illegally by salmon poaching both at sea and in rivers. Numbers are unknown but estimated to be in the low thousands. Small numbers of sea trout are also captured by anglers on rivers closed to angling.

REPORTING ASSESSMENT AND MONITORING BY COUNTRY (ITEM 3.4)

COUNTRY	IRELAND
REGION	All fishery Districts
INSTITUTION(S) MONITORING	Inland Fisheries Ireland, Marine Institute
PURPOSE OF MONITORING	Statutory salmon logbook returns require sea trout >40cm also to be recorded in rod and commercial fisheries. Two rivers, Burrishoole (Annex I) and Erriff (Annex II) have long-term monitoring of sea trout stocks
WHERE IS MONITORED[1)]	All commercial salmon fisheries and selected rod fisheries (approx 62 rivers). Sea trout are monitored in about 20 fish counters monitoring upstream sea trout runs
ITEMS MONITORED[2)]	<u>Monitoring in freshwater:</u> 0+ Density / parr densities (method, time, frequency, intensity, duration of observation) Approx 125 of Irelands 140 salmon rivers have been electro-fished since 2008 to assess salmon fry density. O+ and parr trout are encountered in the shallow riffle sites fished and recorded in this programme over the July to September period. Smolt number (method e.g.: traps with complete catch, traps with partial catch, derived from density, duration of observations, ….), Sea trout smolt and kelt numbers are available from two traps (Burrishoole & Erriff) since 1969 and 1984 respectively and over the 1991- 2011 period in traps in two Connemara fisheries. Spawner number (method: trap with total catch, trap with partial catch, derived from catch (rod, professional, Catch Per Unit Effort, camera total Total upstream sea trout runs are available from the Burrishoole and from two

	Connemara fisheries (1991-2011). Upstream sea trout numbers are available from about 20 rivers with fish counters since 2005.
QUALITY OF DATA	Commercial sea trout catch is accurately recorded Rod fishery sea trout catch is underestimated for fish >40 and poorly recorded for smaller sea trout. The catchment wide electro-fishing programme concentrates on shallow gravel/riffle sites for o+ salmon fry. Trout fry are also captured and some parr. This programme underestimates the density of 0+ trout fry as trout spawn earlier in the season and may have migrated from shallow riffle sites by the start of the programme in July. The Water framework Directive monitoring programme does monitor surveillance sites for all fish species and provides good quality data on juvenile trout density. There is a difficulty in determining whether juvenile trout are the progeny of resident or migratory fish.
OTHER / REMARKS	
REFERENCES / PUBLICATIONS	Anon. (1995). Report of the Sea Trout Working Group, 1994, Department of the Marine, Dublin, 254pp. Mills C.P.R, Piggins D.J. & Cross T.F. (1986). Influence of stock levels, fishing effort and environmental factors on anglers' catches of Atlantic salmon, Salmo salar L., and sea trout, Salmo trutta L. Aquaculture & Fisheries Management, 17, 289-297. Poole, W.R., Dillane, M., deEyto, E, Rogan, G. & Whelan, K. (this meeting). Chracteristics of the Burrishoole sea trout population: census, marine survival, enhancement and stock recruitment, 1971-2003. Paper presented to the 1st International Symposium on the Conservation and Management of Sea Trout. Poole, W.R., Whelan, K.F., Dillane, M.G., Cooke, D.J. & Matthews, M. (1996). The performance of sea trout, Salmo trutta l., stocks from the Burrishoole system western Ireland, 1970-1994. Fisheries Management & Ecology, 3 (1). 73-92. Gargan, P.G., Poole, R, & Forde, G. (2006). In G.S.Harris and N.J. Milner. Sea Trout: Biology, Conservation and Management. Fishing News Books, Blackwells Scientific Publications, Oxford, UK. pp 25-44. Gargan, P.G., Roche, W.K., Forde, G.P. and Ferguson, A. (2006) Characteristics of sea trout (Salmo trutta L.) stocks from the Owengowla and Invermore Fisheries, Western Ireland, and Recent Trends in Marine Survival. In G.S.Harris and N.J. Milner. Sea Trout: Biology, Conservation and Management. Fishing News Books, Blackwells Scientific Publications, Oxford, UK. 60-75.
ACCESSIBILITY OF DATA	Commercial, rod catch data accessible, Juvenile catchment wide electro-fishing trout data available, WFD monitoring data available. Long term monitoring data on Burrishoole published, Long term monitoring data in Erriff being prepared for publication.
REPORTED BY (INSTITUTION, NAME)	Inland Fisheries Ireland

Annex I

Burrishoole juvenile trout populations, 1991–2012

- The tables below summarise juvenile trout densities in the Burrishoole catchment recorded between 1991 and 2012.
- Fish were sampled using the removal method, involving three passes with a backpack electrofisher.
- Fish were allocated to age class based on length frequency histograms.
- Generally, 0+ fish were found to be less than 8cm, 1+ fish between 8 and 13cm, and 2+ fish greater than 13 cm. The 2+ category include 3+, 4+ etc, and anything up to adult Brown trout.
- The border between 1+, 2+ and older is often hard to be definitive about.
- Sampling occurs between July and September each year.
- We must presume that in the absence of significant sea trout runs, the majority of these juvenile are destined to be resident brown trout.
- n refers to the number of sites fished per river. We try and fish the same sites consistently every year, but sometimes we have to move up or downstream a little if there has been a change in the river channel.
- The numbers per m^2 in the tables below are the mean number of trout per m^2. If the three passes did not produce a good enough removal sample, the number is a minimum estimate. Where more than one site in a river is fished, values are averaged across sites.
- These juvenile estimates are tied in with the migratory stocks, which are counted through the Burrishoole traps. Details of the migratory stocks are described in Poole *et al.* (2006) and in the annual reports of the research station (e.g. Marine Institute 2013). These annual reports are publicly available from the Marine Institute's Open Access Repository http://oar.marine.ie/ using the search term 'Newport'.
- These data are supplied by Elvira de Eyto. Contact elvira.deeyto@marine.ie for further details or clarifications.
- Should any of the raw data behind these tables be required, they can be requested through the Marine Institute's data request service, http://www.marine.ie/home/publicationsdata/RequestForData.htm
- References

Poole, W. R., Dillane, M., de Eyto, E., Rogan, G., McGinnity, P. & Whelan, K. (2006) Characteristics of the Burrishoole Sea Trout Population: Census, Marine Survival, Enhancement and Stock-Recruitment Relationship, 1971-2003. In: Graeme Harris, N. M. (eds) *Sea Trout: Biology, Conservation and Management*. Oxford: Blackwell, pp 279-306.

Marine Institute (2013) Newport Research Facility, Annual Report, No. 57, 2012, Marine Institute, Newport, Co. Mayo. 71 pp.

Table 1. Juvenile trout densities in the Burrishoole catchment between 1991 and 2012. Numbers refer to the average (n refers to the number of sites in each river) number of fish per m² recorded in each river according to age class (0+, 1+ and 2+), calculated using removal sampling and the zippin method.

River		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Altahoney	n			3	4	10		10				2
	0+			0.020	0.026	0.074		0.098				0.112
	1+			0.019	0.055	0.073		0.158				0.072
	2+			0.010	0.059	0.048		0.042				0.037
Black	n										1	
	0+										0.065	
	1+										0.013	
	2+										0.000	
Cottage	n							5			5	1
	0+							0.118			0.237	0.518
	1+							0.052			0.125	0.051
	2+							0.051			0.009	0.009
Fiddaunnahoilean	n					4		4			4	
	0+					0.976		0.632			1.522	
	1+					0.074		0.144			0.123	
	2+					0.010		0.009			0.007	
Fiddaunveela	n	3	3	3	3		3	3		3	3	3
	0+	0.668	0.493	0.226	0.384		0.443	0.381		0.243	0.528	0.718
	1+	0.085	0.044	0.039	0.041		0.167	0.144		0.177	0.136	0.118
	2+	0.014	0.028	0.013	0.007		0.012	0.020		0.023	0.000	0.014

Glenamong	n	1	4	3
	0+	0.000	0.018	0.108
	1+	0.011	0.025	0.001
	2+	0.000	0.028	0.001

River		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Altahoney	n	2	10	2	2	2	2	1	2	2	1	2
	0+	0.011	0.065	0.018	0.020	0.115	0.000	0.048	0.041	0.025	0.008	0.016
	1+	0.267	0.100	0.183	0.042	0.013	0.022	0.040	0.043	0.092	0.079	0.008
	2+	0.014	0.023	0.032	0.075	0.047	0.012	0.093	0.041	0.013	0.016	0.036
Black	n					1	1					
	0+					0.051	0.010					
	1+					0.000	0.000					
	2+					0.000	0.000					
Cottage	n	1	5	2		1						
	0+	0.309	0.224	0.176		0.857						
	1+	0.085	0.210	0.104		0.026						
	2+	0.000	0.046	0.101		0.000						
Fiddaunnahoilean	n		4	4	2	2	2	2	2	2	2	2
	0+		0.664	1.089	1.122	1.734	1.151	0.870	0.901	0.604	0.467	1.169
	1+		0.192	0.173	0.268	0.068	0.166	0.050	0.077	0.178	0.116	0.222
	2+		0.007	0.006	0.000	0.000	0.008	0.000	0.000	0.000	0.000	0.018
Fiddaunveela	n	3	3	3	3	3	3	3	3	3	3	3
	0+	0.133	0.337	0.476	0.442	0.564	0.574	0.444	0.515	0.540	0.217	0.730

	1+	0.186	0.311	0.357	0.313	0.247	0.365	0.182	0.065	0.079	0.076	0.027
	2+	0.015	0.019	0.013	0.015	0.034	0.068	0.032	0.034	0.000	0.007	0.017
Glenamong	n	3	5	2	2	2	2	2	2	2	1	2
	0+	0.007	0.037	0.017	0.012	0.081	0.005	0.005	0.021	0.003	0.019	0.003
	1+	0.021	0.014	0.011	0.015	0.021	0.002	0.009	0.004	0.009	0.022	0.003
	2+	0.002	0.008	0.007	0.014	0.002	0.009	0.011	0.003	0.003	0.000	0.006

River		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Goulaun	n	3	6	6	6			6		6		3
	0+	0.091	0.132	0.190	0.260			0.164		0.225		0.297
	1+	0.051	0.022	0.043	0.061			0.061		0.066		0.093
	2+	0.004	0.021	0.027	0.009			0.025		0.028		0.041
Lena	n		1								2	
	0+		0.750								0.135	
	1+		0.031								0.020	
	2+		0.010								0.000	
Lodge	n	2						6				3
	0+	0.061						0.092				0.236
	1+	0.029						0.063				0.092
	2+	0.000						0.063				0.023
Main channel	n											1

	0+											0.118
	1+											0.016
	2+											0.008
Maumaratta	n	1		7				7				1
	0+	0.009		0.043				0.096				0.156
	1+	0.008		0.031				0.099				0.000
	2+	0.000		0.004				0.011				0.000
Rough	n	2	1	5	5	5		5	10	12	2	4
	0+	0.012	0.232	0.144	0.254	0.140		0.137	0.068	0.094	0.311	0.405
	1+	0.012	0.000	0.037	0.065	0.207		0.058	0.027	0.033	0.042	0.069
	2+	0.001	0.000	0.029	0.018	0.023		0.039	0.036	0.016	0.022	0.022

River		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Goulaun	n	3	6	6	6	6	6	6	6	6		6
	0+	0.152	0.361	0.410	0.286	0.407	0.199	0.157	0.211	0.143		0.286
	1+	0.084	0.087	0.078	0.091	0.066	0.099	0.020	0.060	0.028		0.013
	2+	0.037	0.012	0.019	0.018	0.016	0.034	0.024	0.020	0.020		0.021
Lena	n											
	0+											
	1+											
	2+											
Lodge	n	3	5								2	2

	0+	0.090	0.179								0.201	0.385
	1+	0.085	0.072								0.128	0.046
	2+	0.014	0.025								0.018	0.052
Main channel	n	1	1	1	1	1	1	1	1	1	1	1
	0+	0.037	0.084	0.028	0.039	0.063	0.035	0.028	0.050	0.143	0.040	0.085
	1+	0.036	0.017	0.097	0.015	0.011	0.026	0.000	0.004	0.000	0.014	0.000
	2+	0.004	0.003	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maumaratta	n	1	7	1	3	3	3	1	3	3	3	3
	0+	0.026	0.388	0.014	0.003	0.058	0.017	0.029	0.030	0.014	0.005	0.050
	1+	0.039	0.127	0.060	0.097	0.036	0.051	0.006	0.018	0.027	0.016	0.067
	2+	0.008	0.000	0.007	0.009	0.008	0.039	0.022	0.007	0.000	0.002	0.007
Rough	n	12	12	12	9	12	12	12	18	7	7	12
	0+	0.115	0.162	0.133	0.175	0.297	0.161	0.134	0.097	0.144	0.061	0.317
	1+	0.152	0.083	0.092	0.050	0.085	0.097	0.027	0.051	0.039	0.015	0.020
	2+	0.027	0.015	0.031	0.018	0.014	0.036	0.043	0.032	0.034	0.032	0.021

River		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Stream A	n	1	1	1	1		1	1	1	1	1	1
	0+	1.230	2.251	0.440	0.214		1.808	1.177	0.726	1.470	2.818	1.158
	1+	0.087	0.012	0.012	0.061		0.049	0.204	0.061	0.037	0.053	0.037
	2+	0.000	0.000	0.000	0.038		0.000	0.000	0.012	0.012	0.000	0.000
Stream B	n	1	1	1	1		1	1		1	1	

	0+	1.92	1.47	0.87	0.45		1.33	0.77		0.77	0.70	
	1+	0.02	0.11	0.07	0.02		0.04	0.14		0.11	0.09	
	2+	0.00	0.00	0.00	0.04		0.00	0.00		0.00	0.00	
Stream C	n	1	1	1	1		1	1	1	1	1	1
	0+	1.65	2.87	0.34	1.03		2.36	2.29	0.70	1.85	2.24	1.33
	1+	0.00	0.02	0.18	0.11		0.37	0.17	0.17	0.22	0.46	0.05
	2+	0.00	0.00	0.02	0.00		0.02	0.00	0.00	0.00	0.00	0.00
Yellow	n							6				
	0+							0.38				
	1+							0.08				
	2+							0.01				

River		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Stream A	n			1	1	1	1	1	1	1	1	1
	0+			1.700	0.526	1.517	1.088	1.119	2.046	2.394	1.641	1.514
	1+			0.027	0.077	0.024	0.077	0.027	0.043	0.014	0.109	0.073
	2+			0.000	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.014
Stream B	n											
	0+											
	1+											
	2+											
Stream C	n		1	1	1	1	1	1	1	1	1	1

	0+	1.67	1.91	2.34	1.03	2.21	0.72	1.79	0.51	0.57	0.60
	1+	0.03	0.04	0.21	0.30	0.02	0.12	0.09	0.20	0.04	0.12
	2+	0.00	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.06	0.02
Yellow	n	5									
	0+	0.31									
	1+	0.21									
	2+	0.03									

Annex II

Erriff river, Tawnyard trap data (1985–2010).

	Sea trout	Sea trout
	Smolts	Kelts
1985		417
1986	1017	512
1987		489
1988	2877	606
1989	no data	no data
1990	1674	62
1991	3418	116
1992	1818	325
1993	420	332
1994	1474	354
1995	2868	520
1996	3469	478
1997	3021	584
1998	3340	693
1999	3899	739
2000	2642	636
2001	1178	327
2002	3977	669
2003	3481	962
2004	1865	306
2005	3698	346
2006	3235	66
2007	2146	186
2008	1084	344
2009	2152	196
2010	1117	335

4. North Ireland

STATUS OF AND TREND IN DEVELOPMENT IN SEA TROUT POPULATIONS & SEA TROUT CATCHES IN NORTHERN IRELAND AND THE CROSS-BORDER FOYLE AND CARLINGFORD AREA

R.J. Kennedy[1], P. Boylan[2], D. Ensing[1], A. Niven[2], R. Rosell[1] & W. Crozier[1]

General status for, and development in populations since 1994 in your country (If relevant separate descriptions for different parts of the country). Relevant information could include: 0+ / parr densities, Smolt numbers, Spawner numbers (or proxy, e.g. spawning pits etc.)

This report covers Northern Ireland and the cross-border Foyle and Carlingford catchments. This comprises two fishery areas. The Loughs Agency area of jurisdiction covers the waters entering Loughs Foyle and Carlingford whilst the Department of Culture, Arts and Leisure (DCAL) cover the rest of N. Ireland (Figure 1).

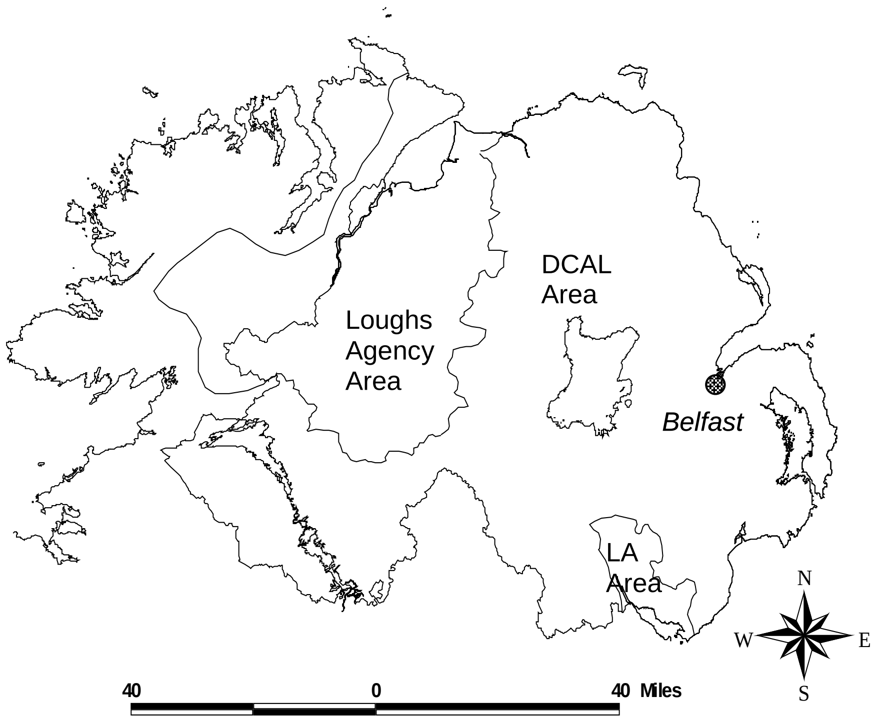


Figure 1 Fishery Jurisdictions in UK (Northern Ireland) and cross border Loughs Agency area.

[1] AFBI
[2] Loughs Agency.

Northern Ireland has 27 main salmon rivers (Crozier *et al.*, 2003) in addition to numerous small coastal streams capable of supporting sea trout. The river catchments vary in size from small coastal streams with drainage areas <5km^2 to major drainage basins (e.g. Lough Neagh > 4450km^2). Sea trout populations are evident, to some extent, in virtually all river systems in Northern Ireland and the cross border Foyle and Carlingford area, although some catchments (e.g. Lough Neagh) are dominated by potamodromous trout populations.

Juvenile Abundance in Sea Trout Producing Rivers

The abundance of juvenile 0+ trout in coastal sea trout producing streams varies across the region and the most recent quantitative (depletion) electric fishing survey (across 12 coastal rivers) indicated an average density for 0+ age class fish of 31 trout/100 m2 in 2011. In general juvenile densities were higher in the rivers located in the south east portion of N. Ireland inclusive of the River Shimna, Annalong, Kilkeel and Moneycarragh (36 trout/100 m2) than in the north eastern region of the country including the Rivers Carey, Margy, Glendun and Glenanne (10 trout/100 m2).

Annual semi-quantitative (SQ) electric fishing surveys were undertaken on 2 DCAL area rivers in Northern Ireland between 2002–2011 (Figure 1). The Glendun (north east) river showed a negative trend across the time series (r = -0.82) whilst the Shimna River (south west) indicated a more cyclical pattern of abundance (Figure 2).

In the Loughs Agency area three of the major rivers with a recognised sea trout run are the Roe, Faughan and Burn Dennett. These have been assessed annually since 2005 as part of the Agencys wider annual SQ electric fishing survey programme (Figure 2). The Roe and Faughan appear relatively stable with some cyclical abundance patterns evident while on the Burn Dennett there was a significant decrease in numbers from the first survey in 2005 however numbers have subsequently remained stable.

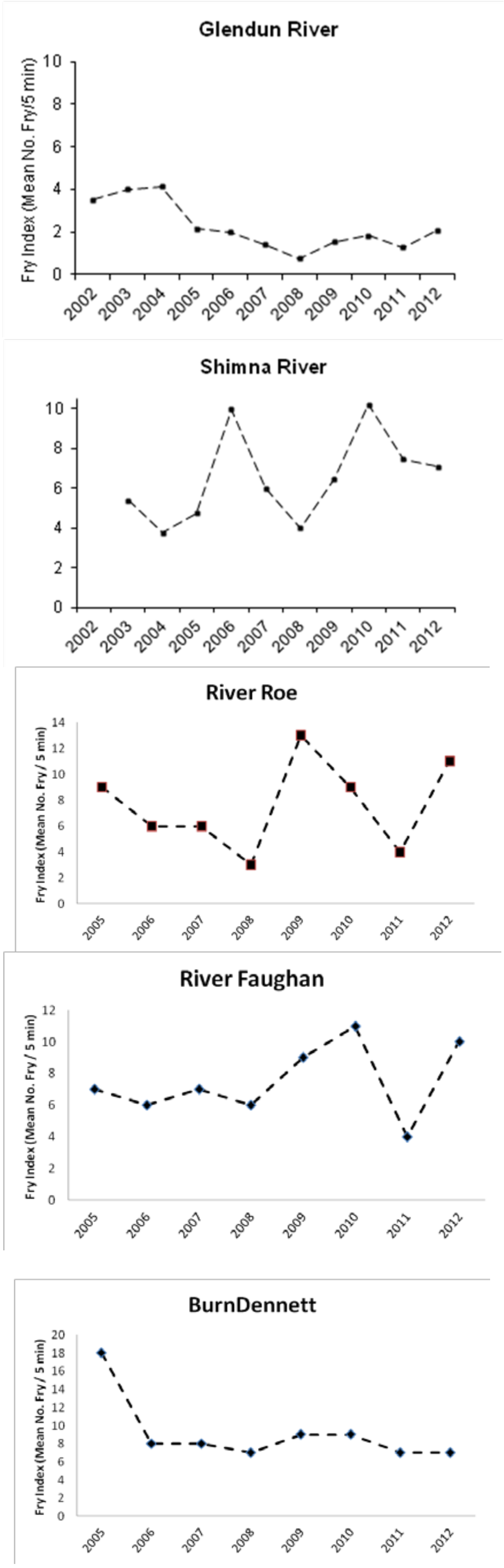


Figure 2. Juvenile (0+) trout fry indices for monitored sea trout rivers in the DCAL area of N. Ireland and the cross-border Loughs Agency area.

Adult Abundance in Sea Trout Producing Rivers

An index of abundance for adult sea trout on the Shimna river was produced from rod catch returns supplied by the local angling club from 2002-2011 (Figure 3). A simple abundance metric was calculated as the mean number of sea trout caught per reporting angler per annum and has varied from 4 (2008) to 39 (2011), indicative of a recent increase in catches. This metric has the advantage that it is inclusive of the entire size range of sea trout evident in the fishery.

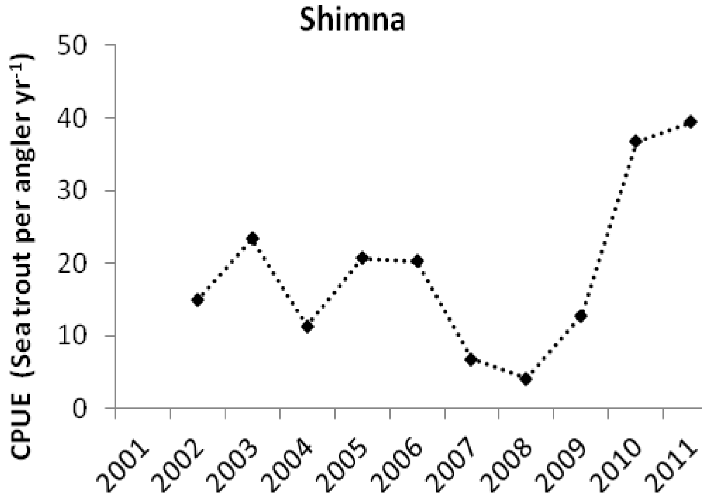


Figure 3. Measures of adult trout abundance on the Shimna river 2001–2011, data indicates the average reported catch per angler per year.

Additional Data Sources

Work is ongoing to quantify sea trout abundance at a number of electronic fish counters across the region some of which have been recently commissioned (e.g. Shimna River). The Loughs Agency are leading on an EU INTERREG IVA funded programme (IBIS) which currently has two PhD students investigating sea trout these are due to report in 2015 and 2016 (www.loughs-agency.org/ibis).

What are the principal reasons for any changes in the status of sea trout populations in your country in recent years?

Declines in sea trout abundance have been noted anecdotally by angling groups in the north eastern region of Northern Ireland. Recent electric fishing work has also shown a decline in juvenile trout in rivers in this local area. Reasons for this potential local decline are currently being investigated.

Predation, particular avian predation, has been shown to represent a significant source of mortality for Atlantic salmon smolts on the River Bush in Northern Ireland (Kennedy & Greer, 1989; Warke & Day, 1995). Initial results from an IBIS funded research project conducted in the Loughs Agency region around Lough Foyle indicated that cormorant predation may be a significant pressure on local anadromous salmonid populations, perhaps cropping up to 50% of total smolt production (IBIS report, 2013).

Other pressures on trout production in Northern Ireland have included barriers to migration and changing land use practices. Loss or damage to small stream habitats through historical schemes, maintenance of land drainage, and water quality in intensively farmed areas is a significant problem particularly in NI south- eastern coastal streams. Impassable or restricting flap valves built to prevent tidal ingress are also a potential problem at some sites. A desktop study based on electrofishing data estimates that due to a combination of these effects production of sea trout in streams feeding the coastal inlet of Strangford Lough is currently of the order of 15% of potential (R. Rosell pers. com.).

Are sea trout caught commercially in your country? If yes, are they the primary target in this fishery?

If yes what type of fishery (professional gear at sea, fixed gear in freshwater) and what is the magnitude in number or tons?

If no, what monitoring and evaluations are there on by-catch?

What measures are in place to ensure that commercial catch-reports are made?

Sea trout were historically captured commercially in Northern Ireland. The total catch of sea trout (nos.) from Northern Ireland between 1975-1993 varied between 155 (1994) to 1418 (1984) and is indicated in Figure 4. The number of licenced nets varied from 244 (1977) to 98 (1999).

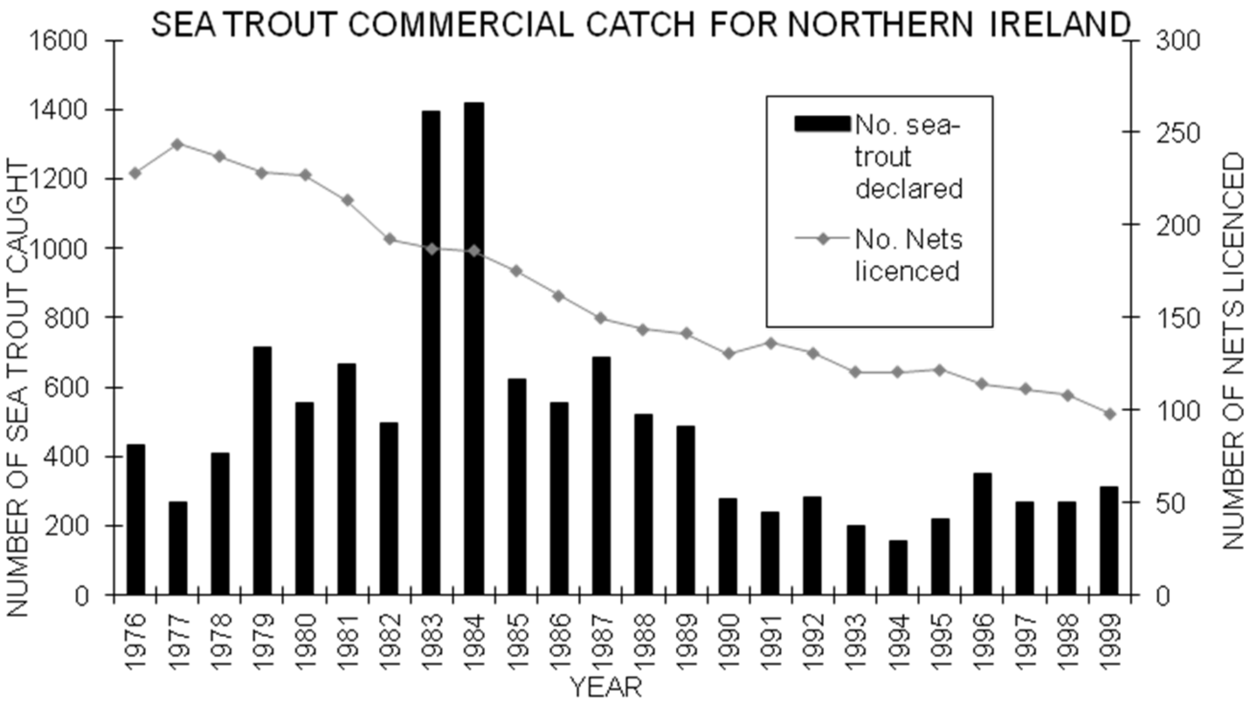


Figure 4. Estimated total landings of sea trout (no.) from commercial fisheries in Northern Ireland 1975-1999.

[3] Explanatory notes on catches; To ensure standardisation with established reporting agreements for Atlantic salmon, historical Foyle area commercial sea trout catches have been allocated to Ireland:N. Ireland on a 50:50 split for reporting purposes. Hence the total UK (N. Ireland) commercial catch reported to ICES represents 50% of the Foyle area catch, plus all the DCAL area catch.

Traditionally sea trout formed a minor by-catch from coastal salmon fisheries, sea trout landings representing c.0.5t/year in comparison to > 100t/ year of salmon (1975-99). Sea trout were subject to carcass tagging regulations (>40cm Loughs Agency area; >50cm DCAL area) from 2001. Declining salmon stocks in Northern Ireland have led to a number of net buy outs and cessations which commenced in 2000-1 with the buy out of c. 75% of the DCAL area commercial licenses. Within the cross-border Loughs Agency area commercial drift net fishing seawards of Lough Foyle ceased in 2007 and the in river draft nets were greatly reduced. Since 2010 no commercial licenses have been issued. The residual DCAL area commercial fishery ceased operation in 2012. Consequently no legal commercial harvest of sea trout is currently undertaken in Northern Ireland or the cross-border Foyle and Carlingford areas. The last 5 year period for which commercial landing data were available is shown in Table 1.

Table 1. Number of sea trout (>50cms) commercially harvested (declared) in Northern Ireland (DCAL Area) 2007–2011.

Year	No.
2007	8
2008	29
2009	7
2010	39
2011	31

Are sea trout caught in recreational fisheries?

If yes what type of fishery (fixed gear at sea, fixed gear in freshwater, rod and line at sea, rod and line in freshwater) and, if known, what is the magnitude in number or weight for last 5 years (or more, if appropriate)?

What measures are in place to ensure that recreational catch-reports are made?

The principal recreational fisheries for sea trout in Northern Ireland and the cross-border Foyle and Carlingford areas are associated with rod and line fishing in freshwater. A smaller rod and line fishery is also conducted in coastal waters (e.g. Strangford Lough).

Catches – DCAL Area

Information on recreational sea trout catches in the DCAL area is available through the carcass tagging and logbook programme. This data is available for the period 2002–2011. The annual sea trout catch return from the DCAL area has varied from 4 in 2007 to 22 in 2011 with an average return of around 13–14 trout per year. Under the current carcass tagging regulations trout in excess of 50cm fork length must be tagged which means that only the larger size component of the sea trout catch is recorded.

Catches – Loughs Agency Area

Information on recreational sea trout catches in the Loughs Agency area is also available through the carcass tagging and logbook programme. Around 400 sea trout per year are recorded from the Loughs Agency area (Figure 5). Under the current carcass tagging regulations trout in excess of 40cm fork length must be tagged which means that only the larger size component of the sea trout catch is recorded. No sea trout, or brown trout of less than 25.4cm (10 Inches) may be retained. In addition a bag limit of 4 brown trout, or sea trout of 40 cm or less in length, or a combination of both on any one day during the period 1st March to 31st October, both dates inclusive may be retained.

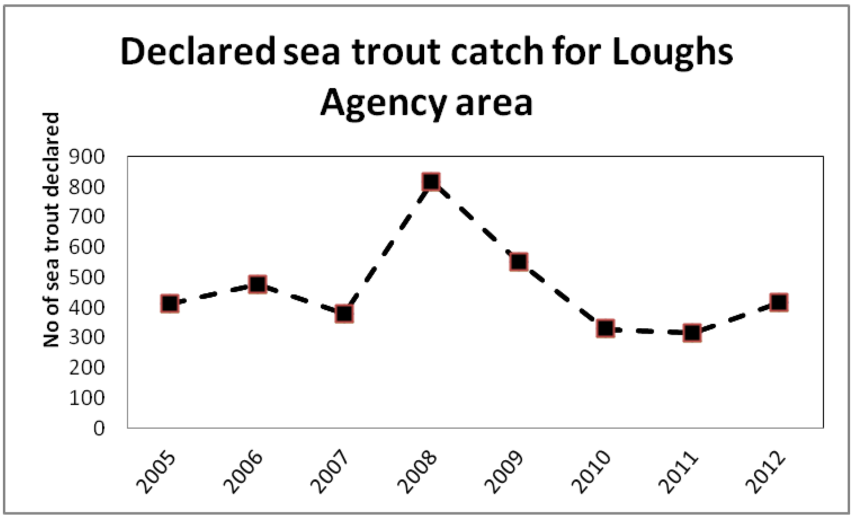


Figure 5. Recreational (declared) sea trout catch for the Loughs Agency area of N. Ireland.

Are sea trout caught illegally? If yes, what type(s) of fishery, and what is the extent (if known)?

Some illegal fishing activity occurs sporadically in Northern Ireland and Foyle and Carlingford area. This activity typically occurs in transitional or freshwater utilizing monofilament netting.

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5. Spain

STATUS OF AND TREND IN DEVELOPMENT IN SEA TROUT POPULATIONS & SEA TROUT CATCHES IN SPAIN

Pablo Caballero (DXCN– Consellería de Medio Ambiente– Xunta de Galicia)

Introduction

The Southern limit of natural distribution for sea trout is the north of Portugal, although more information is needed to get more accuracy about this item. Research about sea trout in Portugal is scarce, but at the end of the twentieth century the author of a thesis about brown trout populations in the Lima basin, asserts that the southern limit for anadromous trout was that river (Valente, 1993). Sea trout in the Iberian Peninsula is only present in rivers that drain to the Atlantic Ocean and the Cantabrian Sea, in their north and northwest area. In Spain, sea trout is present from the Miño River, border with Portugal, to the Bidasoa River, border with France. Sea trout fishery management is responsibility of regional governments (known as Autonomous Communities = CCAA). The five CCAA involved in sea trout management, from east to west, are: Navarre, Basque Country, Cantabria, Asturias and Galicia (see map in Figure 1). To know more accurately sea trout distribution in Spain, a survey to sea trout managers of the five CCAA was made, especially for the WK Trutta Workshop. Survey results showed that, of 52 rivers analysed (all the rivers longer than 15 Km in the area) sea trout was present in 48, the absence in the other 4 rivers, were caused by water pollution in 3 of them and an impassable natural waterfall at the mouth of the river was the non-presence reason in the other. Of the approximately 3,000 Km length of the 48 main courses where sea trout is present in Spain, only the 40% (1 200 Km) is accessible to anadromous fish (Figure 1). This reduced accessibility has been caused mainly by the hydroelectric dam's construction in the second half of the XX Century. As well as the 48 rivers analysed, in Spanish sea trout area there are several small coastal rivers that home very interesting and probably not very exploited sea trout populations.

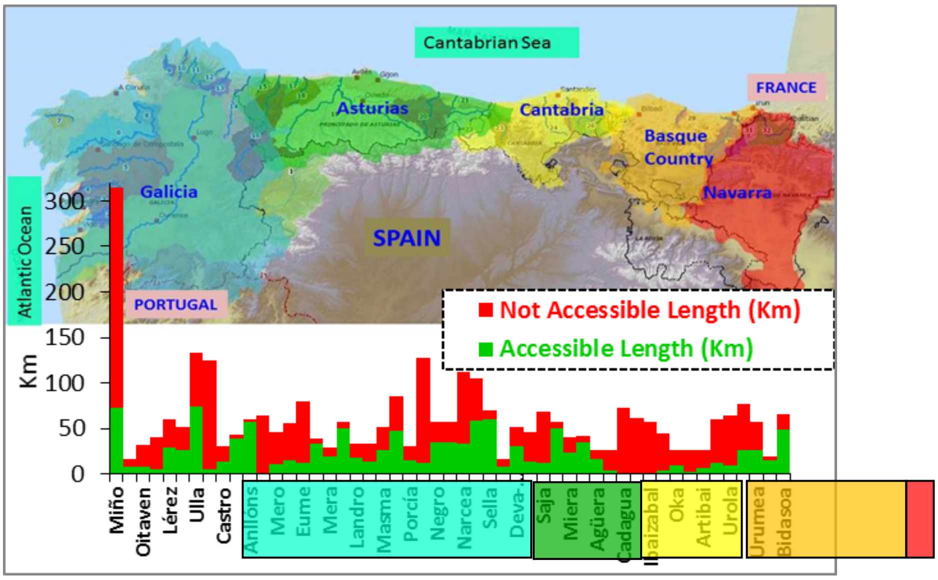

Figure 1. Administrative division in Spanish North and Northwest area and accessible/ not accessible length for sea trout in 52 Spanish Main rivers draining to the Atlantic Ocean and Cantabrian Sea.

In Spain the only CCAA with some degree of information available about sea trout abundance trends are Navarre and Galicia.

In Navarre, the only river with sea trout population is the Bidasoa. In this river, a regular upstream trap has been obtaining information about the adult sea trout run from 1995 until now (Figure 3). Also in one sample point of this river, electrofishing surveys have been done to assess the trend in juvenile density since 1992 (Figure 2).

In Galicia, three regular upstream traps have operated operate since the 90's decade in the rivers Ulla, Lérez and Tea (Miño Tributary) (Figure 3). Two of this also with smolt trap (Ulla and Tea River). Since 1995, electrofishing surveys have been done to assess brown trout abundance, including sea trout waters (Figure2). Since 1992 the angler catches have been mandatory to be declared by law, accordingly an official series of sea trout catches has been produced since 1995 (Figure 4). Although smolt run is studied in two rivers (Ulla and Tea) no estimation of smolt natural production has yet been obtained.

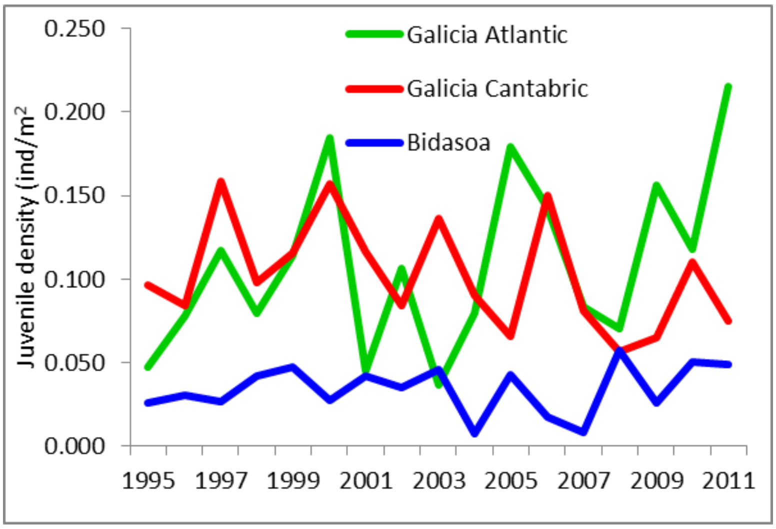

Figure 2. Electrofishing surveys of sea trout juveniles in Spain.

Average of juvenile trout densities for the period of study are relatively low (Galicia Atlantic Rivers = 10.9/100 m², Galician Cantabrian Rivers = 10.2 and Bidasoa River = 3.4) in the sea trout areas from Galician and Bidasoa rivers. The trend of juvenile density in these rivers in this period is more or less stable and no correlation has been found among the rivers studied (Figure2).

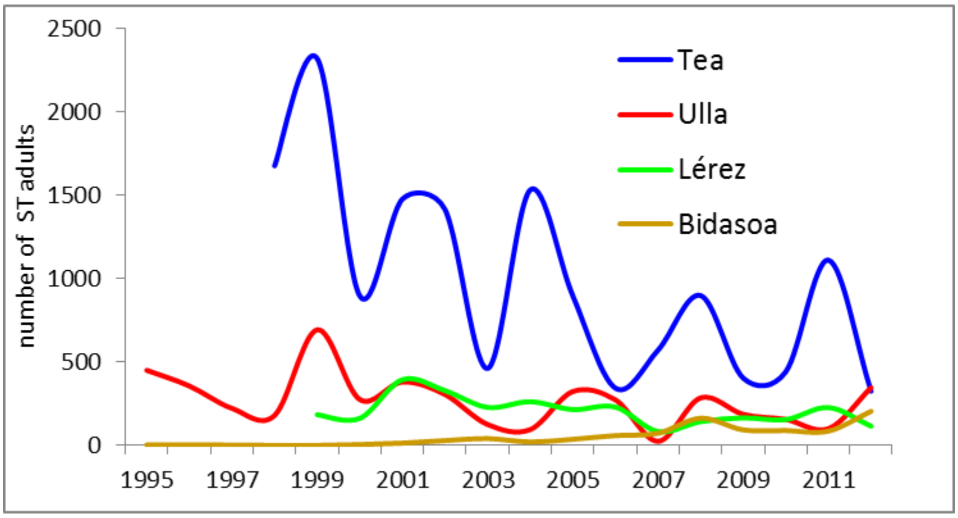

Figure 3. Number of sea trout adults catch at 4 regular traps (Bidasoa River-Bera Trap, Lérez River-Bora Trap, Ulla River-Ximonde Trap and Tea River-A Freixa Trap).

In the three Galician upstream traps, the trend of Galician sea trout run in the period analysed are negative but in the Bidasoa trap trend is positive (probably in the first years of the study period, sea trot was underestimated). The river where more sea trout are caught at traps, is the Tea trap (985 ind. per annum), markedly greater than in Ulla (266), Lérez (207) or Bidasoa (52) traps (Figure3).

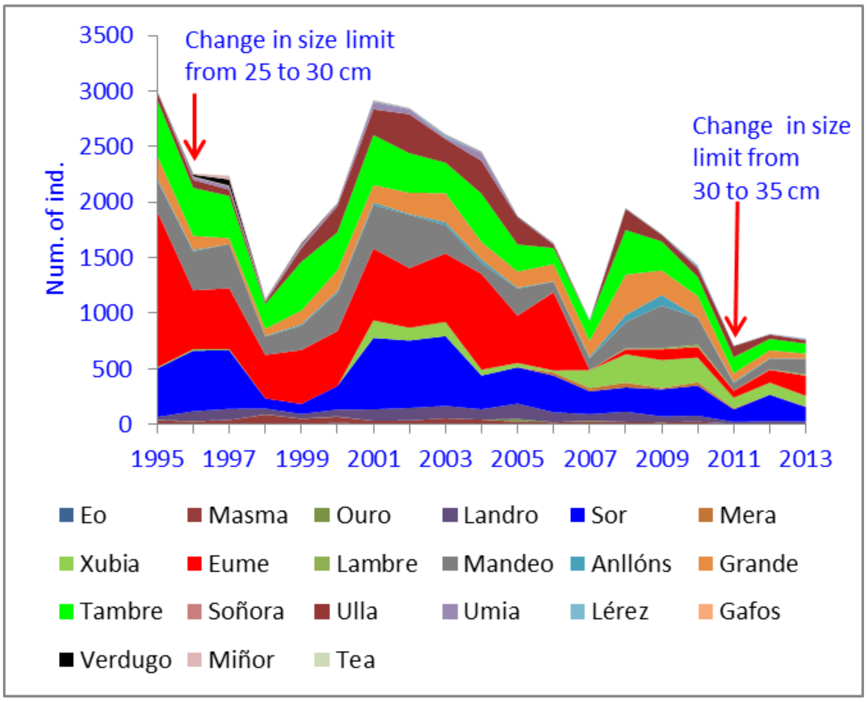

Figure 4. Galicia Sea Trout Recreational Fishery: Official catch in 21 rivers (1995–2013).

Changes on size limit have distorted the Galician sea trout catch series (Figure 4). Catch drop from 3000 sea trout declared in 1995 at around 700 in the three last years (2011–2013). Analysing this series without the size limit change effect, trend is also negative as in the Galician Traps Series. One of the reasons that produced this fall in the catch happened in 2007/2008, when a continuous pyrite discharge in the Eume River (the one with higher sea trout official catch in Galicia, see red colour in Figure 4) collapsed this sea trout population.

What are the principal reasons for any changes in the status of sea trout populations in your country in recent years?

Assessment obtained information suggests a relative stability in sea trout numbers in Spain, although the catch numbers are low, if comparing with other countries of the natural distribution of this fish. In spite of some negative trends detected. It is suggested to increase monitoring and research on this valuable populations in order to establish more accurately their mortality factors.

The lack of: a better environmental awareness in some Spanish society sectors, an active role of NGO's, suitable water quality and habitat restoration plans, and a convenient management of sea trout exploitation at the sea, are some of the problems that Spanish rivers and sea trout population therefore suffer, and probably, these are some of the main reasons that constrain the development of sea trout population in their southern limit distribution. But in the last 25 years, some migration barriers have been removed or fish passes have been improved. Water quality has been improved in many cases, but erosion of sand from stream banks, mainly caused by the construction of new infrastructures in the last 30 years, have resulted in heavy sediment transport. The excess sedimentation associated with the high density of artificial obstacles, above all in small streams, has reduced habitat availability and its variation.

Are sea trout caught commercially in your country? If so, are they the primary target in this fishery?

If so what type of fishery (professional gear at sea, fixed gear in freshwater) and what is the magnitude in number or tons?

If not, what monitoring and evaluations are there on by-catch?

What measures are in place to ensure that commercial catch-reports are made?

The sea trout in salt water is perhaps the pending subject in Spain. The prohibition of salmonid trade in Spain, produced a non-reported by catch fishery in this habitat. This situation should change to reduce the gap of knowledge about this life history stage and also to increase the interest for its conservation. A special case on this issue is the Miño River, for the reason that is the only river where commercial fishery by nets in the Iberian Peninsula occurs. This fishery is regulated by Spanish and Portuguese Governments, salmon and brown/sea trout are regularly caught with out-of-time measures, and trade control is not produced. Nevertheless in 2013, elvers and sea lamprey trade control has started in Spain, but because in Galicia salmonids commercialization is forbidden, this control is not yet possible.

No estimation of how many sea trout are caught in salt water or at the Miño River is possible at the moment.

Are sea trout caught in recreational fisheries?

If so what type of fishery (fixed gear at sea, fixed gear in freshwater, rod and line at sea, rod and line in freshwater) and, if known, what is the magnitude in number or weight for last 5 years (or more, if appropriate)?

What measures are in place to ensure that recreational catch-reports are made?

Sea trout are caught in the recreational fishery legally in fresh and some brackish water areas, only by rod and line. In Galicia since 1992 and in Navarre since 2011, it has been mandatory to declare all sea trout caught in the recreational fishery. In 21 Galician rivers 3,000 individuals were recorded with a lower size limit of 25 cm in 1995, with a size limit of 30 cm (1996-2010) the average catch was 1,956 indiv./year and the last three years of the series has dropped to 766 indiv./year.

Are sea trout caught illegally? If so, what type(s) of fishery, and what is the extent (if known)?

Illegal fishing for sea trout occurs, in sea and freshwater, but the extent is unknown. Nets placed at the rivers are found several times, mostly in summer. Also poaching, by anglers or by underwater fishing is not very uncommon in the lower part of some Spanish rivers.

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6. France

Not to be cited without to contact the authors

Sea trout in France. State of catches & stocks. Trends and population dynamics in river BRESLE

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Introduction

This paper gets back to the major points presented at the Workshop on sea trout, held in ICES Headquarters, Copenhagen, 13–15 November 2013: 1/ overall and rough information on catches in France 2/level of adult runs in 21 rivers, through video-counting or trapping facilities 3/ outline of population dynamics study carried on for a 30 years period on index river Bresle (Upper-Normandy), the only river with both fair population and processed long time-series data.

1. Catches

Figure 1 show catch by net at sea and rod in river, as indicated by the declaration system in place. Note they are only mean reported catches a/ by commercial nets on coast and estuary for nets through compulsory declaration and b/ by rods, on a voluntary basis.

Rods: less 1 tonne is caught, essentially in North West, in which half a ton in Upper Normandy, though where a large under-reporting is known (by a factor 10).

Very few fish are caught in Brittany and in the South-West, that is more surprising for this latter, considering the large populations in the river system (see below).

Nets: near 3 tonnes are landed by coast nets, essentially in the South-West. Some catches appear in Brittany (West Channel) and Upper-Normandy (East Channel), but in this latter, reporting is thought to be very low, considering the strong populations in rivers Bresle and Arques, and the obvious catch of sea trout by both commercial and recreational fisheries.

Four tonnes are reported, but considering the large under-reporting of catches, as a whole, the overall landing is thought to be near of 8 tonnes. Compared to average catch of salmon, 11 tonnes.

[4] With a lot of people through the country, involved in anadromous fish conservation and restoration programmes. See list at the back of the paper.

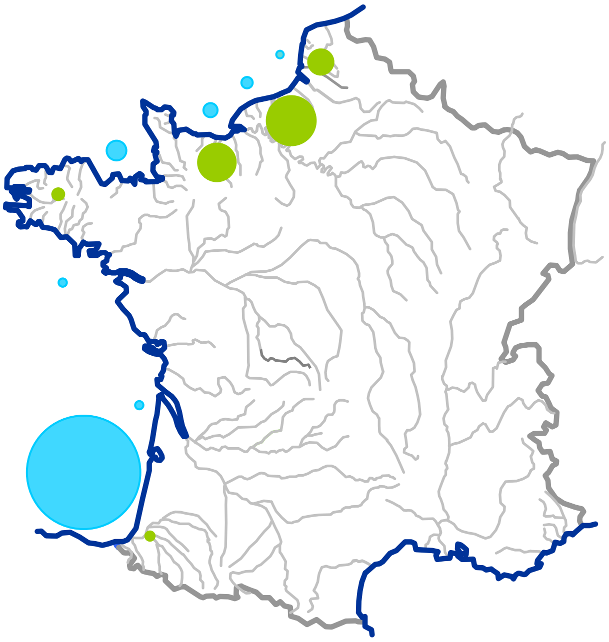


Figure 1. Rod and Net catches, in weight. Circles are proportional to weights. Nets : blue circles, last 3 years average. Rods: green circles, last 10 years average.

2. Stocks

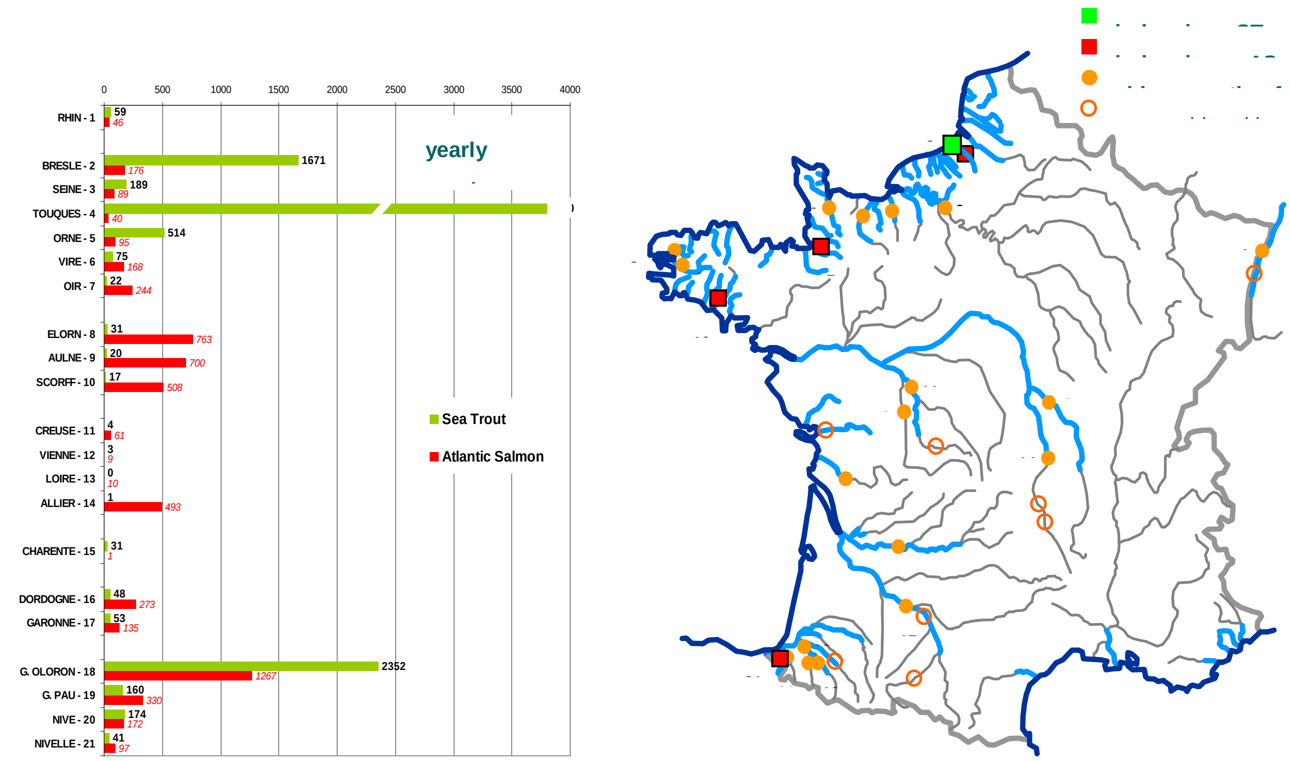


Figure 2. Stock numbers in trapping & counting facilities.

Figure 2 shows on the right, the location of 21 facilities to know adult abundance, mainly by video-counting of the runs, especially on the large rivers, and 4 index rivers, working with traps to control up and downstream runs (except in r. Scorff and Nivelle for smolts).

- the river BRESLE, for both sea trout and salmon populations
- the rivers OIR, SCORFF and NIVELLE, devoted to salmon

The graph, on the left, shows the yearly numbers of sea trout (in green bars) and by way of comparison, salmon (in red).

Three rivers dominate: BRESLE and TOUQUES in the North West , OLORON in the South West ; they are rivers with fair populations, more than 1000 fish a year, near 6000 in the river Touques. A difference however between NW and SW areas: river OLORON houses also a fair salmon population whereas salmon populations are limited in the sea trout rivers in the north west.

The abundance is very low in the west (Brittany) and central areas, with a contrasting figure in this latter : almost absence in the main river Loire and its lower tributaries, whereas 500 fish are trapped in Vichy facility (number 14 on the chart above) on river Allier, very far upstream to the sea.

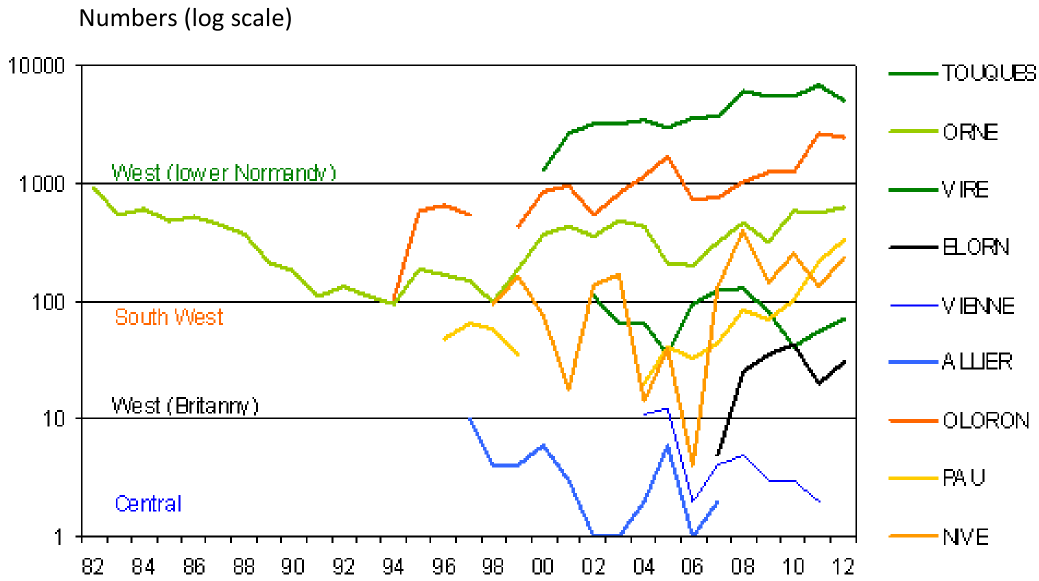


Figure 3. Sea trout adult numbers given by video-counting.

Figure 3 shows the numbers in nine of them, spreading from NW to SW. They are rough numbers, without assessment of facility efficiency.

Small numbers in central area don't lend to an estimation of trend on the last 15 years period ; but, except the norman river Vire, all others rivers show increasing numbers, probably linked with the opening of new production areas by building fishways.

Large information about length distribution (proxy), run timing, day-night migration is available, but not age structure.

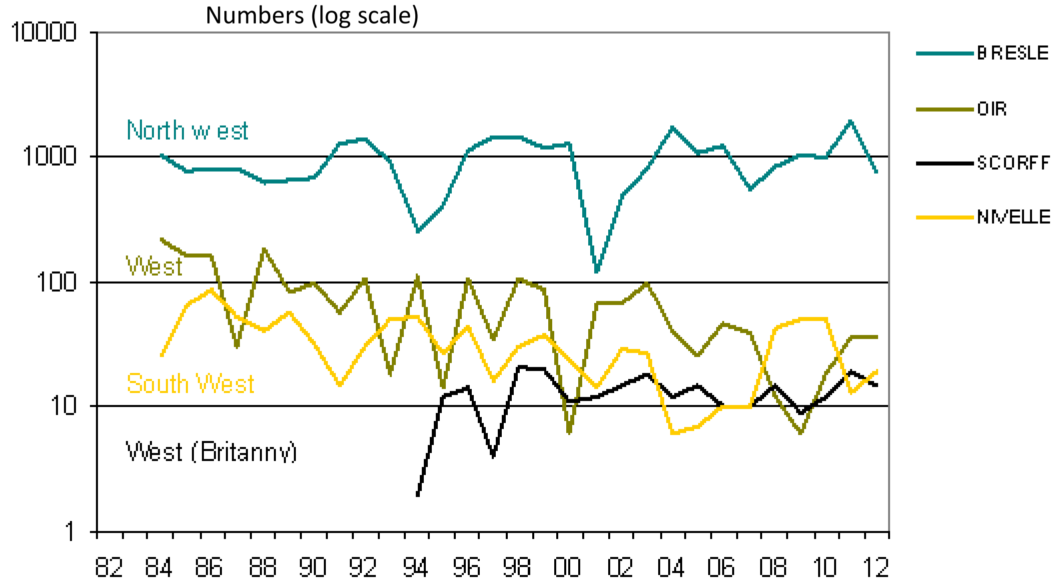


Figure 4. Sea trout adult numbers by trapping in index rivers.

Figure 4 shows estimated numbers in the 4 salmon index rivers, one of them, the river Bresle being index river for sea trout, as well. Numbers are obtained through Catch-Marking-Recapture methods and Bayesian estimations.

The "bumpy" evolution of numbers on the three decades period don't stop to see the positive trend in river Bresle and on a very smaller scale, in river Scorff ; by the contrary, numbers clearly decrease in rivers Oir and Nivelle, in which populations are low.

Length, weight, age and sex (at least on second run) are reliably set here, as well as stock-recruitment relationship in river Bresle.

3. Population dynamics in the Index river BRESLE, evolution on the last 30 years period.

3.1. Adult numbers

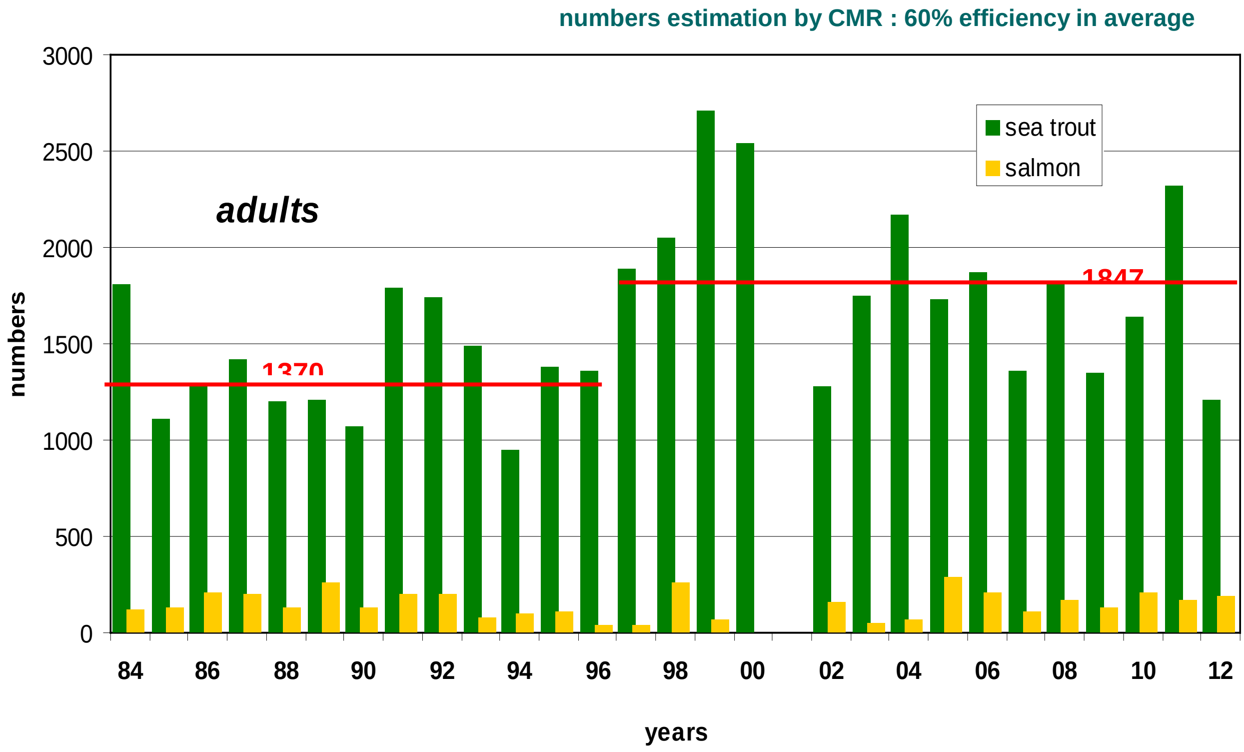


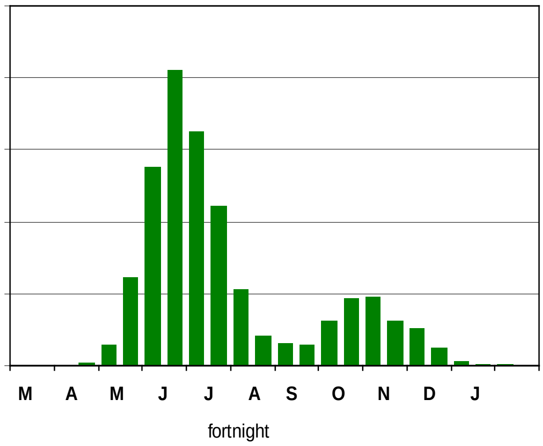
Figure 5. Sea trout adult numbers in index river BRESLE.

Adult run in river Bresle is 1600 fish in average and time-series shows an increasing trend on the period: from 1400 fish in the first decade to 1850 fish in the last ten years, being a 30% increase.

There is a factor 3 between numbers mini (in 1994) and maxi (in 1999).

In the same time, smolt production has increased of 27%, without evident change in river habitat can explain this positive evolution. The reduction of catches by recreational fixed nets at coast around the exit of the river could have played a part in this increase as well.

3.2. Adult run timing



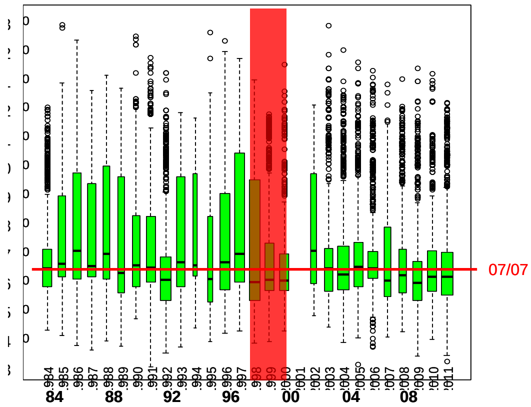


Figure 6 a - adult run timing, average 1984-2012.

(% trapped by month)

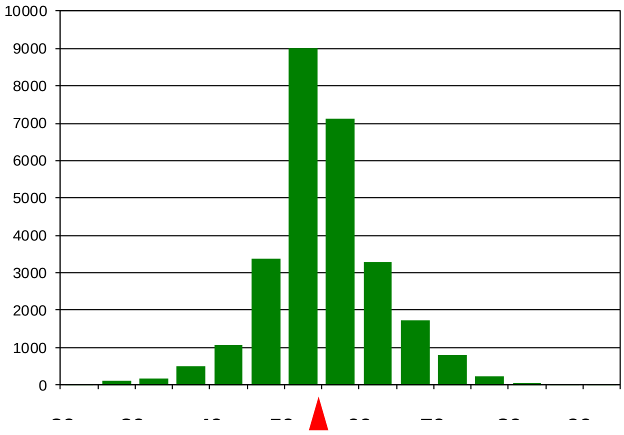
Figure 6 b : adult run timing.

Interannual evolution of the migration timing (median value and quartiles)

Adult fish run upstream in a typical two runs pattern, the first run making up 70%.

Time serie shows a clear change since late 90s. There is no trend of the median value (7 july) but a clear decrease of the second run and a shortening of migration period.

3.3. Length distribution



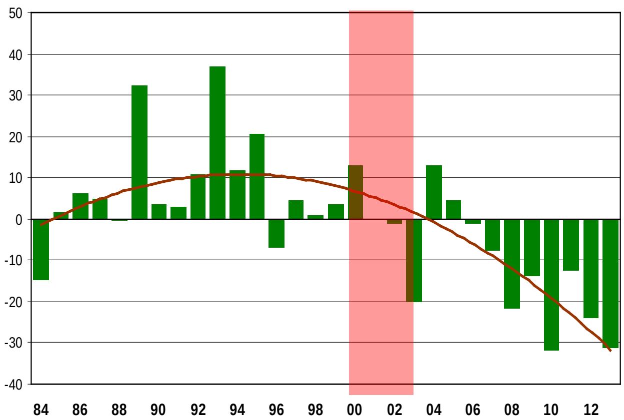


Figure 7a. Length frequency distribution, average 1984–2012.

Figure 7 b. Mean length trend. Expressed here in anomalies or annual deviation versus the 30 years mean

Size range from 20 to 90 cm.

Length and weight average are 55 cm and 2350g respectively.

Figure 7 b shows a clear inversion of mean length anomalies in early 2000 years, revealing a significant decrease of length : 56 cm before 2000 – 54 cm after, 53 cm for the last 5 years.

3.4. Sea age structure

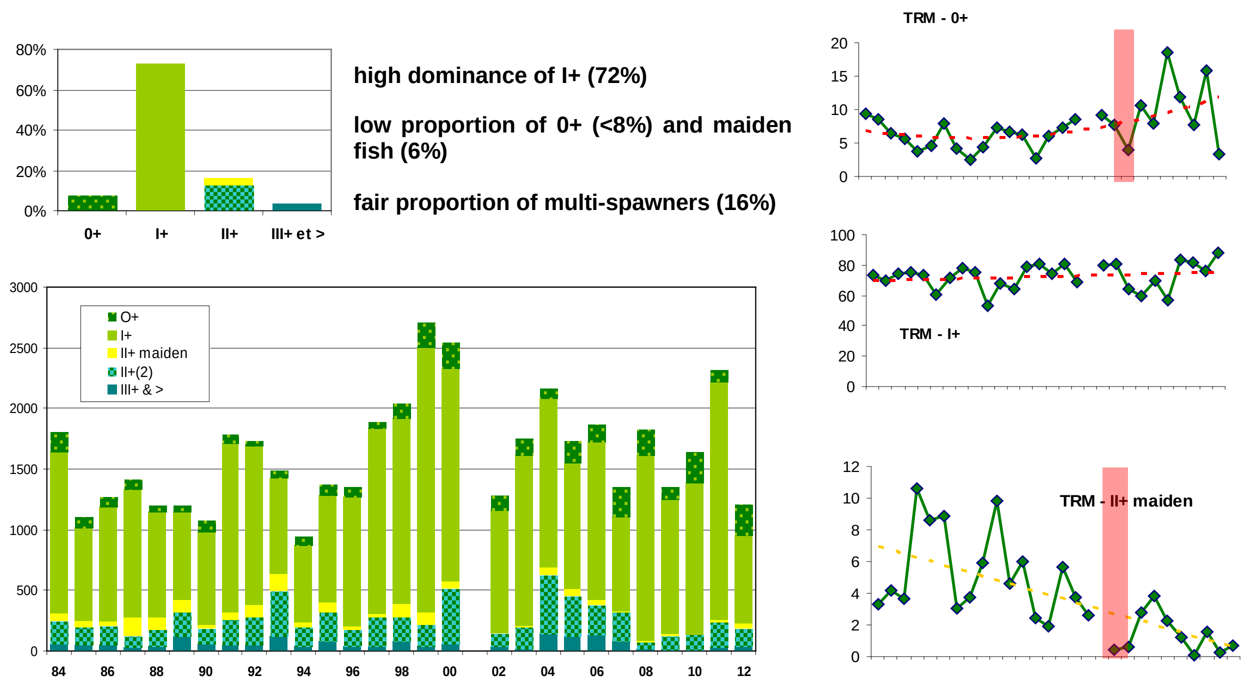


Figure 8. Sea age structure.

In average, run in river Bresle is made up of 72% 1SW fish, 16% of previous spawners, low proportion of finnock (< 8%) and maiden 2 SW fish (6%).

This age structure has changed on the 30 years period, spawners getting younger. 1SW component is stayed relatively stable but finnocks numbers doubled whereas 2 SW maiden fish strongly decreased. Something happened in years 2000.

3.5. In-river survival (egg-to-smolt)

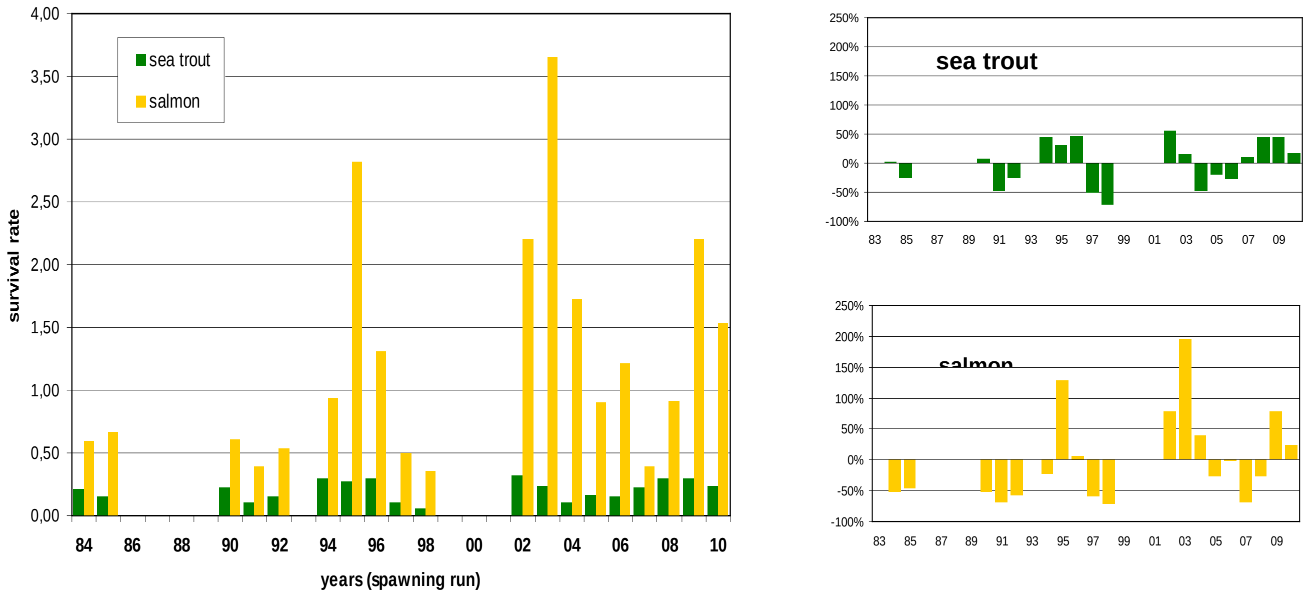


Figure 9. Egg-to-smolt survival on the left: survival rat.e per year ; on the right : trend (deviation from the mean-in %).

Salmon rates are given by way of comparison

Egg-to-smolt survival is low, always low, 0,2% in average. And there is a definite difference between sea trout and salmon, in average rates values (0,2 versus 1,2 %) as in trends : past 2000, increase in rates is slight for sea trout, very significant for salmon.

3.6. Smolt numbers

Figure 10. Sea trout smolt runs.

Salmon numbers are given by way of comparison.

Smolt production, estimated by CMR operations, is 7000 fish in average, ranging from 3200 to 10200 fish. It's twice as salmon 7600).

Sea trout represents 67% of total recruitment in river Bresle.

Yearly numbers increase for both species, 2000 afterwards : + 27% for sea trout, even more for salmon, + 80% and that, without r in production habitat surface.

3.7. In-river return (marine survival)

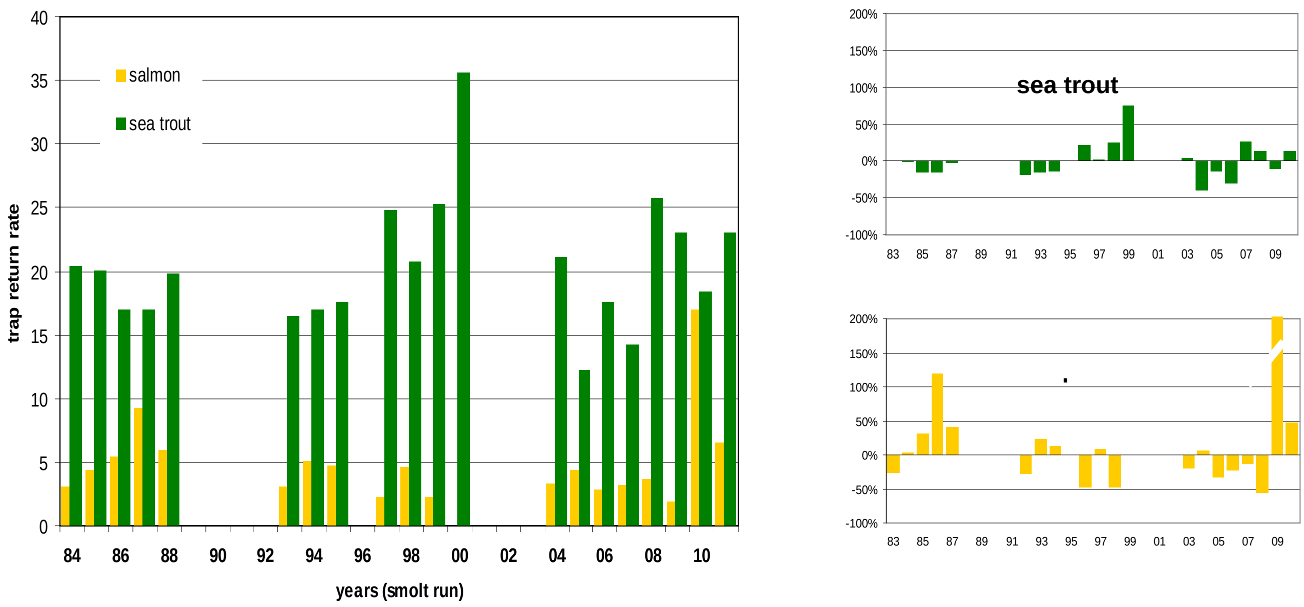


Figure 11. In-river return, proxy of marine survival.

on the left : trap return rates ; on the right : trend, expressed by the deviation from the mean (%)

In average and all sea age classes included, trap return rate is 20, 5%, fairly stable, without significant trend. It ranges from 12 to 34%, that is a ratio mini/maxi of 2,8. Considering only the 1SW component, the mean return rate is 18%.

Then too, it's a definite difference with salmon, which shows always a lower return rate (4 fold down, 4,9%) and comes up after the bearish 90s period, smolt cohort 2010 being exceptionally illustrative.

3.8. Stock-recruitment relationship

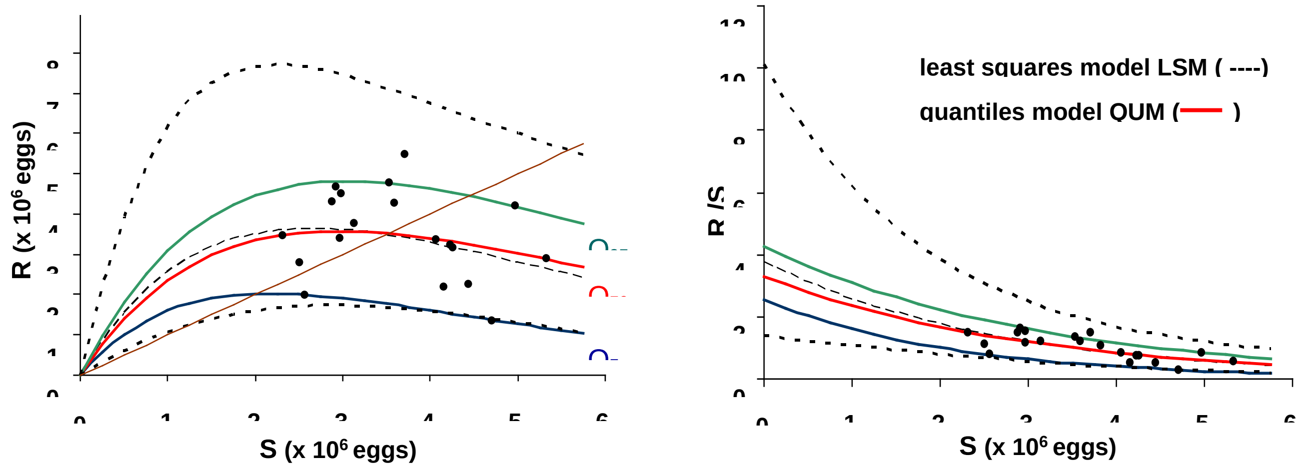


Figure 12. Stock-Recruitment relationship for river BRESLE sea trout.

Recruits are measured as Stocks, i.e. in egg numbers.

Ricker spawner-recruit model is fitted with Bresle sea trout data, using two methods: last squares and quantiles regression, being on of the very few SR relationships for the species in North East Atlantic area.

Mean curves are similar in both models (mid dotted line and Q50 red line).

Main Biological Reference Points are (results by LS model first given) :

S_{Rmax} = 2.6 - 2.9 X 10^6 eggs

S^*= 3,5 X 10^6 eggs

R_{MAX} = 7250 - 7150 smolts (ie 3,6 M. eggs)

Most of observed data are higher S_{Rmax} values, which legitimates to think that spawning stock is really in excess.

4. Contributions

EAST / Alsace

• Saumon Rhin

SCHAEFFER Frédéric & coll.

NORTH / Artois-Picardie

• FDPPMA 62

BOUCAULT Julien

NORTH WEST / Upper-Normandy

• ONEMA-Dast

FOURNEL Françoise

EUZENAT Gilles

FAGARD Jean-Louis

with

Services Départementaux 76-80

• MADE

DELMOTTE Sébastien

• EPTB Bresle

MACQUET Tony

• SEINORMIG :

GAROT Geoffroy

NORTH WEST / Lower-Normandy

• FDPPMA 14

• FDPPMA 50

GOUMI Frédéric

• ONEMA - INRA

DELANOE Richard

MARCHAND Frédéric

(river index OIR)

WEST / Brittany

• BRETAGNE GRANDS MIGRATEURS:

GERMIS Gaëlle

• SMATAH

CROGUENNEC Eric

• SCEA

DARTIGUELONGUE Jean

• INRA

JEANNOT Nicolas

(river index SCORFF)

CENTRAL / Pays de Loire, Centre, Auvergne- Limousin

• LOGRAMI

LEGRAND Marion

CENTRAL / Poitou-Charentes

• EPTB Charente :

BOUARD Eric

SUD-WEST / Midi-Pyrénées-Aquitaine

• INRA

LANGE Frédéric

(river index NIVELLE)

• MIGADO

BOSC Stéphane

CLAVE David

• MIGRADOUR

BARRACOU David

NATIONAL - Sea & river catches

• IFREMER

Port-en-Bessin

VIGNEAU Joël

• St PIERRE & MIQUELON

GORAGUER Herlé

• ONEMA-Cnics

SAUVADET Coralie:

7. Netherlands

STATUS OF AND TREND IN DEVELOPMENT IN SEA TROUT POPULATIONS & SEA TROUT CATCHES IN NETHERLANDS

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Version: January 18th 2013

General status for, and development in populations since 1994 in your country (If relevant separate descriptions for different parts of the country). Relevant information could include: 0+ / parr densities, Smolt numbers, Spawner numbers (or proxy, e.g. spawning pits etc.)

The Netherlands, bordering the North Sea, occupies a special geographic position of two major drainage systems: comprising the lower parts of the rivers Rhine and Meuse; the country also touches the river mouths of the Ems and Scheldt. Rhine salmon became extinct around the 1950s. Other anadromous fish also declined but remained to some extent, such as sea trout. Because adult salmon and sea trout are difficult to separate, both species are mentioned in the Dutch Fisheries Law. They have a year round closed season in inland waters and within the 12 mile Dutch coastal zone. According to the Dutch Red List (de Nie & Van Ommering, 1998) sea trout is vulnerable, indicating that the species is not capable to fulfil its life cycle on its own.

Since 1994 till present, a few (migration) studies have been published on sea trout in the Netherlands (Cazemier 1994, Breukelaar *et al.*, 1998, DeVaate *et al.*, 2000, De Groot 2002, Hartgers and Buijse 2002, Bij de Vaate *et al.*, 2003, Schreiber and Diefenbach 2005); other studies concern ecological rehabilitation in general (including the salmonid fish fauna) of the lower Rhine and Meuse, (e.g. Admiraal *et al.* 1993, Van Dijk *et al.* 1995, Wieriks and Schulte-Wülwer-Leidig 1997, Brenner *et al.* 2004, Bij de Vaate *et al.* 2006). From this information, we can deduct that sea trout populations in the Netherlands are slightly increasing. It is suggested that this increase is mostly due to diverse stocking and escaping of brown trout (put and take fisheries in tributaries), and possibly some natural spawning; the genetic base is thus disputable. There is still much to be learned about the growth and dispersion of the re-introduced populations. The headlines of what we now know are reported in this short document, not critically discussed.

What are the principal reasons for any changes in the status of sea trout populations in your country in recent years?

The role of Lake IJsselmeer

After many technical measures and restocking activities in the River Rhine, there are now signs of salmonids being able to complete their anadromous life cycle (Hartgers & Buijse, 2002). To clarify the function of the lake for salmonids, bycatch data collected throughout the year between 1995 and 1999 were related to various possible migratory strategies known for these species. Species-specific differences were found in timing, length–frequency distribution and maturity stage reflecting different behaviour of Atlantic salmon, *Salmo salar* L. (n=249) and sea trout, *Salmo trutta* L. (n=3962). There was evidence that salmon exhibited traditional anadromous behaviour and use the lake only as a corridor. By contrast, sea trout appears to use the lake both as a corridor and as feeding habitat (resembling lake trout behaviour).

Over half a century of trout stocking

The few trout streams that exist in the Netherlands are at present unable to sustain a wild population of trout, however the water quality has improved substantial since some decades. Put and take fisheries has been normal practice since the 1950's in at least two Dutch streams (the Geul and Roer, tributaries to the River Meuse) as well as in numerous German and Belgium streams. Thus brown trout is stocked every spring in huge numbers, just before the opening day of the season. As a consequence some anadromous brown trout escape downstream. It is suggested that a substantial part of the present sea trout population in the North Sea and the Dutch coastal waters descended from this man-made genetic mix. This was recently underlined by a study (paper in prep. D. Beckevold, DTU, Denmark), where 50 tissue samples (fin clips) of sea trout were genetically analyzed. Those sea trout were captured in coastal waters outside the Haringvlietdam, for a migration study of sea trout in the River Rhine (Breukelaar *et al.* 1998).

Natural production

Naturally production of brown trout populations is very limited in the Netherlands (only a few confirmed are known in tributaries Roer and Geul), for several reasons, but mainly water quality and migration barriers. In 2011, three sea trout were caught in the river mouth of tributary Geul (Figure 1), and a few more in the tributary Roer. But it is unknown whether sea trout spawn in the Netherlands. Many barriers still exist (see the paragraph below) and tributaries often do not offer suitable habitat, e.g. loose gravel or sand banks. As an example of the Dutch situation, in the paragraph below we elaborate on the brown trout production in the River Roer, tributary to the River Meuse, being the most successful re-habilitation program so far for brown trout and salmon in the Netherlands.

Figure 1. One of 3 sea trout caught (and released) in 2011, in the river mouth Geul, tributary to the River Meuse.

Tributary Roer and the Wehebach trout

In the 16th century Atlantic salmon, brown trout and grayling were present in the Roer. Those species became extinct around 1900 due to water pollution, impounding and dredging of gravel banks. The water quality improved from 1980 onwards, when water treatment installations were installed and a ban on waste water discharge was put into order. In 1996 spawning places of adult salmonids were found in a tributary of the Roer in Germany, near the town Düren. This resulted in a reintroduction program of salmon. In 2000, a wild, original genetic trout stem was discovered: the Wehebach trout, Figure 2. The trout stem occupied the river Inde in Germany, a side-tributary of the Roer (D + NL). Due to migration barriers, the cultured trout that had been previously released in the Roer, had never reached this specific tributary Inde. Research, carried out by the Institut für Innenfischerei in Potsdam, showed that the Wehebach trout has original aspects of the autochthonous brown trout (Müller-Belecke A. 2009). The Wehebach trout is bred at fish farm Mohnen (D), for the sole purpose of stocking the river Roer, Table 1. Possibly the released trouts in tributary Roer in Germany contribute to a number of 'natural' sea trout smolts, which are being captured since their first release at the monitoring station within a fish guidance system at hydropower plant Roermond (NL), Table 2. At present, salmonids still cannot reach their spawning areas in Germany, due to several migration barriers (weirs and sluices). However, in 2013, natural spawning of trout (not sea trout) was found near the border in the Dutch part of the Roer. Electro fishing revealed young brown trouts, 0+ till 35 cm TL. The University of Leuven is interested to compare their DNA to those of the Wehebach-stem in 2014.

Figure 2. Wehebach trout, and its characteristic pattern of black and red spots.

Table 1. Release of Wehebach-stem trout in tributary Eifel-Roer.

Roer Düren from Linnich till Stausee Obermaubach	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Trout 0+ in number (*n*)	?	?	?	?	?	175.0000	175.0000	175.0000
Trout > 0+ in kg	?	?	?	?	?	1.750	1.850	1.850
Roer, Heinsberg at border with NL till Linnich	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Trout 0+ in number (*n*)	70.0000	0	150.0000	0	100.0000	50.000	30.000	30.000
Trout > 0+ in kg	0	0	0	0	0	0	0	0

Table 2. Overview of sea trout smolts and adult sea trout caught at hydropower plant Roermond.

*** In 2013 monitoring was obstructed due to technical problems.**

Year	Smolts (*n*)		Adults downstream (*n*)		Adults upstream (*n*)	
2009	20	1-3 till 1-7	2	Dec	11	17-4 till 26-12
2010	100	18-3 till 4-6			21	8-6 till 4-11
2011	38	12-2 till 7-6	3	Feb till April	10	19-8 till 11-12
2012	51	24-3 till 9-6	2	Feb till April	5	9-3 till 18-12
2013*					1	1-4 till 1-9
TOTAL	**209**		**7**		**48**	

Fish migration barriers

In the Netherlands there are 64 native fresh water species of which 30% (*n*=21) are threatened. However, 22 % (*n*=14) of the total (2/3rd of all threatened fish species) are migratory species (Brevé, paper in prep.). The obstruction of migration routes has been specifically damaging to the survival of migratory fish species. In order to facilitate drainage, security against flooding, land reclamation, navigation and impounding, lateral barriers in river systems (e.g. weirs, pumping stations, sluices, dams and hydropower plants) have been raised in their tens of thousands in the Netherlands (Figure 3a). The prioritization of all potential fish migration barriers is outside the scope of any management goal. Thus, the goal of water authorities has been restricted to prioritize the selection of barriers within the rating of water bodies for the EU Water Framework Directive (Figure 3b). In addition, all Dutch main sluice-weir complexes in the Dutch parts of the Rivers Rhine and Meuse have been equipped with fish ladders, facilitating upstream migration for diadromous species (Figure 4). Nevertheless, still many barriers exist in the tributary systems, e.g. in tributaries Roer and Geul, located in the province of Limburg.

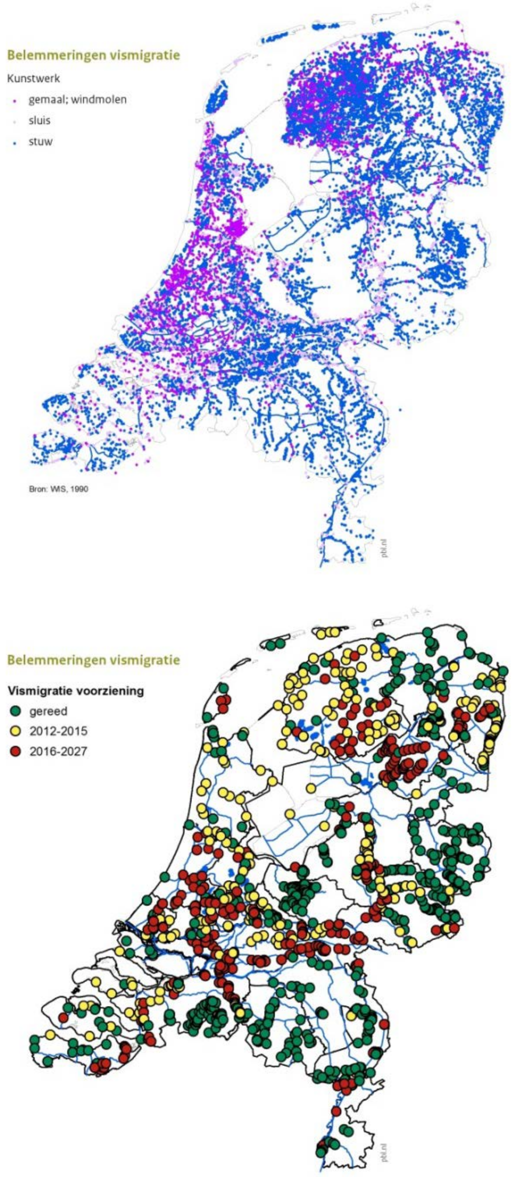

Figure 3. (a) > 20.000 potential migration barriers (weirs, pumping stations and sluices), and (b) the selection of priority fish migration barriers, to be solved according to the EU Water Framework Directive (Wanningen *et al*. 2012); green = fishway is realized, yellow = to be solved before 2015, red = to be solved before 2027.

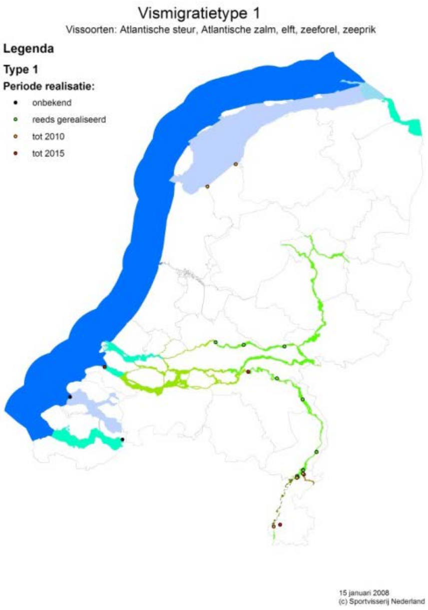

Figure 4. Main migration routes within the Netherlands of Atlantic salmon, sea trout, European sturgeon, Allis shad and Sea lamprey (Kroes *et al.*, 2008), and the barriers that have been equipped with fish ladders, facilitating upstream migration (not specifically downstream migration).

Are sea trout caught commercially in your country? If yes, are they the primary target in this fishery?

If yes what type of fishery (professional gear at sea, fixed gear in freshwater) and what is the magnitude in number or tons?

If no, what monitoring and evaluations are there on by-catch?

What measures are in place to ensure that commercial catch-reports are made?

At sea

Sea trout are caught in the North Sea as by-catch, targeting other species. There are no estimates of the number or weight caught. Because there is a year round closed season there is no necessity, or general obligation to report sea trout catches; they all have to be released immediately.

In the river

In addition, commercial fishing in the main rivers has strongly declined due to a ban on eel fisheries. As a result there are no reports from commercial fisherman, capturing sea trout captures in the rivers. Commercial fisheries are not allowed to catch eel and Chinese crab (*Eriocheir sinensis*) since 1 April 2011 in large parts of the Dutch lower river system. This ban was activated because many of the previously caught eel and crabs contained high concentrations of dioxin and dioxin like compounds (PCB's). Too much dioxin is hazardous for the health of people.

Are sea trout caught in recreational fisheries?

If yes what type of fishery (fixed gear at sea, fixed gear in freshwater, rod and line at sea, rod and line in freshwater) and, if known, what is the magnitude in number or weight for last 5 years (or more, if appropriate)?

What measures are in place to ensure that recreational catch-reports are made?

In the rivers

It was mentioned in the above paragraph that commercial fishing on sea trout is not allowed. However, the year round closed season on sea trout, does legally allow for catch & release. Less than 10 adult sea trout (>40cm) are caught per year by rod and line in the rivers and reported to the Dutch Angling Association (representing 900 angling clubs and over 500 000 members).

In coastal waters

In contrast, we estimated that possibly a few hundred young sea trout (<40 cm) are caught (and released) by anglers in coastal waters. This number was based on several interviews with anglers, and simple expert judgment.

Are sea trout caught illegally? If yes, what type(s) of fishery, and what is the extent (if known)?

'Recreational' fishing with nets

Again, all fishing with the purpose to take sea trout, is illegal in the Netherlands. However, it is not unlikely that captures are taken home now and then, caught by commercial fisherman and anglers. No numbers are known. In addition to this, it is believed that 'recreational' fishing with gill-nets in coastal waters, targeting other species (mainly sea bass) also occasionally take sea trout and salmon. The impact of this type of fishing could be substantial, but is also unknown. For example, the community of the island Ameland issued 374 permits (status October 2013). It is estimated that approximately a thousand recreational fisherman use gill-nets on the Dutch islands in the Waddenzee.

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8. Germany

STATUS OF AND TREND IN DEVELOPMENT IN SEA TROUT POPULATIONS IN THE BALTIC SEA parts of GERMANY & SEA TROUT CATCHES

Contributions by Christoph Petereit[1], Simon Weltersbach[2] and Harry Hantke[3]

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This report focuses on the status of sea trout in the Baltic Sea and rivers that flow into it. In Germany, no continuous studies have been conducted to assess the status of anadromous sea trout populations. Legislation differs due to the federalism among closely related federal states like Schleswig-Holstein (SH) and Mecklenburg-Western Pomerania (MV), which are located on the western Baltic Sea coastline (subdivisions 22 + 24).

In Germany in the federal state Mecklenburg-Vorpommern at least nine rivers contain a self-recruiting wild sea trout population. Sea trout populations in one of these varied from a few hundred to about 2000 spawners over a five year period, and a number of sea trout streams housing recently established populations. It is still uncertain to which extent wild populations are found in Schleswig –Holstein. However, some rivers have been found to produce 0+ trout. The extent is currently being investigated.

Clogging of spawning nests by sand and clay is suggested (and being investigated) as one reason for the possible absence of wild trout populations.

Stocking/supportive breeding:

Both states perform stocking programs in rivers and tributaries. In total, about 1.1 million fry (0.53 million SH + 0.54 million MV) and 14 800 smolts were released in 36 rivers/streams with outlet into the Baltic Sea (subdivision 22 and 24) in 2012 (Figure 1). Data for 2013 are not yet completely available (therefore not shown), and about the same level of fry number is planned to be released in the coming two next years.

Smolts were only released in 14 rivers of SH (subdivision 22). Released smolts are neither tagged nor fin-clipped and are therefore not distinguishable from potential natural production. Only F1 generation fry is released which origin from parental fish ideally from the same river system caught by electrofishing in SH. In MV, only some streams are electrofished to produce fry for all stocked systems.

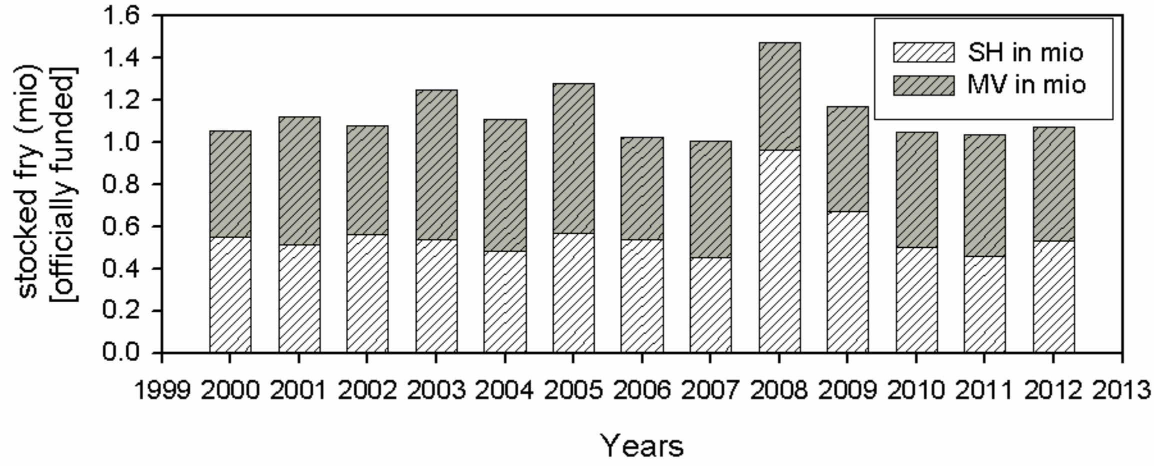

Figure 1. Numbers (in million) of stocked sea trout fry in river systems with outlet to the Baltic Sea since 2000.

Monitoring 0+/parr densities:

From 2002 a monitoring program has been established in MV based on electrofishing (spring survey to assess winter mortality and autumn survey for the 0+ survival) to evaluate the recruitment and stocking success. From initially about 25 rivers and tributaries in 2002, 13 rivers remained to date in the stocking program in MV. No specific stocking monitoring assessing survival has been performed in SH before 2013. Recently, an electrofishing survey for 0+ and 1+ parr stages based on the Trout Habitat Parr Index method (THS) as recommended by the ICES WGBAST, was initiated in SH. Results of the 27 electrofished rivers and tributaries on 118 stations (100m sections) are currently being analyzed.

There is no detailed information available concerning the number of rivers/streams with wild sea trout populations in SH. However, fry and smolts were released in 19 rivers/streams potentially leading to the development of reared/mixed populations. At least some of the 2013 analyzed river systems with no medium-term stocking or supportive breeding history revealed most likely natural trout parr production. A pilot study analyzing the population structure of SH sea trout based on genetic methods is planned for 2014 and is planned to be extended to MV in the future.

Recently, nine rivers contain a self-recruiting wild sea trout population in MV. In four rivers (Köppernitz, Damshäger Bach, Ziese, and Hanshagener Bach) a mixed population exists. Sea trout were released in 33 rivers of Mecklenburg Western-Pomerania between 2000 and 2010.

Monitoring smolts:

Smolt output is not monitored in any river system flowing into the Baltic Sea in SH or MV. Also, no studies analyzing smolt production over time have been performed in SH or MV. This important gap in life history understanding needs to be worked on in future projects.

Monitoring spawning redds:

Some projects have targeted the quality of spawning redds in SH, analyzing rivers flowing into the North Sea, Kiel Kanal and Baltic Sea. The majority of studies judged the quality of the spawning redds as in general rather poor. The main reason for the assumed/shown high egg mortality is the high sediment load (sand and clay fractions) in the study systems which caused clogging of gravel leading to too low oxygen conditions for high egg survival. If this problem can be generalized to all systems in SH cannot be finally judged. However, in a recent electrofishing study some river systems have been found to produce parr most likely as result of natural reproduction (no stocking history known for the systems flowing into the Baltic Sea).

Different projects investigating numbers and quality of spawning redds have been performed or are still ongoing to get first estimates of spawner numbers. In MV, one initiative monitors since 2010 21 rivers/tributaries for numbers of spawning redds and associated criteria (e.g. area, potential age from last use etc.). A second project initiative covers other river systems. A harmonization of methods and results of these different campaigns is intended to be further strived for the future.

Monitoring adult spawners:

An intense scientific monitoring program is established in the Hellbach river system (SD 22) in MV since 2009. The numbers of upstream migrating sea trout varies in the Hellbach between 850–2300 during a spawning season. Since 2011, different video monitoring systems are applied in the Tarnewitzer Bach and Peetzer Bach running now in the third year. Three more systems will be established in 2014 covering more eastern parts of MV (SD 22). The combination of spawner videocounting and habitat structure data analyses in the three previously mentioned reference streams will result in the development of a model to assess adult sea trout biomass in the Mecklenburg Bay. The basic idea in the model is to use the relation between upstream migrating trout and available spawning habitat in the system. The outcome is a capacity index (numbers of fish/available spawning substrate) derived from three reference systems. This capacity index will be used to extrapolate available spawning areas (derived from filtered information collected during the Water Framework Directive habitat mapping) into potential sea trout biomass per system.

Monitoring of toxic substances: PCB/Dioxin/Furane

A Diploma study analyzed the concentrations of PCBs, Furanes and Dioxines in pooled parr & smolt stages and in individual (n=26) adult sea trout caught in selected streams in MV. The results showed that parr and smolt stages (presumably freshwater life-history only) reached 15–20% of the maximum concentrations set for these toxic substances by EU regulation. Oppositely, a considerable fraction of analyzed adult sea trout contained PCB and dioxin concentrations above EU levels. However, the author suggested further scientific studies to approve his findings.

In summary, many baseline data on all sea trout life stages still need to be collected, determined and analyzed in Germany. Existing research projects need to be continued and extended and the collaboration between federal states needs to be strengthened. This is necessary to understand and later to follow sea trout´s status and development during its freshwater and marine life stages.

Sea Trout fishery in the Baltic Sea:

In the Baltic Sea exists a commercial, part time and recreational fishery on sea trout. Fish are targeted both as main species but also together with cod/flatfishes in costal gill net fisheries set at distances of minimum 200m (in SH) from the shoreline. The Schlei Fjord, the Flensburg Fjord and the lower parts of the Trave estuary have special regulations (SH) and also the coastline of MV has other legislations with less distance from the shoreline. There are usually zones of 300–400m from the outlets of rivers where all fishing activity is prohibited, in SH from October 1st to 31st December. The same applies for MV where all fishing activity is prohibited within a radius of 300m around most river mouths from 1 August to 28 February.

Catches and landings:

The commercial landings are in about the same magnitude in subdivisions (SD) 22 (Western Baltic/Belt Sea) and SD 24 (Arkona Sea). The German sea trout catch in SD 25 is very low. Total catch varied between 8–14 tons from 2001–2008, dropped significantly to less than 4 tons and increased by a factor of 4.5 to 18t in 2012. The quality of the official landing data is unknown. No biological information support the discrepancies between the low reported catches from 2009–2011 and the higher catch in 2012. So far, Germany has no information about potential discards in the commercial sea trout fishery. However, discards may also play an important role as parts of the catch have to be discarded (e.g. during the closed season). Official German catch data for the North Sea ICES areas IVb and IVc are much lower compared to the reported Baltic Sea catches. The mean reported annual catch was only 60 kg from 2003–2007. The highest catch was noted in 2004 with 114 kg. However, the personal communication with one local North Sea fisherman indicates potential higher overall catch. Only his own mean seasonal catch consists of around 50 salmonides (sea trout and salmon) per season.

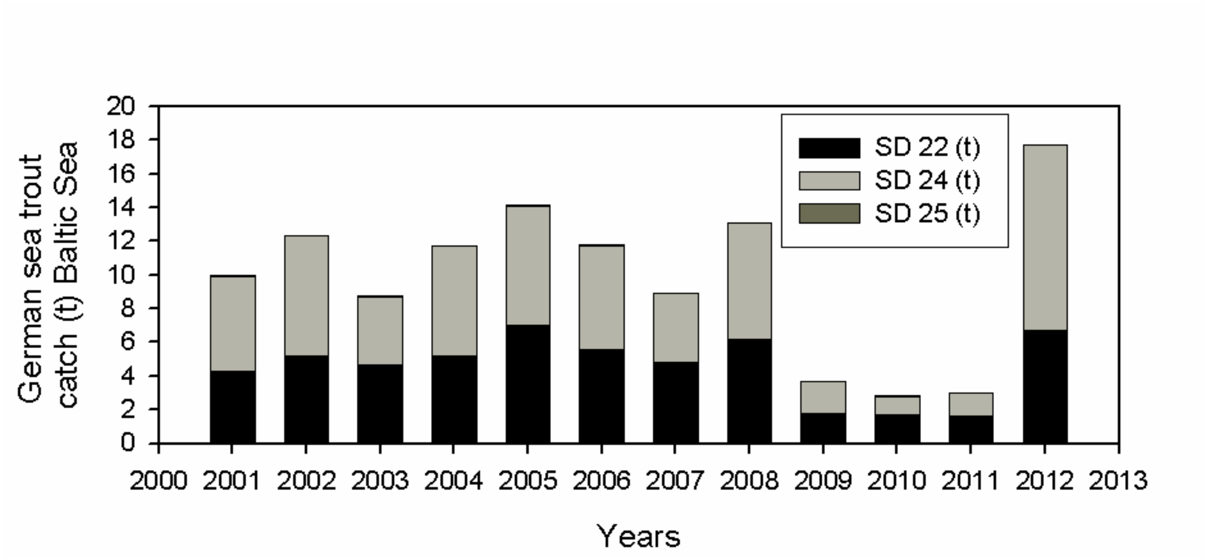

Figure 2. Official German sea trout landing statistics for the Baltic Sea. Stacks represent Baltic Sea ICES subdivisions (SD) where fish had been caught.

Recreational sea trout fishery:

Marine:

There is a highly developed recreational fishery on sea trout with shore- (mainly wading with spinning tackle) and sea-based (trolling with small boats) fisheries along the entire outer Baltic coastline (> 250 suitable beaches and spots along 800 km of coastline). The shore-based fishery accounts for the majority of the total effort. However, CPUE seems to be rather high for trolling which could lead to high sea-based recreational catches.

The shore-based fishery is highly diffuse and variable with strong local and regional changes depending on weather conditions and season. Recreational fishing on sea trout takes places during the whole year with distinct activity peaks in spring and autumn. Fishing times vary between seasons but most anglers' fish a few hours around dawn and dusk. In winter and early spring there is also an activity peak during noontime due to higher water temperatures. Some night fishing occurs in summer.

Even if there is no data available yet, it has been guestimated that recreational catches could exceed the reported commercial catches. Only recently, the TI-OF has started a pilot study to evaluate marine recreational sea trout catches and to quantify the socio-economic impact/importance of the recreational sea trout fishery (using a telephone-diary survey approach).

Freshwater:

There is no data available concerning freshwater catches. However, commercial and recreational freshwater catches are probably low compared to catches from marine waters. In small rivers there is usually no fishery. An exception is the large Trave river system with its tributaries located in SH, where some angling clubs target sea trout in the main river.

Important administrative issues:

In SH Catch & Release is explicitly not allowed by legislation. All sea trout exceeding the minimum size of 40 cm need to be taken (exceptions are coloured fish caught during closed season 1.10 to 31.12). Nevertheless, there is evidence that considerable numbers of sea trout over the minimum size limit are released as anglers´ often have own personal size or bag limits. The picture is similar for MV (minimum size limit of 45 cm, closed season from 15.09. to 14.12. in saltwater; and from 01.09. to 31.03. in freshwater, bag limit of 3 individuals/day) but Catch & Release has not been explicit prohibited in MV yet. However, the practice of voluntary Catch & Release conflicts with the German animal protection act. Post-release mortality of sea trout is unknown.

There are no measures in place that force recreational anglers to report their catches, since there is simply no system running in Germany which would request that for the marine recreational fishery or even gives the possibility to do so voluntarily. There is no official fishing license register accessible due to a very strong protection of privacy in Germany. Hence, there is no sampling panel available whereby probability-based surveys are necessary which makes sampling complex and expensive.

Illegal fishery/poaching:

So far, the magnitude of illegal sea trout fishery has not been scientifically assessed. However, there is evidence that commercial sea trout catches are higher than reported (particularly in coastal waters). A pilot study is planned in 2014 to verify commercial sea trout catches in the Baltic Sea. Sea trout is often marketed unofficially and sold directly to restaurants or consumers. Coloured fish can sometimes be found in restaurants; however, no robust numbers exist on the proportion of fish being sold during the closed season. Gill net fishery usually catches sea trout in the marine and estuarine environment.

Also for freshwater no numbers on the dimension of illegal fishery exist. It is likely to be very river-specific and, as there is only very few fishing at all in most of the Baltic river systems in Germany poaching using rod and line is guestimated to be rather low. However, historically and in very few cases recently poaching using forks or fish spears during night targeting spawning individuals in freshwater has been reported.

9. Denmark

STATUS OF AND TREND IN DEVELOPMENT IN SEA TROUT POPULATIONS & SEA TROUT CATCHES IN DENMARK

General status for, and development in populations since 1994 in your country (If relevant separate descriptions for different parts of the country). Relevant information could include: 0+ / parr densities, Smolt numbers, Spawner numbers (or proxy, e.g. spawning pits etc.)

Denmark has several hundred sea trout rivers, most of them being small. Around 1960 the number of stream systems with sea trout reached was estimated to be only 176 and since then the number has gradually increased. By 2012 trout were found in 408 stream systems, and in individual systems sea trout populations have showed a striking increase. Although the country is small, there are substantial differences in densities in different regions of the country (Figure 1). The overall level observed at electrofishing is densities of 53 trout/100 m2.

The development in smolt production from natural spawning has increased significantly over the last couple of decades (Figures 2 and 3), although the production may have stagnated recently (Figure 3). In the same areas this was accompanied by a reduction in releases (Figure 4).

Wild smolt production is currently estimated to be around 0.6 mill. and total smolt from releases is estimated to be approx. 1.2 mill. By far the largest part of the released trout is presently river mouth releases (smolts ready to migrate).

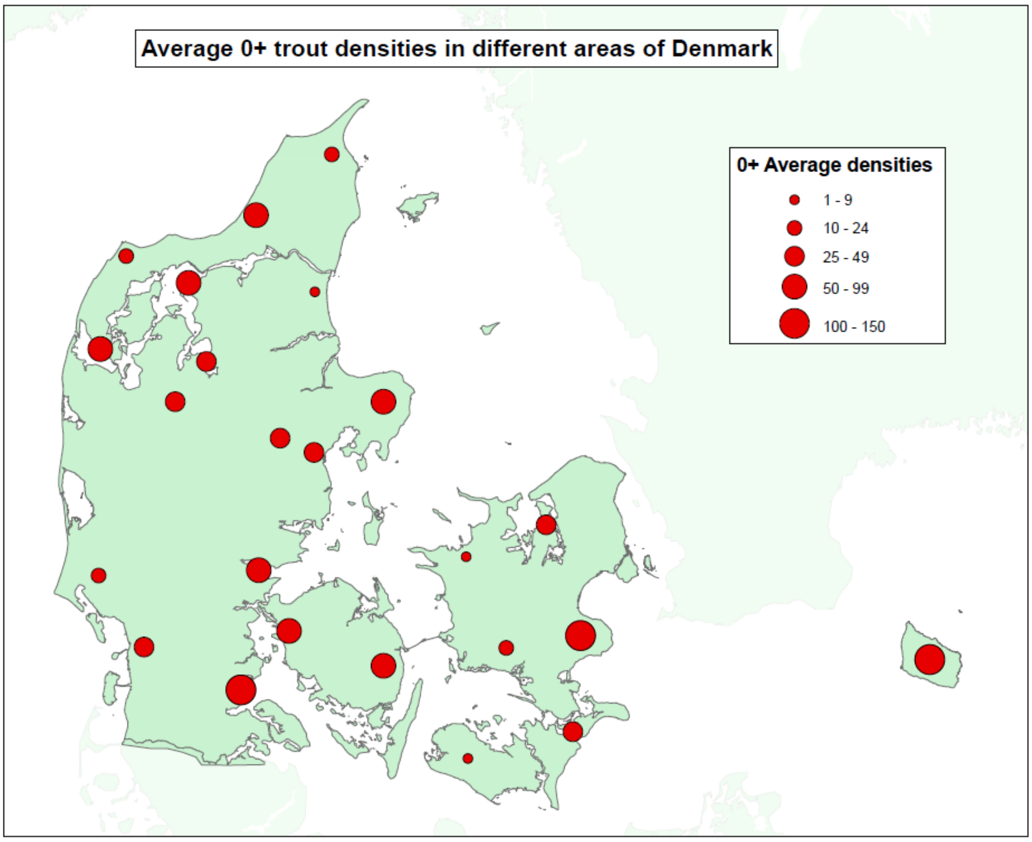

Figure 1. Average densities of 0+ trout in most parts of Denmark according to latest surveys (some areas missing).

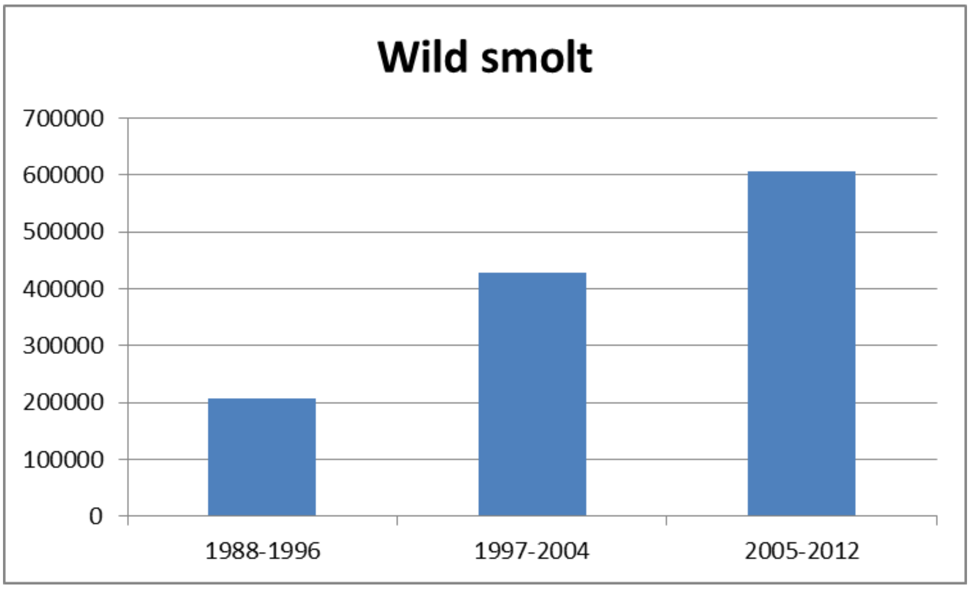

Figure 2. Estimated number of naturally produced smolt in different periods over the last couple of decades.

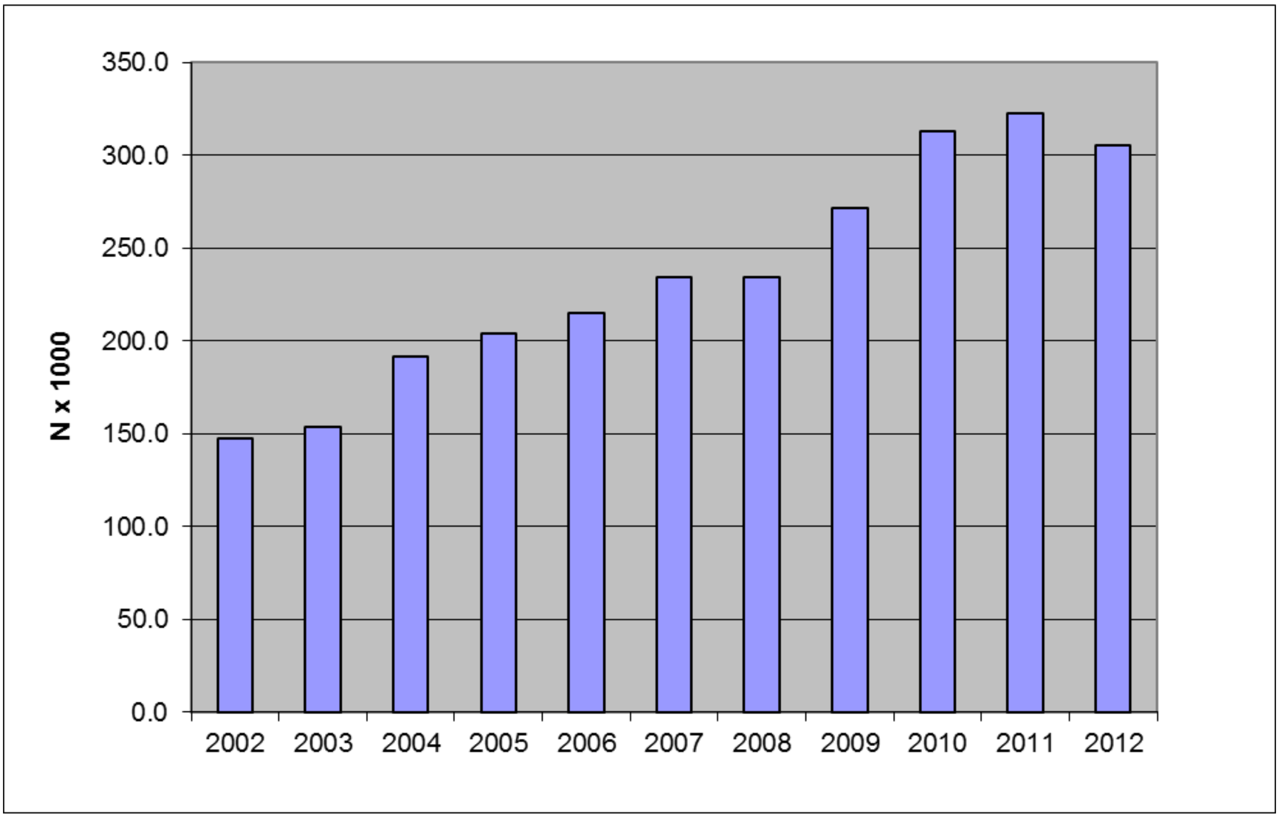

Figure 3. Estimate of smolt production in streams inside the Baltic area 2002–2012.

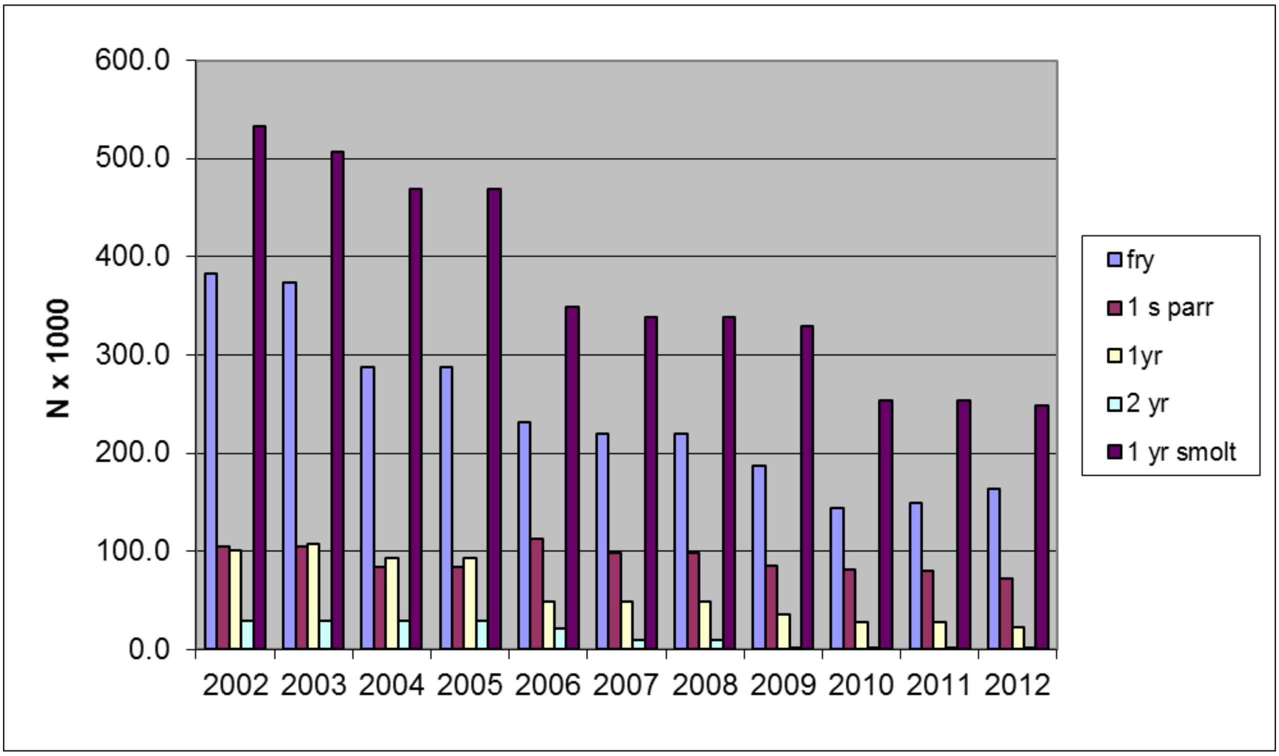

Figure 4. Number of sea trout released at different ages inside the Baltic area.

The increase in production is also evident from the reported number of catch, which almost doubled during a ten year period from the mid 1990s in a sea trout stream on the east coast of Jutland (Vejle Å, Figure 5). In this stream compensatory releases ceased in 2009 and very few 0+ trout were released 2007 and 2008.

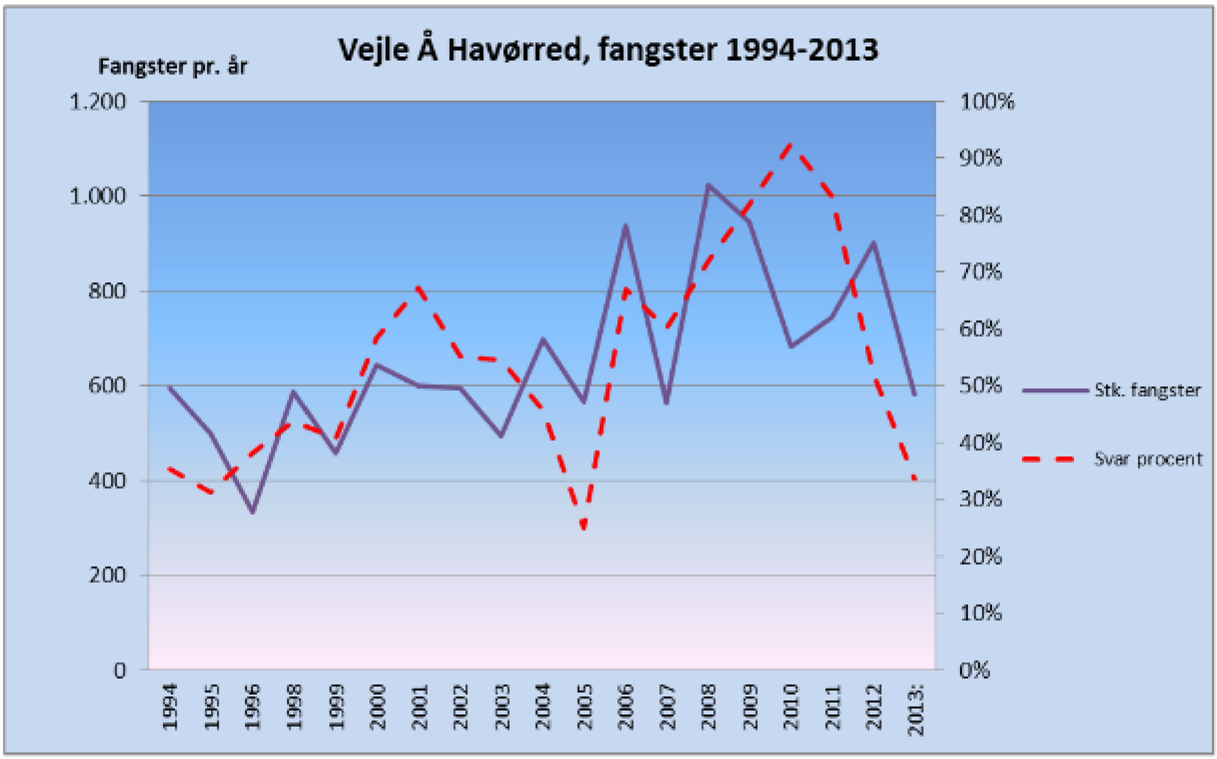

Figure 5. Reported catches in one association of rod fishermen in the stream Vejle Å (blue line). Red line (dotted) shows reporting frequency.

What are the principal reasons for any changes in the status of sea trout populations in your country in recent years?

In recent years, many of the migration barriers have been removed or fish passes have been improved. It is always recommended to completely remove barriers, if at all possible. Smaller scale restoration work in many streams has improved both the accessibility and the possibilities for spawning by the addition of spawning gravel in suitable places. Local NGO's have been very active in this type of restoration. In a few places, and in recent year increasing in number, larger projects have been carried out involving the hydrological system also in the surrounding meadows. Restoration work and technical solutions promoting fish interests are strategically promoted by mission-oriented research and consultancy under the national initiative for fish-care management, where the focus has been changes from compensatory releases to restoration.

Naturally producing trout populations are still limited for several reasons and the potential increase in trout populations is much larger than could have been expected during the last couple of decades.

In many streams conditions are far from optimal considering all phases of the salmonid life cycle. Many barriers still exist and canalized streams often do not offer suitable habitats for young trout.

In a number of streams, artificial lakes have been constructed in the lowermost part of the stream in order to reduce the level of nutrient transport (mainly nitrogen) to the sea. Such lakes have resulted in alarming mortalities in downstream migrating salmonids and in at least two cases the eradication of the local sea trout population has been demonstrated. Several projects involving this type of lake are planned in the near future.

In many areas erosion of sand from stream banks and areas around the streams (fields, roads, urban areas, construction sites etc.) have resulted in heavy sediment transport and sand smothering the spawning gravel and reducing the available habitat. Excess sedimentation of the spawning gravel results in reduced recruitment through the loss of spawning possibilities, severely reduced egg survival and loss of habitats for young trout. Habitat variation is reduced in streams with heavy sediment transport.

The maintenance of streams, such as cutting stream macrophytes, removal of accumulated sediments and of woody debris, is carried out regularly in most of the larger streams according to regulations for the individual stream. In recent years the maintenance has become increasingly environmental friendly, but in many streams the maintenance is still unnecessarily heavy.

Smaller streams are maintained by the land owners and the extent of maintenance generally depends on the land use. Point emission of sewage and industry is not a general problem, but has been observed locally in the upper reaches and tributaries. Sudden and heavy pollution with organic material from farms occur occasionally and more rarely pollution from industry results in fish kills.

Are sea trout caught commercially in your country? If yes, are they the primary target in this fishery?

If yes what type of fishery (professional gear at sea, fixed gear in freshwater) and what is the magnitude in number or tons?

If no, what monitoring and evaluations are there on by-catch?

What measures are in place to ensure that commercial catch-reports are made?

Sea trout are caught in the commercial fishery at sea as by-catch in long-line fisheries for salmon in the Baltic, and in the inner Danish waters targeting other species. Seat trout are not caught commercially in freshwater.

Table 1. Reported commercial catch of sea trout in Denmark 2008–2012.

YEAR	CATCH (TONS)
2008	18
2009	12
2010	8
2011	6
2012	10.6

Reporting is mandatory for commercial fishermen. Before entering the harbour landing fish the Fisheries Inspectors must be notified by telephone.

Are sea trout caught in recreational fisheries?

If yes what type of fishery (fixed gear at sea, fixed gear in freshwater, rod and line at sea, rod and line in freshwater) and, if known, what is the magnitude in number or weight for last 5 years (or more, if appropriate)?

What measures are in place to ensure that recreational catch-reports are made?

Sea trout are caught in the recreational fishery both at sea and in freshwater.

According to recent estimates obtained by omnibus interviews and interviews directed at license holders the annual catch (harvest) in 2010 and 2011 was around 400 – 600 tons. About 90 % of these were estimated to be caught by rod and line and the rest by recreational fishing with gears like gill nets or fyke nets. There are no previous estimates of the number or weight caught before 2010.

About 15% of the recreational catches were in fresh water – mostly on sea trout caught during late spring – autumn before the spawning season.

In freshwater the use of fixed gear is limited and has traditionally mostly been targeting eel.

According to the interviews around 1–1.5 sea trout are released after catch pr 1 kg harvested.

There is no general obligation to report catches in streams, but in some streams the local angling associations demands reporting and in others they encourage reporting.

Are sea trout caught illegally? If yes, what type(s) of fishery, and what is the extent (if known)?

Some illegal fishing for sea trout occurs, but the extent is largely unknown. Nets placed at the river mouth blocking the entrance have been found several times, occasionally together with sea trout carcasses.

Also fishing with nets in closed areas around river mouths (generally a 500 m radius is closed – often more) and within the nearest 100 m from shore (which is also closed for nets).

10. Norway

STATUS OF AND TREND IN DEVELOPMENT IN SEA TROUT POPULATIONS & SEA TROUT CATCHES IN NORWAY

Norway has 1161 water courses with present or former stocks

- 28 stocks are lost due to human activity
- 18 stocks are threatened
- 68 stocks are vulnerable
- 18 stocks are vulnerable, but are maintained by different actions

During the last two decades, the catches in Norwegian rivers have, except for the northernmost areas, declined by 23–66 % (Figure 1).

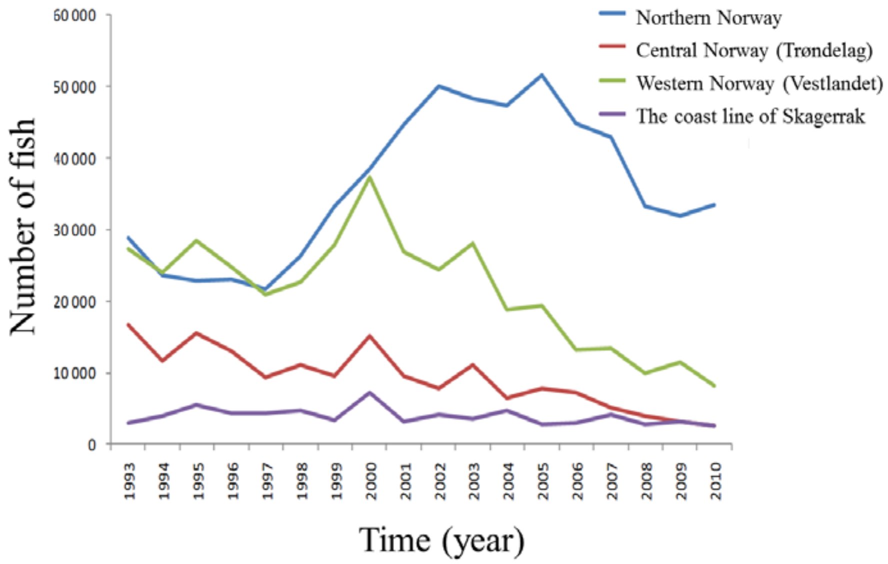

Figure 1. Catch statistics from Norwegian rivers from 1993–2010 based on catch reports from individual fishermen collected by landowners. The number of rivers with reported catch has increased over time. Over time there has been regulations that has influenced on the statistics. As from 1980, fishing gear as salmon trap and fish net was forbidden in most rivers except Numedalslågen and the county of Finnmark. The average fishing period has been decreased and during the last few year's quotas from one to three fishes per person in a 24-hour period has been introduced.

There has also been a significant decrease in sea catches (Figure 2); however this may partly be explained by more strict regulations in the coastal fisheries of sea trout.

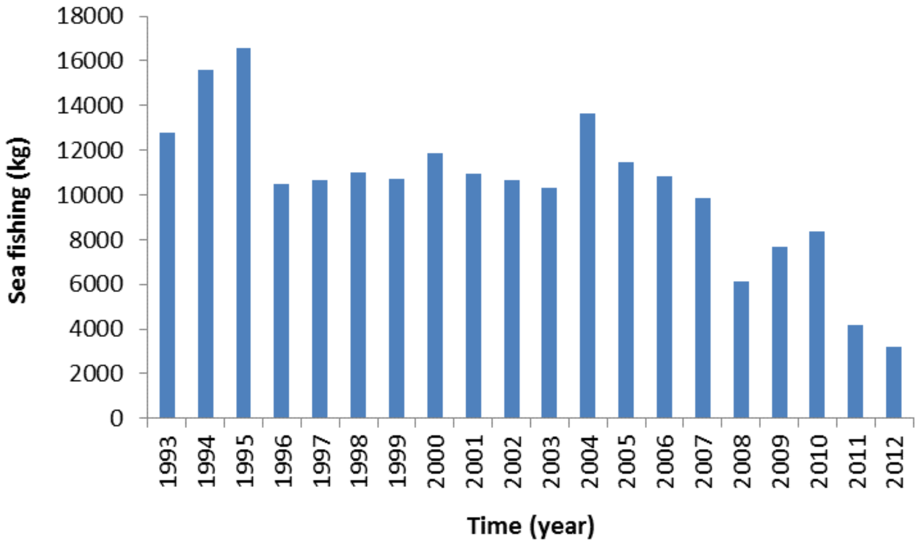

Figure 2. Sea catches of sea trout in Norway from 1993–2012. The statistic refer to all catch by wegde-shaped seine and bend net of salmon and sea trout taken place within the limit of the 12 nautic miles fishing zone. Includes catches for research purposes in ordinary season. As from 1989 drift net fishing is forbidden.

What are the principal reasons for any changes in the status of sea trout populations in your country in recent years?

The exact causes of the general decrease in the Norwegian Sea trout populations are mainly unknown. High impacts of sea lice from aqua culture are likely a major threat in some regions; however ecosystem changes and fish diseases are also expected to impact negatively on the populations.

Are sea trout caught commercially in your country?

Yes, but usually as by catches in the salmon sea fisheries. The most common methods used are wegde-shaped seine and bend net. Drift net fishing has been forbidden since 1989. The magnitude of catches are given in figure 2.

What measures are in place to ensure that commercial catch-reports are made?

The statistics of the commercial sea fishing is based on catch journals from the fishermen themselves and sent to Statistics Norway by the end of the fishing season. All profesionell fishermen have to be registered in ”Sjøfangstregisteret”. Sjøfangstregistret enables Statistics Norway to send reminders to fishermen, asking for missing catch journals.

Are sea trout caught in recreational fisheries?

Yes, sea trout are caught with rod and line both in fresh waters and coastal areas. Illegal fixed gear in coastal areas and in freshwater lakes is not unusual. The magnitude of the recreational fisheries in freshwaters is given in figure 1. The catches from the recreational fisheries are often underreported and especially in smaller water courses with no or poor administration of the fishery licenses. There is no registration of the recreational fisheries in the sea.

What measures are in place to ensure that recreational catch-reports are made?

No official measures, however landowner and fishery administrations may have their own local systems.

Are sea trout caught illegally? If yes, what type(s) of fishery, and what is the extent (if known)?

Yes, both at sea and in fresh waters. Rod and line and fixed gear are the common types. The extent is unknown but probably high.

Sources: Statistics Norway, Norwegian Environment Agency and Norwegian Scientific Advisory Committee for Atlantic Salmon Management.

11. Sweden

STATUS OF AND TREND IN DEVELOPMENT IN SEA TROUT POPULATIONS & SEA TROUT CATCHES IN SWEDEN

General status and development in populations since 1994

In Sweden there are at least 800 individual streams and rivers with sea trout. Of these, electrofishing data from 411 individual streams have been used for reporting to the HELCOM (Helcom 2011). In general, aside of electrofishing data, information on the amount of spawners, spawning pits, catch statistics or other population characteristics are sparse.

Sweden spans a broad latitudinal gradient, from N 55^o to N 68^o. Sea-running trout populations are found along the coast from the border with Finland in the east to the border with Norway in the west (Figure 1). Due to climate, ranging in average air temperature from -2 to +8 ^{o}C, there are large differences in parr densities from cold to warm regions, with an average of twice the densities of trout parr (0+, >0+) in the southern regions as compared to the northern. Parr densities depend on width of stream as trout parr are mainly litoral in larger streams. Median densities of parr range from 68.2 per 100 m^2 in the smallest streams to 1.1 in the large rivers (Table 1).

Table 1. Estimated (median) densities of sea trout parr per 100 m^2 from electrofishing in streams and rivers of different size (area of catchment). Densities only given for sites with sea trout. (n=14709 fishing occasions during 1994–2013).

Trout	Catchment area (km^2)				
parr	<10	<100	<1 000	<10 000	>10 000
Occassions	2249	5047	3325	3435	653
Occurrence (%)	91,6	93,4	77,9	65,9	53,1
0+ per 100 m^2	43,8	18,8	2,7	1,4	0,4
>0+ per 100 m^2	24,4	10,2	1,7	0,6	0,7
Sum per 100 m^2	68,2	29	4,4	2	1,1

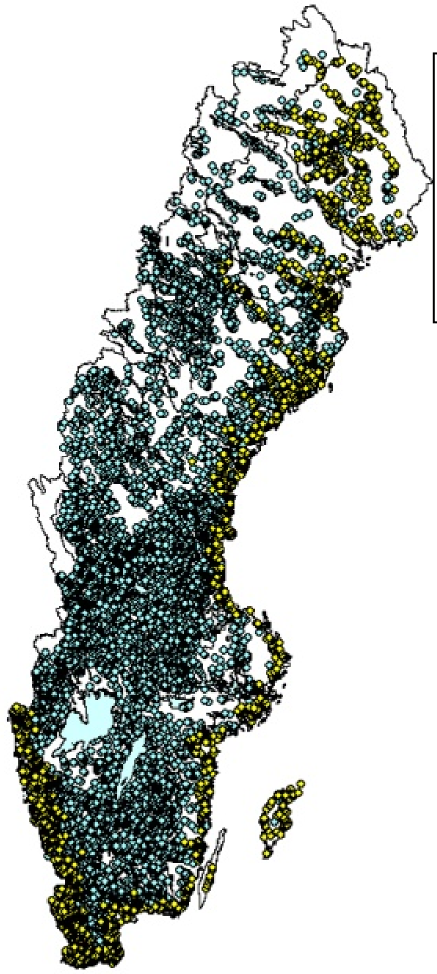

Figure 1. Sweden with electro-fished sites, yellow dots denotes sea trout, and blue dots stream-resident or lake-migrating trout. Data from the Swedish Electro-fishing RegiSter (SERS).

Densities of sea trout parr have decreased significantly 1994 to 2012 in the southern (Pearson correlation =-0,66, p=0.002, n=19) and middle parts (-0.47, p=0.047) of Sweden, while in the northern part densities have increased, however not significantly (+0.23, p=0.34; Figure 2).

Smolt production is sometimes calculated from densities of parr >0+. In the southern part of Sweden the average smolt age is circa 1,5-2 years, whereas it is 3-4 year in the northern part. Calculation of smolt production has to rely also on estimates of available spawning and parr rearing habitat. Such data are generally lacking. Therefore, recent national smolt production estimates are lacking.

Counting of spawners in typical sea trout rivers, i.e. smaller rivers and streams, is rare. Scattered information was only available from River Selångersån (ICES subdiv. 30, MQ 5,3), River Åvaån close to Stockholm (subdiv. 27, MQ <1), River Själsöån (subdiv. 27 at the Island of Gotland, MQ <0,5) and River Nybroån (subdiv. 24, MQ 3). From River Selångersån data was only available from 2005-2008, when an average of 268 sea trout was registered annually.

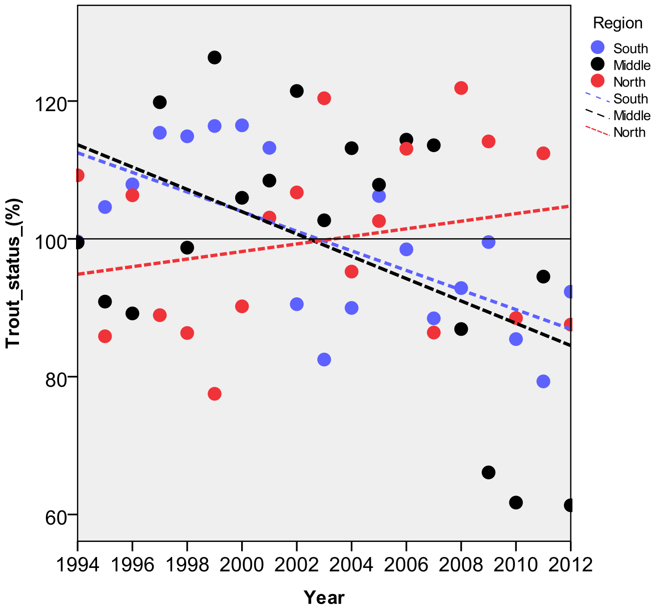

Figure 2. Trends in sea trout parr densities for 380 sites with at least ten years of electrofishing during 1994-2012 (sites included if the first year was 1996 or earlier and the last year 2010 or later). The average trout density (log10) was calculated, and then densities each year for each site were put in relation to the average for the site (average=100%). Best fit for each region done with linear regression.

In the small River Själsöån (0.2 hectares of river bed) the average number of annual spawners in 1992–2007 was 77 individuals, indicating a very large spawning stock as compared to available habitat; one spawner per 26 m^2. As a consequence the average parr abundance has been high; 267±176 (SD) per 100 m^2.

In River Åvaån the number of ascending sea trout averaged 125 in 1998–2007. The total wetted area is 5000 m^2, with 4000 m^2 (0.4 hectares) being habitat for sea trout parr, i.e. a density of one spawner per 40 m^2. With this high spawning population in relation to the available habitat the number of parr has been high, with an average of 180±74 (SD) per 100 m^2. In River Åvaån also spawning redds (pits) have been counted. On average 0.73 spawning redds was found per spawner. As the sex ratio is 50:50, this would amount to 1.46 spawning redds per female.

In the River Nybroån data on spawners was available from 1974 to 2005. On average the period 1990-2005 4571 spawners ascended the river each year. The available spawning and nursery habitat is 6 hectares, i.e. the spawner density averaged one per 13 m^2. The average parr density 1990–2010 was 49.1±29 (SD) per 100 m^2.

Ascending spawners of sea trout are also counted in some of the large salmon rivers. Sweden has four salmon index rivers included in the DCF monitoring program; Mörrumsån (ICES subdiv. 25), Vindelälven (ICES subdiv. 31), Sävarån (ICES subdiv. 31) and Torneälven (together with Finland; ICES subdiv. 31). In most of these, information on sea trout is also collected (ascending adults and descending smolts) using counters in fish ladders, sonar, and smolt traps. The estimates of total smolt numbers from the trap in River Sävarån 2006–2013 was 231-2124, and in River Mörrumsån 2009–2013 was 4219-9652 (Figure 3). In River Mörrumsån, the smolt estimates only cover the upper part of the river (approximately 60% of productive trout habitat). The numbers of smolts have been rather stable over time with a sudden increase in 2013 (Figure 3). On the west coast, a smolt trap is operated in the River Högvadsån. Here the numbers of smolts counted has increased significantly since the 1990s (Figure 4). The increase of smolt counts in River Mörrumsån and Högvadsån may be affected by earlier smolt migration, resulting in a higher number of parr becoming smolts at age one. Also, these rivers are rather large and are not as affected by drought and high temperatures as smaller streams.

In addition, four larger rivers in the ICES subdivisions 30 & 31 have automatic or manual counting. In general has the number of ascending wild sea trout spawners been very low, in three rivers below 100 individuals (Figure 5), considerably lower than the amount needed for utilising available habitat. In three rivers (Kalixälven, Piteälven and Vindelälven) the number of ascending mature wild trout has increased significantly over time (Pearson correlation coefficient 0.88, 0.89 and 0.51, n=19, 21, 19 with p<0.02 for all). Especially in River Piteälven (average flow, MQ, 168 m^3/s) the increase was pronounced and was most likely due to closing of some salmon trap fishing in the estuary. However, there were also significant habitat restorations done during 2002-2005 (e.g. Nilsson *et al.* 2005) that also could have had a positive effect on the sea trout production. In River Kalixälven (MQ 295 m^3/s) improved protected areas at the mouth may be contributing. Further, since 2007 net fishing in shallow water (0-3 m) is limited during spring and autumn in Bothnian Bay (ICES subdiv. 31) to avoid by-catch of sea trout.

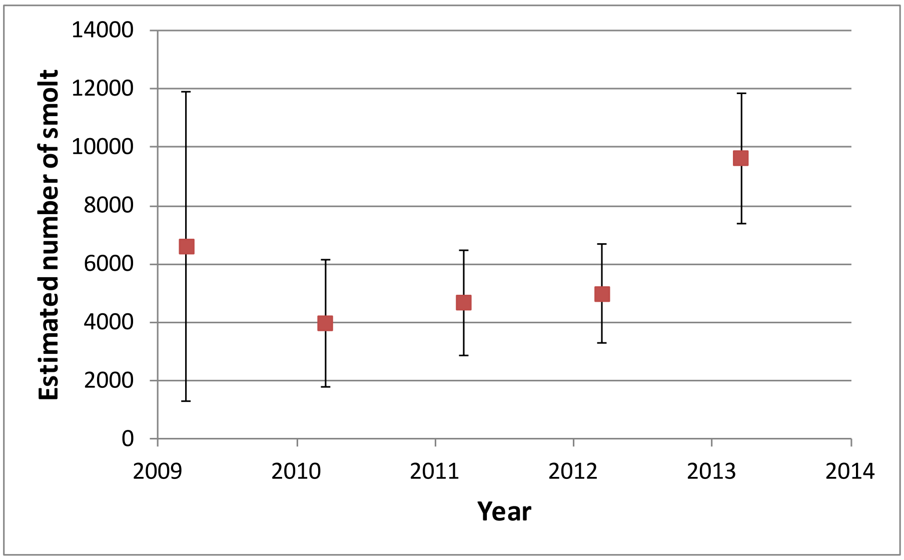

Figure 3. Petersen estimates of smolt production based on numbers sea trout smolts caught in a trap in the upper part of River Mörrumsån, Southern Sweden, bars showing 95% CI.

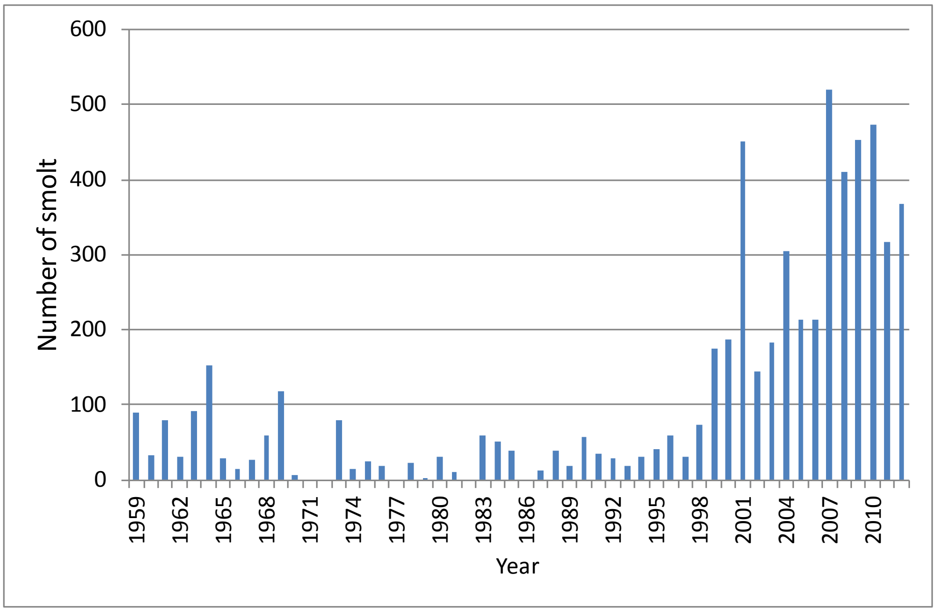

Figure 4. Sea trout smolt counts in the River Högvadsån, Swedish west coast.

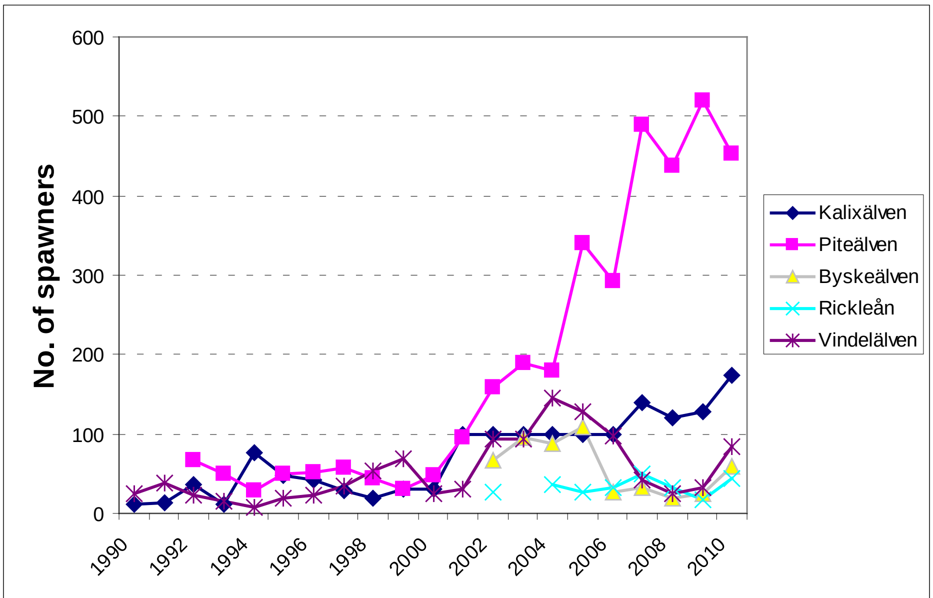

Figure 5. Number of ascending wild sea trout for spawning in five large salmon rivers in Bothnian Sea and Bothnian Bay.

Principal reasons for the present status of sea trout populations

According to Figure 2 and the scattered results from counting of spawners, there is a negative trend in southern and middle Sweden, although the number of spawners is high in individual rivers. In the northern part (Bothnian Bay, ICES subdiv. 31) the sea trout stocks have deteriorated for many decades. The stocks are threatened by overfishing (Lundqvist *et al.* 2007, ICES 2010), and trout is mainly caught as by-catch in net fishing aimed at whitefish or perch (Petersson *et al.* 2009). It is also suggested that the large coastal fishery for salmon in the areas surrounding the large salmon river mouths affects sea trout negatively. This view is strengthened by the fact that the number of sea trout spawners increased in salmon rivers where the number of trap nets decreased or where the closed area at the mouth was increased (Figure 5). Further, tagging of reared sea trout has revealed that catches are centred around the larger salmon rivers, and that sea trout from smaller rivers are attracted to larger rivers during the non-spawning season (Degerman *et al.* 2012). Salmon fishing may therefore be a threat to weak sea trout stocks.

The cause of decline of sea trout status in the middle and southern regions (Figure 2) may be complex. As the sea trout streams are generally small they are more affected by climatic variations, than are the larger salmon rivers. A warmer climate and/or longer periods with summer drought may affect populations. As in Denmark, artificial ponds and wetlands have been constructed in the streams to reduce the level of nutrient transport to the sea. Such artificial water bodies have resulted in declining populations of sea trout (in prep. Degerman *et al.* 2014).

In recent years, some of the migration barriers have been removed or fish passes have been improved. However, in Sweden it is estimated that further 6000 fishways are required to fulfil the demands in the WFD (EU Water framework directive). Hydropower projects generally lacks consideration of biodiversity, and only 10% of hydropower dams are equipped with fish ladders. Loss of habitat due to lost connectivity is a major problem.

Landscape draining projects presently affects most sea trout streams and rivulets in agricultural areas due to low summer flows. Stream restoration work is often initiated by local NGO's, but frequently comes in conflict with landscape draining schemes for agriculture. Canalized streams with low summer flows are not suitable habitats for trout. Often these land drainage operations are determined and approved by environmental courts. There are examples of stream restoration projects that has been required by court order to remove all stones, logs and gravel that had been placed in streams to mimic natural conditions.

Many oligotrophic Scandinavian streams are affected by acid deposition, which is ameliorated through large-scale liming operations (Svenson *et al.*, 1995). Liming operations started in Sweden on a larger scale in 1986 and have continued since. Deposition of acidifying substances in Europe has decreased considerably during the last decade (Skjelkvale *et al.*, 2003), but liming will be required especially on the west coast of Sweden for several decades.

Commercial and non-commercial fishing

Reporting of catch and effort is mandatory for commercial fishermen. Sea trout are caught in the commercial fishery at sea as by-catch in long-line fisheries for salmon in the Baltic and by salmon traps on the coast. In Skagerrak and Kattegatt (West coast) the catch is done by salmon traps (n=3) and gill nets targeting other species (Figure 6). The reported catches on the Swedish west coast are extremely low, annually averaging 112 kg the period 2008–2012. The surveillance of catch reporting is good with respect to the long-line fishing, but less intense when it comes to coastal fishing.

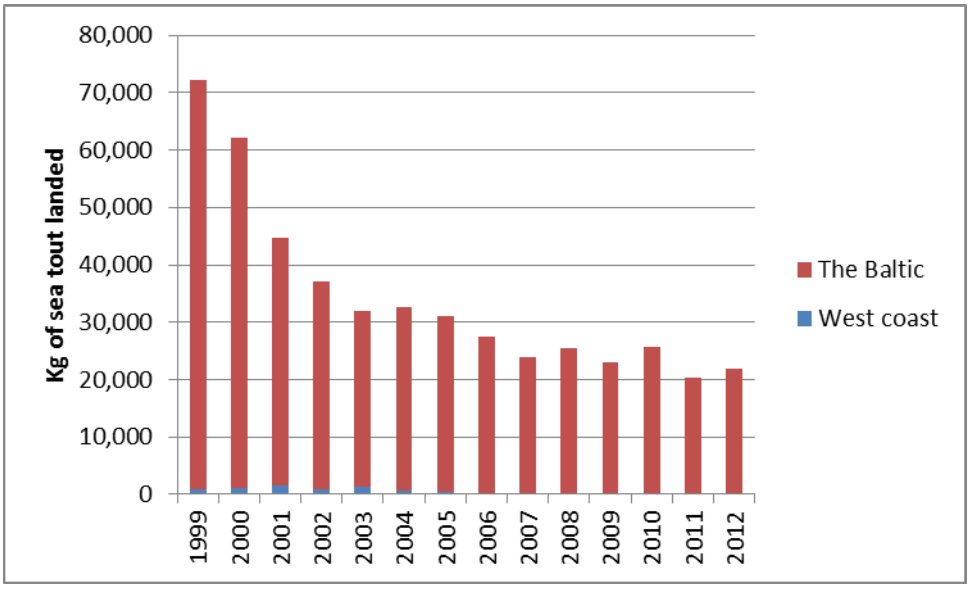

Figure 6. Reported commercial catch of sea trout in Sweden 1999–2012.

A problem for fishery management is not the commercial fishing targeted at sea trout, but the by-catches done both by commercial and non-commercial fishermen. The extent of this is largely unknown. Petersson *et al.* (2009) estimated that 243 ton (316 000 trout) of sea trout was caught in 2007 as a by-catch in coastal gill net fishing aimed at whitefish (*Coregonus lavaretus*) and perch (*Perca fluviatlis*) in the Bothnian Bay and Bothnian Sea in Sweden. This catch, mainly done by non-commercial fishermen, surpasses the official reported catch from commercial fishing. By-catches are not monitored, besides from very limited surveys of trap-nets within the DCF program, so the magnitude of the problem is not quantified except for the single study presented above. In another study it was concluded that especially when gill nets were set in very shallow water the normal selectivity of the gill net was lost and several species and sizes were entangled in the nets (Andersson & Degerman 2010).

Sea trout are targeted in the recreational fishery both at sea and in freshwater. There is no monitoring of non-commercial catches on the coast, but in larger rivers voluntary catch statistics are often available. In Mörrumsån the catch has varied around 500 individuals annually for several years, not including catch and release. Every fifth year a large scale census is made to circa 10 000 Swedish households with questions on fishing. This gives very rough estimates of non-commercial fishing. In general sea trout is fished with rod-and-line, gill nets and to a lesser extent with trolling (main Baltic). The proportion of the catch taken with gill nets is larger in the northern part of the Baltic Sea.

When fishing with rod and line an increasing proportion of sea trout above the minimum size is released. An estimate from the Swedish west coast was that every fifth legal sea trout was released.

Illegal fishing and unreported catch

In freshwater, the extent of illegal fishing for sea trout is not known, but estimated to be insignificant. Unreported catch might however be a problem, but largely unknown for both freshwater and coastal fishery. At sea, substantial misreporting of salmon as sea trout is considered to occur only in the Polish sea fisheries (ICES, 2013).

Fishing regulation

Swedish fishing regulation is generally focussed on salmon, not sea trout. However, the minimum size of sea trout was raised from 40 to 50 cm in Bothnian Bay in 2007 (ICES subdivision 31). Presently the minimum size is, therefore, 50 cm in the whole Swedish part of the Baltic Sea, except in the Bothnian Sea (ICES subdivision 30) where it remains 40 cm, i.e. well below the size of maturity (circa 50–60 cm). On the Swedish west coast, Kattegat and Skagerrak, the minimum size is 45 cm due to smaller size of the fish.

In shallow waters (0–3 m) on the west coast only gill nets with a mesh size of 120 mm is allowed to avoid by-catch of other species and sizes. In the Bothnian Bay, fishing with gill nets is prohibited in spring and autumn to avoid by-catch of sea trout.

Closed areas are frequent in the estuaries during the spawning migration in Kattegatt, Skagerrak and in the Main Baltic (subdivisions 23–29). In the Bothnian Sea (30) and Bothnian Bay (31), normally only larger salmon rivers have closed areas. Instead, all rivers and streams have an area of 200 meter radius from the mouth were fishing is prohibited during 1st September – 31st December.

A large closed area for fishing with commercial gear was established on the west coast in eight fiords just north of Gothenburg in 2010. Sea trout catches are said to have increased with rod and line, but reliable data is lacking. In the streams the densities of sea trout parr has not increased significantly 2010-2012 as compared to 2007-2009.

Fishing for sea trout and salmon is carried out in the rivers during the spawning run, but is prohibited during spawning (generally October-November). On the west coast there is a closed season during September to March in freshwater and on the coast, whereas the closed season generally ends at the end of December in other regions.

There is a general ban on net fishing in fresh water (rivers) where salmon and sea trout are present. A bag limit is seldom used in the national regulation of the fishery, but only one salmon per fisherman per day is allowed for rod and line fishing in northern salmon rivers. It has been suggested that this limit should also be applied to sea trout fishing in fresh waters because of the weakness of the stocks.

As a part of the bilateral agreement between Sweden and Finland on fishing in the Torneälven a total ban of landing sea trout was implemented in spring 2013.

All stocked sea trout and salmon are fin-clipped, i.e. lacking the adipose fin. Although this allows for separating stocked fish from wild fish, it has only occasionally been used in fishing regulations.

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12. Finland

STATUS OF AND TREND IN DEVELOPMENT IN SEA TROUT POPULATIONS & SEA TROUT CATCHES IN FINLAND

General status for, and development in populations since 1994 in your country (If relevant separate descriptions for different parts of the country). Relevant information could include: 0+ / parr densities, Smolt numbers, Spawner numbers (or proxy, e.g. spawning pits etc.)

Finland has nowadays 14 rivers supporting original sea trout stocks, twelve of them flowing into the Baltic Sea and two into the northern Atlantic Ocean (Figure 1). Especially in the two largest river systems, Tornionjoki and Tenojoki, the tributaries are the most important habitats for sea trout. There are also about 20 rivers where sea trout stocks with mixed or moved origin may spawn and reproduce more or less regularly.

Just over 100 years ago there were over 60 sea trout rivers in Finland. The main reasons for the disappearance of most of the natural sea trout stocks were closing of the rivers by dams for producing hydroelectric power and extensive dredgings for promoting log driving or for preventing floods. These measures closed the migration routes of sea trout between the river and the sea and largely damaged spawning and nursery habitats in the rivers. The nutrient and sediment loading from industry and settlements as well as from agriculture and forestry have worsened water quality in the rivers resulting in risks for the natural reproduction. Apart from the coast of the Gulf of Finland, most rivers are naturally humic and slightly acid. Especially in the rivers of the central and northern Gulf of Bothnia, acid sulphide soils have occasionally caused periods of very low pH thus preventing the recovery of the sea trout stocks. In particular since the 1970s sea trout have been harvested already during their first sea years as by-catch of gillnet and trapnet fishery at sea targeted at whitefish, pikeperch and perch. This too high fishing pressure at sea has reduced the spawning stocks of sea trout ascending their natal rivers. For increasing the number of returning spawners supportive stockings have been carried out with hatchery-reared juveniles in most sea trout rivers. In many rivers, however, the adverse conditions have gradually diminished or prevented the natural smolt production. In 2010 Red List of Finnish Species, the remaining natural sea trout stocks have been assessed critically endangered.

There are large annual variations in densities of 0+ parr both within and between rivers, but the overall mean level observed in electrofishing is very low, <10 parr/100 m^2. In some of the Gulf of Finland rivers the densities are mostly >10 parr/100 m^2, but the potential level in all the Baltic rivers is multiple compared to the present. With the exception of occasionally higher densities in some Gulf of Finland rivers, no increasing trend of the parr densities has been observed in the sea trout rivers since 1994.

In the Tenojoki river system, the number of adult sea trout has almost annually been monitored in three tributaries by diving in the vicinity of the spawning grounds.

Wild smolt production of sea trout has been able to estimate only in some years in the Tornionjoki river in connection with salmon smolt trapping. Last in 2011 the number of migrating smolts was about 18 000, while the potential has been assessed to about 80 000 smolts per year. In the other sea trout rivers, no annual estimates are available.

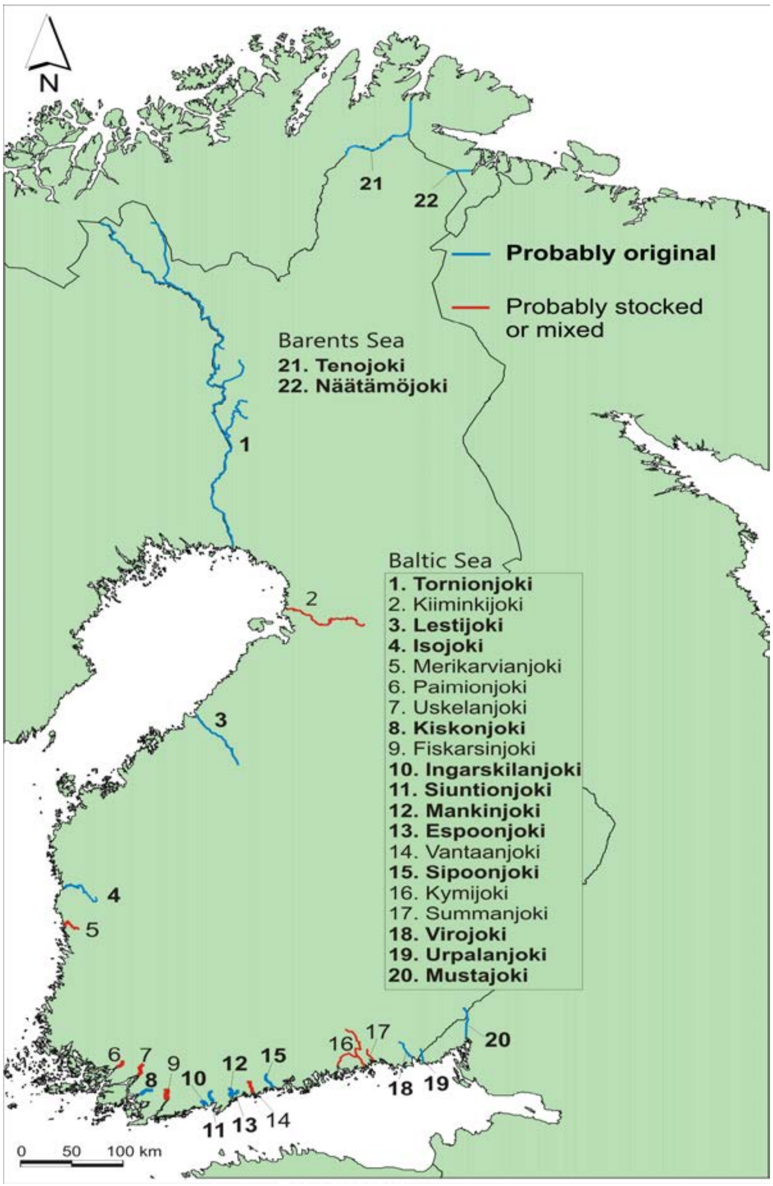

Figure 1. Sea trout rivers in Finland.

Annual catch statistics from the Baltic sea trout rivers are also only available from the Finnish side of the Tornionjoki river system, where the catches have mostly varied between 2000 and 3000 kg per year.

During last ten years Finland has released around 1 million sea trout smolts per year in the Baltic rivers and on the coast (Figure 2). Most of the hatchery-reared juveniles have been 2 yr old smolts, but usually also over 10 000 3 yr smolts have annually been released. Such original sea trout stocks which have been cultivated as brood stocks in the hatchery have been supported by releasing reared parr and smolts in their original rivers. In the 2010s all the reared sea trout parr and smolts released in the Gulf of Finland area have been adipose fin-clipped. Since 2013, all sea trout with uncut adipose fin must be released back into the sea in offshore fishing carried out outside the private shorenear waters in the Gulf of Finland.

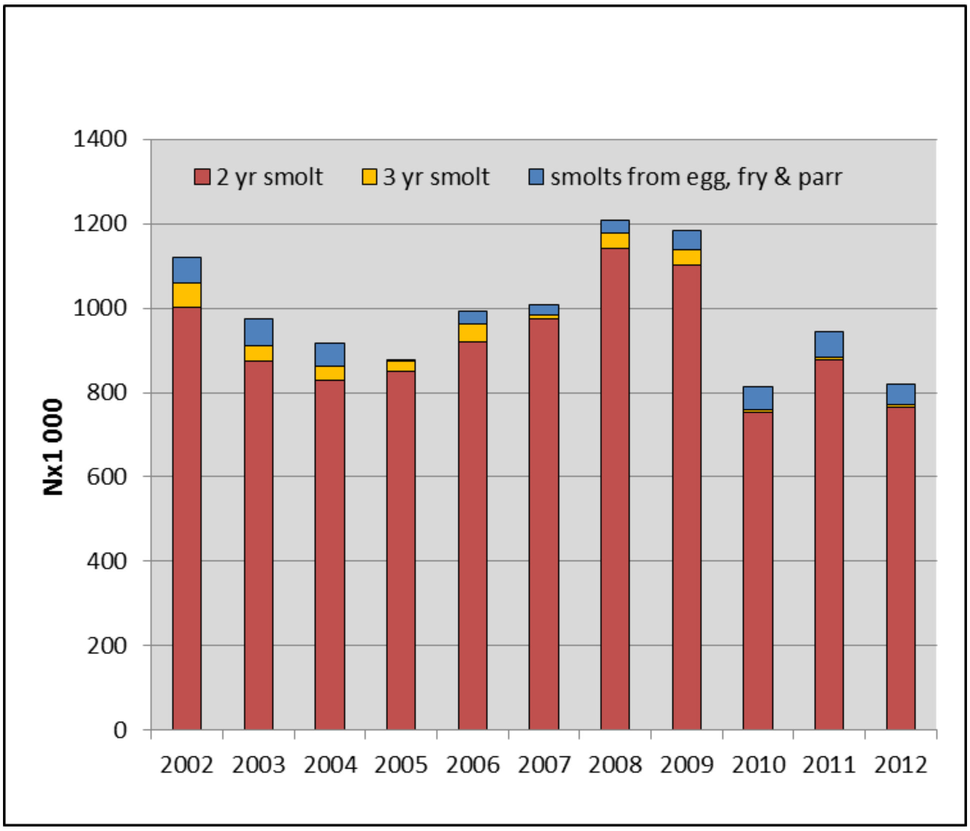

Figure 2. Number of sea trout released at different ages in the rivers and on the coast of the Baltic Sea.

What are the principal reasons for any changes in the status of sea trout populations in your country in recent years?

In recent years, various measures have taken for reducing the threats for the endangered sea trout stocks. Especially in the southern coast of Finland, many dams and migration obstacles have been removed and replaced with natural riffles with stony bottom. In dredged rivers, spawning and nursery areas have been restored by adding spawning gravel and stony material in the rapids. In larger rivers the restoration projects have been funded and supervised by local fisheries authorities. Local NGO´s have been active in restoration of smaller streams and brooks. They have also stocked eggs and fry in smaller streams and brooks.

Supportive stockings with hatchery-reared juveniles have annually been carried out in many rivers by state funding. Started in recent years, all these released parr and smolts have been marked by removing the adipose fin for recognizing the natural and reared trout. At least in the Gulf of Finland, releasing of all wild sea trout will probably become obligatory in few next years. In the management of the migratory fish stocks, restoration works, removing of migration obstacles and favouring of natural reproduction are recommended in the newly agreed national fish way strategy, where the focus has been changed from compensatory releases to restoration.

Except for the commonly deteriorated habitats also the water quality is in most coastal rivers poor. The changes in the natural conditions are smallest in the northern most rivers, but rather large in the others. The nutrient and sediment loading from the industry and settlements is nowadays restricted rather effectively. The diffuse loading from agriculture, forestry and other sources is still commonly too high, thus hindering natural reproduction of sea trout in many rivers. The means and measures to reduce diffuse loading and for improving the water quality in the rivers have until now been inadequate to bring substantial improvement to the situation. Furthermore, the acid soils in the coastal area of the Gulf of Bothnia result in additional risks for the water quality. Also climatic changes may affect the annual reproduction success, when very low flow in dry autumns may hinder the spawners to ascend small coastal rivers.

During the feeding migration at sea, the prevailing too high fishing pressure, especially the gillnet fishery of other target species than sea trout, endangers the survival of the sea trout until ascent to the river for spawning. The harvesting of sea trout takes place commonly already during the first and second sea year when sea trout are caught undersized as by-catch especially in gillnet and trapnet fishing of whitefish, pikeperch and perch. Catching of undersized and immature fish results in both growth and reproduction overfishing of sea trout. The minimum legal size of sea trout was increased to 50 cm in 2008, and it will be 60 cm in 2014. The compliance of this regulation is difficult in practice especially in gillnet fishing with small mesh sizes. The trials to reduce the fishing pressure of sea trout have until now not succeeded to increase the mesh sizes of gillnets. Increasing the minimum legal size may function better in trapnet and rod fishing, but the potential benefits for sea trout stocks of the present changes will be seen only after some years delay.

Since 2013, fishing of sea trout is forbidden in the Tornionjoki river and at the river mouth and all sea trout caught in fishing of other species must be released back in the river. All fishing has already earlier been forbidden in the Ingarskilanjoki in the Gulf of Finland area.

Are sea trout caught commercially in your country? If yes, are they the primary target in this fishery?

If yes what type of fishery (professional gear at sea, fixed gear in freshwater) and what is the magnitude in number or tons?

If no, what monitoring and evaluations are there on by-catch?

What measures are in place to ensure that commercial catch-reports are made?

Sea trout catch of the commercial fishery has been around 50-80 tonnes in the last few years (Table 1). Sea trout is taken solely as a by-catch in the coastal gillnet fishery for whitefish, pikeperch and perch and also in the coastal trapnet fishery for salmon and whitefish. Commercial fishing takes place only in the sea areas and no particular fishery targeting to sea trout occur. Commercial fishermen have obligation to report their catches on monthly basis.

Table 1. Sea trout catch by commercial and recreational fishermen in sea area (1000 kg, C.i. = 95% confidence interval) in 2008–2012. Recreational catch in 2012 not yet available.

Year	Commercial	Recreational (C.i.)
2008	77	163 (78)
2009	71	-
2010	54	56 (43)
2011	49	-
2012	62	-

Are sea trout caught in recreational fisheries?

If yes what type of fishery (fixed gear at sea, fixed gear in freshwater, rod and line at sea, rod and line in freshwater) and, if known, what is the magnitude in number or weight for last 5 years (or more, if appropriate)?

What measures are in place to ensure that recreational catch-reports are made?

Sea trout catch of the recreational fishery has been around 60–160 tonnes in the sea and 3–5 tonnes in the rivers, but since 2013 the catches in freshwater will probably decrease to 1.5–3 tonnes due to the fishing ban in the Tornionjoki river (Table 1). Catches of the recreational fishery are estimated by national postal surveys that are carried out in every second year, but the catch estimates are rather uncertain (see confidence intervals in Table 1). In the most important sea trout rivers the catch statistics are also based on voluntary catch records and on postal surveys addressed to fishing license holders.

In the sea area catch is taken mainly as a by-catch in the bottom gillnet fishery for whitefish, pikeperch and perch. There is also some minor gillnet fishing targeting particularly at sea trout. Rod fishing targeted at sea trout is popular in some the coastal and archipelago areas. The river fishing of sea trout is in general insignificant because of the rarity or absence of fish there. Rod fishing in freshwater is concentrated in few rivers (Kymijoki and Vantaanjoki in the Gulf of Finland and Tenojoki in the Barents Sea area, and before fishing ban in 2013 also Tornionjoki in the northern Gulf of Bothnia).

Are sea trout caught illegally? If yes, what type(s) of fishery, and what is the extent (if known)?

Illegal fishing of sea trout may occasionally exist when gillnets close the legal migration route of fish in the estuary or at the river mouths. In the river, sea trout parr or smolts are sometimes fished and taken undersized as local brown trout. However, the occurrence of these two affairs is unknown and may vary between rivers and years. Most commonly illegal fishing occurs at sea, when sea trout are taken undersized as by-catch in gillnet fishing targeted at other species, usually whitefish, pikeperch and perch.

13. Russia

Detailed description was not available at deadline of the report. The information below is from Sergey Titov pers. comm., HELCOM (2011a,b) and Pedersen et al. 2012.

Currently sea trout is found in more than 50 rivers (including the local populations in the main tributaries). Nine sea trout rivers flow into the Gulf of Gdansk (Kaliningrad region) and 44 into the Gulf of Finland (St. Petersburg area). All of these rivers have an original wild sea trout stock but only about 20% of them are in a favourable state. In the rivers flowing to the Gulf of Finland, the status of the sea trout stocks is better than in the rivers of the Kaliningrad region, where the status is poorly known.

The largest sea trout stock (consisting of some local populations) is found in the River Luga. At present the annual smolt run is about 5000 individuals per year. Totally the production of smolt in the Russian part of the Gulf of Finland was estimated to be 13-16000, while the production capacity was estimated to be 200-250 000.

Densities are low to moderate with average values of 5.5 0+ trout $100m^{-2}$ (0–50), and the status of the sea trout populations far below expected values.

While catching sea trout is illegal in Russia and the species is included in the Red List of the Russian part of the Baltic Sea, a major reason for the poor status is illegal fishing in rivers during spawning migration.

In addition streams are influenced by farming and deforestation and clearing of bushes near the river may increase sediment and nutrient load into the water migration hindered by beaver dams.

Information on sea trout in the White Sea area has not been available.

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14. Estonia

STATUS OF AND TREND IN DEVELOPMENT IN SEA TROUT POPULATIONS & SEA TROUT CATCHES

General status for, and development in populations since 1994 in your country (If relevant separate descriptions for different parts of the country). Relevant information could include: 0+ / parr densities, Smolt numbers, Spawner numbers (or proxy, e.g. spawning pits etc.)

Estonia has about 60 rivers and streams with regular sea trout reproduction (Figure 1). In addition to these there are about 30–40 rivers and streams that have only marginal reproduction or their status in unknown. Most common monitoring method is estimating parr densities by electrofishing. From 1998 to 2004 most sea trout populations went through a period of low abundance. Since 2004 onward the parr densities have gradually been on the rise (Figures 2 and 3). Most productive rivers and streams are located on the Gulf of Finland area (SD 32).

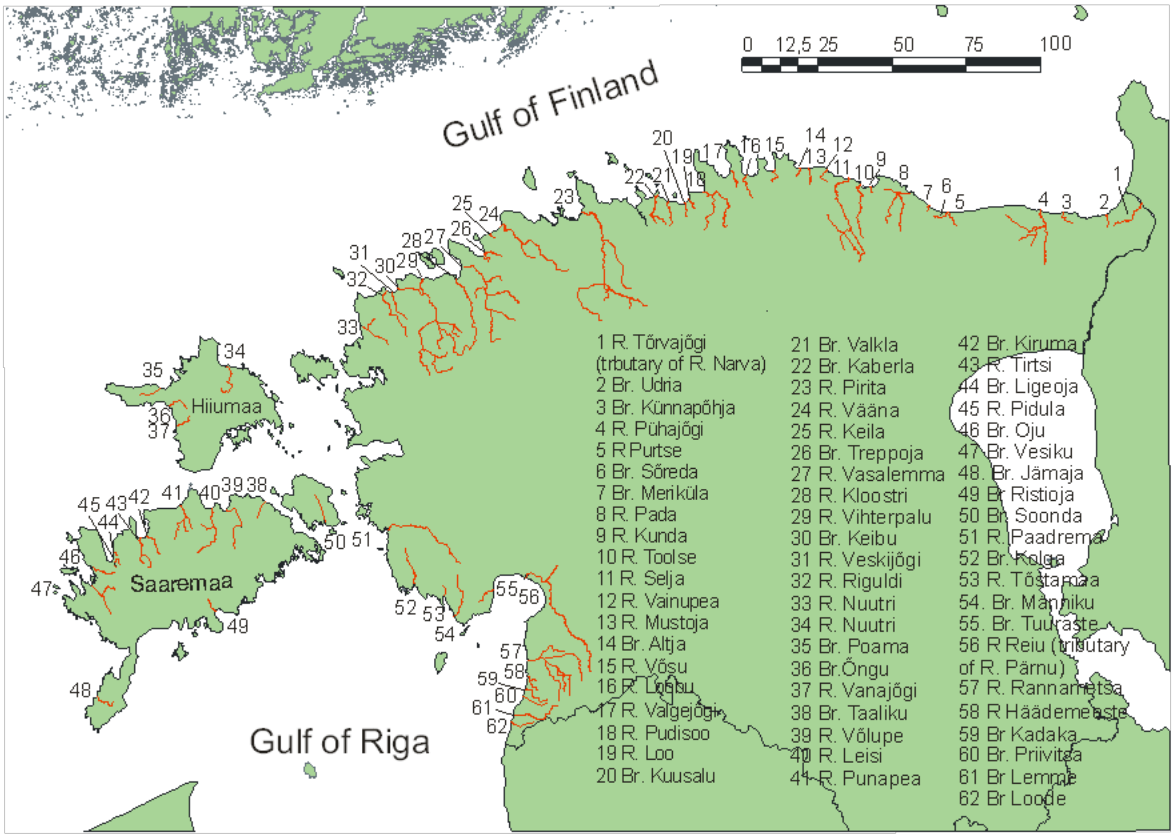

Figure 1. The location of the main sea trout rivers and streams in Estonia.

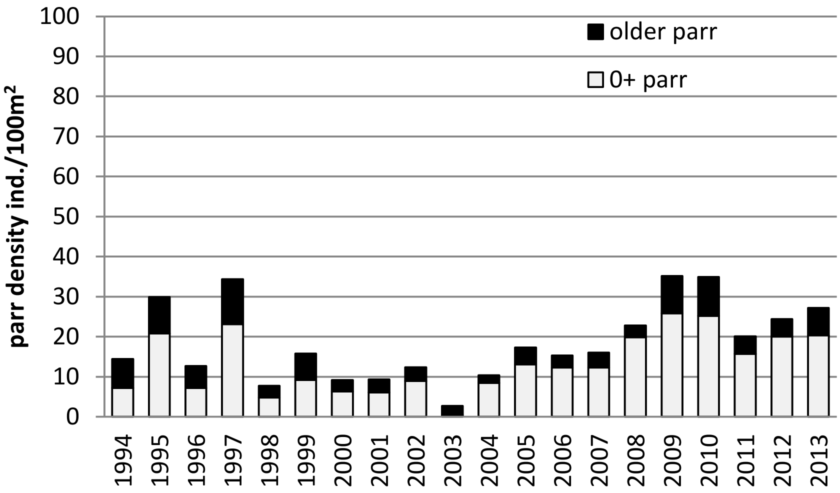

Figure 2. Average trout parr density in rivers and streams flowing to the main basin (SD 32).

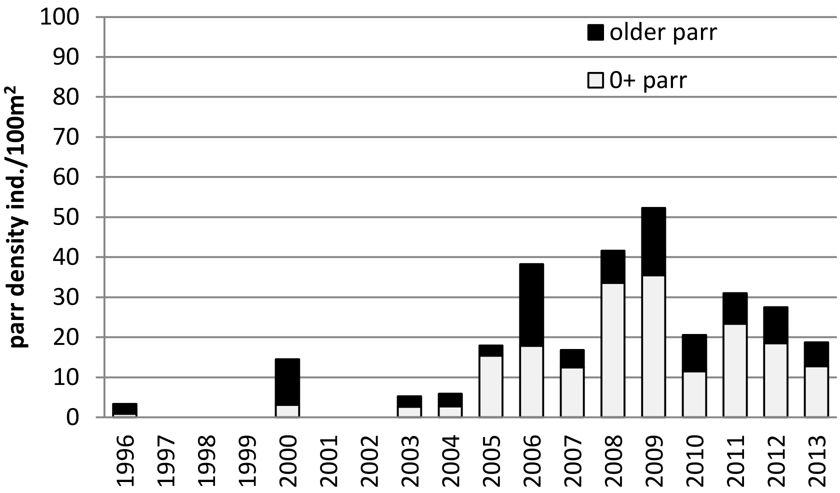

Figure 3. Average trout parr density in rivers and streams flowing to the main basin (SD 28 and 29). Note that there was no monitoring in 1994 and 1995.

What are the principal reasons for any changes in the status of sea trout populations in your country in recent years?

Main reasons for the poor status of stocks in the period from 1998 to 2004 could be associated with too intensive gillnet fishery on the coast and widespread poaching in rivers. Also severe drought in 2002 resulted in almost lack of 0+ year class in 2003. Since then the effort in the gillnet fishery on the coast has slightly reduced and no fishing areas at the river mouth areas around many important rivers were extended. Particularly on the Gulf of Finland area considerably more effort is directed to counteract poaching during spawning season. These actions together are the primary reasons for the positive trend in parr densities in during the last decade. However there are still many populations that are far below from their recruitment potential.

Further increase could be maintained by promoting fish pass (or dam removal) and river habitat improvement projects. Some of such works have been carried out in past years, however the positive effect of these activities remains to be seen.

Are sea trout caught commercially in your country? If yes, are they the primary target in this fishery?

If yes what type of fishery (professional gear at sea, fixed gear in freshwater) and what is the magnitude in number or tons?

If no, what monitoring and evaluations are there on by-catch?

What measures are in place to ensure that commercial catch-reports are made?

Sea trout is mostly caught as bycatch in the fishery that targets mostly perch, whitefish and flounder. The catch reporting is mandatory for all fishermen that use commercial gear (gillnets and trapnets). The amount of misreporting and illegal catch is presently not estimated. Reported sea trout catches in the coastal gillnet fishery vary between 10–20 tons.

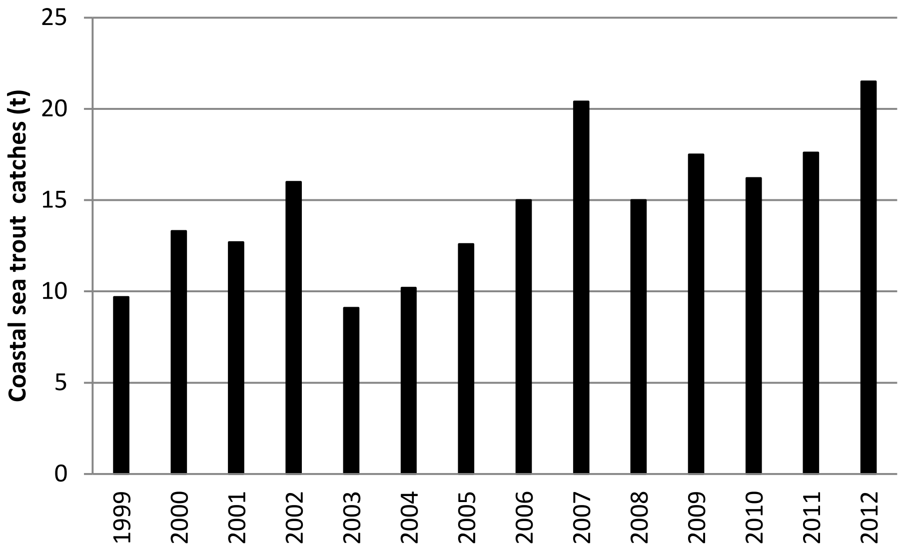

Figure 4. Nominal sea trout catches in the coastal fishery.

Are sea trout caught in recreational fisheries?

If yes what type of fishery (fixed gear at sea, fixed gear in freshwater, rod and line at sea, rod and line in freshwater) and, if known, what is the magnitude in number or weight for last 5 years (or more, if appropriate)?

What measures are in place to ensure that recreational catch-reports are made?

Coastal recreational angling for sea trout has become popular and potentially significant amount could be harvested this way. Presently there is no data about the magnitude of coastal angling as the anglers don't have to report their catches.

Are sea trout caught illegally? If yes, what type(s) of fishery, and what is the extent (if known)?

Illegal fishing during the spawning season has been particularly harmful for sea trout populations. The matter has been on the top priority list in fisheries inspection. In the Gulf of Finland area lots of effort is currently directed to counteract the matter and the situation has improved considerably. Potentially high number of undersized sea trout could also be caught in the coastal gillnet fishery.

15. Latvia

Sea trout occur in 15 rivers and in almost all small rivers and brooks discharging into the Gulf of Riga and Baltic Main Basin and in majority of their tributaries. Including all small rivers and brooks, the total number of potential Sea trout streams is 50–100. Large parts of most streams are inaccessible to migrating salmonids. An estimated 60% of the country territory is inaccessible to migratory fish species due to man made barriers. However, no new barriers will be built legally in future. The rivers Salaca, Gauja and Venta are the three most important sea trout rivers in terms of wild smolt production. In the Salaca density varied between 3.7 and 13.6 in the period 2007 - 2012 0+ pr 100 m2. In Gauja the average density of 0+ was in 1.9 in 2011 and 1.7 in 2011. No data are available for the river Venta. However in the period from 2007-2009 average varied between less than one to 2.2 parr (0+ and older)/100 m2.

Long term analysis carried out in 1999 indicated improvement in densities in Salaca and Gauja. No recent data on status of Sea trout are available for the majority of small streams floating into the Gulf of Riga and Baltic Sea. Sea trout populations have been supported by releases of reared fry, parr and smolt mostly into the upper sections of dammed rivers. Estimated production in all Latvian rivers was about 61 000 smolts annually in the period 2007-2009. In the river Salaca, where a smolt trap has been operated, the number of sea trout smolts has decreased during the last decade, being on average 9.8 thousand smolt annually (1.0–25.6 thousand) during the period 1990–2013.

To conclude: sea trout seems not to be improving, but very recent data are not available, and consequently there is much uncertainty.

16. Lithuania

An updated detailed description not available at deadline for report. The following is based on HELCOM(2011 a, b), Pedersen *et al.* 2012 and pers. comm. Kesminas Vytautus and Antenes Kontautus.

In Lithuania wild sea-trout populations are known in 10 rivers basins (76 rivers) with higher densities in small tributaries. Around 100 sites are surveyed in a running 3 year cycle. Survey is done approx. 100 Mean density of juveniles (0+ and older parr) varied in 2012 varied from 1,5 to 24,1 (mean – 13,6 ind./100 m^2). Calculated smolt production was 44 900 smolt in 2012. Sea-trout populations are particularly numerous in the Western Lithuania – the Minija River catchment. Average density of sea-trout parr in the Minija catchment was 17.7 ind/100m^2 and smolt production 18100 individuals. Smolt production has increased in Eastern part of Lithuania. Sea trout smolt production in Neris basin increased significantly 2,9 times, Žeimena basin 1,4 times and in Šventoji basin it decreased 1,3 times.

Total smolt production was estimated to be 34–46 000, while the potential production has been estimated to be 324 000.

Inventory of spawning places and adult run is conducted by counting the the number of spawning nests on 1 km stretches in autumn / winter in a number of rivers.

In recent years, the sea trout smolt production varied substantially in some rivers. Smolt production mainly depends on the ecological conditions of the river and on spawner abundance.

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17. Poland

STATUS OF AND TREND IN DEVELOPMENT IN SEA TROUT POPULATIONS & SEA TROUT CATCHES IN POLAND

General status for, and development in populations since 1994 in your country (If relevant separate descriptions for different parts of the country). Relevant information could include: 0+ / parr densities, Smolt numbers, Spawner numbers (or proxy, e.g. spawning pits etc.)

A number of sea trout populations in Poland are around 25 (Figure 1). Almost all of them are supported by stocking and its real status is difficult to assess. Only one small stream has a wild population, 16 are mixed, and 8 – reared, what means that no (or very small) natural reproduction occurs and their stocks are kept by stocking.

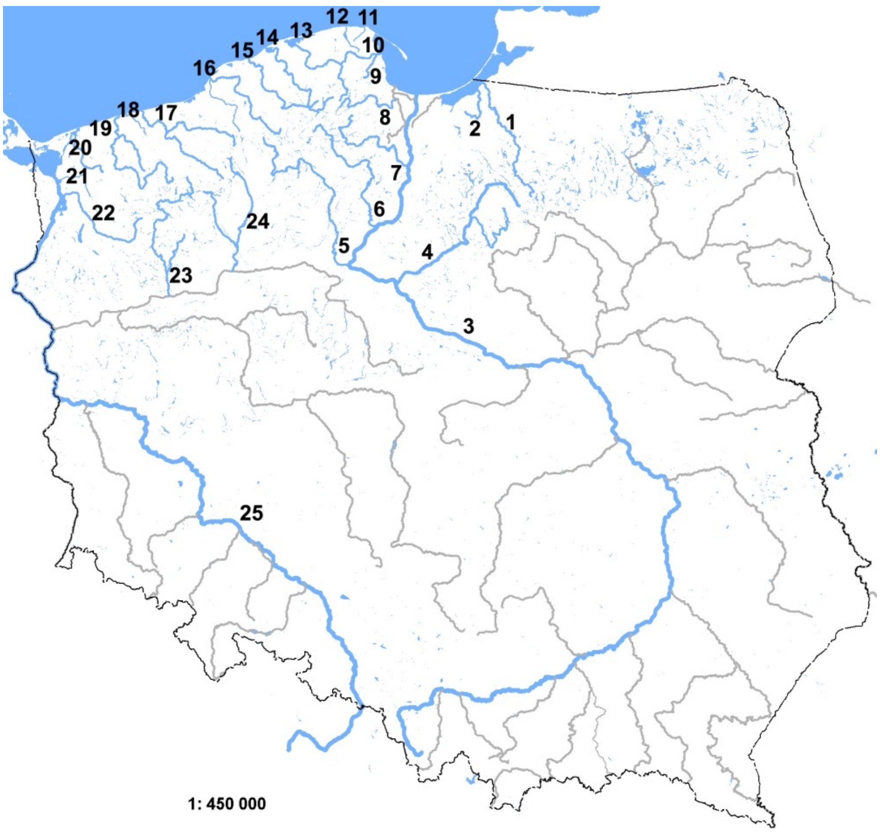

Figure 1. Polish sea trout rivers.

Average densities of 0+ and 1+ parr on monitored spawning grounds are around 60 and 20 ind/100m^2 and vary with years and rivers (Figure 2 and 3).

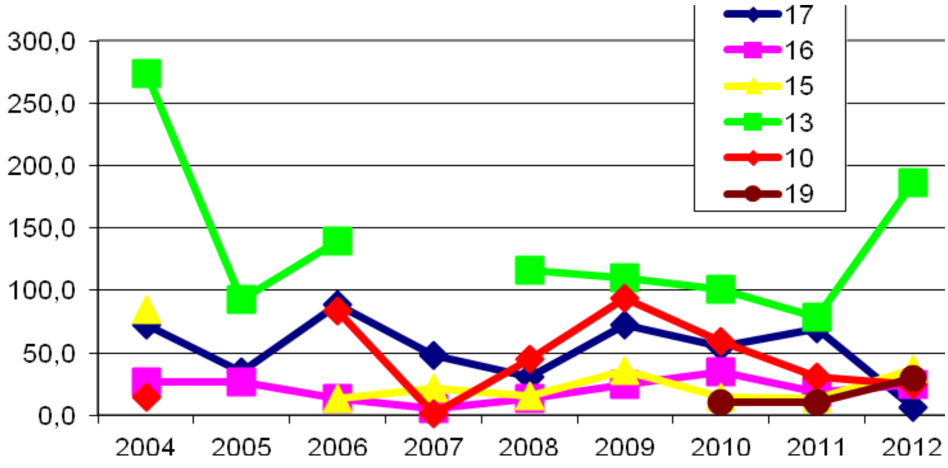

Figure 2. Average densities of 0+ parr (ind/100m²).

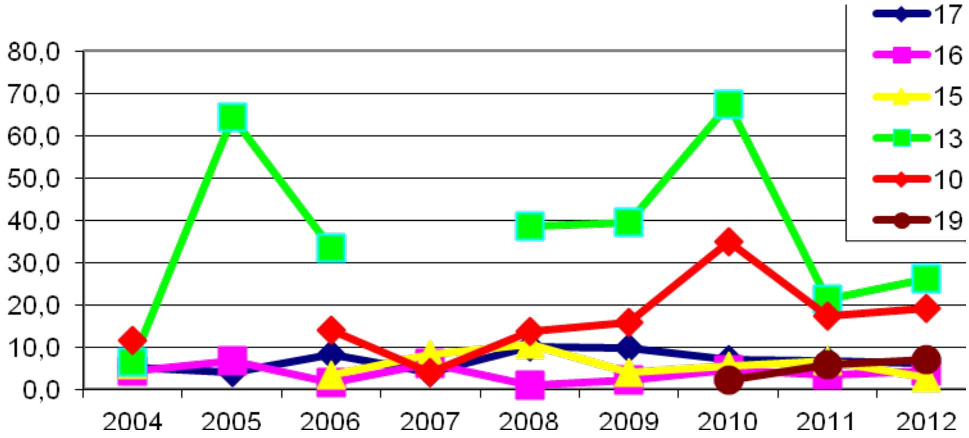

Figure 3. Average densities of 1+ parr (ind/100m²).

There are no estimations of smolt production and run.

All Polish sea trout rivers are stocked, mainly with smolts. Since 1995 amount of released smolts varies around 1200 thousands (Figure 4). More than half of it goes into Vistula River system.

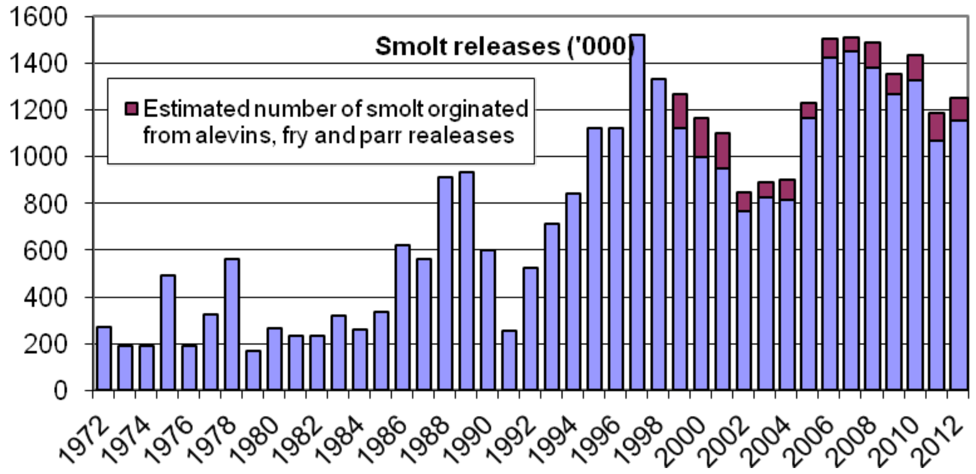

Figure 4. Sea trout releases.

Size of brood stock is estimated only in one river, Slupia River, on a base of counter data (Figure 5).

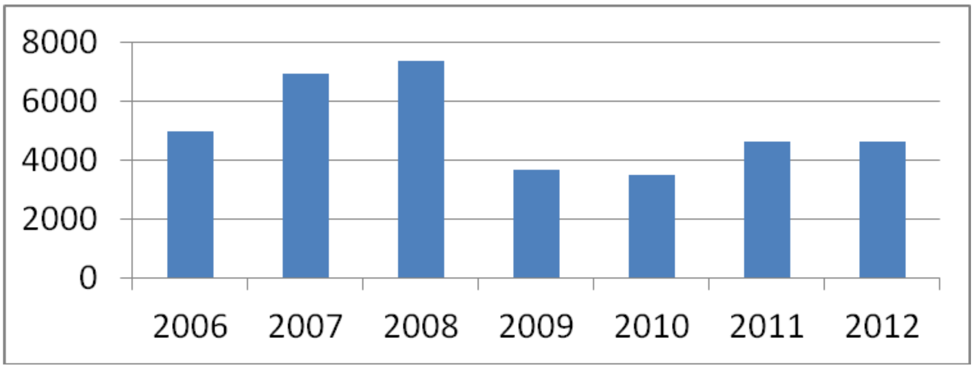

Figure 5. Number of spawners recorded by the counters in Slupsk on the Slupia River.

What are the principal reasons for any changes in the status of sea trout populations in your country in recent years?

The main slumps were in the beginning of XX c. after damming of majority of rivers in northern Poland and in 60ties after cutting off southern Poland by the big dam in the middle run of Vistula River. Improvement of water quality in Polish rivers since the beginning of 90ties and some new fish passes built recently, result in increase of some sea trout population. For few years violent outbreak of UDN has been observed in most of Pomeranian rivers, varying with years and rivers, resulting in very high mortality of spawners and breakdown of stocking programs.

Are sea trout caught commercially in your country? If yes, are they the primary target in this fishery?

If yes what type of fishery (professional gear at sea, fixed gear in freshwater) and what is the magnitude in number or tons?

If no, what monitoring and evaluations are there on by-catch?

What measures are in place to ensure that commercial catch-reports are made?

Sea trout is commercially caught fish in the Polish EEZ and lower part of Vistula River (Figure 6). In the sea it is caught in longline fishery together with salmon, in coastal areas - mainly with fixed gears (gillnets, fykes) and in Vistula - mainly with driftnets and some fixed gears. Sea trout is most important part of all salmonid coastal catches. Reporting of commercial catch is mandatory and there is increasing number of controls done by fishery inspectors. There is also fishery for breeding purposes in Pomeranian rivers and Vistula River done mainly by traps at dams and electrofishing.

Table 1. Polish catch of sea trout in 1998–2012 (t) source: ICES WGBAST Report 2013.

Year	Sea	Coast	River	Total
1998	208	184	76	468
1999	384	126	116	626
2000	443	299	70	812
2001	486	219	11	716
2002	539	271	53	863
2003	583	169	72	824
2004	606	122	36	764
2005	480	86	20	586
2006	418	94	17	529
2007	357	130	38	525
2008	35	89	48	172
2009	271	91	26	388
2010	353	71	30	454
2011	151	53	39	243
2012	53	58	26	137

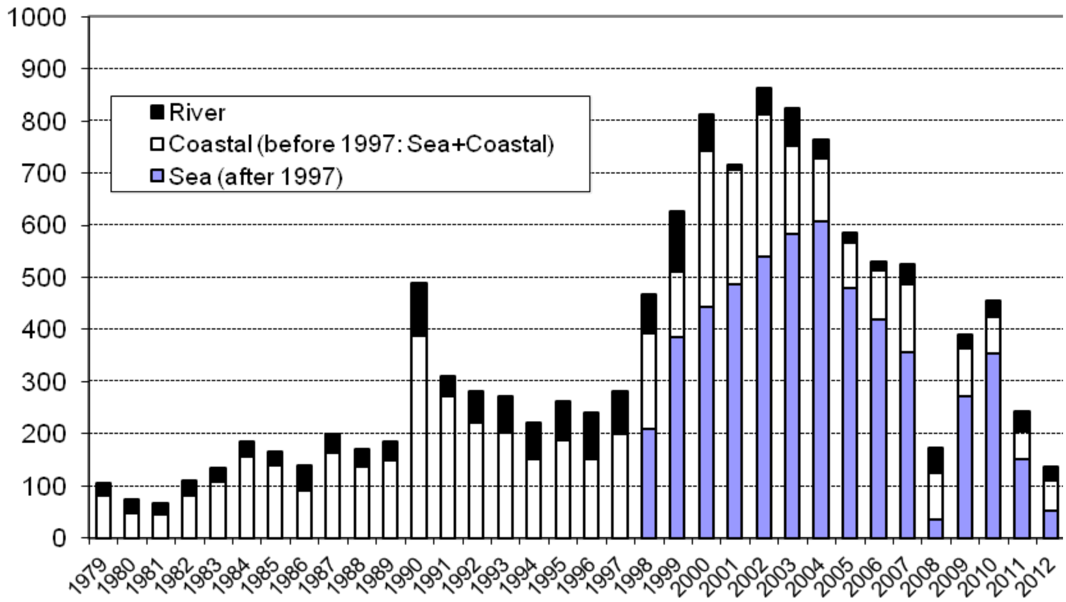

Figure 6. Polish catch of sea trout (t).

Are sea trout caught in recreational fisheries?

If yes what type of fishery (fixed gear at sea, fixed gear in freshwater, rod and line at sea, rod and line in freshwater) and, if known, what is the magnitude in number or weight for last 5 years (or more, if appropriate)?

What measures are in place to ensure that recreational catch-reports are made?

Sea trout is a valuable species in sea and freshwater recreational catches. There is an intensive sport fishing in Pomeranian rivers, mainly for kelts, which can be roughly estimated at 4-6 ton. Coastal angling and trolling are also increasing violently for a few years. There is no idea about a magnitude of this catch.

Are sea trout caught illegally? If yes, what type(s) of fishery, and what is the extent (if known)?

Some illegal (unreported) catch of sea trout exists both in coastal and river fishery, however, magnitude of them is largely unknown. In the coastal area – the most frequent illegal fishery occurs in protected areas around river mouths. In rivers – in every parts, especially during spawning season and it’s believed that magnitude of it is quite high.

Seals predation

Since 2011, there is a growing number of sea trout in gillnet and longline fishery, damaged by seals, both at sea and in Vistula River mouth (Figure 7). The higher losses were reported from Vistula River mouth (ujście Wisły) in September 2012 with damages over 200 sea trout per day. In 2013 catches in Vistula River almost ceased due to seal predation.

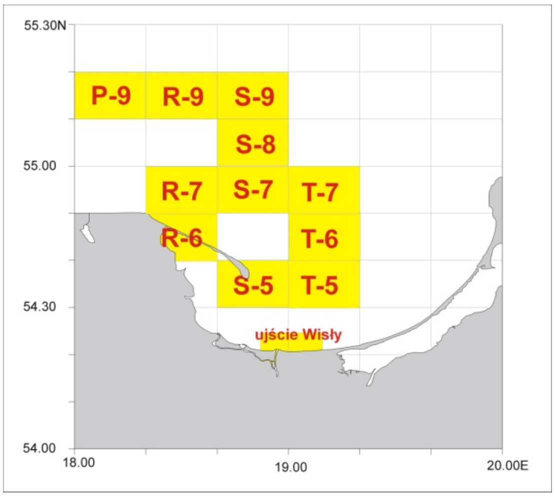

Figure 7. Areas in Polish part of sub-division 26 (in yellow) with registered fish damages by seals in 2012.

18. Iceland

Sea trout in Iceland

By Magnús Jóhannsson

Sea trout occurs in riverine habitats in all regions of Iceland but is most abundant in South and West Iceland. In Southeast part of the country sea trout is the dominant salmonid fish species in many rivers. In other parts of the country, either Atlantic salmon or artic charr are the dominant species.

Research progress

Knowledge on life history of sea trout in Icelandic rivers is rather scarce, though information on catch data and stock sizes is fairly good (Gudbergsson 2013). Extensive studies on sea trout are few in Iceland, and mostly limited to, life history and growth. However studies have been carried out on migration and the sea phase of the sea trout life cycle and counting of immigrants in some rivers.

Juvenile densities of salmonids are monitored by electro-fishing in many Icelandic rivers although the main aim is to monitor salmon other salmonids are included. Special monitoring of sea trout stocks is in River Grenlaekur which is in the Southeast part of the country. Sea trout entering spawning grounds are counted and population densities and growth of juveniles investigated. In the Skafta river system densities studies of fry and parr have be carried out every year since 1986 (Jóhannsson and Einarsson 1993).

Studies in Skafta river system in Southeast Iceland show that sea trout juveniles are the dominant salmonid species. There the main river (Skafta) is glacial but tributaries are with clear water. Densities of salmon and arctic char are generally much lower in the area (Jóhannsson & Einarsson 1993). Density of trout parr has been relatively high dominating by fry (0+). Considerable variation is observed between years but no indication of decrease in fry densities, but resent years reduction is observed in densities of parr.

Studies on sea trout smolts migration in a small river in Southwest Iceland showed that smolt migrated to sea in May and June and the migrants mean size was 16.0 cm Gudjónsson (1993). Sea trout smolts in a nearby river Leirvogsa in Southwest Iceland are of similar size, 15.5 (Antonsson and Johannsson 2012). According to back calculation of fish length from scales in river Skafta, Jóhannsson & Einarsson (1993) found that mean size of sea trout smolts were 25.3 cm and mean age 3.4 years. In river Grenlaekur, a spring-fed productive tributary to Skafta, the average smolt size is even larger 26.2 cm (Antonsson and Johannsson 2012). Most of the sea trout in the Skafta river system migrate 2-4 times for a summer stay in the sea before they mature. Annual mean growth of trout for the first two summers is 12.3 cm and 11.4 cm respectively (Jóhannsson 2014). Most of the sea trout in the Skafta river system matures after 3-4 summers in the sea and mean sea age at maturity is 3.4 summers. The trout in the Skafta area has reached 50-60 cm in length and 1.5-3 kg in weight at maturation. This explains why the sea trout can grow that big and it is not unusual to catch trout over 5 kg.

Food of sea trout was analysed in a brackish lagoon in South Iceland. The main food items were sandeels (*Ammodytidae*), mysids and amphipods (Jóhannsson 1995). By tagging sea trout in river Grenlækur in the Southeast, with data storage tags (DST), Sturlaugsson & Jóhannsson (1996 and 1998) reported that while dwelling in the sea the trout was feeding inshore and in the surface layers of the sea usually in the uppermost 5 meters. Adults enter the sea from middle of May to middle of June and enter fresh water for spawning and/or overwintering after 6-10 week feeding period in the sea.

Tagging of 134 adult sea trout in the Skafta river system show that the homing of mature fish to their home river is very accurate. All recaptures were in the River Skafta area. In total 84.2% of the recaptures was in the tributary of origin or in the River Skafta main stem but three in other tributaries and two in unknown location in the Skafta river system (Jóhannsson & Einarsson 1993).

From 1996 an electronic fish counter (Vaki Riverwatcher counter) have been operated in River Grenlaekur. The counter gathers information on number of fish and fish species migrating upstream to the spawning grounds as well as size of the fish and the time of migration. The time of ascending sea trout (migrating upstream) is from middle of July to middle of October with the highest peak in August. Rain, water flow and water temperature are the most important environmental factors affecting positively on the upstream migration. Sea trout ascend mainly in the evening and at early night hours (Jóhannsson *et al.* 2001). There is a significant positive correlation between the number of fish from the fish counter and the number of fish caught in the rod fishery above the fish counter. This indicates that rod catch can be used as measure of changes in the size of the fish population (Jóhannsson and Jónsson 2008).

Management and catch recording system

In Icelandic rivers the fishing rights go with the ownership of the land adjacent to the rivers. The landowners are usually farmers. All the landowners with fishing rights in a river system have by law to form a fishery association, which manages the exploitation of the fish stocks, within the frame set by the law. Usually the rivers fishery association rents or leases the fishing rights to angling syndicates, angling clubs or individual anglers. The entire riverbank is accessible to the limited number of rod fishermen that have fishing permit each day. Most rivers have fishing lodges with high quality accommodation.

In most Icelandic rivers rod and line is the only fishing gear allowed. A fixed number of rods are used in each river. In most rivers fishing effort has remained almost unchanged since 1970. Each Fishery association needs to make a plan that outlines the management strategy. The management plan needs approval by the Directorate of Fisheries (Fiskistofa) after a review by the Institute of Freshwater Fisheries (Veiðimálastofnun). The fishing season for sea trout (migratory brown trout) can last from April 1 to October 10 with a possible extension to October 20 for fish stocks with harvestable surplus. The 10 day extension needs approval by the Directorate of Fisheries.

Net fishery for migratory salmonids is almost exclusively in large glacial rivers where angling possibilities are limited. In the net fishery gillnets are the most common fishing method and draft net are used at few locations for sea trout and sea-run arctic char. The weekly net fishing period is from Tuesday morning 10 AM to Friday evening 10 PM. The weekly fishing period in net fisheries is 84 hours. The weekend closure is to reduce fishing effort and allow fish migration to the up rivers regions and tributaries. The weekly rod fishery also last for 84 hours. It is 12 hours a day during the fishing season from 7 AM to 10 PM with a 3 hour midday break.

The catch is recorded in special logbooks in the fishing lodges. At the end of the fishing season the logbooks from every river are gathered and statistical information are processed by the Institute of Freshwater Fisheries.

Fry densities

Juvenile denisties are monitored in about 30 rivers and approx. 150 sites and in tvo sea trout rivers (river sistems) on 13 sites. Habitat information has been collected from about 50 rivers.

Juvenile densities have been found to vary between 20 and 73 o+ fry per 100m² with an average of 46 0+ per 100m² in one river dominated by sea trout (Table 1).

Table 1. Autumn densities of salmonids in River Geirlandsá and a tributary (three stations), Numbers are parr and fry in one fishing round in electro fishing (Unpublished data from IFF).

Year	Trout 0+	Trout 1+	Trout 2+	Trout 3+	Trout 4+	Charr 0+	Atlantic Salmon 0+	Atlantic Salmon 1+	Atlantic Salmon 2+
2003	39.4	8.6	2.1	0.0	0.0	0.0	9.1	0.0	0.0
2004	73.0	11.9	3.2	0.0	0.0	0.0	16.0	0.0	0.0
2005	40.1	18.1	5.1	0.0	0.0	0.0	28.5	2.0	0.0
2006	49.9	17.9	7.0	0.0	0.0	0.0	8.0	1.4	0.4
2007	20.7	3.9	3.3	3.3	0.0	0.0	0.6	0.0	0.0
2008	52.1	7.8	0.0	1.0	0.0	0.0	7.6	0.7	1.0
2009	58.1	4.9	0.8	0.0	0.0	0.0	13.7	3.8	0.0
2010	41.5	5.7	1.1	0.0	1.1	0.0	6.8	4.2	0.8
2011	36.0	1.6	0.3	0.0	0.0	0.0	1.0	0.4	1.6
2012	51.1	3.9	1.6	0.0	0.0	0.0	3.8	1.3	0.3

Catches

There are no catch or known bycatch of sea trout in the sea around Iceland.

The annual rod catch in rivers of sea trout in Iceland ranges from 8.821–23.206 fish (Table 1, Figure 1). The number of released fish is available since 1999 and show that the number of released fish have been increasing throughout the period with 32.1% released in 2012 (Figure 2). By region the highest catch in is in South Iceland where 2.661–6.685 are caught annually with peaks in 1995 and 2005. (Figure 3)(years 1990–2012) (IFF database; Gudbergsson 2013). Since 2005 there has been a declining trend in South and West Iceland but in Northwest, Northeast and East catch has shown an increase (Figure 3).

Table 1. Rod catch of sea trout in Icelandic rivers 1990–2012. Total number of fish caught, catch landed and catch and release is given.

Year	Catch total	Catch landed	Catch & release	Catch & release %
1990	8821	8821		
1991	10102	10102		
1992	10529	10529		
1993	9534	9534		
1994	11026	11026		
1995	12388	12388		
1996	12703	12703		
1997	12022	12022		
1998	13406	13406		
1999	12094	11745	349	2,9
2000	14867	14318	549	3,7
2001	16456	15107	1349	8,2
2002	23206	21462	1744	7,5
2003	15972	12316	3656	22,9
2004	18665	15527	3138	16,8
2005	19399	16385	3014	15,5
2006	11204	8828	2376	21,2
2007	15867	12679	3188	20,1
2008	12314	9908	2406	19,5
2009	17488	13020	4468	25,5
2010	17497	13637	3860	22,1
2011	17267	13227	4014	23,2
2012	16104	10938	5177	32,1
Mean	**14301**	**12593**	**2806**	**17,2**

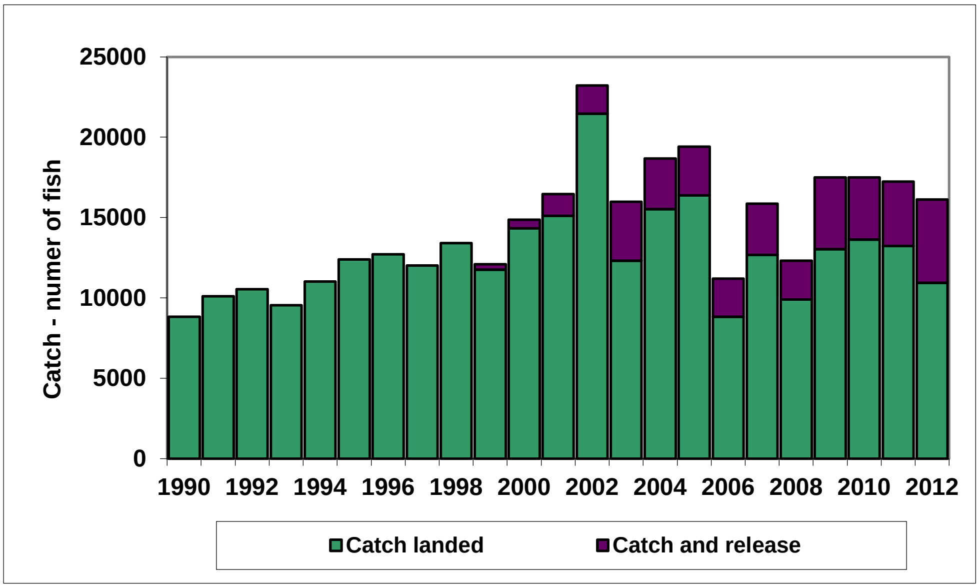

Figure 1. Total catch of Sea trout in Iceland 1990–2012 divided into catch landed and catch and release.

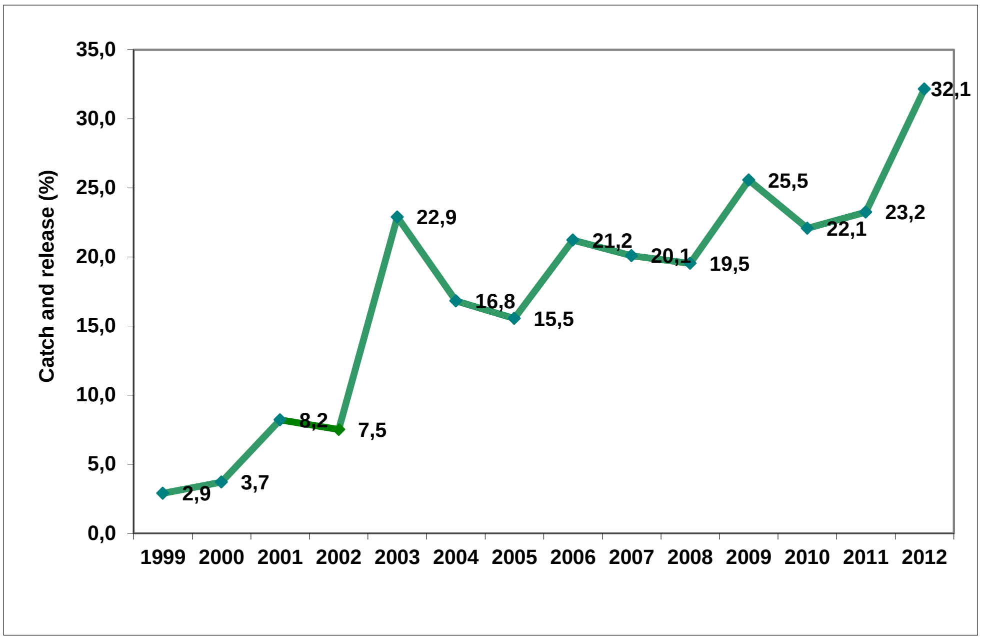

Figure 2. Proportion of catch and release in sea trout fishery in Icelandic rivers 1999–2012.

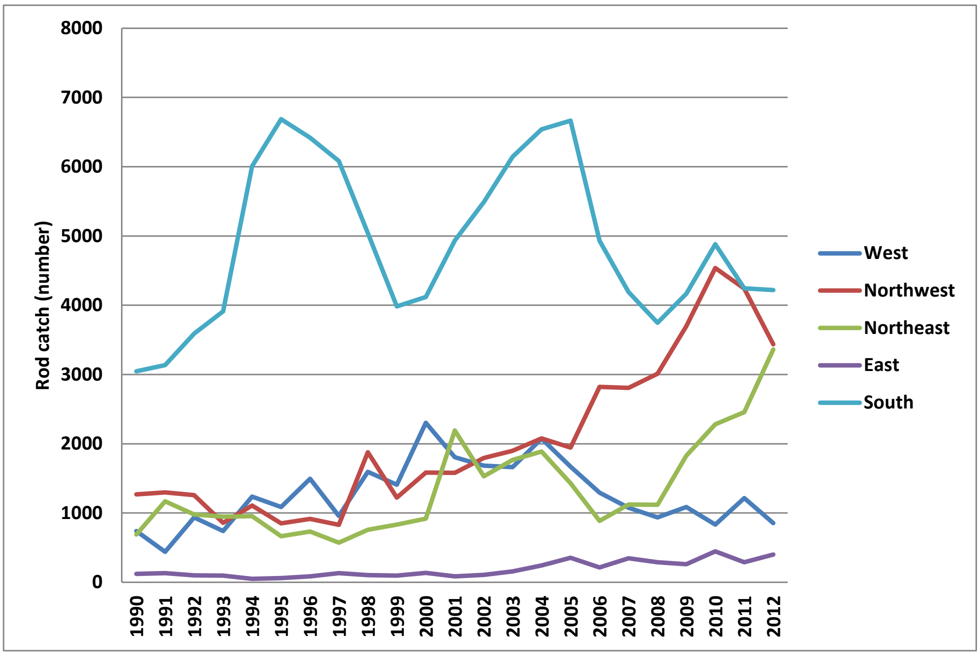

Figure 3. Rod catch of sea trout in Icelandic rivers dived by geographical areas for rivers with annual catch records.

Factors affecting population abundance

Sea lamprey wounds on sea trout

In 2006, sea trout with rounded wounds from sea lamprey (Petromyzon marinus) was for the first time reported on returning sea trout caught in freshwater in South-east Iceland. From that time wounds have been observed on sea trout from many rivers in Iceland but most frequently in South Iceland. Systematic inspection shows that up to 30% of adult sea trout have wounds or suck marks on their skin (Jónsson and Jóhannsson 2008). Few adult sea lampreys have been caught in marine environment and one sucking on salmon in river Ytri-Ranga in South Iceland. To date there are no records of reproduction of sea lamprey in Icelandic rivers although it might have occured. It is not clear whether the sea lamprey causes increased sea trout mortality. The origin of the lampreys has been assigned to the European stock (Pereira et.al). Increasing attacks by sea lamprey in Iceland could be coupled with the oceanographic changes that are taking place at high latitudes caused by climate change.

Changes in sandeel abundance

Sandeels seem to be very important food for sea trout in the sea around Iceland as well as for many other fish species. The sandeel (*Ammodytes marinus*) is the main prey of most seabirds in South and West Iceland. In recent years Atlantic puffins (*Fratercula arctica*) populations in the Vestmanneyjar islands in South have decreased drastically. Research show that the sandeel stock collapsed in 2005 and has since then remained at very low levels. Why the sandeel stock collapses is still an open field of research. The change in abundance of sandeels can be one of the main reasons for reduction in sea trout catch in rivers in South and West Iceland.

Stocking

There have been very little stockings of sea trout fry and parr in recent years in Iceland. Release of salmon smolts in sea trout rivers are a possible threat to the sea trout stocks in few rivers in South Iceland with intensive stocking of salmon smolts for recapture in rod fisheries. In those rivers the sea trout catches have declined. Whether that is related to smolt releases, possible competition between the species, and increased fishing effort is still too early to tell. That needs further investigations and knowledge of the effect of the fishery and possible mechanisms related to smolt release activities as well as other factors.

Habitat degratation

In the spring-fed River Grenlaekur, Southeast Iceland, one of the best sea trout fishing river in Iceland, manmade drought by water transfer, *with total dry weeks in 1998* have decreased the trout production. Very low densities of sea trout parr are found in years with low water flow. This has probably affected the abundance of adult sea trout and the rod catch (Jóhannsson and Jónsson 2011).

Volcanic eruptions are possible factor influencing sea trout populations in Iceland. The latest volcanic eruptions in Iceland were in the glaciers Eyjafjallajökull (2010) and Vatnajökull (2011). These eruptions influenced the freshwater fish biota by distributing a vast amount of volcanic ash into rivers. In 2011 dark water color due to volcanic ash disturbed angling and was probably the main cause of decreased catch of sea trout that year. Despite thick layers of ash sediment in the rivers originating from the eruption in 2011, it only had surprisingly little influence on densities of trout juvenile as measured in electrofishing surveys (Johannsson 2014).

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19. Belgium

Detailed description not available at deadline for report. The text below is pers. comm. M. Ovidio.

The sea trout population in Belgium is very scarce, but do exist and is observed during electric fishing. Resident trout dominates the trout population. One – fifteen sea trout caught per year in the Lixhe Trap in River Meuse. Sea trout caught in this trap are used for artificial breeding.