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Report of the 2008 session of the Joint EIFAC/ICES Working Group on Eels

Leuven, Belgium, 3–9 September 2008

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European Inland Fisheries Advisory Commission
Food and Agriculture Organization of the United Nations
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Preparation of this document

This publication is the report of the 2008 session of the Joint European Inland Fisheries Advisory Commission (EIFAC) and International Council for the Exploration of the Sea (ICES) Working Group on Eels which was held in Leuven, Belgium from 3 to 9 September 2008.

The Working Group would like to acknowledge ICES for undertaking the editing and formatting of this publication and FAO for the printing and distribution of hard copies.

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Abstract

Available information on recruitment, stock and fisheries continues to support and reinforce the advice that the European eel stock has declined in most of the distribution area and is outside safe biological limits. Recruitment of glass eel to the continental stock continues to decline with no obvious sign of recovery. Current levels of anthropogenic mortality are not sustainable and there is an urgent need that these should be reduced to as close to zero as possible, as soon as possible. All glass eel recruitment series demonstrate a clear decline since about 1980 with no sign of recovery. The Baltic indices of young yellow eel recruitment demonstrate a clear decline since about 1950. The decline in recruitment appeared stronger in the more northern and southern parts of the distribution.

In the 1970s, recruitment of glass eel was still at historically high levels indicating that Spawning Stock Biomass was not limiting the production of recruits at that time. Quantifying the 1970s spawner escapement therefore is the simplest derivation of a restoration threshold. The reference threshold should be set at 100% of the 1970s silver eel escapement where data are available, or in the absence of data, at a percentage (40%) of the notional pristine state which would have existed if no anthropogenic mortalities had impacted on the stock.

It is of utmost importance that existing recruitment monitoring is continued and improved, easing the dependence on commercial fisheries, and extended where inadequate. A radical improvement in the assessment of the current state of the stock, including quantification of the impact of anthropogenic mortalities, is urgently needed. Although comprehensive datasets exist in some river basins, this assessment will not be achievable in most river basins from currently limited data. Data discontinuities are likely to occur simultaneously and unlike in the past, statistical modelling will not be able to correct for this.

The first post-evaluation of the EU Regulation is required by mid-2012. Timely development of stock-wide assessment procedures is required, geared to the data becoming available, while indicating the progress towards recovery of the stock. The absence of any internationally driven requirement to maintain a recruitment dataseries needs to be corrected, with reference to the recommendations of the EU contract 98/076: Establishment of a recruit monitoring system for glass eel. The current legislative instruments including the Eel Regulation, DCR, CITES and WFD do not, either individually on in combination, contain sufficient provisions to ensure adequate data supply for such assessments.

It is suggested that managers define interim targets for the management measures in order to integrate local action efficiently to the aim of long-term recovery of the European eel stock. For this purpose sub-targets defining the magnitude of management measures will be linked with eel sub-targets reflecting the expected short-term response of the local eel population. Eel sub-targets should therefore allow a fairly rapid evaluation of the management measures taken but sensitivity and time response of some of the proposed eel sub-targets would need further investigation before their application would be operational. Eel sub-targets should finally be integrated into the evaluation of the status of the whole eel stock. However it has to be recognized that adequate methods, or modelling approaches, for achieving this are still lacking.

There are few quantitative estimates of pristine (pre-1980) and current silver eel production (Regulation EU 1100/2007) to allow comparisons to be made between systems

and there is few data on the importance of estuarine and coastal populations to overall production. Modelling will be needed to transfer estimates from data rich to data poor systems. Some approaches have been outlined by this Working Group which compliment those presented in previous working groups and in EU SLIME (Dekker *et al.*, 2006).

Implementation of EMPs requires the development of methods to obtain silver eel escapement data. They can include either direct (e.g. mark-recapture) or indirect measures (yellow eel proxies to determine habitat-based silver eel production). Use of direct methods, though preferable in many respects, will be severely restricted by uneven distribution of silver eel fisheries within and between regions, limited fishery monitoring resources and extreme fluctuations in river flows during migratory runs affecting the efficiency of capture methods.

A variety of indirect methods, mostly dependant on yellow eel proxies and modelling, are available for areas where direct measurements of silver eel escapement are not possible and should be extensively used to estimate regional and national silver eel escapement. Validation of indirect methods should be undertaken on an ongoing basis for a network of river systems where reliable direct estimation of silver eel escapement biomass is possible. Direct assessment of silver eel may, however, not inform on the impacting factors that require management, where yellow eel monitoring and assessment would be more informative.

Estimation of effective spawner biomass requires quantification of the adverse effects of contaminants, parasites, diseases, low fat levels, non-lethal turbine damage, along the lines previously proposed for *Anquillicola crassus*, as well as other mortality rates throughout the river basin. Present knowledge does not fully permit quantitative assessment of the effects of these factors on the overall stock. The European Eel Quality Database (EEQD) has been updated with data on contaminants, parasites and fat levels in eel, allowing the compilation of an overview of the contaminant load in eel over its distribution area. The data are highly variable within river basin districts, according to local anthropogenic pollution, linked with land use. Persistently elevated contamination levels, above human consumption standards, are seen in many European countries. Fat content of the yellow eels (i.e. in Belgium and the Netherlands) has decreased over the last number of years, which raises concern regarding the migratory and reproductory success of silver eels. *A. crassus* is spreading further into new areas and new data indicate the presence of the nematode in Canada for the first time.

At present, it is estimated that around 7.5 to 15% of the glass eel catch is used for stocking, either directly or as on-grown eels. Estimates suggest an insufficient supply of glass eel from the total fishery for stocking to full capacity at the European level. Nevertheless, the Regulation 1100/2007 requires that 35%, rising to 60%, of glass eel catches are made available for stocking to enhance the stock. If these percentages were applied to recent annual catches of glass eel, the potential lifetime effect of this increased level of stocking, in the absence of anthropogenic mortalities, could be in the same order of magnitude as current fisheries or eel culture. However, there is a continuing and urgent requirement for robust evidence of the extent to which stocking and transfers on local, national and international scales can increase silver eel escapement and spawner biomass.

The risks remain of disease and parasite transfer via stocked material, both from stocking glass eel and on-grown eels. For example, eels in aquaculture infected with pathogens (viruses, etc.) should not be used for stocking purposes. At least half the countries surveyed (17) do not have formal stocking protocols. These should include procedures to prevent the introduction and spreading of parasites and diseases, and eel should be included in the European fish disease prevention policies to help minimize the risks.

Sufficiently long time-series of glass eel recruitment, covering several periods of the natural climatic oscillation over the North Atlantic, reflect the same periodicity. However, the causal link between climate and recruitment strength, is unknown, as well as where and when ocean environmental factors operate on the eel. As long as the causal factors of oceanic influence are unknown, it is not safe to assume that the decline is explained by climate alone, especially while anthropogenic influences are known to be large and better understood. The fact that oceanic climate may contribute to recruitment variation is not grounds for abstaining from all possible measures to increase silver eel escapement to boost spawning-stock biomass. The recent, prolonged strong decline in eel recruitment is out of phase with the dominating climate cycle, the North Atlantic Oscillation.

FAO European Inland Fisheries Advisory Commission; International Council for the Exploration of the Sea.

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Executive summary

This report summarizes the presentations, discussions and recommendations of the 2008 session of the Joint EIFAC/ICES Working Group on Eels which took place in Research Institute for Nature and Forest, Leuven, Leuven (Belgium) from 3 to 9 September 2008.

In this section, the main outcomes from the report are summarized, a forward focus is proposed in the light of the EU Regulation for the Recovery of the Eel Stock and the main recommendations are presented.

It is clear from this report that recruitment is still low, the stock is in decline and urgent protection measures are required. Significant pressures have been placed on the scientific and technical system to support the delivery of Eel Management Plans by December 2008 with parallel processes and undetermined actions resulting in some uncertainties to be coped with by the Working Group in 2008.

Summary of this report

Reviewing the available information on recruitment, stock and fisheries continues to support and reinforce the advice that the global European Eel stock has declined in most of the distribution area and is outside safe biological limits. Recruitment of glass eel to the continental stock continues to decline with no obvious sign of recovery. Current levels of anthropogenic mortality are not sustainable and there is an urgent need that these should be reduced to as close to zero as possible, as soon as possible. All glass eel recruitment series demonstrate a clear decline since about 1980 with no sign of recovery. The Baltic indices of young yellow eel recruitment demonstrate a clear decline since about 1950. The decline in recruitment appeared stronger in the more northern and southern parts of the distribution. It is recommended to use recruitment indices per area (Baltic, North Sea, British Isles, Atlantic Coast, eastern and western Mediterranean), and to collect and analyse additional data to confirm the spatial pattern, and to establish the reliability and bias in the different sampling methods.

In the 1970s, recruitment of glass eel was still at historically high levels. This indicates that SSB was not limiting the production of recruits at that time. Quantification of the 1970s spawner escapement therefore is the simplest derivation of a restoration threshold. Note that in this case, the full escapement of the silver eels in the 1970s (given the anthropogenic mortality of that time) corresponds to the escapement level advised by ICES (2002). That is: one should either set the reference threshold at 100% of the 1970s silver eel escapement where data are available, or in the absence of data, at a percentage (40%) of the notional pristine state which would have existed if no anthropogenic mortalities had impacted on the stock.

It is of utmost importance that existing recruitment monitoring is continued and improved, easing the dependence on commercial fisheries, and extended where inadequate. A radical improvement in the assessment of the current state of the stock, including quantification of the impact of anthropogenic mortalities, is urgently needed. Although comprehensive datasets exist in some river basins, this assessment will not be achievable in most river basins from currently limited data. Data discontinuities are likely to occur simultaneously and unlike in the past, statistical modelling will not be able to correct for this. Therefore, discontinuities will have to be taken for granted.

The first post-evaluation of the EU Regulation is required by mid-2012. Timely development of stock-wide assessment procedures is required, geared to the data becoming available, while indicating the progress toward recovery of the stock. The absence of any internationally driven requirement to maintain a recruitment dataseries needs to be corrected, with reference to the recommendations of the EU contract 98/076: Establishment of a recruit monitoring system for glass eel. The current legislative instruments including the Eel Regulation, DCR, CITES and WFD do not, either individually on in combination, contain sufficient provisions to ensure adequate data supply for such assessments.

It is suggested that managers define interim targets for the management measures in order to integrate local action efficiently to the aim of long-term recovery of the European eel stock. For this purpose sub-targets defining the magnitude of management measures will be linked with eel sub-targets reflecting the expected short-term response of the local eel population. Eel sub-targets should therefore allow a fairly rapid evaluation of the management measures taken but sensitivity and time response of some of the proposed eel sub-targets would need further investigation be-

fore their application would be operational. Eel sub-targets should finally be integrated into the evaluation of the status of the whole eel stock. However it has to be recognized that adequate methods, or modelling approaches, for doing this exercise are still lacking.

There are few quantitative estimates of pristine (pre-1980) and current silver eel production (Regulation EU 1100/2007) to allow comparisons to be made between systems and there is few data on the importance of estuarine and coastal populations to overall production. Modelling will be needed to transfer estimates from data rich to data poor systems. Some approaches have been outlined by this Working Group which compliment those presented in previous working groups and in EU SLIME (Dekker *et al.*, 2006).

Implementation of EMPs requires the development of methods to obtain silver eel escapement data. They can include either direct (e.g. mark-recapture) or indirect measures (yellow eel proxies to determine habitat-based silver eel production). Use of direct methods, though preferable in many respects, will be severely restricted by uneven distribution of silver eel fisheries within and between regions, limited fishery monitoring resources and extreme fluctuations in river flows during migratory runs affecting the efficiency of capture methods.

A variety of indirect methods, mostly dependant on yellow eel proxies and modelling, are available for areas where direct measurements of silver eel escapement are not possible and should be extensively used to estimate regional and national silver eel escapement. Selection of models should take account of SLIME conclusions (Dekker *et al.*, 2006) and advice given elsewhere in this report. Validation of indirect methods should be undertaken on an ongoing basis for a network of river systems where reliable direct estimation of silver eel escapement biomass is possible. Direct assessment of silver eel may, however, not inform on the impacting factors that require management, where yellow eel monitoring and assessment would be more informative.

Estimation of effective spawner biomass requires quantification of the adverse effects of contaminants, parasites, diseases, low fat levels, non-lethal turbine damage, along the lines previously proposed for *Anquillicola crassus*, as well as other mortality rates throughout the river basin. Present knowledge does not fully permit quantitative assessment of the effects of these factors on the overall stock.

The European Eel Quality Database (EEQD) has been updated with data on contaminants, parasites and fat levels in eel, allowing the compilation of a comprehensive overview of the contaminant load in eel over its distribution area. Results demonstrate highly variable data within river basin districts, according to local anthropogenic pollution, linked with land use. Persistently elevated contamination levels, above human consumption standards, are seen in many European countries. The most important reported impact is seen on the fat content of the yellow eels (i.e. in Belgium and the Netherlands) which has decreased over the last number years and which raises concern regarding the migratory and reproductory success of silver eels. There is growing evidence that *A. crassus* is spreading further into new areas and new data indicate the presence of the nematode in Canada (not included in the EEQD yet) for the first time.

At present, it is estimated that around 7.5 to 15% of the glass eel catch is used for stocking, either directly or as on-grown eels. Estimates suggest an insufficient supply of glass eel from the total fishery for stocking to full capacity at the European level. Nevertheless, the Regulation 1100/2007 requires that 35%, rising to 60%, of glass eel catches are made available for stocking to enhance the stock. If these percentages were applied to recent annual catches of glass eel, the potential lifetime effect of this increased level of stocking, in the absence of anthropogenic mortalities, could be in the same order of magnitude as current fisheries or eel culture. However, there is a continuing and urgent requirement for robust evidence of the extent to which stocking and transfers on local, national and international scales can increase silver eel escapement and spawner biomass.

The risks remain of disease and parasite transfer via stocked material, both from stocking glass eel and on-grown eels. For example, eels in aquaculture infected with pathogens (viruses, etc.) should not be used for stocking purposes. At least half the countries surveyed (17) do not have formal stocking protocols. These should include procedures to prevent the introduction and spreading of parasites and diseases, and the eel should be included in the European fish disease prevention policies to help minimize the risks.

Sufficiently long time-series of glass eel recruitment, covering several periods of the natural climatic oscillation over the North Atlantic, reflect the same periodicity. However, the causal link between climate and recruitment strength, is unknown, as well as where and when ocean environmental factors operate on the eel. As long as the causal factors of oceanic influence are unknown, it is not safe to assume that the decline is explained by climate alone, especially while we know that the anthropogenic influences during the continental life stage of the eel are large and better understood. The fact that oceanic climate may contribute to recruitment variation is not grounds for abstaining from all possible measures to increase silver eel escapement to boost spawning-stock biomass. More research is needed to compare the relative impact of climatic effects and continental factors on reproductive success. The recent, prolonged strong decline in eel recruitment is out of phase with the dominating climate cycle, the North Atlantic Oscillation.

Forward focus

This report constitutes a further step in an ongoing process of documenting eel stock status and fisheries and developing a methodology for giving scientific advice on management to affect a recovery of the European eel. A European plan for recovery of the stock was adopted in 2007 by the EU Council of Ministers. This plan obliges the Member States to develop Eel Management Plans by the 31st December 2008. This will require further scientific advice, on the national and international level. The implementation of these plans, foreseen in 2009, will improve and extend the information on stock and fisheries. Improved reliability and better spatial coverage, however, will also generate a breakpoint in several currently available time-series; correction procedures need to be considered. In 2012, Member States will report on protective measures implemented in their territories, and their effects on the stock, for which methodology is currently limited. International post-evaluation requires that data, gathered within this framework of national/regional management plans, become available to the Working Group, although gaps have been identified where these data may fall short of that required. Establishment of an international database and the development of international post-evaluation procedures for measuring the impact on the stock will be required.

The Eel Regulation and eel management plans, CITES and the DCR for Eel will likely radically change management of eel and the Working Group is therefore entering into a dynamic period in which it is difficult to be categorical on it's future focus. The future focus of the Working Group might concentrate on:

- the assessment of the trends in recruitment and stock, for international stock assessment, in light of the implementation of the Eel Management Plans;
- the development of methods to post-evaluate effects of management plans at the stock-wide level;
- the development of methods for the assessment of the status of local eel populations, the impact of fisheries and other anthropogenic impacts, and of implemented management measures;
- the establishment of international databases on eel stock, fisheries and other anthropogenic impacts, as well as habitat and eel quality related data, and the review and development of recommendations on inclusion of data quality issues, including the impact of the implementation of the eel recovery plan on time-series data, on stock assessment methods;
- reviewing and developing approaches to quantifying the effects of eel quality on stock dynamics and integrating these in stock assessment methods;
- responding to specific requests in support of the eel stock recovery Regulation, as necessary; and
- reporting on improvements to the scientific basis for advice on the management of European and American eel.

Main recommendations

1) Since recruitment remains at an all time low since records began, the stock continues to decline and stock recovery will be a long-term process for biological reasons, all exploitation and other negative anthropogenic factors impacting on the stock and affecting the production/escapement of silver eels should be reduced to as low as possible, until long-term stock recovery is achieved.

2) Assessment of the current and future status of the European spawning stock, in light of implementation of EMPs, including an assessment of the impact of anthropogenic mortalities and management actions, is urgently needed. This process should include:

   2.1) The aggregation of river basin specific data and assessments, into stock-wide assessments;

   2.2) The further development of models to assess compliance with the recovery target and evaluate management actions;

   2.3) The development of coherent local stock assessment procedures;

   2.4) The development of proxies for mortality rates;

   2.5) The international assessment of recruitment and stock trends to assess the response of the stock to management actions.

3) Eel Management Plans and their accompanying data should be made available to the joint EIFAC/ICES Working Group on Eel at the earliest opportunity to facilitate the assessments of the stock.

A toast to Leuven, by WGEEL

There are many ways to measure eel
Length, weight, number found in creel
But if the numbers were your only policy
Don't forget to test the *quality*.

We tried to do this, here in Belgium
Without drinking to delirium
Writing decision trees on table mats
While beer flowed fast from the taps.

Our SPR curves were made from chips
And designed us surveys for big ships
To re-search the uncertain ocean
For leptocephali in motion.

Now -Instead of moving down the text
We back-track from what should come next
So go back to line nineteen-twenty
For targets set when eels were plenty.

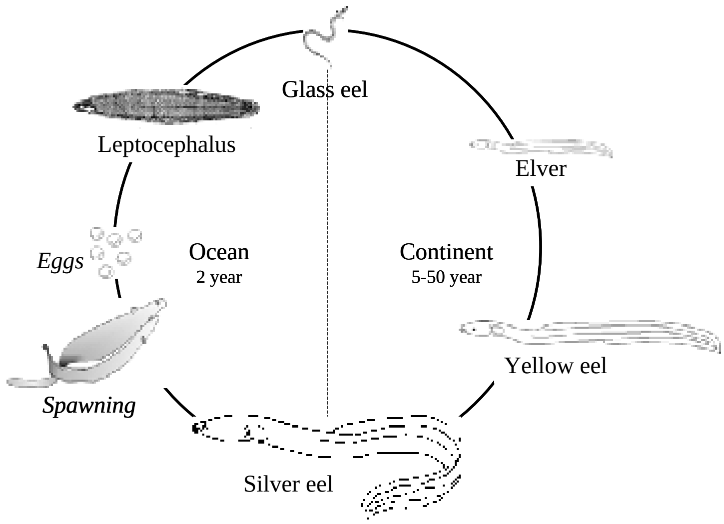
But all this thought is much too hard
For the inebriated bard
So let us re-check the strength of drink
Before our research vessels sink.

Yes, the best beer's rather strong
Best drunk from glasses short, not long
Test them all-find what you like
But don't ride home on a condemned bike.

Or you'll fall on Leuven's cobbled lanes
Tear your *stockings*, or rip your *genes*
So after an evening of perfect libation
Take a taxi home-in *assisted migration*.

Glossary

Eels are quite unlike other fish. Consequently, eel fisheries and eel biology come with a specialised jargon. This section provides a quick introduction for outside readers. It is by no means intended to be exhaustive.



The life cycle of the European eel. The names of the major life stages are indicated. Spawning and eggs have never been observed in the wild.

Glass eel	Young, unpigmented eel, recruiting from the sea into continental waters
Elver	Young eel, in its 1st year following recruitment from the ocean. The elver stage is sometimes considered to exclude the glass eel stage, but not by everyone. Thus, it is a confusing term.
Bootlace, fingerling	Intermediate sized eels, approx. 10–25 cm in length. These terms are most often used in relation to stocking. The exact size of the eels may vary considerably. Thus, it is a confusing term.
Yellow eel (Brown eel)	Life stage resident in continental waters. Often defined as a sedentary phase, but migration within and between rivers, and to and from coastal waters occurs. This phase encompasses the elver and bootlace stages.
Silver eel	Migratory phase following the yellow eel phase. Eel characterized by darkened back, silvery belly with a clearly contrasting black lateral line, enlarged eyes. Downstream migration towards the sea, and subsequently westwards. This phase mainly occurs in the second half of calendar years, though some are observed throughout winter and following spring.

Eel River Basin	"Member States shall identify and define the individual river basins lying within their national territory that constitute natural habitats for the European eel (eel river basins) which may include maritime waters. If appropriate justification is provided, a Member State may designate the whole of its national territory or an existing regional administrative unit as one eel river basin. In defining eel river basins, Member States shall have the maximum possible regard for the administrative arrangements referred to in Article 3 of Directive 2000/60/EC [i.e. River Basin Districts of the Water Framework Directive]."
River Basin District	The area of land and sea, made up of one or more neighbouring river basins together with their associated surface and groundwaters, transitional and coastal waters, which is identified under Article 3(1) of the Water Framework Directive as the main unit for management of river basins. Term used in relation to the EU Water Framework Directive.
Stocking	Stocking is the practice of adding fish [eels] to a waterbody from another source, to supplement existing populations or to create a population where none exists.

Contents

1 Introduction

1.1 The 2008 WGEEL

At the 95th Statutory Meeting of ICES (2007) and the 25th meeting of EIFAC (2008) it was decided that:

2007/2/ACOM15 The **Joint EIFAC/ICES Working Group on Eels** [WGEEL] (Chair: Russell Poole, Ireland), will meet in Leuven (INBO/KUL), Belgium, 3–9 September 2008, to:

(i) assess the trends in recruitment, stock and fisheries indicative of the status of the European stock, and of the impact of exploitation and other anthropogenic factors; analyse the impact of the implementation of the eel recovery plan on time-series data (i.e. data discontinuities). This might also include the establishment of an international database for data on eel stock and fisheries, as well as habitat and eel quality (update EEQD) related data; review and make recommendations on data quality issues;

(ii) develop methodologies for the assessment of the status of the eel stock, the impact of fisheries and other anthropogenic impacts and of implemented management measures; this might include, for example, support for EMPs on the determination of "pristine" spawner production levels and relative contribution of stocking;

(iii) review hypotheses and information on the possible relationships between the European (and American?) eel stock(s), recruitment patterns and climatic and oceanic factors;

(iv) respond to specific requests in support of the development and implementation of the stock recovery Regulation as necessary;

(v) report on progress in work on improvements in the scientific basis for advice on management of European eel fisheries.

WGEEL will report by 16 September 2008 for the attention of ACOM and DFC.

41 people attended the meeting, from seventeen countries (see Annex 1).

The current Terms of Reference and Report constitute a further step in an ongoing process of documenting the status of the European eel stock and fisheries and compiling management advice. As such, the current Report does not present a comprehensive overview, but should be read in conjunction with previous reports (ICES, 2000; 2002; 2003; 2004, 2005a, 2006, 2007).

In addition to documenting the status of the stock and fisheries and compiling management advice, in previous years the Working Group also provided scientific advice in support of the establishment of a recovery plan for the stock of European Eel by the EU. In 2007, the EU published the Regulation establishing measures for the recovery of the eel stock (EC 1100/2007). This introduced new challenges for the Working Group, requiring development of new methodologies for local and regional stock assessments and evaluation of the status of the stock at the international level. Implementation of the Eel Management Plans will likely introduce discontinuities to data trends and may require a shift from fisheries-based to scientific survey-based assessments.

The structure of this report does not strictly follow the order of the Terms of Reference for the meeting, since different aspects of subjects were covered under different headings, and a rearrangement of the Sections by subject was considered preferable. The meeting was organized using the Agenda in Annex 2. Five subgroups, under the headings of "Data and International Stock Assessment", "Methods and Methodologies", "Stocking", "Eel Quality" and "Oceans and Climate" addressed the Terms of Reference.

Chapter 2 presents trends in recruitment, stock, fisheries and aquaculture (ToR a).

Chapter 3 introduces the concept of post-evaluation and stock assessment at the international level, discusses data sources and gaps and presents a decision structure for stock assessment. (ToR a, b and e).

Chapter 4 discusses methods for the estimation of pristine and current escapement, (ToR a and e).

Chapter 5 reviews the data for stocking and aquaculture and updates previous advice on best practice for stocking (ToR a and b).

Chapter 6 updates the European Eel Quality Database (EEQD) and discusses the importance of the inclusion of spawner quality parameters in stock management advice (ToR a).

Chapter 7 reviews the hypotheses and information on possible relationships between recruitment, and climatic and ocean factors (ToR c.).

Terms of Reference a. (revision of catch statistics) is the follow-up of the analysis made in the report of the 2004 meeting of the Working Group (ICES 2005, specifically Annex 2). Following that meeting, a Workshop was held under the umbrella of the European Data Collection Regulation (DCR), in September 2005, Sånga Säby (Stockholm, Sweden). The Workshop report presented catch statistics in greater detail than had been handled by this Working Group before. Additionally, a further improvement of the catch statistics is foreseen, when the DCR is actually implemented for the eel fisheries across Europe.

It is envisaged that additional data and improved data will become available under the Eel and Data Collection Regulations.

2 Trends in recruitment, stocking, yield and aquaculture

2.1 Data

This Section collects the time-series datasets for the analysis of the status of the European eel population through the trends in recruitment, commercial landings, non-commercial and recreational catches stocking and aquaculture production of eel.

2.1.1 Recruitment

Information on recruitment is provided by a number of datasets, relative to various stages (glass eel and elver, yellow eel) recruiting to continental habitats (Dekker, 2002). Data of recruiting glass eels and elvers (young of the year) and yellow eels from 28 rivers in 11 countries are updated to the last season available (2007 and in some cases 2008) and provide the information necessary to examine the trends in recruitment. These data were derived from fishery-dependent sources (i.e. catch records) and fishery-independent surveys across much of the geographic range of European eel, and cover varying time intervals. Some of them date back as far as 1920 (glass eel, Loire France) and even the beginning of 20th century (yellow eel, Göta Älv Sweden). All of them, however, date back as far as 1970. The recruitment time-series data in European rivers are presented in Annex 3 (Tables 1 and 2).

Declining trends were evident over the last two decades for all time-series. After the high levels of the late 1970s, there was a rapid decrease that still continues to the present time. The trend is similar in recruitment dataseries for glass eels in estuarine areas (Figure 2.1) and in time-series for yellow eel colonization, monitored in northern countries where transition to yellow eel stage occurs before entering fresh waters (Figure 2.2).

Latest data for 2007 and 2008 demonstrates that recruitment continues to be at a very low level in most catchments. Although some series demonstrated a slight increase, most series remained at similar or lower levels to the previous season for both eel developmental stages.

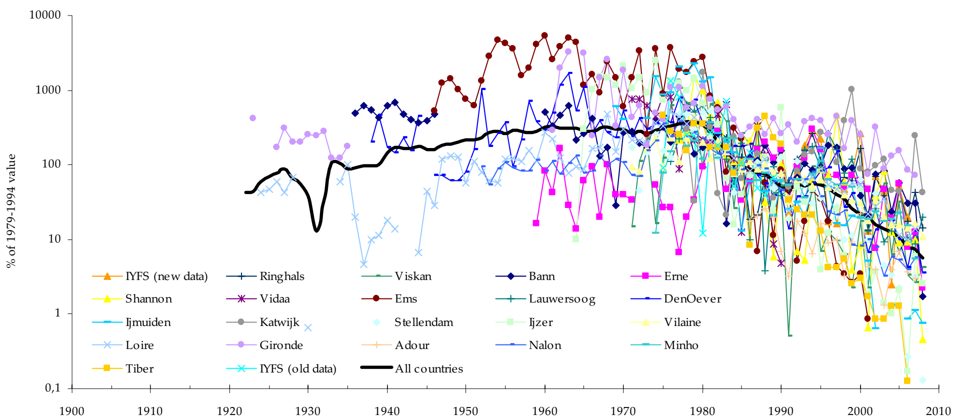


Figure 2.1: Time-series of monitoring glass eel recruitment in European rivers. Each series has been scaled to its 1979–1994 average. Note the logarithmic scale on the y-axis.

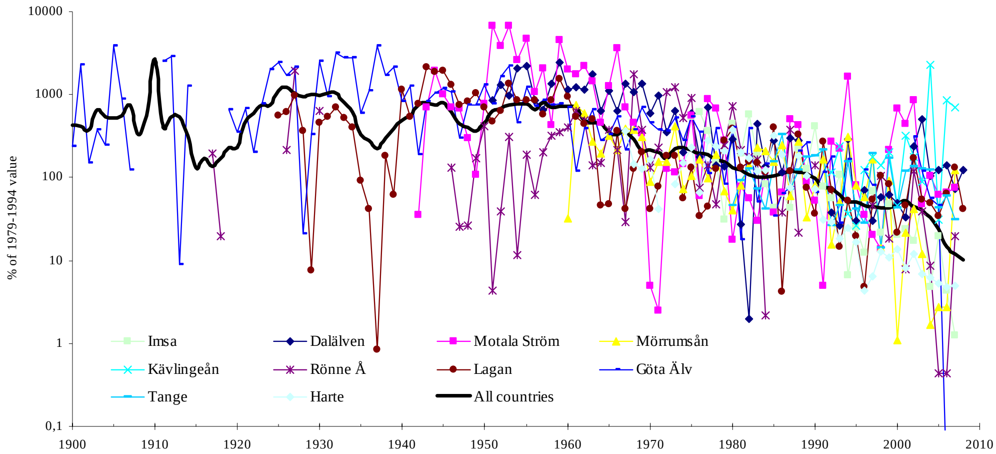


Figure 2.2: Time-series of monitoring yellow eel recruitment in European rivers. Each series has been scaled to the 1979–1994 average. Note the logarithmic scale on the y-axis.

2.1.2 Data on landings

Data on yellow/silver eel landings obtained from country reports 2008 are presented in Annex 3 (Table 3) and in Figure 2.3. Data on official eel landings from FAO sources are presented in Annex 3 (Table 4) and in Figure 2.4. Those two datasets do not include aquaculture production. To compare the two datasets the mean values for corresponding periods were compared (Figure 2.5).

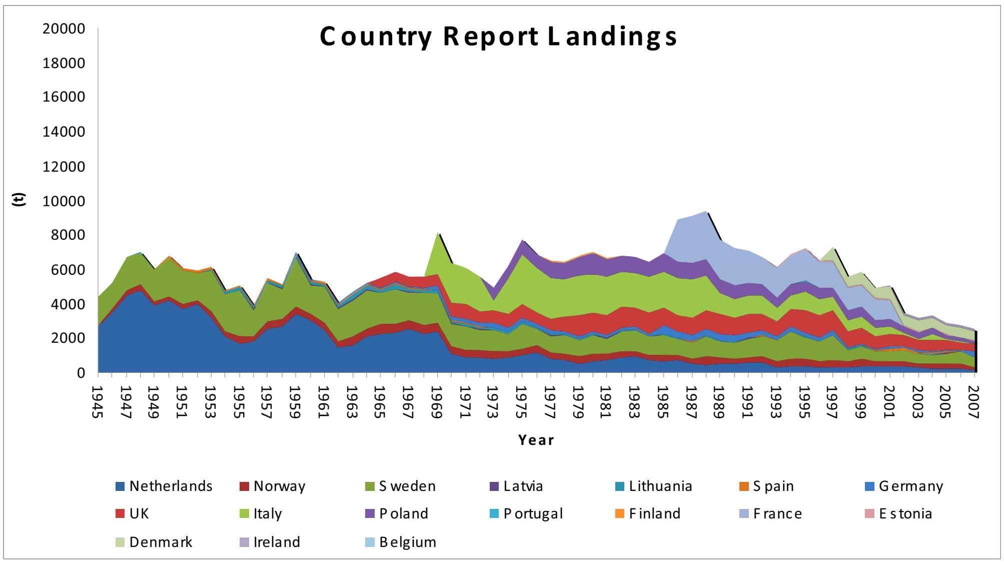


Figure 2.3: Landings of European eel in Europe (tonnes). Source: Country Reports 2008.

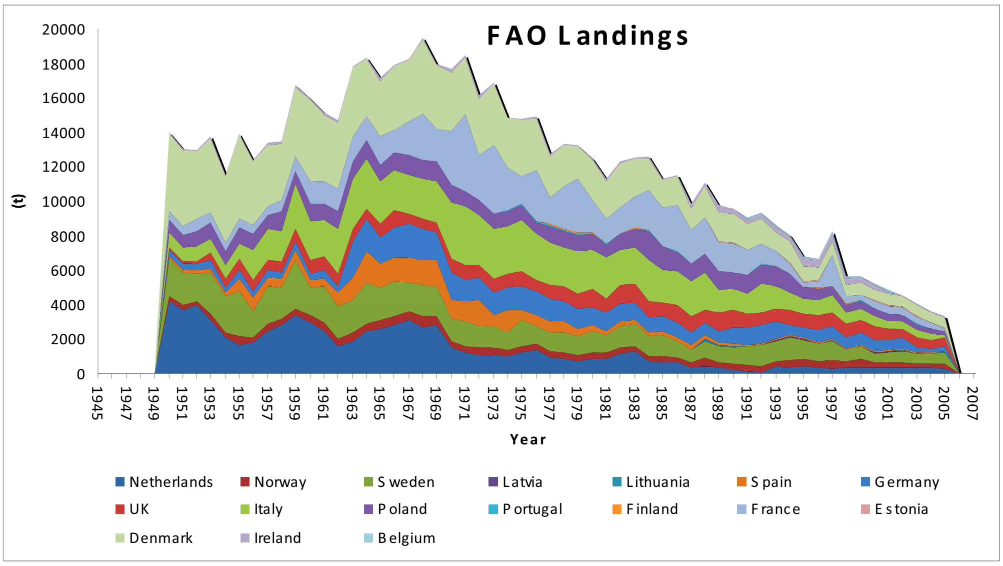


Figure 2.4: European eel landings in Europe (tons). Source: FAO.

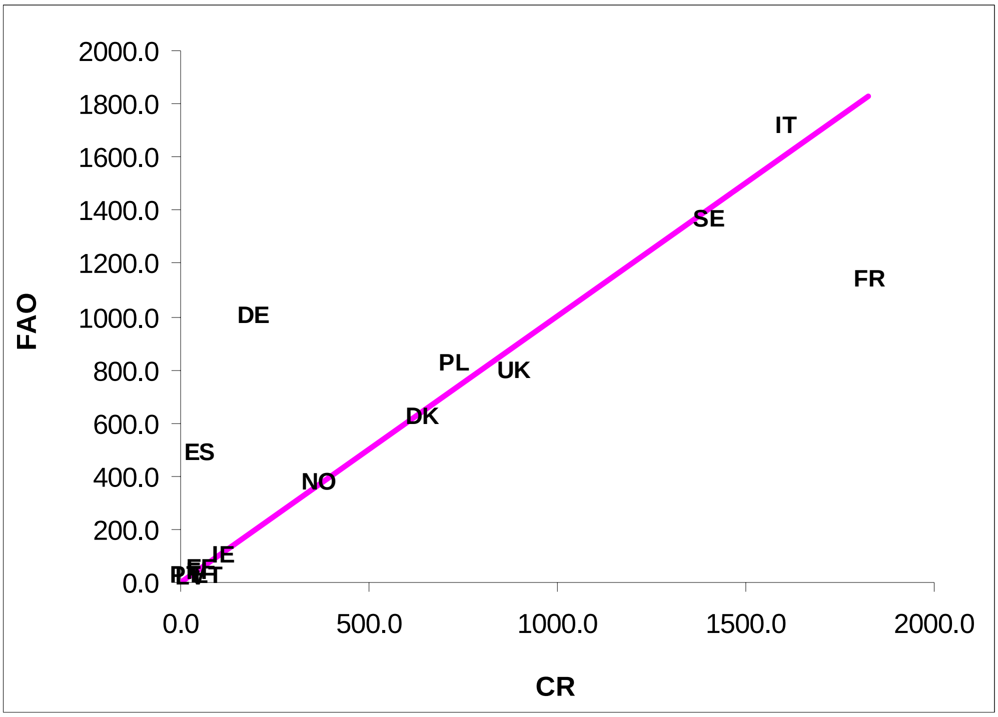


Figure 2.5: Differences in data on European eel landings in Europe obtained from FAO and similar data presented in country reports.

2.1.2.1 Data discontinuities

Both the data officially reported to FAO and the best estimates presented in the Country Reports suffered from reporting discontinuities in the past. Implementation of the EU Eel Regulation will require Member States to implement a full catch registration system. This will lead to considerable improvement of the coverage of the fishery, i.e. underreporting will probably reduce markedly. Dekker, 2003 analysed the trend in historical catch records, correcting for historical discontinuities on the basis of a series of increasingly complex statistical models. Since the discontinuity caused by the implementation of the EU Eel Regulation will affect all dataseries in the same year, statistical analyses will not be able to cope with this. Consequently, the discontinuity will have to be taken for granted.

However, future assessment of the status and trends in the stock, the anthropogenic impacts and the effect of recovery and restoration measures will heavily depend upon new data, which will be collected from the implementation of the Regulation onwards (see also Chapter 3). It seems not that likely, that before/after-comparisons will be achievable. Consequently, the discontinuity in landings data might be of relative minor importance. Direct stock estimates, such as scientific stock surveys, will not suffer from discontinuities, and these might therefore be used to mend the gap. It is therefore of utmost importance, that existing monitoring series will be continued, and additional series be implemented long before the first post-evaluation in 2012.

2.1.3 Recreational and non-commercial fisheries

Non-commercial (i.e. non-commercial usage of fishing gear except angling, which is classed as recreational fishing) catch data of glass eel were made available by France and Spain (Basque Country). For the Gironde Basin in France, non-commercial catches 1978–1982 exceeded commercial landings of glass eel (given in Table 2.1), but thereafter the dominance changed to commercial landings. Non-commercial fishery catches of glass eel have decreased over the time-series available.

Table 2.1: Non-commercial glass eel catches (t) for 1978–2007. FR Total applies to total catch of non-commercial fisheries in France.

GLASS EEL					
Year	FR Adour	FR Gironde	FR Loire	FR Total	ES Basque country
1978		107.8		647	
1979		116.2		697	
1980		217.1		1303	
1981		150.6		904	
1982		36.5		219	
1983		26.9		161	
1984		26.0		156	
1985		11.8		71	
1986		14.4		87	
1987		28.6		172	
1988		6.7		40	
1989		17.3		110	
1990		9.0		54	
1991		14.5		87	
1992		12.8		77	
1993		21.7		130	
1994	18	12.4		74	
1995	10	18.9		113	
1996	12	4.2		25	
1997	6	6.4		39	
1998	7	1.0		6	
1999	2	2.7	1	6	
2000		0.3	1	2	

GLASS EEL			
2001	0.1	1	
2002	6.2	37	
2003	0.1		0.9
2004	0.1		1.2
2005	0.5	2	1.3
2006			0.7
2007	0.1		

There is a lack of data on eel catches by non-commercial fisheries. Where estimates are available for some countries or regions it appears that commercial catches are generally dominating non-commercial catches but latter may comprise up to one third of total yields (Figure 2.6). Therefore, recreational yields and other non-commercial catches are a very important source of mortality in fresh-water eel stocks and reliable estimates are urgently needed.

Estimates of yellow eel catches of anglers were available only for four countries/rivers (Table 2.2). National angling catches of yellow eels of between 86 and 3300t have been reported and can comprise a relatively important part of the total yield.

Table 2.2: Yellow eel landings (t) of anglers from River Elbe, Germany (DE), Netherlands (NL), France (FR) and Poland (PL).

YELLOW EEL (ANGLING)				
Year	DE Elbe	NL	FR	PL
1970				3300
1971				
1972				
1973				
1974				
1975				
1976				
1977				
1978				
1979				
1980				
1981				
1982				
1983				
1984				
1985	114.5			
1986	116.9			
1987	117.5			
1988	118.4			
1989	112.2			
1990	104.6			
1991	92.1			
1992	83.7			
1993	88.0			

YELLOW EEL (ANGLING)				
1994	86.5			
1995	87.8			
1996	89.9			
1997	91.1			
1998	106.0			
1999	108.3			
2000	103.8			
2001	111.2			
2002	112.2			
2003	113.6			
2004	107.5			
2005	105.1		508.655	
2006	104.1			
2007	111.2	200		100

Data for non-commercial catches on yellow eel are given in Table 2.3. In contrast to Norway, where catches have been remaining in the same order of magnitude since 1989, they collapsed in the Gironde Basin.

Table 2.3: Yellow eel landings (t) of non-commercial fisheries other than angling from Norway (NO) Denmark (DK), Netherlands (NL) and France, Gironde Basin (FR).

YELLOW EEL (NON-COMMERCIAL)				
Year	NO	DK	NL	FR Gironde
1978				204.1
1979				229.5
1980				155.7
1981				148.8
1982				133.1
1983				76.2
1984				164.1
1985				170.3
1986				160.5
1987				134.3
1988				97.7
1989	124.9			40.2
1990	133.9			28.3
1991	130.6			15.8
1992	143.0			27.7
1993	116.3			21.4
1994	180.5			21.1
1995	297.6			18.4
1996	178.2			7.7
1997	242.3			9.7
1998	171.9			7.3
1999	187.4			1.5
2000	108.6			1.4

YELLOW EEL (NON-COMMERCIAL)				
2001	127.9			0.6
2002	138.5			1.1
2003	107.2			0.5
2004	97.3	138.1		1.3
2005	106.0			0.6
2006				1.3
2007			25.0	1.3

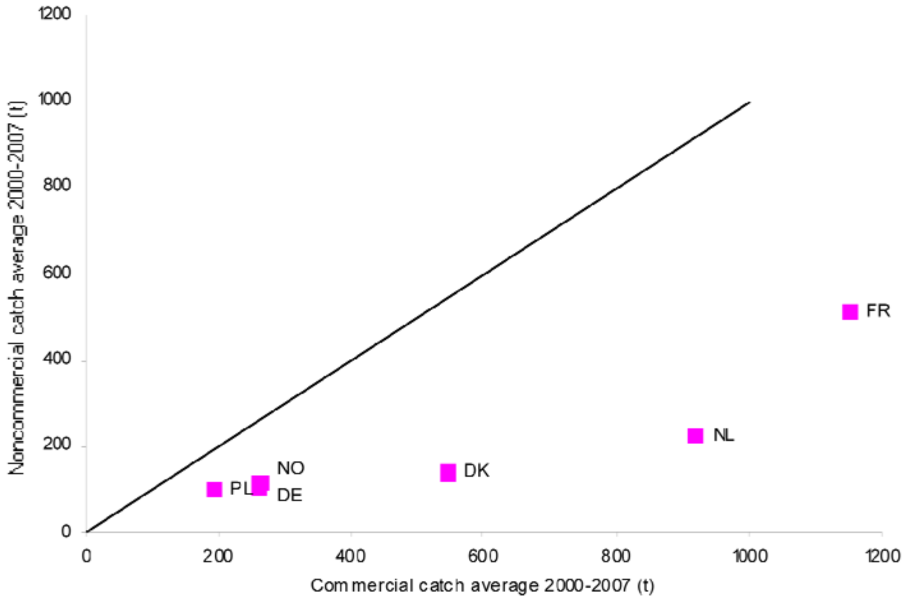


Figure 2.6: Non-commercial catches (Sum of angling and other fishing gear) against commercial catches as an average in 2000–2007. Note that there are inconsistencies in the data quality for commercial vs. non-commercial catches.

2.1.4 Trends in stocking

Data on stocking were obtained from a number of countries, separated for glass eels and for young yellow eels. The size of 'young yellow eel' varies between countries. Most data available were on a weight base. Weights were converted to numbers, using estimates of average individual weights of the eels at the size stocked. These were 3.5 g for Denmark, 10 g for Poland, 33 g for the Netherlands, 20 g for (eastern) Germany, 30–60 g for Elbe RBD (up to 2005, after which actual counts are available), and 90 g for Sweden. An overall number of 3000 glass eels per kg was applied to data from Belgium and Northern Ireland. An overview of data available up to 2008 is compiled in Annex 3 (Tables 5 and 6). Stocking in other EU countries, for which there are no time-series data, and hence are not included in Tables 5 and 6, are also summarized in Annex 3.

In the 2007 report of the WGEEL a sharp drop in glass eel stocking series around 1969 was mainly explained with the fact that Polish stocking figures ceased to be recorded. However, now the old Polish data have been included, but the graph still demonstrates a remarkable drop in glass eel stocking at that time. Obviously, there must have been other causes for the observed decrease.

Stocking with glass eel has decreased strongly since the early 1990s and appears now to be on a very low level with a still decreasing trend (Figure 2.7). However, this has partly been compensated for by an increasing number of young yellow eels stocked since the late 1980s. During the 1990s stocking of young eel demonstrated an increase but dropped again in the late 1990s (Figure 2.8). During the last years, a slight increase could be observed again. If several countries use stocking as a management option in their EMP's, an increasing tendency in stocking numbers may be expected, if sufficient glass eels are available on the market.

Figures 2.9 and 2.10 give a country by country breakdown of glass eel and young yellow eel numbers stocked respectively. Poland, Germany and the Netherlands stocked the largest numbers of glass eel and Germany, Denmark and the Netherlands stocked the largest numbers of young yellow eel.

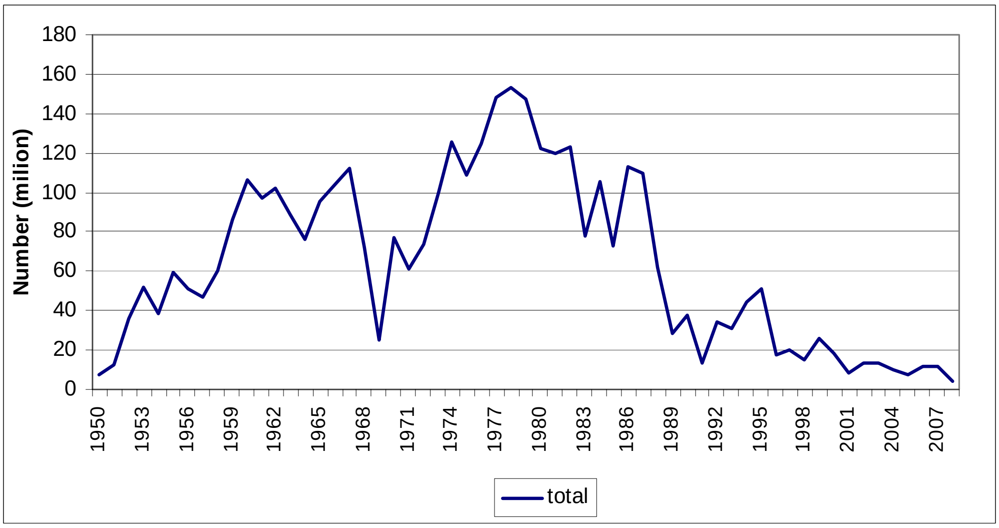


Figure 2.7: Stocking of glass eel and young yellow eel in Europe (East Germany and Elbe RBD, Lithuania, Netherlands, Denmark, Poland, Sweden, Northern Ireland, Belgium, Finland, Estonia and Latvia), in millions re-stocked.

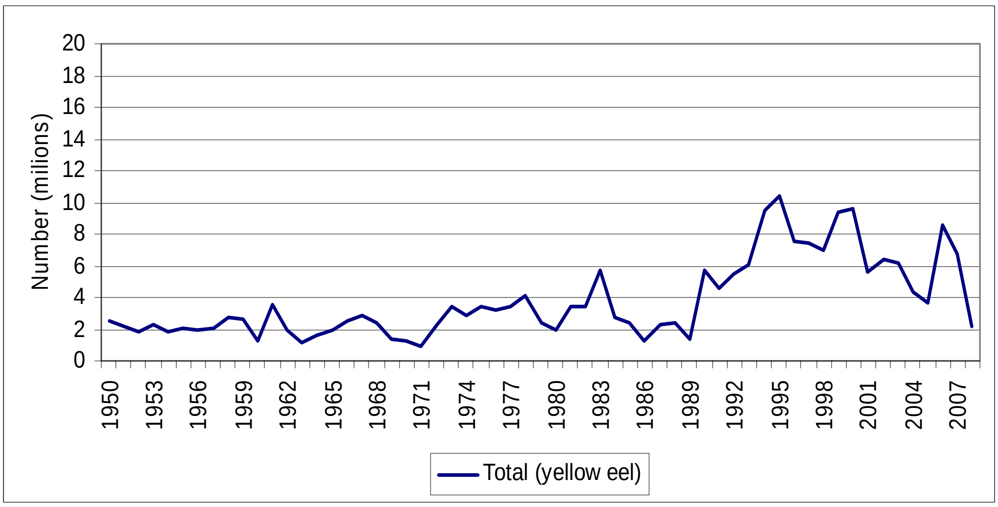


Figure 2.8: Stocking of young yellow eel in Europe (East Germany and Elbe RBD, Lithuania, Netherlands, Denmark, Poland, Sweden, Belgium, Finland, Estonia and Latvia), in millions stocked.

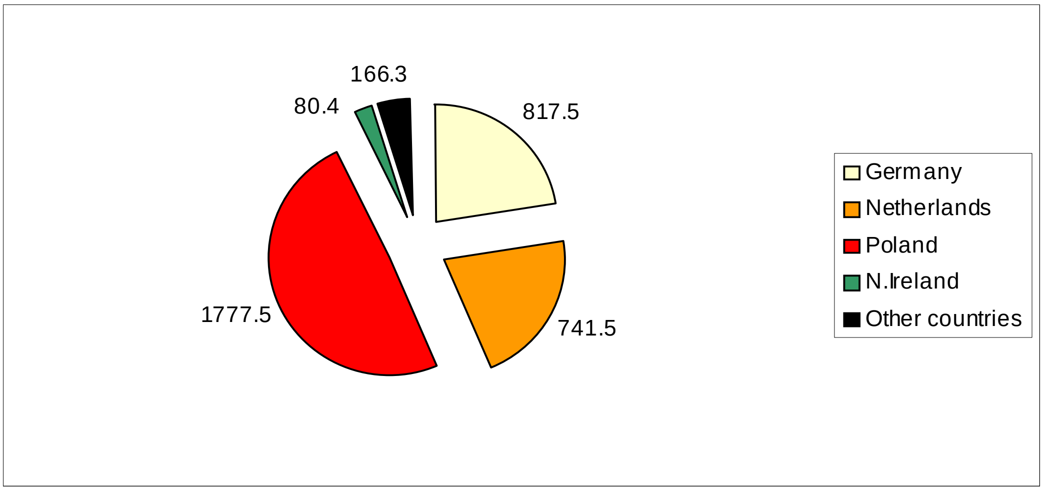


Figure 2.9: Total numbers of stocked glass eels in Europe (former East Germany and Elbe RBD, Netherlands, N. Ireland, Poland and other countries) cumulated for all reported years, in millions stocked.

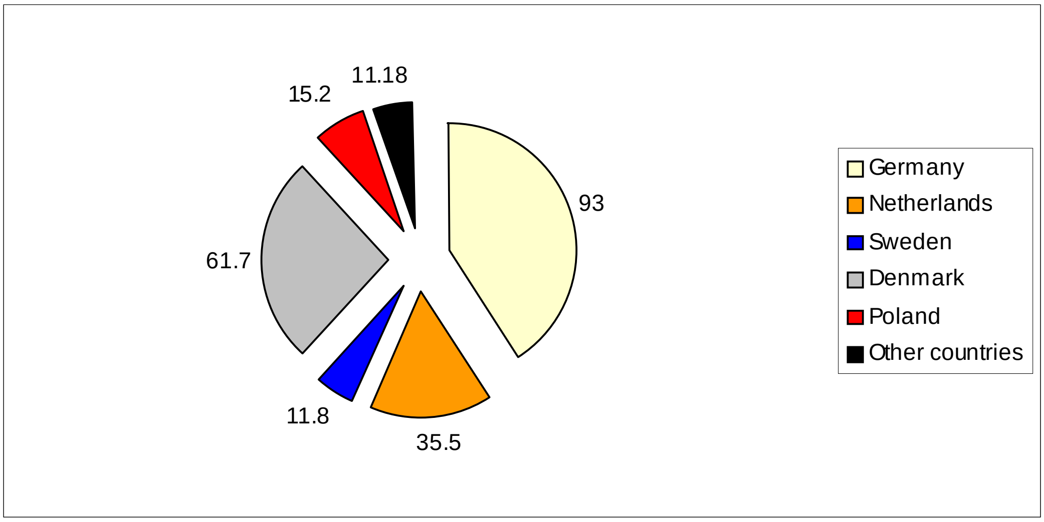


Figure 2.10: Total numbers of stocked young yellow eels in Europe (former East Germany and Elbe RBD, Netherlands, Sweden, Denmark, Poland and other countries) cumulated for all years reported, in millions stocked.

2.1.5 Aquaculture

Aquaculture production data for European eel limited to European countries from 1996 to 2007 are compiled by integrating different sources, FAO (Table 2.4), FEAP (Table 2.5), and Country Reports to WGEEL 2008 (Table 2.6). Some discrepancies still exist between databases and the national reports annexed to this report. These differences are, in some cases, caused by different purposes of using aquaculture production. For example, the total aquaculture production of eel in Germany in 2007 was 740 tons, where 300 tons was used for stocking and 440 tons for human consumption. The peak of production in Europe was reached in 2000 (11 000 tons), although most recently it seems to be fluctuating around 8000–9000 t. Fifty-nine eel farms were estimated to exist in 2006, twenty-nine of which were in the Netherlands, nine in Denmark and the rest scattered in other countries.

Table 2.4. Aquaculture production of European eel in Europe. from 1996 to 2006, in tonnes. ***Source: FAO.***

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Belgium	125	125	125	100	100	100					
Czech	4	3	3	1	1	1	1	1	<0.5	1	1
Denmark	1400	1689	2468	2717	2674	2100	1166	2012	1883	1673	1739
Estonia							5	15	7	40	40
France	160	160	42	42	42	42					
Germany					150	150	150	150	322	329	567
Greece	584	545	681	518	602	639	433	544	557	372	385
Hungary						73	36	11	11	6	
Ireland			20	25	1						
Italy	3000	3100	3150	3200	2700	2500	1699	1550	1220	1132	807
Malta	<0.5										
Netherlands	2800	2443	2634	3228	3700	4000	3868	4200	4500	4000	4200
Portugal	5	4	6	2	4	7	4	5	2	1	1
Romania			1								
Serbia	2	2	3	7	5	7	4	6	9	9	
Spain	249	335	347	383	411	339	424	339	424	427	403
Sweden	161	189	204	222	273	200	167	170	158	222	191
Total	8491	8595	9684	10445	10663	10158	7957	9003	9094	8212	8334

Table 2.5. Aquaculture production of European eel in Europe from 1996 to 2007, in tonnes. Source: Aquamedia (FEAP).

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Belgium	150	150	150	40								
Denmark	1200	1700	2468	2700	2675	2100	2300	2050	1500	1700	1900	2100
Estonia					5	5	13		24	17	23	30
France	160											
Germany	140	150	150		150	150		350	350	350	350	400
Greece	350	312	500	500	300	550	500	500	500	500	450	450
Hungary				19	13	104	48					
Italy	3000	3100	3100	3100	2900	2400	1400	1400	1200	1200	1000	1000
Lithuania			2	2	1	5	17	20	9	8	14	40
Netherlands	1800	1800	3250	3800	4000	4000	4000	4200	4500	4400	3800	4200
Norway	200	200	200									
Portugal	200	200	200	200	200	200						50
Spain	210	266	270	300	425	330	355	325	350	400	400	450
Sweden	184	215	250	250	250	230	230	230	230	230	230	230
Turkey		200	200	200	200							
Croatia											25	50
Total	7594	8293	10740	11109	11111	10074	8863	9075	8663	8805	8192	9000

Table 2.6. Aquaculture production of European eel in Europe from 1996 to 2007, in tonnes: Country reports (CR 2007 and 2008).

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Denmark	1568	1913	2483	2718	2674	2000	1880	2050	1500	1700	1900	2100
Estonia					5	7	15	18	26	19	27	52
Germany	204	221	260	400	422	347	381	372	328	329	567	740
Netherlands	2800	2450	3250	3500	3800	4000	4000	4200	4500	4500	4200	4000
Portugal	21		13	3	4	7	4		2	1		1
Sweden	161	189	204	222	273	200	167	170	158	222	191	175
Total	4754	4773	6210	6843	7178	6561	6447	6810	6514	6771	6885	7068

2.2 Analysis of trends in recruitment

The trends in recruitment data available were analysed in relation to life stage, type of monitoring and geographical area. The objective of this analysis is to derive a reliable index of recruitment, both for the assessment of the stock-to-recruit phase, as for the management and assessment of the recruit-to-stock phase. The available dataseries were qualified regarding:

- life stage (unpigmented glass eel; pigmented young-of-the-year; immigrating yellow eel older than 1 year);
- sampling type (trapping all incoming recruits in a river, trapping the recruits only partially, commercial total landing figures, commercial cpue, scientific survey estimates);
- geographical area (Baltic Sea including Kattegat and Skagerrak, North Sea, Channel, British Isle, Atlantic Ocean, Mediterranean Sea). No datasets are available at the moment for the Channel area.

Considering the small number of datasets, the dataseries for glass eel and for young-of-the-year were merged, and analysed together. Given the spatial distribution of different sampling techniques in Europe (commercial fisheries in the South, trapping mostly in the north), the effect of sampling type and of area can not be analysed concurrently; for young yellow eel older than 1 year only trapping dataseries exist. Consequently three analyses were feasible:

- area effect on glass eel and young-of-the-year (combined);
- sampling type effect on glass eel and young-of-the-year (combined);
- area effect on young yellow eel older than 1 year.

The analyses used generalized linear models (GLMs) with a site effect as a scaling parameter, a log link (site effect and other effects are assumed to be multiplicative) and a gamma error (variance is varying with the square of the mean, i.e. a constant coefficient of variation). The resulting time-trends are scaled to the 1970–1979 geometric mean. Figure 11 and Table 2.7 gives the main characteristics of the 40 datasets used.

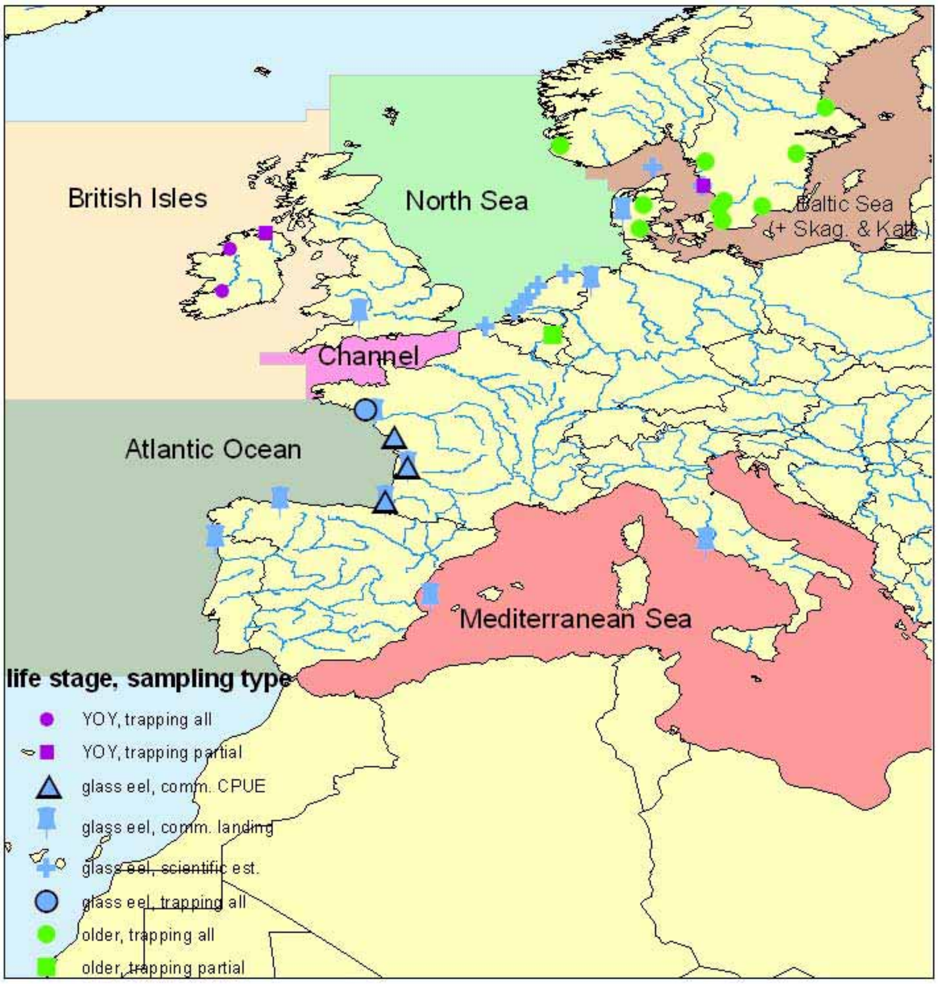


Figure 2.11: Map of the recruitment monitoring sites across Europe. Life stage and sampling method are indicated by the symbols.

Table 2.7: Data sets used for recruitment analysis. YOY = Young-of-the-year.

LIFE STAGE	AREA	MONITORING TYPE	COUNTRY	RIVER	LOCATION	LATITUDE	LONGITUDE
glass eel	North sea	scientific est.	Belgium	Ijzer	Nieuwpoort	51.08	2.45
glass eel	North sea	comm. landing	Denmark	Vidaa	Højer sluice	55.58	8.4
glass eel	North sea	comm. landing	Germany	Ems	Herbrum	53.02	7.2
glass eel	North sea	scientific est.	Netherlands		Lauwersoog	53.25	6.12
glass eel	North sea	scientific est.	Netherlands	Rhine	IJmuiden	52.27	4.36
glass eel	North sea	scientific est.	Netherlands	Oude RIjn	Katwijk	52.12	4.24
glass eel	North sea	scientific est.	Netherlands	Haringvliet	Stellendam	51.50	4.02
glass eel	North sea	scientific est.	Netherlands	Rhine	DenOever	52.56	5.03
glass eel	North sea	scientific est.	Sweden		IYFS	58	10
glass eel	North sea	scientific est.	Sweden		IYFS2	58	10
glass eel	North sea	scientific est.	Sweden	Kattegat-	Ringhals	57.15	12.07
glass eel	British Isle	comm. landing	UK	Severn	EA	51.36	-2.42
glass eel	British Isle	comm. landing	UK	Severn	HMRC	51.36	-2.42
glass eel	Atlantic Ocean	comm. cpue	France	Sèvres	Estuary	46.18	-1.08

LIFE STAGE	AREA	MONITORING TYPE	COUNTRY	RIVER	LOCATION	LATITUDE	LONGITUDE
glass eel	Atlantic Ocean	comm. landing	France	Adour	Estuary	43.32	-1.32
glass eel	Atlantic Ocean	comm. cpue	France	Adour	Estuary	43.32	-1.32
glass eel	Atlantic Ocean	comm. cpue	France	Gironde	Estuary	45.02	-0.36
glass eel	Atlantic Ocean	comm. landing	France	Gironde	Estuary	45.02	-0.36
glass eel	Atlantic Ocean	comm. landing	France	Loire	Estuary	47.18	-2.00
glass eel	Atlantic Ocean	trapping all	France	Vilaine	Arzal	47.3	-2.24
glass eel	Atlantic Ocean	comm. landing	Portugal	Minho	portugese	41.52	-8.51
glass eel	Atlantic Ocean	comm. landing	Spain	Minho	spanish part	41.52	-8.51
glass eel	Atlantic Ocean	comm. landing	Spain	Nalon	Estuary	43.31	-6.04
glass eel	Mediterannean	comm. landing	Italy	Tiber	Fiumara	41.44	12.14
glass eel	Mediterannean	comm. landing	Spain		Albufera de	39.20	0.23
YOY	Baltic Sea	trapping	Sweden	Viskan	Sluices	57.12	12.07
YOY	British Isle	trapping all	Ireland	Shannon	Ardnacrusha	52.42	-8.36
YOY	British Isle	trapping all	Ireland	Erne	Ballyshannon	54.3	-8.15
YOY	British Isle	trapping	Northern	Bann	Coleraine	55.12	-6.42
older	Baltic Sea	trapping all	Sweden	Dalälven		60.34	17.26
older	Baltic Sea	trapping all	Sweden	Mörrumsån		56.20	14.40
older	Baltic Sea	trapping all	Sweden	Lagan		56.31	13.03
older	Baltic Sea	trapping all	Sweden	Motala		58.35	16.11
older	Baltic Sea	trapping all	Sweden	Göta Älv		58.16	12.16
older	Baltic Sea	trapping all	Sweden	Kävlingeån		55.43	12.59
older	Baltic Sea	trapping all	Sweden	Rönne Å		56.16	12.50
older	North sea	trapping	Belgium	Meuse	Lixhe dam	50.45	5.40
older	North sea	trapping all	Denmark	Guden Å	Tange	56.21	9.36
older	North sea	trapping all	Denmark	Harte		55.21	9.25
older	North sea	trapping all	Norway	Imsa	Sandnes	58.54	5.59

2.2.1 Area effect on glass eel and young of the year recruitment

The model explains 72% of deviance (Table 2.8) and all effects were highly significant ($p<0.001$). Table 2.9 and Figure 2.12 give results from this model, i.e. a recruitment index per year by area. Every area demonstrates a declining trend since the end of 1970s or the beginning of 1980s. Before, no particular trend is detected. In recent years, recruitment is continuously declining in all areas. The mean recruitment for the past 5 years (2004–2008) is 10%, 9%, 3%, 3% and 1% of the 1970s reference level, for the British Isles, Atlantic Ocean, Baltic Sea, Mediterranean Sea and North Sea respectively. Apparently, the decline is stronger in northernmost and southernmost area of the species distribution than in the central part. A unique and uniform recruitment index all over the distribution area would require weighing the specific contributions by area, which is not achievable at the moment. More importantly, however, such an index would incorrectly represent the actual trend in each area.

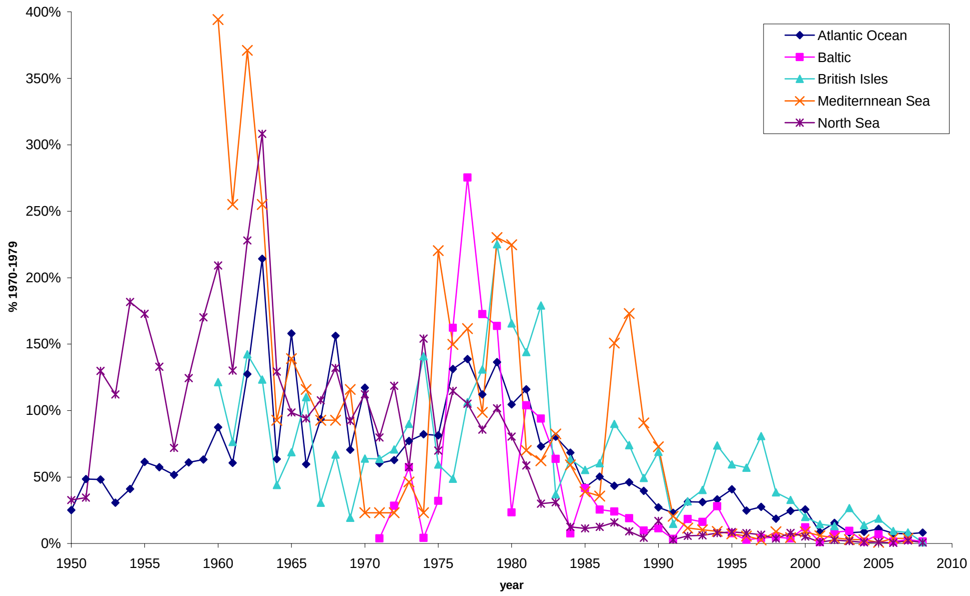
Table 2.8: Analysis of deviance of the area effect on glass eel and young of the year GLM.

MODEL	RESIDUAL DF	RESIDUAL DEVIANCE
NULL	1051	1763.27
Site effect	1023	1545.73
Year x area effect	776	501.83

Table 2.9: Recruitment index per area. Each series have been scaled to 1970–1979 average = 100%.

YEAR	BALTIC SEA	NORTH SEA	BRITISH ISLES	ATLANTIC OCEAN	MEDITERRANEAN SEA
1950		32.7		25.2	
1951		34.6		48.6	
1952		129.9		48.2	
1953		112.2		30.8	
1954		181.8		41.1	
1955		172.8		61.4	
1956		133.0		57.5	
1957		71.9		51.7	
1958		124.5		61.1	
1959		170.2		63.2	
1960		209.2	121.4	87.5	394.2
1961		130.2	76.5	60.7	255.1
1962		228.0	142.4	127.4	371.0
1963		308.2	123.3	214.2	255.1
1964		129.4	44.1	63.5	92.8
1965		98.7	68.7	158.0	139.1
1966		94.2	110.2	59.7	115.9
1967		107.8	30.8	93.6	92.8
1968		132.2	66.9	156.3	92.8
1969		92.2	19.4	70.6	115.9
1970		112.4	63.9	117.2	23.2
1971	3.9	79.8	63.6	60.4	23.2
1972	28.5	118.7	70.9	62.8	23.2
1973	57.3	57.5	90.0	77.2	46.4
1974	4.2	154.1	140.9	82.2	23.2
1975	32.1	69.9	59.4	81.3	220.4
1976	162.3	114.8	48.7	131.4	149.8
1977	275.4	105.1	106.4	138.8	161.7
1978	172.6	85.8	131.0	112.2	98.7
1979	163.7	101.8	225.2	136.5	230.3
1980	23.5	80.4	165.6	104.7	224.8
1981	104.1	58.7	144.0	116.1	70.0
1982	94.0	30.0	179.1	73.1	62.3
1983	63.6	31.1	37.0	80.4	82.5
1984	7.7	12.5	63.5	68.5	59.2
1985	41.8	11.5	55.3	42.3	38.9
1986	25.6	12.6	60.4	50.4	35.7
1987	24.1	15.9	90.0	43.5	150.8
1988	19.1	9.2	74.0	46.1	173.1
1989	9.8	4.4	49.4	39.6	90.7
1990	11.4	17.1	69.0	27.2	72.8
1991	3.5	2.9	14.8	23.2	20.6
1992	18.4	5.8	31.8	31.5	11.7

YEAR	BALTIC SEA	NORTH SEA	BRITISH ISLES	ATLANTIC OCEAN	MEDITERRANEAN SEA
1993	16.3	6.2	40.4	31.3	10.4
1994	28.0	7.9	73.8	33.2	9.2
1995	7.7	8.7	59.5	40.9	7.3
1996	2.7	7.9	57.1	24.8	5.6
1997	4.1	6.6	80.8	27.6	2.7
1998	4.9	3.7	38.5	18.7	8.9
1999	3.9	8.0	32.8	24.5	4.6
2000	12.2	5.3	20.1	25.7	8.8
2001	1.1	1.0	14.5	8.7	5.9
2002	8.5	2.7	13.1	15.6	4.4
2003	9.6	1.9	26.7	8.2	3.0
2004	1.6	0.9	13.7	8.8	2.8
2005	6.9	1.1	18.9	11.2	0.8
2006	1.5	0.5	9.4	7.8	3.8
2007	2.9	2.3	8.4	7.2	3.8
2008	1.7	0.8	1.0	8.2	
mean 2004–2008	2.9	1.1	10.3	8.6	2.8



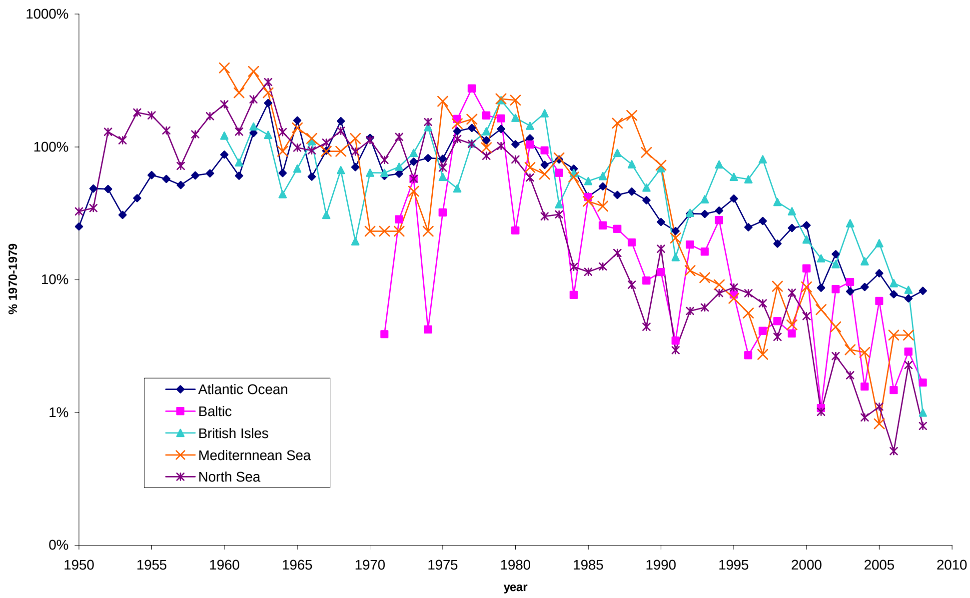


Figure 2.12: Recruitment (glass eel and young of the year) index per area in regular (upper panel) and in logarithmic scale (lower panel). Each series have been scaled to 1970–1979 average.

2.2.2 Sampling type effect on glass eel and young of the year recruitment

This model explains 66% of deviance (Table 2.10) and all effects are highly significant ($p<0.001$). Table 2.11 and Figure 2.13 give results from this model. Recruitment indices per sampling type demonstrate the same trend as recruitment index per area: decreasing trend since the end of 1970s or the beginning of 1980s. Depending on sampling type the present level is between 1% and 11% (2004–2008 average) of 1970–1979 level. Commercial cpue and trapping all, only represented by datasets in the central part of the eel distribution, have the highest present level (11% and 10%). Commercial catch and trapping partial, represented in the central and extreme part of the eel distribution, have intermediate present level (5%), while scientific sampling, only taking place in North Sea, has the lowest present level (1%). The analysis did not suppose any particular distribution pattern of the recruitment; we can thus build an index of recruitment of all Europe. The European index is calculated as the geometric mean of each of the monitoring indices, i.e. the least-squares mean (Table 2.11 and Figure 2.12). This combined index demonstrates that the present recruitment is only 5% of the 1970–1979 level.

Table 2.10: Analysis of deviance of the area effect on glass eel and young of the year GLM.

MODEL	RESIDUAL DF	RESIDUAL DEVIANCE
NULL	1051	1763.27
Site effect	1023	1545.73
Year x monitoring type effect	764	593.15

Table 2.11: Recruitment index per monitoring type and geomean. Each series have been scaled to 1970–1979 average.

YEAR	COMMERCIAL CATCH	COMMERCIAL CPUE	SCIENTIFIC ESTIMATE	TRAPPING ALL	TRAPPING PARTIAL	GEOMEAN
1950	39.5		12.0			21.8
1951	45.7		24.3			33.3
1952	62.8		156.1			99.0
1953	88.4		26.6			48.5
1954	139.0		39.5			74.1
1955	139.9		54.7			87.5
1956	124.8		14.3			42.2
1957	71.5		31.9			47.8
1958	86.6		105.0			95.3
1959	138.1		57.6			89.2
1960	246.6		43.5	56.4	94.9	87.1
1961	130.2	45.7	75.1	28.9	63.2	60.6
1962	186.6	181.2	176.5	113.3	86.3	142.3
1963	198.3	346.7	251.9	19.7	116.2	131.8
1964	135.3		39.8	9.6	40.2	38.0
1965	114.2	201.8	101.3	41.3	48.7	85.9
1966	76.9	73.8	87.6	64.2	79.2	75.9
1967	87.7	90.3	131.6	13.8	24.3	51.1
1968	147.3	145.7	118.3	68.8	32.3	89.2
1969	79.4	88.2	92.0	27.5	5.4	39.5
1970	81.4	113.0	138.9	27.5	51.1	71.0
1971	79.1	67.4	69.3	43.3	29.7	54.4
1972	94.6	70.6	89.5	55.0	41.2	67.0
1973	67.6	87.2	63.9	112.9	61.7	76.5
1974	95.9	92.1	161.5	95.8	40.9	89.0
1975	111.3	65.5	64.9	41.0	55.2	64.0
1976	130.6	149.2	95.0	85.9	147.6	118.6
1977	121.9	112.6	118.9	65.2	260.0	122.6
1978	100.7	119.2	91.3	105.9	169.3	114.5
1979	116.8	123.2	107.0	367.2	143.4	152.0
1980	101.8	107.2	77.7	241.0	34.6	93.3
1981	85.2	105.1	62.0	152.9	151.4	105.1

YEAR	COMMERCIAL CATCH	COMMERCIAL CPUE	SCIENTIFIC ESTIMATE	TRAPPING ALL	TRAPPING PARTIAL	GEOMEAN
1982	63.9	64.1	24.7	235.8	146.1	81.0
1983	65.8	54.1	26.4	67.2	80.9	55.2
1984	51.3	60.6	10.5	53.5	15.1	30.5
1985	31.1	34.7	12.3	69.5	58.0	35.2
1986	37.5	31.3	11.5	75.8	50.7	34.9
1987	51.7	45.1	13.9	118.8	47.0	44.8
1988	51.4	45.0	8.5	74.2	40.6	35.8
1989	32.4	51.1	5.7	46.4	18.5	24.1
1990	27.4	21.0	20.9	72.2	25.5	29.4
1991	16.3	20.2	3.4	18.5	4.4	9.8
1992	18.0	36.7	7.6	36.8	24.4	21.4
1993	18.4	38.0	8.5	43.3	20.9	22.2
1994	22.6	28.6	11.3	91.6	27.6	28.4
1995	25.2	38.6	10.5	66.5	10.4	23.4
1996	19.1	23.3	8.6	39.3	19.7	19.7
1997	17.1	32.5	7.4	109.6	18.2	24.1
1998	15.0	15.8	4.9	31.3	9.5	12.8
1999	14.6	30.2	10.0	24.7	9.1	15.8
2000	12.8	46.0	7.8	22.4	7.2	15.0
2001	5.9	7.8	1.3	22.2	2.5	5.0
2002	8.3	20.5	3.4	16.3	13.7	10.5
2003	6.2	7.9	2.3	29.7	19.4	9.2
2004	6.8	9.1	1.0	10.4	3.5	4.7
2005	7.2	14.3	1.6	17.9	12.1	8.2
2006	5.5	11.7	0.7	6.6	3.6	4.1
2007	4.8	9.9	2.7	8.6	3.4	5.2
2008	0.6	11.7	0.9	4.4	0.3	1.5
mean 2004–2008	5.0	11.4	1.4	9.6	4.6	4.7

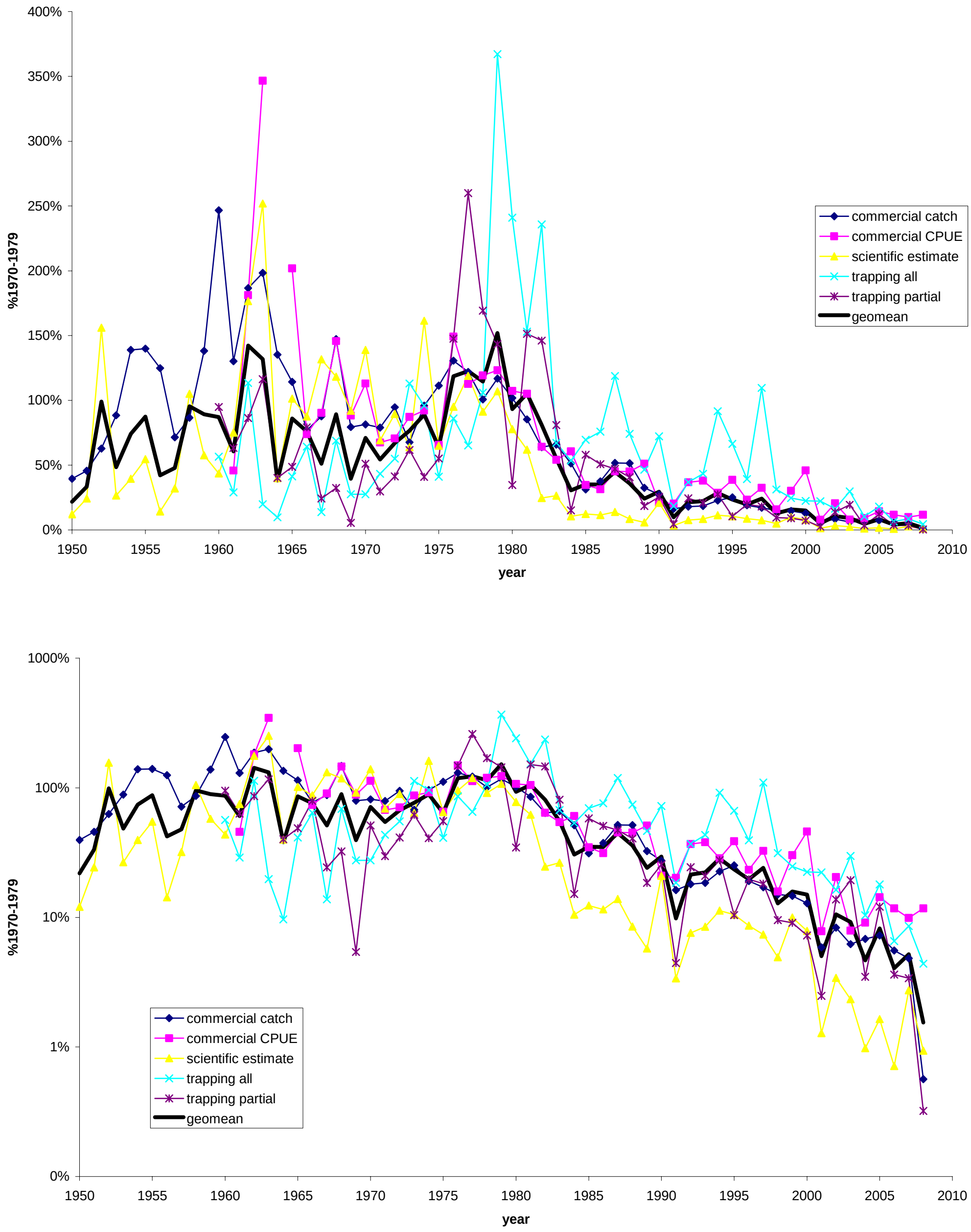


Figure 2.13: Recruitment (glass eel and young of the year) index per monitoring and geomean of these series in regular (upper panel) and in logarithmic scale (lower panel). Each series have been scaled to 1970–1979 average.

2.2.3 Area effect on young yellow eel older than 1 year

Data of two areas only (Baltic Sea including Kattegat, Skagerrak and North Sea) are available to fit this model. It explains 59% of deviance (Table 2.12) and all effect are highly significant ($p<0.001$). Table 2.13 and Figure 2.14 give results from this model, i.e. a young yellow eel older than 1 year recruitment index per area. The Baltic Sea (including Kattegat and Skagerrak) index demonstrates a continuous decline since the beginning of the period (1950). The North Sea index demonstrates the same trend, at least since the mid 1970s. The current level (2004–2008) is only 25% and 6% of the 1970s level for Baltic Sea (including Kattegat and Skagerrak) and North Sea respectively and the Baltic Sea (including Kattegat and Skagerrak) is at 8% of the 1950s level. None of theses series demonstrates any sign of recovery.

Table 2.12: Analysis of deviance of the area effect on young yellow eel older than 1 year GLM.

MODEL	RESIDUAL DF	RESIDUAL DEVIANCE
NULL	448	886.01
Site effect	438	725.79
Year x area effect	342	363.41

Table 2.13: Young yellow eel older than 1 year index per area. Each series have been scaled to 1970–1979 average.

YEAR	BALTIC SEA (INCLUDING KATTEGAT AND SKAGERRAK)	NORTH SEA		BALTIC SEA (INCLUDING KATTEGAT AND SKAGERRAK)	NORTH SEA
1950	269		1980	122	134
1951	360		1981	38	70
1952	356		1982	60	116
1953	572		1983	62	51
1954	290		1984	42	38
1955	431		1985	68	78
1956	207		1986	32	65
1957	226		1987	72	25
1958	232		1988	82	72
1959	492		1989	38	47
1960	245		1990	30	78
1961	249		1991	62	29
1962	244		1992	27	16
1963	214		1993	17	21
1964	82		1994	94	15
1965	152		1995	14	10
1966	214		1996	17	4
1967	117	213	1997	25	19
1968	245	85	1998	22	7
1969	166	74	1999	27	18
1970	68	100	2000	28	9
1971	92	25	2001	24	11
1972	146		2002	66	11
1973	197	50	2003	31	13
1974	77	90	2004	40	7
1975	155	175	2005	11	5
1976	49	139	2006	21	4
1977	79	152	2007	36	8
1978	73	101	2008		
1979	64	68			
			mean 2004–2008	27	6.2

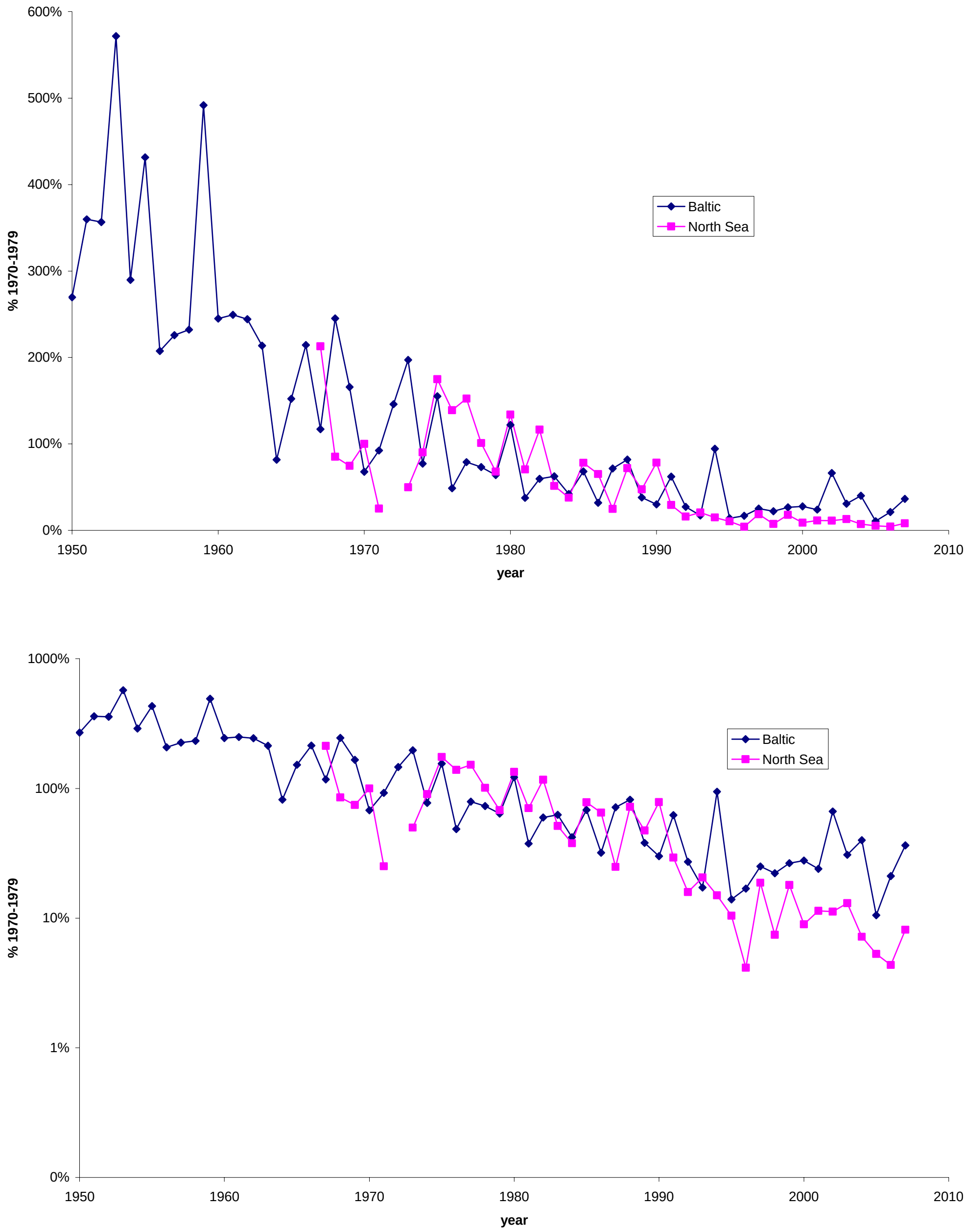


Figure 2.14: young yellow eel older than 1 year index per area in regular (upper panel) and in logarithmic scale (lower panel). Each series have been scaled to 1970–1979 average.

2.2.4 Discussion

Area effect and sampling type effect on glass eel and young of the year recruitment models are fitted on the same data. The area effect model explained more deviance while using fewer degrees of freedom than sampling type effect. On a statistical basis, the geographical pattern seems to fit the data better than the sampling effect, but the difference is not very clear. The geographical pattern can also be explained by the difference found in sampling type. When comparing datasets in different areas with the same sampling type (trapping partial in Baltic Sea including Kattegat and Skagerrak and in British Isles or commercial catches in the North Sea, British Isles, Atlantic Ocean and Mediterranean Sea), the geographical pattern is confirmed. Although sampling biases may exist, geographical pattern (stronger decrease in extreme part of the species distribution area) is the more likely interpretation.

The implementation of the EU Eel Regulation might result in discontinuities in the data on recruitment. First, commercial fisheries might be reduced, affecting the series based on commercial landings and commercial cpues. Second, the Regulation obliges Member States to implement a full registration programme for landings and fishing efforts, probably resulting in more complete coverage of the fishery. The recruitment series based on trapping (all or partial) and the scientific estimates will not be affected. For the (international) analysis of trends, the dataseries suffering from discontinuities will have to be split into "before" and "after", reducing the continuity of the overall analysis. Since this (unwanted but unavoidable) breakpoint will occur in just some sampling methods, it is all the more important to settle the area/sampling problem, i.e. to collect additional unpublished archive dataseries, strengthening the discriminating power of the above analyses.

The Baltic Sea (including Kattegat and Skagerrak) index of young yellow eel older than one year and to a lesser extent the North Sea index for this stage demonstrates a quite different pattern with a decrease starting earlier (at least since 1950 for the Baltic). Unfortunately, the Baltic Sea index for glass eel begins in 1971 only. This index does not differ from other area indices. Two hypotheses can explain these observations;

- the Baltic Sea including Kattegat and Skagerrak glass eel and young of the year index does not start early enough to strongly distinguish from other areas;
- young yellow eel older than 1 year in the Baltic Sea including Kattegat and Skagerrak area started to decline whereas glass eel and young of the year recruitment was constant. The reason for the yellow eel decline is unclear.

The first hypothesis better fits the data, although further information (young yellow eel data in the rest of Europe, or glass eel/young-of-the-year data in the Baltic Sea including Kattegat and Skagerrak area) will be needed to confirm this.

2.3 Conclusions and recommendations for Chapter 2: Trends in recruitment, stocking, yield and aquaculture

2.3.1 Conclusions

All glass eel and young of the year recruitment series demonstrate a clear decline since about 1980 with no sign of recovery. Recruitment is currently at only 5% of the 1970–1979 level. The Baltic Sea, including Kattegat and Skagerrak indices of young yellow eel recruitment, demonstrates a clear decline since about 1950. The decline in recruitment appeared stronger in the more northern and southern parts of the distribution. It is recommended to use recruitment indices per area (Baltic, North Sea, British Isles, Atlantic Coast, eastern and western Mediterranean), and to collect and analyse additional data to confirm the spatial pattern, and to establish the reliability and bias in the different sampling methods.

There needs to be an improvement in the data collected and data reported, particularly on landings and on stocking. Hopefully, the traceability requirements under the EU Regulation and CITES will improve this situation.

2.3.2 Recommendation

The analysis of aquaculture is complicated by the existence of three different datasets. We recommend that the collection of such data are centrally coordinated to provide a single dataset.

The situation is even more complicated for stocking, since in some countries no central databases exist. Therefore, information on stocking is incomplete. This situation should be improved in order to obtain a more comprehensive picture of the stocking activities in Europe.

It is recommended to use glass eel indices per area (i.e. Baltic, North Sea, British Isles, Atlantic Coast, Mediterranean), and to collect and analyse additional data to confirm the spatial pattern, and to establish the reliability and bias in the different sampling methods.