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Report of the Joint EIFAAC/ICES Working Group on Eels (WGEEL)

18–22 March 2013 in Sukarietta, Spain

4–10 September 2013 in Copenhagen, Denmark

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

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Executive summary

The Joint EIFAAC/ICES WGEEL met in March 2013 in AZTI Sukarrieta, Spain. The group was chaired by Martin de Graaf (NL) and Russell Poole (IE) and there were twenty nine participants present at the meeting from thirteen countries.

The Joint EIFAAC/ICES WGEEL met in September 2013 in ICES HQ Copenhagen, Denmark. The group was chaired by Martin de Graaf (NL) and Alan Walker (UK) and there were thirty one participants present at the meeting from fifteen countries.

ICES has provided advice on eel since 1999. Following long-term declines in recruits (e.g. glass eel since 1980, yellow eel since 1960s) and landings (since 1960s), the urgent compilation of a management plan was recommended aiming at a recovery of the international stock. Suggested eel-specific management targets were based on precautionary reasoning and general considerations. In 2007, the EU adopted the Eel Regulation, which led to the development of Eel Management Plans by 2009. Implementation of these plans between 2009 and 2012 has generated more data, and further research studies have been executed.

Reporting to the EU in 2012 by Member States on their post-evaluation of the implementation of the first three years of the Regulation enabled the first compilation of the implemented management actions and the stock indicators. The Terms of Reference for the 2012 and 2013 WGEEL were framed with this approach in mind.

In March, the data, management measures descriptions and updates reported by the Member States in the 2012 EMP Progress Reports were collated. These were updated and cross-checked using the ICES Data Call and the best available information was reviewed. Databases on stock indicators and on management measures were compiled and these were made available to the 2013 EMP Progress Report Technical Review Workshop in May (Workshop Evaluation of the Progress of the Eel Management Plans (WKEPEMP)). Of the 81, Eel Management Plans (EMP) evaluated by WKEPEMP 2013, 38 did not provide the full suite of indicators. Other issues discovered during the review of the data included the double banking or double neglect and even the provided stock indicators were often incomplete and inconsistent (i.e. countries ignoring whole habitats (e.g. tidal, transitional waters)).

Section A: International assessment (Ch. 4–8)

Assessment of the eel stock is not an easy task, because crucial knowledge of basic biological characteristics is incomplete; because the stock is scattered over an extremely large area, in typically small-scaled habitats; and because the stock has experienced a multidecadal decline and is now at a very low level.

Chapter 5 In this chapter the simplest approach is taken: using a minimum of data (trend in recruitment only), the current status and trend are compared to reference points based on the past. This assessment confirms the critical state of the stock; the promising increase in recruitment observed in the last two years is set in historical perspective; but no prediction can be generated, and no evaluation of the implemented stock protection measures achieved. The recruitment increase may or not be the result of protective measures (alternatively, it may reflect an unidentified external effect); the implemented protection may or not be adequate; in the trend-based assessment, there is no way to tell.

Chapter 6 The quantitative assessment applying general reference points takes a middle approach. For the dynamics of the continental phase, the international assessment relies on national building blocks, which in turn should reflect the local situation. In 2012, the national assessments were not coordinated internationally, resulting in a wide variety of assessment methods employed; some of which were more and some were less data driven. In principle, however, the dynamics of the continental phase can be known in whatever level of detail is required; the split over management units is just a pragmatic way of achieving the continent-wide result. For the dynamics of the oceanic phase, however, it is assumed that practically nothing is known. The chapter assumes a stock–recruitment relation of the general type, and takes the EU Regulation biomass limit of "40% of the silver eel biomass relative to the best estimate of escapement that would have existed if no anthropogenic influences had impacted the stock" for granted. Application of the standard ICES protocols leads to an assessment of the status of the stock (spawner escapement well below the target) and of the anthropogenic impacts (above the ICES standards for recovering stocks). The assessment yields the required results, but their validity hinges on the credibility of the assumptions on the oceanic life stage (standard stock–recruit relation).

Based on the information (stock indicators) provided by EU Member States, it is concluded that the stock - at least in the reporting countries - is not within sustainable limits conforming to the Eel Regulation and ICES policies. The biomass of escaping silver eel is estimated to be well below the target of 40% set in the EU Eel Regulation (summed over reported EMUs: 18%; summed over reporting countries: 6%). The anthropogenic mortality ΣA is estimated to be just at (averaged over reporting EMUs) or far above (averaged over reporting countries) the precautionary level that would be in accordance with ICES general policies for recovering stocks (for EMU sums: ΣA=0.41 with target 0.42; for country sums: ΣA=1.40 with target 0.14). On top of this, a major part of the Member States has not (completely) reported stock indicators, the distribution area of the eel extends considerably beyond the EU, and countries in these outer regions have not yet been involved in the assessment and stock recovery process.

Chapter 7 extends the analysis of 2012 WGEEL, reconstructing the historical stock–recruitment relation, using landings data as a proxy for spawner escapement biomass; expert estimated exploitation rates have now been used to correct the landings for past changes in fishing intensity. Though details differ from last year's estimates, the results more or less confirm last year's conclusions. The emerging stock–recruit relation shows an unusual form, with very low recruitment at medium spawner escapement biomass levels. This may indicate a non-stable stock–recruit relationship (e.g. reflecting a change in ocean conditions), or a depensatory stock–recruitment relationship; neither of which is fully provided for in standard ICES protocols. Fitting a segmented regression to the stock–recruit data on eel leads to the conclusion that the B_{lim} target could be set at 15 % of the reported pristine biomass. Fitting a more flexible curve (GAM), it is concluded that the stock might be close to falling into the depensation trap, and - with 95% confidence - might have been so since 1998. The latter would urge an immediate and complete reduction of all anthropogenic impacts (fisheries and other impacts) to zero. **However, we stress the experimental nature of our methods and uncertainties about the data.** The landings data used are reported to be incomplete and less reliable, and many experts pointed at the uncertainty of quantitative conjectures on exploitation rates for years almost gone out of living memory. The use of these extra data allows the derivation of eel-specific reference points, but at the costs of uncertainties in data and processes. **This must be borne in mind when considering this assessment.**

Chapter 8 Which of these three assessment methods is best? On the one hand: the simpler the better; the less demands on the data, and the less risks in misinterpreting the processes. At the same time, the trends-based assessment allows the evaluation of the past, but hardly gives information on the present, and yields no advice for the future. On the opposite end of the scale - the full analysis of the stock–recruitment relation of the eel - the uncertainty in historical data (landings) and in reconstructing historical processes (exploitation rates) is an obvious drawback, although a fully detailed assessment is the preferred method in the ICES Data-Limited Stocks Guidance. To select the best assessment method, one will have to find a judicious balance between adequacy and reliability.

WGEEL notes a critical need for improvement in the quality and consistency of data reporting at the national and EMU level. The lack of a complete suite of reported stock indictors by 38 of the 81 EMPs evaluated by WKEPEMP, variability of reporting standards, level of detail and coverage restricts the scope and value of international evaluation of the eel stock, and limits our ability to provide management advice for the eel stock.

Section B: Background data current advice (Ch. 9–12)

Chapter 9 The WGEEL glass eel recruitment index has increased in the last two years, to 1.5% of the 1960–1979 reference level in the 'North Sea' series, and to 10% in the 'Elsewhere' series, but both remain far from the 'healthy' zone (see Chapter 9). Data on catch were provided by all MS that participated in WG. The total landings from commercial and recreational fishers, provided in Country Reports, in 2012 were 2600 t and about 500 t respectively, giving a total of around 3100 t of eel. For most of Country Reports, the basic indicators on the status of eel fisheries (fishing capacity, fishing effort) were missing or incomplete. Aquaculture production has slowly decreased to below 6000 t in 2012. About 22 million glass eels and 10 million yellow eels were stocked in 2012. The Working Group has continued to collect time-series of yellow and silver eel landings but these do not yet yield long enough time-series to enable analysis.

Chapter 10 In 2013 the best estimate of the total catch of glass eel was 51.6 t, representing a 13% increase on 2012. Of the 51.6 t caught, 30.1 t could be accounted for through exports, internal usage in the donor country and from seizures, so there was a loss rate of ~43% (an increase from the 23% recorded in 2012). Some of this loss may be explained by mortality and weight loss post-capture, some through underreporting of exports and through illegal activities. Of the 2013 catch, 16% was reported to have been used for stocking and 14% for aquaculture, but the destiny of 70% remains unknown. However, using a projection based on the provision of data retrospectively (as performed for 2012 data), this unknown quantity may be expected to fall to ~40% once all data are provided. Note also that some of the glass eel currently classified as going to aquaculture will be stocked in future, but it is very difficult to trace such a secondary use.

A comparison between data presented by the various countries in Country Reports and that obtained from the EuroStat database shows consistency between the two. In 2013, stocking of glass eel was undertaken in nine countries. The mean price of glass eels remains high; ranging from €299–492 per kg over the last five years, though 2013 prices fell to their lowest in 17 years in the UK at €202 per kg by the end of the season.

In its recent meetings, WGEEL has checked annually for new information on the pros and cons of stocking as a suitable tool for eel recovery, with fuller reviews undertaken in 2006 and 2010 (ICES, 2010). Recent reviews (Pawson, 2012; WGEEL 2010) on the contribution of stocking for the recovery of the overall panmictic European eel population unambiguously state that there are major knowledge gaps to be filled before firm conclusions either way can be drawn. There was almost no new evidence available to Pawson in 2012 that was not considered by ICES WGEEL 2010 and the conclusions of both are similar: i.e. that there is evidence that translocated and stocked eel can contribute to yellow and silver eel production in recipient waters, but that evidence of further contribution to actual spawning is limited (by the general lack of knowledge of the spawning of any eel). However, in addition to investigations on the contribution of stocking for the enhancement of silver eel escapement in distinct EMUs, internationally coordinated research is required to judge the net benefit of stocking for the overall population, including carrying capacity estimates of glass eel source estuaries as well as detailed mortality estimates along trade channels. The impact of holding and maintenance feeding of elvers in aquaculture needs to be addressed with regard to a possible adaptation to culture conditions as known from other fish species like salmon and trout.

Chapter 11 Parameters developed for estimating the condition of escaping silver eels have the potential to be used to calculate the reproductive potential of individual female silver eels leaving their catchment, and this quantitative approach in estimating eel quality can be integrated into the stock assessments. This has the potential for important applications for stock management, although the development of this methodology is hampered by the lack of field verified 'dose effect' threshold information and a lack of monitoring data. A conceptual analysis of information needed to reach the goal of the introduction of eel quality parameters into stock wide assessment is presented as a research proposal, which shows the major gaps in knowledge and provides a strategic overview for future research.

Section C Forward focus (Ch. 12–14)

Chapter 12 In this report (Chapter 6), an international assessment is developed using stock indicators taken from national assessments. Evaluation and quality control of national assessment procedures was beyond the remit of this meeting, but this report has listed inconsistencies between areas, impacts, assessment methods and countries, which indeed do affect the international assessment. The international assessment would improve from a rigorous quality check on each and every national assessment or alternatively from standardization in data collection and assessment methodology.

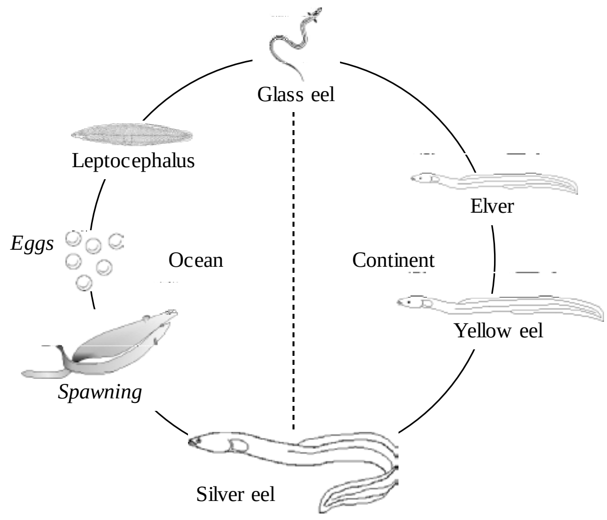
Chapter 13 WGEEL notes a critical need for improvement in the quality and consistency of data reporting at the national and EMU level. Variability of reporting standards, level of detail and coverage restricts the scope and value of international evaluation of the eel stock, and limits our ability to provide management advice for the eel stock. WGEEL proposes standardization of data table formats for use in Country Reports. This standardization is offered as a format which will facilitate national reporting to all international fora requiring eel data. The long-term objective of such standardization is to facilitate the creation of an international database of eel stock parameters that could be updated annually.

Chapter 14 As noted throughout the WGEEL 2013 report, there are a lot of data and knowledge deficiencies that hinder stock assessment (at local, national and international levels), identification and quantification of impacts (natural and anthropogenic), and the development and implementation of locally and internationally effective management measures. WGEEL 2012 summarized the research needs outstanding to address these deficiencies, and made suggestions for those which could be addressed at national or international scales. These research needs remain outstanding, so are repeated in Chapter 14, along with more details of required research on eel quality, its impact on stock dynamics and its integration into quantitative assessments.

Glossary

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

There are two species of eel in the North Atlantic, the European eel (*Anguilla anguilla*) and the American eel (*A. rostrata*).



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 and are therefore only tentatively included. **(Diagram: Willem Dekker).**

The European eel *Anguilla anguilla* (L.) is found and exploited in fresh, brackish and coastal waters in almost all of Europe and along the Mediterranean coasts of Africa and Asia. The life cycle has not been fully elucidated but current evidence supports the view that recruiting eel to European continental waters originate in a single spawning stock in the Atlantic Ocean, presumably in the Sargasso Sea area, where the smallest larvae have been found. Larvae (leptocephali) of progressively larger size are found between the Sargasso Sea and European continental shelf waters. While approaching the continent, the laterally flattened leptocephalus transforms into a rounded glass eel, which has the same shape as an adult eel, but is unpigmented. Glass eel migrate into coastal waters and estuaries mostly between October and March/April, before migrating, as pigmented elvers, on into rivers and eventually into lakes and streams between May and September. Following immigration into continental waters, the prolonged yellow eel stage (known as yellow eel) begins, which lasts for up to 20 or more years. During this stage, the eels may occupy freshwater or inshore marine and estuarine areas, where they grow, feeding on a wide range of insects, worms, molluscs, crustaceans and fish. Sexual differentiation occurs when the eels are partly grown, though the mechanism is not fully understood and probably depends on local stock density. At the end of the continental growing period, the eels mature and return from the coast to the Atlantic Ocean; this stage is known as the silver eel. Female silver eels are twice as large and may be twice as old as males.

Glossary

Glass eel	Young, unpigmented eel, recruiting from the sea into continental waters.
Elver	Young eel, in its first 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 or Eel Management Unit	"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]." EC No. 1100/2007.
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. The term is used in relation to the EU Water Framework Directive.
Stocking	Stocking (formerly called restocking) 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.

Definiton of Terms	
Pristine biomass (B_o)	Spawner escapement biomass in absence of any anthropogenic impacts.
Best achievable biomass (B_{best})	Spawner escapement biomass corresponding to recent natural recruitment that would have survived if there was only natural mortality and no stocking
$B_{current}$	Spawner escapement biomass corresponding to the assessment year
Limit spawner escapement biomass (B_{lim})	Spawner escapement biomass, below which the capacity of self-renewal of the stock is considered to be endangered and conservation measures are requested (Cadima, 2003).
$B_{MSY-trigger}$	Value of spawning–stock biomass (SSB) which triggers a specific management action, in particular: triggering a lower limit for mortality to achieve recovery of the stock.
B_{stop}	Biomass of the spawning stock, at which recruitment is severely impaired, and the next generation is (on average) expected to produce an equally low spawning-stock biomass as the current.
B_{stoppa}	Biomass of the spawning stock at which recruitment is severely impaired, and the next generation has a 5% chance to produce an equally low spawning-stock biomass as the current.
∑F	The fishing mortality rate, summed over the age groups in the stock.
∑H	The anthropogenic mortality rate outside the fishery, summed over the age groups in the stock.
∑A	The sum of anthropogenic mortality rates, i.e. $\Sigma A = \Sigma F + \Sigma H$.
Spawner per recruit (SPR)	Estimate of spawner production per recruiting individual.
%SPR	Ratio of SPR as currently observed to SPR of the pristine stock, expressed in percentage. %SPR is also known as Spawner Potential Ratio.

WGEEL wish to record the death on 7th August 2013 of the Reverend Oliver P Kennedy, Chairman of the Lough Neagh Fishermen's Co-operative Society Ltd. What better way to record his passing than to offer the words of the Nobel Laureate Seamus Heaney from Bellaghy in the Neagh/Bann Catchment, who passed away only weeks after Fr Kennedy:

From "A LOUGH NEAGH SEQUENCE"

(For the fishermen)

Lifting

They're busy in a high boat
That stalks towards Antrim, the power cut.
The line's a filament of smut

Drawn hand over fist
Where every three yards a hook's missed
Or taken (and the smut thickens, wrist-

Thick, a flail
Lashed into the barrel
With one swing). Each eel

Comes aboard to this welcome:
The hook left in gill or gum,
It's slapped into the barrel numb

But knits itself, four-ply,
With the furling, fat, slippy
Haul, a knot of back and pewter belly

That stays continuously one
For each catch they fling in
Is sucked home like lubrication.

And wakes are enwound as the catch
On the morning water: which
Boat was which?

And when did this begin?
This morning, last year, when the lough first spawned?
The crows will answer, "Once the season's in."

Seamus Heaney (13 April 1939–30 August 2013).

Contents

Executive summary i

Glossary vi

Contents x

1 Opening of the meeting 15

2 Adoption of the agenda 16

3 Introduction 20

Section A: International stock assessment 22

4 Introduction to stock assessment, reference points and stock status 22

4.1 Introduction 22
4.2 Spatial cascading 22
4.3 Assessment strategy 23
4.4 Expectations and outcomes 24

5 Trend-based assessment and reference points 26

5.1 Introduction 26
5.2 Trend-based assessment based on recruitment indices 26
5.3 Conclusion on trend-based assessment and reference point 30
5.4 Future development of the trend-based assessment 30

6 Quantitative assessment applying generic reference points 31

6.1 ICES general policy towards advice 31
6.2 Eel specific reference points 31
6.3 Progress reporting 2012 31
6.4 International assessment procedure 32
6.5 Assessment results 32
6.6 Conclusions on quantitative assessment applying generic reference points 36
6.7 Future improving of the international assessment 36

7 Eel-specific reference points based on the stock–recruit relationship 38

7.1 Introduction 38
7.2 Biomass estimate 38
7.3 Improvement of catch data analysis 39
7.4 Development of the theoretical framework to estimate biomass from catches 40
7.4.1 Use of silver eel catch data to calculate an escapement 40

7.4.2 Use of yellow eel catch data to calculate a escapement 41

7.5 Estimate of biomass from silver eel catches 41

7.6 Applying the classical S–R relationship....................51

7.7 Classical biological reference point B_{lim} 52

7.8 A flexible stock–recruitment relation; new biological reference points 53

7.8.1 B_{stoppa}, a proposed new reference point to avoid extremely low stock biomass 53

7.9 Estimation of B_{stoppa} 55

7.10 Discussion on eel-specific reference points....................58

7.11 Conclusions on eel-specific stock–recruit relation and reference points 59

8 Discussion of assessment methods and results 60

Section B: Data, trends and information for current advice 62

9 Data and trends 62

9.1 Recruitment 62

9.1.1 Update on the status of data....................62

9.1.2 Series lost....................64

9.1.3 Trends in recruitment....................65

9.2 Time–series of yellow and silver eel 69

9.2.1 Yellow eel....................69

9.2.2 Silver eel 71

9.3 Data on landings....................72

9.3.1 Collection of landings statistics by country (from CRs) 74

9.4 Recreational and non-commercial fisheries 76

9.5 Eel stocking....................81

9.5.1 Trends in stocking....................81

9.6 Categorizing of the different sizes and origins in stocked eels 86

9.6.1 Methods when converting stocked eel into “glass eel equivalents” 102

9.6.2 Problems and consequences for interpretation....................103

9.7 Fishing effort 107

9.8 Aquaculture production 109

9.9 Conclusion on data and trends 111

10 Glass eel landings and trade....................113

10.1 Introduction....................113

10.2 Trade analysis 114

10.3 Destination of the catch by country 115

10.4 Data audit and anomalies....................119

10.5 Quantity of glass eel identified being used for stocking and aquaculture ... 122
10.6 Trend in the price of glass eel ... 125
10.7 The amount of glass eel stocked by country and in relation to EMP target ... 125
10.8 Stocking literature review ... 129
10.9 Conclusions ... 131

11 Assessment of the quality of eel stocks ... 132
11.1 Introduction ... 132
11.2 New information on eel quality provided in recent publications and country reports ... 132
11.2.1 Contaminants ... 132
11.2.2 Parasites and pathogens ... 137
11.3 Eel quality and reproductive potential. A way forward in developing approaches to quantifying the effects of eel quality on reproductive potential and integrating these into stock assessments ... 139
11.4 Urgent knowledge requirements as the basis for a Research Proposal "Towards understanding and quantifying the effects of contaminants on the reproductive success of the European eel and integration in stock wide assessments" ... 149
11.4.1 Overall objective of the research proposal ... 150
11.4.2 Experimental work ... 152
11.4.3 Modelling work ... 153
11.5 Joint Workshop of the Working Group on Biological Effects of Contaminants and the Working Group on Eel under the subject "Are contaminants in eels contributing to their decline?" ... 153
11.6 Workshop of a Planning Group on the Monitoring of Eel Quality ... 154
11.7 Conclusions ... 155
11.8 Recommendations ... 155

Section C: Planning for future reporting and assessment ... 156

12 Local stock assessment ... 156
12.1 Introduction ... 156
12.1.1 Lessons learned from the May 2013 ICES expert group convened to assess implementation of EU eel management plans (WKEPEMP) ... 156
12.1.2 Need for harmonization of categories of nil response in data tables ... 158
12.1.3 Guidance on units of measurement ... 158
12.2 Catch-effort-cpue ... 159
12.3 Underreporting and illegal catches ... 162
12.4 Aquaculture ... 163
12.5 Amount stocked ... 163

12.5.1 Catch of eel <12 cm and proportion retained for restocking..........164
12.5.2 Glass eel destination..........165
12.5.3 Reconstructed time-series on stocking..........167
12.5.4 EMP stocking objective..........168
12.6 Stocking indicator table..........168
12.7 Eel quality..........170
12.7.1 Scientific work or monitoring of eel contamination and diseases..........171
12.7.2 Closure of fisheries / recommendation to prevent consumption..........171
12.7.3 New and ongoing research..........171
12.7.4 Reproductive Potential: Basic requirements for assessing the quality of the silver eels leaving your EMU/basins..........171
12.7.5 Eel Quality Index: Basic requirements for assessing the quality of the yellow eels in your EMU/basins..........171
12.7.6 Presence and abundance of *Anguillicola crassus*..........172
12.7.7 Incidental eel mortality (non-fishing)..........172
12.8 Management measures overview..........172
12.9 Biological data..........176
12.9.1 Silver eel age..........176
12.9.2 Silver eel length..........176
12.9.3 Silver eel sex ratio..........176
12.10 DCF (DC-MAP)/research reporting..........177
12.11 Appendix..........177
12.11.1 Methods (Definitive scientific explanation enabling examination/repeat by others)..........177
12.11.2 Estimate of B_0..........177
12.11.3 Management measures details..........177
12.11.4 Time-series data..........178
12.11.5 Time-series fishing capacity..........178
12.11.6 Publications/reports..........178
12.12 Subgroup conclusion..........178
13 Forward Focus of the WGEEL..........179
14 Research needs..........184
15 Reference list..........186
Annex 1: Participants list..........192
Annex 2: Agenda, timetable and meeting tasks..........198
Annex 3: WGEEL terms of reference for 2014 Meeting..........205
Annex 4: Recommendations..........208
Annex 5: Planned Workshop WKBECEEL ToRs 2015..........209
Annex 6: Planned Workshop WKPGMEQ ToRs 2014..........211

Annex 7: Tables for Chapter 9 ... 213

Annex 8: Country Reports 2012: Eel stock, fisheries and habitat reported by country ... 226

Annex 9: Technical minutes from the Review Group on Eels ... 227

1 Opening of the meeting

The Joint EIFAAC/ICES WGEEL met in March 2013 in AZTI, Sukarrieta, Spain. There were twenty nine participants present at the meeting from thirteen countries, including J-J Maguire, Chair of ACOM, ICES. The list of attendees is given in Annex 1. The meeting was preceded by a Task Leaders coordination meeting on Sunday 17th March and the full meeting was opened at 09.30 am on Monday 18th March 2013.

The Joint EIFAAC/ICES WGEEL met in September 2013 in ICES HQ Copenhagen, Denmark. There were thirty one participants present at the meeting from fifteen countries. The list of attendees is given in Annex 1. The meeting was preceded by a Task Leaders coordination meeting on Tuesday 3th September and the full meeting was opened at 09.30 am on Wednesday 4th September 2013.

2 Adoption of the agenda

The ToRs, a draft agenda and a list of Tasks to address the ToR had been circulated prior to the meetings. The ICES Data Call for the relevant Stock Indicators was also circulated in advance of the March Meeting. However, in some countries the data call never reached the relevant person and data were not returned in time for the March meeting. The information was provided at the March meeting by the Country Participants.

In March the Chair went through the agenda and Tasks in detail and the Task Leaders gave preliminary presentations on the proposed work plan for the week. Following that, there was a short discussion on the Terms of Reference for the ICES Technical Evaluation of the 2012 EMP Progress Reports and how the two WGEEL meetings would interrelate to the ICES Workshop (WKEPEMP). It was confirmed that the March meeting would provide a summary report of the Tasks relevant to the WKEPEMP and the remaining tasks would work towards the final WGEEL Report at the September meeting. The agenda, timetable and tasks were agreed by the meeting and the agenda was updated throughout the meeting where needed (Annex 2).

In September the Chair went through the agenda and Tasks in detail and the Task Leaders gave preliminary presentations on the proposed work plan for the week. The agenda, timetable and tasks were agreed by the meeting and the agenda was updated throughout the meeting as appropriate (Annex 2).

The **Joint EIFAAC/ICES Working Group on Eels** (WGEEL), chaired by Martin de Graaf, The Netherlands, Alan Walker, UK and Russell Poole, Ireland, met in Sukarietta, Spain, 18–22nd March and in ICES Copenhagen, Denmark, 4–10th **September** 2013, to:

Preparatory work

a) Develop data call in conjunction with ICES for stock indicators and supporting information on local/national methods used to derive indicators;

b) Support ICES to issue data call to MS via EU in first week of December 2012 for return deadline 1st February 2013;

c) Collate the returns from the data call and from the Member States 2012 Reports to the EU.

Spring Meeting (18–22nd March 2013 Sukarietta, Spain)

d) Complete the *broad-brush quality assurance* checking of the reported Eel Management Unit biomass and mortality estimates, and prepare the data for the international stock assessment;

e) Provide a summary report on the reported data and stock indicators and the *quality assurance* of the indicators;

f) Provide a first compilation of the best available biomass and mortality data, along with additional data from the Baltic and GFCM areas;

g) Further develop the S/R relationship and reference points, following the ICES peer-review, and using the latest available data.

Autumn Meeting (4–10th September 2013 ICES HQ Copenhagen, Denmark)

h) Evaluate the EU Regulation (EC No. 1100/2007) and its consistency with the precautionary approach, following the plan developed in WGEEL 2012;

i) Apply the reported biomass and mortality data to the precautionary diagram using PA limits and the EU Regulation derived target/limits if different (WGEEL 2011) and provide appropriate advice on the state of the international stock and its mortality levels;

j) assess the latest trends in recruitment, stock (yellow and silver eel) and fisheries, including effort, 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). Update international databases for data on eel stock and fisheries, as well as habitat and eel quality (EQD) related data;

k) In conjunction with WGBEC and MCWG, review and develop approaches to quantifying the effects of eel quality on stock dynamics and integrating these into stock assessments. Develop reference points for evaluating impacts on eel;

l) Respond to specific requests in support of the eel stock recovery regulation, as necessary.

WGEEL will report by 27th September 2013 for the attention of ACOM, WGRECORDS, SGEF and FAO, EIFAAC and GFCM.

Supporting Information

Priority	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. In its Forward Focus (2011), WGEEL mapped out a process for post-evaluation of the EU Regulation, based on 2012 reporting to the EU by Member States, including an international assessment of the status of the stock and the levels of anthropogenic mortalities. ICES understands the evaluation of the 2012 reports will be undertaken by the EU Commission. The international eel stock assessment will require a process that collates good quality local biomass and anthropogenic mortality data and aggregates to the national and international levels. The 2012 meeting of WGEEL was the first step in this process. A further two meetings are envisaged, with data preparation in advance, in order to complete the international stock assessment. Countries must be committed to this process in order for it to succeed and it must be internationally coordinated.
Scientific justification	European eel life history is complex and atypical among aquatic species. The stock is genetically panmictic and data indicate random arrival of adults in the spawning area. The continental eel stock is widely distributed and there are strong local and regional differences in population dynamics and local stock structures. Fisheries on all continental life stages take place throughout the distribution area. Impacts vary from almost nil to heavy overexploitation. Other forms of anthropogenic mortality (e.g. hydropower, pumping stations) also impact on eel and should also be quantified in the 2012 national reports to the EU. Exploitation that leaves 30% of the virgin spawning–stock biomass is generally considered to be a reasonable target for escapement. Due to the uncertainties in eel management and biology, ICES proposed a limit reference point of 50% for the escapement of silver eels from the continent in comparison to pristine conditions (ICES, 2003). This is higher than the escapement of at least 40% "pristine" set by the EC Regulation for the escapement of silver eels. ICES has evaluated the conformity of country management plans with EC Regulation 1100/2007 (ICES Advice Reports 2009 and 2010, Technical Services), but it has not evaluated the consistency of the regulation itself with the precautionary approach. ICES will undertake such an evaluation based on country reports due in 2012 under EC Regulation 1100/2007. WGEEL (ICES, 2010a; Annex 5) recommended that Eel Management Plan reporting must provide the following biomass and anthropogenic mortality data: • B_{post}, the biomass of the escapement in the assessment year; • B_o, the biomass of the escapement in the pristine state. Alternatively, one could specify B_{lim}, the 40% limit of B_0, as set in the Eel Regulation; • B_{best}, the estimated potential biomass in the assessment year, assuming no anthropogenic impacts (and without stocking) have occurred and from all potentially available habitats. • $\sum A$, the estimation of B_{best} will require an estimate of A (anthropogenic mortality (e.g. catch, turbines)) for density-independent cases, and a more complex analysis for density-dependent cases. Most EU Member States now have quantitative estimates of B_o and B_{post} silver eel production, although the reliability and accuracy of these data have not yet been fully evaluated. Estimates of current anthropogenic mortality have only been made by some Member States, although it is anticipated this information will be available when reporting by Member States under the Regulation in 2012 is completed.

Resource requirements	Access to Member States 2012 Reports to the EU
Participants	ICES and EIFAAC Working Group Participants, Invited Country Administrations, EU representative
Secretariat facilities	SharePoint
Financial	At Country Expense
Linkages to advisory committees	ACOM
Linkages to other committees or groups	WGRECORDS, SCICOM
Linkages to other organizations	FAO EIFAAC, GFCM, EU DGMARE, EU DGENV

3 Introduction

This report is a further step in the ongoing process of documenting the status of the European eel stock and fisheries and compiling management advice. As such, it does not present a comprehensive overview, but should be read in conjunction with previous reports (ICES, 1999 to 2012) and with the SGIPEE reports (ICES 2010, 2011).

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 has now introduced discontinuities to data trends (e.g. fisheries dependent recruitment series) and the shift from fisheries-based to scientific survey-based assessments is now needed.

In its Forward Focus (ICES, 2011), WGEEL mapped out a process for post-evaluation of the EU Regulation, based on 2012 Progress Reporting to the EU by Member States, including an international assessment of the status of the stock and the levels of anthropogenic mortalities.

The 2012 meeting of WGEEL was the first step in this post-evaluation process undertaking a preliminary review of the available 2012 EMP Progress Reports and developing references points for the international stock. A further two meetings were planned for 2013 in order to complete the post-evaluation.

In December 2012, EU DGMARE sent ICES a Special Request for: "Technical evaluation of the progress reports submitted by the EU Member States to the European Commission in line with Article 9 of the Eel Regulation (EC 1100/2007). The reports describe the progress achieved since the implementation of the Member States' eel management plans. ICES is asked to carry out an assessment of the progress achieved via the measures implemented. In view of this, the regulation may be amended and further/additional measures may be taken in order to ensure the recovery of the eel stock". ICES set up an ACOM Resolution for an independent workshop (WKEPEMP) to carry-out this assessment, which was held in Copenhagen in May 2013.

The March WGEEL meeting addressed the stock and mortality data needs for the international stock post-evaluation and the resulting database (stock indicators and management measures per EMU) was available for the use of the WKEPEMP. Considerable areas of the range of eel remain where data are limited or absent (e.g. Mediterranean Region) and it is important that the planned (June 2013) but postponed GFCM workshop addresses this situation in the near future.

The current report of WGEEL took note of the Technical Minutes from the review of the 2012 WGEEL report. The recommendations of this technical review were addressed by the relevant task subgroups and incorporated in the following report. However, time limits prevented the preparation of specific written response to the Technical Review.

The structure of this report does not strictly follow the order of the Terms of Reference for the meeting. The March and September meetings, and consequently the report, were organized in Tasks using the Agenda in Annex 2 of this report. In Section A "International stock assessments" three different assessment methods are presented to determine to current status of the stock, in Section B "Background data current advice" an update is provided of basic data on research surveys, catches, glass eel trading, stocking, eel quality issues (contaminants, diseases and parasites), and in Section C “Forward focus” a suggestion for standardized data reporting is presented and a possible direction of the eel stock assessment and the WG towards 2014–2018 is provided.

Section A: International stock assessment

4 Introduction to stock assessment, reference points and stock status

4.1 Introduction

This chapter, and the next three, discuss the overall status of the stock and the effect of protective measures taken; and discuss reference values and management targets and their consistency with the precautionary approach. This addresses Terms of Reference h, i and part of j:

h) Evaluate the EU Regulation (EC No. 1100/2007) and its consistency with the precautionary approach, following the plan developed in WGEEL 2012;

i) Apply the reported biomass and mortality data to the precautionary diagram using PA limits and the EU Regulation derived target/limits if different (WGEEL 2011) and provide appropriate advice on the state of the international stock and its mortality levels;

j) assess the latest trends in recruitment, stock (yellow and silver eel) and fisheries, including effort, 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). Update international databases for data on eel stock and fisheries, as well as habitat and eel quality (EQD) related data.

In this chapter in particular, the overall approach will be presented, including a short discussion on objectives, actions and resulting expectations. Chapter 8, subsequently, reviews the methods, and discusses how to select between them.

The first post-evaluations of the effectiveness of the implementation of Eel Management Plans have been reported by Member States to the EU in 2012 for completion of the review with the Commission reporting to the European Parliament and Council by the end of 2013.

4.2 Spatial cascading

The stock in the whole distribution area is considered to constitute one single panmictic population. This contrasts strongly with the scattered, small-scale pattern of the continental stock and the national/regional scale of management (Dekker, 2000; 2008). Management of the stock by uniform measures all over the EU (e.g. a common minimum legal size, a common closed season or a shared catch quotum, etc.) were not feasible or applied, since uniform measures could not be designed in a way that would be effective all over the EU (or the wider range of the eel). Regionalised management; i.e. a common objective and target, but local action planning, local measures and local implementation, was central to the EU Eel Regulation (Dekker, 2004; 2009) and on this basis Eel Management Plans have been developed per country/region. Few cross-boundary EMPs exist. Note, however, that the European eel range extends beyond the EU and that the management of the eel and anthropogenic impacts is necessary throughout its range.

The post-evaluation process commencing with the reporting by Member States in 2012 has been first and foremost a synchronized process of national post-evaluations. National reports have evaluated to what extent the implementation of the EMP(s) has been successful, and whether the targets have been achieved.

Standard fish stock assessments, for stocks exploited by several countries, usually proceed as follows: field data are collected in each country (total landings weight, length–frequency, length–age-key, etc.), worked up to a catch-at-age matrix, which is summed over the countries; and finally a single, international stock assessment based on the (summed) catch-at-age matrix yields the required stock indicators. That is: orchestrated data collection, feeding into a single, shared assessment. Though this approach could be followed for eel too, the assessment would be almost meaningless (ICES 2010a). For instance, the number-at-age-5 would combine small yellow eels far below the minimum legal size in Scandinavia, with some of the oldest and largest silver eels in the Mediterranean that have already endured almost all their anthropogenic mortalities; the estimated anthropogenic mortality at this age would represent a meaningless mix of northerly and southerly processes, that could nowhere be related to specific anthropogenic actions. A single pan-European assessment of the continental stock (not: the oceanic stock!) is therefore not meaningful. The alternative is to assess local stocks by country/area, to derive local stock indicators, and to design an international integration procedure for the local stock indicators (Dekker, 2010).

The national assessments and post-evaluations in 2012 have been executed by individual Member States, with only little coordination or standardization in-between. To achieve a population-wide, international assessment, it would be desirable to have a standardized assessment across Europe, using the primary field data, but the variety of data available (related to the variation in field conditions and to national monitoring policies) does not allow such an approach. Instead, WGEEL has developed an approach for an international assessment, in which only the national stock indicators are used (Dekker, 2010a; ICES 2010a,b; 2011a,b; 2012b). Hence, the international stock assessment is based on national data only through the national stock indicators, not directly on the data themselves. ICES (2012b) discussed the need for quality control on the national assessments. ICES (2013a, 2013b) scrutinised the national progress reports submitted in 2012, accepting the national assessments in good faith. Since there has been no opportunity for further quality control, the international assessment presented here is conditional on the available national stock indicators - in good faith again.

4.3 Assessment strategy

In recent years, ICES (ICES 2012c, DLS Guidance) has developed a coherent strategy for the assessment of data-limited stocks, building upon experiences with many stocks over several decades. For the eel, data restrictions and assessment procedures have been discussed by ICES (2000 Silkeborg; 2002 Copenhagen; 2003 Nantes; 2008 Leuven; 2010a,b Sgipee and Hamburg; 2011a,b Sgipee and Lisbon), referring to contemporary protocols.

Past advice on eel stock protection and management (ICES Advice 1999 through 2012) was based on precautionary principles: all indications are that the current stock is far below its historical level, and recruit surveys indicate a prolonged decline over the past decades. ICES (1999) advised to compile a stock recovery plan and - pending the implementation - to reduce all anthropogenic impacts to as close to zero as possible. This advice fits with ICES DLS Guidance (ICES 2012c: method 5.3), even though it was developed over a decade prior to the guidance. In 2013, however, two things have changed: 1. due to the implementation of the recovery plan, more data have become available, which may or not suffice for a quantitative assessment (DLS Guidance, method 1.1.2); and 2. The most recent few years have shown a significant increase in recruitment (*see Chapter 9*), which raises a discussion on how to deal with a (real or perceived) break in a hitherto consistent, multidecadal decline (for which DLS Guidance does not provide a method). Finally, the available data indicate that recruitment has declined more rapidly than the (reconstructed) spawner escapement, which may indicate a. an inappropriate reconstruction of the trend in spawner escapement, or b. a non-stable stock–recruit relationship (e.g. change in ocean conditions), or c. a depensatory stock–recruitment relationship; none of which is fully provided for in the DLS Guidance. Given this situation, WGEEL decided on a three-tiered approach:

1) *Trend-based assessment*. In line with advice given in the past, DLS Guidance method 5.3 is selected, and options for dealing with a change in trend are considered.
2) *Quantitative assessment applying generic reference points*. Following ICES (2002) advice to take generic reference points as the basis for eel-specific ones, the EU Eel Regulation has set a target for restoration of the spawner escapement at 40% of the pristine stock. Taking this as a preliminary value for $B_{MSY\text{-}trigger}$, DLS Guidance method 1.1.2 can be applied.
3) *Eel-specific reference points based on the Stock–Recruit relationship*. Noting the aberrant trends in spawner escapement and recruitment, the emerging stock–recruitment relation is characterized by a ‘standard’ (hockey-stick or segmented regression) or a more flexible functional relationship, along the lines set out by ICES (2012b); i.e. B_{stop} and B_{stoppa}.

Each of these three tiers will be elaborated in one of the following three chapters.

4.4 Expectations and outcomes

The European eel stock has been in gradual decline for at least half a century (see *Chapter 7*), and recruitment declined sharply from 1980 to 2010 (*see Chapter 9)*. Coordinated protective measures have been enacted by the EU and others since 2009, considering reductions in the fishery on glass eel, yellow eel and silver eel; restocking; mitigation of the effect of migration barriers (upstream and downstream); and other measures.

Some measures have been immediately and fully implemented in 2009 (e.g. fishing closure in Ireland); while others have been delayed or implementation has not been complete yet (ICES 2013a). For management measures aiming at the silver eel stage (e.g. fishing reduction, trap & transport across barriers), an immediate effect on spawner escapement is expected - while for other measures directed at glass eel (e.g. fishing reduction, restocking) or yellow eel (e.g. fishing reduction, predation reduction), a number of years will have to pass before those eels have grown to the silver eel stage, and escapement is eventually affected. All in all, the net effect of the actions taken in 2009 on the total 2009 silver eel escapement is probably small, far below the targets of the EMPs and/or the ultimately sustainable level.

The effect of the increase in the autumn 2009 silver eel escapement will have affected the spawning–stock biomass in early 2010, which in turn produced a new generation of glass eels, that recruited to the European coast in 2011 or 2012 (the whole oceanic lifespan lasting 2–3 years, depending on views). If the initial protective measures already have had a small effect, it might be detectable in the recruitment of these years. In reality (*Chapter 9*), an increase in recruitment was noted in 2012, which continued in 2013 (and for the series outside the North Sea area, is now significantly different from the past trend). That is: the small increase in recruitment observed in recent years *does* match in time with the earliest management measures. Those actions being little in comparison to the targets, and the increase in recruitment being small in comparison to the historical decline, this increase can certainly not been considered as proof of the causal relation and of the effectiveness of the protection established, but neither can the reverse be said. A final post-evaluation of the effect of all management actions can only be held after some extra years (until even the glass eel have grown to silvering size), at which time a detailed and quantitative evaluation will be required, that also considers the effect of external factors, such as ocean climate change.

The silver eel currently escaping belong to glass eel cohorts that recruited to the continent several years ago. In the years since that cohort recruited, weaker and weaker cohorts have been observed, which will lead to fewer and fewer silver eel being produced in the years coming. Management actions to protect the stock may increase the relative survival from glass eel to silver eel escapement, but on top of that there is the anticipated downward trend in stock productivity (the echo of the declining recruitment in the past) (Åström and Dekker, 2007). Simplistic interpretation of the trends in glass eel recruitment (now increasing) or of the silver eel escapement (expected to decline) can easily lead to misjudgements. Quantitative assessment of the net mortality and survival in the continental stage, and a patient perseverance in trend-monitoring will be required.

5 Trend-based assessment and reference points

5.1 Introduction

Trend-based assessment is a valuable and robust tool to assess stock status, especially in data-poor situations. This kind of method has several advantages: it requires few kinds of data, it relies on few assumptions and consequently it is quite robust, simple and easy to understand, and harvest control rules may be easily defined. This kind of approach has been implemented for various European stocks and has been widely implemented by Fisheries and Oceans, Canada for the development of the precautionary approach, and is generally recommended by ICES for data-poor situations (DLS Guidance). However, this kind of approach also has the disadvantages of simplicity: ignoring the complex spatial structure of the stock and the impossibility to make predictions. Furthermore, caution should be taken when analysing recruitment trend: a positive increase may be the result of appropriate management measures but may also result from favourable environmental conditions. However, in either case, it is a good signal for stock status.

5.2 Trend-based assessment based on recruitment indices

Two methods based on recruitment trend analysis are proposed. Two reference points were defined:

- R_{target} which is equal to the geometric mean of observed recruitments between 1960 and 1979, periods in which the stock was considered as healthy;
- R_{down} which is equal to the 5% quantile of observed recruitments between 1960 and 1979.

These two thresholds are used to define three zones for the recruitment (terminology according to DFO 2006):

- a *healthy* zone when recruitment is above R_{target};
- a *cautious* zone when recruitment is between R_{target} and R_{down};
- a *critical* zone when recruitment is below R_{down}.

This approach is applied to the eel recruitment indices for the North Sea area, and for the remaining area (Elsewhere), to both raw data and to five-years moving average smoothed series (Table 5-1, Figure 5-1 and Figure 5-2).

Table 5-1. Thresholds estimates for recruitment indices, based on the two recruitment series presented in Chapter 9. Units as in Chapter 9, i.e. the 1960–1980 average is set to 1.0.

	Elsewhere Europe		*North Sea*	
	raw data	*moving average*	*raw data*	*moving average*
R_{target}	*0.94*	*0.91*	*0.93*	*0.93*
R_{down}	*0.53*	*0.63*	*0.54*	*0.73*

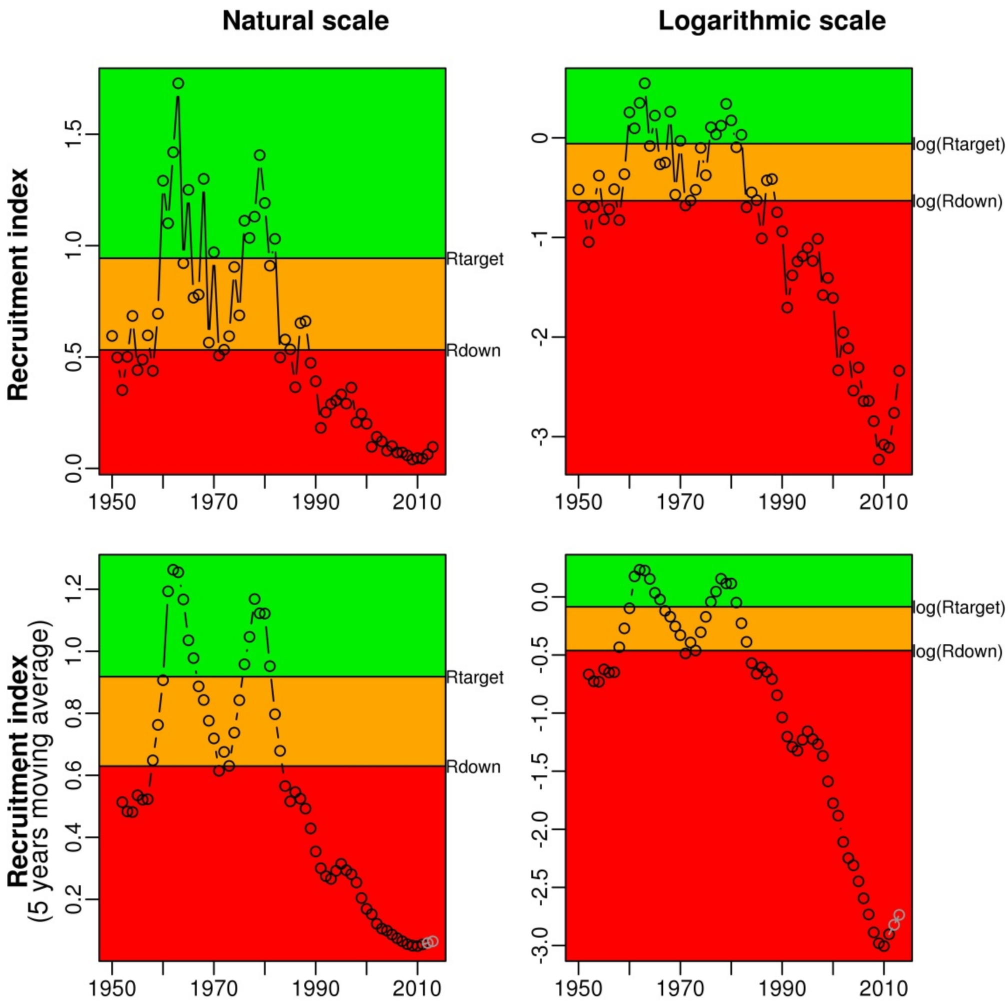


Figure 5-1. Trend in recruitment (<u>Elsewhere</u> Europe index) with respect to healthy zone (green), cautious zone (orange) and critical zone (red) in natural scale (left) and logarithmic scale (right), for the raw observation (top) and the five-year moving average (bottom). For the five-year moving average diagrams, the last points (in grey) apply a smaller moving average window.

The recruitment entered the critical zone in the early 1980s in the North Sea area, and the mid-1980s in Elsewhere Europe. Despite an increase for the last few years (especially visible in Elsewhere Europe logarithmic scale), the recruitment remains in the critical zone, far below R_{down}.

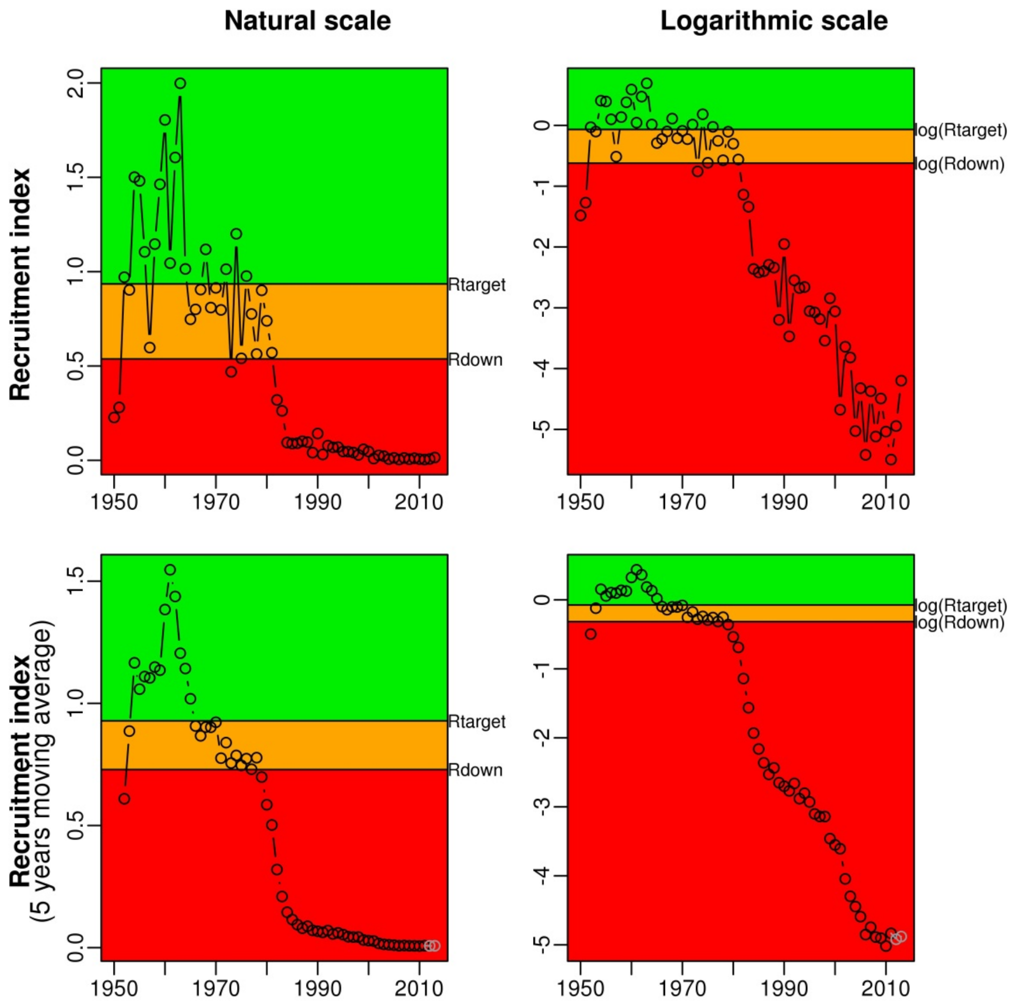


Figure 5-2. Trend in recruitment (North-Sea index) with respect to healthy zone (green), cautious zone (orange) and critical zone (red), on a natural scale (left) and logarithmic scale (right), for the raw observation (top) and the five-year moving average (bottom). For the five-year moving average diagrams, the last points (in grey) are calculated with a smaller moving average window.

A second type of diagram is proposed to assess recruitment status. It is based on the analysis of two metrics:

- the ratio of current recruitment over R_{target};
- the exponential trend observed during the last five years (0 indicates stable, positive value indicates an increase in recruitment, while a negative value indicates a decrease). A range of periods over which the trend was calculated was explored and a five year period appeared to be an appropriate compromise, reflecting the recent evolution in recruitment while smoothing interannual variability.

Four zones are defined on this two-dimensional diagram:

- healthy zone: if recruitment is above R_{target} and the trend is positive (i.e. recruitment status is good and no deterioration is expected);
- cautious zone: if recruitment is above R_{target} but the trend is negative (i.e. recruitment status is good but may deteriorate in future);

- high cautious zone: if recruitment is below R_{target} but the trend is positive (i.e. recruitment status is bad but signs of possible improvements are observed);
- critical zone: if recruitment is below R_{target} and the trend is negative (i.e. recruitment status is bad and may deteriorate in future).

This approach is again applied to the Elsewhere Europe and North Sea recruitment indices (Figure 5-3) and for R/R_{target} directly applied on raw data or on a five year moving average.

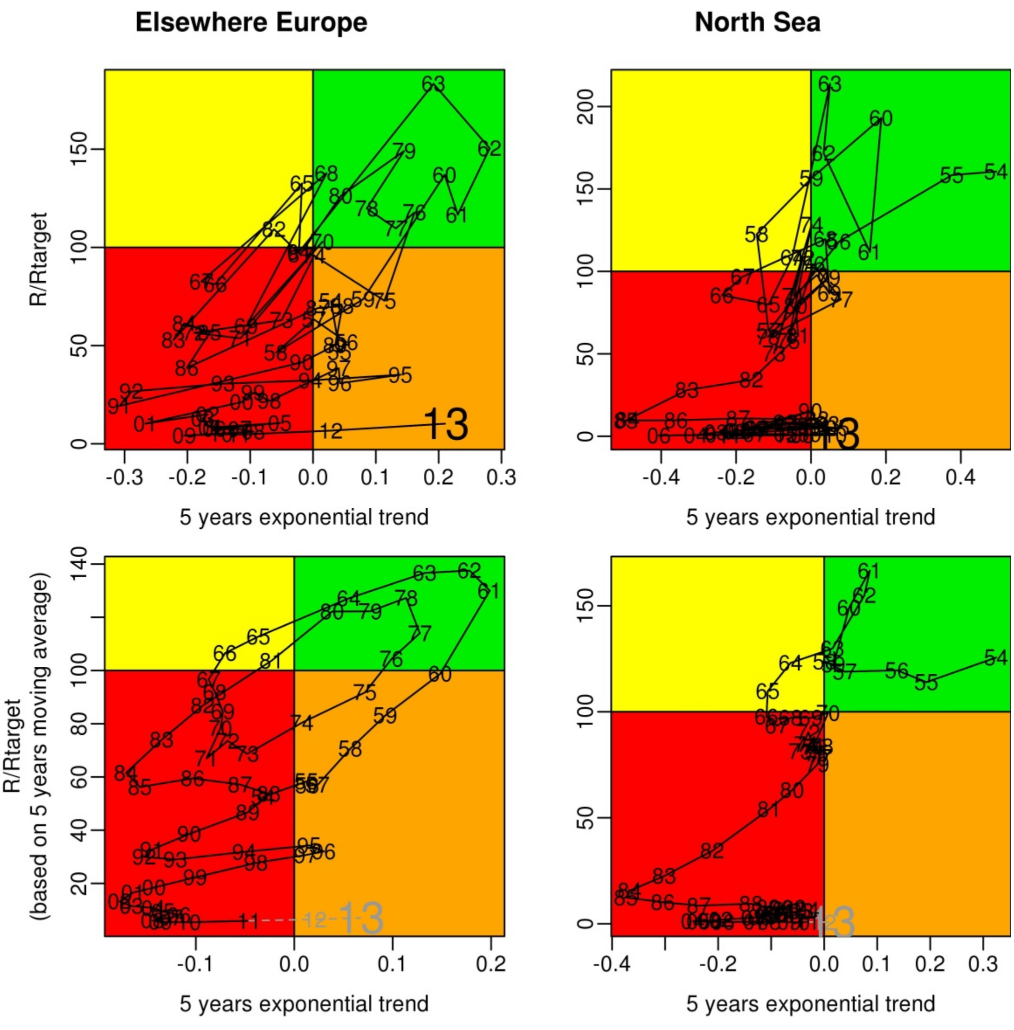


Figure 5-3. Trend in the two metrics (ratio of recruitment over R_{target}) with respect to the four zones (green=healthy zone, yellow=cautious zone orange=high cautious zone, , red=critical zone). For the five year moving average diagrams, the last points (in grey) are calculated on the basis of a smaller moving average window.

The results are consistent with previous diagrams (Figures 5-1 and 5-2) though recruitment entered the critical zone of this second method a little bit earlier. The recruitment briefly exits this zone in the mid-1990s reflecting higher recruitment in Elsewhere Europe, but it was not enough to fulfil stock recovery and the recruitment then returned to the critical zone. The recent increase in recruitment in 2012 and 2013 brings the recruitment back to the high cautious zone. However, this recent trend does not necessarily imply future stock recovery, as illustrated by the previous entry in the high cautious zone in the mid-1990s.

5.3 Conclusion on trend-based assessment and reference point

The status-and-trend diagrams presented above provide a comprehensive and consistent view on the current recruitment status and evolution. Despite an increase in recent years, the recruitment appears to be in critical status and far from recovery to the healthy zone.

5.4 Future development of the trend-based assessment

This current trend-based assessment only uses the recruitment indices, the most reliable data available. Additional indices may be used in future, such as silver eel indices, though data are scarce, and may be uncertain. Moreover, silver eel data may be more representative for the local area where they are collected than for the global stock status because of the contrasts in population dynamics and anthropogenic pressures at the distribution area scale.

6 Quantitative assessment applying generic reference points

6.1 ICES general policy towards advice

ICES provides fisheries advice that is consistent with the broad international policy norms of the Maximum Sustainable Yield approach, the precautionary approach, and an ecosystem approach, while at the same time responding to the specific needs of the management bodies requesting advice. For long-lived stocks with population size estimates, ICES bases its advice on attaining an anthropogenic mortality rate at or below the mortality that corresponds to long-term biomass targets (B_{MSY}). However, $B_{MSY\text{-}trigger}$ is a biomass level triggering a more cautious response. Below $B_{MSY\text{-}trigger}$, the anthropogenic mortality advised is reduced, to reinforce the tendency for stocks to rebuild. Below $B_{MSY\text{-}trigger}$, ICES applies a proportional reduction in mortality reference values (i.e. a linear relation between the mortality rate advised and biomass).

6.2 Eel specific reference points

In 2002, ICES provided advice on management reference points stating that exploitation that provides 30% of the virgin (F=0) spawning–stock biomass is generally considered to be a reasonable provisional reference target. Considering the many uncertainties in eel management and biology, a preliminary value for eel could be 50%. Subsequently, the EU adopted the Eel Regulation, in which the objective is "to reduce anthropogenic mortalities so as to permit with high probability the escapement to the sea of at least 40% of the silver eel biomass relative to the best estimate of escapement that would have existed if no anthropogenic influences had impacted the stock". WGEEL reads this in the sense that the EU uses the 40% target as the trigger point, below which actions should be taken to rebuild the stock. The Eel Regulation, however, does not indicate what approach should be made to rebuild the stock (or correspondingly, what time-scale for rebuilding the stock is acceptable). For ICES, it will be in-line with its existing advice policy, to recommend a linear reduction in mortality below the 40% target adopted by the EU.

The Eel Regulation specifies a limit reference point (40% of pristine biomass B_0) for the biomass of the escaping silver eel, but does not specify a mortality limit. That is: the endpoint of the recovery process is specified, but not the route (the time required, the speed of recovery) towards that point. However, a mortality limit (above $B_{MSY\text{-}trigger}$) of lifetime mortality $\Sigma A=0.92$ can be shown to correspond to the 40% biomass limit (Dekker 2010; ICES 2010, 2011 WGEEL).

6.3 Progress reporting 2012

In 2012, EU Member States post-evaluated the implementation of their Eel Management Plans, and provided estimates of national stock indicators 3Bs&ΣA for before, and since implementation of their EMPs (putatively 2008–2012). ICES (2013 WKEPEMP) reviewed those progress reports, concluding that information is not always completely reported or available, and the quality of the national data and assessment is hard to evaluate. Subsequently, ICES has decided to use the reported stock indicators in good faith (ToR i: 'Apply the reported biomass and mortality data…'), which is what is done in this report.

6.4 International assessment procedure

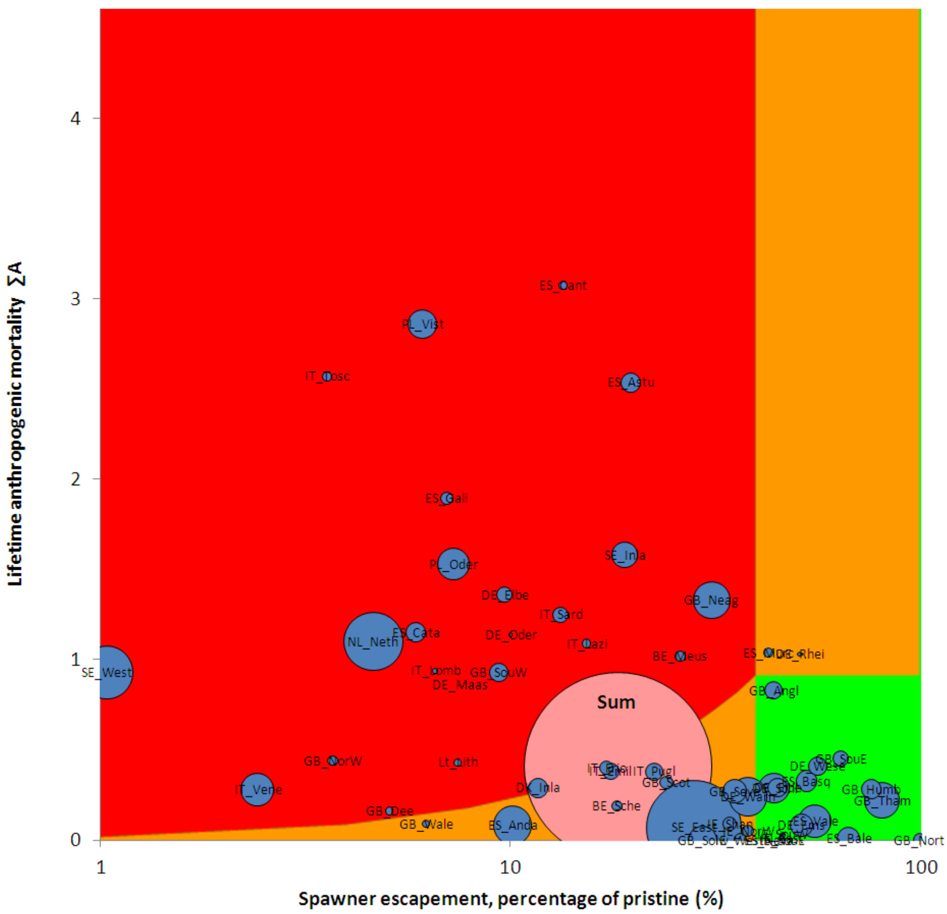
In the 2010 Report of ICES Study Group on International Post-Evaluation of Eel (SGIPEE) (ICES 2010a), a pragmatic framework to post-evaluate the status of the eel stock and the effect of management measures was designed and presented, including an overview of potential post-evaluation tests and an adaptation of the classical ICES precautionary diagram to the eel case. In the Precautionary Diagram, annual fishing mortality (averaged over the dominating age groups) is plotted vs. the spawning–stock biomass. In the modified Precautionary diagram (Dekker 2010; ICES 2010, 2011 WGEEL), lifetime anthropogenic mortality ΣA (or the spawner potential ratio %SPR on a logarithmic scale) is plotted against silver eel escapement (in percentage of B_0). This modified diagram allows for comparisons between EMUs (%-wise SSB; lifetime summation of anthropogenic mortality) and comparisons of the status to limit/target values, while at the same time allowing for the integration of local stock status estimates (by region, EMU or country) into status indicators for larger geographical areas (ultimately: population wide).

6.5 Assessment results

The modified Precautionary Diagrams shown below plot the 3Bs&ΣA-indicators as provided by Member States in their 2012 progress reports (with minor updates and corrections provided in Country Reports to WGEEL 2013) against the background of the generic reference points according to the 40% biomass target of the EU Eel Regulation, the corresponding mortality limit of ΣA=0.92 - taking the 40% biomass limit as $B_{MSY\text{-}trigger}$ and a linear trend (but here plotted on log-scale) in the mortality limit below $B_{MSY\text{-}trigger}$.

The modified Precautionary Diagrams evaluate the status against generic reference values, using data provided by the Member States. Since not all have reported (and not for all years from 2009 onwards), the presented stock-wide sum represents the reporting countries; not all countries within the distribution area, and not even all countries within the EU. Moreover, the set of countries reporting indicators has changed over the years; therefore, the sum of reporting countries cannot be compared between the years. WGEEL decided to restrict the graphical presentation to the latest data year, 2011. In some countries, additional management measures have been taken in 2012 (e.g. Sweden closing the fishery in SE-west), but these have not been considered in this report.

The diagrams present the indicators per Eel Management Unit (Figure 6-1 top), and per country (Figure 6-1 bottom); each plot also contains the Sum of the reported areas. Some countries (notably France) did not report all stock indicators (in particular B_0) for each EMU, but did so for the country as a whole. Thus, France is not represented in the first plot, but it is in the second, and continent-wide sums differ between the plots. The difference in outcomes between the plots emphasizes the importance of a consistent and full-coverage set of stock indicators. Finally, Figure 6-2 presents the status of each EMU in relation to the modified Precautionary Diagram (i.e. the background colour that applies to the zone where the EMU bubble sits in the modified Precautionary Diagram) in a map, where data-deficient areas have been shown by a ☹. This map indicates that major areas have not assessed their part of the stock; while the sum of the reporting countries is far away from the required stock-wide total. In the next chapter, a tentative analysis will be made of the relation between spawning–stock biomass and subsequent recruitment; in that analysis, all countries for which landings data were available are included; that is: a wider spatial coverage.


Lifetime anthropogenic mortality ∑A
Spawner escapement, percentage of pristine (%)
0
1
2
3
4
1
10
100
Sum
ES_Cant
PL_Vist
IT_Tosc
ES_Astu
ES_Gali
SE_Inla
PL_Oder
DE_Elbe
GB_Neag
IT_Sard
NL_Neth
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IT_Lazi
BE_Meus
DE_Rhei
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DK_Inla
IT_Pugl
GB_Scot
BE_Sche
SE_East
IE_Shan
GB_SouE
DE_Wese
ES_Basq
GB_Humb
GB_Tham
DE_Warn
DE_Ems
ES_Vale
ES_Bale
GB_Nort

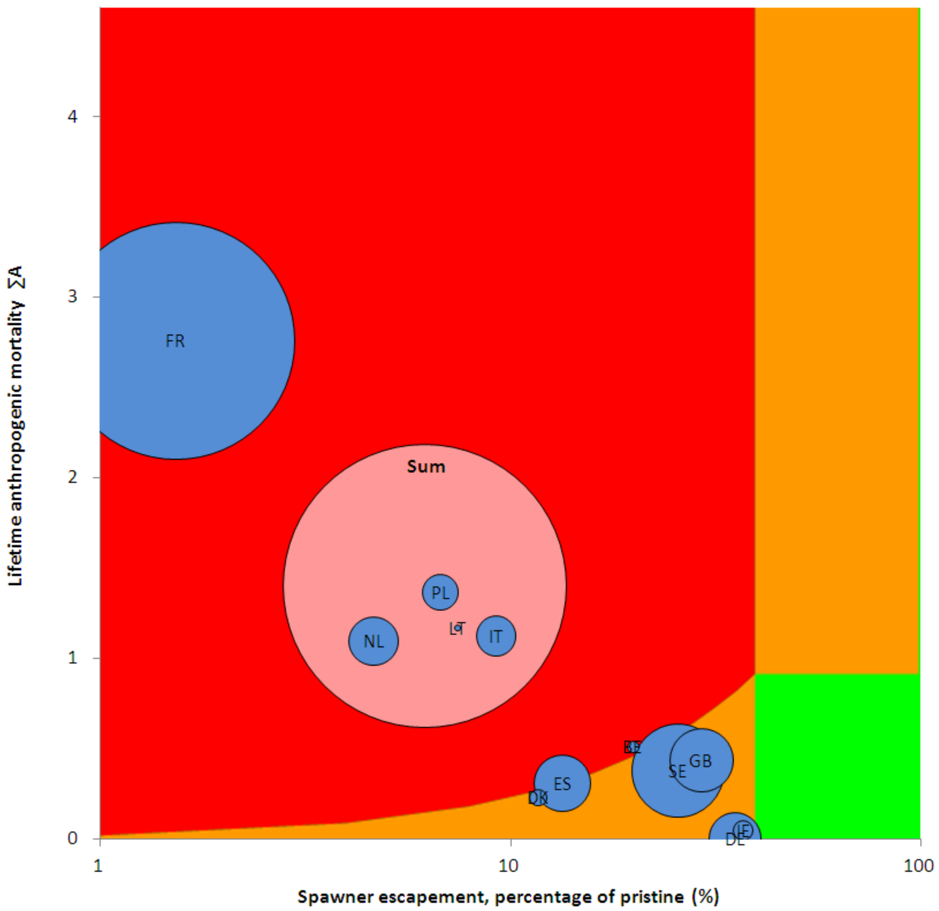


Figure 6-1. Modified Precautionary Diagram, presenting the status of the stock (horizontal, spawner escapement expressed as a percentage of the pristine escapement) and the anthropogenic impacts (vertical, expressed as lifetime mortality ΣA). Data from the 2012 progress reports (ICES 2013, WKEPEMP). The size of the points (bubbles) indicates the size of B_{best}, while their location indicates the status of eel in the EMU in terms of spawning biomass against the 40% target, and anthropogenic mortality against the rate equivalent to that biomass target (i.e. $\Sigma A = 0.92$ if $B_{current} >$ 40% B_0 or $\Sigma A = 0.92 * B_{current}/(40\%B_0)$ if $B_{current} <$ 40% B_0). Green indicates the local stock is fully compliant, amber indicates that one target is reached but not the other, and red indicates that neither target is reached. In most cases, the 2011 indicators are shown; when these were missing, the 2010 indicators are used. Top: stock indicators by EMU and for the sum of the reported EMUs (59 EU-EMUs are missing); bottom: stock indicators by country and for the sum of the reported countries (26 EU and no-EU countries are missing). Note that non-reporting EMUs/countries do not show up in these plots.

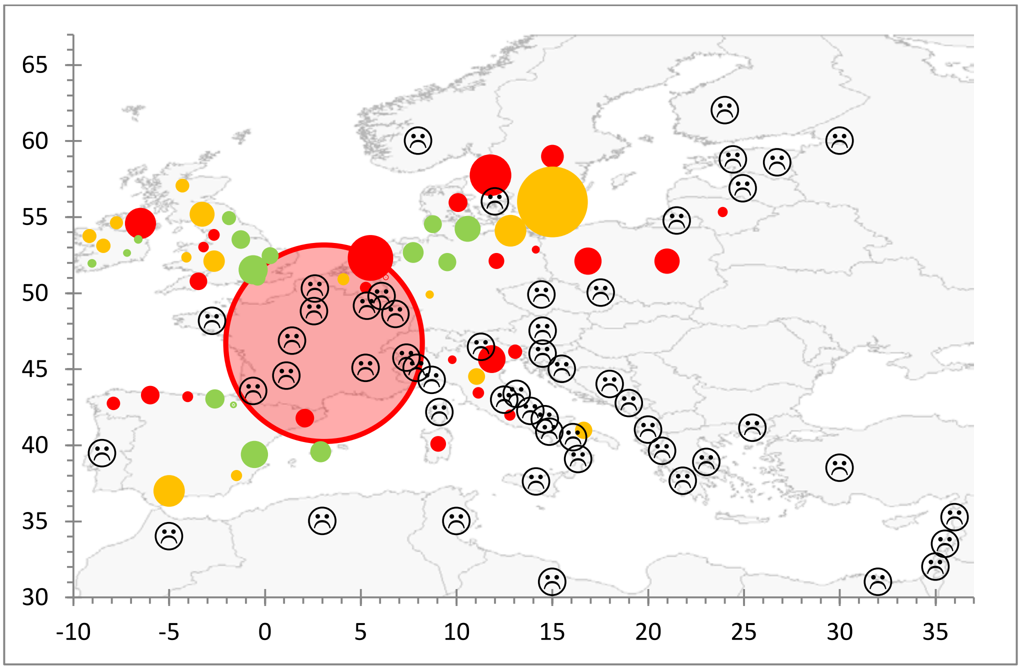


Figure 6-2. Stock indicators from the modified Precautionary Diagram (Figure 6-1), plotted on the location of the EMU they refer to. The size of each bubble corresponds to B_{best}, the biomass of escaping silver eels if no anthropogenic impacts had affected the current stock. The colour of each bubble corresponds to the position of the indicators, relative to the reference limits of the modified Precautionary Diagram (the background colour in Figure 6-1, above). For EMUs/countries that did not report their stock indicators (or incompletely), a ☹ of arbitrary size is shown. Data from the 2012 progress reports (ICES 2013, WKEPEMP). In most cases, the 2011 indicators are shown; when these were missing, the 2010 indicators are used. For France, indicators have only been reported for the country as a whole, not for the constituting EMUs; that country-total is shown (shaded red), along with the EMUs (☹).

6.6 Conclusions on quantitative assessment applying generic reference points

Based on the information (stock indicators) provided by EU Member States, it is concluded that the stock - at least in the reporting countries - is not within sustainable limits conforming to the Eel Regulation and ICES policies. The biomass of escaping silver eel is estimated to be well below the target of 40% set in the EU Eel Regulation (summed over reported EMUs: 18%; summed over reporting countries: 6%). The anthropogenic mortality ΣA is estimated to be just at (averaged over reporting EMUs) or far above (averaged over reporting countries) the precautionary level that would be in accordance with ICES general policies for recovering stocks (for EMU sums: ΣA=0.41 with target 0.42; for country sums: ΣA=1.40 with target 0.14). On top of this, a major part of the Member States has not (completely) reported stock indicators, the distribution area of the eel extends considerably beyond the EU, and countries in these outer regions have not yet been involved in the assessment and stock recovery process.

6.7 Future improving of the international assessment

The international assessment, presented above, has some obvious shortcomings. First, the 2012 progress reporting did not achieve full coverage. Though all relevant EU countries supplied a report, not all of them contained the requested stock indicators, or not for all years. Improving the spatial coverage, extending beyond the borders of the EU, and completing the reporting of indicators, will facilitate the post-evaluation. For the 2012 reporting, no standards were set, and countries used a wide range of different methods and assessment tools. Standardization of methods could speed up the international assessment process; and more importantly, standardization will enable quality control, which was not achieved in 2012. The geographic variation in biological characteristics of the eel, as well as the variation in the types and magnitude of fishing and other anthropogenic impacts, might require some spatial variation in techniques. It is suggested that ICES, EIFAAC, the EU and Member States, and GFCM consider regional standardization (e.g. by ecoregion), or even full standardization on a small number of related techniques. Achieving the full international coordination/standardization (see recommendations of WKESDCF 2012) requires international initiative (c.f. the Bonus-proposal BaltEel), in addition to regional cooperation between Member States.

7 Eel-specific reference points based on the stock-recruit relationship

7.1 Introduction

Last year, ICES (2012 WGEEL) analysed the potential relation between the stock abundance and subsequent recruitment, along the lines set out in Dekker (2004). In particular, a new fitting procedure was proposed (GAM (General Additive Model: Hastie and Tibshirani, 1990)) on stock–recruitment combined with a simple replacement line), leading to novel reference points (B_{stop} and B_{stoppa}) that could accommodate for depensation and/or change in stock–recruit-regimes. This chapter follows the same approach, updating the data and improving the estimates of historical spawner escapement for a potential change in exploitation rate.

7.2 Biomass estimate

The actual spawning–stock biomass (in the Sargasso Sea) has never been observed. The best available proxy is the escapement that exists after all of the fisheries and other mortalities (both natural and anthropogenic) in the continental and littoral waters have occurred.

For present and future, according to EU Regulation 1100/2007, Member States will provide the best estimate of the escapement for each EMU. However, no direct estimate of historical escapement at the stock scale is available. The aim of this chapter therefore is to reconstruct a time-series of escapement for the past 60 years from proxy data. The idea is to use the landings, prioritizing the silver eel fishery since they are the closest to the escapement. If it is not possible to use silver eel data, information from the yellow eel fishery may be used, although it will complicate the procedure.

It will be very difficult to also consider catches of glass eel for this calculation. The impact of these on the SSB is delayed by a number of years and complicated by the additional natural and anthropogenic mortality that will be exerted on these before they contribute to the silver eel biomass.

In order to prepare further developments (replacement line, stock-wide population dynamics) the geographical area was split into functional units within which factors impacting on eel growth/exploitation are considered by expert opinion to be similar. These units are treated as a kind of subpopulations having different ecological or anthropogenic characteristics in the continental phase, though contributing to the same single oceanic spawning stock (c.f. TRANSLOCEEL in ICES, 2011). These functional units are defined according to ICES ecoregions (Figure 7-4): Baltic Sea (L), North Sea (F), Celtic Sea (E), South European Atlantic Shelf (G) which is referred to as the Bay of Biscay in the following figures for simplicity even if it encompasses the Portugal, and the Mediterranean Sea (H, I and J).

To ease the work, some EMU's were assigned to one and only one ecoregion, even where they span across the border between two; these EMUs were assigned to the ecoregion in which the major part of the eel stock resides. This simplification was applied in cases where the biological characteristics did not differ that much between the ecoregions (e.g. Scotland spans the North Sea (F) and Celtic Sea (E) ecoregions). In other cases (e.g. France, covering the Atlantic and the Mediterranean), catches were partitioned over the ecoregions. There are currently no estimates of regional catches within countries available to WGEEL, so for the current purposes the proportions of catches in each region are estimated, either based on collected series made available to the WGEEL or by expert knowledge.

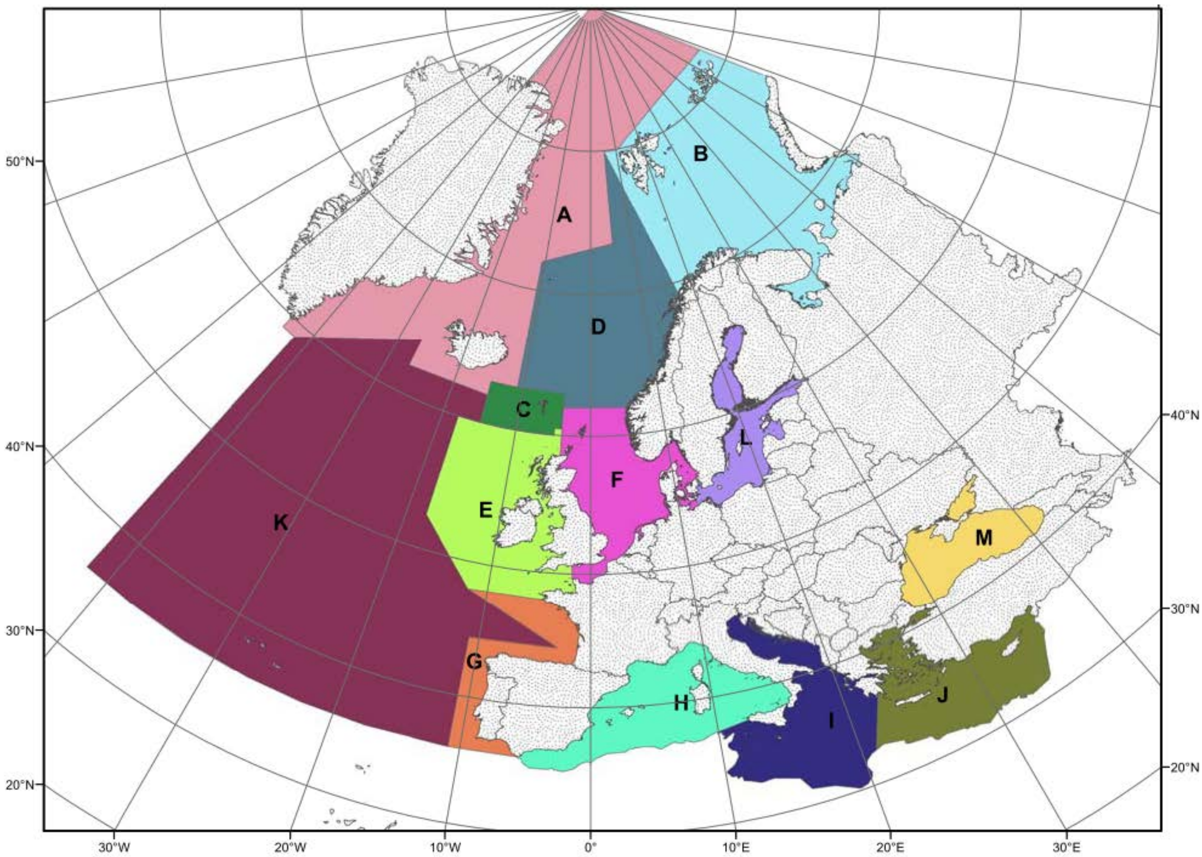


Figure 7-4. ICES ecoregions.

7.3 Improvement of catch data analysis

Since last report (2012) the catch data have been updated and the theoretical framework to evaluate the escapement biomass has been extended.

The relationship between catches and stock varies over time. The reasons for this are not always related to the stock itself but could be caused by factors as diverse as the weather, market fluctuations, availability of other work, etc. Of more concern for predicting this relationship is whether significant changes in effort or gear have occurred. Such changes would affect the relation between landings and escapement if the expert-supplied exploitation rate estimates do not account for this.

WGEEL (ICES, 2012) concluded that dataseries from the Country Reports continued to be unreliable but were improving. A great heterogeneity in landings data reports was observed, with countries making reference to an official system, some of which report total landings, others report landings by Management Unit or Region, and some countries not having any centralized system. However, some countries have revised their dataseries, with extrapolations to the whole time-series, for the necessities of the Eel Management Plan compilation (Poland, Portugal) or of the WGEEL (Spain).

Landings data were incomplete, with some years missing for some of the countries. An estimate of the missing values is first provided by simple GLM (General Linear Model) extrapolation (after Dekker, 2003), with landings in log scale and year and countries as the explanatory factors.

The catches are further divided by stages (yellow eel and silver eel), either based on collected series made available to the WGEEL or by expert knowledge.

Based on this work we have estimates of catches per country, per ICES ecoregion and per stage.

7.4 Development of the theoretical framework to estimate biomass from catches

The approach of Potter *et al.* (2004) to reconstruct a time-series of Atlantic salmon abundance before exploitation based on catch declarations was adopted with some modifications. For the Atlantic salmon, minimum and maximum values based upon best available knowledge of the missing data (non-reporting rates, exploitation rates, natural mortality, and migration times) were providing by national experts These values are likely centred on the true values, and are used to delimit uniform distributions for these parameters in a Monte Carlo simulation (MCS).

7.4.1 Use of silver eel catch data to calculate an escapement

The calculation of escapement using silver eel catch data can be achieved if it is assumed that mortalities (fishing and other source of mortality) operate sequentially. This approach does not need to take account of anthropogenic mortality impacting the eel before they are susceptible to the fishery.

Let $B_{s,u}(t)$ be the biomass before the silver eel fishery in functional unit u and the exploitation rate for silver eel fishery in unit u, $\beta_{s,u}(t)$, is the ratio between catch and this biomass:

$$\beta_{s,u}(t) = \frac{C_{s,u}(t)}{B_{s,u}(t)}$$

The escapement in unit u, $E_u(t)$, is the biomass that survives from the fishery and from other anthropogenic mortality after the silver eel fishery.

$$E_u(t) = \left(B_{s,u}(t) - C_{s,u}(t)\right)e^{-H_{s,u}}$$

In this case the natural mortality relative to fishery mortality is assumed to be negligible.

Combining the two previous equations, we obtain

$$E_u(t) = \left(\frac{C_{s,u}(t)}{\beta_{s,u}(t)} - C_{s,u}(t)\right)e^{-H_{s,u}}$$

Or

$$E_u(t) = C_{s,u}(t)\left(\frac{1-\beta_{s,u}(t)}{\beta_{s,u}(t)}\right)e^{-H_{s,u}} \qquad (0)$$

Estimates of $\beta_{s,u}$ and/or H will be required in order to construct an informative SSB proxy. Estimates for $\beta_{s,u}$ and H generally being available for most recent years in the national progress reports, this yields an estimate of escapement in those recent years; for the preceding decades, the trend in exploitation since 1950 is taken from expert knowledge (see below).

7.4.2 Use of yellow eel catch data to calculate a escapement

Though some progress has been made in deriving formulae for the estimation of escapement biomass from yellow eel landings, this approach could not be completed during the meeting. As a consequence, the escapement biomass was reconstructed from silver eel data only.

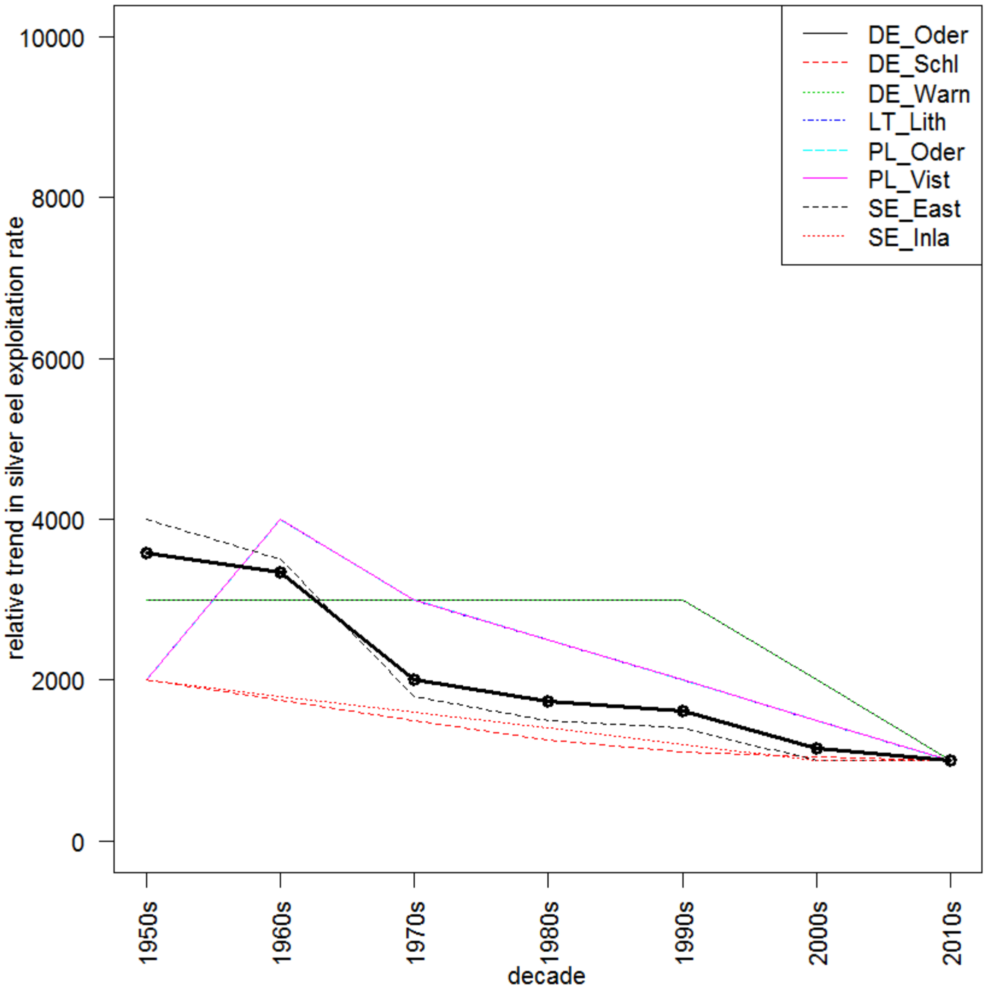
7.5 Estimate of biomass from silver eel catches

The escapement biomass and the exploitation can be calculated on the basis of the reported values from the ICES data call. It is not necessary to use absolute estimates of exploitation rates in past decades, as trends in combination with most recent (2012 progress reports) exploitation rates will be sufficient to go back in time. Information on this trend in exploitation rate of the silver fisheries has been collected during the WGEEL from the available experts, broken down by decade and EMU.

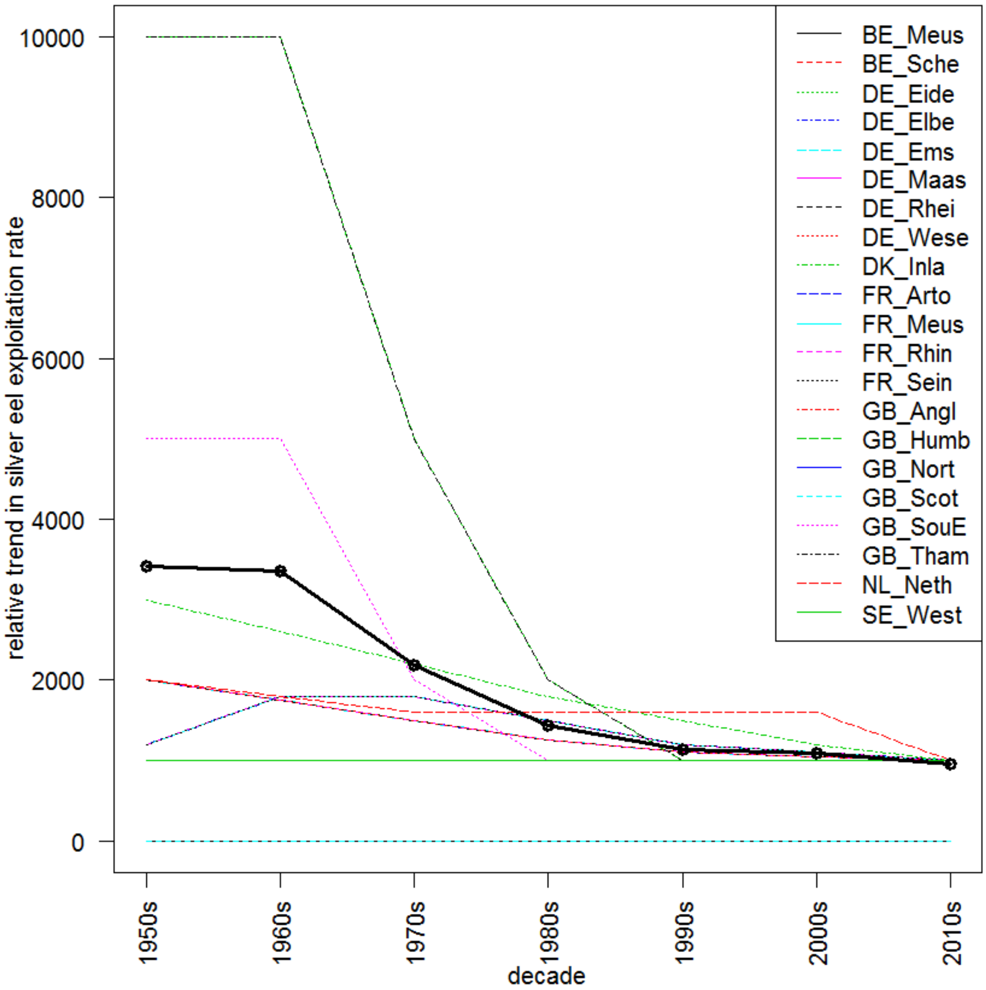
Exploitation rate trends for EMU in each ecoregion are aggregated according to $B_{current}$ estimates for 2008–2011 (Figure 7-5 and Figure 7-6). The trend is converted into an absolute value dataseries by multiplying it by the 2008 exploitation rate calculated with the formula:

$$\beta_{s,u}(2008) = \frac{\sum_u C_{s,u}(2008)}{\sum_u \left(C_{s,u}(2008) + B_{current,u}(2008)\right)}$$

Baltic Sea

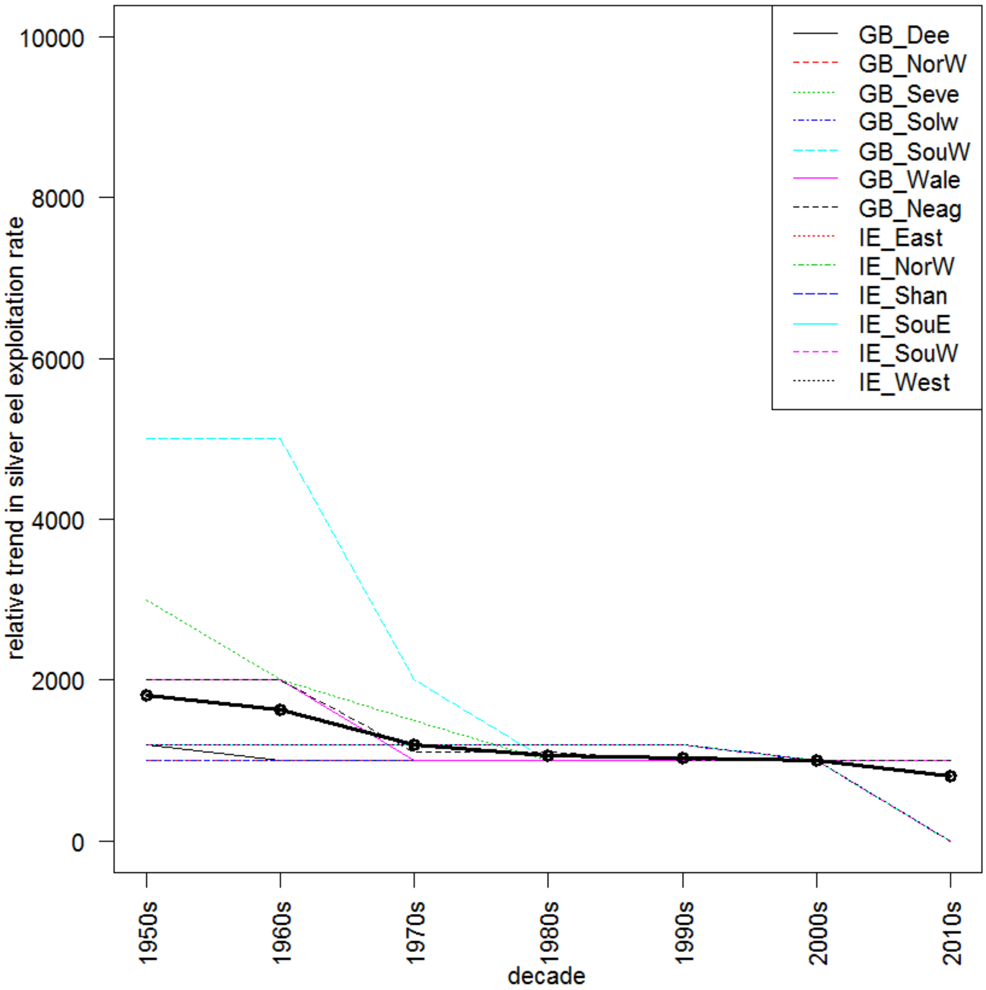

10000
8000
6000
4000
2000
0
relative trend in silver eel exploitation rate
1950s
1960s
1970s
1980s
1990s
2000s
2010s
decade
DE_Oder
DE_Schl
DE_Warn
LT_Lith
PL_Oder
PL_Vist
SE_East
SE_Inla

North Sea



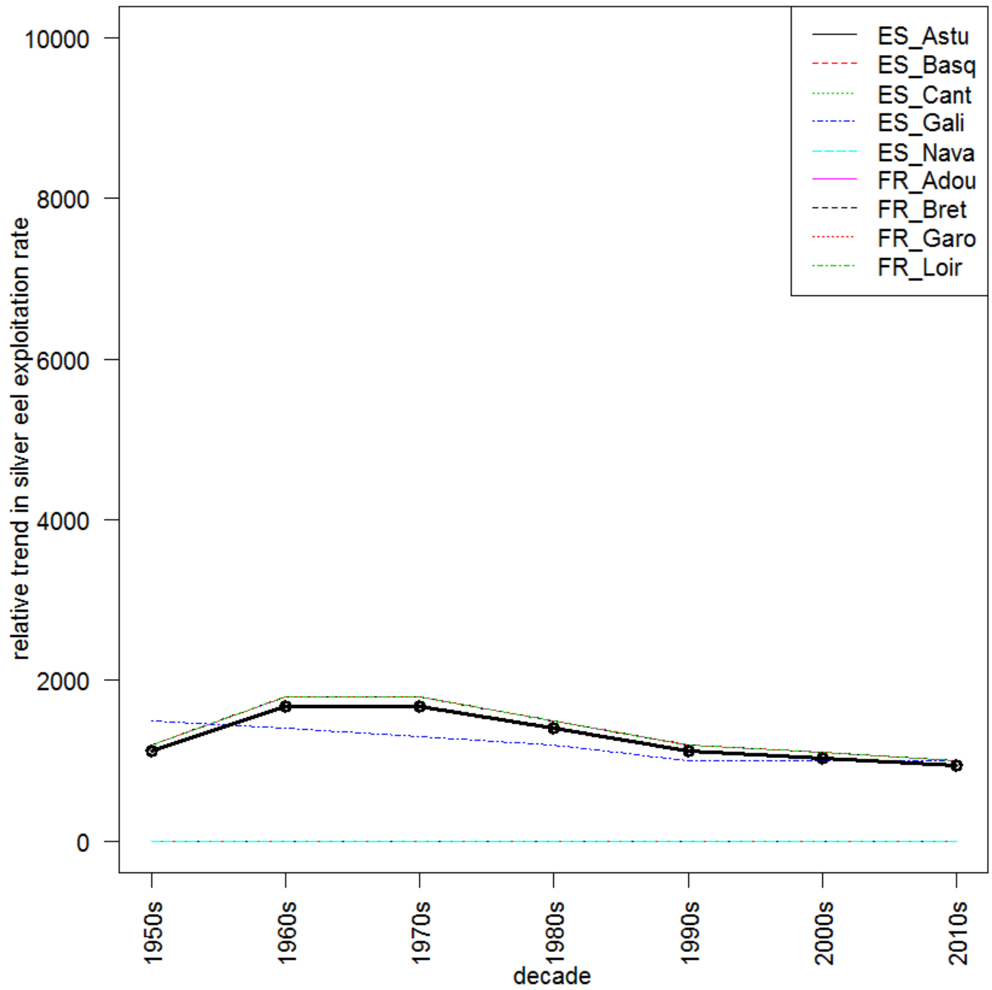
10000
8000
6000
4000
2000
0
relative trend in silver eel exploitation rate
1950s
1960s
1970s
1980s
1990s
2000s
2010s
decade
BE_Meus
BE_Sche
DE_Eide
DE_Elbe
DE_Ems
DE_Maas
DE_Rhei
DE_Wese
DK_Inla
FR_Arto
FR_Meus
FR_Rhin
FR_Sein
GB_Angl
GB_Humb
GB_Nort
GB_Scot
GB_SouE
GB_Tham
NL_Neth
SE_West

Celtic Sea



GB_Dee
GB_NorW
GB_Seve
GB_Solw
GB_SouW
GB_Wale
GB_Neag
IE_East
IE_NorW
IE_Shan
IE_SouE
IE_SouW
IE_West
relative trend in silver eel exploitation rate
10000
8000
6000
4000
2000
0
1950s
1960s
1970s
1980s
1990s
2000s
2010s
decade

South European Atlantic Shelf



Mediterranean Sea

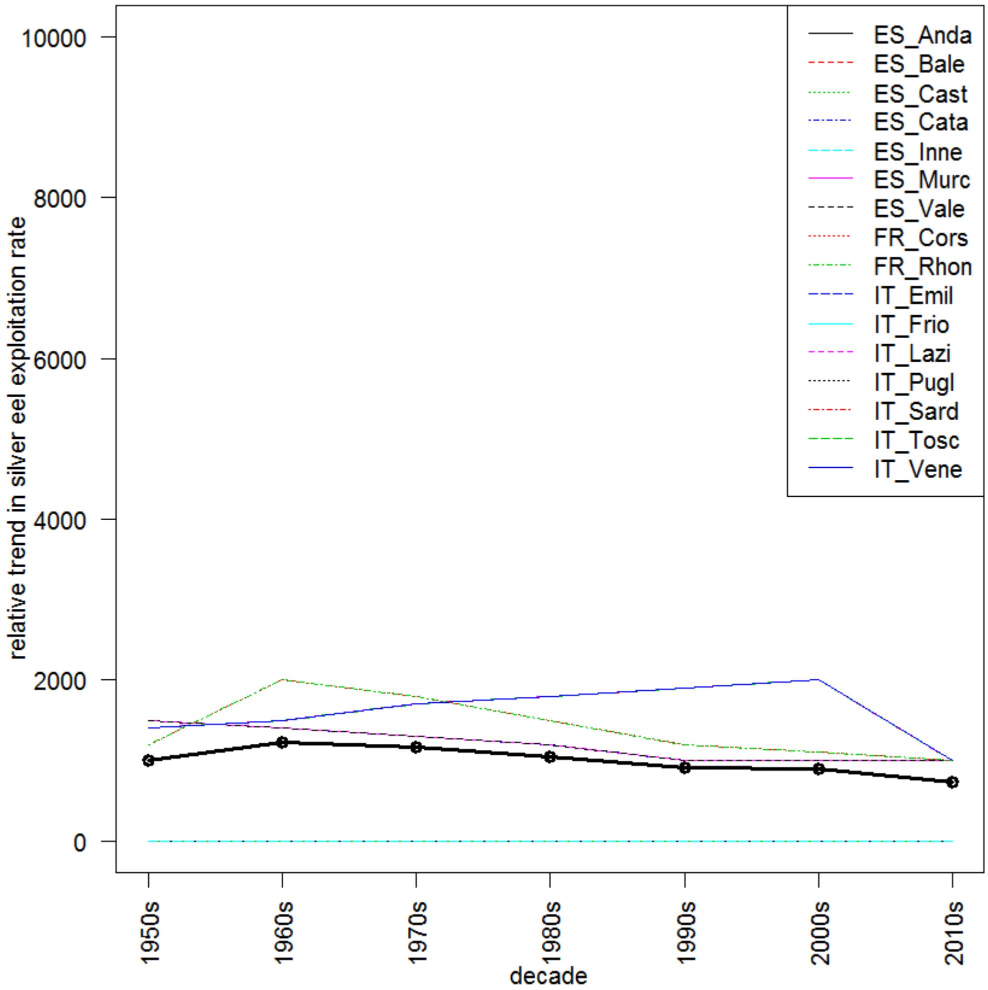


Figure 7-5. Relative trend in silver eel exploitation rate by EMU (thin line) and the weighted mean trend for the ICES ecoregions (black line).

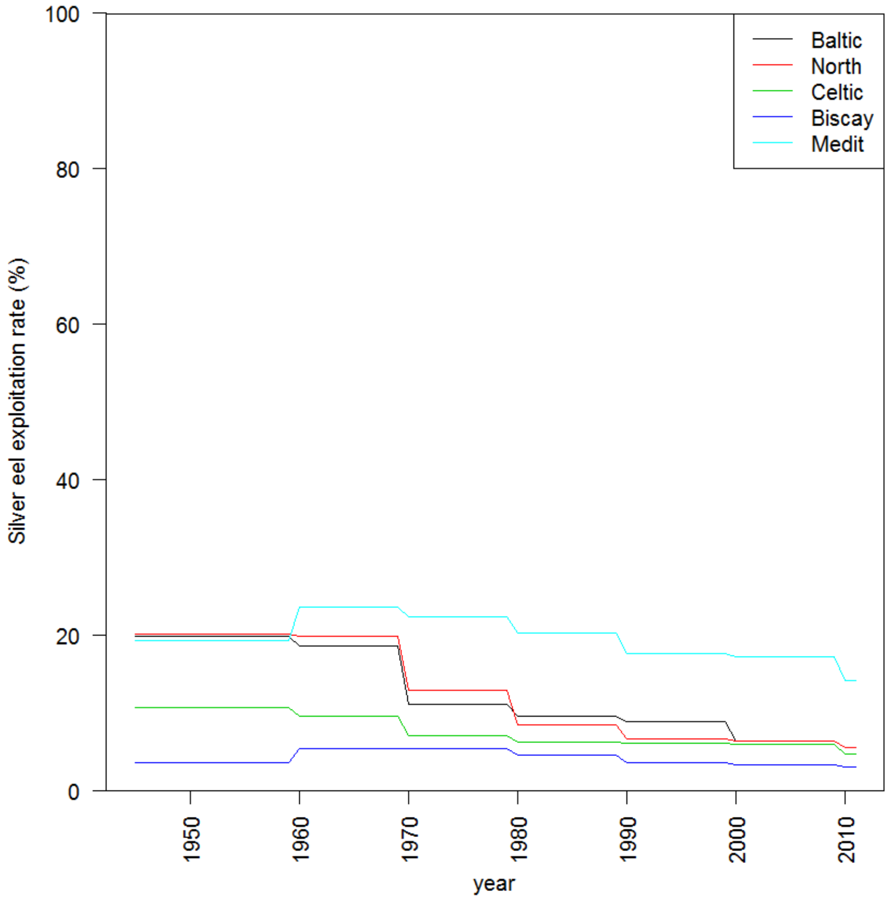


Figure 7-6. Mean exploitation rate by ICES ecoregions.

The mean exploitation rate (Figure 7-6) was applied to the summed silver eel catches by ICES ecoregions (Figure 7-7) to calculate the escapement from each ecoregion with equation (0) considering there is no anthropogenic mortality after the silver eel fishery ($H_s = 0$) (Figure 7-8).

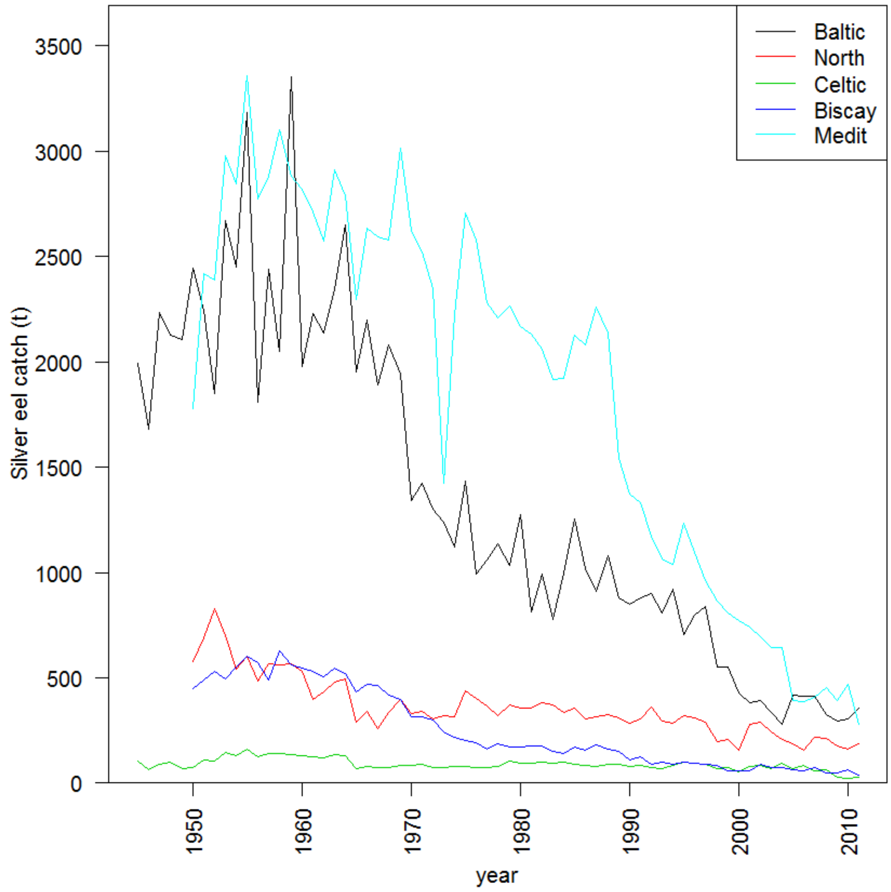


Figure 7-7. Silver eel catches summed by ICES ecoregions.

This estimate of biomass is compared to the corresponding estimate of pristine biomass made by each country in the ICES data call (B_0 for Baltic Sea: 18 000 t, North Sea: 41 000 t, Celtic Sea: 5000 t, South European Atlantic Shelf: 77 000 t, Mediterranean Sea: 52 000 t; Figure 7-9) and to the total of catches previously used as a proxy of biomass (e.g. Dekker 2004; WGEEL 2012; Figure 7-10).

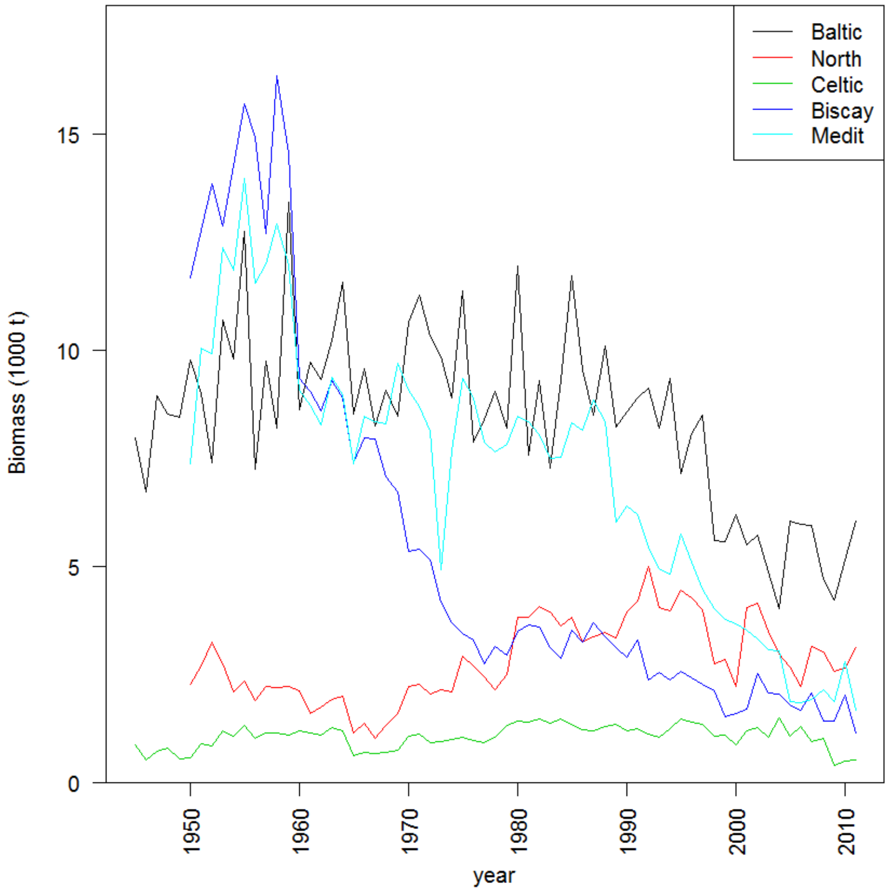


Figure 7-8. Escapement (silver eel biomass) by ICES ecoregion.

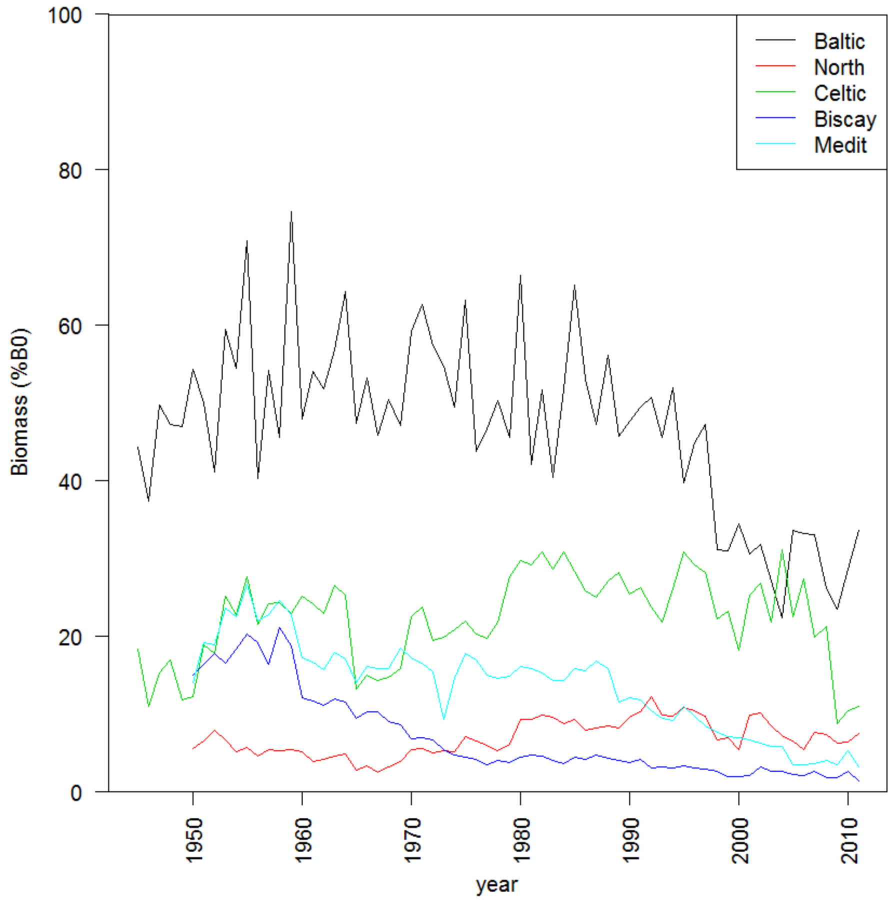


Figure 7-9. Estimate of silver eel biomass by ICES ecoregion compared to the corresponding pristine biomass estimates provided in MS Progress Reports and Country Reports.

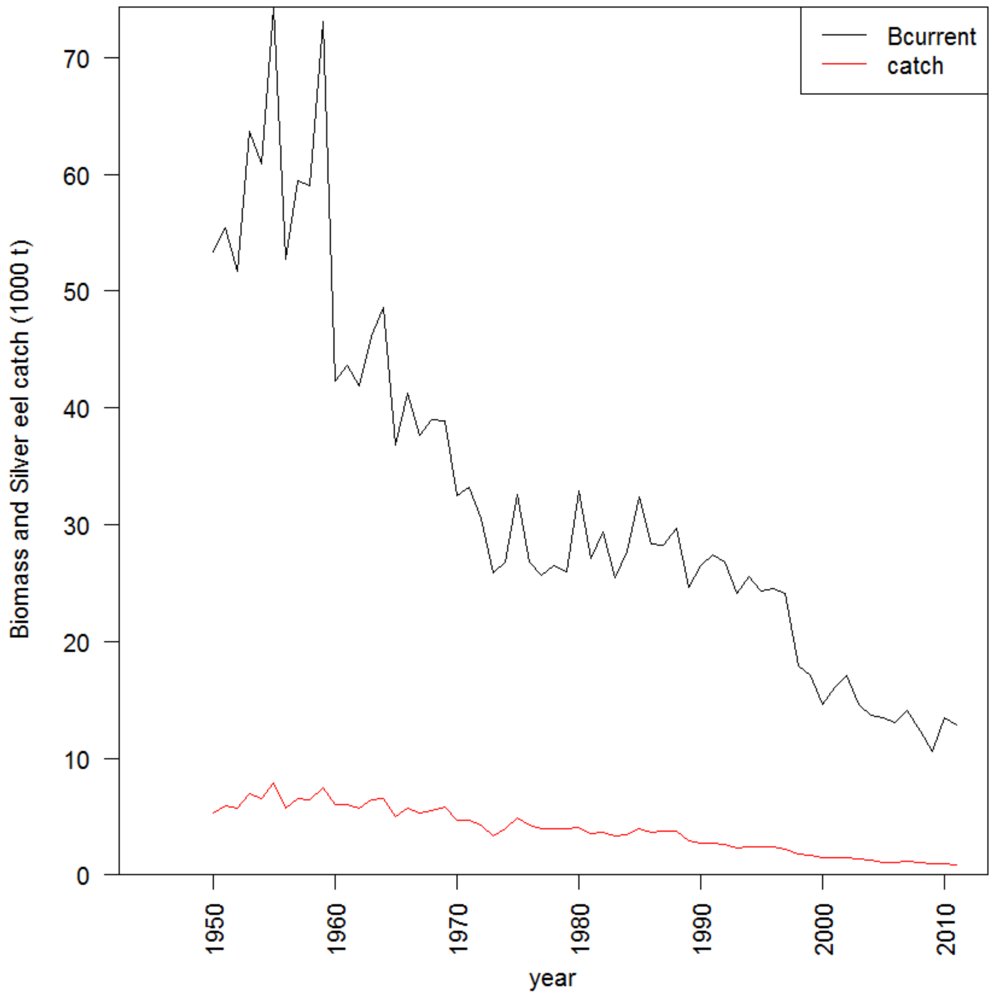


Figure 7.10. Estimate of silver eel biomass and corresponding catches.

7.6 Applying the classical S-R relationship

The stock–recruitment relationship was fitted using the "Elsewhere" recruitment index from 1952 to 2012 (pending the combination of "Elsewhere" and "North Sea") and the time-series of escapement from 1950 and 2010 (from the previous section) as a proxy of spawning–stock biomass (SSB). The two-year lag corresponds to the duration of the oceanic journeys.

Several models of stock–recruitment relationship were tested using the Akaike Information Criterion (AIC) (Akaike, 1974). The Ricker model presents an overcompensation that leads to a maximum production at an intermediate level of SSB. The Beverton and Holt model presents a compensation for high recruitment. In that case, the recruitment does not increase as fast as the SSB. The hockey-stick model is a simplification corresponding to a one-breakpoint segmented regression with the first segment passing through origin. This model assumes that recruitment is independent of SSB above some change point, below which recruitment declines linearly towards the origin at lower values of SSB. A two-breakpoint segmented regression allow for the integration of a possible Allee affect (Allee, 1931) in the stock–recruitment relationship when upward concavity in the curve is observed. This effect, also known in the fishery literature as the depensation (Hilborn and Walters, 1992), corresponds to a drop in the production of recruits when the stock size decreases. It can seriously accelerate population decline and drive a population to extinction, or at least heavily hamper its recovery (Walters and Kitchell, 2001).

The AIC for each model (Table 7-1) lead to the selection of a two-breakpoint model, shown in Figure 7-8. This model selection highlights a possible Allee effect which is consistent with earlier analyses (Dekker 2004; ICES 2007).

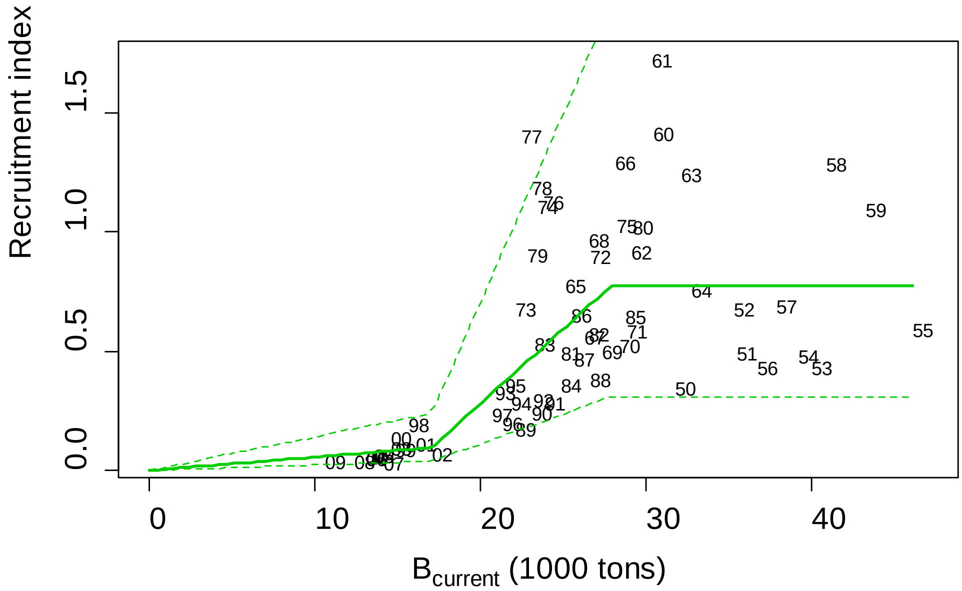


Figure 7.11. Two-breakpoint segmented regression between spawning–stock biomass ($B_{current}$) and recruitment index between 1950 and 2010. Two-digit labels indicate the years of silver eel escapement, recruit occurs two years later, the dashed lines indicate 95% confidence interval).

Table 7-1. AIC for the four stock–recruitment models tested.

	PARAMETER NUMBER	AIC
Ricker	2	28.68
Beverton	2	29.08
Hockey stick (one-breakpoint)	2	29.04
Two-breakpoint model	4	-24.28

7.7 Classical biological reference point B_{lim}

B_{lim} is defined as the SSB below which there is a substantial increase in the probability of impaired recruitment.

Historic stock–recruit data for eel show that eel falls into the categories of stock where recruitment has been impaired. In this case, ICES (2012b) considered that a hockey-stick regression is a statistically objective tool for estimating **B_{lim}**. However such a relation provides an unrealistic fit to the data (Figure 7-9): observed recruitment has been below that predicted by the model ever since 1995. The fit of this model is strongly rejected by AIC (Table 7-1).

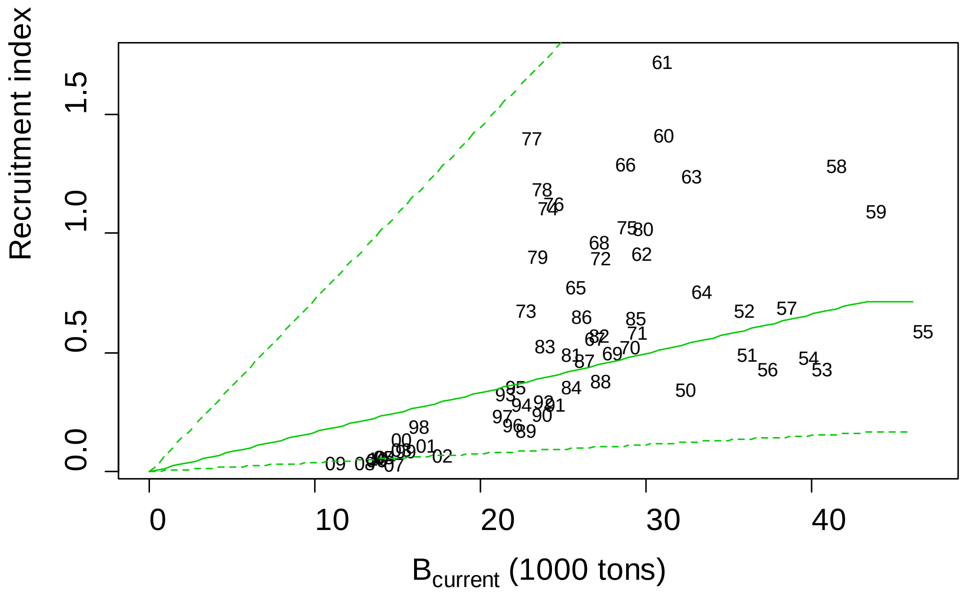


Figure 7.12. Hockey-stick regression between spawning–stock biomass (estimated $B_{current}$) and recruitment index between 1950 and 2010. Two-digit labels indicate the years of silver eel escapement, recruitment occurs two years later; the dashed lines indicate 95% confidence interval). Note the breakpoint in the regression line at the far right, at B=43 thousand tonnes.

We also applied a two-breakpoint, segmented regression, for which the right-hand breakpoint estimates the SSB above which recruit is independent of SSB, which is a candidate for $\mathbf{B_{lim}}$. This breakpoint was found at 27.8 thousand tonnes of silver eels (95% confident interval 23.1–33.5).

The pristine biomass B_0 was estimated in Eel Management Plans and 2012 Progress reports, for each EMU independently. Here, the sum over the EMUs is taken as a first estimate of the global B_0. For this, only the EMUs that were also represented in the estimation of $B_{current}$ were selected. This B_0 is estimated at 193 thousand tonnes. The breakpoint is at 14.4% of this B_0.

As a preliminary value of B_{lim}, a value of 27.8 thousand tonnes of silver eels is proposed, but this absolute value refers to the areas for which adequate data were available only. However, expressing B_{lim} as a percentage, a generic value of 14.4% of pristine biomass could be used throughout the distribution area. This value is considerably lower than the one adopted in the EU Regulation (40%). The value of 14.4% should be taken with caution since the calculation uses data with only a partial coverage of the distribution area and only on the silver eel fishery. An unreliable estimate of pristine escapement can also explain such a small $\%B_{lim}$.

7.8 A flexible stock–recruitment relation; new biological reference points

7.8.1 B_{stoppa}, a proposed new reference point to avoid extremely low stock biomass

At spawning–stock biomass below $B_{MSY\text{-}trigger}$, ICES advises to reduce fishing mortality below F_{MSY}. At extremely low spawning–stock biomass, normal recovery mechanisms might break down, and additional protection might be required. WGEEL last year (ICES 2012b) proposed a new protocol and applied that to the eel case.

Stock dynamics and biological reference points are governed by the relation between spawner biomass and resulting recruitment (the oceanic phase for eel), and the relation between incoming recruitment and subsequent spawner production (the continental phase).

We assume that the pristine conditions correspond to the theoretical equilibrium point of the population dynamics. Pristine stock biomass B_0 comes with a high (but varying) recruitment around R_0, and pristine recruitment R_0 leads to a spawning biomass around B_0.

Historical data on spawning–stock biomass and recruitment can provide estimates of B_0 and corresponding average recruitment R_0.

The line connecting the point (B_0, R_0) to the origin corresponds to biological processes between incoming recruitment and subsequent spawner production. It is known as the replacement line in pristine conditions (F=H=0). Assuming that the growing phase is not substantially affected by density-dependent processes, this replacement line indicates the potential for spawning–stock production *if all anthropogenic mortality would be set to zero*. Note that the replacement line gives spawning–stock biomass as a function of incoming recruitment; the replacement line in the graph is read from a given recruitment on the vertical axis towards a resulting biomass on the horizontal.

Recruitment as a function of spawning–stock biomass corresponds to processes related to mating, birth and larval survival. At high spawning–stock biomass, recruitment is almost not related to the size of the spawning stock. At lower spawning–stock biomass, recruitment is impaired by the low spawning–stock size. Standard ICES protocols can be used to estimate the spawning–stock biomass B_{lim}, above which recruitment is not impaired. Functions such as the Beverton–Holt stock–recruitment relation or segmented regression can be fitted (see previous paragraph).

Here we will not assume any functional relationship. In the following, we choose to fit a Generalized Additive Model (Hastie and Tibshirani, 1990) as a flexible relationship between spawning–stock biomass and recruitment. This relation will provide an estimate of expected recruitment as a function of biomass B, as well a confidence interval for the individual prediction (95% confidence, one-sided, lower bound).

By definition, where this lower confidence bound crosses the replacement line, the probability of a recruitment that cannot replace the current biomass, is α=5%. If it happens that recruitment is indeed below the replacement line, spawning–stock biomass is not replaced, i.e. spawning stock is in further decline, at least for the next generation. Where the mean predicted recruitment crosses the replacement line, there is a 50% chance of further deterioration, even *if all anthropogenic impacts would be set to zero*. We label the biomass resulting in a mean predicted recruitment equal to the replacement line as B_{stop}, and the biomass at which the 5% lower bound crosses the replacement line as B_{stoppa}. For 'normal' fish stocks with a Beverton–Holt like stock–recruitment relation, $B_{stop} = 0$; for a depensatory case, $B_{stop} > 0$; for both, $B_{stoppa} > 0$. At B_{stoppa}, the probability of a further deterioration of B is exactly α=5%. Recommending *setting all anthropogenic impacts to zero* at B_{stoppa} will be in agreement with the risk-averse strategy of the precautionary approach.

For cases for which very few years of low spawning–stock biomass have been observed, the estimated lower confidence bound at low spawning–stock biomass is predominantly based on extrapolation; a wide confidence interval will result. In this case, a rapid reduction in spawning–stock biomass far below B_{stoppa} will create a considerable risk, since few such low biomass levels have ever been observed before. If, however, B_{stoppa} is approached slowly, the estimate of B_{stoppa} will be updated on the basis of the new observations, and it is likely that new estimates of B_{stoppa} gradually slide to the left as the confidence intervals converge towards the now available data.

Applying the B_{stoppa} protocol to a depensatory stock–recruitment relation (as suspected for eel, see above) results in a B_{stoppa} at considerable higher spawning–stock biomass threshold. It therefore correctly integrates the risk of depensation that the stock slides quickly towards extremely low spawning–stock biomass. Note that the estimation protocol was not specifically adapted for the depensatory case, but identified the increased risk automatically. Along the same line of thinking, B_{stoppa} will probably also adapt to potential changes in environmental covariates, if (and only if) the regression R=GAM(B) assigns more weight to more recent observations.

Repeating the above derivation of B_{stoppa}, replacing the replacement line (F=0) by a line characterizing F=0.1, an estimate is derived of a minimum biomass at which the risk of further deterioration is α=5%, *even if F is kept at F=0.1*. At this biomass, the recommendable advice is to reduce F to F=0.1. Repeating this derivation for a range of F-values generates a data-driven relation between (low) spawning–stock biomasses and recommended F-values. Note that no assumption is made on the form of the relation between the F advised and spawning–stock biomass, i.e. the straight line is omitted.

Summarizing the derivation of B_{stoppa}

1) In a plot of R vs. B, determine B_{lim}, B_0, R_0, and the replacement line;

2) Fit R=GAM(B);

3) Find the 5% confidence interval, one-sided, lower bound, of the single observation;

- Where that confidence interval crosses the replacement line, we define B_{stoppa}. For B < B_{stoppa}, advise F+H=0.

7.9 Estimation of B_{stoppa}

In this section, B_{stop} and B_{stoppa} are estimated by fitting a lognormal GAM on the same spawning–stock biomass and recruitment dataseries as in the paragraph 7. A cubic spline smoother with order 3 is used. A 5% lower bound is finally calculated as a one-side prediction confidence interval. The AIC for this model is -25.73, which is slightly lower than the ones for the classical models. It also shows an upward concavity in the low level of spawning stocking in agreement with a possible depensatory dynamic.

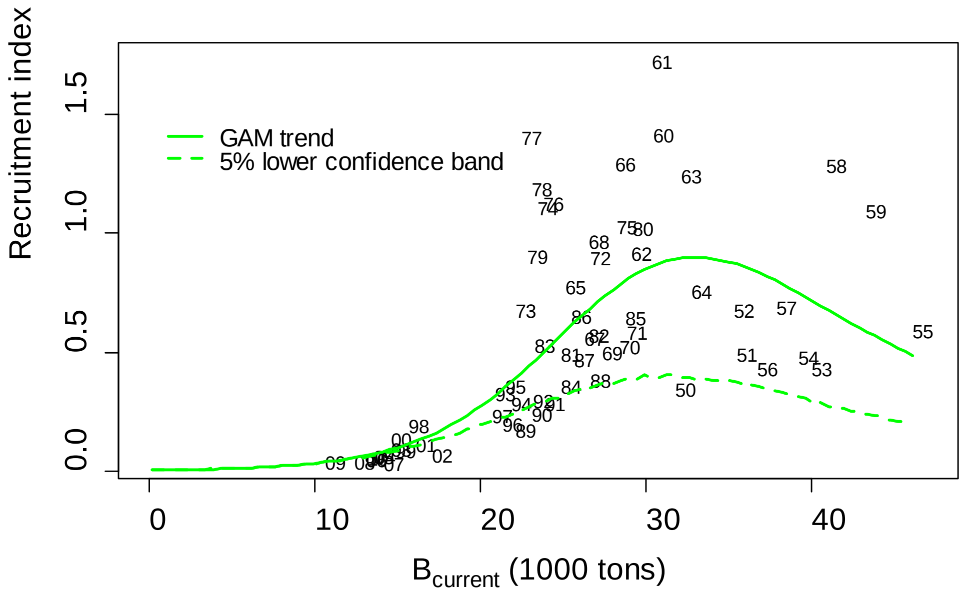


Figure 7.13. Stock–recruitment relationship fitted by a GAM.

Illustrating the flexibility of the method, a model incorporating a linear effect of the year and a smoothed effect of North Atlantic Oscillation (NAO) (average of monthly mean NAO indices (http://www.noaa.gov/) during the two years between escapement and recruitment) was fitted. The AIC dropped to -31.66. The stock–recruitment relationship was higher in 1980 compared to the present year. The NAO has a small effect with negative values decreasing the recruitment. Notice that a model with only a year effect and smoothed effect of NAO gave a worse result (AIC = -0.98).

This short exploration of alternative models does not aim to provide a final and best estimate, but to show the flexibility of the approach. Further analyses, covering different explanatory variables and/or different relations, will be required. This may include covariates that may represent a regime shift in oceanic conditions, and other environmental variables.

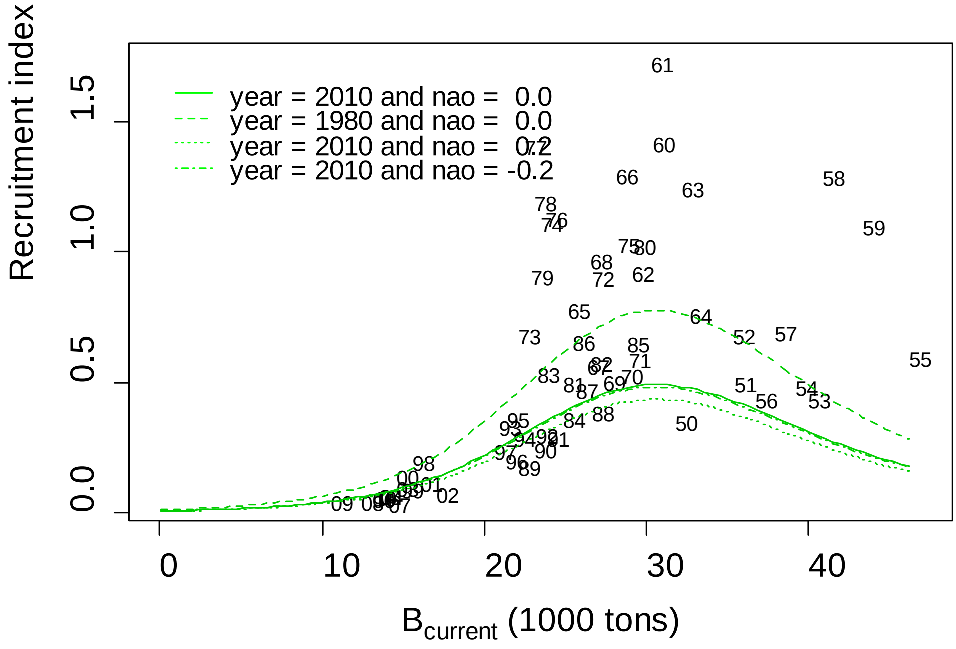


Figure 7.14. GAM for recruitment with a year effect and smoothed effect of spawning–stock biomass and NAO index. Since the stock–recruit relationship depends not only on the current biomass $B_{current}$, but also on external covariates (i.e. NAO), predictions (regression lines) can be generated for the whole range of biomasses, for different values of the NAO-index. The graph provides predicted regression lines, spanning the historical range in recruitment and the range in NAO values.

The replacement line (ΣA=0) is determined by the line crossing the origin and the point with coordinates B_0 and R_0. The pristine spawning biomass B_0 was calculated by summing estimates delivered by each EMU, resulting in a value of 193 thousand tonnes. The pristine recruitment is approximated, using the geometric average of recruitment between 1952 and 1981, i.e. a value of 0.19.

The intersection point of the replacement line with the 5% lower bound of the GAM fitted only on the escapement biomass gives an estimation of B_{stoppa} at 17.2 thousand tonnes. Since 1998, biomass has been below this value. The intersection point of the GAM curve leads to 11.5 thousand tonnes for B_{stop}. The current escapement was only one time, in 2009, below this B_{stop} but it has remained close to this value since 2005.

Given the currently (2013) available data and insights, the B_{stoppa} reference point would have suggested to advise minimizing all anthropogenic mortality to zero 15 years ago. Since 2005, these results indicate a high risk that the stock is already in the depensatory trap. The recent increase in recruitment seems to contradict this, but the present situation is still too far below B_{stoppa} to be confident about a recovery of the stock.

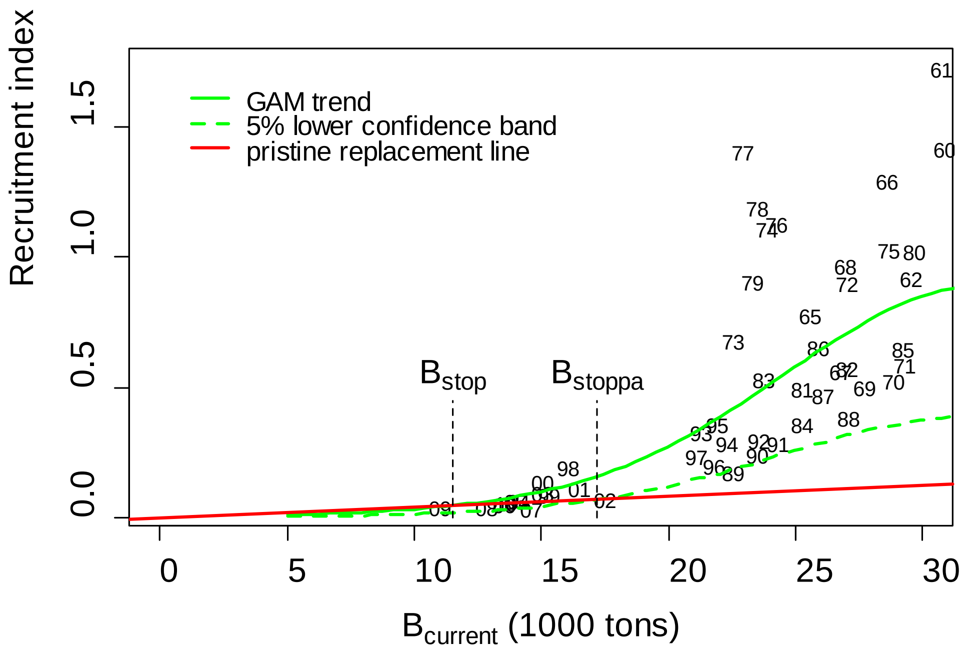


Figure 7.15. Result of B_{stoppa} procedure for eel data.

7.10 Discussion on eel-specific reference points

In this work we only consider EMUs or countries that provided both catches and $B_{current}$. If either of these data is not available, the EMU/country is not taken into account in our estimate. The used EMUs are given in Figure 7-5 top. Even if we cover an important part of the stock and of catches, one should notice that some EMU/countries with high stock and/or catches have thus been left out (e.g. Norway, marine part of Denmark, Portugal, North Africa).

Although the use of silver eel catches as a proxy for silver eel biomass seems appropriate to ecoregions with the highest exploitation rate (Baltic Sea, North Sea, Mediterranean Sea), applying the same approach to ecoregions with low silver eel exploitation rate (Celtic Sea, South European Atlantic Shelf; Figure 7-6) warrants further consideration. For these latter ecoregions, any small change in catches or exploitation rate may lead to big changes in biomass estimates. Therefore, an alternative approach may be required.

Even if the quality of catch series data is improving, some of them remain unreliable. And note also that the splitting of catches by stage has been mainly done using today's expert knowledge, whereas expert knowledge from decades in question would be required.

Expert opinion was also canvassed to provide the trends in exploitation rate. This proved a difficult exercise, no doubt because of the rarity of personal knowledge of the past 60 years. Therefore, the most common data available to estimate trends in exploitation are either effort or catch. In the latter case, this may lead to circular thinking (using catch data to derive exploitation rate for using catch data to derive biomass). It may be better to collect effort data along with catch series and base our exploitation rate estimate on these data.

If the WGEEL continues to develop the stock–recruitment relationship using these methods, it is of utmost importance that catch series are improved and that the splitting of these data by stage is also improved. The work on estimates of yellow eel catches should be continued as well because these may provide proxies for silver eel from missing ecoregions. In 2013, we only used biomass estimated by our method while some EMUs/countries have made some estimates of historical escapement. It could be worthwhile to collect these escapement estimates and to use them as well as, or instead of our proxy method.

The estimation should be extended to EMUs/countries that have not supplied $B_{current}$ and/or catches by extrapolating results from EMUs in the same ecoregions and/or collecting data from these countries if they exist. Finally, specific task/workshops for separate ecoregions may be required to provide the local knowledge necessary to improve the overall estimate.

7.11 Conclusions on eel-specific stock-recruit relation and reference points

Fitting a segmented regression to the stock–recruit data on eel leads to the conclusion that the B_{lim} target could be set at 15% of the reported pristine biomass. Fitting a more flexible curve (GAM), it is concluded that the stock might be close to falling into the depensation trap, and, with 95% confidence, might have been so since 1998. The latter would urge an immediate and complete reduction of all anthropogenic impacts (fisheries and other impacts) to zero. **However, we stress the experimental nature of our data and methods. This must be borne in mind when considering this assessment.**

8 Discussion of assessment methods and results

In the above chapters (Chapters 5–7), three different approaches to the eel assessment are presented. In this chapter, the three are brought together, contrasted and discussed.

Assessment of the eel stock is not an easy task: because crucial knowledge of basic biological characteristics is incomplete; because the stock is scattered over an extremely large area, in typically small-scaled habitats; because the impacts vary from area to area; and because the stock has experienced a multidecadal decline and is now at a very low historical minimum of the data.

In Chapter 5, the simplest approach is taken: using a minimum of data (trend in recruitment only), the current status and trend are compared to reference points based on the past. This assessment confirms the critical state of the stock; the promising increase in recruitment observed this year is set in historical perspective, but no prediction can be generated, and no evaluation of the implemented stock protection measures achieved. The recruitment increase may or may not be the result of protective measures (alternatively, it just reflects an unidentified external effect); the implemented protection may or may not be adequate; in the trend-based assessment, there is no way to tell.

Chapter 6, the quantitative assessment applying general reference points, takes a middle approach. For the dynamics of the continental phase, the international assessment relies on national building blocks, which in turn should reflect the ground situation. Results indicate that the current stock biomass is considerably below, and mortality substantially above, the reference values. In 2012, the national assessments were not coordinated, resulting in a wide variety of assessment methods employed, some of which were more and some were less data driven. In principle, however, the dynamics of the continental phase can be known in whatever level of detail is required; the split over management units is just a pragmatic way of achieving the EU-wide result. For the dynamics of the oceanic phase, however, it is assumed that practically nothing is known. This chapter assumes a stock–recruitment relation of the general type, and takes the agreed biomass limit of 40% of pristine escapement for granted. Application of the standard ICES protocols leads to an assessment of the status of the stock (spawner escapement well below the target) and of the anthropogenic impacts (above the ICES standards for recovering stocks). The assessment yields the required results, but their validity hinges on the credibility of the assumptions on the oceanic life stage (standard stock–recruit relation).

Chapter 7 extends the analysis of 2012 WGEEL, reconstructing the historical stock–recruitment relation, using landings data as a proxy for spawner escapement biomass; expert estimated exploitation rates have now been used to adjust the landings for past changes in fishing intensity. Though details differ from last year's estimates, the results more or less confirm last year's conclusions. The emerging stock–recruit relation shows an unusual form, with very low recruitment at medium spawner escapement biomass levels. This may indicate a non-stable stock–recruit relationship (e.g. change in ocean conditions), or a depensatory stock–recruitment relationship; neither of which is fully provided for in standard ICES protocols. The landings data used are reported to be incomplete and less-reliable (*see Chapter 9*), and many experts pointed at the uncertainty of quantitative conjectures on exploitation rates for years almost gone out of living memory. The use of these extra data allows the derivation of eel-specific reference points, but at the cost of uncertainties in data and processes.

Which of these three assessment methods is best? On the one hand: the simpler the better; the less demands on the data, and the less risks in misinterpreting the processes. At the same time, the trends-based assessment allows the evaluation of the past, but hardly gives information on the present, and yields no advice for the future. On the opposite end of the scale, the full analysis of the stock–recruitment relation of the eel, the uncertainty in historical data (landings) and in reconstructing historical processes (exploitation rates) is an obvious drawback, although a fully detailed assessment is the preferred method in the ICES DLS Guidance. To select the best assessment method, one will have to find a judicious balance between adequacy and reliability.

Section B: Data, trends and information for current advice

9 Data and trends

Chapter 9 addresses the Terms of Reference j:

j) assess the latest trends in recruitment, stock (yellow and silver eel) and fisheries, including effort, 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). Update international databases for data on eel stock and fisheries, as well as habitat and eel quality (EQD) related data.

Note that eel quality is addressed in Chapter 11.

9.1 Recruitment

9.1.1 Update on the status of data

The information on recruitment is provided by a number of datasets, relative to various stages, (glass eel, young small eel and larger yellow eel), recruiting to continental habitats (Dekker, 2002). The recruitment time-series data in European rivers and a description of the dataseries is presented in Annex 7: Tables 9-1, 9-2, 9-3.

The time-series used for recruitment analysis are from 48 series, of which 45 have data in the period 1979–1994; the latter are used as a scaling for all the series (Figure 9.1). For glass eel[1], 20 time-series were updated to 2013. The number of available series has declined from a peak of 31 series in 1994.

For recruitment at the yellow eel stage, nine series were updated to the last year available (2012) out of a maximum of eleven which were available in 1997 (Figure 9.2).

Some countries report data on shorter time-series. These have so far not been added to the WGEEL database or included in the analysis, but they are available in national Country Reports (see Annex 8).

[1] In this chapter on recruitment series, glass eel correspond to pure glass eel in some series and a mixture of glass eel and young yellow eel stage in others.

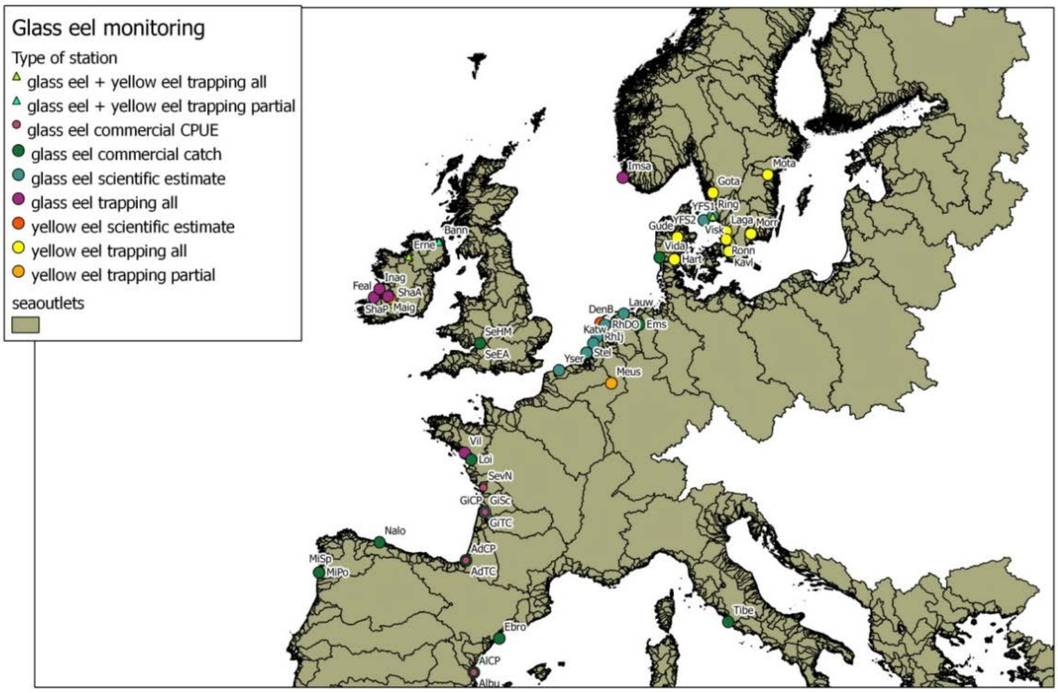


Figure 9.1. Location of the recruitment monitoring sites in Europe. The code of the stations and their short description is given in Annex 7: Tables 9.1–9.3.

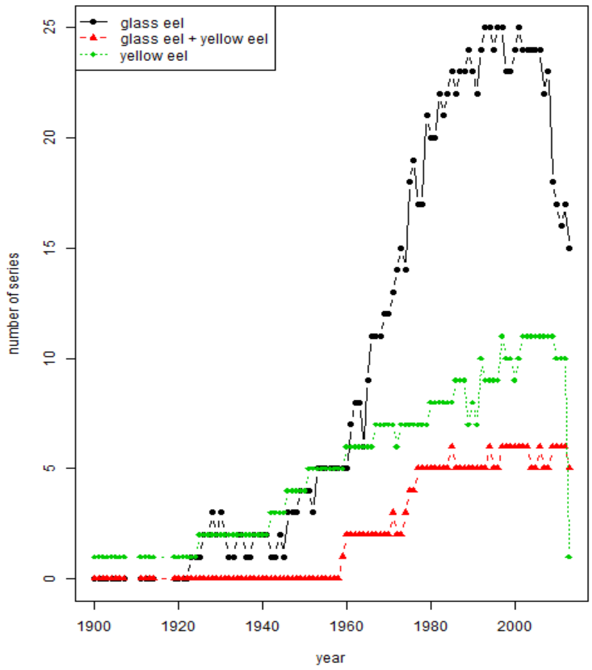


Figure 9.2. Trend in number of available dataseries per life stage, updated to 2013.

9.1.2 Series lost

Some of the series have been stopped, as the consequence of a lack of recruits in the case of the fishery-based surveys (Ems in Germany, 2001; Vidaa in Denmark, 1990) or as a consequence of a lack of financial support (the Tiber in Italy, 2006). It is anticipated that two series should resume in Italy (the Tiber, and the Marta which is a shorter experimental fishing series), and this is welcomed as increasing the number of series in the Mediterranean was a recommendation made by WGEEL in 2011 (ICES, 2011). Noting this development, the WGEEL encourages the development of other new recruitment monitoring time-series in the Mediterranean basin.

Last year, four out of the six French series were discontinued as the catch statistics no longer reported the precise location of the catch, only the EMU. Moreover, new management rules (quota system) implemented as part of the French Eel Management Plan mean that catch is not necessarily representative of abundance and therefore has altered these fishery-dependent series to such an extent as to make them incomplete. From 2012, the Vilaine series can also be considered as stopped, as the quota system has diminished the fishing period, and only the Gironde scientific series remains as a reliable indicator of the trend in recruitment.

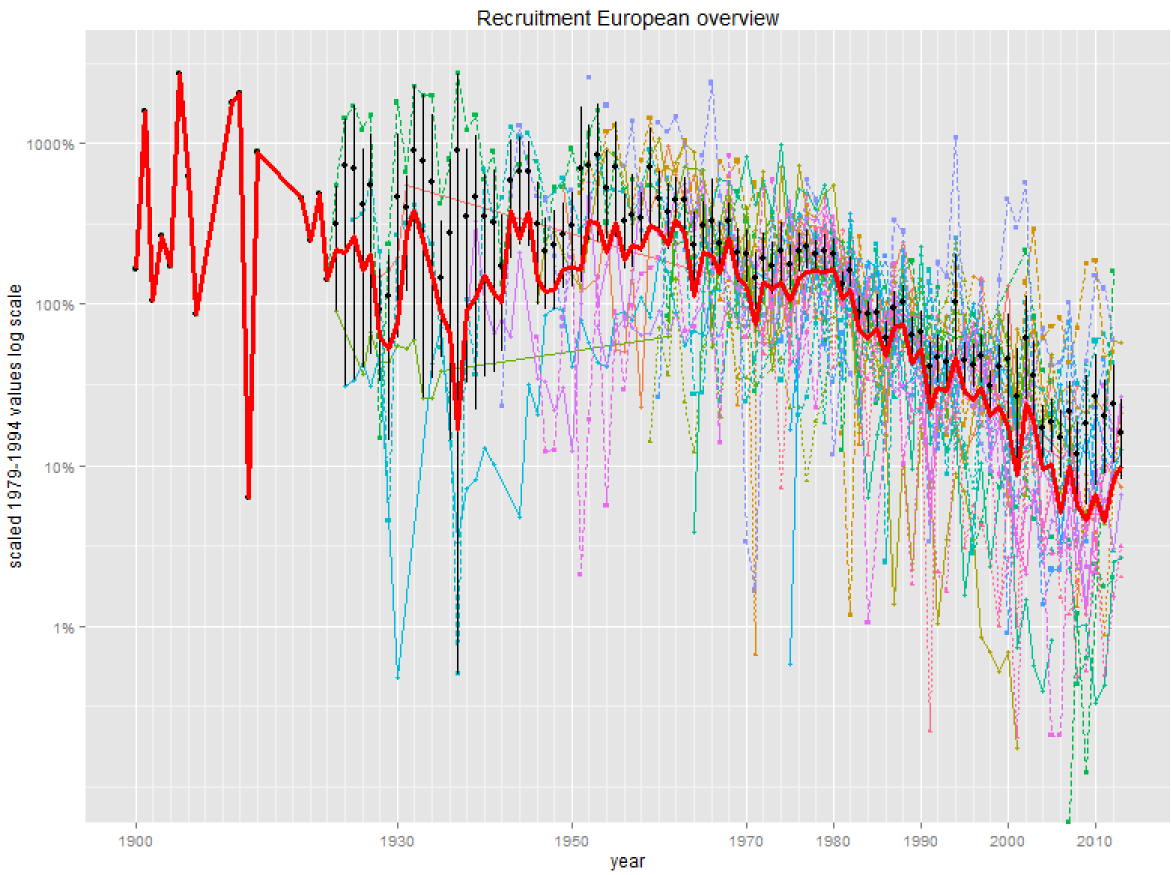


Figure 9.3. Time-series of glass eel and yellow eel recruitment in European rivers with dataseries >35 years (45 rivers), updated to 2013. Each series has been scaled to its 1979–1994 average. Note the <u>logarithmic scale</u> on the y-axis. The mean values and their bootstrap confidence interval (95%) are represented as black dots and bars. Note: for practical reasons, not all series are presented in this graph. Geometric means are presented in red.

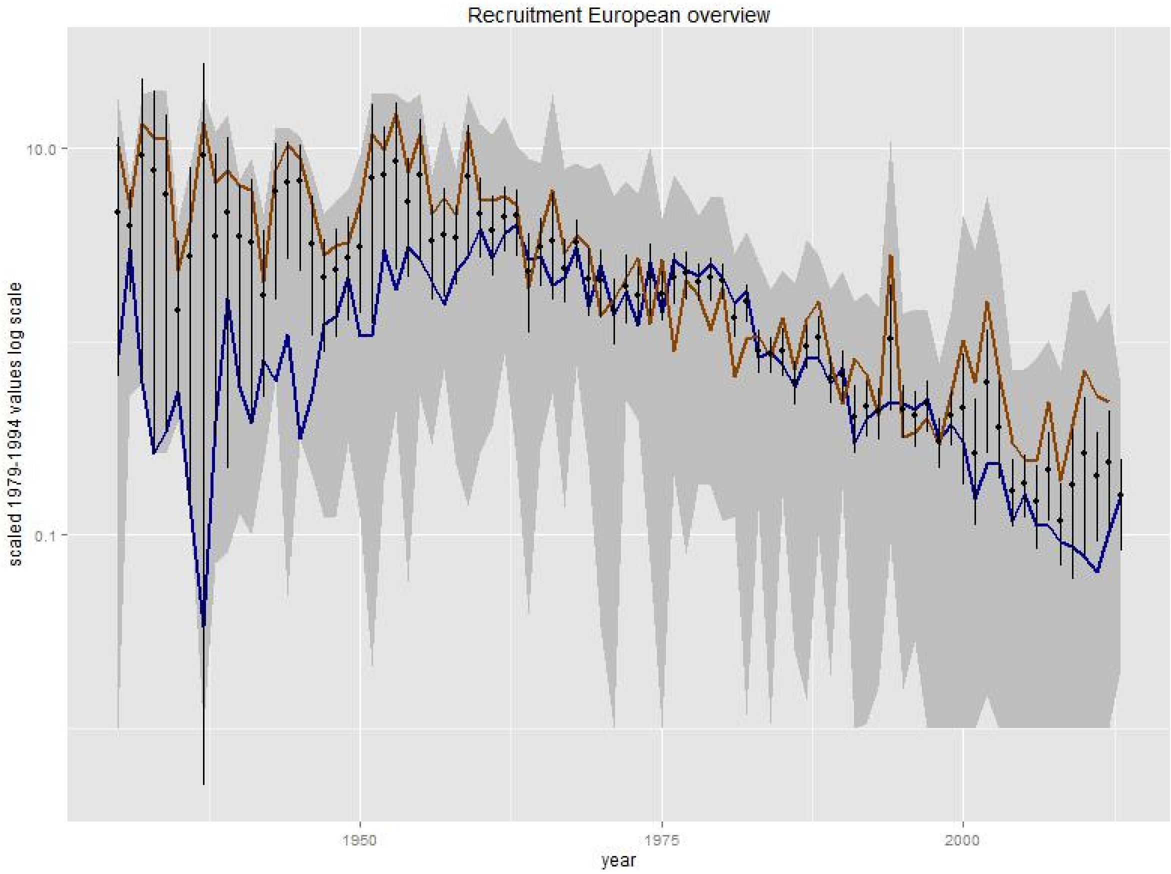


Figure 9-4. Time-series of glass eel and yellow eel recruitment in European rivers with dataseries >35 years (45 rivers), updated to 2013. Each series has been scaled to its 1979–1994 average. Note the logarithmic scale on the y-axis. The mean values of combined yellow and glass eel series and their bootstrap confidence interval (95%) are represented as black dots and bars. The brown line represents the mean value for yellow eel series, the blue line represents the mean value for glass eel series. The range of the series is indicated by a grey shade. Note that individual series from Figure 9-3 were removed for clarity.

9.1.3 Trends in recruitment

The recruitment time-series data are derived from fishery-dependent sources (i.e. catch records) and also from fishery-independent surveys across much of the geographic range of European eel. The series cover varying time intervals and only those series covering >35 years were selected for a final analysis of the trend. Some series date back as far as 1920 (glass eel, Loire, France) and even to the beginning of 20th century (yellow eel, Göta Älv, Sweden).

The glass eel recruitment series have also been classified according to two areas: North Sea and Elsewhere Europe, as it cannot be ruled out that the recruitment to the two areas have different trends (ICES 2010). The Baltic area does not contain any pure glass eel series, because recruitment here includes yellow eels. The yellow eel recruitment series are comprised of either a mixture of glass eel and young yellow eel, or as in the Baltic, are of young yellow eel only.

The WGEEL recruitment index is a reconstructed prediction using a simple GLM (Generalised Linear Model): *glass eel~year:area+site*, where glass eel is individual glass eel series, site is the site monitored for recruitment and area is either the North Sea or Elsewhere Europe. In the case of yellow eel series, only one estimate is provided:

yellow eel~year+site. The trend is reconstructed using the predictions for the whole time range for all series.

Some zero values have been excluded from the GLM analysis: 4 IJmuiden values in the Netherlands, 1 value for the Tiber, and 3 values for the young fish survey in the North Sea.

For graphical presentation, the series are scaled to 1979–1994 as it is not possible to set an appropriate reference earlier than 1980 for most of the series. But, the reconstructed values when using the GLM analysis are given in reference to the mean reconstructed estimate of the 1960–1979 period. Declining trends are evident over the last three decades for all time-series. After high levels in the late 1970s, there has been a rapid decreasing trend that continues to the present time (Figures 9.3–9.6; note the logarithmic scales).

The WGEEL recruitment index is currently low, 1.5% for the North Sea and 10% elsewhere in the distribution area with respect to 1960–1979 (Tables 9-4 and 9-5). The recruitment has increased in the most recent two years, to 1.5% of the 1960–1979 reference level in the 'North Sea' series, and to 10% in the 'Elsewhere' series (Tables 9-4 and 9-5), returning both to the level observed in 2005–2006, but both remain far from the 'healthy' zone (see Chapter 5).

The glass eel landings in France in 2010 and 2011 were higher than in 2009. This upward trend might have continued in France in 2012 and 2013, but for both years the quota was reached in most estuaries, limiting the amount of glass eel caught by the French glass eel fishery.

The reduction in estimated landings of the French marine commercial fishery between 2007–2008 (71.4 t) and 2011–2012 (30.5 t) is about 60%, and this value is consistent with the drop in daily fishing effort (daily fishing) estimated as 56% (WGEEL French country report).

The catch from the UK increased from 3.8 t in 2012 to 8.6 t in 2013 with little variation in effort. The catch increased in Spain from 6.8 t in 2012 to 8.7 t in 2013.

This raw analysis of glass eel catch and effort also indicates that recruitment levels might have risen back to values slightly higher than 2005 levels.

The series for yellow eel recruitment show a continuous decrease to a low level around 10% of their mean of 1960–1979 levels (Figure 9-6, Tables 9-4 and 9-5).

Table 9-4. Working Group on Eel series on recruitment, GLM N=area:year+site estimated values from 2001 to 2013 for glass eel and yellow eel recruitment.

	Glass eel		Yellow eel
	Elsewhere Europe	North sea	
2001	0.097	0.009	0.173
2002	0.142	0.026	0.365
2003	0.121	0.022	0.187
2004	0.079	0.007	0.247
2005	0.100	0.013	0.066
2006	0.071	0.004	0.127
2007	0.071	0.013	0.200
2008	0.058	0.006	0.082
2009	0.040	0.011	0.073
2010	0.046	0.006	0.127
2011	0.045	0.004	0.137
2012	0.063	0.007	0.124
2013	0.096	0.015	

Table 9-5. Working Group on Eel series on recruitment, GLM N=area:year+site. Five year averages.

	Glass eel		Yellow eel
	Elsewhere Europe	North sea	
1950	0.53	0.78	2.40
1955	0.53	1.16	2.03
1960	1.29	1.49	1.37
1965	0.93	0.88	1.20
1970	0.70	0.88	0.78
1975	1.07	0.75	0.65
1980	0.84	0.40	0.49
1985	0.54	0.08	0.48
1990	0.28	0.08	0.31
1995	0.29	0.04	0.16
2000	0.13	0.02	0.23
2005	0.07	0.01	0.11
2010–2013	0.06	0.01	0.13

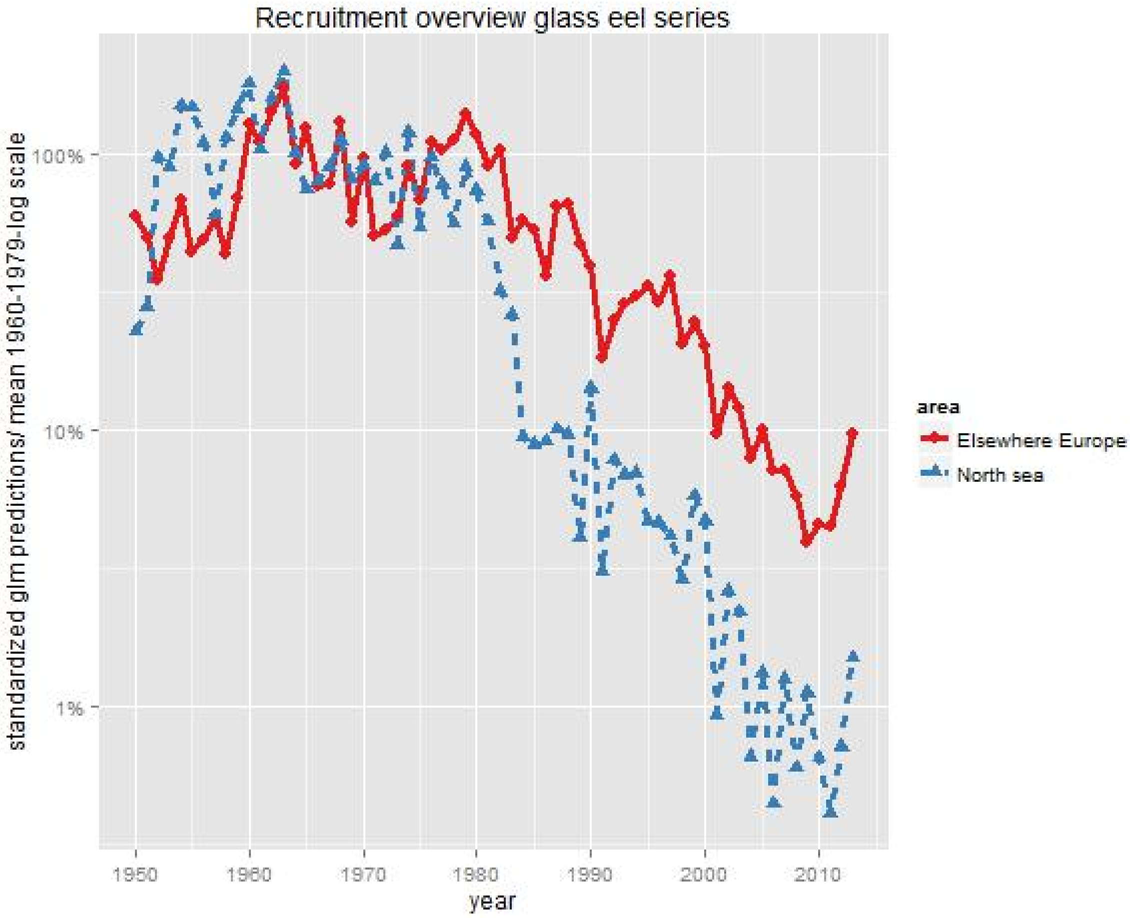


Figure 9-5. WGEEL recruitment index: mean of estimated (GLM) glass eel recruitment for the North Sea and elsewhere in Europe updated to 2013. The GLM (recruit=area:year+site) was fitted on 34 series glass eel series comprising either pure glass eel or a mixture of glass eels and yellow eels and scaled to the 1960–1979 average. No series for glass eel are available in the Baltic area. Note the <u>logarithmic scale on the y-axis</u>.

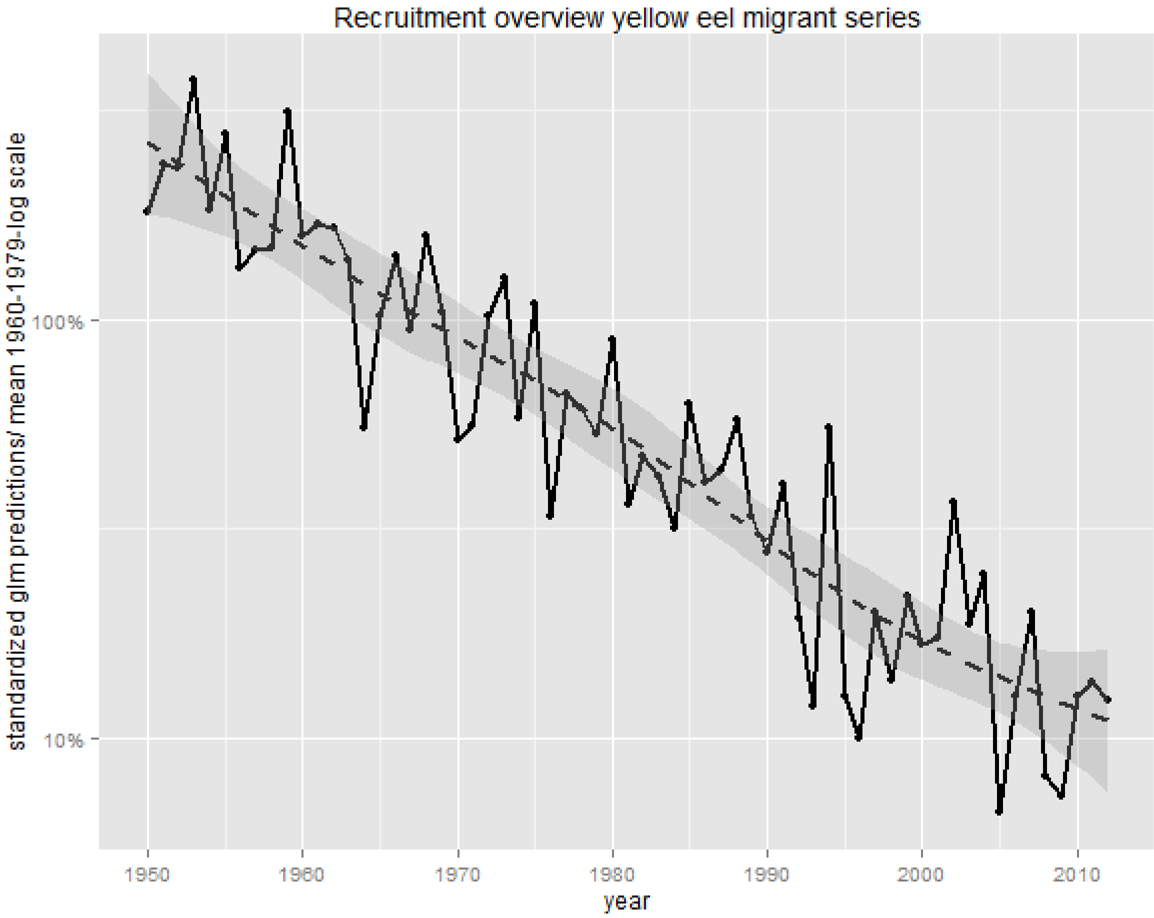


Figure 9-6. Mean of estimated (GLM) yellow eel recruitment and smoothed trends for Europe updated to 2013. The GLM (recruit= year+site) was fitted to ten yellow eel series and scaled to the 1960–1979 average. Note the <u>logarithmic scale on the y-axis</u>. The grey band shows the 95% pointwise confidence interval of the smoothed trend.

9.2 Time-series of yellow and silver eel

9.2.1 Yellow eel

Several Country Reports present information on long-term monitoring of yellow eel abundance in various habitats, and these values have been updated in the WGEEL database. Methodologies vary from electrofishing and traps in rivers to beach-seines, fykenets and trawls in larger water bodies. In some cases, detailed information on catches and effort in commercial fisheries are combined to give estimates on local abundance.

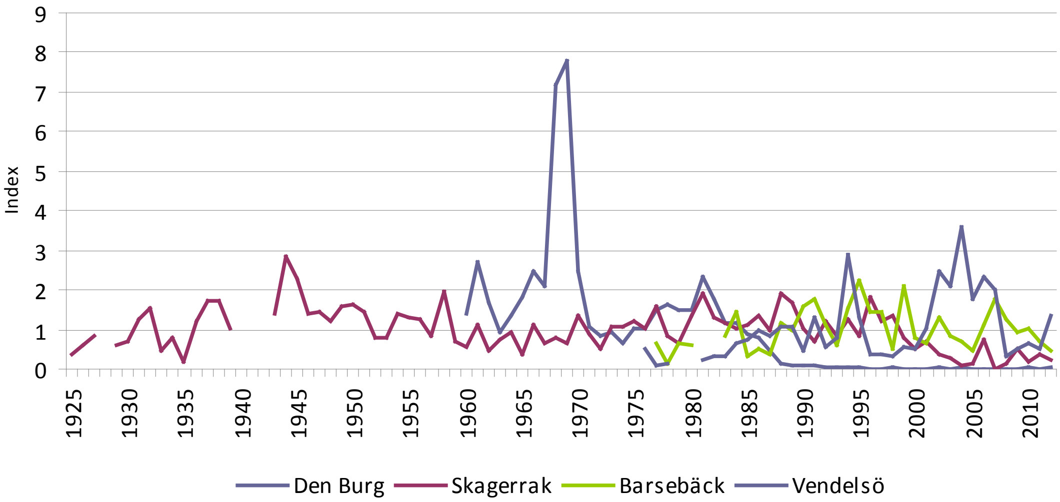
Coastal habitats in southern Norway were monitored with beach-seine nets since 1925 (Skagerrak). No trend in eel abundance occurred until a sharp decrease started in the early 2000s. Cpue in fishery-independent fykenet surveys on the Swedish west coast (Barsebäck and Vendelsö) have decreased in recent years, coincident with a change in sex ratio towards female dominance, and an increase in mean weight compensated for a decrease in abundance. Fykenet catches at Den Burg and Texel, declined to close to zero in the 1980s and remain very low. Decreasing of abundance but increasing individual size was observed in eel from Dutch estuaries in the last decade. In Lake Ijsselmeer, yellow eel densities have decreased significantly in recent decades. In the estuary of the River Scheldt (Kastel, Steendorp) the abundance of yellow eel decreased in 2012.

Commercial yellow eel cpue has not changed substantially in Norwegian and Swedish coastal fisheries since the 1970s. In the Garonne estuary, France, eelpot cpue has not changed significantly since 1987. However, concerns over comparability of data within trends were raised in two of these cases due to changes in fishing gear and fishing operations during the time-series.

Poulet *et al.* (2011) report a decrease of occurrence and density of yellow eel using extensive and long-term electrofishing monitoring throughout France. However, those data have not been made available to the WGEEL.

Available information on long-time changes in yellow eel abundance shows that the decrease in recruitment since 1980 is not necessarily reflected in a subsequent decrease in yellow biomass for some of the series. A decrease in number may be compensated for by an increase in the proportion of females, which typically grow to a heavier individual weight. In areas already dominated by females, a decrease in recruitment may result in reduced pressure for the eel to colonize distant/marginal habitats. These factors, as well as bias introduced by biotic or abiotic circumstances, have to be taken into consideration in future design and interpretation of data from a variety of different survey methods.

Information on long-term changes in yellow eel abundance in many cases is the only way to assess the status of eel production in the absence of a significant fishery. A development towards standardized methods was suggested by WKESDCF to be included in the DC-MAP framework (ICES 2012).



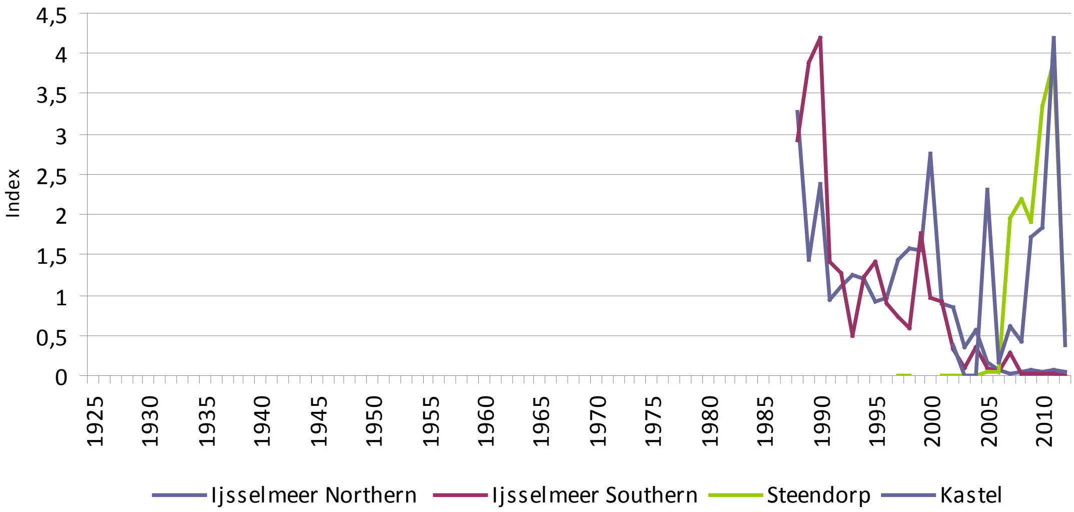


Figure 9-7. Trends in yellow eel abundance from fishery-independent surveys. Upper panel, data from coastal surveys in the North Sea area; lower panel, data from freshwater (IJsselmeer) in the Netherlands and from upstream of the Scheldt estuary in Belgium. Data were normalized as annual fractions of the long-term mean in each series, and updated to 2012.

9.2.2 Silver eel

Country Reports in 2013 presented fishery-independent data on silver eel escapement from one river in Norway, one from Ireland and from three rivers in Scotland. All series show reductions of about 50% from the 1970s to the years since 2000 (Figure 9-8).

In the Burrishoole, although there have been substantial variations between year, the trend in escapement biomass has changed little throughout the time-series since 1971 (Figure 9-8). However, numbers of silver eel had declined, as the decrease in abundance was compensated for by an increase in average weight (contributed to by a change in sex ratio and increasing size of female eels; see Country Report for Ireland). However, the silver eel run increased from 1969 eels in 2011 to 3335 eels in 2012 and the average weight decreased from 180 g to 163.5 g. The sex ratio changed from 24% to 45% over the past five years.

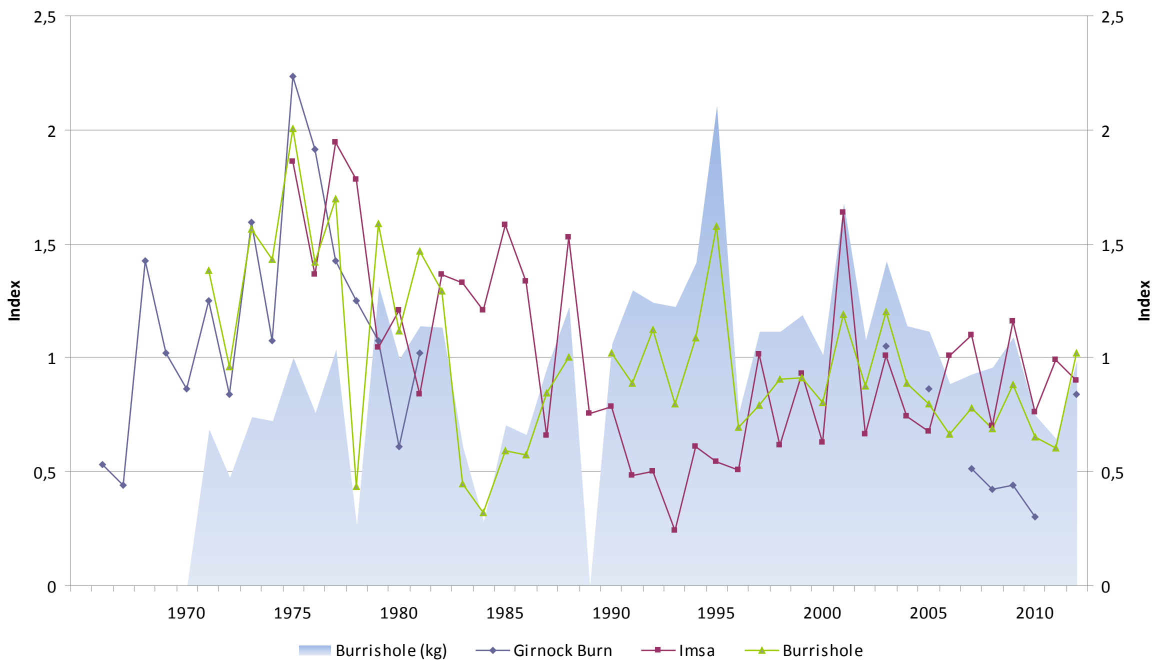


Figure 9-8. Trends in silver eel abundance and/or biomass from river traps in Burrishoole in Ireland, Girnock Burn in Scotland and Imsa in Norway. Normalized trends were based on kg/ha (Girnock Burn) and counts in numbers and weight (Burrishoole) and counts in numbers (Imsa).

In Sweden, cpue based on detailed landing statistics from selected poundnets in specific sites were used to estimate silver eel escapement from the Baltic Sea coastal fishery since the late 1950s (Andersson *et al*., 2012). Escapement by numbers decreased in all but one of four investigated areas, the major decrease (50%) taking place in the late 1960s and in the early 1970s. The decrease in numbers was compensated for by a 70–100% increase in average body weight. A reduction in fishing mortality and increasing seawater temperature are suggested to explain a lack of correlation between Baltic recruitment indices and escapement.

In the French Frémur River, between 1996–1997 and 2000–2001, the mean number of silver eel was about 850 (150 kg). The silver eel number decreased to 152 (36 kg) in 2011–2012, the smallest number of the series. This last number is due both to the eel stock decline and to particularly low discharge that year that caused low possibility of escapement past the Bois-Joli Dam. Preliminary results from the 2012–2013 season show an increase of the silver eel escapement to about 600 silver eels (185 kg). This escapement may include eels that were ready to migrate in 2011–2012, but delayed their trip to 2012–2013.

9.3 Data on landings

In WGEEL 2010, data on total eel landings obtained from Country Reports were presented, without data on official eel landings from FAO sources as these differed from Country Report data.

At the present 2013 status, dataseries from the Country Reports continue to be inconsistent but are improving. A review of the catches and landing reports in the CR showed a great heterogeneity in landings data reports, with countries making reference to an official system, some of which report total landings, others report landings by Management Unit or Region, and some countries haven't any centralized system.

Furthermore, some countries have revised their dataseries, with extrapolations to the whole time-series, for the necessities of the Eel Management Plan compilation (Poland, Portugal).

The EU Eel Regulation requires that Member States implement a full catch registration system, along with the Data Collection Framework. This was expected to improve the coverage of the fishery, i.e. reduce underreporting markedly. Since landings data were incomplete, with some years missing for some of the countries, an estimate of the missing values is provided by simple GLM extrapolation (after Dekker, 2003), with year and countries as the explanatory factors (Figure 9-9).

In addition, new landings data are given for countries not reporting to WGEEL. These are the Mediterranean countries: Egypt, Tunisia, Morocco, Turkey and Albania. According to FAO FishStat, catches from these countries were high during the last decade, reaching 4635 tonnes in 2006 exceeding all reported European catches by 60% (Figure 8-10) However, the quality of these data is uncertain.

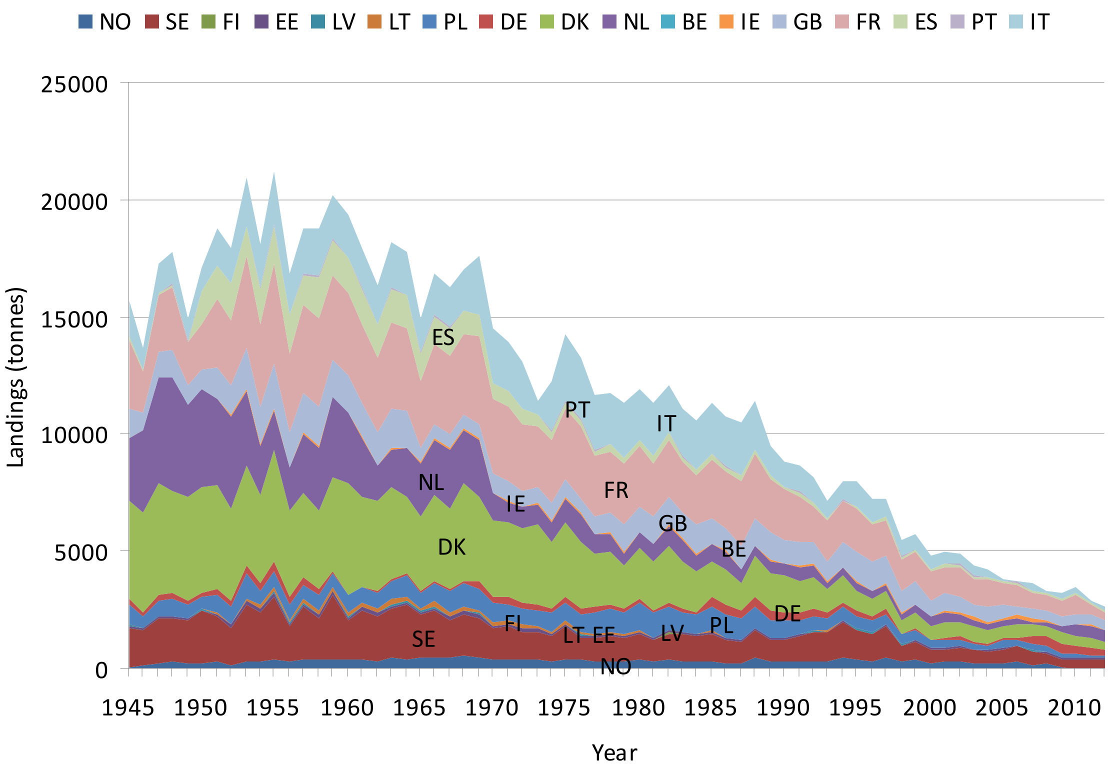


Figure 9-9. Total landings (all life stages) from 2013 Country Reports (not all countries reported); the corrected trend has missing data filled by GLM.

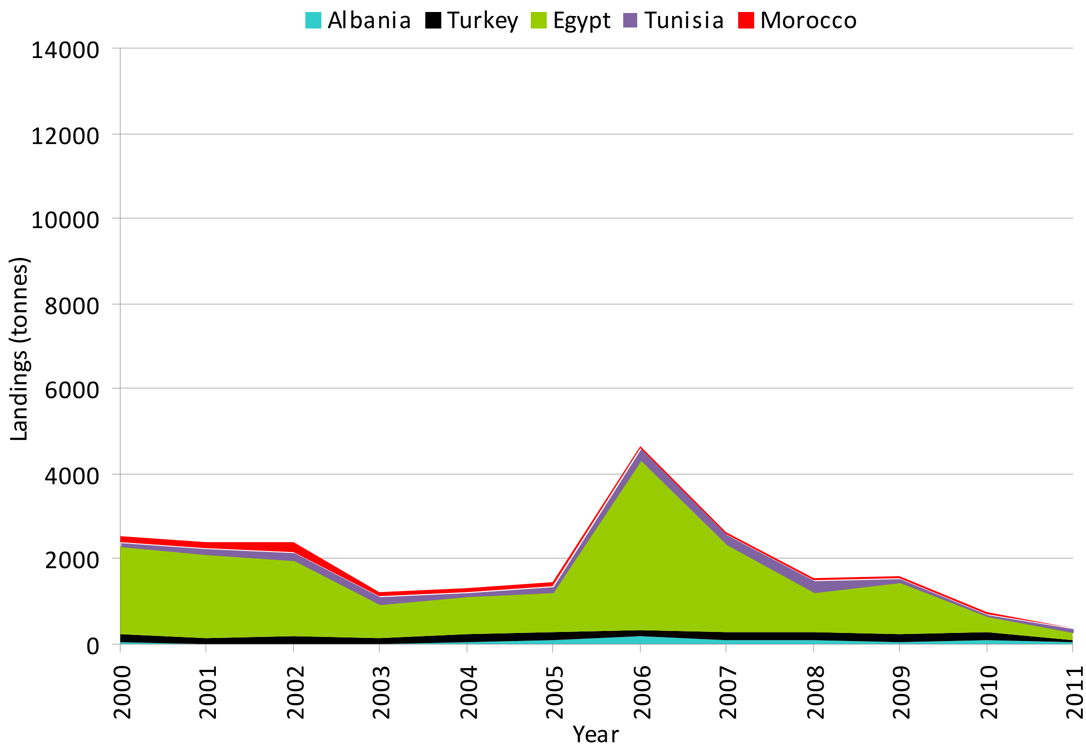


Figure 9-10. Total landings (all life stages) from Countries not reporting to WGEEL (FAO FishStat).

9.3.1 Collection of landings statistics by country (from CRs)

Landings data are presented in Annex 7, Table 9.6.

Norway: Provided official landing statistics (Fisheries Directorate) calculated according to the number of licences. Fishing for eel has been banned in Norway since January 1, 2010.

Sweden: Data on eel landings in coastal areas are based on sales notes sent to the appropriate agency and in recent years also from a logbook system. There is a discrepancy between the data derived from the traditional sales notes system and the more recent logbook system. During the most recent years this difference was considerable, as in 2011 when sales notes report 238 tonnes, while the logbooks say 355 tonnes (all from the marine areas). Landings data from freshwaters come from a system with monthly or yearly journals. Fishing for eels in private waters was not reported before 2005. Data from logbooks and journals are stored at the Swedish Agency for Marine and Water Management**.**

Finland: The statistical data are collected by the FGFRI. Data from professional fishers are collected by logbooks and recreational questionnaires. For 2011 only marine landing data provided. 2012/2013 country report was not provided.

Estonia: The catch statistics are based on logbooks from inland and coastal fisheries. No data available for 2011.

Latvia: Eel landings are reported by monthly logbooks on date of fishing basis. Number and type of gear, time in operation are registered in logbooks. Logbooks from coastal and inland fisheries were collected by local Boards of MIWA and transmitted to BIOR for data summarization and storing.

Lithuania: Fisheries companies provide information according to their logbooks about catch on a monthly basis to the authority issuing permits: a Regional environmental protection department under the Ministry of Environment of the Republic of Lithuania if a company is engaged in inland fisheries (including the Curonian Lagoon), or the Fisheries Service of the Ministry of Agriculture of the Republic of Lithuania if a company is engaged in maritime fisheries. Data on recreational fisheries are collected using questionnaires.

Poland: The (approximate) data on inland catches were obtained by surveying selected fisheries facilities, and then extrapolating the results for the entire river basin. The data from the lagoons and coastal waters were drawn from official catch statistics (logbooks).

Germany: Eel landings statistics from coastal fishery are based on logbooks. The obligation to deliver the inland catch statistics separate for both stages has only recently been established in most states. Fishers have to deliver the information to the authorities at least on a monthly basis. Data are missing for the some states for inland landings in 2012.

Denmark: The yellow and silver eel catches are reported by commercial fishers to the Ministry.

Netherlands: For Lake IJsselmeer, statistics from the auctions around Lake IJsselmeer are now kept by the Fish Board. For the inland areas outside Lake IJsselmeer, no detailed records of catches and landings were available until 2010. In January 2010, the Ministry of Economic Affairs, Agriculture and Innovation introduced an obligatory catch recording system for inland eel fishers. Catches and landings in marine waters are registered in EU logbooks.

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

Ireland: Until 2008, eel landing statistics in Ireland were collected from voluntary declarations. From 2005 to 2008 this was improved by issuing catch declaration forms with the licence. From 2009, commercial fishing of eel has been closed.

United Kingdom: In England and Wales, the Environment Agency authorize commercial eel fishing. It is a legal requirement that all eel fishers submit a catch return, giving details of the number of days fished, the location and type of water fished, and the total weight of eel caught and retained, or a statement that no eel have been caught. Annual eel and glass eel net authorizations and catches are summarized by gear type and Environment Agency region (soon to be RBDs) and reported in their "Salmonid and Freshwater Fisheries Statistics for England and Wales" series (www.environment-agency.gov.uk/research/library/publications/33945.aspx). The yellow and silver eel catches reported to the Environment Agency have historically been reported to the WG as a single catch for England and Wales. Since 2005, catches have been recorded according to the "nearest waterbody" and reported separately for yellow and silver eels.

In Northern Ireland, overall policy responsibility for the supervision and protection of eel fisheries, and for the establishment and development of those fisheries, rests with the Department of Culture, Arts and Leisure (DCAL). Catch returns from the one remaining commercial fishery are collated at a single point of collection and marketing, and reported to DCAL.

There have been no large-scale commercial fisheries for eel in Scotland for many years, and no catch data are available. Fishing for eel has been effectively banned for a number of years.

France: The marine professional fisheries in Atlantic coastal areas, estuaries and tidal part of rivers in France have been monitored by the "Direction des Pêches Maritimes et de l'Aquaculture" (DPMA) of the Ministry of Agriculture and fisheries through the Centre National de Traitement Statistiques (CNTS, ex-CRTS) from 1993 to 2008 and is now by France-Agrimer. This system is evolving and is supposed to include marine professional fishers from Mediterranean lagoons. In this system, glass eels are distinguished from subadult eel, but yellow and silver eels were not separated until recently. The professional and amateur fishers in rivers above marine estuaries (and in lakes) have been monitored since 1999 by the ONEMA (Office National de l'Eau et des Milieux Aquatiques, ex-CSP). These two monitoring systems are based on mandatory reports of captures and effort (logbooks) using similar fishing forms collected monthly (or daily for glass eel) and sometimes with the help of local data collectors. Some scientific monitoring of landings exist, e.g. in the Gironde Basin.

Spain: Data on eel landings in the Country Report are mostly collected from fishers' guild reports and fish markets (auctions). The precision of the information of the catches and landings differs greatly among Autonomies. No data available for marine fishery.

Portugal: The eel fishery is managed by DGPA (General Directorate of Fisheries and Aquaculture) with responsibility in coastal waters, and AFN (National Forestry Authority) with responsibility in inland waters. Fisheries managed by DGPA have obligatory landing reports, while in inland waters, landing reports are obligatory in some fishing areas but in other areas only if requested by the Authorities.

Italy: The management framework for DCF is the same as has been set up for the eel management under Regulation 1100/2007. In the eleven Regions that preferred to delegate eel management to central government (Directorate-General for Sea Fishing and Aquaculture of the Ministry of Agricultural, Food and Forestry Policy) where commercial eel fishing has been stopped completely since the year 2009, no data collection is carried out. In the remaining nine regions, where eel fisheries are ongoing, eel fishery data are collected with a standard methodology, as foreseen by the Italian National Plan for the Data Collection Framework. Detailed data on catches and landings (by life stage, by type of fishing gear, by EMU, commercial and recreational, etc.) are available from 2009.

9.4 Recreational and non-commercial fisheries

More data for recreational catch and non-commercial landings were available this year compared with previous WGEEL reports. For the purpose of compilation and cross-checking, two sources of data were used; Country Reports and the ICES WGRFS 2013 report. This analysis showed some discrepancies between sources and not reporting, even if required by DCF. The legal framework for collection of recreational fisheries data by EU Member States is given by the EU Data Collection Framework (Council Regulation (EC) No 199/2008 and Council Decision 2008/949/EC). Recreational fishery data on eels are to be collected, where appropriate, in the following areas:

- Baltic (ICES Subdivisions 22–32);

- North Sea (ICES Division IV and VIId) and Eastern Arctic (ICES Division I and II);
- North Atlantic (ICES Division V–XIV);
- Mediterranean and Black Sea.

The EC (DG-MARE) has indicated some general principles in DC-MAP (anticipated 2015 onwards) which are relevant to diadromous species, including improvement in the quality of data and coverage of recreational fisheries. The ICES workshop about eel and salmon data collection (WKESDCF 2012) recommended the collection of data on all recreational and commercial eel and salmon fisheries regardless of how the catches are made.

The data reported in the Country Reports were incomplete in some cases because they omitted marine or inland waters, reported only passive gears catches while angling is not prohibited, or because some of the countries are not fully sampling recreational catches, focusing only on a selected life stage.

These facts make it impossible in 2013 to assess the most recent total landings of recreational and non-commercial fisheries. Table 9-7 presents data reported in CR`s. Information about the fate of released eels was only provided by the Netherlands. A short overview of the inconsistencies of catch reports to WGEEL and WGRFS is given in Table 9-8.

Table 9-7. Recreational catches (t) reported to WGEEL.

	RETAINED							RELEASED						
	inland			marine				inland			marine			
Country/year	angling	passive gears	total inland	angling	passive gears	total marine	Total retained	angling	passive gears	total inland	angling	passive gears	total marine	Total released
Finland														
2010		9	9		1	1	10							
Estonia														
2012	0.02		0.02				0.02							
Latvia														
2012					0.102	0.102	0.102							
Lithuania														
2012	0.9		0.9				0.9							
Poland														
2012	32		32	1		1	33							
Poland														
2012	32		32	1		1	33							
Germany														
2012			240				240							
Denmark														
2011		8	8		80	80	88							
Netherlands														
2010	53		53	26		26	79	143		143	25		25	168
France														
2012		5.3	5.3				5.3							
Spain*														
2012					1.5	1.5	1.5							

*** Only glass eel stage reported.**

Table 9-8. Overview of recreational fishery sampling activities.

Country	Data availability to WGEEL		Comments from WGRFS	WGEEL remarks
	inland	marine		
Norway			N.A.	Fishing is prohibited
Sweden			N.A.	Fishing is prohibited
Finland	X	X	A nationwide biannual recreational fishing survey is done for all species and gears	2011 data are missing, 2012 figures will be ready after WGEEL meeting
Estonia	X		Catch data are reported and stored in EFIS for passive gears.	Marine catches are missing
Latvia		X	Sampling on triennial basis in lakes and rivers - on-site survey.	Inland catches are missing
Lithuania	X		N.A.	Marine catches are missing
Poland	X	X	Significant only inland waters. Anglers are licensed and obligated to record catches in weight in special register.	
Germany	X		Results will be available in 2013.	Unclear for marine waters
Denmark	X	X	Sampling design similar to cod	Reported to WGRFS also releases, figures differs between sources
Netherlands	X	X	Survey was carried out in 2012, results will be published in 2013	Data available for 2010, 2012 will be ready next year
Belgium	X		No information	
Ireland			N.A.	Fishing is prohibited

Country	Data availability to WGEEL	Comments from WGRFS	WGEEL remarks
UK (England)		Marine recreational survey design as for cod sampling. Available 2013	Eel caught on rod and line in inland and marine waters must be returned alive to the same water
France	X	No information	Allowed for yellow eels in inland waters, angling information is missing
Spain	X	Reported eel catches correspond to glass eel	There is a recreational glass eel fishery in the Basque Country and Cantabria and a yellow and silver recreational fishery in Valencia, Catalunya and Balearic Islands; but the catches are not recorded
Italy		Recreational fisheries are being recorded only since 2009 within the DCF	2012 not available to WGEEL

9.5 Eel stocking

9.5.1 Trends in stocking

Data on stocking were obtained from a number of countries, separated for glass eels and for young yellow eels.

An overview of data available up to 2012 (partly 2013) is compiled in Annex 7, and presented in Tables 9-9 and 9-10. Note that various countries use different size and weight classes of young yellow eels for stocking purposes.

Stocking with glass eel peaked in the late 1970s and early 1980s, declined to a low in 2009 but has increased thereafter, presumably because of the implementation of EMP`s (Figure 9-11). The stocking of young yellow eels has been increasing since the late 1980s (Figure 9-12).

The WGEEL learned this year that French stocking data are only available since 2010; before then stocking occurred but data were not reported (ND = No Data). So the time-series only show the reported amount of stocking, but underestimate the true amount of stocking.

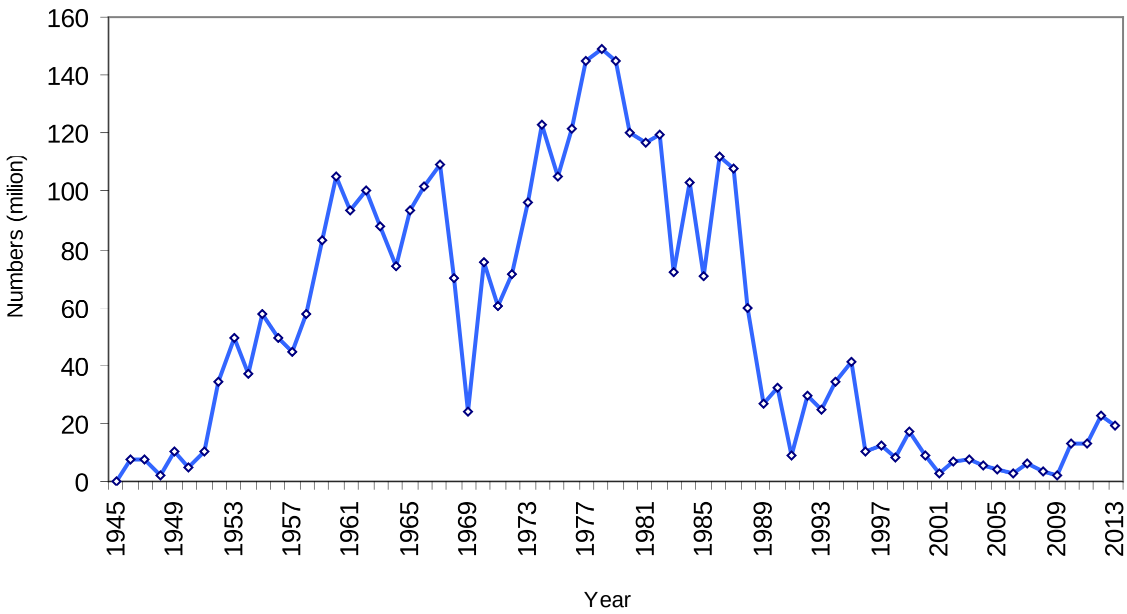


Figure 9-11. Reported stocking of glass eel in Europe (Sweden, Finland, Estonia, Latvia, Lithuania, Poland, Germany, the Netherlands, Belgium, Northern Ireland, France (no data before 2010) and Spain) in millions stocked. 2012–2013 data not fully available.

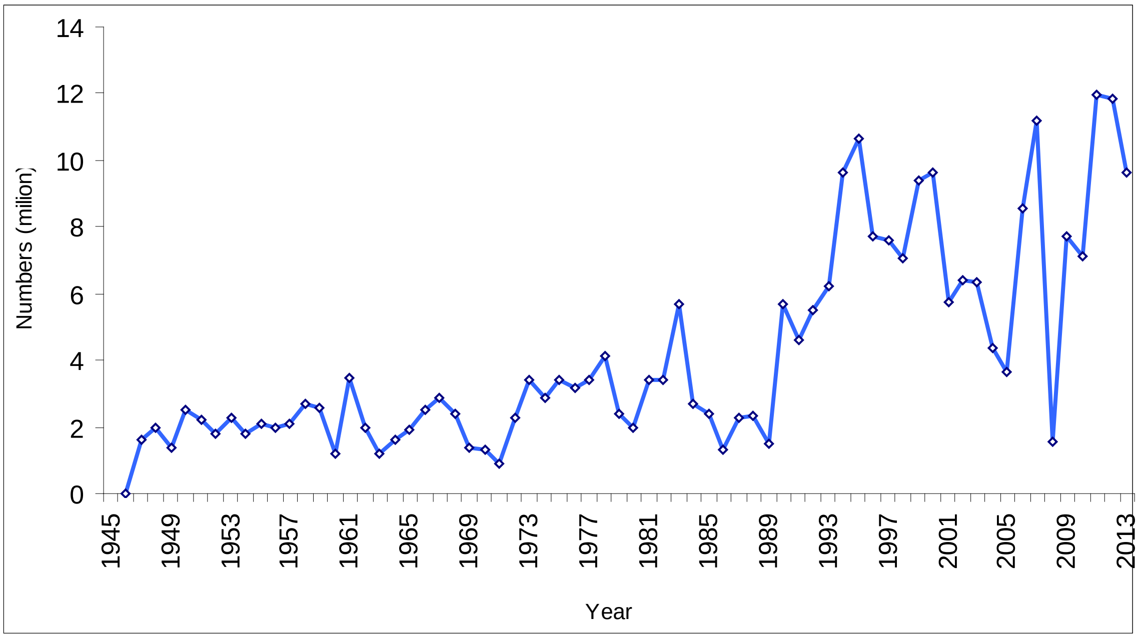


Figure 9-12. Reported stocking of young yellow eel in Europe (Sweden, Finland, Estonia, Latvia, Lithuania, Poland, Germany, Denmark, the Netherlands, Belgium, and Spain), in millions stocked. 2012–2013 data not fully available.

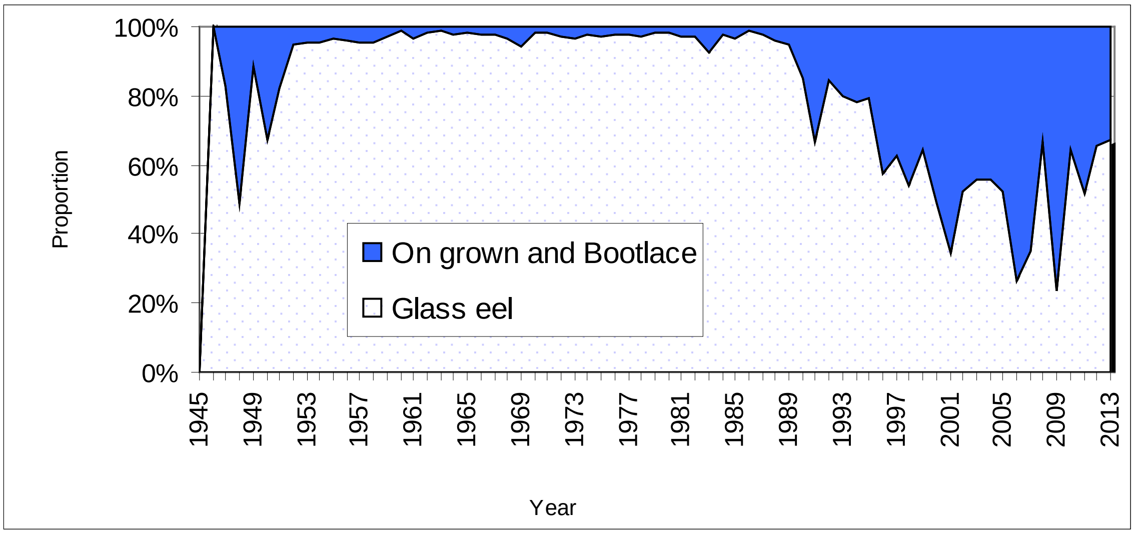


Figure 9-13. Stocking proportion in numbers stocked between on-grown and glass eel in Europe.

Norway: No stocking on a national level.

Sweden: Until the 1990s, the transport of medium sized yellow eels from the west coast to the east coast (Sättål) dominated the stocking programmes. Recently, however, quarantined glass eel (i.e. ongrown) stocking is the only action left. Trollhättan eel (from Göta Älv) has always been a small quantity, and this transport ended in 2005. In 2013, catches at Trollhättan were transported upstream past three hydropower plants and released in Lake Vänern, i.e. "assisted migration". In 2012 and 2013, glass eels were again imported from River Severn (UK), after a few years when they had been supplied by French glass eels. According to the Swedish EMP, about 2.5 million glass eels (in practice ongrown cultured eels) will be stocked annually. All stocked eel have been chemically marked since 2009.

Finland: In 1989, it was decided to carry on stocking only with glass eels reared in a careful quarantine. Since then, glass eels originating in River Severn in the UK have been imported through a Swedish quarantine and restocked in almost one hundred lakes in Southern Finland and in the Baltic along the south coast of Finland. All stocked eel have been chemically marked since 2009.

Estonia: A historical database is available on stocking of glass eel/young yellow eel in Estonia, with records back to 1950. Estonia had a state stocking programme of fish, including eel, for 2002–2010. During the period 2011–2014, the stocking of eel into the Lake Peipsi basin is supported by the European Fisheries Fund (EFF) up to a limit of 255 000 EUR (co-financing up to one third of total annual financing). In 2011, 680 000 glass eels were stocked; in 2012, 910 000 glass eels and 120 000 ongrown cultured eels were stocked; and in 2013, 810 000 glass eels were stocked.

Latvia: Data on stocking from 1945–1992 were obtained from archives of USSR institution Balribvod that was responsible for fish stocking and fisheries control in the former USSR. Since 1992, every stocking of fish in natural waterbodies in Latvia must be reported to Ministry of Agriculture (BIOR) by special documents. In 2011, Latvia started stocking again. Glass eel were imported from UK Glass Eel by a supplier from Czech Republic. Generally, few people ("commission") representing the local municipality and the fish supplier actually participate in stocking to certify the fact.

Lithuania: Stocking of Lithuanian inland waterbodies with glass eel originating in France or Great Britain began in 1956. During 1956–2007, a total of 148 lakes and reservoirs covering an area of 95 618 ha was stocked. About 50 million glass and juvenile eels were stocked in total. Stocking activities started again in 2011. 134 000 ongrown individuals were released in 2011, 444 000 individuals in 2012. In 2013, 1 million glass eel and 500 000 ongrown individuals were released to the inland waters.

Poland: Eel stocking was initiated in regions within current Polish borders as early as at the beginning of the 20th century. This was done mainly in rivers in the Vistula River basin and in the Vistula Lagoon. The stocking material of the day originated from the coasts of Great Britain (glass eel), although the Vistula Lagoon was also stocked with eel (20–30 cm total length) inhabiting the River Elbe. In 2011, Poland started stocking within EMP framework. Data on stocking by private stakeholders comes from eel importers. All eels are foreign source: glass eels from France and England, and ongrown/cultured yellow eels from Denmark, Germany and Sweden.

Germany: There is no central database on stocking, but some data are available. Data for 2011 and 2012 are not provided.

Denmark: Stocking by fishers in inland waters has taken place for decades, in places where recruitment of young eel was limited or absent because of migration barriers or distance to the ocean. Glass eels are imported mostly from France and are grown in heated culture to a weight of 2–5 g before they are stocked. Stocking is done as a management measure. In 2013, a total of 1,270 million eels of size 2–5 g were stocked in lakes and rivers as a management measure and 0.25 million were stocked in marine waters.

Netherlands*:* Glass eel and young yellow eel are used for stocking inland waters for as long as anyone can remember, mostly by local action of stakeholders. Future stocking of 1–1.6 t of glass eel is foreseen. All young yellow eel stocked in 2012 originated from glass eel caught in France in 2011 and 2012. All stocked glass eel are sourced outside the Netherlands. The main stocking material is glass eels in the Netherlands. Note however that the average weight of stocked young yellow eel decreased from ~30g to ~3 g between 1920 and 2010.

Belgium: Glass eel stocking in Belgium, both in Flanders and in Wallonia, has been carried out from 1964 onwards, with glass eel from the catching station at Nieuwpoort (River Yser). However, due to the low catches after 1980 and the shortage of glass eel, together with regionalisation of the fisheries, this stocking was stopped in Wallonia. In Flanders, stocking was continued after 1980 with foreign glass eel imported mostly from the UK or France. Also, yellow eels were restocked, mostly from The Netherlands, but this was ceased after 2000 as yellow eels used for stocking contained high levels of contaminants. In Wallonia, glass eel stocking was again initiated in 2011, in the framework of the Belgian EMP. Quantities of glass eel stocked amount to 40 and 50 kg for Wallonia in 2011 and 2012 respectively, in Flanders 120 and 156 kg. The glass eel were supplied from the Netherlands but originated from France. In 2013, 140 kg has been stocked in Flemish waters using glass eel supplied by a French company (SAS *Anguilla*, Charron, France).

Ireland: Purchase of glass eel for stocking from outside the state does not currently take place. Assisted migration of upstream migrating pigmented small eel takes place in the Shannon (Ardnacrusha) and Erne (Cathaleen's Fall), and of pigmented young eel (bootlace) on the Shannon (Parteen Regulating Weir). Prior to 2009, small amounts of glass eel and pigmented small eels were taken in the Shannon Estuary and in neighbouring catchments and these were stocked into the Shannon above Ardnacrusha and Parteen Hydropower Stations.

UK: There is no stocking of ongrown eel anywhere in UK. Glass eel from the England and Wales fishery are stocked into river systems of England and Wales: 53.6 kg in 2010, 50.1 kg in 2011 and 20.5 kg in 2012. No eel stocking takes place in Scotland. In Northern Ireland, recruitment of glass eel and pigmented small eel to Lough Neagh has been supplemented by stocking of purchased glass eel since 1984, and these eel have been sourced from the glass eel fishery in England and Wales. However, in 2010 the 996 kg of glass eel purchased from "UK Glass Eel Ltd" originated from fisheries in San Sebastian, Spain and the west coast of France: no glass eels from UK waters were purchased. In 2011 and 2012, glass eel from UK and French sources were stocked into Lough Neagh though all were purchased from "UK Glass Eels Ltd." Glass eel are not routinely quarantined before stocking into Lough Neagh, but arrive from "UK Glass Eels Ltd" with a Veterinary Health certificate. There is limited stocking undertaken in England and Wales, all of which is using glass eel obtained from either Severn or South West RBDs.

France: A public tender of 2 million Euros for stocking (and stocking monitoring) has been made each year since 2010. Glass eels are all caught in the EMU in which they are stocked. Thus, there is no stocking in EMU where there isn't a glass eel fishery. Glass eels have been quarantined in fish sellers' tanks for the duration of sanitary analyses. All stocking sites are monitored to assess the efficiency of stocking. The first nationally organized stocking action started in 2010 in the Loire River (209 kg: glass eel mean weight 0.233 g and thus 900 000 individuals). However, the glass eel came from a CITES seizure. In 2011, eleven projects were selected for a total amount of 4024 kg, but only 733 kg was really stocked, partly because of late selection process and partly because of limited supply. In 2012, eleven projects were selected for a total amount of 3475 kg, of which 3086 kg were ultimately stocked. In 2013, eleven projects were selected for a total amount of 3400 kg; 2940 kg have been stocked this year. Apart from this national stocking programme, some local stocking may have taken place but the quantity, life stage, origins and objectives are unknown. For example, there is a long history of stocking in Lake Grand Lieu (Adam, 1997) to enhance fishery with a maximum of more than 2 t of glass eels in the 1960s and more than 1.5 t of elvers in the 1990s.

Spain: No stocking is managed on a national level. Each autonomy has its own rules and experience concerning stocking. In Spain, different stocking experiences have been carried out:

- in Navarra, stocking is carried out in the Ebro River but only as a measure of artificial maintenance of the presence of eel in the rivers. Since 1988, C. Valenciana fishermen from the Albufera and from the Bullent and Molinell Rivers must give a percentage of their glass eels catches for stocking;
- in Asturias, the Head Office of Fishery purchased 6 kg and 8 kg of glass eel that were released in Sella and Nalón Rivers in 2010 and 2011, respectively;
- in Catalonia Inner River Basins and the Ebro RBD, different stocking experiences have been carried out since 1996. During 1998–2007, fishermen gave 5% of their seasonal glass eel catches approximately for stocking in the Fluvia, Muga, Ter and Ebro Rivers;
- in Cantabria, 40% of the total glass eel landings of the 2010–2011 season was used for stocking. Some of the catches were kept alive in tanks by the Consejería de Medio Ambiente and stocked weekly along the fishing period in different river basins depending on the source of landings;
- in the Basque Country, a new pilot study started in the Oria River in 2011. In the first phase, 2400 young eels trapped in the Orbeldi trap (in Usurbil, Gipuzkoa) were translocated up to the Ursuaran River (in Idiazabal, Gipuzkoa). Both rivers belong to the same river basin (Oria River basin). During 2012, and within the same project, 2.8 kg of glass eels from the fishery were stocked directly in the Oria River and another amount was kept for fattening in an eel farm; 1.7 kg of ongrown glass eel was stocked. In 2013, 6250 glass eel from the fishery in the Urola River were stocked directly upstream. During summer 2011, 2012 and 2013 different electric fishing operations have been carried out to monitor the stocked individuals.

Portugal*:* No stocking on a national level.

Italy: The new glass eel regulation foresees that glass eel fisheries can continue on a local scale, provided that 60% is used for stocking in national inland waters open to the sea, and provided that fishers compile specific and detailed logbooks of catches and sales. This new system, together with reinforced controls by the *Corpo Forestale dello Stato*, shall ensure that information on recruitment in Italy is available from year to year, that most glass eel is conveyed to stocking and that illegal fishing is definitively prevented. Up to 2010, the new regulation was not in force, its definite approval being achieved in 2011. From 2011, the new regulation being in force, fishing has started again and catches are declared to the Ministry on a weekly basis. In the 2012–2013 season 145.25 kg of glass eel from national fisheries were used for stocking, amounting to 35.4% of the total glass eel catch in Italy in this season (409.90 kg). The remainder (209 kg, 50.9%) was used for aquaculture, either intensive or extensive (*vallicoltura*).

9.6 Categorizing of the different sizes and origins in stocked eels

This section examines the data from countries performing stocking, compiled and grouped according to their origin (local or foreign source) and to their size class (glass eel with or without quarantine, small yellow eel from the wild, ongrown eel from culture units). The aim was to update figures showing the development of stocking activities given in previous years (Section 4.5 of this report) and to distinguish between local and foreign origin of eels stocked. For this, data given in Country Reports were used. Portugal, Morocco and Norway state they do not stock at all.

Harmonization procedures were restricted to cases where data do not correspond to size classes given in the template or when just biomass of stocked eels were available and had to be converted into numbers. The results (Table 9-11; Figure 9-14) indicate that stocking of larger eels, either pre-grown in farms or small yellow eel from the wild, prevails today, while in previous times most eels were stocked as glass eel.

Table 9-11. Numbers of stocked glass eels, small yellow eel and ongrown cultured eels in Member States that stock.

YEAR	SWEDEN							
	Local				**Foreign**			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	Ongrown cultured
2002	0	0	210 234	0	0	1 516 372	0	0
2003	0	0	278 598	0	0	701 866	0	0
2004	0	0	204 692	0	0	1 312 493	0	0
2005	0	0	66 158	0	0	1 037 331	0	0
2006	0	0	2850	0	0	1 313 978	0	0
2007	0	0	27 067	0	0	971 507	0	0
2008	0	0	117 168	0	0	1 379 946	0	0
2009	0	0	16 478	0	0	763 214	0	0
2010	0	0	0	0	0	1 936 510	0	0
2011	0	0	0	0	0	2 625 984	0	0
2012	0	0	0	0	0	2 561 774	0	0
2013	0	0	0	0	0	2 651 878	0	0

Year	FINLAND							
	Local				Foreign			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	Ongrown cultured
2002	0	0	0	0	0	55 000	0	0
2003	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	63 500	0	0
2005	0	0	0	0	0	64 000	0	0
2006	0	0	0	0	0	55 000	0	0
2007	0	0	0	0	0	107 000	0	0
2008	0	0	0	0	0	206 000	0	0
2009	0	0	0	0	0	117 500	0	0
2010	0	0	0	0	0	153 000	0	0
2011	0	0	0	0	0	306 000	0	0
2012	0	0	0	0	0	177 000	0	0
	0	0	0	0	0	197 000	0	0

Year	ESTONIA							
	Local				Foreign			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured
2002	0	0	0	0	0	0	0	360 000
2003	0	0	0	0	0	0	0	540 000
2004	0	0	0	0	0	0	0	440 000
2005	0	0	0	0	0	0	0	370 000
2006	0	0	0	0	0	0	0	380 000
2007	0	0	0	0	0	0	0	330 000
2008	0	0	0	0	0	0	0	190 000
2009	0	0	0	0	0	0	0	420 000
2010	0	0	0	0	0	0	0	210 000
2011	0	0	0	0	680 000	0	0	200 000
2012	0	0	0	0	910 000	0	0	120 000
2013					810 000			NA

naYear	LATVIA							
	Local				Foreign			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	Ongrown cultured
2002	0	0	0	0	230 000	0	0	200 000
2003	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0
2005	0	0	0	0	120 000	0	0	0
2006	0	0	0	0	6000	0	0	0
2007	0	0	0	0	18 000	0	0	0
2008	0	0	0	0	0	0	0	3000
2009	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	7700
2011	0	0	0	0	386 000	0	0	3600
2012	0	0	0	0	1 030 000	0	0	0
2013	0	0	0	0	0	0	0	0

Year	LITHUANIA							
	Local				Foreign			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	Ongrown cultured
2002	0	0	0	0	0	0	0	0
2003	0	0	0	0	353 000	0	0	0
2004	0	0	0	0	0	0	0	71 000
2005	0	0	0	0	0	0	0	2000
2006	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	5000
2008	0	0	0	0	0	0	0	5000
2009	0	0	0	0	0	0	0	11 000
2010	0	0	0	0	0	0	0	29 000
2011	0	0	0	0	0	0	0	152 000
2012	0	0	0	0	0	0	0	491 000
2013	0	0	0	0	1 000 000			400 000

Year	POLAND							
	Local				Foreign			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	Ongrown cultured
2002	0	0	0	0	0	0	0	600 000
2003	0	0	0	0	500 000	0	0	500 000
2004	0	0	0	0	2 300 000	0	0	500 000
2005	0	0	0	0	0	0	0	700 000
2006	0	0	0	0	0	0	0	1 100 000
2007	0	0	0	0	0	0	0	900 000
2008	0	0	0	0	0	0	0	1 000 000
2009	0	0	0	0	0	0	0	1 400 000
2010	0	0	0	0	0	0	0	1 400 000
2011	0	0	0	0	0	0	0	2 700 000
2012	0	0	0	0	0	0	0	1 700 000
2013	0	0	0	0	0	0	0	4 300 000

Year	GERMANY							
	Local				Foreign			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	Ongrown cultured
2002	0	0	0	0	2 905 514	0	0	7 173 966
2003	0	0	0	0	1 992 455	0	0	7 353 251
2004	0	0	0	0	1 641 157	0	0	7 287 534
2005	0	0	0	0	1 867 015	0	0	6 622 402
2006	0	0	0	0	1 081 956	0	0	9 632 642
2007	0	0	0	0	1 012 270	0	0	8 704 726
2008	0	0	0	0	501 200	0	0	8 575 113
2009	0	0	0	0	755 128	0	0	8 282 973
2010	0	0	0	0	4 813 464	0	0	8 190 661
2011	0	0	0	0	NA	0	0	NA
2012	0	0	0	0	3 060 750	NA	NA	4 515 710

Year	DENMARK							
	Local				Foreign			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	Ongrown cultured
2002	0	0	0	0	0	0	0	2 430 000
2003	0	0	0	0	0	0	0	2 240 000
2004	0	0	0	0	0	0	0	750 000
2005	0	0	0	0	0	0	0	300 000
2006	0	0	0	0	0	0	0	1 600 000
2007	0	0	0	0	0	0	0	830 000
2008	0	0	0	0	0	0	0	750 000
2009	0	0	0	0	0	0	0	810 000
2010	0	0	0	0	0	0	0	1 550 000
2011	0	0	0	0	0	0	0	1 560 000
2012	0	0	0	0	0	0	0	1 530 000
2013	0	0	0	0	0	0	0	1 520 000

Year	THE NETHERLANDS							
	Local				**Foreign**			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured
2002	0	0	0	0	1 600 000	0	0	100 000
2003	0	0	0	0	1 600 000	0	0	100 000
2004	0	0	0	0	300 000	0	0	100 000
2005	0	0	0	0	100 000	0	0	0
2006	0	0	0	0	582 000	0	0	0
2007	0	0	0	0	216 000	0	0	0
2008	0	0	0	0	0	0	0	230 000
2009	0	0	0	0	300 000	0	0	300 000
2010	0	0	0	0	2 714 400	0	0	62 000
2011	0	0	0	0	798 630	0	0	996 293
2012	0	0	0	0	2 374 600	0	0	499 500
2013					1 830 780			498 534

Year	BELGIUM							
	Local				Foreign			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured
2002	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0
2008	0	0	0	0	375 000	0	0	0
2009	0	0	0	0	456 000	0	0	0
2010	0	0	0	0	429 000	0	0	0
2011	0	0	0	0	480 000	0	0	0
2012	0	0	0	0	618 000	0	0	0
2013					432 000			

Year	IRELAND							
	Local				Foreign			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured
2002	711 000	0	0	0	0	0	0	0
2003	431 100	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0
2005	3000	0	0	0	0	0	0	0
2006	6600	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0

Year	UNITED KINGDOM							
	Local				Foreign			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured
2002	3 021 000	0	0	0	0	0	0	0
2003	4 104 090	0	0	0	0	0	0	0
2004	1 281 270	0	0	0	0	0	0	0
2005	2 156 010	0	0	0	0	0	0	0
2006	990 000	0	0	0	0	0	0	0
2007	3 000 000	0	0	0	0	0	0	0
2008	1 284 000	0	0	0	0	0	0	0
2009	645 000	0	0	0	0	0	0	0
2010	160 800	0	0	0	2 988 000	0	0	0
2011	1 113 300	0	0	0	2 142 000	0	0	0
2012	2 761 500	0	0	0	1 200 000	0	0	0
2013	5 598 000							

Year	FRANCE							
	Local				Foreign			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured
2002	ND	ND	ND	ND	ND	ND	ND	ND
2003	ND	ND	ND	ND	ND	ND	ND	ND
2004	ND	ND	ND	ND	ND	ND	ND	ND
2005	ND	ND	ND	ND	ND	ND	ND	ND
2006	ND	ND	ND	ND	ND	ND	ND	ND
2007	ND	ND	ND	ND	ND	ND	ND	ND
2008	ND	ND	ND	ND	ND	ND	ND	ND
2009	ND	ND	ND	ND	ND	ND	ND	ND
2010	0	0	0	0	0	627 000	0	0
2011	2 242 500	ND	ND	ND	ND	ND	ND	ND
2012	9 258 000	ND	ND	ND	ND	ND	ND	ND
2013	8 820 000							

Year	SPAIN							
	Local				Foreign			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured
2002	0	0	0	99 999	0	0	0	0
2003	0	0	0	198 406	0	0	0	0
2004	35 769	0	0	143 938	0	0	0	0
2005	0	0	0	2117	0	0	0	0
2006	0	0	0	25 028	0	0	0	0
2007	0	0	0	103 432	0	0	0	0
2008	0	0	0	36 142	0	0	0	0
2009	0	0	0	75 108	0	0	0	0
2010	0	0	0	127 839	0	0	0	0
2011	17 748	0	0	252 105	0	0	0	0
2012	248 057	0	0	81 087	0	0	0	0
2013	6250			0				

Year	ITALY							
	Local				Foreign			
	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild small yellow eel*	On-grown cultured
2002	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0
2009	300 000	0	950 200	0	0	0	0	0
2010	133 500	0	894 000	0	0	0	0	0
2011	195 000	0	685 700	0	0	0	0	0
2012	435 000	0	193 000	0	600 000	0	0	0
2013	1 035 750							

Where stocking with eel from local sources takes place, this is mainly using glass eel, with fewer wild small yellow eel and no ongrown cultured eel.

When eels from foreign origin are stocked, ongrown cultured eel dominate by far but the proportion of glass eel has increased in the last three years. Wild small yellow eel of foreign origin are not being stocked.

In total, eel of foreign origin dominated stocking. The proportion of local sourced eel went down from >20% to <10% until 2010, but has increased again in the last two years to >40%. This is partially attributed to the fact that data for Germany for these years are missing. In Germany a large amount of ongrown cultured eels have been stocked every year, so the absence of current data is of great impact on the ratio shown in Figure 9-14.

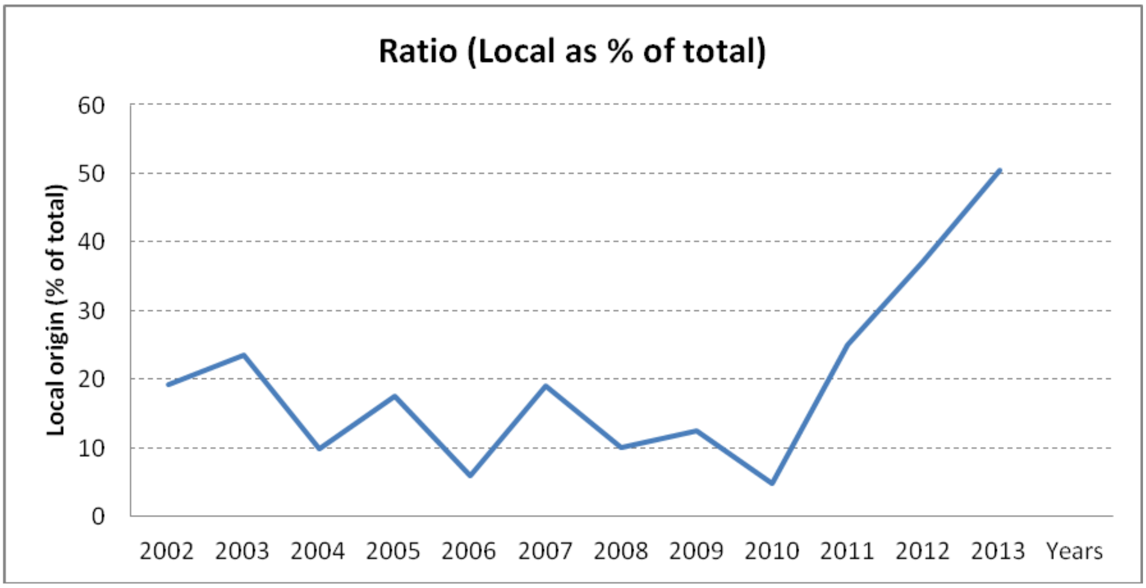


Figure 9-14. Percentage of stocked eel of local origin in relation to the total amount of eel stocked.

9.6.1 Methods when converting stocked eel into "glass eel equivalents"

Due to the fact that stocked eel differ in size, an assessment of stock dynamics requires a synchronization of stocked eel with respect to size and time. Therefore, stocked eel of different individual size were converted into "glass eel equivalents" and shifted to the respective year when they would have been glass eels. Such glass eel equivalents are the number of true glass eels that would be required under natural circumstances to produce the same number of eels of the size actually stocked. The conversion is based on the average size and age of the stocked eels, and the expected number of eels that would have died between the glass eel stage and the stocking event. That means an ongrown eel of a certain size stocked in year x corresponds to a certain larger number of individuals of eel stocked in year x–y considering appropriate growth and mortality rates. Such normalized "glass eel equivalents" are to be used as a potential input parameter for following stock modelling and to clearly illustrate the total amounts of stocked eels if they would all have been stocked as glass eel.

For transformation of weight into length classes, the following equation was used for all datasets based on biomass values:

Total length [cm] = 9.604 * Body mass [g] ^0.3033 (according to Simon, unpublished).

After this, numbers of individuals in length groups were transformed into equivalents of glass eel 7 cm in length. For countries operating VPA-models for stock analysis (e.g. Germany), mortality and growth rates from these models were applied. For all other countries, natural mortality was set at M = 0.138 (Dekker, 2000). An example of the total transformation from weight to glass eel equivalents is given in Table 9-13.

In terms of growth rates, data from literature and approximations were applied as in Table 9-12.

Table 9-12. Annual increment used to transform yellow eel into glass eel equivalent.

Country	*Annual length increment [cm]*
Sweden	4.5
Finland	4.5
Estonia	4.5
Latvia	4.5
Lithuania	4.5
Poland	5.0
Germany	Na
Denmark	4.5
the Netherlands	5.0
Belgium	Na
Ireland	Na
United Kingdom	Na
France	Na
Spain	6.0
Italy	7.7

Table 9-13. Example for conversion procedure to calculate virtual glass eel equivalents from eels stocked at different sizes.

Type of stocking material	Glass eel	Ongrown (small)	Ongrown (large)	Ongrown (large)
Year of stocking	2012	2012	2012	2013
Length at stocking	7	10	25	25
Number stocked	100	100	100	100
Growth (cm/year)	4	4	4	6
Age (calculated)	0	0.75	4.5	3
M (natural mortality)	0.139	0.139	0.139	0.139
Year equivalent	2012	2011	2008	2010
Number equivalent	100	111	187	152

9.6.2 Problems and consequences for interpretation

The size and origin of eels stocked has been diverse and is not known in detail for a number of countries. In these cases, assumptions were made, especially with regard to average size, which may have led to the misclassifying of those eels into size groups.

The natural mortality used in back-calculation of larger eels into glass eel equivalents applies to eels in natural habitats. The French EDA model used an additional 20% survival from the glass eel to the yellow eel stage. When larger eels were raised in aquaculture facilities before stocking, they might have experienced a different mortality. In addition, transformation of larger eels into glass eel equivalents led to a time shift. For example, 15 cm long ongrown eels stocked in 2013 were transformed into glass eel equivalents stocked in 2011. For small yellow eel caught in the wild, this shift resembles reality. However, eels pre-grown in farms should have had a much faster growth rate during that time and may originate in the same age cohort as the glass eel stocked that year. Therefore, the values of calculated glass eel equivalents are of theoretical origin only and should not be interpreted and used as the true amount of glass eel assigned to stocking in a particular year.

There are some indications that farm sourced eels may experience problems after being stocked into natural waters and therefore display a poorer performance concerning growth and survival compared to glass eel (e.g. Pedersen, 2000; Simon and Brämick, 2012). As a result, the factors used here to transform ongrown eels into glass eel equivalents (e.g. 1.0 ongrown eel of 15 cm in total length was transformed into 1.3 glass eels) may not hold true, particularly in cases where farm sourced eels were used for stocking.

When interpreting the data on glass eel equivalents, it has to be kept in mind that due to the time shift applied to ongrown and small yellow eel when being converted into glass eel equivalents, the values of the recent years (from 2007 onwards) will be affected by stocking of eel other than glass eel in coming years. Therefore, the trend of glass eel equivalents stocked can be judged only up until 2007. Nevertheless, a sharp decrease between 1992 and 2005 can be observed (Table 9-14 and Figure 9-15). The increase indicated from 2012 will most probably remain.

Another approach to this concept of "glass eel equivalents" would be to also incorporate mortalities until the eels are supplied to a dealer or actually all mortalities except the natural ones between fishing and stocking. Thus, fishing, handling, holding and transport mortalities should be monitored and incorporated in the conversion. In that way, a number of stocked eel could be converted to the corresponding number of glass eels in the sea giving the basis for the stocked number.

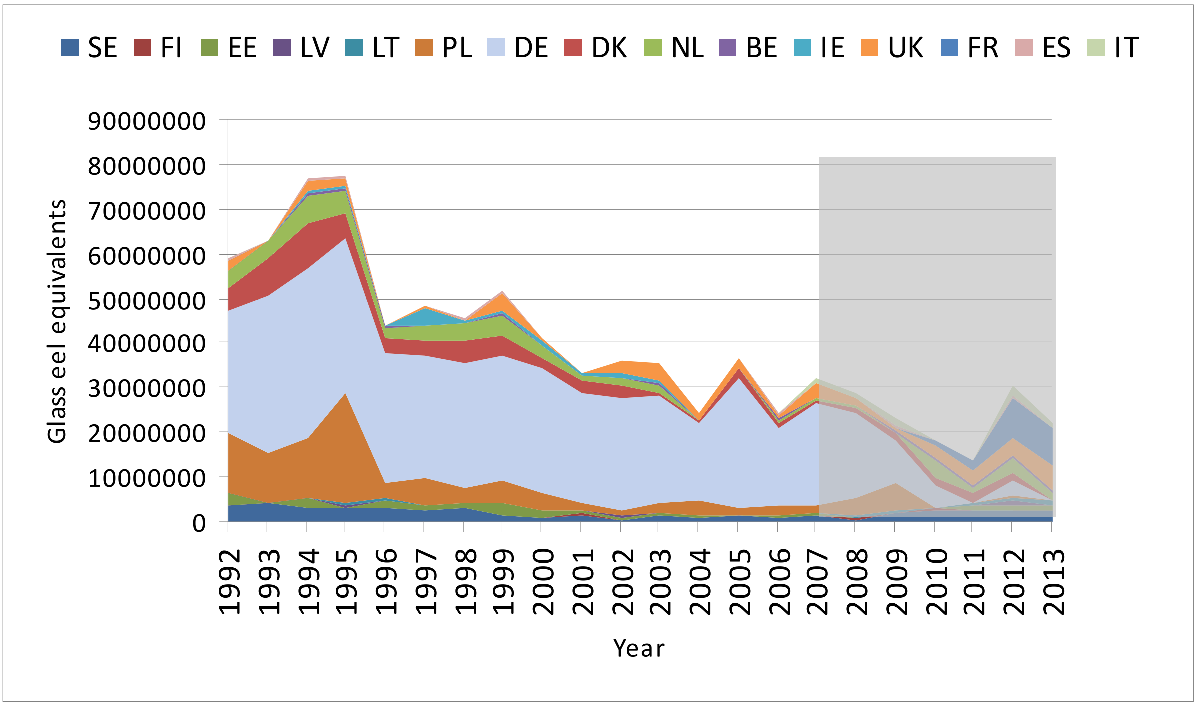


Figure 9-15. Total number of stocked eels in equivalent of glass eels stocked in Sweden (SE), Finland (FI), Estonia (EE), Latvia (LV), Lithuania (LT), Poland (PL), Germany (DE), Denmark (DK), the Netherlands (NL), Belgium (BE), Ireland (IE), United Kingdom (GB), France (FR), Spain (ES) and Italy (IT) during 1992–2012. Values from 2007 onwards are shaded because stocking in coming years will lead to changes in this period.

Table 9-14. Numbers of stocked eels in equivalent of glass eels stocked in Sweden (SE), Finland (FI), Estonia (EE), Latvia (LV), Lithuania (LT), Poland (PL), Germany (DE), Denmark (DK), the Netherlands (NL), Belgium (BE), Ireland (IE), United Kingdom (GB), France (FR), Spain (ES) and Italy (IT).

	SE	FI	EE	LV	LT	PL	DE	DK	NL	BE	IE	GB	FR	ES	IT	Total
1992	3 688 731	113 406	2 717 090	0	0	13 800 000	27 409 773	4 875 332	3 743 130	0	0	2 357 610	0	342 147		59 047 219
1993	4 253 551	111 786	0	0	0	11 320 964	35 164 545	8 500 368	3 800 000	0	0	0	0	175 712		63 326 926
1994	3 286 333	233 941	1 900 000	0	70 897	13 786 122	37 471 324	10 390 859	6 200 000	525 000	462 000	2 315 610	0	227 586		76 869 672
1995	3 247 799	80 551	0	600 000	529 000	24 565 157	34 529 250	5 663 264	4 998 130	472 500	582 000	2 058 000	0	137 123		77 462 774
1996	3 421 263	88 781	1 400 000	0	467 713	3 520 964	29 085 001	3 114 795	2 286 261	507 000	312 000	99 570	0	136 484		44 439 832
1997	2 842 197	83 759	900 000	0	5897	6 253 543	27 357 723	3 423 121	3 029 391	432 000	3 879 000	211 410	0	222 396		48 640 437
1998	3 167 614	67 504	1 136 798	0	77 268	3 365 157	28 000 950	5 072 315	3 958 783	0	516 000	51 810	0	233 105		45 647 304
1999	1 489 731	65 900	2 821 017	300 000	0	4 865 157	27 776 330	4715283	4 115 652	754 500	810 000	3 600 000	0	408 701		51 722 271
2000	1 014 868	49 143	1 881 525	0	0	3 820 964	27 819 693	2 092 946	2 921 565	0	1 044 000	450 990	0	131 949		41 227 643
2001	1 933 017	59 403	636 798	233 306	104 673	1 420 964	24 731 658	2 791 337	1 021 565	162 000	354 000	0	0	274 548		33 723 269
2002	799 579	0	535 490	230 000	2949	1 009 350	25 502 208	2 757 763	1 721 565	0	711 000	3 021 000	0	189 927		36 480 831
2003	1 417 571	68 584	549 962	0	353 000	2 086 122	23 824 494	923 358	1 721 565	324 000	431 100	4 104 090	0	2793		35 806 639
2004	1 120 379	69 124	477 599	0	7371	3 597 736	17 101 592	369 343	300 000	0	0	1 281 270	0	68 794		24 393 208
2005	1 419 175	59 403	274 981	120 000	7371	1 441 929	29 318 732	1 837 917	100 000	0	3 000	2 156 010	0	193 192		36 931 710
2006	1 049 286	115 566	607 853	6000	14 743	2 018 700	17 498 863	1 021 850	582 000	330 000	6 600	990 000	0	155 765		24 397 226
2007	1 490 424	222 492	303 927	21 500	2949	2 176 568	22 563 170	923 358	495 600	0	0	3 000 000	0	0	1 185 922	32 228 042
2008	824 317	126 907	289 454	0	197 552	4 095 836	19 320 210	997 227	364 696	375 000	0	1 284 000	0	168 685	1 115 780	28 957 036
2009	2 091 546	165 249	144 727	8982	654 576	6 438 524	13 739754	1 780 482	375 370	456 000	0	645 000	0	332 655	1 448 339	23 262 837
2010	2 836 220	330 498	0	4200	160 000	0	6 750 796	1 920 585	3 925 546	429 000	0	3 148 800	627 000	0	133 500	18 328 813
2011	2 766 869	191 171	680 000	386 000	530 000	0	NA	1 883 651	1 405 848	480 000	0	3 255 300	2 242 500	196 659	195 000	14 212 998
2012	2 652 115	183 242	1 034 202	1 030 000	414 106	1 058 041	3 060 750	1 871 340	2 9674 60	618 000	0	3 961 500	9 258 000	248 057	2 183 500	30 540 313
2013	2 745 396	203 947	810 640	0	1 000000	0	NA	0	1 830 780	432 000	0	5 598 000	8 820 000	6250	1 035 750	22 482 763

9.7 Fishing effort

The WGEEL examined the time-series of fishing effort provided in Country Reports to monitor and compare changes in fishing effort. However, no comparable analysis between countries was possible because fishing effort is reported in a variety of units (days at sea, number of gears, soaking time, number of licenses etc.). Therefore, this chapter is limited to a short review of the information provided in Country Reports.

Norway

Eel fishery is prohibited.

Sweden

Monthly reports by coastal fishermen since 1999 indicate the number of companies landing eel but do not allow a reconstruction of fishing capacity and/or effort. In recent years, the number of companies has declined, primarily in Västerhavet and in Bottenhavet. Since 2006, a minimal landing of 400 kg per year is required to obtain a licence. This increased the number of companies reporting, especially in Södra Östersjön, but otherwise, the number of companies shows a downward trend here too. The fishery in Kattegat and Skagerrak was closed in spring 2012, corresponding to a 40% decrease in coastal licences. Data from 2012 are incomplete, but as only 180 licences were issued for this year a further decrease is expected. For inland waters, no reliable time-series on fishing capacity or effort exist.

Finland

No data.

Estonia

No data.

Latvia

No data.

Lithuania

Fisheries companies provide information according to their logbooks (each fishing case, including gears used and catch must be obligatory recorded) about fishing effort on a monthly basis to the authority issuing permits: a regional environmental protection department under the Ministry of Environment of the Republic of Lithuania if a company is engaged in inland fisheries (including the Curonian Lagoon), or the Fisheries Service of the Ministry of Agriculture of the Republic of Lithuania if an company is engaged in maritime fisheries.

Poland

Effort is recorded only in marine and transitional waters, via standard monthly declaration and daily logbooks for vessels longer than 12 m. There is no statistical system of effort data collection in inland waters.

Germany

Fisheries in Germany usually are mixed fisheries, which catch different species and also both yellow and silver eel (although some gears are more specialized for one of the stages). Therefore, fishing effort cannot be presented separately for yellow and silver eel. Except for large fykenets, a decreasing tendency in fishing effort is documented for the period 2008 to 2010.

Denmark

Denmark reports capacity of the 783 commercial fishermen and entities with registered landings and poundnets in the reference period 2004–2006 applied for a total of 525 licences. A total of 406 commercial licenses were allocated in 2009. Since then 45 licenses have been cancelled, reducing the number of active commercial fishing licenses in 2012 to 361 (Danish AgriFish Agency).

Netherlands

In 2012, all eel fishers were obliged for the first time to record their catches and effort (type of gear and number of gear) every week and report to the Ministry of Economic Affairs. The weekly records of deployment of eel fishing gear in Lake IJsselmeer/Markermeer demonstrate that for most gears there was a "overcapacity" of fishing gears. Except for train fykes, the number of fishing gears actually used was considerably lower that the number of legal, available gears.

Belgium

Eels are not documented in marine waters, inland fishery is prohibited.

Ireland

Eel fishery is prohibited.

Great Britain (England and Wales)

Since 2005, glass eel fishermen have been required to annually report the number of days fished as part of their catch return, and these data are being used to develop time-series of fishing effort.

Since 2005, yellow and silver eel fishers are now required to annually report the number of days fished as part of their catch return, and these data allow the development of a time-series of fishing effort, which is the number of codends multiplied by the number of nights fished and summed for the entire fishing season. Note that there is no separation of effort into that targeting yellow vs. silver eel.

France

The best available effort information is of the glass eel fishery. The trend in effort is provided by comparing Beaulaton *et al.* (2009) data with current fishing effort. The number of marine fishermen reporting a catch has dropped from 827 (extrapolated number in 2009) to 528 in 2012. The actual number is consistent, because it stands between the number of licences issued for 2011 (573) and for 2012 (500). The drop in the number of fishermen reporting a catch is of 36%, a little bit larger than the drop in the number of licensees.

The fishing trips for marine glass eel fishermen are grouped daily, each day corresponding to one or two trips. When looking at the number of daily catch, the current number represents 44% of 2007/2008 daily catch, while it was about half that number (48%) in 2011, so there is a diminution in fishing effort of about 56% from 2009 to 2011. In 2010 and 2011, this diminution is mostly the consequence of trade closure as the quota set at the national level was not attained, and thus was not restrictive to the fishing activity. However, in 2012 the quota was attained quite rapidly in some places, and the fishery stopped in most of the sectors.

In places where many boats are competing with each other, the diminution in fishing effort might be somewhat compensated by the greater individual efficiency of boats as the overall number of boat diminishes. This decrease in fishing effort can thus be considered as an overestimation of the diminution in fishing mortality.

Spain

Not all the EMUs record effort data, and the ones recording it have their own data collection system.

Portugal

Fishing effort is not recorded in the Portuguese eel fishery.

Italy

Glass eel fishing is allowed by authorization on a yearly basis, both in coastal and inland waters, in the nine EMUs, to firms dealing with juvenile fish harvest and commercialization. Authorized firms are obliged to return catch data including details on the fishing site and fishing effort, but for this first period of implementation; returned forms were unsatisfactory with regards to this information.

Yellow and silver eel catches were assessed with the same method.

The methodology to describe the commercial fishing effort is based on direct and detailed interviews of a sample of fishermen, extracted on a statistical basis for each habitat typology in each EMU. Almost all the eel catch is from fykenets fisheries, used in all habitat typologies in all EMUs, with the exception of fish barriers used in managed coastal lagoons. Longlines are sporadically used in only one or two lakes.

The interviews consist of questionnaires where each fisherman reports catch data (yellow and silver eel separated), type of gear, number of gears used daily and number of fishing days per year. A detailed cpue in each habitat typology of all nine EMUs has been derived from a reliable subset of interviewed fishermen: an average parameter of fishing effort (number of gears * number of fishing days) was multiplied by the total fishermen operant in each habitat typology.

9.8 Aquaculture production

Aquaculture production data for European eel limited to European countries from 2004 to 2012 are compiled by integrating data from Country Reports to WGEEL 2013 (Table 9-15), FAO (Table 9-16) and FEAP (Table 9-17). Some discrepancies exist between databases and the national reports annexed to this report, but overall the trend in aquaculture production is decreasing from 8000–9000 t in 2003 to approximately 5000–6000 t in 2011/2012 (Figure 9-16). Some of the discrepancies between FAO and the Country Reports data result from eel used for stocking not being reported to the FAO.

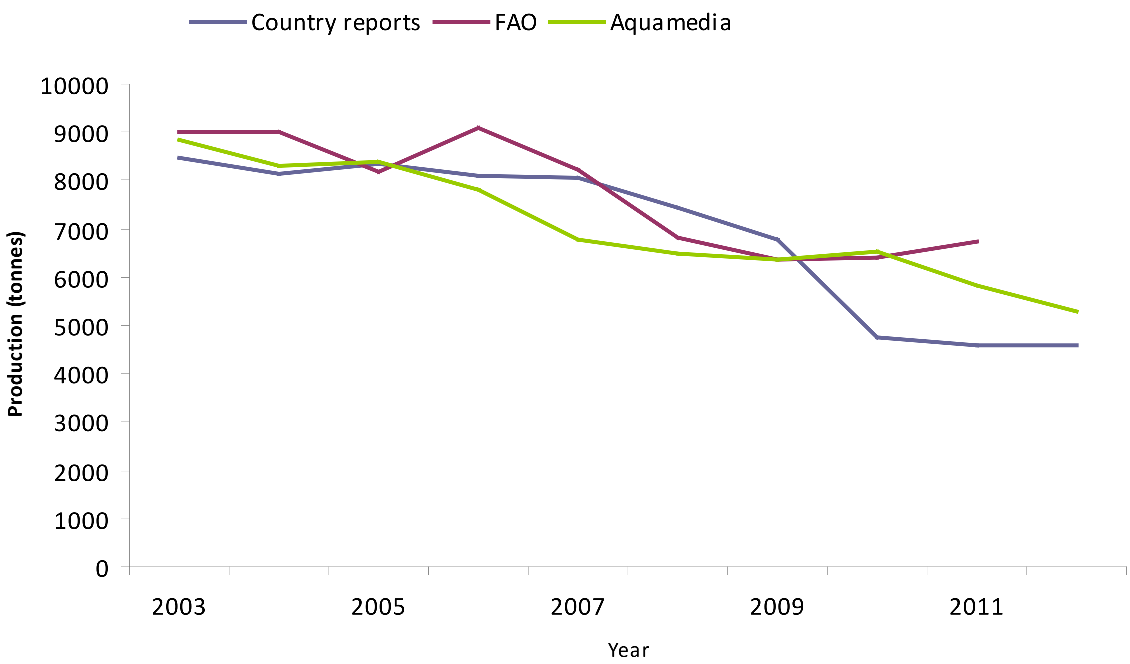


Figure 9.16. Different sources of data for aquaculture production of European eel in Europe from 2003 to 2012, in tonnes.

Table 9.15. Aquaculture production of European eel in Europe from 2004 to 2012, in tonnes as reported in the Country Reports. n.d. = no data.

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sweden	158	222	191	175	172	139	91	94	93
Estonia	26	19	27	52	45	30	20	25	35
Poland	1	1	1	1	1	1	1	1.5	1.5
Germany	328	329	567	740	749	667	681	660	706
Denmark	1500	1700	1900	1617	1740	1707	1537	1156	1093
Netherlands	4500	4500	4200	4000	3700	3200	2000	2300	2300
Spain	424	427	403	478	461	450	411	391	352
Portugal	1.5	1.4	1.1	0.5	0.4	1.1	n.d.	0.6	n.d.
Italy	1220	1131	807	1000	551	587	n.d.	n.d.	n.d.
Total	8157	8329	8096	8063	7419	6781	4741	4602	4580.5

Table 9-16. Aquaculture production of European eel in Europe from 2004 to 2011, in tonnes. Source: FAO FishStat.

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sweden	158	222	191	175	172	0	0	90	
Estonia	7	40	40	45	47	30	22	10	
Germany	322	329	567	440	447	385	398	660	
Denmark	1823	1673	1699	1614	895	1659	1532	1154	
Netherlands	4500	4000	5000	4000	3700	2800	3000	3000	
Spain	424	427	403	479	534	488	423	434	
Portugal	2	1	2	1	1	1	0	1	
Italy	1220	1132	807	1000	551	567	647	1000	
Greece	557	372	385	454	489	428	372	370	
Hungary	11	5	0	0	0	0	0	0	
Total	9024	8201	9094	8208	6836	6358	6394	6719	

Table 9-17. Aquaculture production of European eel in Europe from 2004 to 2012, in tonnes. Source: Aquamedia.

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Sweden	158	222	191	175	172	170	170		
Denmark	1500	1610	1760	1870	1870	1500	1899	1154	1154
Netherlands	4500	4500	4200	3000	3000	3200	3000	2800	2300
Spain	390	405	440	280	390	510	446	402	350
Italy	1220	1132	808	1000	550	568	568	1100	1100
Greece	500	500	385	454	489	428	428	372	372
Hungary	20	20	20						
Total	8288	8389	7804	6779	6471	6376	6511	5828	5276

9.9 Conclusion on data and trends

The WGEEL recruitment index is currently low, 1.5% for the North Sea and 10% elsewhere in the distribution area with respect to 1960–1979 reference period. The recruitment has increased in the last two years, but remains far from the ‘healthy’ zone (see Chapter 5).

The WGEEL has continued to collect yellow and silver time-series. This work needs to be extended in order to enable an analysis of those series, permitting in future some fishery-independent trends to be included in the advice.

Data on catch was provided by all MS participated in WG. In total, around Europe professional fishers and recreational fisherman were reported to have landed about 2600 t and 500 t, respectively, giving a total of around 3100 t of eel. Total commercial landings for fisheries in Europe have declined. There are some reports from outside Europe of equal or even greater landings, but quality of the information is uncertain. This stresses the importance of extending the data collection to all countries (e.g. GFCM countries) within the natural range of the European eel.

The reported landings of recreational and non-commercial fisheries are incomplete. Only one MS (NL) has so far reported on the amount of eels released by commercial fishermen, though this practice does not occur in every country. It is unclear whether any post-release mortality of eels occurs where catch and release is practised by recreational fishermen.

Aquaculture production has decreased to 4500 t in 2012.

In 2012, about 22 million of glass eels and 10 million of yellow eels were reported for stocking.

For most of country reports, the basic indicators on the status of eel fisheries (fishing capacity, fishing effort) were missing or incomplete. The inaccuracy and poor representativeness of these indicators leads to wide uncertainties, and prevents any comparisons.

10 Glass eel landings and trade

Autumn meeting

Chapter 10 addresses the following Terms of Reference:

j) 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). Establish an international database for data on eel stock and fisheries, as well as habitat and eel quality (update EQD) related data; seek advice from ICES Data-Centre for this task; review and make recommendations on data quality issues;

and has links to:

j) respond to specific requests in support of the eel stock recovery Regulation, as necessary.

This task was organized under the following headings:

1) Assess quantities of glass eel caught and their destiny:
- caught in the commercial fishery;
- internal trade between EU Countries;
- used in stocking;
- used in aquaculture for consumption;
- consumed direct;
- mortalities;
- evidence of export to Asia.

2) where possible track "movement through" countries and match up imports/exports;

3) compare with the commitments to stocking in the EMP (use stocking data supplied in ICES review table);

4) Revisit and update the "use" of stocking glass eel.

10.1 Introduction

Given the decline in eel stock, information on the trade of all stages of the European eel is necessary for a complete understanding of the fishery mortality. However, a complete description of eel trade was deemed to be beyond the scope of the WGEEL at the present time and given the value and continued use of glass eel for consumption, aquaculture and stocking, the decision was made to continue the task of trade assessment by focusing on the glass eel trade. In addition, the Eel Regulation requires that:

- For those Nations with glass eel fisheries "60% for stocking is to be set out in an Eel Management Plan established in accordance with Article 2. It shall start at least at 35% in the first year of application of an Eel Management Plan and it shall increase by steps of at least 5% per year. The level of 60% shall be achieved by 31 July 2013." Article 7,2.

- "No later than 1 July 2009, Member States shall: take the measures necessary to identify the origin and ensure the traceability of all live eels imported or exported from their territory." Article 12.

Glass eel trade data incorporated into the EuroStat Database and EIFAAC/ICES WGEEL Country Reports were examined to determine the destiny of glass eel in 2013. The results were compared with those from similar analyses in 2012 (ICES, 2012b).

10.2 Trade analysis

Two datasets were used in the trade analysis. These were provided by country representatives at the WGEEL, and from the EuroStat database (EU27 trade since 1988 by CN8 (DS_057380)).

Five EU nations (see Table 10-1) have a glass eel fishery. The best estimate of the total catch of glass eel in 2013 was 51 621 kg (Table 10.1), an increase of 5929 kg (13%) from 2012. From the 2013 catch, 5502 kg were declared as being internally stocked within the country of origin, inferring that 46 119 kg (89.9% of the catch) were exported for use in stocking, aquaculture or direct consumption elsewhere in the EU. Four of the glass eel fishing nations recorded an increase in harvest from 2012 (Great Britain, Spain, Portugal and Italy) with the most significant increase in glass eel catch coming from Great Britain with a rise of 4840 kg. However the French catch fell slightly from 34 256 kg in 2012 and will have been influenced by the introduction of a quota in 2010 on the French glass eel fishery.

Table 10-1. The amount of glass eel caught and exported/internally stocked in 2013. This table is based on preliminary data; the intention is to show the technique, but specific outcomes will certainly change in future assessments.

Country	Total Catch (kg)	Total Export (kg)	Internally Stocked (kg)	Total utilised (kg)	Loss (%)
Great Britain	8660	5639	2152	7790	10.1
France	33 618	16 000*	2940	18 940	43.7
Spain	7852	1900	43	1943	75.3
Portugal	1081	1081	0	1081	0
Italy	410	0	145	410***	0
Morocco**	no data	no data			
Total 2012	51 621			30 164	43%

***included data for 3712 kg restocking exports..**

****A catch of 1356 kg was returned for Morocco in 2012.**

***** Entire Italian catch was used for internal stocking and local aquaculture.**

Difference between catch and exports

Of the total catch of ~51.6 t the destiny of 30.1 t was accounted for, representing an overall loss rate of 43%, compared to 23% in 2012. Some of this loss may be explained by mortality and loss of weight post-capture, some through underreporting of exports and through illegal activities.

For Great Britain, glass eel are caught using handnets and this combined with weight loss following capture is thought to account for the lower loss rate of 10.1%. For Spain the export includes 1900 kg derived from the EuroStat database which represents a loss rate of ~75%. Some of this loss may be explained by mortality in the trawl fishery and also possibly from the illegal (undisclosed) export of glass eel.

However the loss rates for France and Spain are high, almost double those found in 2012 (ICES, 2012b).

For Italy, the loss rate is minimal as they operate a truck and transport system with only one or two days between capture (using fykenets) and stocking in the wild or transfer to an aquaculture facility. For Portugal all glass eels were exported to Spain.

10.3 Destination of the catch by country

The initial destination of glass eels landed in France, Portugal, Spain and Great Britain are reported here in two different ways, using

1) data from Country Reports or by country representatives at WGEEL (="WGEEL-CR");
2) by querying the EuroStat import/export database (Table 10-2).

The EuroStat database query was for the period July 2012–June 2013 and undertaken on 06/09/2013. The query collected export data from France (FR), Portugal (PT), Spain (ES), Italy (IT) and Great Britain (GB), to BE, CZ, DE, DK, EE, EL, ES, FR, IT, LT, NE, PO, PT, SE, SK, GB. The EuroStat database has been updated since 2011, and distinction is now made by type of eel consignment, allowing live eels of <12 cm to be readily identified. However, it appears from the prices charged that some of the exports are not correctly labelled, and in such cases distinction between glass eel and yellow eel was made according to the methods in Briand *et al*. (2008). The EuroStat database has several limitations when dealing with glass eel. Sometimes the nature of the exports is not clear and must be assumed from its price. Furthermore all data in EuroStat are rounded to the nearest 100 kg, while much trading of glass eel takes place in smaller quantities: in such cases a more precise estimate of the weight of the consignment can be made by assuming that the mean price for glass eels was paid.

The total export of glass eel according to EuroStat was 16 t for France, 7.8 t for GB, 1.9 t for Spain and 1.7 t for Portugal (Total 27.4 t).

Accordingly it appears that EuroStat can well describe glass eel exports in Europe (although perhaps not fully until later in the reporting year than September), and at present appear to be more reliable than the reporting systems of the main exporting countries (with the possible exceptions of Great Britain and Portugal), which are not currently adequate for assessing even the initial exports of glass eels. However EuroStat itself is not useful for tracing any subsequent re-exports of glass eel consignments as highlighted by French export to Great Britain then to Denmark. The spatial distribution and quantities of exported eels from the main donor countries are presented in Figures 10-1, 10-2 and 10-3.

Table 10-2. The direct destination and quantity of glass eel landed in France, Portugal, Spain and Great Britain in the 2012–2013 fishing season, recorded from two different sources: Country Reports (C.R) to WGEEL and EuroStat. This table is based on preliminary data; the intention is to show the data were collected, but specific outcomes will certainly change in future assessments because these will take account of late reporting.

Destination	Quantity exported (kg)							
	Great Britain		France		Spain		Portugal	
	C.R.	EuroStat	C.R.*	EuroStat	C.R.	EuroStat	C.R.	EuroStat
Austria	8							
Belgium	4	0	140	100	n d	0	0	0
Czech Rep.	470	600	181	100	n d	0	0	0
Denmark		1800	446	1800	n d	600	0	0
Estonia	480	300	0	0	n d	0	0	0
France	0	0	2940*	0	n d	0	0	0
Germany	470	700	1491	6200	n d	0	0	0
Greece	1005	1900	0	200	n d	100	0	0
Italy	0	0	0	0	n d	100	0	0
Latvia	15	0	0	0	n d	0	0	0
Lithuania	180	200	573	400	n d	0	0	0
Netherlands	1620	1100	0	5000	n d	1000	0	0
Poland	95	100	143	100	n d	0	0	0
Portugal	0	0	0	0	n d	100	0	0
Slovakia	0	0	0	500	n d	0	0	0
Spain	0	0	460	1600	n d	0	1081	1700
Sweden	1300	1100	0	0	n d	0	0	0
Great Britain	2151	0	307	0	n d	0	0	0
Total	7790	7800	6652	16000	n d	1900	1081	1700

***data only available for eels destined for stocking. nd is no data.**

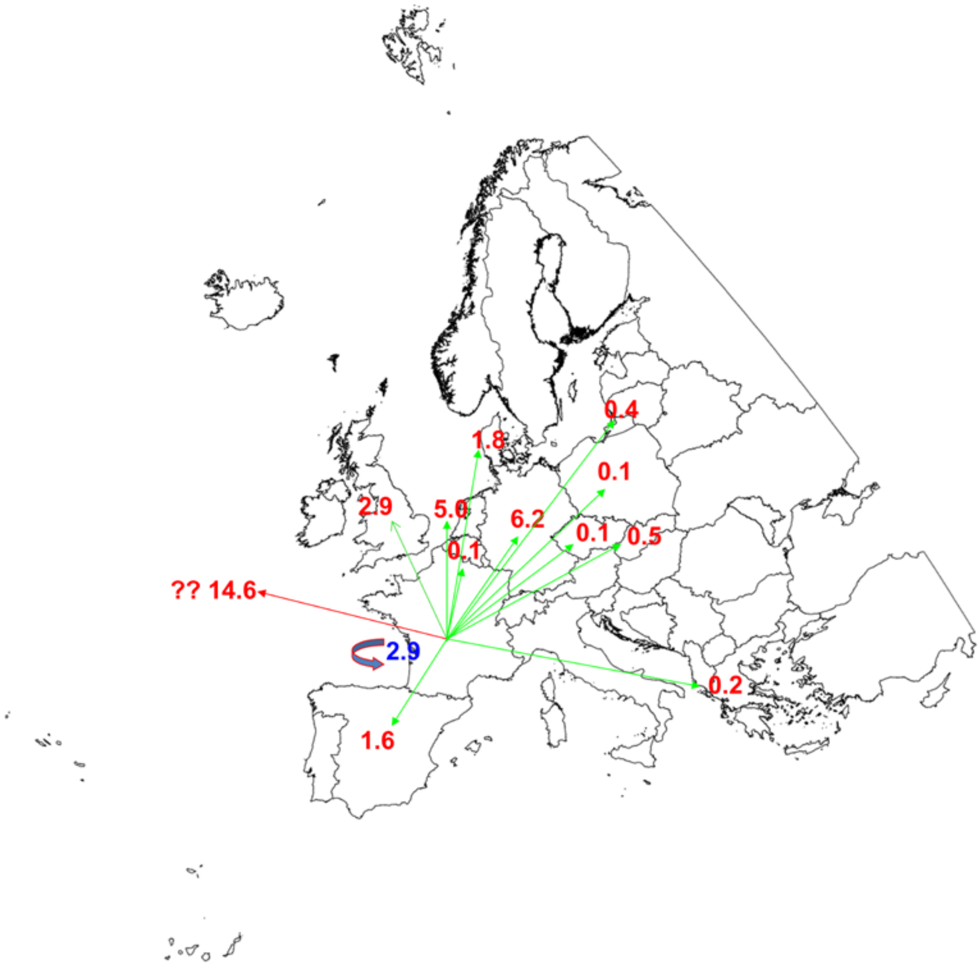


Figure 10-1. Destination and quantity of glass eels landed in France for the 2012–2013 fishing season, (data from EuroStat, values in tonnes). The total recorded export was 16.0 t. Together with 2.9 t sold for use within France (data from Country Report) this leaves a total of 14.6 t unaccounted for when compared with the reported landings of 33.6 t. These 'lost' eels may be accounted for by a combination of post-fishing mortality and/or underreporting and illegal trade (see Section 10.2). This map is based on preliminary data; the intention is to show the technique, but specific outcomes will certainly change in future assessments.

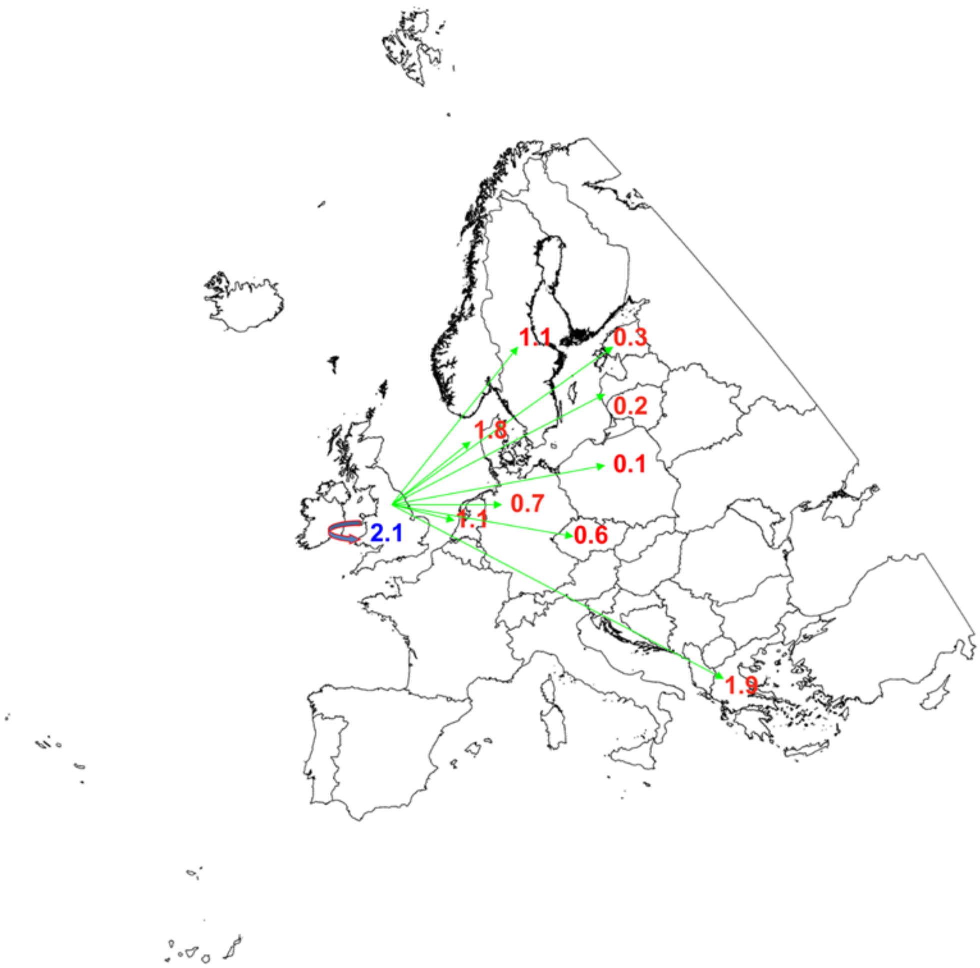


Figure 10-2. Destination and quantity of glass eels landed in Great Britain for the 2012–2013 fishing season, data from EuroStat (values in tonnes). A total of 5.6 t were exported, and 2.1 t were used within the GB (from Country Report). When comparing the reported landings, against exports and internal stocking gives a total of 0.9 t unaccounted for. These are thought to be the result of weight loss and mortalities post-capture). This map is based on preliminary data; the intention is to show the technique, but specific outcomes will certainly change in future assessments.

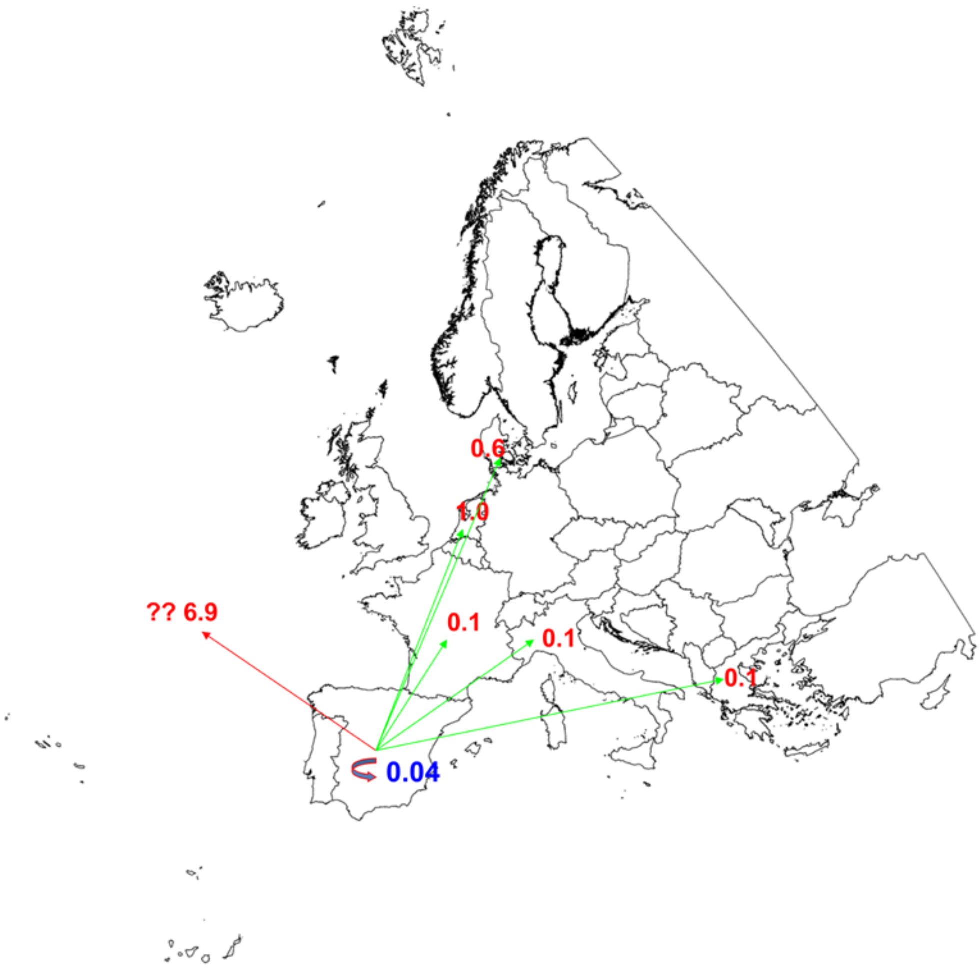


Figure 10-3. Destination and quantity of glass eels landed in Spain for the 2012–2013 fishing season (data from EuroStat), values in tonnes). At total of 1.9 t were exported, and 0.043 t was stocked internally. Compared with the reported landings of 7.9 t, added to 1.1 t imported from Portugal (CR data), this leaves a total of 6.9 t unaccounted for. These 'lost' eels are likely the consequence of post-fishing mortality and/or the result of underreporting and/or illegal trade (see Section 10.2). This map is based on preliminary data; the intention is to show the technique, but specific outcomes will certainly change in future assessments.

10.4 Data audit and anomalies

In order to assess the reliability of any glass eel trade traceability system among countries, a comparison has been made of import and export declarations data for the year 2013, as reported by donor countries (Great Britain, France, Spain, Portugal and Italy), by recipient countries (all) and as derived by the EuroStat database query (see Section 10.2). Country data, both donor and recipient, have been derived from the Country Reports and by the specific questionnaires submitted by WGEEL delegates.

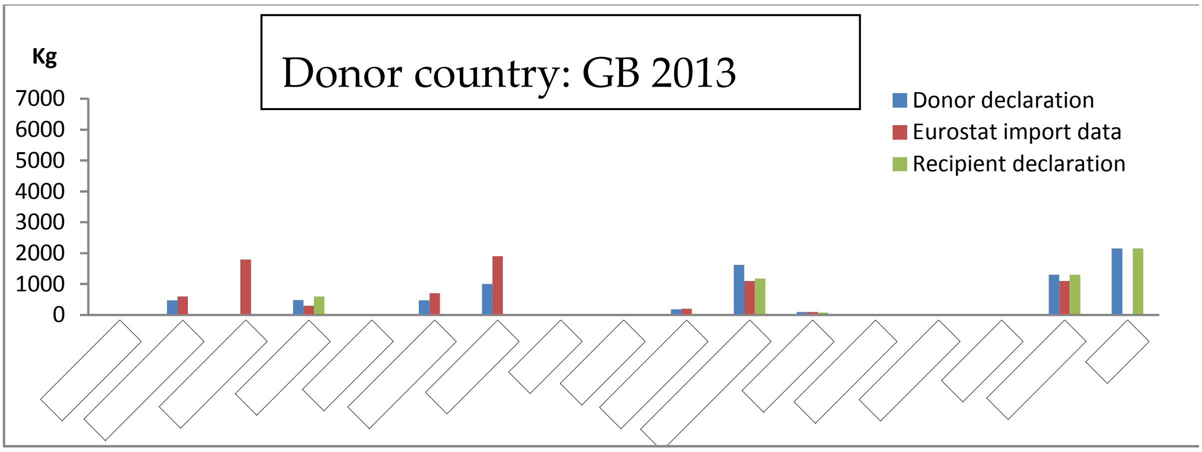
Results are reported in Figure 10-4, where glass eel quantities, as declared by the different sources (donor country, recipient country and EuroStat system), have been plotted separately for the three main donor countries (Great Britain, France and Spain). It is evident that there are discrepancies in most cases.

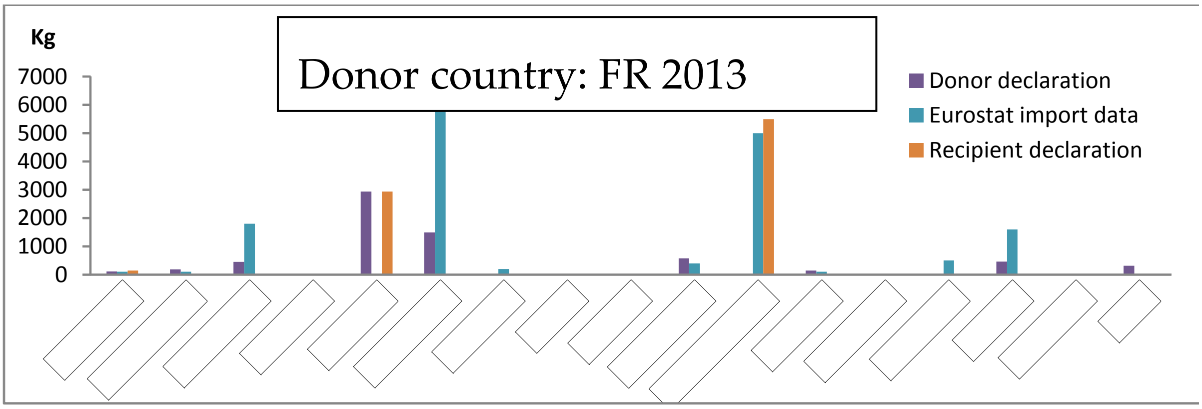
For some countries, it was not possible to trace the destination of their entire glass eel catch, amounting to ~22 t, even if in the WGEEL-CR it is stated that no use for stocking, aquaculture or direct consumption occurs within the country. Portuguese glass eel catch occurring in the Minho is exported to Spain (1081 kg declared to be exported to Spain in 2013).

Two of the most noticeable discrepancies are the missing import reports for Germany and Denmark in their 2013 CR but which usually become available retrospectively. This is discussed further in Section 10.5.

A further element of confusion originates from the fact that some countries buy glass eels on tender by companies that have purchased them from abroad, and therefore the original donor country is not identifiable. Similarly Finland has stocked ongrown eels bought from Sweden, that were quarantined, and ongrown from glass eels originating in Great Britain.

Another source of anomaly may arise from illegal trade, which traceability systems will not solve, but will highlight.





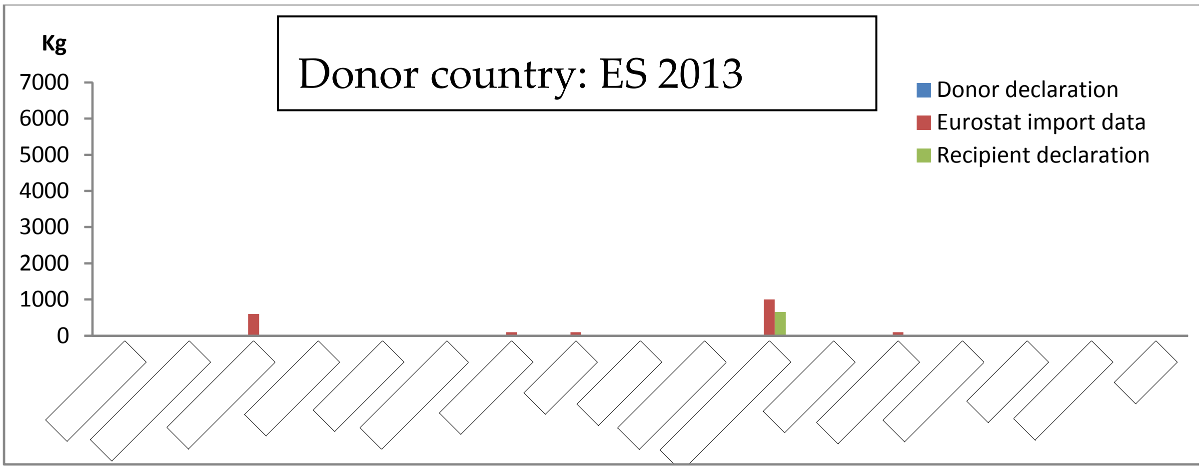


Figure 10-4. Comparison of the quantity of glass eel received by a country as identified from the EuroStat database and recipient and donor country WGEEL Country Reports. Data split by export country (Great Britain, France and Spain).

10.5 Quantity of glass eel identified being used for stocking and aquaculture

Following the provision of additional data for 2012 the amount of glass eel that was stocked, used for aquaculture or consumed, together with the proportion where the destiny could not be identified was recalculated and is shown in Table 10-3. From the original analysis of trade data in 2012 (ICES, 2012), at least 16% was used for stocking and 22% was used in aquaculture. It was not possible to identify the destiny of the remaining 62% (Figure 10-5, top left). However retrospective calculations using data provided by Germany and Denmark for 2012 (Table 10-3) which allocated approximately 8.3 t of "unaccountable" glass eels to aquaculture changed these data significantly with the outcome that 16% were used in stocking, 42% in aquaculture and the destiny of 42% remaining unknown (Figure 10-5, bottom left).

Analysis of the 2013 data (Table 10.4) found that of the 51.6 t caught in 2013 16% went to stocking, 14% went to aquaculture whilst the final destiny of 70% remained unknown (Figure 10-5, top right). However if a speculative calculation is made based on a similar historical usage of glass eel by Germany, Denmark and a EuroStat export record of 2 t of glass eel for Greece (totalling approximately 13 t) the figures relating to the destiny of glass eel change with 18% going to stocking, 38% to aquaculture and 44% remaining unknown (Figure 10-5, bottom right). The proportion of the glass eel catch which remains unaccounted for has been very similar for each of the last two years (38% and 42%, 2011 and 2012 respectively) with the speculated projection for 2013 at 44%.

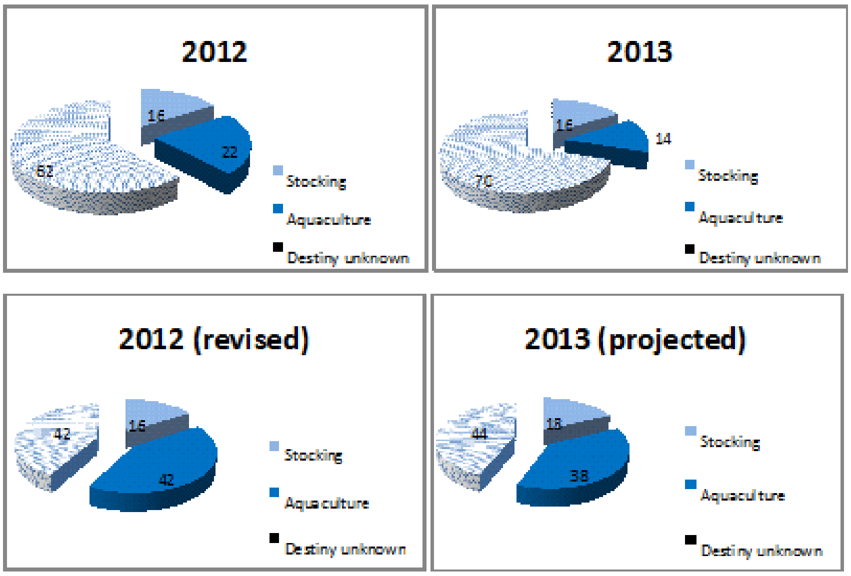


Figure 10-5. Figures showing the proportion of glass eel that was identified by WGEEL as being stocked, used for aquaculture, or whose destiny was unknown. The top left shows the data for 2012 (WGEEL 2012) and the bottom left shows the proportions updated for additional data in 2013. The top right shows WGEEL 2013's best estimate for 2013, and the bottom right gives a possible outcome by applying a similar correction to the data as applied to the 2012 data.

Table 10-3. The destiny of glass eel by country in 2012 (revised figures).

Country	Quantity (kg)			
	Total	Stocked	Aquaculture	Unknown
Austria				
Belgium	206	206	0	0
Bulgaria				
Cyprus				
Czech Rep	596	0	0	596
Denmark	6050	593	4366	1091
Estonia	90	0	0	90
France	3086	3086	0	0
Germany	5743	0	5743	0
Greece	450	0	450	0
Finland	159	159	0	0
Hungary				
Ireland				
Italy	729	248	352	129
Latvia	343	343	0	0
Lithuania				
Luxembourg				
Malta				
Morocco				
Netherlands	7541	766	6775	0
Norway				
Poland	210	210	0	0
Portugal				
Romania				
Slovakia				
Slovenia				
Spain	5799	652	0	5147
Sweden	1200	852	348	0
Great Britain	1320	1320	0	0
Hong Kong				

Table 10-4. The destiny of glass eel by country in 2013. Table is based on preliminary data.

	Quantity (kg)			
Country	Total	Stocked	Aquaculture	Unknown
Austria	8	8	0	0
Belgium	140	140	0	0
Bulgaria				
Croatia				
Cyprus				
Czech Rep	570			570
Denmark	4200	600		3600
Estonia	600	270	330	0
France	2940	2940	0	0
Germany	6900			6900
Greece	2200			2200
Finland	78	65	13	0
Hungary				
Ireland				
Italy	100		100	
Latvia	15	0	0	15
Lithuania	180			180
Luxembourg				
Malta				
Morocco				
Netherlands	7330	630	6700	0
Norway	0	0	0	0
Poland	238	95	0	143
Portugal				
Romania				
Slovakia	500			
Slovenia				
Spain	1081	43	0	1048
Sweden	1222	845	377	0
Great Britain	2151	2151	0	0
Hong Kong				

Glass eel trade of other Anguillid species

Since the listing of *Anguilla anguilla* by CITES under Appendix II came into force in March 2009 and the export/import ban issued by EU in 2010, the international trade of glass eels has changed. Species other than *A. anguilla*, including several tropical species, seem to have replaced the European eel on the international market. In addition countries including Canada, USA, the Dominican Republic, Morocco, Madagascar and the Philippines have now entered the market and supply glass eel for the farming industry in mainland China, Japan, Taiwan and the Republic of Korea (Crook, 2013).

10.6 Trend in the price of glass eel

The glass eel prices since 1961 show an exponential rise from around €5 in the 1960s to more than €500 per kg in 2005 (Figure 10-6 and Table 10-5). The high price in 1969 corresponds to the onset of Japanese buying on the French market. The prices are corrected for inflation using price index in France.

The data from EuroStat show that prices have fallen from €492 in 2012 to €411 in 2013. This fall in price was not reflected in the amounts of glass eel purchased as reported to the WGEEL meeting. The mean price of glass eels remains high ranging from € 299–442 per kg over the last five years, though prices fell to their lowest in 17 years in Great Britain at €202 per kg by the end of the 2013 season.

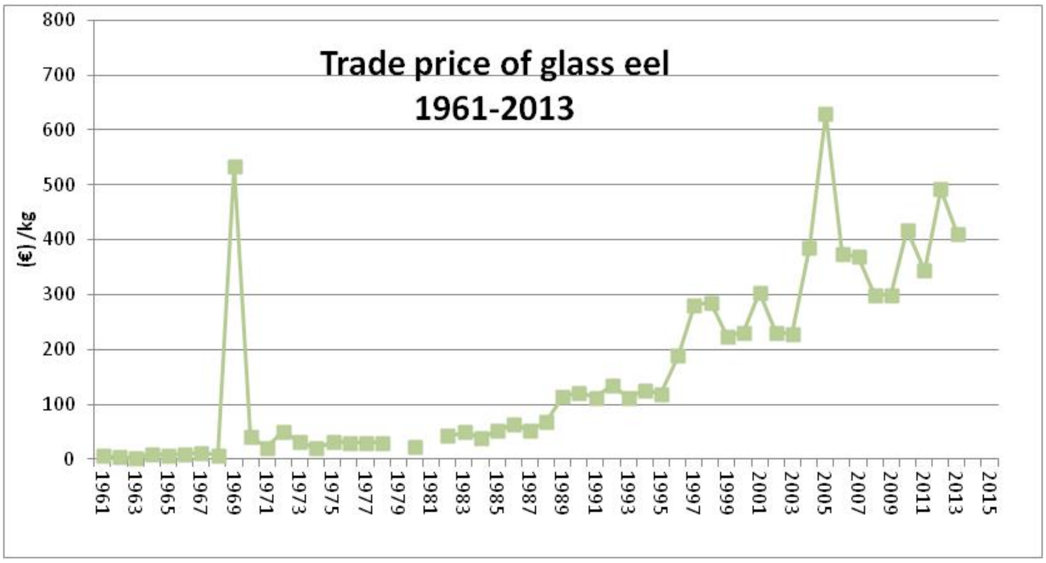


Figure 10-6. Trend in the price of glass eel 1961 to 2013.

10.7 The amount of glass eel stocked by country and in relation to EMP target

In 2008, twelve countries proposed the use of stocking in their management plans to enhance eel populations (ICES, 2008). In 2013 stocking of glass eel was undertaken in nine countries (Table 9-6). Of the countries which stocked glass eel six (Denmark, France, Netherlands, Poland, Sweden and Great Britain) achieved their target in 2013.

The most common reason given for a country being unable to achieve its stocking target was a lack of funding to buy them, which is different from the past two years when the cost of glass eel was given as the cause.

ICES identified ~40 $t.yr^{-1}$ of glass eels were needed to meet EMP requirements (ICES, 2009). In terms of the overall catch of glass eel and the perceived requirement of approximately 40 t to fulfil the EU stocking requirements our findings for 2013 appear more positive than those for 2011 and 2012 given a declared catch of 51.6 t. However when one takes into account losses upon first export, the amount available (30.1 t) is less than that required. Additionally, (as in the years 2011 and 2012 when we were only able to identify that 12–16% of glass eels caught were destined for direct stocking) 16% were identified for stocking in 2013. However as stated before (ICES 2011,

2012) we believe the true figure may be higher given that some glass eel listed as being in aquaculture are there to be ongrown prior to stocking.

From the original analysis of trade data in 2012 (ICES, 2012), at least 16% was used for stocking, 22% was used in aquaculture, while it was not possible to identify the destiny of the remaining 62%. However retrospective calculations using data provided by Germany and Denmark for 2012 (Table 10-3) which allocated approximately 8.3 t of "unaccountable" glass eels to aquaculture changed these data with the outcome that 16% were used in stocking, 42% in aquaculture and the destiny of 42% remaining unknown.

Similar analysis of the 2013 data (Table 10.4) found that of the 51.6 t caught in 2013 16% went to stocking, 14% went to aquaculture whilst the final destiny of 70% remained unknown. However if a speculative calculation is made based on a similar historical usage of glass eel by Germany, Denmark and Greece (totalling approximately 13 t) the figures relating to the destiny of glass eel change with 18% going to stocking, 38% to aquaculture and 44% remaining unknown.

The proportion of the glass eel catch which remains unaccounted for has been very similar for each of the last two years (38% and 42%, 2011 and 2012 respectively) with the speculated projection for 2013 at 44%.

Table 10-5. Trends in glass eel trade price (€) 1961–2013 computed from various sources. The prices are corrected for inflation using price index in France.

Year	French custom	French trader	Asturian (Spain) Market	Eurostat France	Eurostat Spain	Eurostat GB	Average price
1961		7					7
1962		4					4
1963		3					3
1964		10					10
1965		7					7
1966		9					9
1967		12					12
1968		8					8
1969	1055	13					534
1970	68	13					41
1971		21					21
1972	77	25					51
1973		33					33
1974		20					20
1975	42	22					32
1976	45	14					30
1977	41	19					30
1978	42	19					31
1979							
1980	24						24
1981							
1982	43						43
1983	51	43	57				50
1984	33	29	59				40
1985	50	37	70				52
1986		49	82				65
1987	63		43				53
1988	59	54	91				68
1989	108	110	128				115
1990	109	120	135				121
1991	94	109	136				113
1992	162		111				136
1993	156	86	97				113
1994	177	109	96				127
1995	135	94	90		163		120
1996	202	199	148	206	186	193	189
1997	246	366	224	260	247	344	281
1998	297	267	251	295	313	295	286
1999	213	270	174	208	214	267	224
2000	226	207	227	216	254	254	231
2001	331	358	261	267	306	304	304

Year	French custom	French trader	Asturian (Spain) Market	Eurostat France	Eurostat Spain	Eurostat GB	Average price
2002	247	252	231	220	230	202	231
2003	235	254	216	236	199	226	228
2004	496	452	432	423	282	230	386
2005	856	872	563	648	308	530	630
2006	432		374	370	297	404	375
2007			443	499	343	265	369
2008			466	316	282		299
2009			428	344	146	408	299
2010			374	588	325	341	418
2011			363	373	228	431	344
2012			368	406	508	563	492
2013			175	407	383	442	411

Table 10-6. The quantity of glass eel purchased with EMP target in brackets, the % of the EMP target reached, the % of the glass eel purchased used for stocking and the quantity of glass eel harvested from the years 2012–2013, by country. This table is based on preliminary data and the intention is to update this in future.

COUNTRY	PURCHASED (KG) (EMP TARGET)	TARGET ACHIEVED (%)	% USED FOR STOCKING	GLASS EEL HARVEST (KG)				
	2012	2013	2012	2013	2012	2013	2012	2013
Austria	no data	8	no data	no data	no data	100		
Belgium	206 (1200)	140(1200)	17.2	11.7	100	100		
Bulgaria	no data	no data	no data	no data	no data	no data		
Cyprus	no data	no data	no data	no data	no data	no data		
Czech Rep	no data	no data	no data	no data	no data	no data		
Denmark	6000 (295)	(295)	100	100	4.9	no data		
Estonia	654 (500)	600(500)	54	54	41.4	45		
France	3086 (2570)	2940(2570)	100	100	100	100	34 256	33 618
Germany	no data	no data	no data	no data	no data	no data		
Greece	no data	no data	no data	no data	no data	no data		
Finland	159 (1000)	177(500)	15.9	15	100	no data		
Hungary	no data	no data	no data	no data	no data	no data		
Ireland	n/a	n/a	n/a	n/a	n/a	n/a		
Italy	730 (6753)	410 (6000)	3.7	57.5	34	100	299.5	410
Latvia	334 (334)	15 (250)	100	0	100	0		

COUNTRY	PURCHASED (KG) (EMP TARGET)	TARGET ACHIEVED (%)	% USED FOR STOCKING	GLASS EEL HARVEST (KG)				
	2012	2013	2012	2013	2012	2013	2012	2013
Lithuania	no data	no data	no data	no data	no data	no data		
Luxembourg	no data	no data	no data	no data	no data	no data		
Malta	no data	no data	no data	no data	no data	no data		
Morocco	no data	no data	no data	no data	no data	no data	1356	no data
Netherlands	7541 (550)	7330(550)	100	100	10	9		
Norway	n/a	n/a	n/a	n/a	n/a			
Poland	80 (4000)	95 (4000)	100	100	100	100		
Portugal	no data	no data	no data	no data	no data	no data	807	1081
Romania	no data	no data	no data	no data	no data	no data		
Slovakia	no data	no data	no data	no data	no data	no data		
Spain	no data	no data	no data	no data	no data	no data	6209	7852
Sweden	1200 (833)	1300(833)	100	100	71	70		
Great Britain	1321 (2054)	2151(2054)	64.3	105	100	100	3820	7790
Total							45 392	51 621

10.8 Stocking literature review

In its recent meetings, WGEEL has checked annually for new information on the pros and cons of stocking as a suitable tool for eel management, with fuller reviews undertaken in 2006 and 2010 (ICES 2010). This section provides a further update on this issue.

An unpublished literature review by Pawson (2012) (http://www.sustainableeelgroup.com/eel-conservation/) reviewed the instances and effectiveness of stocking and translocation as a conservation measure to increase the net production of silver eel. There was almost no new evidence available to Pawson in 2012 that was not considered by ICES WGEEL in its 2010 report and the conclusions of both are similar: i.e. that there is evidence that translocated and stocked eel can contribute to yellow and silver eel production in recipient waters, but that evidence of further contribution to actual spawning is limited (by the general lack of knowledge of the spawning of any eel).

WGEEL has considered four potentially relevant new papers published or submitted since ICES (2010), and the unpublished Pawson review, which are described below. The first two deal with the potential contribution of eels originating from stocking programmes to the reproductive effort.

Couillard *et al.* (*submitted*) compared reproductive fitness of migrant silver American eels (*Anguilla rostrata)* originating from a stocking programme (SM) and native wild migrants (WM), having grown in the same location. Body size, muscle lipids, oocyte development and morphometric indices of silvering eels were compared between SM and WM captured in the St Lawrence Estuary. SM were smaller than WM and their size was similar to migrating wild silver eels from their site of origin, on the Atlantic coast of New Brunswick and Nova Scotia (Canada). A bio-energetic model was used to estimate costs of migration and reproduction and duration of migration. The adequacy of the measured lipid reserves to meet these estimated energetic costs was assessed for SM and WM. Compared to WM, SM had less advanced gonad maturation and stage of silvering. They had lower initial muscle fat reserves and higher estimated energetic requirements for migration as a consequence of their smaller size. It was estimated that 100% of the SM would not have adequate fat reserves for migration and reproduction whereas the majority of WM would have adequate reserves. Smaller size SM would take 1.6 times longer to reach the spawning grounds than WM and thus, would likely not arrive in synchrony with these wild eels Thus, early outmigrating stocked eels are less likely to complete successfully their migration and reproduction than wild migrants. These results support the recommendation to source and stock eels at sites where they have similar life strategies to increase the likelihood of successful silver eel escapement.

On the other hand, Prigge *et al.* (2013) investigated the extent to which European silver eels originating from stocking programmes in the Baltic Sea tributaries, can contribute to the spawning stock. Stocked silver eels emigrating from a river were tagged and 11% were recaptured up to 14 months after release. Stocking history of recaptured eels was confirmed by otolith microchemistry. Recapture locations were concentrated around the outlet of the Baltic Sea with 62% of all recaptures reported there or in the Kattegat. Recaptured eels showed a reduction in both total length (LT) and mass (mean ±s.d.=−1.5 ±0.9 cm and -125.3 ±50.1 g) while average total fat content remained close to values previously reported as high enough to provide energy resources to allow successful completion of the spawning migration (mean ±s.d.=28.4 ±4.4%). The documented mean rate of travel (0.8 km/day), however, indicated a delay in the migration that might be interpreted as a delayed initial migration phase of orientation towards the exit of the Baltic Sea.

Concerning survival and growth, Simon and Dörner (2013) reported that European eels stocked as wild-sourced glass eels showed a better overall performance of growth and survival compared with farm-sourced eels after stocking in five isolated lakes within a seven-year study period in Germany. Eels stocked as farm eels lost their initial size advantage over eels stocked as glass eels within 3–5 years after stocking. Population sizes estimated for consecutive stocking batches indicated that 8–17% of eels stocked as farm eels survived 3–6 years after stocking compared with 5–45% of eels stocked as glass eels. This study coupled with results of previous studies (Simon *et al*., 2013) suggests that stocking of farm eels may have no advantage in growth and survival compared with stocking of glass eels if stocking occurs at an optimal time in spring. In addition, the use of relatively expensive farm eels may provide no general advantage over stocking of glass eels presumably because they needed a longer period to switch from artificial food to natural prey and to adapt to new foraging strategies. However, if glass eels are only available for stocking purposes very early in the year, lower survival rates than obtained in the present study can be assumed and stocking with relatively more expensive farm eels could possibly be a better option.

In southern France, Desprez *et al.* (2013) estimated demographic parameters of a stocked population (stocked as yellow and glass eel stages) in a 32-ha freshwater pond in the river Rhône delta using a multistate capture–recapture model. They estimated population size and predicted the number of future spawners obtained by stocking. They found that the stage in which eels were stocked did not influence their future survival and that the maximal number of silver eels was quickly reached, after three years following stocking. They concluded that stocking experiments in the Mediterranean region are efficient for fast production of silver eels. But they also suggest that further studies should assess the quality of these spawners.

10.9 Conclusions

In terms of the overall catch of glass eel and the perceived requirement of approximately 40 t to fulfil the EU stocking requirements our findings for 2013 appear more positive than those for 2011 and 2012 given a declared catch of 51.6 t. However when one takes into account losses upon first export, the amount available (30.1 t) is less than the 40 t required. Additionally, (as in the years 2011 and 2012 when we were only able to identify that 12–16% of glass eels caught were destined for direct stocking) 16% had a similar fate in 2013. However, as stated before (ICES 2011, 2012) we believe the true figure may be higher given that some glass eel listed as being in aquaculture are there to be ongrown prior to stocking.

Nonetheless these findings may have implications for the fulfilment of Articles 7.2 and 12 of the Regulation which stated that by 31st July 2013, 60% of glass eel caught should be marketed for stocking and that a traceability system be established for imports/exports of all live eels. Our analyses indicate that these criteria have not been achieved by all Member States.

Inconsistencies within the data submitted by MS to the glass eel trade questionnaire undermines the data integrity within this chapter and reasons for this should be reviewed.

Recent reviews (Pawson, 2012; WGEEL 2010) on the value of stocking for the recovery of the overall panmictic European eel population unambiguously state that there are major knowledge gaps to be filled before firm conclusions either way can be drawn. There was almost no new evidence available to Pawson in 2012 that was not considered by ICES WGEEL in its 2010 report and the conclusions of both are similar: i.e. that there is evidence that translocated and stocked eel can contribute to yellow and silver eel production in recipient waters, but that evidence of further contribution to actual spawning is limited (by the general lack of knowledge of the spawning of any eel).

However, in addition to investigations on the value of stocking for the enhancement of silver eel escapement in distinct EMUs, internationally coordinated research is required to judge the net benefit of restocking for the overall population, including carrying capacity estimates of glass eel source estuaries as well as detailed mortality estimates along trade channels. The impact of holding and maintenance feeding of elvers in aquaculture needs to be addressed with regard to a possible adaptation to culture conditions as known from other fish species like salmon and trout.

It is recommended that all countries adhere to the conditions laid out in the Eel Regulation of 2009 and establish the required international traceability system in line with Article 12.

This will 1) permit cross-checking of imports and exports between countries for each batch of glass eel exported, 2) be able to identify the quantity of glass eel which are classified as going to aquaculture that are subsequently stocked and 3) identify if 60% of glass eel are made available for stocking.

11 Assessment of the quality of eel stocks

Chapter 11 discusses the importance of the inclusion of spawner quality parameters in stock management advice and updates information on the Eel Quality Database (EQD). The chapter addresses the following Terms of reference:

j) Update international databases for data on eel stock and fisheries, as well as eel quality related data;

m) In conjunction with WGBEC and MCWG, review and develop approaches to quantifying the effects of eel quality on stock dynamics and integrating these into stock assessments. Develop reference points for evaluating impacts on eel.

11.1 Introduction

In recent years WGEEL has discussed the risks of reduced biological quality of (silver) eels. The reduction of the fitness of potential spawners, as a consequence of (specific) contaminants and diseases, and the potential mobilization of high loads of reprotoxic chemicals during migration, might be key factors that decrease the probability of successful migration and reproduction. An increasing amount of evidence indicates that eel quality might be an important issue in understanding the reasons for the decline of the species. Previous WG reports have presented an overview and summaries of a variety of reports and data on eel quality. Hence, this chapter should be read in conjunction with the 'eel quality' chapters in previous reports (2006–2012).

During the WGEEL 2013 meeting, we summarized scientific advancements regarding the better understanding of the status and effects of contamination and diseases in the European eel, in order to facilitate future local assessments of the stock. We made progress in developing a framework for assessing reproductive potential of silver eels leaving their catchment taking into account, fitness, body mass and distance to the spawning grounds. In this session the working group highlights the urgent requirements for experimental work on the assessment of the impact of contaminants on the reproductive success of eel. Internationally coordinated research is needed to be able to integrate quality parameters into stock wide assessment. In order to harmonize/standardize future monitoring, a planning group has to be initiated.

11.2 New information on eel quality provided in recent publications and country reports

In the following paragraphs, information on eel quality provided in new international publications is summarized.

11.2.1 Contaminants

Concentrations of polychlorinated biphenyls (PCBs), OCPs, and PBDEs were determined in American and European eels from seven locations in Canada, USA and Belgium (Byer *et al.*, 2013b). Concentrations were related to the local environmental pressure and were lower than historic values. Concentrations of PCDD/Fs, dl-PCBs, and PCNs were also determined (Byer, 2013a). The risk to eel reproduction was evaluated with 2,3,7,8-TCDD toxic equivalents, and increased by tenfold from the least to most contaminated site. The risk to eel recruitment from dioxin-like compounds in American eel was considered low.

Persistent Organic Pollutant (POP) concentrations and lipid content were studied in eels from three Italian sites (Quadroni *et al.*, 2013). There were low-to-moderate contamination levels at two sites, but lipid reserves were considered insufficient to sustain the energetic costs of the transoceanic migration in one of the sites. POP concentrations were high at the third site, which was a heavily urbanized river.

The distribution and concentrations of PCBs were determined in several fish species in a heavily polluted water reservoir in Slovakia (Brazova *et al.*, 2012). The study revealed serious PCB contamination and significant interspecific as well as tissue-specific differences in PCB uptake.

The levels of PBDEs, alternate BFRs and dechloranes in elvers, yellow and silver eels were investigated in the German rivers Elbe and Rhine (Sühring *et al.*, 2013). PBDEs were the dominating flame retardants (FRs) in yellow and silver eels, while the alternate BFR 2,3-dibromopropyl-2,4,6-tribromophenyl ether (DPTE) and the Dechlorane 602 were the dominating FRs in elvers. FR concentrations in silver eels from the Rhine were generally higher than concentrations in other life stages. The concentrations in yellow and silver eels from the Elbe were similar while PBDE concentrations in elvers were comparably low, which lead to the conclusion that these contaminants were mostly ingested within the rivers. Among the alternate BFRs and dechloranes, DPTE as well as the Dechlorane 602 and Dechlorane Plus (DP) were found in all life cycle stages and rivers. Dechlorane 603 was only detected in silver eels from the Rhine. Pentabromoethyl-benzene (PBEB) was only found in yellow and silver eels and bis(2-ethylhexyl)tetrabromophthalate (BEHTBP) only in elvers. The results emphasize the growing relevance of emerging contaminants such as alternate BFRs and dechloranes.

Quality of migrant male silver eels from four Mediterranean habitats in France were studied, including *Anguillicola crassus* and EVEX virus and the concentration of chemical contaminants including PCBs, OCs and heavy metals (Amilhat *et al.*, 2013). A proportion of eels were strongly impacted with levels of contaminants/parasites that could potentially impair migration and reproduction. Low to moderate contamination levels were recorded compared with other Mediterranean sites previously reported, except high concentrations of DDTs and Cu in one lagoon. This paper also includes valuable results and methods for assessing the quality of yellow eel stock by calculating the eel quality index.

Concentrations of arsenic, cadmium, mercury and lead have been measured in eight freshwater fish species in France, including eel (Noel *et al.*, 2013). Heavy metal contamination (Zn, Fe, Cu, Pb and Cr) were also assessed in eels collected along the Moroccan Atlantic coast (Wariaghili *et al.*, 2013). Accumulation of chromium and copper was related to anthropogenic activities.

A methodology to simultaneously determine mercury (MeHg, IHg) and butyltin (TBT, DBT, MBT) compounds in eel samples was assessed and validated (Navarro *et al.*, 2013). In eels from the Adour estuary in France, the accumulation of methylmercury in glass eel tissue was related to body mass, with higher concentrations in smaller individuals. Butyltin concentrations were close to the detection limit, and no differences were detected between glass and yellow eels.

The human lipid regulator gemfibrozil (GEM) is a drug found at biological active concentrations in the aquatic environment. The effects of GEM on yellow eel were investigated (Lyssimachou *et al.*, 2013). GEM was shown to inhibit CYP1A, CYP3A and CYP2K-like catalytic activities. On the contrary, GEM had little effect on the phase II enzymes examined (UDP-glucuronyltransferase and glutathione-S-transferase). Peroxisome proliferation inducible enzymes (liver peroxisomal acyl-CoA oxidase and catalase) were weakly induced. No evidence of a significant effect on the endocrine system of eels was observed in terms of plasma steroid levels or testosterone esterification in the liver.

To what extent migratory behaviour and habitat choice of European eel affected spawner quality was examined in a German study (Marohn *et al.*, 2013). Individuals that exclusively inhabited freshwater had significantly lower muscle fat contents than eel that never entered freshwater.

Impact of exposure to tributyl (TBP) phosphate on morphology, physiology and migratory behaviour of European eel was studied during the transition from freshwater to the sea (Privitera *et al.*, 2013). TBP exposure significantly affected plasma glucose concentration and reduced plasma levels of sodium and chloride both in freshwater and three days after transfer to salt water. However, exposure did not affect subsequent movements of the eels in the river or fjord.

Cocaine at environmental concentrations was shown to behave like an endocrine disruptor, changing brain dopamine and plasma catecholamine levels and the activity of pituitary-adrenal/thyroid axes in silver eel (Gay *et al.*, 2013). The endocrine system plays a key role in the metabolic and reproductive processes of the eel.

Toxicological effects related to the leakage of yperite from rusted bomb shells dumped at sea were examined (Della Torre *et al.*, 2013). A significant increase of EROD and UGT activity and an acute inflammatory response in skin layers and muscle was observed, associated to cell degeneration and necrosis after 48 hours at the highest dose of yperite.

Contamination and genomics

There has been recent concern about the role of pollutants in impacts on organisms via changes in gene expression. The presence of pollutants may lead to an increase in the transcription of genes involved in detoxification (perhaps often functional), but at a cost of the reduced expression of genes involved in vital organism processes, such as respiratory metabolism.

Pujolar *et al.* (2012) provide evidence of induced detoxification gene expression in eels from a high toxicity site when compared to a low toxicity site, together with a suggestion of lower expression of genes involved in metabolism. They concluded that pollution could be directly linked to decreased energy production.

A study was undertaken to better understand the gene transcriptional response of European eels chronically exposed to pollutants (Pujolar *et al.*, 2013). Silver eel females were measured for polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs) and brominated flame retardants (BERs). Multipollutant levels of bioaccumulation were linked to their genome-wide gene transcription using an eel-specific array of 14,913 annotated cDNAs. The transcription level of many genes encoding enzymes involved in the mitochondrial respiratory chain and oxidative phosphorylation were down-regulated in eels from a highly polluted site, suggesting that pollutants may have a significant effect on energy metabolism in silver eel females.

Eels with varying contaminant loads from three Belgian rivers (metals, PCBs, organochlorines) were compared with non-contaminated eels of aquacultural origin (Maes *et al.*, 2013). Variation in body condition was associated with contaminant load, and at higher contaminant levels reduced expression of hepatic and gill transcription genes, and dysfunctional regulation of toxicity regulating genes was observed.

New perspectives for proteomic approaches for the assessment of eel quality

A research project was conducted in Belgium to develop a mildly invasive biomarker approach based on the protein expression profiles (in the post-nuclear fraction of peripheral blood mononuclear cells, PBMC) in European eel exposed to environmental contaminants. This model has been used to investigate the direct impact of PFOS, DDT and cadmium on PBMC in a controlled environment. Besides providing clues about the toxicity of these compounds in European eel, a general stress index, termed "Integrated Biomarker Proteomic Index" was developed in order to provide information about global adverse environmental effects as well as the pollutants involved. The calculation of the index may be promising in helping environmental managers to assess and follow the health status of a species and to decide if a species is at risk or not, and if protective measures have to be taken (Pierrard *et al*., 2012; Roland *et al.*, 2013a, b, c).

Maternal transfer of contaminants

In the following, a short summary is given on maternal transfer of contaminants which may be valuable for future assessments of the effects of contamination on eel reproduction. During this session due to time constraints this could not be fully worked out.

Russell *et al.* (1999) developed theoretical models of pollutant transfer, and tested these models in the field to show that embryos can be expected to be exposed to the same effective internal concentration of organochlorines as the maternal organisms from which the eggs originated. They concluded that "if developing embryos are more susceptible to chemical contaminants than the adult organisms, toxic effects are more likely to occur in developing embryos than in the adult organisms. This observation should be taken in account when conducting ecological risk assessments of chemical substances and when developing environmental quality guidelines." No data specific to embryotoxic effects in eel have yet been published, nor are reliable data likely to arise in the near future, given the difficulties in generating or obtaining viable/representative eel embryos. Accordingly, data from other species are briefly examined here.

Heiden *et al.* (2005) showed significant differences between levels of 2,3,7,8 TCDD associated with impacts at different stages of the zebrafish spawning activity. Dietary administered TCDD led to levels as high as 36ng/g in adult tissue, which were not associated with overt toxic effects or changes in spawning activity. However, ovosomatic index was influenced by tissue concentrations a low as 0.6ng/g and ovarian necrosis occurred at 3 ng/g, while offspring health was impacted with an accumulation of as little as 1.1 ng/g of TCDD female. Meanwhile, the ecological relevance of this kind of study has been underlined by Haldén *et al.* (2011) who fed Baltic fish species levels of brominated dioxins at proportions designed to reflect Baltic Sea mixture, and concluded that dietary exposure to sublethal concentrations of brominated dioxins may impair reproductive physiology in fish. Ostrach *et al*., 2008 have shown maternal transfer of polychlorinated biphenols in striped bass *Morone saxatilis* in San Francisco Bay, a population with a similar historical time-scale of decline to the European eel, currently impairs egg and larval development in wild fish. Serrano *et al.* (2008) quantified maternal transfer of organochlorines from liver to oocytes occurred a ratio of about 0.5, meaning that half the total contaminant load was transferred to eggs in wild sea bream *Sparus aurata*.

While these data suggest cause for concern in assessment studies that regard escapement of silver eels from the continent as the endpoint of stock recovery, they cannot be directly related to eels with the current knowledge framework because of uncertainty about the actual levels at which toxic effects might occur in eel reproductive performance. Differences in physiology and ecology, as well as in contaminant types, will inevitably result in different transfer and toxicity rates in different species. Elonen *et al.* (1998) for example provide evidence of toxicity levels of embryos of different freshwater fish species to waterborne TCDD differing by an order of magnitude; minimum effect at 270 pg/g in lake herring *Coregonus artedii*, vs. 2000 pg/g in zebrafish (*Danio rerio*).

Meanwhile, an example of a pragmatic approach to setting realistic stock conservation minimum targets levels of toxic accumulants when an extensive collection of information is available is given by Meador *et al.* (2002) who selected 2.4 pg/g of lipid as an environmental threshold level of tissue concentration of PCBs in salmonids; (based on the 10th percentile of the minimum levels at which biological effects were noted in 15 studies).

From this brief review it may be concluded that eel specific experiments are needed in order to progress in understanding the impact of contamination on eel reproduction success.

Eel Quality Index for the quality of yellow eel stocks

During previous sessions WGEEL made progress in the quantification of eel quality with regard to contamination and diseases, among others by developing an Eel Quality Index. Some published papers have used and further developed this index (see e.g. Amilhat *et al*., 2013). Within the time limits of the session WGEEL 2013 was not able to further develop or apply the existing methods.

Additional closure of fisheries

WGEEL 2012 listed waterbodies where fisheries were closed due to exceeded levels in contaminants. This list is now updated.

In **Germany**, Sühring *et al*. (2013) showed the relevance of PBDEs as contaminants in rivers and river-dwelling species but also the growing relevance of emerging contaminants such as alternate BFRs and dechloranes, but there have been no new closure of fisheries.

In the **Netherlands**, a large part of the eel fishery was closed in 2011 due to high levels of PCB. This closure has affected approximately 50 fishing companies, roughly a third of the annual landings. This closure has been kept in force.

In **Italy** some lake eel fisheries (Lago di Garda) have been closed in 2011 and remained closed in 2012, due to fish contamination by dioxin.

There has been no additional fishery closure in **Germany, Belgium** and **France**.

Monitoring in countries current and future

Monitoring programmes involving biological sampling are carried out in **Sweden**, **Poland, Germany, the Netherlands, Belgium** and **Ireland.**

In **the Netherlands**, seven locations were monitored in 2012 and there were no significant changes compared to previous years. All locations that have eels with concentration of sum-TEQ or sum six ndl-PCBs above the regulatory levels come from the river Rhine or Meuse.

A pilot project for monitoring contaminants in eel in the framework of the WFD has been initiated recently in **Belgium** (in Flandres).

In **France**, the national PCB monitoring has stopped in 2010. Sampling is still carried out on the Rhone.

Eel kills due to contamination and diseases

No occurrence of recent eel kills due to pollution or disease outbreaks were reported through the Country Reports or by the delegates present at the meeting.

11.2.2 Parasites and pathogens

Anguillicola crassus

Recent information in scientific literature gives further evidence of a stronger infestation of the swimbladder parasite *Anguillicola crassus* in freshwater compared to more saline habitats (Habbechi *et al.*, 2012; Quadroni *et al.*, 2013; Wysujack *et al.*, 2013). Swimbladder damage appears to be the most common effect of infestation (Habbechi *et al.*, 2012; Quadroni *et al.*, 2012; Zimmerman *et al.*, 2012; Lefebvre *et al.*, 2013; Wysujack *et al.*, 2013). Lefebvre *et al.* (2013) studied effects on body condition, size increase and reproduction potential on eel of known age, revealing the unforeseen effect that hosts of the same age were larger when infected by *A. crassus*. They suggested that a high food consumption level increased the risk of being infected. The finding of Lefebvre *et al.* (2013) was contradicted by results from the upper Potomac River (US) (Zimmerman and Welsh, 2012). Evidence of possible hybridization between *A. crassus* and *A. novaezelandie*, also introduced in Europe, was suggested to explain the disappearance of *A. novaezelandie* in an Italian lake (Grabner *et al.*, 2012.)

Six countries report in their Country Reports of 2013 results of monitoring programmes for the swimbladder parasite. Occasional inventories are reported from another four countries and another five countries had no data to report. The parasite was introduced to Europe in the 1980s and where long time-series exist, prevalence has stayed relatively stable (Sweden), or declined (Northern Ireland) after an initial phase with higher levels (Figure 11-1). Late introductions were observed in Northern Ireland (1998) and on the Irish west coast at Burrishoole (2010–2011). Prevalence in most cases was highest in freshwater, decreasing with increasing salinity. In Burrishoole though, infestation was hitherto only observed in the lower saline sections of the system. Where both life stages were studied on the same site, prevalence of *A. crassus* was higher in silver eel than in yellow eel.

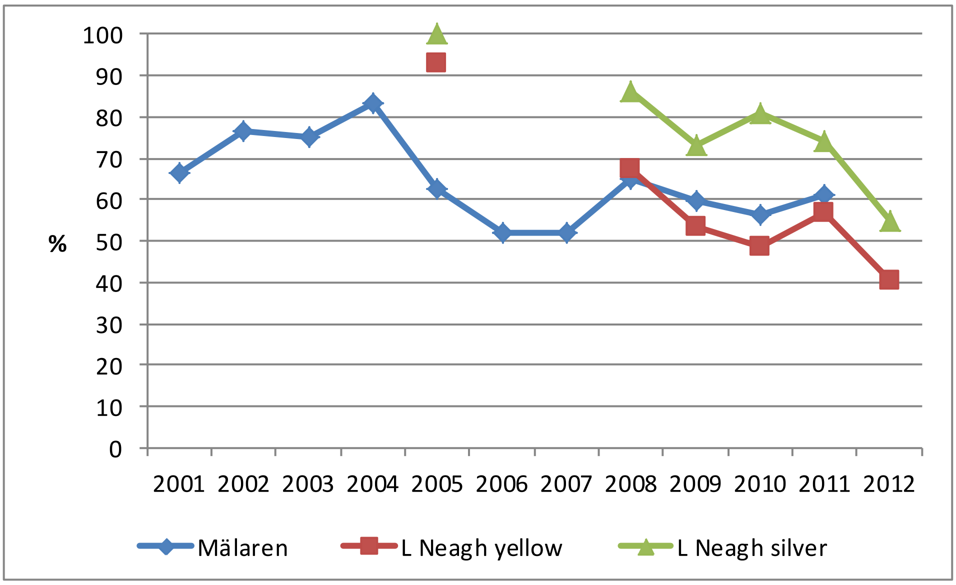


Figure 11-1. Prevalence of *A. crassus* in eel in Lake Mälaren, Sweden, and in Lough Neagh (Northern Ireland).

In **Sweden**, the prevalence of swimbladder parasite *A. crassus* has been monitored in samples taken from commercial catches, in freshwaters and coastal areas. Prevalence in yellow eels was lower until 2011 and generally lower in marine areas (6% in Skagerrak and 13% in the southern Kattegat), and higher (50%) inside the Baltic. In 2012, prevalence increased to 33% along the Skagerrak. This is probably due to a change in sampling areas which were more inland than previous years. In inland lakes, prevalence was generally much higher (79–90%). In the Swedish part of the Baltic Sea, prevalence was slightly higher in yellow eel, but in this case the origin of the silver eel may be anywhere in the Baltic region.

In **Finland**, one third of the eels are infected with *A. crassus*.

Anguillicola crassus was found in **Latvia** and **Lithuania**, although not officially recorded.

In **Poland**, parasitological tests indicated a very high infection prevalence of *A. crassus* among the fish tested.

In **Denmark,** the number of *Anguillicola* infected eels (prevalence) has remained constant over the period 1987–2012.

In **Germany**, there was a prevalence of 78% of *A. crassus* in 2012.

The Burrishoole catchment (**Ireland**) has remained free of the parasite until recently. In the fykenet survey in 2012, samples of yellow eels captured in L. Furnace (saline) and at the Back of the House (tidal lough below L. Furnace) were found to be infected with *A. crassus.* The parasite is now considered to be ubiquitous throughout Northern Ireland.

In **Spain** the prevalence of the parasite has either increased or remained stable depending on the location.

Anguillicola crassus seems to be widespread in **Portugal**.

Other disease agents

Reports of parasites other than *A. crassus* were scarce in the Country Reports of 2013.

The National Veterinary Institute in **Sweden**, reported a strain of an IPN-like virus (Infectious Pancreatic Necrosis) isolated from symptom-free rainbow trout, the virus was very similar to EEV (European Eel Virus) and potentially could affect wild eel populations.

A screening for parasites in **Poland**, besides a heavy infestation of *A. crassus*, did not reveal any serious signs of other parasites, including pathogenic bacteria and viruses.

In **Germany**, seven eels (5.8%) were tested positively for HVA and EVEX was found in 13 eels (16.3%).

Van Beurden *et al.* (2012) present a review of current knowledge of aetiology, prevalence, clinical signs and gross pathology of three pathogenic viruses in eel. The prevalence in wild yellow and silver eel in **the Netherlands** in two decades was highest for the alloherpes virus anguillid herpes virus 1 (AngHV1), while EVEX was only found sporadically, and EVE was never isolated.

In **Ireland**, all lakes sampled over the last two years under the Eel Monitoring Programme appeared to have a number of eels with red spots to varying degrees. Further research is needed to identify the pathogen infecting the eels.

In **Great Britain**, tests to detect eel herpes virus in serum samples, in 2011, were completed for 15 river sites across England and Wales. Some sites showed high prevalence (17–33%). Tests for eel viruses were carried out on seven elver samples, but were all negative.

In **France**, Filippi *et al.* (2013) presented evidence that the parasitic fauna in eel can be used as a bio-indicator for site, season, silvering stage and length.

A report described bacterial infections in glass eel in **Spain** (Andree *et al.*, 2013).

Micro-distribution of the monogean trematode *Pseudodactylogyrus anguillae* and the copepod *Ergasilus lizae* on the gills of eel was studied by Soylu *et al*. (2013) in a **Turkish** lake.

11.3 Eel quality and reproductive potential. A way forward in developing approaches to quantifying the effects of eel quality on reproductive potential and integrating these into stock assessments

During WG2012 the working group made progress in the assessment of the effect of eel fitness (in terms of size and lipid reserves) on the reproductive potential. Several authors have proposed that the lipid content of silver eels is crucial to their successful migration and reproduction. An approach was developed to quantifying the effects of eel condition on reproductive potential, and how such information could be integrated into stock assessments.

The reproduction potential of a female silver eel (RP) is dependent of several parameters. Apart from other condition parameters (such as physiological state, occurrence of parasites, etc.), RP will be a function of body size, muscle lipid content, and the migration distance to the Sargasso Sea (DSS) (see WGEEL 2012).

The net energy of silver eels starting their migration can be roughly estimated using a simplified model (net fat content was calculated assuming all fat is muscle fat, assumptions see Belpaire *et al*., 2009).

Net fat content at start of migration = Body mass * % Lipids/100

The energy requirements (cost of transport, COT) for a silver eel to reach its spawning ground increases with the DSS. Energy expenditure of female silver eels during swimming has been estimated through experiments in swimming tunnels, and is also related to their size (relative energy expenditure decreases with increasing body size). Measurements of COT, derived from swim tunnel experiments, have indicated costs of 11.5 and 17.5 mg fat/kg/km, dependent of two different methods used (Palstra and Van den Thillart, 2010). Here we present the range of values, and adopt an intermediate value of this range, 14.5 mg fat/kg/km, as a midpoint/mean for graphical presentation. In WGEEL 2012 a fixed value for COT was taken regardless of the length/body mass of the eel. This was recognized as a significant weakness in the model, and WG EL 2013 addressed this by incorporating a direct relationship between body mass and expenditure.

Mean cost of transport is thus calculated as

Mean COT (g fat) =Body mass (kg) * 14.5 (mg fat/kg/km)* DSS (km)
Lower COT (g fat) =Body mass (kg) * 11.5 (mg fat/kg/km)* DSS (km)
Upper COT (g fat) =Body mass (kg) * 17.5 (mg fat/kg/km)* DSS (km)

DSS being the distance from the sampling site to the spawning location in the Sargasso Sea at 61°00'W and 26°30'N (i.e. the centre of the area described in van Ginneken and Maes, 2005), and measured as a straight line (over the sea) between spawning location and catch site.

From this, the energy remaining for reproduction in female eels by arrival at their spawning ground (ER_{ind}) can be deduced:

ER_{ind} = Net fat content at start of migration – COT

or

ER_{ind} = (Body mass * % Lipids /100) - (Body mass (g) * 0.0000145 * DSS(km)

RP was calculated as the mass of eggs which could be produced after using all ER_{ind}, based on a conversion factor of 1.72 g eggs/g fat (as used in van Ginneken and van den Thillart, 2000):

RP_{ind} = ER_{ind} (g fat) * 1.72

If data are available from a representative sample of female silver eels from a given catchment or EMU, it should be possible to infer the reproduction potential of female silver eel escapement from the catchment or EMU (RP_{EMU}). Individuals with a negative or zero ER_{ind} will not contribute to the spawning stock as they will not have energy reserves necessary to reach the spawning ground or for egg production, respectively. From the ER_{ind}, the RP_{EMU} can be calculated using the following equation:

$RP_{EMU} = \sum RP_{ind\ ER>0} / N_{ind\ ER>0)} * N_{EMU\ ER>0}$

$N_{EMU\ ER>0}$ = number of female silver eels with $ER_{ind} > 0$ leaving the catchment.

$N_{ind\ ER>0}$ = number of female silver eels with data on lipids and body mass and with a calculated $ER_{ind} > 0$.

If sufficient monitoring data on body mass and lipid content of silver eels leaving continental waters were available, this would allow eel managers to obtain information on the reproduction potential of the various catchments/EMUs, and their contribution to the spawning stock.

Below, the impact on reproductive potential of the variation in size (body mass), muscle lipids content and distance from the catchment to the Sargasso Sea has been analysed, using the equations as presented above, and incorporating body mass dependent COT values.

Despite high swimming efficiency and low energy costs for swimming (van Ginneken *et al.* (2005), the individual figures illustrate that low levels of muscle lipid content in female silver eels put the likelihood of completion of the spawning migration at risk, for eels of all sizes (Figure 11-2). Eels with fat levels of 10% are not expected to complete a journey of 6000 km or above. The relationship body mass and reproductive potential: a 1000 g eel with an initial lipid level of 20% has about twice as much energy left for egg production as a 600 g eel with initial lipid of 20% after a 7000 km journey. A 1000 kg eel with initial lipid levels of 20% has approximately 25% less energy for reproduction if it undertakes a 7000 km migration rather than a 5000 km migration.

Model estimates representing the range of values of energetic costs of transport in swimming chambers is indicated in Figure 11-3. These suggest that any eel with 20% or more lipids should have sufficient energy reserves to complete migrations of at least 7000 km, while eels with 10% initial lipid levels may not have sufficient reserves to even complete a 6000 km migration.

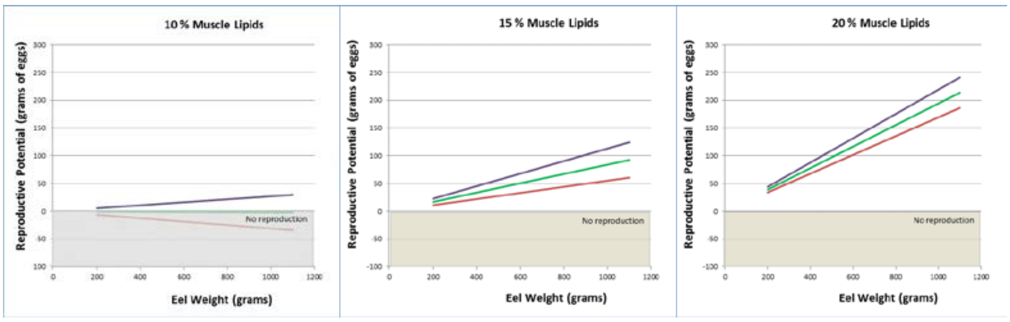
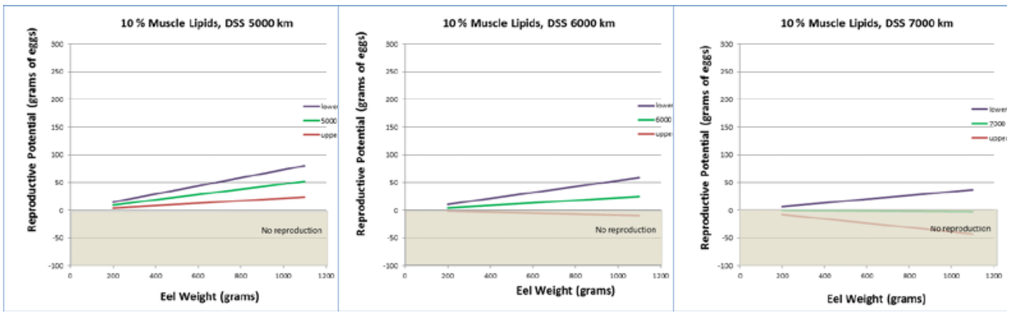


Figure 11-2. Modelled impact of body mass and distance to the Sargasso Sea on the reproductive potential of female silver eels leaving a catchment as a function of increasing muscle lipid levels (using mean estimate of energetic costs of swimming).



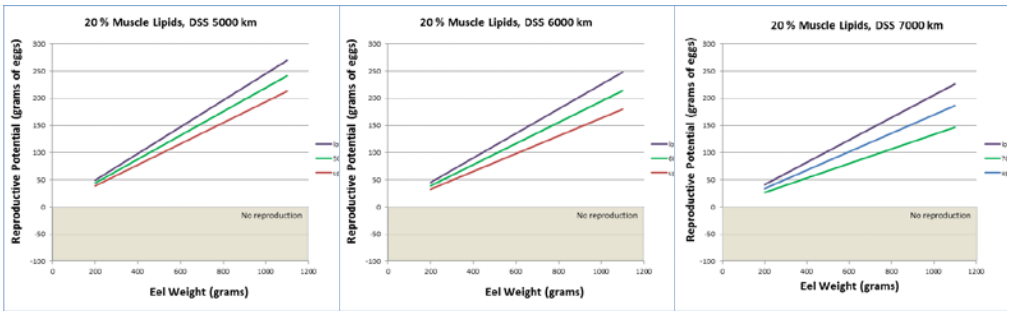


Figure 11-3. Modelled impact of body mass and different muscle lipid levels of female silver eels leaving a catchment on their reproductive potential as a function of increasing distance to the Sargasso Sea, incorporating upper and lower limits of published estimates of energetic costs of swimming.

In the next section we apply the new model to the available field data on size, body mass and lipid levels of silver eels, both females and males.

Following information was made available:

- Preliminary data of lipid content in silver eels provided from Irish and GB catchments in Europe sampled and analysed during the Eeliad project (www.eeliad.com);
- Preliminary data of lipid content in silver eels from Belgium sampled during the Eeliad project and analysed by Belgium;
- Unpublished data of lipid content in silver eels from Poland as provided by T. Nermer in 2012 and 2013;
- Unpublished data of lipid content in silver eels from Lough Neagh and Erne as provided by K. Bodles and D. Evans in 2012;
- Unpublished data of lipid content in silver eels from Norway as provided by C. Belpaire and E. Thorstad in 2012;
- Unpublished data of lipid content in silver eels from Sweden as provided by H. Wickström (Clevestam *et al*., 2011);
- Unpublished data of lipid content in female and male silver eels from Germany as provided by L. Marohn in 2013.

It should be stressed that the collection of these data was not designed to measure the RP of the catchment, and analysed individuals may not be representative of the catchments from which they were sampled. Hence, the results on individual RP presented in these figures may not be representative for the RP of the catchment, or the country, the results are presented only to illustrate the concept, and conclusions must be interpreted with great care.

The distribution of RP of female silver eels on arrival at the Sargasso Sea is presented in Figure 11-4, showing a strong positive skew. The median value was around 200–250 g eggs, with a few individuals contributing over 750 g and up to 1000 g of eggs. The figure also indicates the source of the samples, with Swedish eels numerically dominating the sample. It appears that the individual German and Swedish eels in the samples tended to contribute high RPs, while GB, French and Belgian eels contributed small RPs, and perhaps in general eels from the Baltic had higher reproductive potential than eels from more southern latitudes.

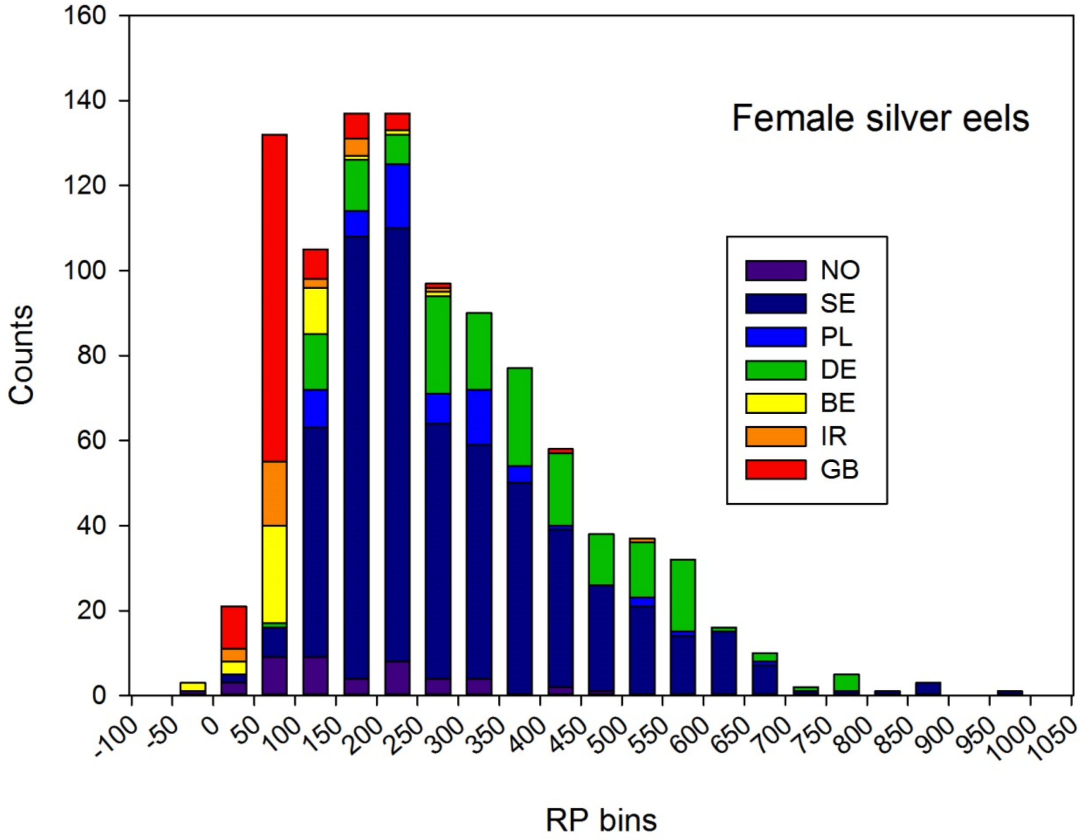


Figure 11-4. Distribution of the RP (g/eggs) of female silver eels, together with an indication of their country of origin.

According to our model, six eels out of 1066 had negative RP, meaning their energy level would not allow them to reach the spawning grounds.

We found that RP tends to increase with distance to Sargasso Sea (Figure 11-5), at least for part of the range. In every part of the range however, wide variation in the reproductive potential, reflecting variation in both body mass and lipid content, is evident.

RP increases with body length (L) (Figure 11-6) according to:

$RP=a * L^b$

Where $a = 1.23x\ 10^{-8}$ and $b=3.58$

Figure 11-7 shows RP calculated using the range of different estimates available. How these COT estimates will affect the resulting RP largely depends on eel size.

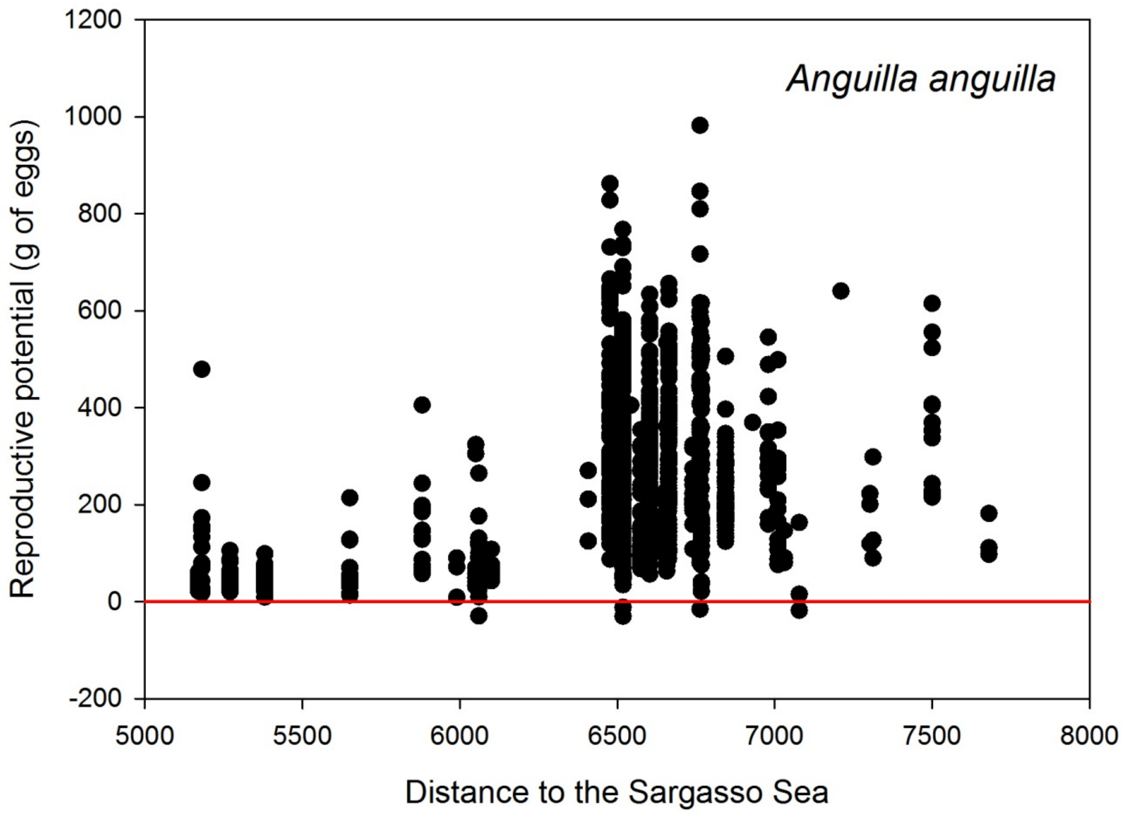


Figure 11-5. The modelled reproductive potential (g of eggs) according to distance to the Sargasso Sea (km) of female silver eels.

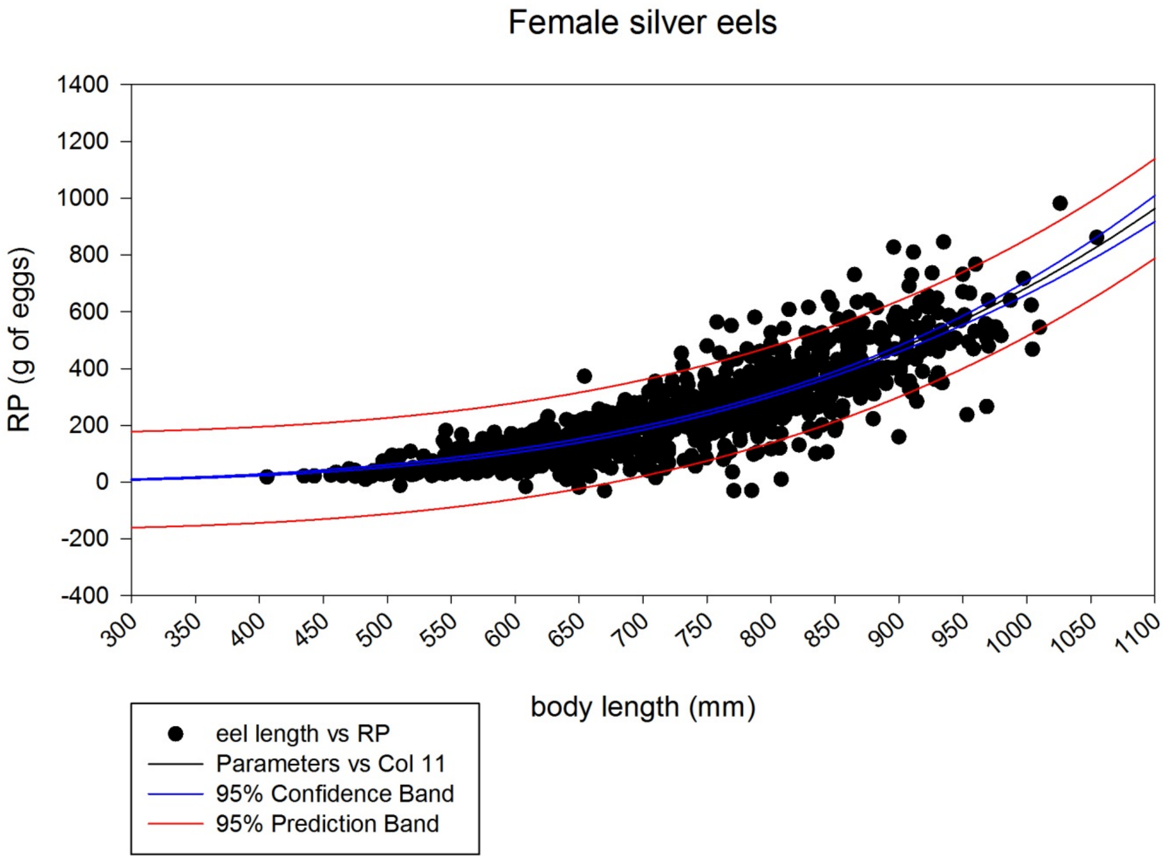


Figure 11-6. Relationship between body length of eels and RP (reproductive potential) of female silver eels.

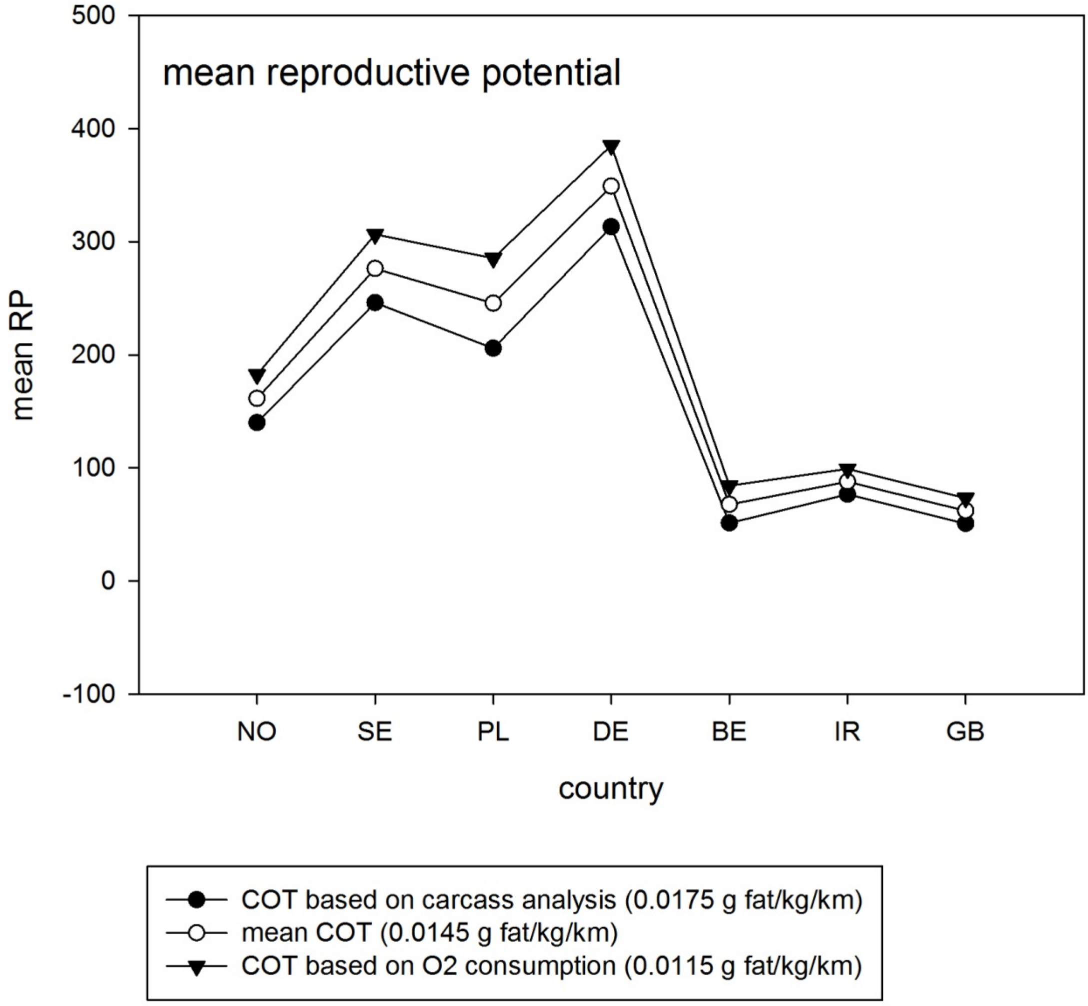


Figure 11-7. Mean RP per country calculated using different estimates for the COT.

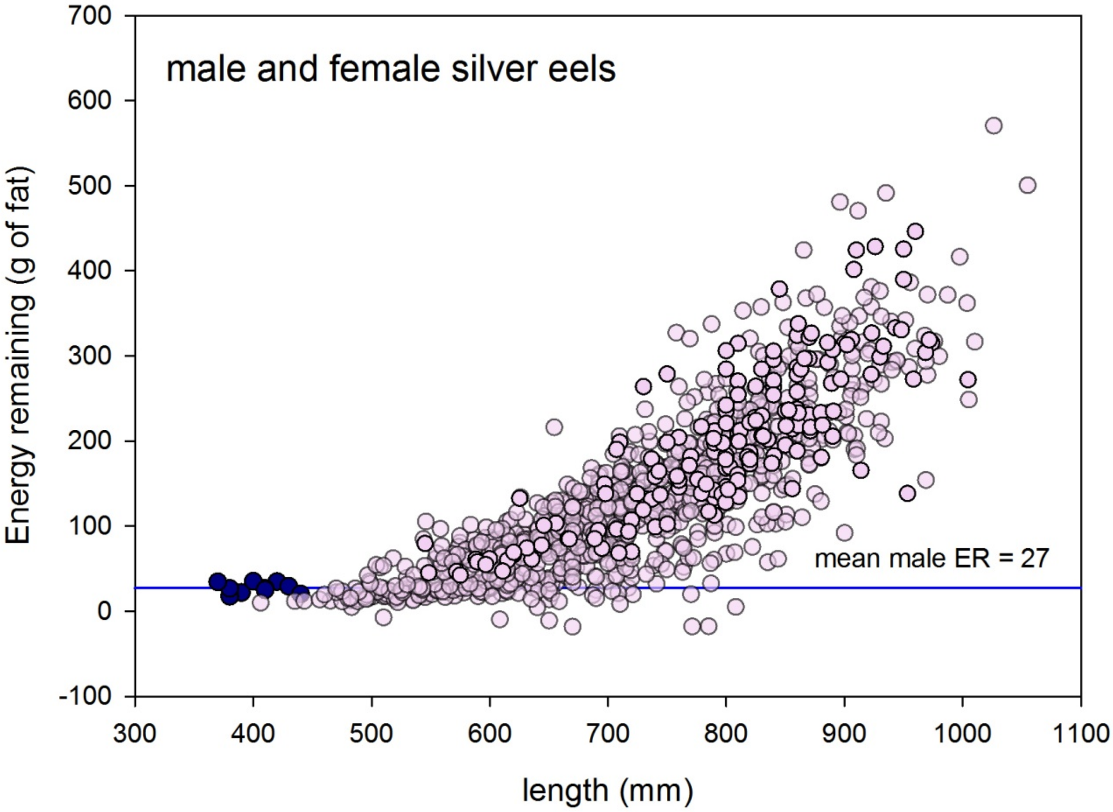


Figure 11-8. Energy remaining after migration to the spawning grounds of male (filled circles) and female (empty circles) silver eels according to body length.

In Figure 11-8 we show the energy remaining after migration for both male and female eels in our sample. Male eels (all of the samples from Germany) are predicted to have relatively high energy levels for their size. This reflects higher fat contents amongst males.

Overall, our models and analysis show that lipid content, body size and distance to the Sargasso Sea all contribute to the variation in potential reproductive success of eels, and it is the interaction between the three that governs reproductive potential at the spawning grounds. While the theoretical model elucidates this interaction, its application to field data suggests that eels with long migration journeys tend to arrive with higher reproductive potential than eels with shorter journeys, because they have grown larger/fatter before the spawning migration. Meanwhile it appears that eels from Ireland, France and GB, with relatively short journeys tend to arrive with low reserves, due to smaller size and/or % lipid content. The biological explanation(s) for this result are not clear, and we offer no further speculation or discussion here.

Shortcomings of the Reproductive Potential Model

At present the Reproductive Potential Model should perhaps be regarded as heuristic only, because there are necessarily a range of simplifications and shortcomings. We list some of these below, along with, some possible ways of addressing them if time, resources and further information allow.

1) COT is modelled as an energetic cost per km, based on calorimetry measures in a swimming chamber. This was based on van Ginneken *et al.*,

2005 paper in WGEEL 2012 report, but in this report we instead use the range of published energetic costs of swimming in eels collected in Palstra and Van den Thillart, 2010, and also used by Clevestam *et al*., 2011. These range from 11.5–17.5 mg fat/kg/km. However, metabolism has two components, a basal or resting rate, and a rate associated with activity being taken. Thus the model effectively assumes that eels swim constantly, with no resting phase (since eels in the swimming chamber were forced to swim constantly). If eels actually spend a portion of time resting during migration, then the actual cost of migration will be higher than modelled. Based on the Van Ginneken *et al*., 2005 paper, the resting metabolism is approximately half that the cost of swimming. Thus if an eel were to spend one month at rest during the supposed six month journey, the actual cost of reaching the Sargasso would be elevated by approx. $^1/_{12}{}^{th}$ in comparison to the model output.

2) In WGEEL 2012 body mass of the eel was not taken into account. In the present report the model has been adapted to generate body mass-specific costs. Average scaling exponents for teleost fish have been reported at 0.79 across 69 teleost species (Clarke and Johnston, 1999). For convenience here was used a direct relationship between body mass and metabolic costs, i.e. a scaling of 1.0, which falls close to the centre of reported scalings in the European eel values (ranging from 0.67 and 1.29 Degani *et al.*, 1989). An additional, but likely more minor, correction may be required for size-related swimming efficiency, since in general longer fish have lower size-corrected swimming costs. However, Burgerhout *et al.* (2013a) have recently reported very high swimming efficiency in male silver eels.

3) The model is fundamentally sensitive to the input value of eel living costs. These are based on a single laboratory experiment on nine individuals. Forced swimming inside a chamber is likely somewhat different from the swimming in natural migration, both in terms of fluid dynamics (there are no 'sides' in the ocean) and in terms of stress induced side effects. At present there is no way of assessing the representativeness of the input values used in the model.

4) Burgerhout *et al*. (2013b) have recently measured the impact of schooling on swimming costs in a chamber in male silver eels, and found that transport costs were reduced by almost 50% when schooling than when swimming individually. If eels habitually school on migration then the cost of swimming used here may overestimate true costs.

5) Metabolism is typically found to vary substantially between individuals, even when controlling for size. Resting metabolic rates of eels have been shown to vary widely in the laboratory (Boldsen *et al.*, 2013), and to be related to organ size. Morphological variation in eels (e.g. in head width) may also have implications for the COT. These variations between individuals are not considered here, because we have no means of identifying or quantifying them.

6) The migratory route(s) taken to the breeding grounds are not known, so exact distances cannot be calculated. In the model DSS were calculated as a straight line (over sea), which will be an underestimation. Additionally whether or to what extent eels can take advantage of ocean currents is unknown, and could significantly reduce the costs of migration.

7) Mean daily vertical migrations of 564 m were reported for large female eels on their ocean migration (Aarestrup *et al.*, 2011); these may involve some additional metabolic costs, since they involve an additional straight line travel of approximately 1.1 km per day, or approximately 3% additional journey for the deep-water section of the journey. However, it has been hypothesized that such vertical migrations may be part of a strategy to minimize transport costs, by optimizing temperature and pressure conditions (Scaion and Sébert, 2008). Since we are not here able to take account of the effect of these temperature differences on transport costs, we cannot comment on their significance, but suggest that a 3% increase in overall costs is likely to be the upper limit to the increase in costs over those modelled.

8) The present model takes no account of toxic effects on eels as metabolites of contaminants are released in fat breakdown during transport (Palstra *et al.*, 2005).

9) The potential impact of *Anguillicola crassus* on migration and reproductive performance is not included in the model. There are clear reasons to suppose some impact does occur, and there is a need for a simple approach to incorporating a cost of infection in the model. Rather than to introduce an estimated level of mortality due to *A. crassus* infection, one approach is to assume a general impact of energetic capacity in an infected organism, and estimate the proportion of individuals which are or have been infected. Clevestam *et al*. adopted the arbitrary figure of a 20% increase in COT in their 2011 model. However, we do not include any such *A. crassus* effect in this model because of uncertainty of the scale of effect if any, but note that such costs could be incorporated readily if data were available.

At present application of the model (see figures above) is also hampered by an inadequacy of data to populate it. Data on the lipid content of silver eels is both scant and not well-distributed throughout the species range. In particular data on lipid content from silver eels leaving catchments in the southern part of Europe is lacking. There is also some concern about comparability of lipid measurements. The option to make *in vivo* measurements of lipid content is a welcome development, but the technology is somewhat limited and *in vivo* measures are likely neither precise nor accurate, and may not be comparable with more accurate analytical methods.

11.4 Urgent knowledge requirements as the basis for a Research Proposal “Towards understanding and quantifying the effects of contaminants on the reproductive success of the European eel and integration in stock wide assessments”

An increasing amount of evidence is pointing toward pollution in general and more specifically the pressure by bioaccumulating lipohylic compounds as having a major negative impact on the European eel stock. Considering the major knowledge gaps and lack of experimental evidence related to the understanding and quantification of the impact of contaminants on the stock, research should be urgently initiated.

WGEEL 2012 noted that essential issues to assess the importance of eel quality for reproductive success, such as evaluations of the effects of specific contaminants on the ability for eel to migrate and reproduce, are currently not included in ongoing research projects. WGEEL 2012 recommended specific research on these issues, and addressed to EU and funding agencies the request to support research resulting in a better understanding of the eel's sensitivity towards contaminants with respect to survival, migration and reproduction success.

Given the urgent need for this experimental work, WGEEL 2013 recommends initiating an internationally coordinated research project with the aim of improving the understanding and quantification of the effects of contaminants on the reproductive success of the European eel for integration in stock wide assessments. Such a coordinated project could be initiated within the EU Framework Programme for Research and Innovation (EU Horizon 2020, http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=h2020) funding scheme. Therefore, WGEEL 2013 discussed and listed the most urgent requirements and outlined the objectives of such an international project, taking into consideration the presence of expertise within the eel scientific community and new technological developments.

11.4.1 Overall objective of the research proposal

International stock assessment requires the development and integration of approaches to quantify the effects of eel quality on reproductive potential and integrating these into stock assessments. Contamination by (especially lipophilic) compounds bioaccumulating in the yellow eel during its continental growth period has been shown to affect several fitness related parameters in the silver eel at the onset of the reproductive migration. Contamination may result in lowered lipid levels and hence insufficient energy for migration and reproduction. Reprotoxic effects of these compounds may also affect the gonad quality (endocrine disruption, altered gametogenesis, decreased fecundity, altered sperm quality), and subsequently the reproduction success, in terms of number of larvae survival. Significant gaps in scientific knowledge have been recognized, such as to what extent and at what level these contaminants affect the eel reproductive success. A flow chart identifying the different levels of potential impact by contaminants is given in Figure 11-9 and presents the various effects of contaminants that need to be experimentally assessed. The results will provide input data needed to integrate eel quality estimates into stock wide assessment. The overall objective is to carry out experimental and modelling work aiming to better understand and quantify the effects of contaminants on the reproductive success of the European eel and to integrate eel stock quality parameters in stock wide assessments.

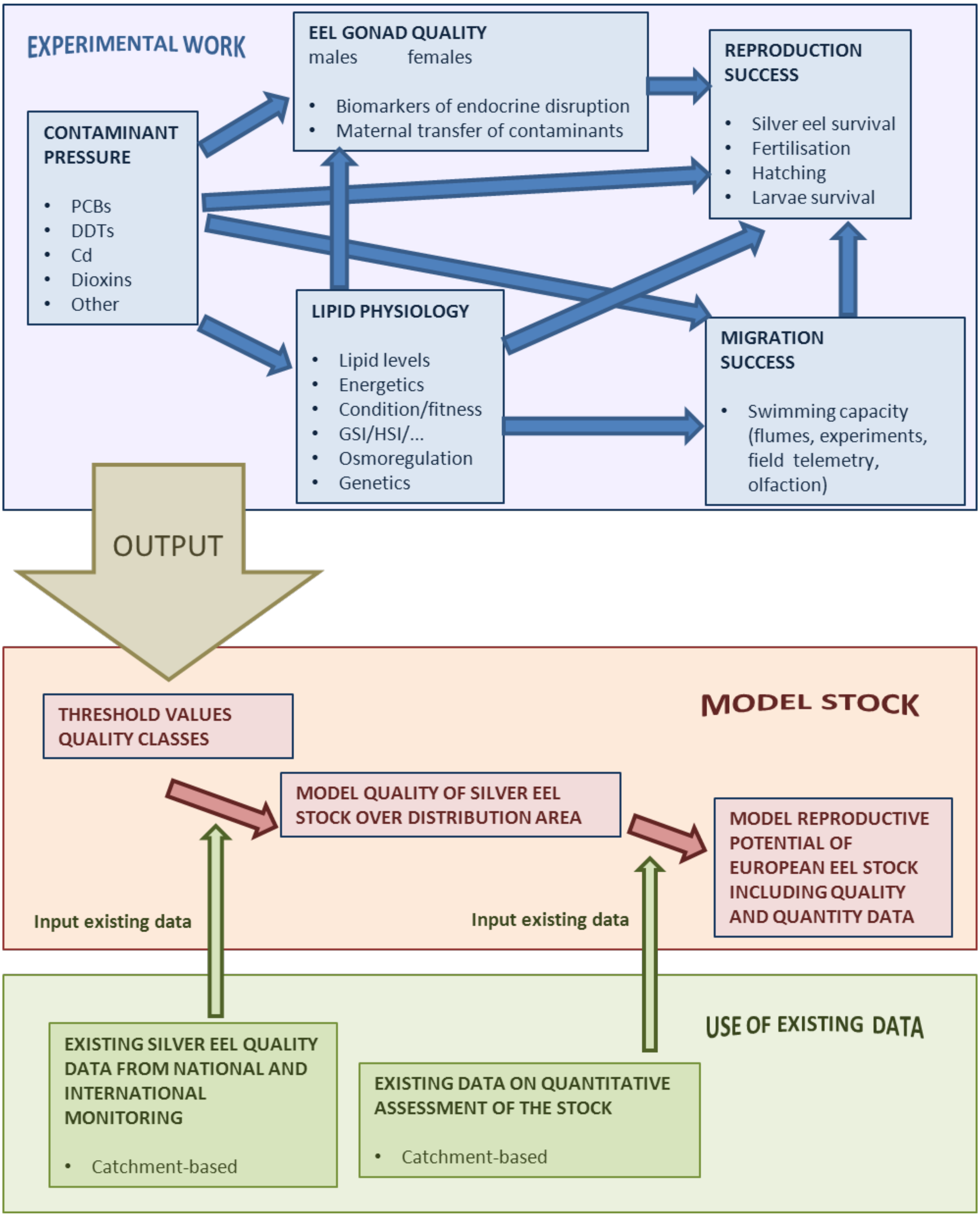


Figure 11-9. Different levels of potential impact by contaminants and various effects of contaminants that need to be experimentally assessed.

11.4.2 Experimental work

Contaminants

Thousands of compounds may affect the European eel negatively, and many are known to bioaccumulate. PCBs, DDTs, Cd and dioxins are recognized as priority substances for future impact studies. Also other compounds can be taken into consideration.

Impact of contaminants on (lipid) physiology

Lipid reserves and energetic contents of silver eels leaving their catchment vary considerably. Moreover, in some areas a significant decreasing trend in lipid levels has been reported. In other species, contaminants have been reported to cause the impairment of lipid metabolism, resulting in lowered muscle lipid levels. Also in the eel, some indication for this is available. However, experimental work for a quantitative assessment of the effect of these compounds on lipid metabolism is needed. This can be done for example through experiments using aquaculture facilities in experiments using (glass) eel exposed to various levels of contaminants and impacting fitness related parameters such as growth, condition, lipid and energetic metabolism, but also other biomarkers (proteomics, genomics, etc.) may be integrated into these assessments. Contaminants may also impact osmoregulation. At some levels even mortality might occur due to toxification.

Impact of contaminants on migration

Some values regarding the swimming efficiency and the Cost of Transport of silver eels migrating to the spawning grounds are available but include a variety of uncertainties (see under Section 10.3). Flume experiments and/or field studies using telemetry are required for a better estimate of the energetic requirements of reproductive migration, and for studies of potential effects by contaminants on swimming speeds, behaviour patterns and olfaction. Although some data exist on the direct and indirect effects of contamination on the swimming capacity and energetic requirements, this needs to be further addressed.

Impact of lipid reserve and lowered fitness on migration

Migration success of male and female silver eels leaving their catchment depends on parameters such as body size, energetic content and DSS. Catchment based threshold values of fitness related parameters need to be defined to enable stock wide assessments.

Impact of contaminants and impairment of lipid metabolism on eel gonad quality

Contamination has been reported to induce impairment of gonads in a large number of species, but this is poorly studied in eels. Levels of maternal transfer of contaminants from muscle fat into the ovaries needs quantification. The impact of specific compounds in both ovarian and testicular tissue of eel needs to be addressed. Recent advances in eel reproduction techniques make it now possible to assess biomarkers for endocrine disruption (including histology) after exposure of maturing eels to contaminants (fecundity, sperm quality, GSI, Vtg, etc.). Impairment of lipid metabolism and lowered energy reserves will have an impact on gonads and fecundity, which needs quantification.

Impact of contaminants on reproduction success

Reproduction experiments using eels exposed to variable internal levels of contaminants will enable to quantify the impact of contaminants on reproduction success, both in males and in females. Biomarkers may include fertilization success, hatching of eggs, and survival of the larvae.

11.4.3 Modelling work

By integrating threshold values from the experimental work, biological characteristics of individual eels as well as populations, the effect of different contaminants on the production and quality (size, fat content, gonad quality, toxic load, migration success, etc.) of silver eels can be revealed, quantified and integrated in a form that will be representative of catchments and modelled over the distribution area. Existing (current and past) silver eel quality data from national and international monitoring will specifically be used together with output data from the experimental work to develop models of the quality of silver eel stock over the distribution area. Further, existing data on the quantitative assessment of the stock will be integrated in a combined model of the reproductive potential of European eel stock including both quality and quantity data.

11.5 Joint Workshop of the Working Group on Biological Effects of Contaminants and the Working Group on Eel under the subject "Are contaminants in eels contributing to their decline?"

During previous meetings WGEEL (2008–2012) made considerable progress in understanding and describing the potential impact of contaminants on the European eel, both on individual and stock level. Several recent studies have produced an increasing quantity of information demonstrating the negative impact of pollution on eel (see reviews by Geeraerts *et al*., 2011; Elie and Gerard, 2009, and WGEEL 2008–2012).

The level of contaminants, and of diseases and parasites and body condition, are treated as an index of eel 'quality'. However, substantial gaps remain in knowledge of the importance of eel 'quality' for reproductive success, which limit the use of this metric in quantitative stock assessment and associated management. For example, uncertainty remains about the effect of specific contaminants or cocktails of contaminants on the ability of silver eels to migrate to the spawning ground (the Sargasso Sea), their residual reproductive potential once there, and about the impact of transferred maternal contaminants on embryonic and larval development.

WGEEL 2012 suggested a joint cooperation with experts from WGBEC (**Working Group on Biological Effects of Contaminants)**, and recommended an exchange of information concerning the influence of contaminants on fish, in order to make progress in understanding the contribution of contaminants to the decline of eel. WGEEL 2012 proposed an **exchange via a joint meeting of the two working groups in 2015**. The experience and knowledge base within WGBEC concerning the effects of contaminants in other species is anticipated to expedite progress in, and broaden understanding of, the role of contaminants in the eel stock decline. The joint workshop will review all sources of information (including work on other species) to better understand how contaminants in eels contribute to their decline.

WGEEL 2013 proposes the following Terms of Reference for this joint Workshop between WGEEL and WGBEC:

j) To describe the spatial and temporal trends in concentrations of "traditional" and/or "emerging" contaminants in eel (note this will be mainly based on information available from WGEEL 2008–2013);

b) To describe the potential impacts of contaminants on reproductive performance in the European eel, based both on eel-specific data and from models of other species (including endocrine disruption, effect on sex ratio, maternal transfer of bioaccumulated contaminants to eggs and their effects on larvae);

c) To describe the impacts of contaminants on body condition in general, and lipid metabolism specifically, in the European eel, and assess the potential impact on migratory performance of silver eels;

d) To review the impacts of contaminants on the gene-expression of the European eel;

e) To explore whether there is potential to transfer the experience in assessment/quantification of the bioaccumulation + fitness status in other species, which could advance the assessment of eel quality (Eel Quality Index) and to quantify the impact of eel quality.

11.6 Workshop of a Planning Group on the Monitoring of Eel Quality

Reliable assessment of the eel stock quality and its quantitative effect on the reproductive stock is currently not possible, due to basic gaps of knowledge (see Section 10.4) and insufficient spatial and temporal coverage of data on eel quality. WGEEL (2009) emphasized the need to establish a comprehensive overview, with improved spatial coverage, of the quality of the eel population across Europe as an essential and urgent requirement. Many countries have started compiling data on the health status of eels in their water bodies. Objectives for these monitoring actions are diverse but there is a large amount of information collected. However, procedures with respect to sampling, analysis and reporting are not harmonized, jeopardizing stock wide comparisons of eel quality. WGEEL 2012 recommended that Member States implement routine monitoring of lipid levels, contamination and diseases, but also identified the need to develop standardized and harmonized protocols for the estimation of eel quality. Some guidance to standardization has been developed (e.g. in Eeliad, UK-Environment Agency, etc.)

WGEEL 2013 recommended the development of standardized and harmonized protocols for the estimation of eel quality through the organization of a Workshop of a Planning Group on the Monitoring of Eel Quality).

This will enable future integration of eel quality parameters in quantitative assessments of the reproductive potential of the stock.

Following Terms of Reference for this Workshop are proposed

j) To design standardized and harmonized protocols for the estimation of eel quality with regard to the bioaccumulation of contaminants (including sampling, analysis and reporting);

b) To design standardized and harmonized protocols for the estimation of eel quality with regard to diseases (including sampling, analysis and reporting).

11.7 Conclusions

Further improvement was made of a model to assess Reproductive Potential of individual female silver eels leaving their catchment. Dependence of body mass on cost of transport was introduced as a new variable. General conclusions of last year's report remain that distance to the Sargasso Sea, size and lipid content, have a large impact on reproductive potential. The new figures show considerable variation in reproduction potential between countries/catchments. Spatial coverage of monitoring data on the quality of silver eels over its distribution area is poor, and insufficient experimental data and uncertainties in assumptions still hamper the possibility to introduce Reproductive Potential in stock wide assessments of SSB.

A conceptual analysis of information needed to reach the goal of the introduction of eel quality parameters into stock wide assessment is presented as a research proposal, which shows the major gaps in knowledge and provides a strategic overview for future research.

11.8 Recommendations

- We recommend that monitoring of silver eel quality should be introduced as part of new or existing programmes (DCF/DCMAP).
- We recommend the initiation of an internationally coordinated research project aiming to improve the basis for introduction of eel quality into eel stock assessment.
- We recommend an exchange of information between WGBEC (Working Group on Biological Effects of Contaminants) and WGEEL concerning the influence of contaminants on fish, in order to progress in developing crucial Eel Quality Index components. We propose to enable an exchange via a joint meeting of the two working groups in 2015.
- We recommend the organization of a Workshop of a Planning Group on the Monitoring of Eel Quality towards the development of standardized and harmonized protocols for the monitoring of eel quality.

Section C: Planning for future reporting and assessment

12 Local stock assessment

12.1 Introduction

At present, reports on eel stocks at country level are required for several different reporting purposes, with differing levels of technical and descriptive detail and at differing intervals. Not all countries report on eel to all the same organizations. There is considerable overlap between the various reporting requirements and the working group is of the view that harmonization of the format in which data are collected, recorded and reported would offer benefits to all concerned. A subgroup of WGEEL 2013 was tasked to examine the requirements and scope for simplification/harmonization, **with the prime purpose of facilitating and improving country reporting for local and international assessment eel stocks**. This section gives detail of the outcome of that task.

Currently, the following reporting takes place:

- Reports by ICES Member States to WGEEL, comprising annually updated quantitative indicators of stock abundance.
- Reports by EU Member States to the EU Commission on progress and compliance with the EU Eel Recovery Regulation, at intervals determined by the Regulation. This was initially set at reports in 2012 (now submitted) and then 2015, 2018, 2024, 2030 and every six years thereafter, but could change on planned review of the Regulation. Reports comprise specific requirements set under the Regulation, including quantitative indicators of stock abundance and measured effects of management measures taken to comply with the Regulation.
- National reports to the EU Commission by the EU Data Collection Framework (DCF) coordinators in those countries drawing financial support for eel monitoring from the EU DCF. These reports consist of financial information on expenditure on work eligible for subsidy, accompanied by a narrative (technical) report describing the work carried out and a summary of the data gathered.
- Reports to CITES on compliance with the CITES listing of eel. These are compiled annually by the EU CITES committee with contributions from individual states on catch, movement and trade in eel.
- Reporting of catch data to EIFAAC for inclusion in the FAO statistics (Required August 31st annually).
- For the Mediterranean countries there is a requirement to report catch and aquaculture statistics, describe fisheries and habitat, eel biology and ecology, trade and their management frameworks to the GFCM.

12.1.1 Lessons learned from the May 2013 ICES expert group convened to assess implementation of EU eel management plans (WKEPEMP)

Following the evaluation of the EU Member States' reports to the EU Commission on implementation of eel management plans, by an ICES expert group in May 2013 (WKEPEMP), a report was produced which, *inter alia*, commented on the data provided in the MS reports and its usefulness in facilitating the assessment. ICES

WGEEL had previously advised on the data required and provided a template during its March 2013 meeting. Despite this, the expert group's report lists the following areas where data provision could be improved:

- The data needs to be provided in a standard format in clearly defined tables. Some reports contained data in described text which the assessors found it difficult to extract.
- The group did not have the ability to read all the languages in which reports were supplied. An agreed set of working languages is required.
- Where derived data are required to be derived from raw parameters, clear instructions are required for the production of the derived data.
- Not all countries provided all the stock indicators required.
- Data were not all supplied in standardized units.
- Where data were supplied compiled to Eel Management Unit (EMU) level, these were not all compiled in a standard manner and were hence difficult to compare.
- Data reporting periods varied, for periods chosen to represent pre- and post-regulation implementation.

In subgroup discussion and with WGEEL members present who had been at the expert assessment process, the following additional issues were identified:

- Where data are not reported, the reasons for non-reporting need to be clear to distinguish whether the absence of information is due to legitimate non-applicability of the criterion, an absence of data which could be collected or other reason. Choice of coding could be used to clarify this, for example ND for no data, NA for not applicable, NC for not collected, etc. Use of these types of code needs to be prescribed and standardized in advance across all tables (See below).
- There are differences between the needs of different reporting/reviewing organizations, for example while ICES requires data on all eel producing areas, the EU Eel Regulation or DCF reports are interpreted by some as only requiring data from fished or formerly fished areas. Any harmonized data reporting scheme, in order to meet all requirements, needs to record to the highest required level of detail.
- Where levels of detail and content are not prescribed, there will be inevitable differences in quantity and detail required. Information above and beyond standard tables can obscure analysis, and should be relegated to annexes. Examples discussed include the detail of how to create derived data, lists of historical time-series data going earlier than the minimum required, and lists of areas and habitat quantities in EMUs.

The subgroup discussed the creation of a database of data on eel at EMU level, which could house much of the historical or established data supporting assessments but not necessarily used at every step. Such a database could be useful in supporting the reporting for a variety of purposes (e.g. Country reports, DCF, and EU Regulation compliance), but there are major resource implications surrounding the database establishment, host location, and management.

12.1.2 Need for harmonization of categories of nil response in data tables

Inevitably, there are many occasions where data cannot be supplied in all categories required for stock assessment. When this is the case, it is often not clear why there is no entry and some standardization of the "nil return" entry could help considerably in compiling advice on where improvements to data supply are required. NA (Not available or Not applicable), and "ND" can conceal many different reasons for non-reporting. Some standardization could help in adding increased resolution to the reasons for absence of data. The following usage is suggested.

- 0: Reserve this designation for a measured data point with an actual zero value (for example when the catch is zero but the effort is >zero).
- NP: "Not Pertinent", where the question asked does not apply to the individual case (for example where catch data are absent as there is no fishery or where a habitat type does not exist in an EMU).
- NR: "Not Reported", data or activity exist but numbers are not reported to authorities (for example for commercial confidentiality reasons).
- NC: "Not Collected", activity / habitat exists but are not collected by authorities (for example where a fishery exists but the catch data are not collected at the relevant level or at all).
- ND: "No Data", where there are insufficient data to estimate a derived parameter (for example where there are insufficient data to estimate the stock indicators (biomass and/or mortality)).

12.1.3 Guidance on units of measurement

The subgroup compiling proposals for harmonizing local stock assessment noted considerable variation in units used for data reporting (Table 12-1). On consideration, the following units and levels of resolution are suggested as a step toward harmonizing data entry and facilitating use of RBD level data for wider scale stock assessment.

Table 12-1. Proposed units and decimal places.

Parameter	Unit	Decimal places (minimum)
Length of glass eel	mm	0
Length of yellow/silver eel	mm	0
Age yellow silver eel	year	0
Age glass eel/on grown	days	0
Area (EMU scale)	ha	0
Area (Sub EMU scale)	ha	0
Weight (individual Glass eel)	g	2
Weight (Yellow or silver eel)	g	0
Weight (Catch level) GE	kg	0
Weight (Catch level) Other	kg	0
Site/position	Lat Long units (WGS84)	Deg + decimal Min (2)
Biomass (B_0 B_{best} $B_{current}$ Etc)	kg	0
Mortality rate	∑F, ∑H, ∑A per year	2
Effort	Gear days, gear hours	0
Language	English	
Price	Euros	0
Distance	km	
Season	Clearly define season	

12.2 Catch-effort-cpue

Data on catch, effort and catch per unit of effort (cpue) are requested from Member States by various organizations such as ICES, EU, EIFAAC, CITES and by the Data Collection Framework (DCF). In the Country Reports to WGEEL, Chapter 5 requests information on effort in the fishery; Chapter 6 refers to catch and landings and Chapter 7 relates to catch per unit of effort. For ease of reporting it has been suggested that a single table be filled out containing all necessary information.

The information contained in this table is then used by the Working Group for various tasks to evaluate the eel stocks. Total catch is used in the recruitment trend. International stock assessment requires catch separated at the yellow and silver life stage. Effort data were used in the WKEPEMP.

Where the fishing season extends from one year to the next, it is important to define the season that the catch relates to (the fishing season should be recorded in an appendix). For example, the glass eel season varies with latitude, being earlier in the south than the north. So for a given glass eel cohort the catch in Spain would be from October to January the following year, while in the UK the season is from February to May of the same year. To ensure consistency in reporting, Spain would report their catch statistics for 2012–2013 while the UK would report 2013.

Table glossary

- EMU_Code: Eel Management Unit;
- Source: Source of the data; Commercial, Recreational;

- Habitat: Habitat type assessed for stock indicators; River, Lake, Estuary, Lagoon, Coastal & Marine Water, Inland Water, Total;
- Lifestage: Glass; Yellow; Silver; Combined Yellow + Silver;
- Gear: To be described in the appendix;
- Year: Reporting year (YYYY);
- Catch: The reported catch (kg);
- Effort: The reported effort;
- Effort Unit: The unit of effort;
- Cpue: Catch per unit of effort (The quantity of eel caught (in number or in weight) with one standard unit of fishing effort);
- Percent Released: % of catch released under a Trap and Transport programme.

Table 12-2. Catch and effort by EMU, habitat and gear type.

EMU_code	Source	Habitat	Life stage	Gear	Year (20XX)	Catch (kg)	Effort	Effort unit	CPUE	% released (T and T)
	Commercial	River	Glass			kg				%
	Recreational	Lake	Yellow							0.00
		Estuary	Silver							
		Lagoon	Yellow & Silver							
		Coastal & Marine Water								
		Inland Water								

12.3 Underreporting and illegal catches

Table 12-3. Estimation of underreported catches in Country, per EMU and Stage.

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

AIM: Determine the % of the underreporting and the total catches of the Country per stage.

NOTE: Please indicate in the text whether the percentage underreported catch is a direct measurement or a guess using the estimate to calculate the underreported kgs and Total catches.

Table 12-4. Existence of illegal activities, its causes and the seizures quantity they have caused

		GLASS EEL			YELLOW EEL			SILVER EEL			COMBINED (Y +S)		
Year	EMU	Y/N/?	Cause	Seizures (kg)	Y/N/?	Seizures (kg)	Cause	Y/N/?	Seizures (kg)	Cause	Y/N/?	Seizures (kg)	Cause
2013	EMU_a												
	EMU_b												
	EMU_c												
	EMU_d												
	EMU_e												
	EMU_f												

AIM: Identify the illegal fishing activities and in case it is possible its causes and the seized kgs in case they were seizures.

NOTES:

- Y/N/?:

- Y: you know for sure they have been illegal activities;
- N: illegal activities are considered negligible / not significant;
- ?: You do not know whether they have been illegal activities or not.

- Cause: One of the followings:

- Fishing out of the season;
- Fishing without licence;
- Fishing using illegal gears;
- Retention of eel below or above any size limit;
- Illegal selling of catches.

12.4 Aquaculture

Table 12-5. Aquaculture seed supply, production (kg) and destination.

		SEED		DESTINATION OF PRODUCTION			
Year	**EMU-Code**	**Source**	**Quantity (kg)**	**Stocking**		**Human consumption**	
				kg	**%**	**kg**	**%**
2013	EMU_a						
	EMU_b						
	EMU_c						
	EMU_d						
	EMU_e						
	EMU_f						

AIM: Identify the seed quantity per donor country, what it has produced and whether they have been restocked or sold for human consumption.

NOTES:

- EMU: Emu where the aquaculture activity takes place;
- Seed source: Origin of the country where the seed (glass eel) was purchased;
- Seed quantity: kgs of glass eel that were purchased;
- Destination: The final quantities (kg) that were destined for stocking or consumption.

12.5 Amount stocked

Table 12-6. Source and per stage quantity of eels stocked in Eelland.

YEAR	EMU_CODE	SOURCE COUNTRY	STAGE	NUMBER	TOTAL WEIGHT (KG)	MEAN WEIGHT (G)	MEAN SIZE (MM)	GEE (N)
2013	EMU_a	UK						

2013	EMU_a	France
2013	EMU_b	UK
2013	EMU_b	France
2013	Total	

AIM: Identify the quantity of eel stocked in your country and its characteristics.

NOTES:

- EMU_code: EMU where the eels were stocked;
- Source Country: Origin of the stocked eels;
- Stage: Choose among the following ones, do not include any more:
  - Wild glass eel;
  - Quarantined glass eel;
  - Wild yellow;
  - Ongrown cultured.
- Please translate your quantities into Glass Eel Equivalents (GEE).

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

Table 12-7. Catch of eel <12 cm and proportion retained for restocking in home country and other EU countries.

			National		EU export		Total	
Year	EMU_code	Glass eel catches (kg)	Stocking (kg)	% Stocking	Stocking (kg)	% Stocking	Stocking (kg)	% Stocking
2013	EMU_a	NR	NC	NC	NC	NC	NC	NC
	EMU_b	3511	0	0	NC	NC	NC	NC
	EMU_c	NR	NC	NC	NC	NC	NC	NC
	EMU_d	1534	2.1	0.1	0.0	0.0	2.1	0.1
	EMU_e	2584	0	0	NC	NC	NC	NC
	EMU_f	223	50.2	22.5	NC	NC	NC	NC
	Total/mean (%)	7852	52.3	0.7	NC	NC	NC	NC

AIM: In case you have a glass eel fishery, identify the quantity of eel stocked inside and outside your country in order to *determine whether you meet the EC 1100/2007 Regulation requirement* regarding the use a percentage of the glass eel catch for stoking.

NOTES:

- EMU_code: EMU where the eels where caught;
- National: Quantity and percentage, in relation to catches, of glass eels that were stocked inside the country;
- EU countries: Quantity and percentage, in relation to catches, of glass eels that were stocked in other EU countries.

12.5.2 Glass eel destination

Donor countries

Table 12-8. Glass eel catches destination per EMU in Country.

		National								UE Export (kg)		Unknown	
Year	EMU_code	Glass eel catches (kg)	Stocking		Human consumption		Aquaculture		Total National				
			kg	%	kg	%	kg	%		kg	%	kg	%
2012	EMU_a	500	23	4.6	10	2.0	24	4.8	57.0	23	4.6	420.0	84.0
	EMU_b	3511	0	0.0	NC	NC	NC	NC	NC	3	0.1	3508.0	99.9
	EMU_c	23423	23	0.1	23	0.1	23	4.6	69.0	NC	NC	23354.0	99.7
	EMU_d	1534	2.1	0.1	1532	99.9	0	0.0	1534.1	0	NC	0.0	0.0
	EMU_e	2584	0	0.0	45	1.7	354	70.8	399.0	0	0.0	2185.0	84.6
	EMU_f	223	50.2	22.5	35	15.7	35	7.0	120.2	3	1.3	99.8	44.8
	Total/mean (%)	31775	98.3	0.3	1645	5.2	436	87.2	2179.3	92.7	0.3	185.1	0.6

AIM: In case you have a glass eel fishery, determine *where your glass eels have gone* and highlight the percentage of the catches whose destination is unknown.

NOTES:

- Some information of the previous table is repeated in this one; but the aim is different;
- EMU_code: EMU where the eels where caught;
- National: Quantity and percentage, in relation to catches, of glass eels that were used with different purposes in the glass eel Country of origin;
- EU export: Total quantity and percentage, in relation to catches, of glass eels that were exported to other EU countries.

Table 12-9. Glass eel catches exports per EMU and importing Country, in Country.

			Exported (kg)					
Year	EMU	Glass eel catches (kg)	Austria	Belgium	Czech Republic	Estonia	UK	Total
2012	EMU_a	500	23.0	4.6				27.6
	EMU_b	3511	3.0	0.1				3.1
	EMU_c	23423	23.0	234.0				257.0
	EMU_d	1534	0.0	24.0				24.0
	EMU_e	2584	0.0	0.0				0.0
	EMU_f	223	3.0	1.3				4.3
	Total	31775	52.0	264.0	0.0	0.0	0.0	316.0

AIM: determine where the countries with glass eel fishery export their eels in order to analyse price spatial-temporal trends.

NOTES:

- Some information of the previous table is repeated in this one; but the aim is different;
- EMU: EMU where the eels were caught;
- Exported (kg): Quantity of the exported eels per country.

Table 12-10. Glass eel sale price in country of origin.

		Price (euros)			
Year	EMU	Mean	Min	Max	Source
2012	EMU_a	350.0	200.0	500.0	
	EMU_b				
	EMU_c				
	EMU_d				
	EMU_e				
	EMU_f				
	Total				

AIM: In case you have a glass el fishery, determine the price those were sold in order to analyse price spatial-temporal trends.

NOTES:

- EMU: EMU where the eels where caught;
- Source: source of the information regarding prices;

Receptor countries

Table 12-11. Glass eel imported by Country and final destination.

			DESTINATION					
			Stocking		Human consumption		Aquaculture	
Year	Donnor Country	Quantity (kg)	kg	%	kg	%	kg	%
2012	UK	2342	23	1.0	10	0.4	24	10.3
	France	234						
	Spain	0						
	Portugal	67						
	Italy	234						
	Morocco	2342						
	Others…							
	Total/mean	5219	23	0.4	10	2269.1	24	1.1

AIM: In case you have import glass eels, determine which are the donor countries and which is the destination of those.

NOTES:

- Donor Country: Country to whom the glass eel are bought;
- Source: source of the information regarding prices.

12.5.3 Reconstructed time-series on stocking

Table 12-12. Stocking of cultured and wild eel in country since 1984.

	LOCAL SOURCE					FOREIGN SOURCE				
Year	Glass eel (n)	Quarantined Glass (n)	Wild Yellow (n)	On-grown cultured (n)	Total	Glass eel (n)	Quarantined Glass (n)	Wild Yellow (n)	On-grown cultured (n)	Total GEE (n)
1953										
1954										
1955										
1956										
1957										
1958										

AIM: track the quantity and sizes of eels being stocked in order to assess the biomass (and mortality rates) derived from stocked eel.

NOTES:

- Local Source: The source of the stocked eels is local;
- Foreign Source: Eels come from another country;
- Split the stocked eels into the stages in the column headings, do not add anymore;

- Please, translate the number of Wild Yellow and on-grown cultured into GEE (Glass Eel Equivalents). If you are not able to do that, you must provide average size of stocked eels; and in case you have it, mortality rates and growth and/or age in order to make the transformation to GEE.

12.5.4 EMP stocking objective

Table 12-13. Eelland stocking objective in the EMP and its fulfilment.

		STOCKING OBJECTIVE		FULLFILLMENT	
EMU	Year	Stage	Number	Number	%
EMU_a	2012	Wild glass eel-fishery	15 000	10 000	66.7
EMU_a	2012	Ongrown cultured	10 000	5000	50.0
EMU_b	2012	Wild glass eel-fishery	15 000	10 000	66.7
EMU_b	2012	Glass eel quarantined	20 000	2344	11.7

AIM: determine whether the country has met the stocking measures provided in the EMP.

NOTES:

- EMU: EMU where the eels where stocked;
- Stocking Objective: Stage and number of eels that the EMP provided to use in stocking;
- Fulfilment number: Number of eels of a given stage that have been really stocked;
- Fulfilment %: % of the achievement of the stocking objective;
- Stage: Choose among the following ones, do not include any more:
    - Wild glass eel
    - Quarantined glass eel
    - Wild yellow
    - Ongrown cultured

12.6 Stocking indicator table

ICES (2010a, 2011) derived a framework for international assessment based on national/regional stock indicators, using four estimates (B_0, $B_{current}$, B_{best}, ΣA). This information was requested in the EU template for the Review of Eel Management Plans and is reported in the Annual Country Reports to WGEEL. WGEEL 2012 undertook a review of the stocking indicators and how they were created. This review was not designed to evaluate the stock indicators themselves, just the methods and reporting structure of the table. The recommendation of WGEEL 2012 was for a consistency and standardization in how the stocking indicators are created and reported.

Table 12-14. Stock indicators per EMU.

													(% of $B_{current}$ wetted area assessed)					
EMU_code	Year	Habitat type	B_0 Wetted Area	$B_{current}$ Wetted Area	B_0	$B_{current}$	B_{best}	∑F	∑H	∑A	R;Total Stocked glass eel	Date stamp for Data used to calculate Estimates	River	Lake	Estuary	Lagoon	Marine & Coastal	Inland Waters
	YYYY	River	ha	ha	kg	kg	kg	rate	rate	rate	kg	MM/YYYY	%	%	%	%	%	%
		Lake			ND	ND	ND				GEE							
		Estuary																
		Lagoon																
		Marine/Coastal																
		Inland Waters																
		Total																

Table glossary

- EMU: Eel Management Unit.
- Year: Year assessed (YYYY).
- Habitat: Habitat type assessed for stock indicators; River, Lake, Estuary, Lagoon, Marine & Coastal Waters, Inland Water, Total.
- B_0WetArea: Total natural wetted area available to eels (Hectares).
- $B_{current}$WetArea: Total wetted area currently accessible to eels (Hectares).
- B_0: The amount of silver eel biomass that would have existed if no anthropogenic influences had impacted the stock (tonnes).
- $B_{current}$: The amount of silver eel biomass that currently escapes to the sea to spawn (in the assessment year) (tonnes).
- B_{best}: The amount of silver eel biomass that would have existed if no anthropogenic influences had impacted the current stock (tonnes).
- ΣF: The fishing mortality rate, summed over the age groups in the stock, and the reduction effected.
- ΣH: The anthropogenic mortality rate outside the fishery, summed over the age groups in the stock, and the reduction effected.
- ΣA: The sum of anthropogenic mortalities, i.e. $\Sigma A = \Sigma F + \Sigma H$.
- R: The amount of glass eel used for restocking within the country, Glass Eel Equivalent (tonnes).
- Time Stamp: An indication into what year the analysis took place to act as a time stamp for improvements in the assessment method resulting in an update of the table.
- River: Proportion of rivers $B_{current}$ wetted area assessed in the creation of the stocking indicators (%).
- Lake: Proportion of lake $B_{current}$ wetted area assessed in the creation of the stocking indicators (%).
- Estuary: Proportion of estuary $B_{current}$ wetted area assessed in the creation of the stocking indicators (%).
- Lagoon: Proportion of lagoon $B_{current}$ wetted area assessed in the creation of the stocking indicators (%).
- Marine/Coastal Water: Proportion of marine or coastal water $B_{current}$ wetted area assessed in the creation of the stocking indicators (%).
- Inland Waters: Proportion of inland waters $B_{current}$ wetted area assessed in the creation of the stocking indicators (%).

12.7 Eel quality

The aim is to ensure that all the raw data have been included in the Eel Quality Database and the summary data are presented in the tables below.

In introduction to the section in each country there is a need to address the following:

- Whether or not your country is monitoring contamination or diseases in eel? And if yes how representative is the sampling of the EMU (e.g. is it a country wide assessment, specify the number of sites).
- Which contaminants or disease agents are assessed?

- Which organization(s) is responsible for the assessments?
- What is the periodicity of the assessments (annual, biannual, other)?
- Under what Framework have these assessment been undertaken (e.g. Water Framework Directive (Chemical quality in biota), Eel Regulation, DCF, controls in function of human health protection and sanitary control of fisheries products, other)?

12.7.1 Scientific work or monitoring of eel contamination and diseases

Provide an overview/abstract of recent reports and papers describing issues of eel quality (status, trends, effects of contamination and diseases) together with the full reference in the reference.

12.7.2 Closure of fisheries / recommendation to prevent consumption

Report, by EMU, where fisheries have been closed due to contamination, or if regulations or recommendations have been issued to prevent fishing/consuming eels due to contamination. If a fishery has been closed or consumption of eel banned, report the type and level of the contamination including the date and if available the reference of the decree.

12.7.3 New and ongoing research

Provide a brief summary of any new or ongoing research on contaminants and diseases, stating the objectives, research teams and period.

12.7.4 Reproductive Potential: Basic requirements for assessing the quality of the silver eels leaving your EMU/basins

By EMU, report the mean size (mm), percentage lipid and the sum of PCB28, PCB52, PCB101, PCB138, PCB153 and PCB180 (∑ 6 PCBs) (ng/g wet weight). Indicate analytical method for lipid measures. Include a reference, if available.

Table 12-15. Reproductive potential in silver eels per EMU.

EMU_CODE	SITE	YEAR	MALE				FEMALE			
			No. silver eels	Mean size (mm)	% Lipids	∑ 6 PCBs* (ng/g ww)	No. silver eels	Mean size (mm)	% Lipids	∑ 6 PCBs* (ng/g ww)

*** PCB28, PCB52, PCB101, PCB138, PCB153 and PCB180.**

12.7.5 Eel Quality Index: Basic requirements for assessing the quality of the yellow eels in your EMU/basins

By EMU, provide the mean size (mm), total wet weight of PCB28, PCB52, PCB101, PCB138, PCB153 and PCB180 (∑ 6 PCBs), *p,p'*-DDD, *p,p'*-DDT, *p,p'*-DDE (∑ DDTs), cadmium, lead and mercury (ng/g wet weight) of yellow eel. Include a reference, if available.

Table 12-16. Compilation of information to assess the quality of the yellow eels per EMU.

EMU_CODE	SITE	YEAR	SEX	N	MEAN SIZE (MM)	∑ 6 PCBS (NG/G WW)	∑ DDTS (NG/G WW)	CADMIUM (NG/G WW)	LEAD (NG/G WW)	MERCURY (NG/G WW)

12.7.6 Presence and abundance of *Anguillicola crassus*

By EMU, report the prevalence and abundance of *Anguillicola crassus* in yellow and silver eel, providing details of when the site was surveyed, the number and mean size of yellow and silver eel sampled and a reference (if available).

Table 12-17. Presence and abundance of *Anguillicola crassus* per EMU.

EMU_CODE	SITE	DATE/YEAR	YELLOW EEL				SILVER EEL			
			N	Mean size (mm)	Prevalence (%)	Abundance (n)	N	Mean size (mm)	Prevalence (%)	Abundance (n)

12.7.7 Incidental eel mortality (non-fishing)

By EMU, report and document the incidence of eel killed due to contamination or disease agents or from other causes other than fishing (e.g. Hydro, pumps, pollution incidents). Provide waterbody, date of the eel kill, biomass and/or numbers killed, suspected or known cause and a reference (if available).

Table 12-18. Non fishery incidental eel mortality per EMU.

EMU_CODE	SITE	DATE/YEAR	NO. OF EEL COUNTED	TOTAL WEIGHT OF EEL (KG)	SIZE RANGE		SUSPECTED CAUSE	REFERENCE
					min	max		

12.8 Management measures overview

Provide an overview of the management measures proposed and implemented in each EMU, grouped according to action type and subtype. For measures that do not fit into any of the action types, the option "other" is given. It should be indicated by colours, whether a measure was planned in the EMP and how its implementation is proceeding (green = planned and fully implemented, yellow = planned and partly implemented, red = planned and not implemented, grey = not planned). The habitat type of each EMU should also be indicated.

If available, quantitative information about the measures should be given directly in the corresponding field of the table (e.g. % of reduction of fishing effort, number of days per year for closure of fisheries, number of installed fish passes, etc.)

Please report the change in $B_{current}$ as a result of the management measures (% change since 2009).

Table 12-19. Colour code for management measures overview.

Colour	Meaning
(green)	PLANNED AND FULLY IMPLEMENTED
(yellow)	Planned and partially implemented
(red)	Planned and yet not implemented
(grey)	Not planned

Table 12-20. Management measures overview per EMU and habitat type.

ACTION TYPE	SUBACTION	EMU_CODE / HABITAT TYPE: EXAMPLE_A — RIVER
Commercial fishery	Reduction of silver eel fishing effort (%)	15
	Reduction of yellow eel fishing effort (%)	15
	Reduction of glass eel fishing effort (%)	
	Introduction of silver eel quota (kg)	
	Introduction of yellow eel quota (kg)	
	Introduction of glass eel quota (kg)	
	Introduce close season (days)	60
	Introduce/increase minimum size (from-to cm)	30–40
	Control and enforcement	
	Other	
Recreational fishery	Reduction of silver eel fishing effort (%)	15
	Reduction of yellow eel fishing effort (%)	15
	Reduction of glass eel fishing effort (%)	
	Introduce quota (kg)	
	Introduce catch and release	
	Introduce close season (days)	40
	Introduce/increase minimum size (cm)	None–40
	Control and enforcement	
	Communication and consciousness raising	
	Other	
Hydropower & obstacles	Assessment of barriers and their passability (number of sites)	
	Barriers screen (number of sites)	
	Installation of downward eel passes (n)	5
	Installation of upward eel passes (n)	5

ACTION TYPE	SUBACTION	EMU_CODE	EXAMPLE_A
		HABITAT TYPE	RIVER
	Trap and transport (kg)		
	Other		
Habitat improvement	Predator controll		
	Improve water quality (contaminants etc.)		
	Limit the spread of parasites and diseases		
	Identify and improve areas/measures for habitat restoration		
	Establish protected areas		
	Other		
Stocking	Wild glass eels stocked according to EMP (in GEE)		
	Quarantined glass eels stocked according to EMP (in GEE)		5464
	Wild yellow eel stocked according to EMP (in GEE)		8005
	On grown eel stocked according to EMP (in GEE)		6528
	Other		
Other management actions			
% change in $B_{current}$ since 2009			

12.9 Biological data

The main biological data needed for the International stock assessment are silver eel age (and length) and the sex ratio of the population, reviewed on annual basis.

12.9.1 Silver eel age

Table 12-21. Silver eel age (years) per EMU.

EMU_CODE	SITE	YEAR	FEMALE				MALE			
			N	Mean	Variance	Range	N	Mean	Variance	Range

12.9.2 Silver eel length

Table 12-22. Silver eel length (mm) per EMU.

EMU_CODE	SITE	YEAR	FEMALE				MALE			
			N	Mean	Variance	Range	N	Mean	Variance	Range

12.9.3 Silver eel sex ratio

Table 12-23. Silver sex ratio per EMU.

EMU_CODE	SITE	YEAR	N	PROPORTION FEMALE (%)

12.10 DCF (DC-MAP)/research reporting

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

Table 12-24. Summary of the DCF (DC-MAP) monitoring implementation per EMU.

Data	River	Lakes	Estuaries	Lagoons	Coastal & Marine
No. of production / escapement surveys[1]					
No. of recruitment time-series surveys[2]					
No. fished aged					
No. of fished sexed					
No. of fish examined for parasites					
No. of fish examined for contaminants					
No. of non-fishery mortality studies[3]					
Socio-economic survey					

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

[2] Fishery-independent surveys.

[3] Studies to determine ∑H for non-fisheries anthropogenic impacts, such as hydropower, barriers, predation, etc.

12.11 Appendix

12.11.1 Methods (Definitive scientific explanation enabling examination/repeat by others)

- Estimation of B_0, B_{best} and/or $B_{current}$, and mortality rate.

12.11.2 Estimate of B_0

Table 12-25. Reference period for B_0.

EMU_code	B_0 (kg/ha)	Reference time period	Whether or not changed from value reported last year (Y/N)

12.11.3 Management measures details

Detailed information about the single management measures, the progress of their implementation and their expected effect on the stock should be given for each EMU.

It should also be indicated whether a measure was planned in the original EMP or only since the EMP was approved.

Table 12-26. Detailed information of management measures.

EMU_CODE	ACTION TYPE (SEE TABLE 20)	SUB-ACTION (SEE TABLE 20)	DETAILED INFORMATION	PROGRESS OF IMPLEMENTATION (FULLY, PARTLY, NOT)	EXPECTED EFFECT ON THE STOCK	PLANNED IN THE EMP (Y/N)

12.11.4 Time-series data

Data of recruitment and landing (glass, yellow and silver eel) time-series should be presented here in the same way as in previous years.

12.11.5 Time-series fishing capacity

Please report time-series of number of licences sold by gear type and/or the number items of gear licenced. For example one person may be licensed to fish with fykenets (one licence) but the person fished with 50 double-ended fykenets (100 fykenet ends).

12.11.6 Publications/reports

12.12 Subgroup conclusion

WGEEL notes a critical need for improvement in the quality and consistency of data reporting at the national and EMU level. Variability of reporting standards, level of detail and coverage restricts the scope and value of international evaluation of the eel stock, and limits our ability to provide management advice for the eel stock.

Recommendation

WGEEL proposes standardization of data table formats for use in country reports. The standardization of country report tables is offered as a format which will facilitate national reporting to all international *fora* requiring eel data. The long-term objective of such standardization is to facilitate the creation of an international database of eel stock parameters updated annually.

13 Forward Focus of the WGEEL

Background

This report is a further step in an ongoing process of documenting stock and fisheries of the eel (*Anguilla anguilla*) and developing methodology for giving scientific advice on management to effect a recovery in the European eel stock. In 2007, a European plan for recovery of the stock was adopted by the EU Council of Ministers (Council Regulation No. 110/2007). In accordance with this plan, Member States developed Eel Management Plans (2008 and onwards) for the stock on their territory, aiming at a silver eel (spawner) escapement of at least 40% of the silver eel biomass relative to the best estimate of escapement that would have existed if no anthropogenic influences had impacted the stock. In July 2012, Member States reported on the actions taken, the reduction in anthropogenic mortalities achieved, and the state of their stock relative to their targets. In May 2013, ICES evaluated these progress reports in terms of the technical implementation of actions (WKEPEMP). In September 2013, ICES assessed the current status of the whole European eel stock (WGEEL 2013). By the end of 2013, the EU Commission will present a report to the European Parliament and the Council with a statistical and scientific evaluation of the outcome of the implementation of the Eel Management Plans, and recommendations for modifications to EC 1100/2007 to achieve the recovery of the eel stock. During the 2nd half of 2013, the Fisheries Committee (PECH) has considered recommendations for modifications to EC 1100/2007. In 2015, Member States will again report on progress with implementing their eel management plans, and the cycle will repeat.

Development of the assessment approach

In recent years, ICES has advised on the state of the stock; has provided technical consultations of the national management plans; and has developed a methodology for international post-evaluation based on national status reports.

The WGEEL 2013 presents three approaches (tiers) to the international stock assessment: an index based assessment (recruitment; possibly older yellow and/or silver eel in future); the modified Precautionary Diagram derived from EU and ICES targets; and, reference points based on the stock–recruitment relationship. The future development of ICES advice on the international stock status, and associated data collection and analysis, depends on which of these approaches are supported/adopted by ICES. Hence, the future focus of WGEEL depends somewhat on this decision.

The index and stock–recruitment approaches are based on monitoring data collected by the countries and reported to the WGEEL every year, and therefore these assessments can be updated annually. The modified Precautionary Diagram is based on the biomass and mortality rate stock indicators reported by the countries in their periodic EMP Progress Reports. The 2007 version of the Eel Regulation sets a reporting period of three years, with the first having been in 2012. Therefore, this assessment can be updated every three years (or as frequently as updates to the stock indicators are reported; amendments to the Regulation proposed in 2013 include increasing this reporting frequency to every two years).

The frequency of international stock assessments therefore depends on the approaches adopted by ICES.

However, none of the three assessment approaches is ideal. The trend based assessment is the simplest approach: using a minimum of data (trend in recruitment only), the current status and trend are compared to reference points based on the past. This assessment confirms the critical state of the stock; the promising increase in recruitment observed this year is set in historical perspective, but no prediction can be generated, and no evaluation of the implemented stock protection measures achieved. The recruitment increase may or not be the result of protective measures (alternatively, it just reflects an unidentified external effect); the implemented protection may or not be adequate; in the trend-based assessment, there is no way to tell.

The stock indicators approach, which follows ICES standards for fish, suffers for eel because of unreported stock indicators from many EU countries, and all non-EU countries within its natural range, and the inconsistencies and lack of quality control in the reported stock indicators. During the (inter)national assessments in 2013 (WKEPEMP, WGEEL) the stock indicators provided by the MS were assumed to be correct and complete and used in the Precautionary Diagram assessment in "good faith" without any independent quality check of Data, Model and Indicators. However, "a broad brush" quality check of indicators (WGEEL 2012; WKEPEMP 2013) clearly demonstrated a wide range of problems with the stock indicators used in 2013 that can be summarized as (1) missing values and (2) inconsistencies in approach. Furthermore, the natural range of eel extends considerably outside the EU and biomass and mortality stock indicators from these countries are lacking.

Before the evaluation in 2015, these issues will need to be resolved. In the first place the important missing countries along the Mediterranean will need to be involved, and the GFCM could be in a position to help with this task.

The stock–recruitment approach suffers from the fact that the landings data used are reported to be incomplete and less-reliable, and many experts pointed at the uncertainty of quantitative conjectures on exploitation rates for years almost gone out of living memory. The use of these extra data allows the derivation of eel-specific reference points, but at the costs of uncertainties in data and processes. Some of the above mentioned issues of the three assessment methods can be addressed, given time, resources, planning and coordination.

A decision needs to be made as to whether ICES accepts any or all of the three assessment approaches presented here, supports calls for a thorough independent review of the methods used to develop national stock indicators, or that the standard ICES approach to assessing shared marine stocks, a coordinated data collection programme supporting a single international assessment, will be pursued. Alternatively, countries run a standardized assessment method, using standard data and analysis.

This ICES-standard approach could be developed for the European eel, adopting a standardized international data collection (e.g. based on WFD fish monitoring modified to be eel-specific, International Bottom-Trawl Survey, Demersal Fish Survey) and analysis to support the international stock assessment. Note this international data collection and analysis would not replace the local stock assessment (which is necessary to support local management). If the international data collection and analysis approach is supported by ICES, **there is an urgent need for planning (data exchange and methodologies), and for tuning expectations and opportunities**. The urgency of this requirement and the size of the task are such that it should be pursued **outside** the normal annual cycle of the WG.

If the international assessment based on national stock indicators continues, there is an urgent requirement to test, and where necessary improve, the quality of data and analyses used in deriving these stock indicators (independent review). This too requires urgent planning and coordination before 2015.

A full international stock assessment should include data from all parts of the natural range of European eel. There is an urgent requirement, therefore, to support the development of suitable assessment data in the remainder of the productive range of the European eel.

Mortality vs. biomass indicators

Due to the long lifespan of eel it will take at least 5–10 years before the effect of a management measure impacting on the glass eel or yellow eel stage will be visible in the estimate of escapement biomass. In contrast, the impact of management actions on mortality indicators is visible immediately.

It will be in line with the conventional ICES procedure and the modified Precautionary Diagram to focus on immediate effects (mortality indicators A, F and H), ignoring the inherent time-lag in spawner escapement (biomass indicator).

Defining mortality targets and trajectories to reduce mortality to achieve standard ICES targets within a defined time period would improve the chance of recovering the eel stock.

Time line of eel assessments 2012–2018, to inform the Forward Focus

Note the following assumes that it takes more than six months to evaluate progress reports, propose and deliver changes to the Regulation.

YEAR	MANAGEMENT		ASSESSMENT TIERS		
	Regulation	EMPs	Indices	Stock Indicators	Stock recruitment
			Independent of EU	*Dependent on EU*	*Independent of EU*
2012		Progress Reports	Annual updates to time-series		
2013	Evaluate Progress Reports, propose new Reg from 2013 stock assessment		Annual updates to time-series	Using stock indicators from the 2012 progress reports	Annual updates to recruitment and landings
2014	Update Regulation		Annual updates to time-series	No change, unless the EU targets change	Annual updates to recruitment and landings
2015		Progress Report, maybe revised EMPs because of changed Regulation	Annual updates to time-series	New assessment, using stock indicators 2015 (assuming WGEEL in autumn)	Annual updates to recruitment and landings
2016	Evaluate Progress Reports, propose new Reg from 2015 assessment		Annual updates to time-series	No change, unless the EU targets change	Annual updates to recruitment and landings
2017	Update Regulation		Annual updates to time-series	No change, unless the EU targets change	Annual updates to recruitment and landings
2018		Progress Report, maybe revised EMPs because of changed Regulation	Annual updates to time-series	New assessment, using stock indicators 2018 (assuming WGEEL in autumn)	Annual updates to recruitment and landings

Conclusion: the EU requires the next international stock assessment in 2015, and then another in 2018, to inform the evaluation of the Regulation. Annual assessments in between are useful for monitoring the trend in status.

In summary, the Forward Focus of WGEEL will be to

- Fill the data gaps inside and outside the EU within the natural range of the European eel;
- Press for standardized data collection and the review of the quality of national assessments;
- Consider standardization and unification of the international assessment process;
- Develop the focus of assessments on the pragmatic use of mortality indicators (immediate impact) as intermediate or short-term goals, leaving biomass indicators (long-term impact) for the longer-term goals.

14 Research needs

As noted throughout the WGEEL 2013 report, there are a lot of data and knowledge deficiencies that hinder stock assessment (at local, national and international levels), identification and quantification of impacts (natural and anthropogenic), and the development and implementation of locally and internationally effective management measures. WGEEL 2012 summarized the research needs outstanding to address these deficiencies, and made suggestions for those which could be addressed at national or international scales. These research needs remain outstanding, so are repeated below, along with more details of required research on eel quality, its impact on stock dynamics and its integration into quantitative assessments.

International Stock Assessment of the Eel Stock in support of the EU Regulation for Eel Stock Recovery

Mortality based indicators and reference points routinely refer to mortality levels assessed in (the most) recent years. ICES (2011) noted that the actual spawner escapement will lag behind, because cohorts contributing to recent spawner escapement have experienced earlier mortality levels before. As a consequence, stock indicators based on assessed mortalities do not match with those based on measured spawner escapement. There is therefore, a need for both biomass and mortality reference points.

The diverse range of data collection and analysis methods used by MS to estimate their stock indicators, and the uncertainties associated with extrapolating from local to national stock assessments mean that there are inevitable but so far unquantifiable levels of uncertainty in the national and stock-wide assessments. These uncertainties need to be addressed at local, national and international levels, either through standardization of methods, setting minimum standards for data and methods (cf DCF), or both. Each of the following research needs should address and facilitate standardization wherever possible.

Biomass/density assessment

- An international calibration and standardization of eel standing stock estimates. Calibration between electro-fishing streams, cpue in lakes, estuaries, and other large waterbodies; standardization and intercalibration between methods. Links to DCF, WFD and EU Regulation.
- A coordinated programme of work should be undertaken to address the assessment of densities or standing stock of eels in large open waterbodies, such as lakes, deep rivers, transitional and coastal waters; this is a suitable topic for an international "Pilot Study" under the DC-MAP. Links to SGAESAW, DCF, WFD and EU Regulation;
- An international pilot study under the auspices of the new DC_MAP is required to establish minimum standards for data collection on the basis of current expert judgement; to analyse achieved precision levels where adequate databases exist; and to stimulate further analysis when and where more data become available within the framework of the DC-MAP.
- An EU-wide approach to assessing stocking and determining net benefit to the stock. Links to EU traceability, CITES, EU Regulation and ICES advice.

- Assess whether density-dependent influences (DD) on eel population dynamics occur at the local level and whether DD will play a role at the continental scale in the decline/recovery of the eel stock.
- International surveys at sea of eel in the spawning area in the Sargasso Sea. Links to DCF.

Mortality assessment

- The stock response to implemented management actions, in terms of silver biomass, will be slow and difficult to monitor. There is a need for developing methods for quantifying anthropogenic mortalities and their sum 'lifetime mortality' and estimating same across Europe. Links to DCF, WFD, EU Regulation. WKESDCF recommends that the new DC-MAP should include support for the collection of data necessary to establish the mortality caused by non-fisheries anthropogenic factors.
- It is recommended that research to investigate factors that cause Natural Mortality (M) to vary in space and time be given the high priority. Thus further data collection and research should be encouraged to support and improve the knowledge of this difficult research topic in order to obtain more and more reliable stock assessments.

Eel Quality

WGEEL 2013 recommends initiating an internationally coordinated research project with the aim to improve the understanding and quantification of the effects of contaminants on the reproductive success of the European eel for integration in stock wide assessments.

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Annex 2: Agenda, timetable and meeting tasks

Agenda for Joint EIFAAC/ICES WGEEL 2013 in Sukarrieta

Sunday 17th March

Meeting of task leaders in the afternoon 17:00–19.00

Monday 18th March

9.00	Get organized
9.30–10.00	Welcome by MDG; Local Welcome & Information by Esti and Lorezo Motos Director Marine research Division AZTI-Tecnalia
10.00–10.15	Intro to Working Group, ToR, EIFAAC, GFCM, etc. MDG
10:15–10:30	Regional Coordination; update GFCM, evaluation EMPs ICES
10.30–10:45	Coffee
10.45–11.00	Task 1; introduced by Klaus and Alan
11.00–11.15	Task 2; introduced by Fabrizio and Miran
11.15–11.30	Task 3; introduced by Willem and Cedric (& summary history)
11.30–11.45	Task 4; introduced by Laurent and Patrick (& summary history)
11.45–12.00	Task 5; introduced by Uwe and Derek
12.00–12.30	Questions and organization
12.30–13.30	Lunch
14.30–18.00	Break-out into Task Groups
17.00–18.00	Plenary (Task Leaders); plan of attack, gaps, etc.

Tues 19th March

9:00–12:30	Task Groups breakout
12:30–13:30	Lunch
13:30–16:00	Task Groups breakout
16:00–18:00	Plenary (whole group)

Wed 20th March

9:00–12:30	Task Groups breakout
12:30–13:30	Lunch
13:30–16:00	Task Groups breakout
16.00–18.00	Plenary (whole group)
18:00–late	Social programme (visit maritime museum, dinner, drinks)

Thurs 21th March

9:00–12:30	Task Groups breakout

	Task 1 and Task 2 provide stock indicator Table to Task 3
	Draft conclusions and recommendations **[DEADLINE 12:30]**
12:30–13:30	Lunch
13:30–18.00	Producing draft report [**DEADLINE 18:00**]
Evening	Circulate draft report for comment

Fri 22th March

9.00–11:00	Review recommendations and conclusions
11.00–12:30	Review report
12:30–13:30	Lunch
13:30–18:00	Review report

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Work plan Spring Meeting 18–22 March 2012 ToRs

d) Complete the broad-brush quality assurance checking of the reported Eel Management Unit biomass and mortality estimates, and prepare the data for the international stock assessment;

e) Provide a summary report on the reported data and stock indicators and the quality assurance of the indicators;

f) Provide a first compilation of the best available biomass and mortality data, along with additional data from the Baltic and GFCM areas;

g) Further develop the S/R relationship and reference points, following the ICES peer-review, and using the latest available data.

Task 1: Quality check (completeness) reported EMU biomass and mortality estimates (Task 2), provide an overview of reported stock indicators and prepare the reported stock indicators for assessment (Task 3) (ToR d & e) led by Klaus and Alan

- Compile a table of reported (in 2012 reports to EU) and missing stock indicators before and after implementation of the EMP in each EMU.
- Compile a table with reported and derived (see Task 2) stock indicators for Task 3.
- Provide an overview of the completeness of reported stock indicators (e.g. are all waters included, etc.); continuation of the work started at WGEEL 2012 (Klaus's Table WGEEL 2012).
- Provide a basic insight of the "strengths & weaknesses" of the models used to estimate the stock indicators (Alan's Table WGEEL 2012).

Task 2: Development of a practical, conservative methodology for "filling in" missing stock indicators ("Bs&As) (ToR f) led by Fabrizio and Miran

- Develop and clearly document a robust protocol for deriving "missing" biomass stock indicators.
- Develop and clearly document a robust protocol for deriving "missing" mortality stock indicators.

Task 3: Compilation biomass and mortality estimates (*reported and derived*) for European Eel into a database for the stock assessment in the September meeting (ToR f) led by Willem and Cedric

- Conduct preliminary assessment (precautionary diagrams by EMU, by country and for the whole stock) of the European Eel stock using the tables in Task 1 (reported and derived stock indicators) and an evaluation of the EU Regulation for recovery of the eel stock (EC No. 1100/2007) using the protocols developed in Chapter 9.6 of WGEEL 2012.

Task 4: Development of S/R relationship and reference points (ToR g) led by Laurent and Patrick

- Continue the development of reference points and S/R relationship started at WGEEL 2012, incorporating the comments by the Review Group (Chapters 4, 8, 9 2012 WGEEL report).
- Re-examine the data going into the S/R, such as the recruitment time-series and the landings data, incorporating the comments by the Review Group (Chapters 4, 8, 9 2012 WGEEL report).

Task 5: Prepare an overview of the planned and implemented management actions in each EMU led by Uwe, Eva and Derek

- Prepare and tabulate an overview of management targets for each EMU and their progress based on the available MS evaluation report.

Agenda for Joint EIFAAC/ICES WGEEL 2013 in Copenhagen

Tuesday 3th September

Meeting of task leaders in the afternoon 15:00–19.00

Wednesday 4th September

09.00	Get organized
09.30–10.00	Welcome by MDG
	Local welcome and information by Helle Gjeding Jørgensen
10.00–10.15	Intro to Working Group, ToR, EIFAAC, GFCM, etc. MDG
10:15–10:30	Regional Coordination; updates from GFCM, WKEPEMP, BALTIC
10.30–10:45	Coffee
10.45–11.00	Task 1; introduced by Thomas
11.00–11.15	Task 2; introduced by Hakan
11.15–11.30	Task 3; introduced by Claude
11.30–11.45	Task 4; introduced by Miran
11.45–12.00	Task 5; introduced by Willem
12.00–12.30	Questions and organization of people among tasks
12.30–14.00	Lunch

Country Report Highlights (10 min per Country)

14.00–14.30	Norway, Sweden, Estonia
14.30–15.00	Latvia, Lithuania, Poland
15.00–15.30	Denmark, Germany, Netherlands
15.30–15.45	Coffee
15.45–16.15	Belgium, United Kingdom, Ireland
16.15–16.45	France, Spain, Portugal
16.45–17.30	Morocco, Italy, Canada, Discussion
17.30–18.00	Plenary (Task Leaders); plan of attack, gaps, subgroups.

Thursday 5th September

09:00–18:00	All Task Groups breakout
18:00–19:00	Subgroup/Task leaders' coordination meeting

Friday 6th September

09:00–16:00	All Task Groups breakout
16.00–18.00	Plenary (whole group; decisions on what goes in/out e.g. name/shame)

Saturday 7th September

09:00–18:00	All Task Groups breakout

Sunday 8th September

09:00–11:00	Task Leaders Draft Advice, conclusions and recommendations
09:00–18:00	All Task Groups breakout
18:00	Circulate Draft Advice for comments

Monday 9th September

09:00–12:00	All Task Groups breakout
12:00	**DEADLINE DRAFT REPORT to Chairs**
12:00–16:00	Chairs prepare report for review
16:00–18:00	Reading report

Tuesday 10th September

09:00–13:00	Review report
14:00–15:30	Discuss and agree main conclusions, and agree Technical Advice draft
15:30–16:00	Outstanding issues
16:00	Close Working Group

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Work plan Autumn Meeting 4–10 September 2013 ToRs

h) Evaluate the EU Regulation (EC No. 1100/2007) and its consistency with the precautionary approach, following the plan developed in WGEEL 2012;

i) Apply the reported biomass and mortality data to the precautionary diagram using PA limits and the EU Regulation derived target/limits if different (WGEEL 2011) and provide appropriate advice on the state of the international stock and its mortality levels;

j) assess the latest trends in recruitment, stock (yellow and silver eel) and fisheries, including effort, 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). Update international databases for data on eel stock and fisheries, as well as habitat and eel quality (EQD) related data;

k) In conjunction with WGBEC and MCWG, review and develop approaches to quantifying the effects of eel quality on stock dynamics and integrating these into stock assessments. Develop reference points for evaluating impacts on eel;

l) Respond to specific requests in support of the eel stock recovery regulation, as necessary:

Task 1: Data and Trends (ToR J) led by Tomasz Nermer

Update data *A. anguilla* time-series for glass eel, yellow eel and silver eel and include time-series for *A. rostrata*: recruitment, commercial and recreational fishery, scientific time-series, aquaculture and stocking (see Task 2). Also report on Total Catches x life stage; Include New Areas: e.g. GFCM, North America if the data are available. Analysis of trends in recruitment, catch, etc. Data Quality issues. Data problems due to changes in management, quota, etc.

Task 2: Glass Eel Data & Stocking in Eel Management Plans (ToR J) led by Håkan Wickström/ Derek Evans

For the 2012/2013 Glass Eel Fishing Season Assess quantities x destination of glass eel caught in the commercial fishery, exported to Asia, exported to EU Countries, used in stocking, used in aquaculture for consumption, consumed direct and mortalities. Assess where possible "movement through" countries and match up import/exports. Compare with the commitments to stocking in the EMPs (use stocking data supplied in ICES review Table).

With recent developments in stocking, including quarantine and on-rearing it is getting more difficult to track the quantity and sizes of eels being stocked. This information will be required for assessing the biomass (and mortality rates) derived from stocked eel. This task should reconstruct the time-series of stocked eel into different categories: split restocking categories into (local or foreign) by (glass eel, quarantined glass eel, wild bootlace, cultured eels); not all combinations will exist. Where possible, this reconstruction of the time-series should be retrospective as well as current and future.

Revisit and update the "use" of stocking glass eel.

Task 3: Quality of eel stocks and effective SSB (ToR J, K) led by Claude Belpaire

Develop a framework for integrating quality of eel factors in local stock assessments. Apply knowledge of eel quality to local stock assessments on: Impact on local yellow eel stocks, impact on silver eel biomass and impact on effective SSB. In conjunction with WGBEC and MCWG, review and develop approaches to quantifying the effects of eel quality on stock dynamics and integrating these into stock assessments. Develop reference points for evaluating impacts on eel.

Update information on LD50s, threshold values, quality indices (e.g. silvering (eye, fin, colour), fat levels, Anguillicoloides) and EELIAD.

Task 4: Local Stock Assessment and Indicators (ToR I) led by Miran Aprahamian

Task 4a: Compile EMU biomass and mortality estimates, and an overview of their quality

Compile a table of reported (in 2012 reports to EU and EU Data call) and missing stock indicators before and after implementation of the EMP in each EMU (Update tables from WKEPEMP).

Provide an overview of the completeness of reported stock indicators (e.g. are all waters included, etc.); continuation of the work WGEEL 2012 and March 2013. Provide a basic insight of the "strengths & weaknesses" of the methods used to estimate the stock indicators.

Task 4b: Develop an improved format for the 2015 Progress Reports

Confirm what data and information must be reported, and the reporting rules (units, methods, language, etc.). Design a spreadsheet reporting template (starting with the WKEPEMP evaluation form).

Develop new country reports which feed into the Progress Reports. Link with ICES database?

Develop guidelines for how indicators are calculated (ref SLIME, POSE, etc.), including Guidelines for calculating eel mortality indicators (update WGEEL 2011 Chapter 4.2).

Task 5: International Stock Assessment & post-evaluation (ToR I, H) led by Willem Dekker/Laurent Beaulaton

Conduct assessment (precautionary diagrams for the whole stock) of the European Eel stock and an evaluation of the EU Regulation for recovery of the eel stock (EC No. 1100/2007) using:

a) Glass eel time-series

Revisit WGEEL 2011; Chapter 2.2 “Power to detect a change in the trend (of recruitment)”. Assuming that the increased catches of glass eel this season are uniform, ICES needs to advise on how many more years are required before we can say with statistical confidence that the recruitment is increasing. Develop new diagram (R vs. dR/dT, moving average 1,3,5,1o average lifespan).

b) Stock–recruitment relationship

Continue the development of reference points and S/R relationship started at WGEEL 2012, incorporating the comments by the Review Group (Chapters 4, 8, 9 2012 WGEEL report). Re-examine the data going into the S/R, such as the recruitment time-series and the landings data, incorporating the comments by the Review Group (Chapters 4, 8, 9 2012 WGEEL report).

c) Stock indicators and Precautionary Diagram

Discuss the issues of MS not reporting indicators and “missing” non-EU countries.

Annex 3: WGEEL terms of reference for 2014 Meeting

The **Working Group on Eels** (WGEEL), chaired by Martin de Graaf, Netherlands and Alan Walker, UK, will meet in (details to be determined) 2014 to:

a) Assess the latest trends in recruitment, stock and fisheries, including effort, indicative of the status of the European stock, and of the exploitation and other anthropogenic factors;

b) Further develop the stock–recruitment relationship and associated reference points, using the latest available data;

c) Work with ICES DataCentre to develop a database appropriate to eel along ICES standards (and wider geography);

d) Review the life-history traits and mortality factors by ecoregion;

e) Explore the standardization of methods for data collection, analysis and assessment;

f) Respond to specific requests in support of the eel stock recovery regulation, as necessary;

g) Report to ACOM on the state of the international stock and its mortality levels; and

h) Address the generic EG ToR from ACOM.

WGEEL will report by (details to be determined) November 2014 for the attention of ACOM, WGRECORDS, SSGEF and FAO, EIFAAC and GFCM.

Supporting Information

Priority	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. In its Forward Focus (2011), WGEEL mapped out a process for post-evaluation of the EU Regulation, based on 2012 reporting to the EU by Member States, including an international assessment of the status of the stock and the levels of anthropogenic mortalities. The 2012 and 2013 meetings of WGEEL were the first step in this process. The WGEEL meetings in 2013 highlighted the following main issues: -lack of standardization of the methods used by MS to estimate the required stock indicators -lack of quality assessment of the assessment methods and reported stock indicators -incomplete reporting by MS of the required stock indicators to the EU in 2012, and to ICES in 2013 -lack of stock indicators of countries that are outside the EU but inside the natural range of the European eel (i.e. north African countries) In its Forward Focus (2013), WGEEL mapped out a process how (some of) the current limitations of the assessment process could be improved before the next EMP evaluation in 2015. In order to complete the international stock assessment, countries must be committed to this process in order for it to succeed. The international assessment would be improved if it could include information from outside the EU. ICES and the WG will continue to work with relevant countries and umbrella institutions (e.g. GFCM) to facilitate the provision of these indicators.

Scientific justification	European eel life history is complex and atypical among aquatic species. The stock is genetically panmictic and data indicate random arrival of adults in the spawning area. The continental eel stock is widely distributed and there are strong local and regional differences in population dynamics and local stock structures. Fisheries on all continental life stages take place throughout the distribution area. Local impacts by fisheries vary from almost nil to heavy overexploitation. Other forms of anthropogenic mortality (e.g. hydropower, pumping stations) also impact on eel and vary in distribution and local relevance. Exploitation that leaves 30% of the virgin spawning–stock biomass is generally considered to be a reasonable target for escapement. The EC Regulation set a limit for silver eel escapement to the sea of at least 40 % of the silver eel biomass relative to the best estimate of escapement that would have existed if no anthropogenic influences had impacted the stock. WGEEL (ICES, 2010a; Annex 5) recommended that Eel Management Plan reporting must provide the following biomass and anthropogenic mortality data: -B_{post}, the biomass of the escapement in the assessment year; -B_o, the biomass of the escapement in the pristine state. Alternatively, one could specify B_{lim}, the 40% limit of B_0, as set in the Eel Regulation; -B_{best}, the estimated potential biomass in the assessment year, assuming no anthropogenic impacts (and without stocking) have occurred and from all potentially available habitats. -$\sum A$, the estimation of B_{best} will require an estimate of A (anthropogenic mortality (e.g. catch, turbines)) for density-independent cases, and a more complex analysis for density-dependent cases. Most but not all EU Member States reported quantitative estimates of the required stock indicators to the EU in 2012. The reliability and accuracy of these data have not yet been fully evaluated. Furthermore, the stock indicators of all non-European countries that lay within the natural range of the European eel are lacking.
Resource requirements	Sharepoint; Access to the EU Commission evaluations of EMP progress reports.
Participants	ICES, GFCM and EIFAAC Working Group Participants, Invited Country Administrations, EU representative, Invited specialists
Secretariat facilities	Support to organize the logistics of the meeting.
Financial	At countries expense
Linkages to advisory committees	ACOM
Linkages to other committees or groups	WGRECORDS, SCICOM, SSGEF
Linkages to other organizations	FAO EIFAAC, GFCM, EU DG-MARE, EU DG-ENV

Annex 4: Recommendations

Recommendation	Adressed to
1. Internationally coordinated project to achieve standardization of data, analysis and assessment.	ICES / EU
2. Joint Workshop of the Working Group on Eel and the Working Group on Biological Effects of Contaminants will be established under the subject "Are contaminants in eels contributing to their decline?"	SCICOM, WGRECORDS
3. Workshop of a Planning Group on the Monitoring of Eel Quality under the subject "Development of standardized and harmonized protocols for the estimation of eel quality."	SCICOM, WGRECORDS
4. Internationally coordinated project on the effects of contaminants on the reproductive potential of eel (dose-effect relationship) in order to quantify the effects of contaminants in the assessment.	EU, SCICOM

Annex 5: Planned Workshop WKBECEEL ToRs 2015

Joint Workshop of the Working Group on Eel and the Working Group on Biological Effects of Contaminants (WKBECEEL) will be established under the subject "Are contaminants in eels contributing to their decline?" WKBECEEL will be chaired by Claude Belpaire and John Thain, and will meet in 2015 (location and dates to be determined) to:

a) To describe the spatial and temporal trends in concentrations of "traditional" and/or "emerging" contaminants in eel (but mainly refer to figures available from WGEEL 2008–2013);

b) To describe the potential impacts of contaminants on reproduction in the European eel; based on science of eel and what can be learned from other species models (including endocrine disruption, effect on sex ratio, maternal transfer of bioaccumulated contaminants toward the eggs and effects on the larvae);

c) To describe the potential impacts of contaminants on lipid metabolism and migration in the European eel based on eel science and what can be learned from other species;

d) To review the impacts of contaminants on the genetics of the European eel;

e) To explore whether there is experience with assessing/qualifying the bioaccumulation + fitness status in other species, which can be helpful for the eel's quality assessment (Eel Quality Index) and to quantify the impact of eel quality.

WKBECEEL will report by DATE for the attention of WGEEL, WGRECORDS and SCICOM.

Supporting information

Priority	During previous meetings WGEEL (2008–2013) made considerable progress in understanding and describing the potential impact of contaminants on the European eel stock. During the last sessions WGEEL 2012 and WGEEL 2013 indicated that the WG would clearly benefit from a joint cooperation with experts from other ICES WGs, and specifically WGBEC. The experience and knowledge concerning the effect of contaminants in other species, as present within WGBEC, is anticipated to be very beneficial to make further progress in understanding the role of contaminants in the eel stock decline.
Scientific justification	The stock of the European eel *Anguilla anguilla* is in decline and there is an increasing awareness that poor health status due to contaminants might be a key element in this decline and might be a hindrance to recovery. Several studies have recently been initiated to study the degree and the effects of pollution on the eel, resulting in an increasing quantity of information that demonstrates the negative impact of pollution on eel. These advances in the science of the effects of contaminants on the eel have been reviewed recently (e.g. Geeraerts *et al*., 2011; by Elie and Gerard, 2009, and WGEEL 2008–2012). However, essential issues to assess the importance of eel quality for reproductive success, such as to evaluate the effect of specific contaminants on the ability for eel to migrate and to reproduce have still to be developed. The joint workshop will review all sources of information (including work on other species) to better understand how contaminants in eels contribute to their decline.
Resource requirements	
Participants	WGEEL and WGBEC Working Group participants, and other experts. The Workshop is anticipated to be attended by some 15–20 members and guests.
Secretariat facilities	Sharepoint
Financial	
Linkages to advisory committees	WGEEL,WGBEC and ACOM
Linkages to other committees or groups	WGRECORDS, SSGEF, SCICOM
Linkages to other organizations	FAO EIFAAC, GFCM, EU DG MARE, EU DG ENV

Annex 6: Planned Workshop WKPGMEQ ToRs 2014

Workshop of a Planning Group on the Monitoring of Eel Quality under the subject "Development of standardized and harmonized protocols for the estimation of eel quality." (WKPGMEQ) will be established and chaired by Claude Belpaire (BE) and (to be determined), and will meet in 2014 (location and dates to be determined) to:

a) Design standardized and harmonized protocols for the estimation of eel quality with regard to the bioaccumulation of contaminants (including sampling, analysis and reporting);

b) Design standardized and harmonized protocols for the estimation of eel quality with regard to diseases (including sampling, analysis and reporting).

WSPGMEQ will report by DATE for the attention of the SCICOM.

Supporting information

Priority	WGEEL 2012 stated that to improve the assessment of the impact of contaminants and diseases on effective spawner biomass and reproductive success of European eel, monitoring programmes are urgently required to provide a standard suite of data across the productive range of the species. The EC Eel Regulation (1100/2007) does not refer to the health status of the population of European eel or possible impacts on the population due to contamination and diseases. Hence, regular monitoring programmes for eel are neither run nor reported to the EU. WGEEL 2012 recommended that Member States implement routine monitoring of lipid levels, contamination and diseases, but also identified the need to develop standardized and harmonized protocols for the estimation of eel quality. As the standard data need to be collected across many countries, this requires a standard monitoring programme developed internationally. Therefore, in 2014 WGEEL will organize a Workshop of a Planning Group on the Monitoring of Eel Quality, including contaminants and diseases, in order to integrate eel quality parameters in quantitative assessment of the reproductive potential of the stock.
Scientific justification	Reliable assessment of the eel stock quality and its quantitative effect on the reproductive stock is currently not possible, due to insufficient spatial and temporal coverage of eel quality information. WGEEL (2009) emphasized the need to establish a comprehensive overview with improved spatial coverage of the quality of the eel population across Europe as an essential and urgent requirement. Many countries have started compiling data on the health status of eels in their water bodies, but the objectives for these monitoring actions are diverse and there is a large amount of information collected by EU member countries. However, procedures with respect to sampling, analysis and reporting are not harmonized, jeopardizing stock wide assessments and potentially leading to a large investment in collecting data that are not suitable for the international assessment process.
Resource requirements	
Participants	WGEEL Participants, other experts/representatives from member states
Secretariat facilities	Sharepoint
Financial	

Linkages to advisory committees	WGEEL and ACOM
Linkages to other committees or groups	WGRECORDS, SCICOM
Linkages to other organizations	FAO EIFAAC, GFCM, EU DG MARE, EU DG ENV

Annex 7: Tables for Chapter 9

Table 9-1. Description of the recruitment-series. Series updated to 2013.

REC_NAMESHORT	LOC_NAME	LOC_COUNTRY	LOC_AREA	REC_LFS_NAME
Ring	Ringhals scientific survey	Sweden	North sea	glass eel
Stel	Stellendam scientific estimate	Netherlands	North sea	glass eel
Yser	Ijzer Nieuwpoort scientific estimate	Belgium	North sea	glass eel
YFS2	IYFS2 scientific estimate	Sweden	North sea	glass eel
SeEA	Severn EA commercial catch	UK	British Isle	glass eel
SeHM	Severn HMRC commercial catch	UK	British Isle	glass eel
ShaA	Shannon Ardnacrusha trapping all	Ireland	British Isle	glass eel + yellow eel
Albu	Albufera de Valencia commercial catch	Spain	Mediterannean Sea	glass eel
Nalo	Nalon Estuary commercial catch	Spain	Atlantic Ocean	glass eel
Feal	River Feale	Ireland	Atlantic Ocean	glass eel + yellow eel
RhDO	Rhine DenOever scientific estimate	Netherlands	North sea	glass eel
RhIj	Rhine IJmuiden scientific estimate	Netherlands	North sea	glass eel
Katw	Katwijk scientific estimate	Netherlands	North sea	glass eel
MiPo	Minho portugese part commercial catch	Portugal	Atlantic Ocean	glass eel
Lauw	Lauwersoog scientific estimate	Netherlands	North sea	glass eel
Ebro	Ebro delta lagoons	Spain	Mediterannean Sea	glass eel
AlCP	Albufera de Valencia commercial cpue	Spain	Mediterannean Sea	glass eel
ShaP	Shannon Parteen trapping partial	Ireland	British Isle	yellow eel
Bann	Bann Coleraine trapping partial	Northern Ireland	British Isle	glass eel + yellow eel
Visk	Viskan Sluices trapping all	Sweden	North sea	glass eel + yellow eel
Erne	Erne Ballyshannon trapping all	Ireland	British Isle	glass eel + yellow eel

Table 9-2. Description of the recruitment-series. Series updated to 2012.

REC_NAMESHORT	LOC_NAME	LOC_COUNTRY	LOC_AREA	REC_LFS_NAME
Kavl	Kävlingeån trapping all	Sweden	Baltic	yellow eel
Dala	Dalälven trapping all	Sweden	Baltic	yellow eel
Imsa	Imsa Near Sandnes trapping all	Norway	North sea	glass eel
MiSp	Minho spanish part commercial catch	Spain	Atlantic Ocean	glass eel
Ronn	Rönne Å trapping all	Sweden	North sea	yellow eel
Hart	Harte trapping all	Denmark	Baltic	yellow eel
Laga	Lagan trapping all	Sweden	North sea	yellow eel
GiSc	Gironde scientific estimate	France	Atlantic Ocean	glass eel
Meus	Meuse Lixhe dam trapping partial	Belgium	North sea	yellow eel
Gota	Göta Älv trapping all	Sweden	North sea	yellow eel
Morr	Mörrumsån trapping all	Sweden	Baltic	yellow eel
Mota	Motala Ström trapping all	Sweden	Baltic	yellow eel

Table 9-3. Description of the recruitment-series. Series not updated to 2012 or stopped.

REC_NAMESHORT	LOC_NAME	LOC_COUNTRY	LOC_AREA	REC_LFS_NAME	YEAR
YFS1	IYFS scientific estimate	Sweden	North sea	glass eel	1989
Vida	Vidaa Højer sluice commercial catch	Denmark	North sea	glass eel	1990
Ems	Ems Herbrum commercial catch	Germany	North sea	glass eel	2001
Tibe	Tiber Fiumara Grande commercial catch	Italy	Mediterannean Sea	glass eel	2006
AdCP	Adour Estuary (cpue) commercial cpue	France	Atlantic Ocean	glass eel	2008
AdTC	Adour Estuary (catch) commercial catch	France	Atlantic Ocean	glass eel	2008
GiCP	Gironde Estuary (cpue) commercial cpue	France	Atlantic Ocean	glass eel	2008
GiTC	Gironde Estuary (catch) commercial catch	France	Atlantic Ocean	glass eel	2008
Loi	Loire Estuary commercial catch	France	Atlantic Ocean	glass eel	2008
SevN	Sèvres Niortaise Estuary commercial cpue	France	Atlantic Ocean	glass eel	2008
Gude	Guden Å Tange trapping all	Denmark	North sea	yellow eel	2011
Vil	Vilaine Arzal trapping all	France	Atlantic Ocean	glass eel	2011

Table 9-6. Total landings (all life stages) from 2013 Country Reports, except note Finland, Latvia, Lithuania, Netherlands, Portugal, Spain, France and GB (see table notes at bottom of table). Norway (NO), Sweden (SE), Finland (FI), Estonia (EE), Latvia (LV), Lithuania (LT), Poland (PL), Germany (DE), the Netherlands (NL), Belgium (BE), United Kingdom (GB), Ireland (IE), France (FR) and Spain (ES), Portugal (PT) and Italy (IT).

	NO	SE	FI Δ	EE	LV	LT	PL	DE	DK	NL ●	BE	GB	IE	FR Δ	ES ●	PT #	IT
1945	102	1664							4169	2668							
1946	167	1512			1				4269	3492							
1947	268	1910			10	8			4784	4502							
1948	293	1862			10	14			4386	4799							
1949	214	1899			11	21			4492	3873					9		
1950	282	2188			14	29			4500	4152					4		
1951	312	1929			13	32			4400	3661					92		
1952	178	1598			14	39			3900	3978					102		
1953	371	2378			30	80			4300	3157					97		
1954	327	2106			24	147	609		3800	2085					112		
1955	451	2651			47	163	732		4800	1651					117		
1956	293	1533			26	131	656		3700	1817					124		
1957	430	2225			25	168	616		3600	2509					97		
1958	437	1751			27	149	635		3300	2674					128		
1959	409	2789			30	155	566	84	4000	3413					120		
1960	430	1646			44	165	733	51	4723	2999					125		
1961	449	2066			50	139	640	48	3875	2452					125		
1962	356	1908			46	155	663	67	3907	1443					119		
1963	503	2071			64	260	762	55	3928	1618					115		
1964	440	2288			43	225	884	56	3282	2068					108		
1965	523	1802			41	125	682	56	3197	2268		566			97		
1966	510	1969			43	238	804	68	3690	2339		618			126		

	NO	SE	FI Δ	EE	LV	LT	PL	DE	DK	NL ●	BE	GB	IE	FR Δ	ES ●	PT #	IT
1967	491	1617			46	153	906	92	3436	2524		570			133		
1968	569	1808			34	165	943	103	4218	2209		587			140		
1969	522	1675			43	134	935	302	3624	2389		607			127		2469
1970	422	1309			29	118	847	238	3309	1111		754			146		2300
1971	415	1391			29	124	722	255	3195	853		844			166		2113
1972	422	1204			25	126	696	239	3229	857		634			109		1997
1973	409	1212			27	120	636	257	3455	823		725			91		588 *
1974	368	1034			20	86	796	224	2814	840		767			100		2122
1975	407	1399			19	114	793	226	3225	1000		764			110		2886
1976	386	935	6		24	88	803	205	2876	1172		627			142		2596
1977	352	989	4		16	68	903	214	2323	783		692			89		2390
1978	347	1076	3		18	70	946	163	2335	719		825			137		2172
1979	374	956	4		21	57	912	158	1826	530		1206			90		2354
1980	387	1112	5		9	45	1221	140	2141	664		1110			102		2198
1981	369	887	3		10	27	1018	131	2087	722		1139			90		2270
1982	385	1161	2		12	28	1033	166	2378	842		1189			146		2025
1983	324	1173	2		9	23	822	155	2003	937		1136			71		2013
1984	310	1073	2		12	27	831	114	1745	691		1257			98		2050
1985	352	1140	2		18	29	1010	477	1519	679		1035			100		2135
1986	272	943	3		19	32	982	405	1552	721		926		2462	63		2134
1987	282	897	0		25	20	872	359	1189	538		1006		2720	84		2265
1988	513	1162	0		15	23	923	364	1759	425		1110		2816	55		2027
1989	313	952			13	21	752	379	1582	526		1172		2266	46	14	1243
1990	336	942			13	19	697	374	1568	472		1014		2170	37	13	1088
1991	323	1084			14	16	580	335	1366	573		1058		1925	35	23	1097
1992	372	1180			17	12	584	322	1342	548		915		1585	40	30	1084

	NO	SE	FI ∆	EE	LV	LT	PL	DE	DK	NL ●	BE	GB	IE	FR ∆	ES ●	PT #	IT
1993	340	1210		59	19	10	495	250	1023	293		857		1736	41	34	782
1994	472	1553		47	19	12	531	246	1140	330		1077		1694	34	27	771
1995	454	1205		45	38	9	507	242	840	354		1312		1832	49	24	1047
1996	353	1134		55	24	9	499	220	718	300		1246		1562	61	26	953
1997	467	1382		59	25	11	384	263	758	285		1190		1537	61	25	727
1998	331	645		44	30	17	397	28	557	323		943		1345	79	23	666
1999	447	734		65	26	18	406	38	687	332		963		1253	91	23	634
2000	281	561		67	17	11	305	36	600	363		702		1200	85	22	588
2001	304	543		65	15	12	296	141	671	371		742	98	1103	149	15	520
2002	311	633	0	50	19	13	236	130	582	353		650	123		157	27	415
2003	240	565	0	49	11	12	204	125	625	279		574	111		142	11	446
2004	237	551	1	39	11	16	148	117	531	245		634	136		110	9	379
2005	249	628	0	36	11	22	284	108	520	234		545	101		126	7	75 *
2006	293	670	0	33	8	16	257	87	581	230		408	133		114	10	56 *
2007	194	568	1	31	10	15	244	317	526	130		427	114	698	152	11	277
2008	211	495	1	30	13	14	227	398	457	122		397	125	657	79	7	56*
2009	69	388	2	22	5	9	156	446	467	275		458	0		99	8	280
2010	32	417	2	19	9	19	178	313	422	517	0	434	0	781	76	11	249
2011	0	440	2	18	7	11	119	357	370	550	0	459	0	392	337	7	150
2012	0	445	2	19	6	8	119	245	325	519	0	418	0	298	95	4	141

● Partial, for area (Netherlands till 2010) or life stage (Spain till 2010) ∆ Partial, discontinued #Coastal yellow eel landings only (Portugal till 2010).

Table 9-9. Stocking of glass eel. Numbers of glass eels (in millions) stocked in Sweden (SE), Finland (FI), Estonia (EE), Latvia (LV), Lithuania (LT), Poland (PL), Germany (DE), the United Kingdom (UK), Belgium (BE), Northern Ireland (NI), France (FR), Spain (ES) and Canada (CAN - *A. rostrata*).

	SE	FI	EE	LV	LT	PL	DE	NL	BE	UK	FR	ES	IT	TOTAL
1927				0.3										
1928					0.1									
1929					0.2									
1930														
1931				0.4	0.2									
1932					0.2									
1933				0.3	0.2									
1934					0.3									
1935				0.2	0.6									
1936					0.3									
1937				0.3	0.3									
1938					0.4									
1939				0.2	0.1									
1940														
1941														
1942														
1943														
1944														
1945														0
1946								7.3						7.3
1947								7.6						7.6
1948								1.9						1.9
1949								11						10.5
1950								5.1						5.1

	SE	FI	EE	LV	LT	PL	DE	NL	BE	UK	FR	ES	IT	Total
1951								10						10.2
1952						18		17						34.5
1953						26	2.2	22						49.6
1954						27	0	11						37.1
1955						31	10	17						57.5
1956			0		0.3	21	4.8	23						49.4
1957						25	1.1	19						44.8
1958						35	5.7	17						57.6
1959						53	11	20						83.3
1960			1	3.2	2.3	64	14	21						105.3
1961						65	7.6	21						93.7
1962			1	1.9	2	62	14	20						100.3
1963				1.5	1	42	20	23						87.8
1964			0	0.9	2.4	39	12	20						74.4
1965			1	0.4	2.1	40	28	23						93.3
1966		1.1			0.7	69	22	8.9						101.6
1967		3.9		1	0.5	74	23	6.9						109.3
1968		2.8	1	3.7	3	17	25	17						69.7
1969					0	2	19	2.7						23.9
1970			1	1.8	2.8	24	28	19						75.6
1971					1.6	17	24	17						60.3
1972			0	1.6	0.3	22	32	16						71.1
1973					1.4	62	19	14						96
1974			2		1.8	71	24	24						122.7
1975					2.2	70	19	14						105.2
1976			3	0.6	1	68	32	18						121.7
1977			2	0.5	1.4	77	38	26						145.2
1978		3.7	3		2.7	73	39	28						148.8

	SE	FI	EE	LV	LT	PL	DE	NL	BE	UK	FR	ES	IT	TOTAL
1979					0.8	74	39	31						144.65
1980			1		1.8	53	40	25						120.5
1981			3	1.8	3	61	26	22						116.4
1982			3		4.6	64	31	17						119.4
1983			3	1.5	3.7	25	25	14						72.1
1984			2			49	32	17		4				103.1
1985			2	1.5	1.6	36	6	12		10.9				70.52
1986			3		2.6	54	24	11		17.8				111.61
1987			3	0.3		57	26	7.9		13.8				107.55
1988				2.2		16	27	8.4		6.32				59.42
1989						5.9	14	6.8						27
1990	0.8	0.1				8.6	17	6.1						32.2
1991	0.9	0.1	2			1.7	3.2	1.9						9.2
1992	1.1	0.1	3			14	6.5	3.5		2.36				29.06
1993	1	0.1				11	8.6	3.8	0.8					24.5
1994	1	0.1	2		0.1	12	9.5	6.2	0.5	2.32				34.52
1995	0.9	0.2		0.6	1	24	6.6	4.8	0.5	2.06				40.96
1996	1.1	0.1	1		0.4	2.8	0.8	1.8	0.5	0.1		0.1		10.37
1997	1.1	0.1	1			5.1	1	2.3	0.4	0.21		0.1		12.58
1998	0.9	0.1	1		0.1	2.5	0.4	2.5		0.05		0.1		8.36
1999	1	0.1	2	0.3		4	0.6	2.9	0.8	3.6		0.2		17.02
2000	0.67	0.1	1			3.1	0.3	2.8		0.45		0.1		9.23
2001	0.44	0.1				0.7	0.3	0.9	0.2			0		3
2002	0.26	0.1		0.2			0.3	1.6		3.02		0		6.94
2003	0.27	0			0.4	0.5	0.1	1.6	0.3	4.1		0.1		7.89
2004	0.18	0.1				2.3	0.2	0.3		1.28		0.1		5.5
2005	0.07	0.1		0.1			0.6	0.1		2.16				4.05
2006	0.003	0.1		0				0.6	0.3	0.99				3.08

	SE	FI	EE	LV	LT	PL	DE	NL	BE	UK	FR	ES	IT	TOTAL
2007	0.03	0.1		0			1	0.2	0	3		0		5.3
2008	0.12	0.2					0.5		0.3	1.28				3.68
2009	0.02	0.1					0.76	0.3	0.4	0.65				3.01
2010	0.8	0.2					4.8	2.7	0.4	3	1	0		14
2011	0.9	0.31	0.7	0.4				0.8	0.5	3.3	2.2	0	0.2	11.04
2012		0.18	0.9	1.0	1.0		3.0	2.4	0.6	4.0	9.3	0.2	1.3	22.8
2013		0.19	0.8	0		1.0		1.8	0.4	5.6	8.8	0.1	1.0	19.5

Table 9-10. Stocking of young yellow eel. Numbers of young yellow eels (in millions) stocked in Sweden (SE), Finland (FI), Estonia (EE), Latvia (LV), Lithuania (LT), Poland (PL), Germany (DE), Denmark (DK) the Netherlands (NL), Belgium (BE), and Spain (ES).

	SE	FI	EE	LV	LT	PL	DE	DK	NL	BE	ES	IT	Total
1947									1.6				1.6
1948									2				2
1949									1.4				1.4
1950							0.9		1.6				2.5
1951							0.9		1.3				2.2
1952							0.6		1.2				1.8
1953							1.5		0.8				2.3
1954							1.1		0.7				1.8
1955							1.2		0.9				2.1
1956							1.3		0.7				2
1957							1.3		0.8				2.1
1958							1.9		0.8				2.7
1959							1.9		0.7				2.6
1960							0.8		0.4				1.2
1961		0		1			1.8		0.6				3.5
1962		0		0.7			0.8		0.4				2
1963				0.4			0.7		0.1				1.2
1964		0		0.4			0.8		0.3				1.6
1965		0		0.3			1		0.5				1.9
1966		0					1.3		1.1				2.5
1967				0.8			0.9		1.2				2.9
1968							1.4		1				2.4
1969							1.4						1.4

	SE	FI	EE	LV	LT	PL	DE	DK	NL	BE	ES	IT	Total
1970				0.4			0.7		0.2				1.3
1971							0.6		0.3				0.9
1972							1.9		0.4				2.3
1973						0.2	2.7		0.5				3.4
1974							2.4		0.5				2.9
1975							2.9		0.5				3.4
1976				0.3			2.4		0.5				3.2
1977						0.1	2.7		0.6				3.4
1978							3.3		0.8				4.1
1979		0					1.5		0.8				2.4
1980							1		1				2
1981							2.7		0.7				3.4
1982				0.3		0.1	2.3		0.7				3.4
1983				0.4		2.3	2.3		0.7				5.7
1984						0.3	1.7		0.7				2.7
1985						0.5	1.1		0.8				2.4
1986						0.2	0.4		0.7				1.3
1987							0.3	1.58	0.4				2.28
1988			0.2	0.8		0.1	0.2	0.75	0.3				2.35
1989						0.7	0.2	0.42	0.1		0.06		1.48
1990	0.7					1	0.4	3.47			0.03		5.7
1991	0.3					0.1	0.5	3.06			0.06		4.62
1992	0.3					0.1	0.4	3.86			0.06		5.52
1993	0.6						0.7	3.96	0.2	0.2	0.17		6.23
1994	1.7				0.1	0.1	0.8	7.4		0.1	0.12		9.62
1995	1.5		0.2				0.8	8.44		0.1	0.22		10.66

	SE	FI	EE	LV	LT	PL	DE	DK	NL	BE	ES	IT	Total
1996	2.4					0.5	1.1	4.6	0.2	0.1	0.1		7.7
1997	2.5					1.1	2.2	2.53	0.4	0.1	0.14		7.57
1998	2.1				0.1	0.6	1.7	2.98	0.6	0.1	0.09		7.07
1999	2.3				0.1	0.5	2.4	4.12	1.2	0.04	0.04		9.4
2000	1.4					0.8	3.3	3.83	1		0.05		9.65
2001	0.8		0.44			0.6	2.4	1.7	0.1		0.06		5.74
2002	1.7		0.36	0.2		0.6	2.4	2.43	0.1	0.01	0.04		6.4
2003	0.8		0.54			0.50	2.60	2.24	0.10	0.01	0.06		6.32
2004	1.3		0.44		0.10	0.50	2.20	0.75	0.10	0.01	0.06		4.34
2005	1		0.37			0.70	2.10	0.30		0.01	0.12		3.67
2006	1.1		0.38			1.10	5.50	1.60					8.58
2007	1		0.33			0.90	8.7	0.83			0.02		10.81
2008	1.4		0.19			1.00	8.5	0.75	0.23		0.04		10.83
2009	0.8		0.42			1.40	8.3	0.81	0.30		0.02		11.27
2010	1.9		0.21			1.40	8.2	1.55	0.10		0.01		13.41
2011	2.6		0.20	0.004	0.13	2.70		1.56	1.0		0.02	0.69	6.30
2012	2.5	0.17	0.10		0.5	1.70	4.5	1.53	0.5		0.16	0.2	11.8
2013	2.6	0.19			0.4	4.3		1.53	0.5		0.1	0.0	9.6

Annex 8: Country Reports 2012: Eel stock, fisheries and habitat reported by country

In preparation to the Working Group, participants of each country have prepared a Country Report, in which the most recent information on eel stock and fishery are presented. These Country Reports aim at presenting the best information, which does not necessarily coincide with the official status.

Participants from the following countries provided an (updated) report to the 2013 meeting of the Working Group:

- Belgium
- Denmark
- Estonia
- Finland
- France
- Germany
- Ireland
- Italy
- Latvia
- Lithuania
- Netherlands
- Norway
- Poland
- Portugal
- Spain
- Sweden
- The United Kingdom of Great Britain and Northern Ireland

For practical reasons, this report presents the country reports in electronic format only (URL). Soon to be available.

Annex 9: Technical minutes from the Review Group on Eels (RGEEL)

- Review of the Report of the Joint EIFAAC/ICES Working Group on Eels (2013)
- Conducted by correspondence 16–31 October 2013
- Reviewers: ICES: David Cairns, Canada; Gerald Chaput, Canada; Ted Potter, UK (Chair). EIFAAC: Ciara O'Leary, Ireland.
- NB: Some of the minor editorial errors noted in this review were corrected before the WGEEL report was published. These are indicated below by the following: [DONE].

1. Introduction

The Review Group conducted its work by correspondence. The report arises from two meetings of the Joint EIFAAC/ICES Working Group on Eels held during 2013 (18–22 March in Sukarietta, Spain and 4–10 September in Copenhagen, Denmark) and was made available to the Review Group on 16 October 2013. The Review Group was asked to examine all sections of the Working Group report except Annexes 1, 2, 4, 5, 6, 8 and 9 but giving priority to Sections 4–8. Draft reviews were exchanged within the Review Group during 23–29 October 2013, and the draft technical minutes were prepared, reviewed and finalised on 30–31 October 2013.

2. Overview

General comments

The overall conclusion of the Working Group on the state of the European eel stock is supported by the trend in the indicators. Recruitment at the glass eel stage has declined substantially in all monitored areas over the past four decades and remains low. Indicators of spawner production, either as yellow eel indices or in the limited silver eel indicators, suggest that spawner production has also declined. The decline has been more important for the glass eel indices compared to the yellow/silver eel indices which may indicate a density-dependent response in the continental phase of the life cycle, a possibility which is alluded to by the Working Group in references to increases in size of eels and proportions of females as abundance has declined. The slight increase in the glass eel indices of the past two years is a positive sign which may be related to increased abundance of spawners resulting from management interventions and/or to improved conditions in the North Atlantic for survival and recruitment of the early life stages. If current environmental conditions are more favourable for survival of leptocephali and glass eels, it would be desirable to further increase spawning escapement to take advantage of them and rebuild the continental abundance.

The summary of the stock indicator variables indicates that management measures to date have been insufficient to meet the EU eel rebuilding objectives in most of the countries and Eel Management Units (EMUs). However, rebuilding the European eel stock will take several decades as the yellow and silver eel numbers recorded today are the result of recruitment to the continent that occurred a decade or more in the past. As the recruitment indices have continued to decline, attainment of the biomass rebuilding objectives will take time, but there is no reason to not try to achieve the anthropogenic mortality targets in all countries and EMUs.

The Working Group (p. 180) has asked ICES to advise on which of the three assessment approaches (analysis of recruitment trends, use of stock indicators by country or EMU, and single international assessment) should be pursued, although it gives no indication of its own views. The answer is all three. The analysis of recruitment trends is particularly informative about recent conditions and therefore provides an indication, delayed by a few years, of the extent of the management interventions required. The use of stock indicators as presently formulated relative to defined management objectives provides the real-time measureable indicators of progress towards meeting the management objectives. The international species-wide assessment potentially provides the best description of the overall stock status and, in the absence of past information, the Working Group should clarify what data need to be obtained in order to develop such an assessment in the future.

The Working Group has also raised the issue of whether annual assessments, between those required for reporting under the Eel Regulation, are necessary; they are said to be useful for monitoring the trend in status, but no strong case is made for conducting them. While limiting the assessments to every third year might provide more time to develop new methods, consideration should be given to the difficulty of maintaining and populating the databases used to undertake the assessments if they are not undertaken annually.

Since a rebuilding objective has already been defined for the European eel, there is no need to develop alternate reference points. The objective of exceeding 40% of pristine spawning biomass has been taken to correspond to the term used by the Working Group of $B_{MSYtrigger}$ (but see comments below). Alternate objectives, based on recruitment trend indicators (R_{target} and R_{down}) are not useful for informing management decisions as they cannot be measured directly against silver eel biomass or removal rate objectives. The development of the relationship between stock (proxy value for silver eel biomass) and recruitment (index of glass eels from Elsewhere Europe) is too preliminary to justify providing alternative, more precautionary, reference points (B_{stop} and B_{stoppa}) to the 40% of pristine biomass value.

Problems with the choice of reference points are also reflected in the Precautionary Diagram (Figure 6-1). This figure is similar to the ICES advice plot for an F_{MSY} harvest control rule for '*long lived stocks with population size estimates*' (ICES 2013a). In the ICES advice plot, the value on the stock status axis (x-axis) is spawning–stock biomass before exploitation in the year for which the advice is given, and the value on the removal rate axis (y-axis) is the annual fishing mortality within that year. The Precautionary Diagram for eel shows $B_{current}$ on the x-axis, and it would be more appropriate to show B_{best} (the expected biomass in the absence of anthropogenic impacts). In addition, the Precautionary Diagram shows the maximum removal rate, 60% (corresponding to $\Sigma A = 0.92$), being applied at $B_{MSYtrigger}$, but this removal rate can only be sustained at or above the pristine biomass (B_0) without reducing escapement below 40% of B_0.

We suggest that eel is actually more akin to a '*short-lived stock with population size estimates*' (ICES 2013a) because the anthropogenic mortality is calculated as a single lifetime value (ΣA), and that mortality occurs before the fish spawn. For such stocks, the ICES MSY approach is aimed at achieving a target escapement (MSY $B_{escapement}$) which would accord with the 40% of B_0 reference point set by the EU. ICES (2013a) has also proposed that catches should be limited to the stock biomass in excess of the target escapement, and that no catch should be allowed unless the escapement can be achieved each year. On this basis, Figure 6-1 might take the form of Figure 1 below.

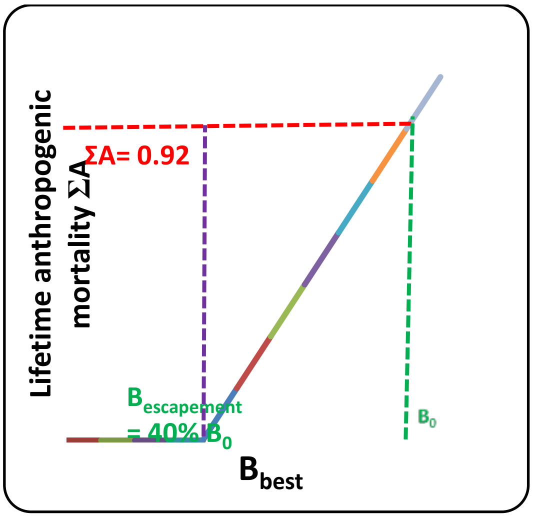

Figure 1. Alternative harvest control rule for eel, showing allowable lifetime anthopogenic mortality at different levels of B_{best}.

Depensation is again highlighted by the Working Group as a process which may be affecting European eel. The evidence put forward to support the depensation hypothesis is a stock and recruitment (S–R) relationship that is based on a partial index of silver eel spawning escapement and a relative index of glass eel recruitment. In the ICES review of the 2012 WGEEL report (ICES 2012, Annex 11), alternate hypotheses for the pattern in glass eel indices and silver eel indices were described. These alternative hypotheses are still worthy of consideration. Depensation is defined in S–R analysis as recruits per spawner that increase from the origin and then decline at an intermediate spawner abundance (Hilborn and Walters, 1992). The causal mechanisms of depensation are primarily associated with Allee effects, by which spawning success is compromised by low spawner abundance. To demonstrate depensation, the recruits and spawners must be in similar units. Production of glass eel that is low relative to historic abundance is not sufficient to demonstrate depensation.

It could be that the low values of the glass eel indices since the 1990s are the result of less favourable survival conditions of the early life stages (possibly due to a regime shift) perhaps exacerbated by reduced spawner quality associated with contaminants or other factors in freshwater. There may be subsequent compensatory responses in the spawner production in the continental phase of the life cycle that results in a spawner to spawner ratio which is greater than one, before potential spawners are killed in continental areas. Evidence is provided in the report of some of these, including increased size and proportion females among silver eels as abundance has declined (see Sections 9.11.1 and 9.11.2). It is notable that marine mortality of Atlantic salmon, which is most unlikely to demonstrate depensation during the marine phase, also shows signs of having been affected by a regime shift around 1990 (ICES 2013b).

The management advice is the same regardless of whether the S–R dynamic is due to non-stationarity (density-independent or density-dependent phenomenon associated with reduced resources) or depensation; to maintain and increase recruitment, the spawner biomass must be increased.

Report structure and layout

The Terms of Reference (ToRs) presented in Section 2 of the report include four tasks for the March meeting and five tasks for the September meeting. The ToR ('d' to 'g') for the March meeting consisted primarily of reviewing the biomass and mortality estimates by EMU in preparation for the international assessment. The ToR for the September meeting (‘h’ to ‘l’) were primarily to assess the stock and mortality indicators relative to precautionary approach and EU Regulation objectives, and to assess the stock of European eel based on the indicators of abundance and mortality. In addition, an ICES Workshop on Evaluation Progress Eel Management Plans (WKEPEMP) (ICES, 2013c) was convened in May 2013 with the main objective to review the Eel Management Plan (EMP) progress reports submitted to the European Commission in 2012.

The combined report of the March and September meetings excludes any information on the work undertaken to address ToR ‘d’ to ‘g’. The WKEPEMP report (ICES 2013c) contains some of the information collated during the March meeting. The summary tables of the key stock indicators by EMU, referred to as the 3Bs&ΣA-approach, which are summarized later in the PA summary plots of status by EMU and country in Section 6.5 of this report, are provided in ICES (2013c) and a similar table should have been included in this report, as a response to ToR ‘e’ and ‘f’. Given that these stock indicators are proposed as key indicators of stock status and progress by states in achieving stock rebuilding objectives, readers of this report would have benefited if a section describing these stock indicators, their origin, and how they are used to assess stock status had been provided.

ToR ‘h’ to ‘k’ are addressed in this report, and ToR ‘g’ is also discussed in Section 7.

The Working Group has a difficult task to pull together data from a large and diverse group of countries and to develop unified assessments of the eel stock. However, the report is not clearly structured, and sections neither fully address specific ToR (e.g. ToR ‘j’ is addressed in Sections 4, 5, 6, 9, 10 and 11) nor provide complete answers to specific advisory questions (e.g. Section 5 describes the trend based assessment using the recruitment indices, but the indices and the associated analyses are presented in somewhat more detail, including descriptions of the recruitment-series and the analyses undertaken, in Section 9.1). If organised in the context of an assessment, the report would present the catches, description of the monitoring data, the assessment models (trend analyses, run reconstruction), the results and then the conclusions on stock status relative to management objectives. Questions related to eel quality and other progress on research issues that do not immediately impact the assessment and the advice would follow logically after the assessment sections.

Throughout the report, reference points are frequently referred to as ‘targets’ when they are actually ‘limits’. This is an important distinction which has significant implications for management.

There are several sections in which figure numbers have been duplicated. This is difficult to avoid when compiling a large report quickly, but it could be reduced by employing the normal ICES convention for numbering figures and tables, which is decimal numbering according to the section they are in. Thus figures in Section 3.4.1 are numbered in sequence 3.4.1.1, 3.4.1.2, etc. This also assists cross-referencing figures and tables to the text.

In several sections the decimal section numbering is incorrect; this appears to apply to the third tier decimal numbers, in which the second number is always 11 (e.g. Sec 9.11.1). [DONE]

Many of the citations in the text are incomplete or incorrect (particularly references to ICES reports), but these errors are so numerous that we have not attempted to list them in this review. [DONE] In addition, a large number of references are missing from the reference list (Section 15); these have been listed in the Section 15 comments below. [DONE] ICES should be able to provide guidance to the Working Group on improving the tracking of references during the review of the report.

3. Comments by section

Sections 1–3: Opening, Agenda and Introduction

General comments

The Working Group report was prepared in response to ToR which are presented at the end of Section 2, entitled 'Adoption of the agenda'. The ToR would be easier to find if they were placed in a stand-alone section at the start of the report. It would also be helpful to indicate which management body(ies) are requesting the advice (See Technical Review 2012). It is helpful that some sections of the report are prefaced by the ToR which they address; it would also be helpful if the list of ToR at the beginning of the report showed the section in which each ToR is considered (e.g. see ICES (2013b), page 7).

Annex 3 appears to indicate that the ToR are proposed by the Working Group itself, but clarification is required on the customer(s) for the advice and the precise management needs. It might be helpful if future ToR reflect the ultimate advisory need (e.g. an assessment of the status of the eel stock across its range) rather than the process for achieving that need (e.g. compilation of data).

Section 3 states that the recommendations in the report of the 2012 Technical Review (ICES, 2012; Annex 11) were addressed by the relevant task subgroups and incorporated in the 2013 report but that time limits prevented the preparation of a specific written response to the Technical Review. While some points have certainly been taken on board, many others have not and it is not clear why. The Review Group recommends that in future the Working Group provides an annex listing the Review Group's comments and either provides a response or indicates where in the report that response can be found.

In the absence of a stock annex all data and methods used should (as far as practicable) be provided in the report; it is not reasonable to expect the reader to look through more than 15 Expert Group reports to find the relevant information. Where the volume of data is too great to be included in the report, the information should be summarized and sources given.

Specific comments

Cover page: The header at the top of the cover page should be 'EIFAAC/ICES ICES WGEEL REPORT 2013' not 2012. [DONE]

p.ii, para 3: Here and in several other parts of the report references are made to *'Last year'* and similar; to aid reading in future years, specific years should be referenced, i.e. *'In 2012, …'*, etc.

p. iii, Section B, Chapter 10, 1st para. Unclear what 'exports' means; is it exports out of the EU, or exports out of the fishing country?

p. vi, Glossary, para 3: leptocephalus and leptocephali should be in lower case and non-italics. [DONE]

p. viii, Definition of terms: For ∑F and ∑H, what does 'and the reduction effected' mean? [DONE]

p. 20, para 5, line 8: 'set up' should read 'setup'. [DONE]

p. 20: Implementation of the EMPs has now introduced discontinuities in data trends (e.g. fisheries-dependent recruitment-series); the Working Group should consider the implications and review the need to shift from fisheries-based to scientific survey-based assessments.

Section 4: Introduction to stock assessment, reference points and stock status

General comments

Sections 4 to 8 together address the assessment of the eel stock, partly answering ToRs 'h', 'i' and 'j'; Section 4 provides a useful overview of the three approaches being considered by the Working Group in the subsequent sections.

In Section 4.2, the Working Group presents a narrow view of what are termed 'standard stock assessment techniques' and suggests that, if these techniques were applied to eel, the assessment would be meaningless. However, the problem is not with eel biology or ecology, it resides with the lack of adequate basic stock assessment data for European eel, including catch data, biological data including length and weight-at-age and stage (yellow *vs.* silver eel) and estimates of exploitation rates across the species range. If these data were available, the European eel could very well lend itself to standard assessment approaches, such as statistical catch-at-age or cohort analyses. If such information was collated and integrated over all regions, this would constitute an international assessment to which WGEEL aspires. The references to previous WGEEL reports, which are the source of the text in this section, do not provide scientific support for discounting standard assessment procedures. In the meantime, there remains an urgent need to introduce further quality control into the separate regional assessments undertaken.

Specific comments

P .23, para 3, 3rd last line. There seems to be a word missing before 2012. [DONE]

p. 23, Sec 4.3: It would be helpful to clearly present the management objectives (e.g. the EU Regulation) against which the three assessment methods described in Section 4.3 are conducted.

p. 23, Sec 4.3, para 2, line 1: not clear which reports *'ICES(1999 through 2012)'* refers to. [DONE]

p. 23, Sec 4.3, para 2, line 4–5: past advice is said to have been *'based on precautionary grounds:'* What does 'precautionary grounds' mean? (NB the ICES (1999) advice could not have been based upon the ICES (2012) guidance.) [DONE]

p. 23, Sec 4.3, para 2: the references to DLS Guidance are unclear; the name should be spelt out in full the first time it is mentioned and the correct reference should be included. Furthermore the references to Methods 1.1.2 (*If estimated stock biomass in the intermediate year is less than MSY* $B_{trigger}$) and 5.3 (*If catches have declined significantly over a period of time and this is considered to be representative of a substantial reduction in biomass, a recovery plan and possibly zero catch is advised*) do not appear to match the text.

p. 24, para 1, line 3: the report refers to 'a discussion on how to deal with a (real or perceived) break in a hitherto consistent, multidecadal decline (for which DLS Guidance does not provide a method)'; this statement is unclear; there is not a break, it is an upturn.

p. 24, para 1, line 5–6: the report states, 'Finally, the available data indicate that recruitment has declined more rapidly than the (reconstructed) spawner escapement, which may indicate a.) an inappropriate reconstruction of the trend in spawner escapement, or b.) a non-stable stock–recruit relationship (e.g. change in ocean conditions), or c.) a depensatory stock–recruitment relationship.'. However this is to be expected; in a compensatory S–R relationships, recruitment (R) will decline faster than spawner escapement (S) when S is less than the spawners required to achieve MSY (S_{MSY}). (R will decline less rapidly than S when $S > S_{MSY}$).

p. 24, Sec 4.4, para 2: It is suggested, 'the net effect of the actions taken in 2009 on the total 2009 silver eel escapement is probably small, far below the targets of the EMPs and/or the ultimately sustainable level.' These conclusions are not justified without a list of the actions taken and the life stages likely affected.

p. 24, Section 4.4: It is not clear why this section is included prior to presenting the assessments.

p. 25: para 2, line 6: refers to *'... the autonomous downward trend in stock productivity ...'*. What is the meaning of 'autonomous' in the context of the downward trend in stock productivity? What is the measure of stock productivity being referred to? Rather than automomous, does the Working Group mean a continuous or monotonic decline? [DONE]

Section 5: Trend based assessment and reference points

General comments

This section addresses trend based assessments of recruitment which is part of ToR 'j'. Most of the comments on the analysis of the recruitment time-series provided by the Review Group in 2012 are relevant to the 2013 report as well.

Little information is provided on the derivation of the recruitment indices used in this assessment; Table 5-1 refers to *'the two recruitment-series presented in Chapter 9'*, but that section deals with three life stages (glass, yellow and glass+yellow) and two areas (North Sea and Elsewhere). (NB Comments on the time-series analysis are presented for Section 9 below).

The two analytical approaches presented in this section provide different ways of assessing the recruitment trends and comparing recent recruitment with past recruitment. The main limitations of these analyses, particularly the impossibility of making predictions, are well explained. However, while the derivation of R_{target} and R_{down} is clear, the biological rationale behind them is less obvious given no information on the absolute status of the stock during the baseline period (1960–1979). Choice of the baseline period is a key element of these analyses, and this is not explained either here or in the general discussion of data compilation (Chapter 9). The period 1960–1979 is chosen as a baseline because *'the stock was considered to be'healthy' during this period'*, but elsewhere the report says that yellow eel recruits have been declining since the 1960s (p. i). Recruitment in the 1950s, shown in Figures 5-1 and 5-2, was lower than in the 1960s and 70s, but data from the 1950s were not included in the baseline period. Glass eel data go back to the 1920s or earlier (Figure 9-1), but these earlier datapoints were likewise not included. Making a defendable choice of a baseline is often not easy; early periods may be closer to a 'pristine' condition, but early periods have fewer dataseries, making them less reliable. The report ought to indicate the reasoning used to define the baseline period, and if there is a subjective component to this decision, it should be acknowledged.

The report draws a firm conclusion from the trend analysis that *'the stock remains in the critical zone.'* This is based on the chosen baseline, and additional analyses should be presented to confirm whether the report's conclusion on trends is upheld using alternate baselines. The extent to which the recruitment index varies with baseline choice would also help in the evaluation of the robustness of this method.

The concept of a 'baseline,' a period when the population was 'healthy', has a relevance that goes beyond Chapter 5. The analytical approach of Chapter 6 is based on a hypothetical population that is unaffected by anthropogenic activities, which is another way of saying a baseline population. These baselines should be consistent.

It is not clear that the presentation of the recruitment trends in Figure 5-3 adds significantly to Figures 5-1 and 5-2, particularly given that the five year exponential trend appears to be quite sensitive to relatively small annual fluctuations in R and many of the datapoints are superimposed. The reference points used in these analyses are not reference points for management, and managers may be confused by the introduction of the new status terminology; the use of a 'high cautious' zone is confusing, and the distinction with the 'cautious' zones may also be misleading (for example, a strongly decreasing trend when R/R_{target} is marginally greater than 1.0 (cautious zone) would appear to pose much greater risk to the stock than a strongly positive trend with R/R_{target} marginally less than 1.0 (high cautious zone)).

The difference in timing of declines between the North Sea and the Elsewhere Europe is interesting and more in line with continental recruitment being affected by oceanographic conditions. For a panmictic species, a decline in recruitment to northern areas but not in southern areas is not consistent with depensation.

Overall, the trend analyses confirm the continuing severely depleted state of the recruitment, and this is clearly described. A number of comments are made about the recent upturn in the recruitment indices, and this raises the issue of determining when these changes should be considered significant. The Working Group might consider whether examination of previous year-to-year variation in the indices (e.g. annual changes, sequences of increase/decreases, etc.) could be used to evaluate the significance of recent changes. As indicated, it would be desirable to be able to present similar trends in yellow and/or silver abundance, even if these trends may reflect local differences in population dynamics and anthropogenic impacts.

Specific comments

This section is about recruitment-series, but the text repeatedly equates recruitment status with stock status. Stock status and recruitment status are not necessarily the same thing, and this section should refer to recruitment status only. [DONE]

p. 26, Sec 5.2: R_{down} is based on the 5% quantile of recruitment. Since there are 20 years between 1960 and 1979, it appears that R_{down} should be the recruitment during the poorest recruitment year between 1960 and 1979. If this is correct, it should be stated in the text.

p. 26, line 5: the reference to using trend analysis in the development of the PA by Fisheries and Oceans, Canada is unclear.

p. 26, Sec 5.2, last line: reference to Figure 5-3 should be Figure 5-2. [DONE]

p. 26, Table 5-1: the caption refers to a reference period of 1960–1980; should this be 1960–1979 (or it is inconsistent with the reference period used elsewhere)?

p. 27: the report states, '*The stock entered the critical zone in . . . . the late 1980s in Elsewhere Europe'.* Figure 5-1 appears to show that the recruitment index in Elsewhere Europe entered the critical zone in the mid 1980s. [DONE]

p. 29, Figure 5-3: The y-axis should indicate that R/R_{target} is expressed as a %. The reason for using a five year exponential change for the x-axis should be explained in the text.

Section 6: Quantitative assessment applying generic reference points

General comments

This section addresses quantitative assessment of spawner escapement estimates against targets across the full range of the species which is part of ToRs 'i' and 'j'. Section 6.2 provides an important description of the management objectives and should be the basis for the management advice. However, the EU's reference point of 40% of pristine biomass is referred to as a 'target' (lines 3 and 9) but also as a trigger point (line 9) and as a 'limit' reference point (line 15); it is important to be clear whether this is a target or a limit. It is not made clear whether this is being equated specifically to $B_{MSY\text{-}trigger}$ (although this is the case in Section 6.5). Section 6.3 refers to 'stock indicators 3Bs&ΣA' but it is not immediately clear which biomass reference points are being referred to (the glossary defines seven biomass reference points). It would be helpful to provide a definition of the relevant indicators (B_0, $B_{current}$ B_{best} and ΣA?) in a text table and relate these to the ICES reference points (e.g. $B_{MSY\text{-}trigger}$). It appears that values are not provided for all EMUs and the reason for this needs to be discussed and solutions explored. [NB: However, in relation to this and following comments on Section 6, see the 'Overview - General comments' regarding the Precautionary Diagram.]

The assessment results presented appear to have been taken directly from Member States' 2012 progress reports on their EMPs, and no new analysis seems to have been undertaken by the Working Group. There is clearly a need for some degree of quality/consistency review. It is not possible to provide full details of these assessments within reasonable limits of space, but some key points need to be explained to allow readers to judge the strength of the approach and the limits to its interpretation. These include:

1) The foundation of the approach is the concept of an EMU which produces silver eels in a manner unaffected by anthropogenic impact. What would we have to alter to return to this 'pristine' state? Would it suffice to end all fisheries? Would we have to remove all dams? Would we also have to end chemical pollution or other habitat impacts? If the anthropogenic impact is fisheries alone, does that mean that EMUs that have stopped fishing would be at 100% of SPR?

2) As the report indicates, there are substantial data gaps in the analysis. These gaps can fall into various categories, including:

    2.1) gaps in an area, within a broad region; for example Portugal is a data gap, but the rest of the Iberian Peninsula is covered.

    2.2) gaps in broad regions; there are no data from the eastern Baltic, from the southern coast of the Mediterranean, and from the eastern Mediterranean.

2.3) gaps in habitat types; eels use both saline and fresh water for growth habitat, but most fisheries and research efforts are directed at fresh waters.

The impact of these gaps on the overall assessment may vary with the type of gap. Data from Portugal are missing, but data from adjoining EMUs on the Iberian Peninsula may provide a valid proxy. Gaps in broad regions are more problematic. The Mediterranean basin may be as important as the Atlantic for European eel production, but there are no data for about 3/4 of the Mediterranean coastline. If we cannot assess eel status there, it leaves a large gap in the picture for the species as a whole. Can tentative or preliminary conclusions be drawn on the basis of reported landings for this region? Reported eel landings in non-EU Mediterranean countries (particularly Egypt) are very large, peaking at >4000 t in 2006 (Figure 9-10), which exceeded total reported European landings at that time.

Most EMUs include both coastal and inland waters (Figure 6-2). ICES (2009) reported that fisheries effort and research information on coastal saline waters was generally sparse for the European eel. Do many or most EMUs have substantial eel production areas in saline waters that are not fished and lack biological data? If saline areas are poorly covered or not covered in models, what is the effect on the assessments? Would inclusion of unfished saline waters in models boost silver eel production and raise the modelled $B_{current}$ for that EMU? Eel growth is more rapid in saline than fresh water (ICES 2009); do models take this into account?

It would not be realistic to expect an exhaustive analysis of all issues and limitations in the analysis summarized in Chapter 6, but the report should discuss the main points.

Incomplete reporting by EIFAAC/ICES members is clearly an ongoing problem, and the Working Group should clearly spell out in tables the data/indicators that have been provided by EMU or country (distinguishing EU-MSs).

Specific comments

p. 32, Sec 6.5, line 1 & Figure 6-1 states that the Precautionary Diagrams plot the 3Bs & ΣA. In fact they appear to plot $B_{current}/B_0$(%) against ΣA. The boundaries between the coloured zones in Figure 6-1 should be defined in the text and/or the figure caption.

p. 32, line 6: Should 'limit mortality' read 'mortality limit'? [DONE]

p. 35, Figure 6.1: the caption does not explain the bubble symbols. ICES (2013c) explains the summary plots, and similar text should be used in this report (*viz*: *'The size of the points (bubbles) indicates the size of the B_{best}, while their location indicates the status of eel in the EMU in terms of spawning biomass against the 40% target, and anthropogenic mortality against the rate equivalent to that biomass target (i.e. $\Sigma A = 0.92$ if $B_{current} > 40\% B_0$ or $\Sigma A = 0.92 * B_{current}/(40\% B_0)$ if $B_{current} < 40\% B_0$). The green area indicates the local stock is fully compliant, amber indicates that one target is reached but not the other, and red indicates that neither target is reached.'* [DONE] Figure 1 from ICES (2013c) (p. 41) is a good figure to include in the report as it explains what information is being summarized in this figure.

p. 35–36, Figures 6.1 and 6-2: it is not clear how the overall sum for <u>ΣA</u> (from the EMU or country data) is derived. The overall ratio for the biomass indicator could be estimated as $\Sigma B_{current}$ / ΣB_0 for reporting jurisdictions. For ΣA, does the report calculate the overall value as: (ΣB_{best} – $\Sigma B_{current}$) / ΣB_{best}?

p. 35: In Figure 6-1, scaling the bubbles by B_{best} confuses the productive capacity (large areas can produce lots of eels) with the realized production. For communication to managers, it might be better to not use B_{best} to scale the bubbles but rather use similar sized symbols for all EMUs or countries but with two colours representing the following conditions: a white symbol to indicate $B_{best}/B_0 < 40\%B_0$ (i.e. failure to meet the target even in the absence of all anthropogenic mortality) and a solid symbol to indicate $B_{best}/B_0 >= 40\%B_0$ (potential to attain the target in the absence of mortality). This would show whether the failure of an EMU or country to achieve its objective ($B_{current}/B_0 < 40\%B_0$) is due to insufficient management intervention in the given year versus failure to meet the target due to low potential production in that year.

p. 36: The same issue arises with Figure 6.2 regarding the size of the bubble being scaled to B_{best}. It is not possible to judge from this figure whether the estimate of B_{best} in the EMU or country is close to 40% B_0 or the bubble is large simply because the EMU or country has a large amount of productive area. The information that needs to be communicated to managers is where $B_{current}$ is relative to 40%B_0 and ΣA (the three colours) and where B_{best} would be relative to B_0. In this case, using the sad or happy face symbols could be used to communicate this information (sad face means B_{best} was below 40%B_0, happy face means $B_{best} >= 40\%B_0$) with the same colour scheme of red, yellow, and green to describe the current state of the stock, and the white symbols to indicate no information. This scheme would avoid placing the large red symbol for France as it currently appears in Figure 6.2.

p. 36, Sec 6.6: the first paragraph states, 'The anthropogenic mortality ΣA is estimated to be just at (averaged over reporting EMUs) or far above (averaged over reporting countries) the precautionary level that would be in accordance with ICES general policies for recovering stocks (for EMU sums: ΣA=0.41 with target 0.42; for country sums: ΣA=1.40 with target 0.14).' It is difficult to understand the values for the target ΣAs. In reference to Figure 6.1, the sum of the biomass indicator over all EMUs (top panel of Figure 6-1) shows the $B_{current}/B_0$ at a value of 18% which would give a maximum ΣA of 0.41 according to the rule (0.92 * $B_{current}$/40%B_0 = 0.92 * 18%B_0 / 40%B_0). For the country sum, $B_{current}/B_0$ equals 6% which would give a maximum ΣA of 0.14 (0.92 * 0.06/0.40). Perhaps the following would be clearer to the reader: 'The biomass of escaping silver eel ($B_{current}$) estimated over all EMUs reporting was 18% of B_0. The maximum ΣA for that level of spawner production equals 0.41 (i.e. 0.92 * 0.18/0.40). The estimated realized ΣA was 0.42, at the maximum level. The biomass of escaping silver eel estimated over all reporting countries was 6% of B_0. The maximum ΣA for that level of spawner production equals 0.14 (i.e. 0.92 * 0.06/0.40). The estimated realized ΣA was 1.40, greatly above the ΣA limit.'

But this comment should be considered in the light of what was mentioned above regarding ΣA = 0.92 for $B_{best} = B_0$ rather than for $B_{current}$ = 40%B_0.

p. 37, Sec 6.7, line 1: 'shortcomings' rather than 'short comings'. [DONE]

Conclusions from this section are considered in at least three parts of the report (Sec 6.7, Sec 8 and Sec 13); this is confusing and they should be brought together in one place.

Section 7: Eel specific reference points based on the S–R relationship

General comments

This section describes efforts by the Working Group to develop stock and recruit time-series and establish an S–R relationship for the whole stock. This could then be used to define reference points, further the understanding of population dynamics and lead to possible tests of recruitment hypotheses, including regime shifts in the ocean, spawner quality and depensation.

The development of the appropriate time-series has proven to be challenging. Efforts of EU Member States to provide estimates of exploitation rates with which to derive estimates of total abundance and of spawners is an important step. However, the Working Group needs to document the input data, the methods for aggregating from local scales to ecoregion and eventually the species scale, and to be clearer on the limitations of the data and the models used. As presented, there remain major issues with how the catches are collected, collated and partitioned into life stage, and how missing data are treated. The reconstruction of catches back in time for all countries is not currently acceptable based on the information provided by the Working Group. If this component of the reconstruction is flawed, then all subsequent analyses and discussions are premature.

Ideally, one would want to undertake the S–R analysis with a biomass estimate for the entire panmictic stock, but there is clearly substantial silver eel production which is outside the scope covered in the analysis. For example, silver eel fisheries are generally directed at production from river systems, where silver eels can be readily caught by interceptory gear at predictable times of the year. Silver eels produced in saline areas cannot be readily caught by interceptory gear and are generally not subject to targeted fisheries (with the exception of the Baltic Sea). In addition, in the eastern and southern Mediterranean Sea, there are eel fisheries which may rival in size those of European countries (Figure 9-10), but landings from these countries are not included in the analysis, perhaps because there are insufficient harvest data. The question therefore arises as to how robust the approach is without these data. If the biomass value used in the model underestimates the true stock biomass but is linearly related to it, it may be regarded as a biomass index rather than an estimate. However, there is a need to determine whether the index may be biased and whether the S–R analysis would be valid if this biomass index was 90%, 50%, 25% etc. of the true biomass value.

The overriding interpretation of the Working Group on the preliminary S–R relationship is that depensation, by Allee effects (whereby spawners are unable to find mates due to low abundance), is the dynamic that explains the reduction in glass eel recruitment. This was discussed by the Review Group in 2012. No evidence has been presented in this report to reinforce the depensation argument, and such a conclusion is premature. If true biomass is greater than calculated biomass, would the proposed conclusions regarding stock dynamics at low recruitment remain valid?

The management advice for European eel is the same whether the declines in indices of recruitment are due to depensation, declines in the survival of the early life stages at sea or declines in silver eel spawner quality associated with continental factors. Regardless of the mechanism, the only action that can be taken to increase recruitment is to increase spawning escapement by reducing anthropogenic mortality on the continental stages of European eel. There is no guarantee that reducing mortality at those stages will result in increased recruitment, but it is more likely that recruitment will continue to be low or decline further if anthropogenic mortality rates remain high, as estimated in this assessment.

The detailed discussion in Section 7 is not essential for providing management advice. Higher priority for the Working Group is improving the catch data, biological sampling and the indices of abundance from this point forward.

Section 7.7 (p. 53) considers the estimation of B_{lim}. However, if B_0 is 193 kt (not million tons - see editorial comments) then the limit reference point in the EU Eel Regulation (40% of B_0) is about 77 kt, which is >70% greater than any $B_{current}$ in the historical time-series. This would imply that the stock has not been sustainably managed for more than 60 years, which then casts doubt on using the 1960–1979 period as a baseline for assessment. There are clearly various possible explanations for these anomalies (incorrect estimation of B_0, β_{su}, etc.) and they need to be explored.

Specific comments

This section uses a run–reconstruction approach to estimate historic spawner escapement and compares these with stock–recruitment (S–R) reference points. In the absence of a stock annex, all the parameters used in the equations and their suffixes need to be defined and parameter values used in this model (referred to in Sections 7.4 and 7.5) should be provided in the report. Data are provided for 67 of the 81 EMUs but more information should be provided on where the data have come from and flaws associated with them.

p. 38. Sec 7.2, line 2: the text suggests that the best available proxy for SSB is the escapement that exists after all of the fisheries and other mortalities (both natural and anthropogenic) in continental and littoral waters have occurred. However this information is also unavailable, so the real proxy is reported landings.

p. 40, para 2: the report states that the catches were further divided by stage (yellow and silver eel) based on collected series made available to WGEEL or by expert knowledge. This information should be included in a table.

p. 40, Sec 7.11.1: (NB Section number is incorrect.) All the parameters used in the equations and their suffixes need to be defined: s appears to refer to silver eels but is not really required; H appears to be the instantaneous rate of anthropogenic mortality but is later set at 0 so could be omitted; 't' is undefined but is shown to refer to year in Sec 7.5 and, as such, should be shown as a suffix (at present it appears to be a variable). For clarity, a symbol other than β should be used for exploitation rate, as it is easily confused with the biomass symbol.

p. 40, Sec 7.4: The use of expert opinion to derive starting values for exploitation rates is a good beginning in the effort to develop estimates of silver eel escapement. However, there is insufficient information to allow the reader to understand how the expert opinions on exploitation rate were developed, why the aggregation for ICES ecoregions at this stage, and how the exploitation rates for an ecoregion and time period were determined.

p. 40 *et seq.*: Sections 7.11.1 and 7.11.2 should be numbered 7.4.1 and 7.4.2. [DONE]

p. 42–46, Figure 7-5: the ICES ecoregion names have slipped. [DONE] The legend box appears to define the EMUs included in each panel, but there are far fewer lines than EMUs; this needs to be explained. The scale and units of the vertical axes which represent relative trends in exploitation rates are not indicated and, as a result, not comprehensible.

p. 47, below Figure 7.6, line 3: a reference is given to 'equation (0)', but only one equation is numbered (p. 41) so this is not very helpful.

p. 49, Figure 7-8: there appears to be a leveling or upturn of escapement in the Baltic, North Sea and Celtic Sea but not Bay of Biscay and Mediterranean; can this be attributed to the management measures?

p. 53, Figure 7-9: replace 'tons' (imperial unit) with 'tonnes' (metric unit). Also, p. 53, para 1, line 3; para 2, line 4; para 3 line 1; p.57, para 1, line 3…. etc. [DONE]

p. 51, Figure 7-10: need to make clear in caption that catches are silver eels only.

p. 51, Sec 7.6, para 2: Lines 2–5 provide an awkward and incorrect description of S–R relationships. The Beverton–Holt function has maximum recruitment occurring at infinite spawner abundance, not compensation for high recruitment. Both Ricker and Beverton–Holt have maximum recruits per spawner at the origin, declining monotonically with increasing spawner abundance, and recruitment increases faster than SSB for SSB less than the value for maximum gain.

p. 52, line 4: '*Figure 8*' in the text refers to Figure 7-8, however this figure is incorrectly numbered (see below). [DONE]

p. 52–56: Figure numbers 7-8 to 7-10 are duplicated; Section 7 figures from p. 52 onwards need to be renumbered. [DONE]

p. 52, second Figure 7-8: Caption [DONE] and y-axis should refer to 'Estimated biomass'.

p. 53, second Figure 7-9: y-axis label should be 'Biomass / B_0 (%)' and this should be reflected in the caption.

p. 53, para 2: B_0 should presumably be 193 thousand tonnes not 193 million tons (otherwise B_{lim} estimate of 27.8 thousand tons (*sic*) would be only 0.014% of B_0 (not 14.4%)). This error is repeated on p. 57, para 1. [DONE]

p. 54, Section 7.8, para 5: This paragraph provides a confusing (or incorrect) explanation of the replacement line; in the absence of density-dependent processes the potential for spawning stock production should defined by the gradient of the S–R relationship not by the replacement line.

p. 56–58, Figures 7-10, 7-11 and 7-12: these figures are not referred to in the text.

p. 56 Figure 7.11: the legend overwrites the point for 1977; it should be moved to make the legend clear.

p. 57, line 9: it appears to have been the 2009 escapement that was below B_{stop} not 2008. [DONE]

Figure 9-9, showing 'Total landings (all life stages) from 2013 Country Reports (not all countries reported); the corrected trend has missing data filled by GLM.' should be moved to this section of the report as this is the figure for modelled landings. Figure 9-9 should not appear in Section 9 as it gives the impression to the reader that landings are reported for all those countries back to 1945.

Section 8: Discussion of assessment methods and results

General comments

This section provides an overview of the three methods used to assess the status of the eel stock. The comments on Sections 5 and 6 do not add much to the conclusions within Sections 5.3 and 6.6, and may be better included there; the summary of Section 6 is hard to follow. The comments on Section 7 introduce some of the potential risks with this approach which again might better be included in Section 7.11. The evaluation of the relative merits of the different approaches is spread among Sections 5.4, 6.7, 8 and 13 and is therefore disjointed and confusing; these conclusions would have been better amalgamated into a single section. Section 13 provides the clearest conclusions and guidance on how the Working Group could further develop these assessments.

Specific comments

p. 60, para 5: the reconstructed time-series are of partial indices of both spawners and recruits, and the latter is of a very early stage in the life cycle. The statement that the stock may be entering an extinction vortex is premature and should not appear in this report. [DONE]

Section 9: Data and trends

General comments

This is a diverse section in which a number of databases on eel stocks and fisheries are updated (part of ToR 'j'). A substantial part of this section appears to comprise updating of tables and figures with some limited analysis of the data therein. It is not obvious why some tables are included in the body of the report (e.g. Table 9-11) while other tables are placed in Annex 7 (e.g. Tables 9.6 and 9.9). Large tables, such as Table 9-11, would be better placed in Annex 7.

Section 9.1 describes the time-series of data on glass and yellow eel recruitment. The selection of time-series and the method used to combine them need more explanation (see also editorial comments). The fact that some time-series have been terminated because of lack of recruits (e.g. Ems and Vidaa) suggests that the use of time-series starting and ending at different times may introduce biases. It is recognised that efforts must be made to make the best use of available data, but the data can be tested to see whether such biases exist. For example, if there were two groups of time-series with group 1 spanning the period from 1980 to 2000 and group 2 the period from 1980 to the present, the groups could be compared over the initial period to see whether the loss of group 1 might introduce a bias in the later years.

Limited information is provided on the time-series that are excluded from the analysis and the reasons. It would be helpful to include in Tables 9-1 to 9-3 (Annex 7) the start and end date of the time-series, the number of years for which estimates are available, and any comments about potential uncertainty in the data, e.g. if sampling is conducted upstream of a fishery. More explanation is required on the fluctuating nature of the recruitment series in Figures 9-3, 9-4 and 9-5.

Section 9.2 describes trends in yellow eel and silver eel abundance from a small number of monitoring programmes. The data are not presented in tabular form and are difficult to interpret from Figure 9-7. The data are limited but sufficient to suggest that the relationship between recruitment and yellow/silver abundance can be complex. These complexities provide another reason for suggesting non-stationarity in any S–R relationships.

The conversion of stocking numbers to glass eel equivalents should attempt to include all mortality between capture and release (p. 104). It is not clear why this has not been modelled. Stocking remains an important, and contentious, issue for eel management and so more should be made of these data. It may be possible, for example, to assess the proportional loss or gain of glass eel equivalents in different areas to assess the extent that stocking could be impacting stock abundance.

Specific comments

p. 62, line 1: The ToR addressed is 'j'. [DONE]

Many of the following points and requests for clarification were raised by RGEEL (2012) but have not been addressed or commented on in this report.

p. 62–65: throughout Section 9 the three decimal Section numbering is incorrect (e.g. Subsections 9.1.1, 9.1.2, etc. are numbered 9.11.1, 9.11.2, etc.). [DONE]

p. 62, Sec 9.11.1 and Figure 9-1: It is unclear what the figure is showing; the number of available time-series should never decrease, so is this the number of 'active' time-series? Does this ignore gaps in the time-series?

p. 62, Sec 9.1, line 5: refers to 49 time-series but p. 212 *et seq*., Annex 7, Tables 9-1 to 9-3 describe 48 time-series not 49 as given in the text (Sec 9.1.1). [DONE]

p. 62, final para: it appears that time-series are only used in the analysis if they exceed a certain number of years, and it would be helpful if this was explained here rather than in Section 9.11.3; how large a gap is acceptable? The time-series are scaled to the 1979–1994 mean, but it is not clear whether data must be available for that full period or for a certain number of years within it; this is a potential source of bias. It appears that any time-series spanning the 1979–1994 period might be used; so how was the 35 year limit determined? A reference is made to the Country Reports in Annex 8, but these are not provided and the URL link is missing in the Annex. [DONE]

p. 63: there are two Figure 9-1s; the Figures in this section therefore need renumbering. [DONE]

p. 64, para 1: the 'recommendation from 2011' should be referenced to the WGEEL or SGIPEE report. [DONE]

p. 64, para 2: to aid reading in future years, specific years should be referenced, i.e. 'In 2012, …', etc. rather than 'Last year, …'.

p. 64, Figure 9-1: there are two Figures 9-1; the second should be renumbered Figure 9-2. [DONE]

p. 64, Figure 9-2: This should be renumbered 9-3 (the caption to Figure 9-4 would then be correct) [DONE]: Is any lag (negative) applied to the yellow eel time-series to compare them with the glass eels - or should it be? The y-axis caption indicates a ratio, but the data show %; this should be the same as Figure 9-4.

p. 65: Figure 9-4 is not referred to in the text and has a confusing caption; the time-series of glass and yellow eel are not shown in the figure as suggested; in addition the difference between the 'mean values' shown in Figures 9-2 and 9-4 is unclear (or are they the same?).

p. 66, para 4: the first two sentences say the same thing; no indication is given of the state of the recruitment indices between 2006 and 2012 (i.e. where the indices have increased).

p. 68, Figure 9-5: it should be possible to add confidence limits for the GLM estimates.

p. 69, Figure 9-6: indicates that there is a smoothed trend with confidence intervals but there is no description of how the smoothing was performed.

p. 70, para 2, line 3: for 'incomparability' read 'comparability'. [DONE]

p. 69–70: It is difficult to conclude anything from the description of the yellow eel time-series. There is no reference to Figure 9-7 in the text, and it is not clear what conclusion is drawn from these data.

Table 9-6 (Annex 7): It would be helpful to clarify the difference between years for which there are no data, years when the fishery was closed and years with a fishery but no catch (if this occurs).

p. 71 and Figure 9-8: the text refers to three Scottish dataseries but only one is shown in the figure. Additional dataseries from Sweden and France are described but are not presented in tables or figures. Why not?

pp 72–76: Sections 9-3 and 9-4 both describe landings data from the Country Reports and it is unclear why there are two Sections.

p. 73, Sec 9.3: there is no specific description of the reported/estimated landings in this section and more information is provided elsewhere in the report; more information is required on how different parts of the fisheries have changed (i.e. glass, yellow, silver eel). How has the EU Regulation affected the data, i.e. national closures and other measures?

p. 73, Figure 9-9: This figure should not be presented in Section 9 as it gives the impression that landings are reported for all those countries back to 1945. If such modelling results are presented, minimally, an accompanying panel should show the total reported landings, the modelled predicted landings, and the proportion of the predicted landings which are reported; Figure 2 shows an example developed using the data in Table 9.6. It is striking that the reported landings during 1945 to about 1992 totalled about 10 000 t annually.

p. 73, para 3: (the reference to Figure 8-10 should be Figure 9-10.) It would be more helpful to compare the mean catch over a number of years in countries reporting to WGEEL and countries not reporting to WGEEL rather than highlighting 2006.

p. 78, Table 9-7 and 9-8: It is unclear what can be drawn from Table 9-7 and no explanation is provided in the text. Similarly, no conclusions are drawn from Table 9-8.

p. 81: Section 9.5 deals with the compilation of data on stocking and Section 9.6 evaluates the size and origin of stocked fish and the development of 'glass eel equivalents'. These sections seem out of place in this sequence, as Section 9.7 is about fishing effort. Section 9.5, 9.6, and 9.8 deserve their own main section, given the question and the amount of detail.

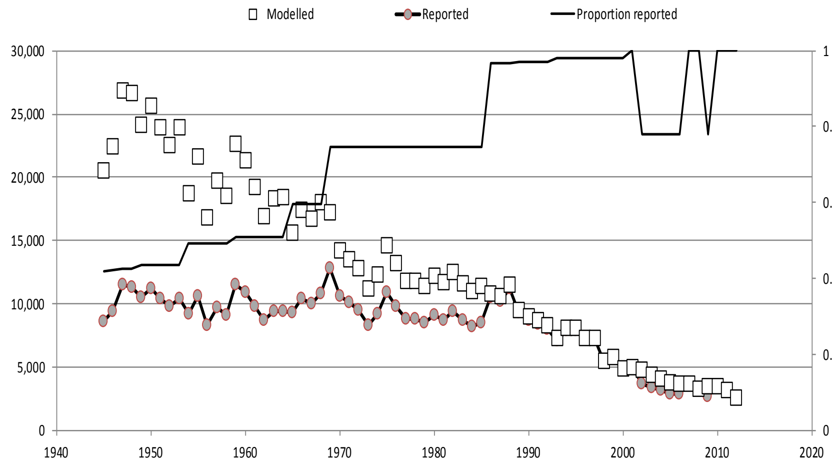

Figure 2. Reported landings (t) and modelled landings (t) (LH y-axis), and reported landings expressed as a proportion of the modelled landings (RH y-axis) by year (1945 to 2012) (x-axis).

p. 81: it would be helpful to clarify that the data presented in Figures 9-11 and 9-12 are derived from Tables 9-9 and 9-10 respectively; while information is provided on the stocking programmes in each country, it would be helpful to provide a summary that explains the overall trends in the data. Are there differences in the regional trends? What caused the decline in glass eel stocking from around 1990 and the increase in yellow eel stocking around the same time? Figure 9-13 presents the ratio of yellow to glass eel stocking, but is not referred to in the text.

p. 102, line 6: An annual mortality of 0.138 for glass eels seems unlikely. If the true mortality is higher than this, then the estimate of the number of 'glass eel equivalents' stocked will be underestimated.

p. 106–107, Figures 9-13 and 9-14: The captions refer to United Kingdom (GB); Northern Ireland is part of UK but not part of GB, so either UK or GB should be referred to. NB: with reference to other sections, GB is not an EU Member State, UK is.

p. 107: Section 9.7 deals with effort, which potentially provides a means for assessing trends in exploitation used in run-reconstruction approach, but no reference is made to these data in Section 7.

p. 109: Section 9.8 presents data on aquaculture from three sources, which show essentially the same trends. No explanation is provided for the decline in eel aquaculture production, although this appears surprising at a time when availability of wild caught eel must be declining. Is this because of difficulties of obtaining juvenile eels for on-growing?

p. 109, final para; refers to Country Reports being annexed to the report; they are not. [DONE]

p. 110, Table 9-15: the caption says the 'n.d.=no data' but the table itself shows 'N.A.'; is this the same? [DONE]

p. 111: Section 9.9 provides a brief summary of each of the earlier sections, some of which is repeated in other sections, but provides no overview. Conclusion on data and trends should appear before the section on eel stocking and aquaculture.

Section 10: Glass eel landings and trade

General comments

This section also addresses parts of ToR 'j' and has links to ToR 'l', however the overall purpose of the section is not entirely clear. Sections 10.2 to 10.4 deal with glass eel catches and trade, and thus cover much of the same ground as Sections 9.1, 9.5 and 9.6. Sections 10.5 and 10.7 address stocking and aquaculture and therefore overlap with Subsections 9.5, 9.6 and 9.8. Overall these sections are confusing, and it would be helpful to identify clear objectives for collating these data; the analysis could then be directed towards achieving those aims. These objectives might be to (reliably) quantify the anthropogenic losses to stocks from fishing and additions to stocks from stocking, and assess likely future trends.

There is a requirement under EMPs that those MSs with glass eel fisheries must set aside 60% for stocking, but there is no requirement for MSs to purchase these eels. Section 10.8 concludes that the stocking target is not being achieved by all MSs. Why are the remaining countries not stocking and not reaching targets - funding? Is the Working Group able to comment on where traceability is working and why data presented in Country Reports, EuroStat, etc. differ?

The information in Section 10.2 to 10.4 appears to be relevant to the EU-CITES Committee in relation to CITES discussions on the listing of eel, but it is not clear whether they are provided for or used by that committee.

Specific comments

p. 114, Table 10-1: The heading for col. 5 (Total (kg)) is unclear; it should perhaps be 'total utilised'. [DONE]

p. 115, final para: it is stated, '*EuroStat can well describe glass eel exports in Europe*' despite a number of caveats being highlighted; does this comment apply to the raw or corrected EuroStat data?

pp. 115–120: Sections 10-3 and 10-4 appear to address the same issues; it would be clearer if they were combined.

p. 116, Table 10-2: the caption states that, '*the intention is to show the technique, but specific outcomes will certainly change in future assessments*'; it's unclear what this means. i.e. what technique and what outcomes? [DONE]

pp. 117–119, Figures 10-1 to 10-3: a lot of information is included in the caption which would be better placed in the text (Section 10.3).

p. 130, para 2: it is stated, 'Recaptured eels showed a reduction in both LT and mass (mean ±s.d.=–1.5 ±0.9 cm and 125.3 ±50.1 g)...'. LT should be given in full; should 125.3 be negative? [DONE]

Section 11: Assessment of quality of eel stocks

General comments

This section addresses parts of ToR 'j' and 'k' and presents a review of literature relating to the effects of contaminants, diseases and parasites on eel and consideration of how such data may be incorporated into assessments. Section 11 is focused on the question of whether '*reduction of the fitness of potential spawners, as a consequence of (specific) contaminants and diseases, and the potential mobilization of high loads of reprotoxic* *chemicals during migration, might be key factors that decrease the probability of successful migration and reproduction. An increasing amount of evidence indicates that eel quality might be an important issue in understanding the reasons for the decline of the species.*'

Section 11.2 provides a useful review of recent literature on contaminants, diseases and parasites on the quality of emigrating eels. An update is provided on incidence of *Anguillicola crassus* in different countries but much of the information is not quantitative. Section 11.3 provides preliminary results from a model estimating the reproductive potential of silver eels when they reach the Sargasso Sea, depending on origin, size, sex, and initial fat content. While the report indicates many uncertainties in the model, the results highlight some interesting and potentially important considerations concerning the reproductive potential of eel from different areas (particularly the effects of distance to the spawning areas and size at emigration). The Working Group might consider incorporating uncertainties into the model, thus allowing an assessment, for example, of the proportion of eels that have a greater than X% probability of having a reproductive potential >Y.

While the current results are very interesting, it is premature to state, '*The new figures show considerable variation in reproduction potential between countries/catchments.*' (Section 11.6), and the Working Group should be more cautious about their conclusions. More work is required on some of the model inputs (e.g. energy costs of migration under oceanic conditions (effects of currents and pressure at different depths), the influence of shoaling, etc.).

The Working Group advocates international research be undertaken on eel quality and has developed a proposal, 'Towards understanding and quantifying the effects of contaminants on the reproductive success of the European eel and integration in stock wide assessments'. Section 11.4 addresses this proposal, and Sections 11.5 and 11.6 propose two Workshops and an International Project to take the work forward. Based on the result of these workshops a standardized monitoring protocol for assessing silver eel quality could become a requirement of the DCF or the Regulation. Monitoring eel quality is an expensive undertaking, and at the moment no guidance is available to prioritise what assessments should be conducted that will give meaningful information. While this is potentially important work, it should be evaluated against other data deficiencies and research needs to ensure that it is the highest priority area for improving the assessment and management of eel; at present collecting adequate information on catches, biological characteristics, and abundance indices that can be used to deliver a stock wide assessment must be a higher priority. Any progress made on improving the knowledge about the effects of contaminants will be difficult to incorporate in a stock wide assessment that doesn't exist.

Specific comments

p. 132, Sec 11: ToR 'a' should read ToR 'j'. [DONE]

p. 132, Sec 11.1: refs are required for relevant WGEEL reports.

Section 12: Local stock assessment

General comments

This section makes proposals for standardizing data collection to simplify and improve provision of reports to a range of customers/fora. Such efforts are to be commended, although the Working Group should be cautious about seeking excessive detail in the data reporting. Data needs should be identified in relation to specific requirements of customers. Thus, it would be helpful to prioritize the data which are most important for assessment purposes and those that are associated with meeting requirements under the EU Eel Recovery Regulation. Other information requirements are to address commitments on monitoring activities or commitments to CITES and it is not clear that these should be led by Science, including ICES. The priorities for the assessment are probably:

Catch-effort-cpue (Sec 12.2)
Stock (*not stocking*) indicator table (Sec 12.6)
Estimate of B_0 (Sec 12.11.2)
Biological data (Sec 12.9)
Management measures overview (for estimating changes in exp. rates) (Sec 12.8)
Management measures details (including expected effect on the stock) (Sec 12.11.3)

Other data tables listed are used for responding to other commitments unrelated to the assessment of the EU Eel Recovery Regulation.

Specific comments

Table 12-1: SI units are kg and km (not Kg and Km). [DONE]

Sections 13 and 14: Forward focus and research needs

General comments

Section 13 provides a brief history of eel management over the past ~five years and an evaluation of the assessments provided in Sections 4-8. It covers much of the same ground as Section 8 and might sensibly be combined with or replace that section. Section 14 addresses data deficiencies and research needs identified by the Working Group, although more detail on some research areas is provided in other sections and not all the proposals are for research. It would be helpful to have all the data deficiencies and research needs described in similar detail in one section. This needs to be accompanied by an evaluation of the priorities for the various proposals and a more systematic examination of what is feasible. Such an examination would assist in determining which analyses should be pursued and which dropped. At present it is difficult to determine whether eel quality, for example, is the most pressing research need or just has the most fervent advocate.

For a particular type of analysis, necessary input data would be listed and categorized as:

a) data that are in hand, or data which are available from ongoing and reliable data sources;
b) data which could be obtained through new research programs; and
c) data which are not possible to obtain.

From this, the examination would proceed to ask:

a) if a data category is not obtainable, are there alternatives or proxies that would nevertheless serve?
b) if the data category can be covered for part but not all of the species range, can the analysis nevertheless be successful?

The S–R analysis of Chapter 7 is a case in point. This analysis requires conversion of silver eel landings to biomass, using exploitation rate. For Europe, historic silver eel landings are of poor quality and exploitation rates are poorly known, and perhaps not known at all for early years. Further digging into historic data files might improve data quality somewhat, but overall quality will almost certainly remain low. There are also major uncertainties arising from silver eel production from non-EU countries, and it seems unlikely that these could be resolved. The question then becomes, in the face of immutable limits to data availability and quality, can the analysis nevertheless provide useful information? If the answer is no, then this analytic approach should be dropped from future planning.

In general, it is more tractable to obtain data in the future than from the past. The proposal for a coordinated campaign to estimate standing stocks (p. 186) might be a feedstock for useful analysis of stock status that is not reliant on historic data which may not be obtainable.

Section 15: References

References to ICES reports have been provided in a variety of formats and have frequently been omitted. The Working Group should cite the relevant report whenever previous work of the Working Group on related expert groups is referred to and should use the standard ICES format for these reports (e.g. ICES, 2013).

The following references are cited in the text (in page order) but are not present in (or are inconsistent with) the reference list: [ALL DONE]

FAO (2006), p. iv.

Cadima (2003), p. viii.

Åström and Dekker (2007), p.25.

ICES (1998), p.20, Sec 3.

Dekker (2000, 2008 and 2009), p. 22; sec 4.2.

Dekker (2008), p.22, p.38, p.48, p.52.

Dekker (2009), p.22.

Dekker (2010), p.31, p.32.

Dekker (2010a), p.23.

ICES (2013), p. 23, sec 4.2.

ICES (2012, DLS Guidance), p. 23, sec 4.3.

ICES (2000 and 2003), p. 23, sec 4.3.

Dekker (2003), p.40, p.73.

Allee (1931), p.51, Sec 7.6.

Hilborn and Walters (1992), p.51, Sec 7.6.

Walters and Kitchell, (2001), p.52, Sec 7.6.

ICES (2013), p.52, Sec 7.7.

Dekker (2002), p.62, Sec 9.1.

Andersson *et al*., 2012), p.72.

Pawson (2012), sec 10.8.

Pedersen, (2000), p.104.

Simon and Brämick, (2012), p.104.

Beaulaton *et al*. (2009) , p.108.

Briand *et al*. (2008), p.114.

Crook, (2013), p.124.

Couillard *et al*. (submitted), p.129, sec 10.8.

Prigge *et al*. (2013), p.129, sec 10.8.

Simon and Dörner (2013), p.130, sec 10.8.

Simon *et al*. (2013), p.130, sec 10.8.

Desprez *et al*. (2013), p.130, sec 10.8.

Clevestam *et al*. (2010), p.148 (NB Clevestam *et al*., 2011 provided in ref list.).

Geeraerts *et al*. (2010), pp. 153 and 209 (NB Geeraerts and Belpaire (2010) provided in ref list.)

The following reference appears in the reference list but does not appear to be cited in the report:

Mace and Sissenwine (1993) [DONE]

Annex 3: Draft ToR for WGEEL 2014

It would be helpful if future ToR clearly reflected (a) the specific advisory requirements (e.g. report on the status of the European eel stock by region), (b) methodological developments to meet those advisory needs (report on the further development a stock–recruitment relationship for European eel), (c) other issues requiring attention in order to provide the advice (e.g. research and data needs) (e.g. report on the development of methods to incorporate eel quality in current assessments.)

In addition see comments following each of the proposed ToR for WGEEL in 2014:

a) *Assess the latest trends in recruitment, stock and fisheries, including effort, indicative of the status of the European stock, and of the exploitation and other anthropogenic factors;*

How does this differ from ToR 'g'? Do you need both?

b) *Further develop the stock–recruitment relationship and associated reference points, using the latest available data;*

OK.

c) *Work with ICES DataCentre to develop a database appropriate to eel along ICES standards (and wider geography);*

Put the two data questions together so that they can be placed together in the report.

d) *Review the life-history traits and mortality factors by ecoregion;*

Provide a reason or question so that it is clear how the question should be addressed.

e) *Explore the standardization of methods for data collection, analysis and assessment;*

Put with ToR 'c'.

f) *Respond to specific requests in support of the eel stock recovery regulation, as necessary;*

Not needed; if a customer asks a question, ACOM will decide whether to pass it on.

g) *Report to ACOM on the state of the international stock and its mortality levels;* and

This should be one of the first ToR; it is not normally necessary to refer to the customer, but since the Working Group is proposing the ToR this may be helpful.

h) *Address the generic EG ToR from ACOM.*

Not needed; if ACOM has generic questions it will ask them.

Annex 4: Recommendations

In 2012, the Working Group (ICES 2012) made 16 recommendations but there is no update to say what progress has been made or is planned.

It is not clear where Recommendation 1 originates from in the report.

The following recommendations are made in the report but not included in Annex 4:

> p.132: It is recommended that all countries adhere to the conditions laid out in the Eel Regulation of 2009 and establish the required international traceability system in line with Article 12.
>
> p.154: WGEEL 2013 recommended the development of standardized and harmonized protocols for the estimation of eel quality through the organization of a Workshop of a Planning Group on the Monitoring of Eel Quality.
>
> p.155, Sec 11.8: We recommend that monitoring of silver eel quality should be introduced as part of new or existing programmes (DCF/DCMAP).
>
> p.185: It is recommended that research to investigate factors that cause Natural Mortality (M) to vary in space and time be given the high priority. Thus further data collection and research should be encouraged to support and improve the knowledge of this difficult research topic in order to obtain more and more reliable stock assessments.

Annex 7: Chapter 9 tables

It is not clear why some tables are in this Annex while others are in the text. [NB Is there a standard ICES format; e.g. placing all tables and figures at the end of each section?]

4. Literature cited

Burgerhout E., Brittijn S.A., Tudorache C., deWijze D.L., Dirks R.P., van den Thillart G.E.E.J.M. 2013. Male European eels are highly efficient long distance swimmers: Effects of endurance swimming on maturation. Comp. Biochem. Physiol. A. http://dx.doi.org/10.1016/j.cbpa.2013.08.002.

Hilborn, R. and C. J. Walters. 1992. Quantitative fisheries stock assessment: choice, dynamics and uncertainty. Chapman and Hall, New York.

ICES. 2009. Report of the ICES Study Group on anguillid eels in saline waters (SGAESAW). ICES CM/DFC:06. 183 pp.

ICES. 2012. Report of the Joint EIFAAC/ICES Working Group on Eels (WGEEL).

ICES. 2013a. General context of ICES advice. In Report of the ICES Advisory Committee, 2013. ICES Advice 2013, Book 1, Section 1.2.

ICES. 2013b. Report of the Working Group on North Atlantic Salmon (WGNAS), 3–12 April 2013, Copenhagen, Denmark. ICES CM 2013/ACOM:09. 380 pp.

ICES. 2013c. Report of the Workshop on Evaluation Progress Eel Management Plans (WKEPEMP), 13–15 May 2013, Copenhagen, Denmark. ICES CM 2013/ACOM:32. 757 pp.