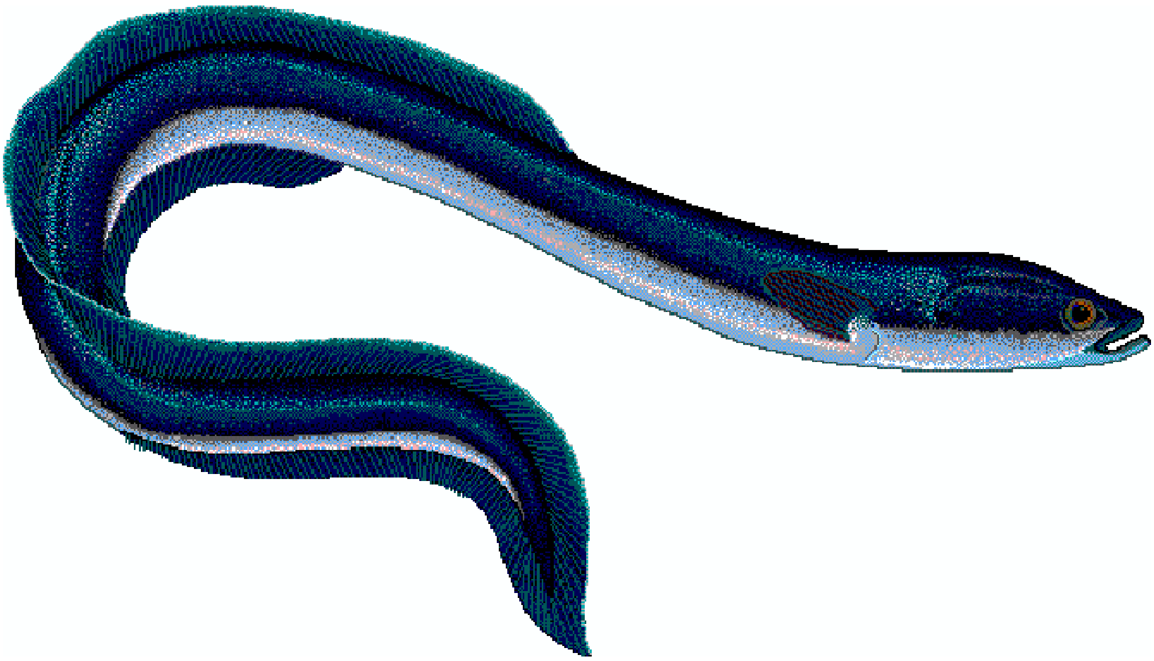
OSPAR COMMISSION

# Background Document for European eel

## *Anguilla anguilla*



Biodiversity Series

2010

### OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention") was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

### Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998.
La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l'Espagne.

## Acknowledgement

This document was prepared by Amelia Curd for France as lead country. The contributions of the following are gratefully acknowledged: Anthony Acou, Alexandre Carpentier, Eric Feunteun, Tony Robinet, Claude Belpaire, Kris Cooreman, Isabel Domingos, Sabine Christiansen.

Photo acknowledgement
Cover page: Illustration of European eel© Robbie N. Cada, FishBase

# Contents

# Background Document for the European eel *Anguilla anguilla*

## Executive Summary

This background document on the European eel *Anguilla anguilla* has been developed by OSPAR following the inclusion of this species on the OSPAR List of threatened and/or declining species and habitats (OSPAR Agreement 2008-6). The document provides a compilation of the reviews and assessments that have been prepared concerning this species since the agreement to include it in the OSPAR List in 2008. The original evaluation used to justify the inclusion of *A.anguilla* in the OSPAR List is followed by an assessment of the most recent information on its status (distribution, population, condition) and key threats prepared during 2009-2010. Chapter 7 provides recommendations for the actions and measures that could be taken to improve the conservation status of the species. In agreeing to the publication of this document, Contracting Parties have indicated the need to further review these proposals. Publication of this background document does not, therefore, imply any formal endorsement of these proposals by the OSPAR Commission. On the basis of the further review of these proposals, OSPAR will continue its work to ensure the protection of *A.anguilla*, where necessary in cooperation with other competent organisations. This background document may be updated to reflect further developments or further information on the status of the species which becomes available.

## Récapitulatif

Le présent document de fond sur l'*Anguille européenne* a été élaboré par OSPAR à la suite de l'inclusion de cette espèce dans la liste OSPAR des espèces et habitats menacés et/ou en déclin (Accord OSPAR 2008-6). Ce document comporte une compilation des revues et des évaluations concernant cette espèce qui ont été préparées depuis qu'il a été convenu de l'inclure dans la Liste OSPAR en 2008. L'évaluation d'origine permettant de justifier l'inclusion de l'*Anguille européenne* dans la Liste OSPAR est suivie d'une évaluation des informations les plus récentes sur son statut (distribution, population, condition) et des menaces clés, préparée en 2009-2010. Le chapitre 7 fournit des propositions d'actions et de mesures qui pourraient être prises afin d'améliorer l'état de conservation de l'espèce. En se mettant d'accord sur la publication de ce document, les Parties contractantes ont indiqué la nécessité de réviser de nouveau ces propositions. La publication de ce document ne signifie pas, par conséquent que la Commission OSPAR entérine ces propositions de manière formelle. A partir de la nouvelle révision de ces propositions, OSPAR poursuivra ses travaux afin de s'assurer de la protection de l'*Anguille européenne*, le cas échéant avec la coopération d'autres organisations compétentes. Ce document de fond pourra être actualisé pour tenir compte de nouvelles avancées ou de nouvelles informations qui deviendront disponibles sur l'état de l'espèce.

# 1. Background Information

### Name of species

*Anguilla anguilla* (Linnaeus, 1758) European eel.

### Species ecology and reproductive biology

European eel life history is complex and atypical among aquatic species. As the European eel is believed to spawn in the eastern part of the Sargasso Sea (although spawning has never been directly observed) so the distribution of eels on their spawning migration extends all the way from northern Europe across the Atlantic Ocean and down to the Sargasso Sea, north by north-east of the West Indies. The newly hatched leptocephalus larvae drift with the Gulf Stream and the North Atlantic Current to the continental shelf of Europe and North Africa where they metamorphose into glass eels that enter continental waters at an age of approximately 1-2 years according to authors and methods (Lecomte-Finiger 1992; Bonhommeau et al. 2009). This question still remains unsolved. Glass eels can settle in estuaries or migrate further up in the river basin before they become yellow eels. This stage may last from 2-25 years (even more than 50 years) prior to maturation and metamorphosis to the silver eel stage.

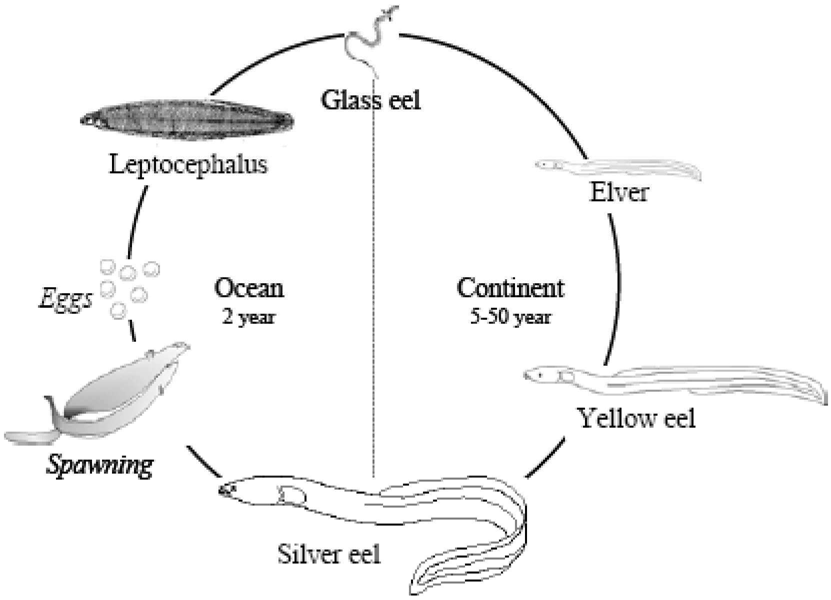



Figure 1: The life cycle of the European eel (Dekker, 2000). The names of the major life stages are indicated. Spawning and eggs have never been observed in the wild.

Age at maturity varies according to latitude, ecosystem characteristics and density-dependent processes (Feunteun et al., 2003; Robinet et al., 2007; Acou et al., 2009). The European eel life cycle is shorter for populations in the southern part of their range compared to the north and therefore the age at which the eels become silver varies from four to twenty years (Feunteun, 2007). Silver eels then migrate to the Sargasso Sea where they spawn and die after spawning (Tesch 2003).

Yellow eels can however be found in estuarine and coastal habitats throughout the area where glass eels occur naturally, and some may actually remain in the marine environment during their entire life cycle (Tsukamato et al. 1998).

## 2. Original Evaluation against the Texel-Faial selection criteria

### List of OSPAR Regions and Dinter biogeographic zones where the species occurs

OSPAR Regions: I, II, III, IV & V

Dinter biogeographic zones: Azores shelf, Lusitanean (Cold/Warm) , Cold-temperate pelagic waters, Boreal-lusitanean, Seamounts and plateaus Norwegian Coast (Finnmark), Norwegian Coast (Westnorwegian) , Norwegian Coast (Skagerrak), Southeast Greenland, North Iceland Shelf, High Arctic Maritime, North Atlantic Abyssal Province

### List of OSPAR Regions where the species is under threat and/or in decline

All where it occurs.

### Original evaluation against the Texel-Faial criteria for which the species was included on the OSPAR List

*A.anguilla* was nominated for inclusion in the OSPAR list on the basis of an evaluation of its status according to the Criteria for the Identification of Species and Habitats in need of Protection and their Method of Application (the Texel-Faial Criteria) (OSPAR 2003), with particular reference to its global/regional importance, decline and sensitivity, with information also provided on threat.

**Table 1:** Summary assessment of *A. anguilla* against the Texel-Faial criteria

| Criterion | Comments | Evaluation |
|---|---|---|
| Global importance | Global importance. As a conservative estimate, at least 80% (possibly 100%) of the larvae of European eel pass through the OSPAR Maritime area, and at least 50% of the adult eels live in river systems flowing into the area. Therefore, OSPAR Maritime Area is of global importance for *Anguilla anguilla* (OSPAR 2008). | Qualifies |
| Regional importance | The European eel (*Anguilla anguilla*) is widely distributed in marine, coastal and freshwater habitats of Europe and occurs from the Atlantic coast of North Africa, in all of Europe (including the Baltic Sea) and in the Mediterranean waters of Europe and northern Africa. In addition the European eel also occurs in the Canary Islands, Madeira, the Azores and in Iceland. The latter island is probably unique because it also harbours American eels (*Anguilla rostrata*). Furthermore, there is also evidence of natural hybrids of the two eel species occurring there (Avise et al. 1990 in CITES 2007; Albert et al. 2006). | Qualifies |
| Rarity | According to the Texel-Faial Criteria, the total population size determines the rarity of a highly mobile species such as the European eel. Despite the fact that the stock is at a historical minimum in most of the distribution area and continues to decline (ICES 2008), European eels are still common in many areas thanks to stocking in northern Europe (OSPAR 2008). Furthermore, there are currently no overall estimates of total population size or number of mature individuals for this species (FAO 2007). | Does not qualify |

| | | |
|---|---|---|
| Sensitivity | The European eel *Anguilla anguilla* has an unusual life history, making its sensitivity difficult to assess. Eels are long-lived and spawn only once in their lifetime (OSPAR 2008). An analysis of the stock dynamics under different management regimes indicates that the recovery time for eel could be expected within 80 years of reducing fisheries to zero, whereas under an ultimately sustainable fishing regime of just 10% of the current rate of fishing mortality, recovery may take more than 200 years (Åström and Dekker 2007). There are however other models (Knights & Bonhommeau (unpublished data and analyses), *in* ICES (2009a): which predict that a recovery of recruitment patterns to "normal" levels is possible within 10 years under favourable climatic conditions. Other (non-natural) causes of mortality (including e.g. by turbines) also need to be taken into account. | Qualifies |
| Keystone species | Not a species which has a controlling influence on any community within the OSPAR region. | Not applicable |
| Decline | The decline in glass eel recruitment was first noticed in 1985 (EIFAC 1985). The prolonged decline in landings was mentioned as early as 1975 (ICES 1976) but has received much less attention than that of recruitment. After a considerable drop in recruitment in the 1980s, glass eel abundance is still at a low level, with no signs of an upturn. | Qualifies – severely declined |

Threats have not changed since the species was listed, but are further described in section 4, below.

### Relevant additional considerations

**Trade and restocking:** Although adult eel products are imported into the European Union, the primary product in trade in the European Union for the past decade has been exports of live young eels for aquaculture (Ringuet *et al.,* 2002). Value of live young eels has greatly increased on European markets in response to demand from Asian aquaculture producers and is high enough to support smuggling of live young eels (FAO 2007). Since artificial reproduction of the eel is currently at the experimental stage and is highly costly for the Japanese eel *Anguilla japonica* and experiments on artificial reproduction conducted on the European Eel (successful hatching of larvae in studies in The Netherlands and Denmark) are unlikely to yield a commercially viable reproduction in the short- to medium-term,, all aquaculture and restocking has to rely on capture of wild glass eels (OSPAR 2008). Restocking glass eels in a particular water body does have a positive effect on the yield, some years later. Whether restocking actually contributes to the spawning stocks is unknown (Dekker 2003).

There is no international database of glass eel yield and/or trade. Statistics on landings include total catch per country, comprising both glass eel fisheries and fisheries for yellow and/or silver eels. It does not appear possible to provide very clear analyses about the trade paths of glass eels because the situation is very dynamic or poorly reported (ICES 2008). However, by combining data from various sources, Dekker (2003), presented the following picture for the early 1990s (Fig.2). Most of the annual recruitment is used for aquaculture, mainly in Asia (43%) but also within the EU (7%); As for the remaining part 18% is consumed as glass eel (mainly in Spain); 18% is trapped and transported to restocking areas (within or between countries); and 14% migrate freely to inland waters. Glass eels are mainly purchased from France or from the UK. However, even glass eels bought from the UK, may previously have been imported from France.

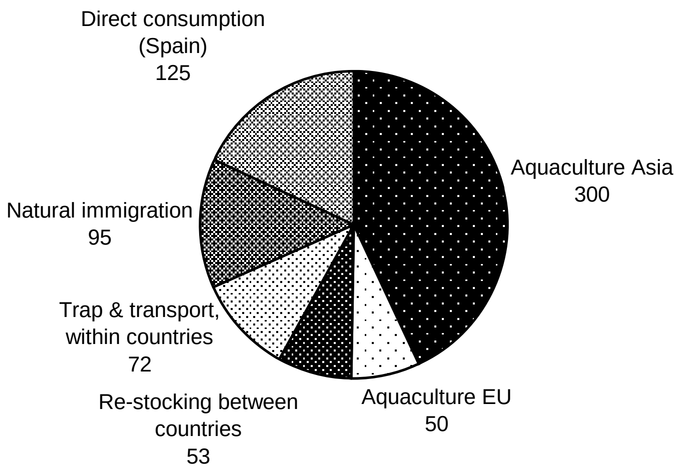



Figure 2: Disposition of glass eel landings in the EU. Numbers indicate quantities in metric tons per year. (Data for the mid-1990s, from Moriarty and Dekker 1997; Dekker 2000b in Dekker 2003)[1].

The CITES proposal also provides an estimate that some 43 percent of glass eel landings were exported to Asia in the mid-1990s (CITES 2007). Despite considerable uncertainty about some of the figures, it seems clear from the information available that substantial quantities of young European eels originating in the European Union are in international trade, and may represent around one-third of production in recent years. Given also the recent very high values for live young eels on international markets stemming from a general decline in availability, it is reasonable to conclude that international trade is a significant factor in driving fisheries for young European eels.

At present it is not possible to trace the origin and trade paths of glass eels and young yellow eels. However, as a consequence of the obligations arising in 2009 from the CITES convention (*A. anguilla* was listed under Appendix II of the convention but this protective measure entered into force in March 2009) and from the EU Council Regulation (1100/2007 the “Eel Regulation” *cf.* section 5), Member States have to develop systems for the traceability of traded eels. Consequently, the availability of information on numbers/biomass of eel traded and their trade paths are expected to improve in the future (ICES 2008). Although the EU Regulation 1100/2007 requires that 35%, rising to 60%, of glass eel catches are made available for stocking to enhance the stock, there is continuing and urgent requirement for robust evidence of the extent to which stocking and transfer on local, national and international scales can contribute to improved spawner escapement. Significant risks remain of disease and parasite transfer via stocked material, both from stocking of glass eel and on-grown eels. Stocking protocols should include procedures to prevent the introduction and spreading of parasites and diseases, and the eel should be included in the European fish disease prevention policies to help minimise health risks (see section 4).

[1] Recent figures for glass eel landings have been estimated to a total of only 40t (Draft Report of the 2009 Session of the Joint EIFAC/ICES Working Group on Eels, Gothenburg, Sweden, 7.-12. September 2009).

# 3. Current status of the species

### Distribution in the OSPAR maritime area

In the Anguillidae family, the European eel is most certainly the species with the widest distribution area. Its continental distribution (figure 3) stretches across the majority of coastal countries in Europe and North Africa, with its southern limit in Mauritania (30°N) and its northern limit situated in the Barents Sea (72°N). All of the Mediterranean basin and the Black sea also contain European eels up to 45°E (Adam 1997).

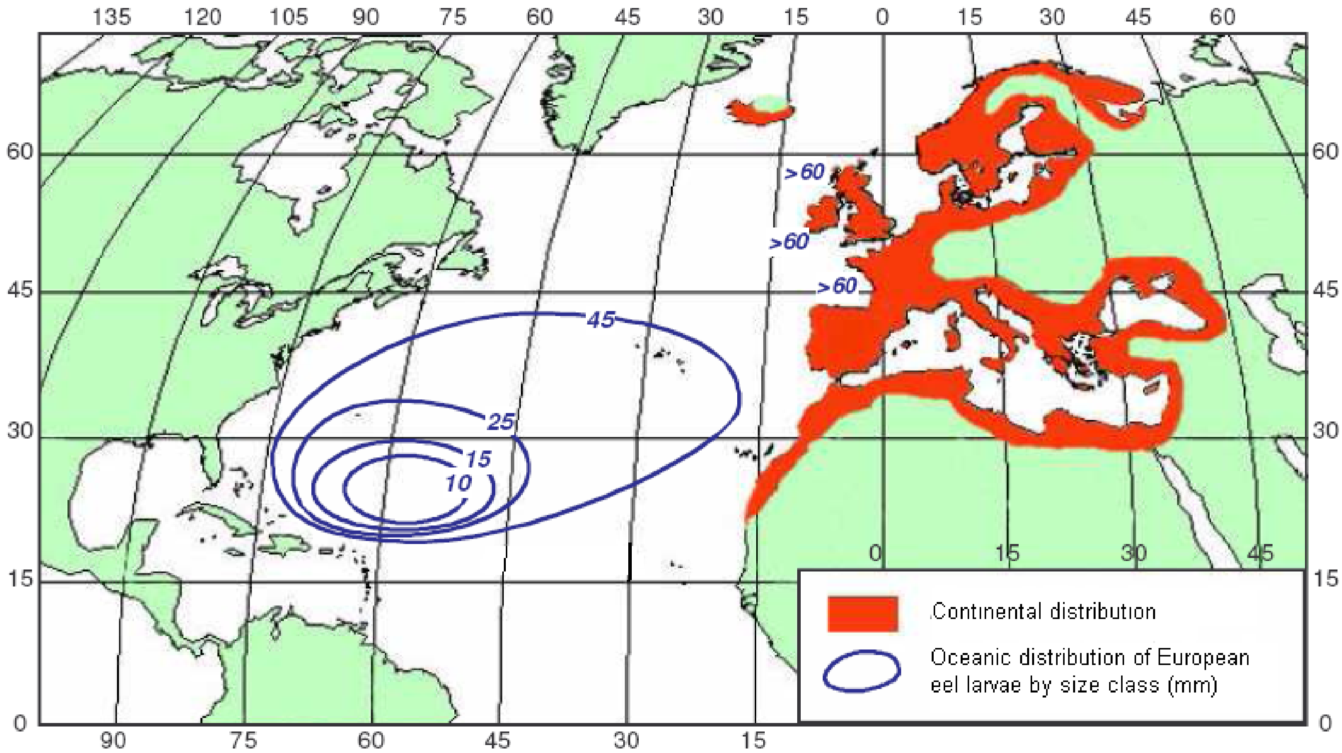



Figure 3: Distribution area for *A.anguilla*, adapted from Adam (1997).

The ecosystems which constitute the eel's habitat are many and varied; brackish waters (bays, fjords, lagoons, estuaries), lotic (rivers, streams, torrents) and lentic (lakes, ponds, canals) freshwater systems; only physical obstacles to migration seem to restrain the eel's upstream distribution area.

The marine phase in the distribution of this species was explored during the oceanographic campaigns of Schmidt in 1906 and 1920.A distribution map of the pre-leptocephalus and leptocephalus larvae was drawn up, which by taking account of the total length of captured individuals, enabled to locate the hypothetical spawning site for the European eel in the Sargasso sea (between 22° and 30°N and 48 and 74°W depending on the studies (Schmidt 1922; Mac Cleave et al., 1987 in Adam, 1997).

### Population (current/trends/future prospects)

It has been generally accepted that the European eel comprises a single panmictic stock (e.g. Schmidt 1925, DeLigny and Pantelouris 1973, Tesch 1977, Avise, Helfman, Saunders and Hales 1986, Lintas, Hirano and Archer 1998 in CITES 2007). A study by Wirth and Bernatchez (2001) who used highly polymorphic gene markers provided evidence of genetic differentiation. These authors found that the distribution of genotypes were indicative of non-random mating and indeed of restricted gene flow among eels from the three broad groups found – the Mediterranean, the North Sea and Baltic and the northern groups (Iceland) respectively. These findings would have had far-reaching implications for eel management. However, a more recent study (Dannewitz et al 2005) indicated a more subtle, temporal pattern, that might have appeared as a spatial pattern in the study of Wirth and Bernatchez (2001), due to unsynchronised sampling in northern and southern areas. Whether a single panmictic stock or a species with a more complex stock structure, the management of the European eel must be co-ordinated to ensure adequate escapement throughout the species range (Russel and Potter 2003). Taking this into account the ICES Working Group on Application of Genetics in Fisheries and Mariculture (WGAGFM) recommended in their 2007 report that "in the light of emerging information suggesting putative stock structure of European eel, it is recommended from the genetic viewpoint that glass eels, elvers and other life history stages should not be trans-located between river basins for restocking purposes" (OSPAR 2008).

In its present advice on eel management, ICES expressed its concerns about re-stocking programmes for several reasons. The amount of glass eels available for re-stocking is probably too low to meet the requirements on a stock-wide scale. Furthermore, there are mortalities related to the catch and transport of glass eels and anthropogenic stresses in the river systems where the eels are stocked may sometimes be higher than in the source rivers. In addition, it is still not clear if stocked eels are able to migrate to the spawning grounds and contribute to the spawning portion of the stock.

Therefore, ICES advises to consider re-stocking critically. If re-stocking is chosen as an option for management, it should be done carefully and preferably in unpolluted waters with low burdens of pathogens and diseases and minimal other anthropogenic stresses like fisheries and hydropower turbines. The target has to be an enhancement of silver eel escapement

Elver recruitment in Northern Europe has declined by approximately 90%[2] in the last two decades possibly due to a combination of increases in man-made structures acting as barriers to migration, pollution, changing oceanic currents, overfishing and exposure to the parasite *Anguillicoloides crassus* (cf. section 4). All available information indicates that the stock is at an historical minimum in most of the distribution area and continues to decline. Fishing and other anthropogenic mortalities are thought to be high both on juvenile (glass eel) and older eels (yellow and silver eels). Recruitment to the stock is at a historically low level and most recent observations do not indicate any recovery. Recruitment is presently at only 5% of the level observed in the 1970s. Figure 4 illustrates the recruitment of glass eels and elvers in Northern Europe.

Every area shows a declining trend between the end of the 1970s and the beginning of the 1980s. In recent years, recruitment is continuously declining in all areas, with the strongest decline occurring in the more northern and southern parts of the distribution. The mean recruitment for the past 5 years (2004–2008) is 10%, 9%, 3%, 3% and 1% of the 1970s reference level, for the British Isles, Atlantic Ocean, Baltic Sea, Mediterranean Sea and North Sea respectively. Officially reported yield data have declined to about 25% of that from the mid-1960s (ICES 2008).

[2] According to the most recent analyses (Draft Report of the 2009 Session of the Joint EIFAC/ICES Working Group on Eels, Gothenburg, Sweden, 7.-12. September 2009), present recruitment to the Baltic is at about 91% when compared to the average of the period 1979-1994. The reason is, of course, that the decline in the Baltic region started already in the 1950's and 1960's. Therefore, the reference level for this comparison (average of 1979-1994) was already lower.

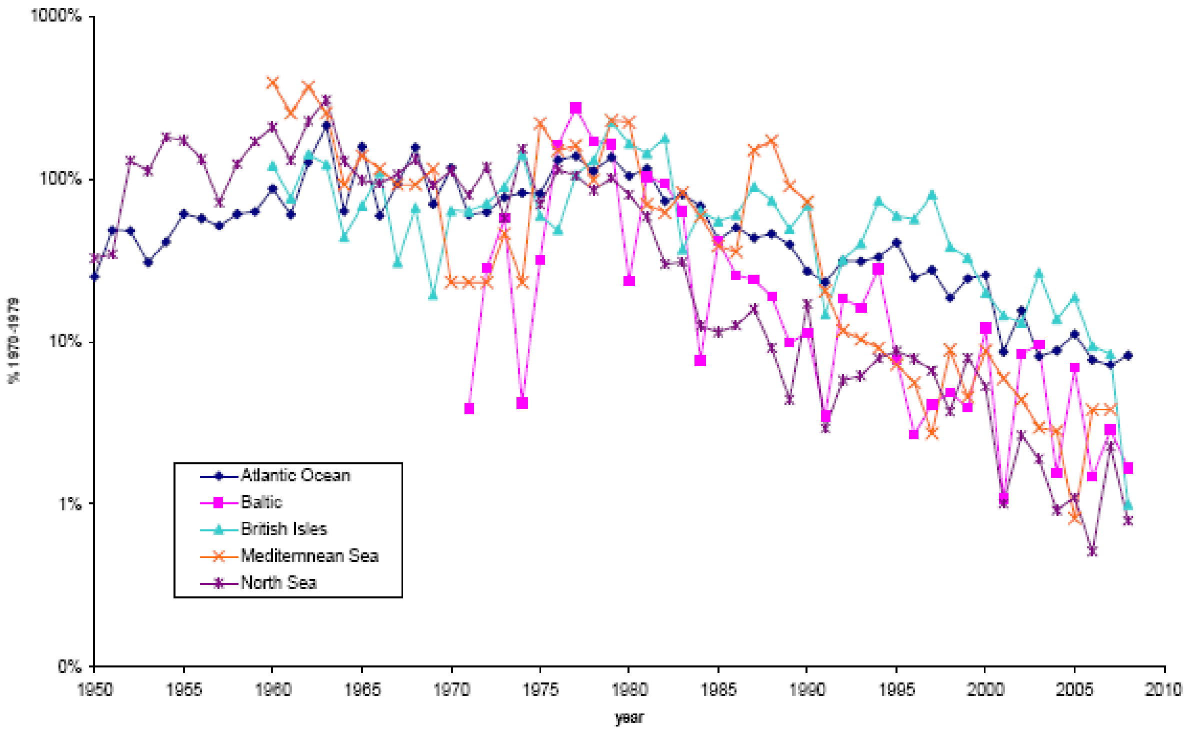



Figure 4: Recruitment (glass eel and elvers) index per area in logarithmic scale. Each series have been scaled to 1970–1979 average (ICES 2008).

### Condition (current/trends/future prospects)

The overall status of the eel stock is poorly known. Neither the absolute size nor the overall impact of exploitation and other anthropogenic factors have been reliably assessed.

### Limitations in knowledge

**Eel research needs:** National monitoring of the various eel stages is fragmentary. Some traps on rivers provide fairly reliable data on upstream migration of young yellow eels, but there are virtually no regular routine surveys of yellow and silver eels in fresh water or along the coasts. Routes of the adult spawning migration, location of spawning sites, spawning conditions and reproductive biology are still largely unknown. The lack of specific knowledge about eel biology, particularly about the spawning area and aspects of larval biology, makes it difficult to identify changes in the environment that might be critical to eel survival. Possible factors include changes in access to food as well as changes in the direction and intensity of ocean currents that transport the leptocephalus larvae to European coasts (OSPAR 2008). Moreover, the marine stages of the European eel still remains very poorly documented. There is still a controversy about the duration of the larval migration as physical transport models predict 2 to 3 years of migration from Sargasso sea to European coasts (e.g. Bonhommeau et al. 2009) while otolith readings predict a maximum of 1 year. None of the approaches have been thoroughly validated up until now.

The size of the silver eel population remains badly known as no overall population estimate is available. This is mainly due to the lack of information on marine habitats as estuaries and coastal waters. There is an urgent need to produce reliable estimates of silver stocks in marine habitats. The fate of silver eels after their escapement from inland habitats is currently unknown.

The joint EIFAC/ICES Working Group on Eels (WGEEL) believes that the best approach is a series of integrated and internationally co-ordinated projects which are set out in Figure 5. A research programme is needed to address gaps in knowledge, gather data to evaluate the overall status of the stock, and further develop holistic stock assessment methods to determine compliance with targets and the effectiveness of management actions at the international and local level.

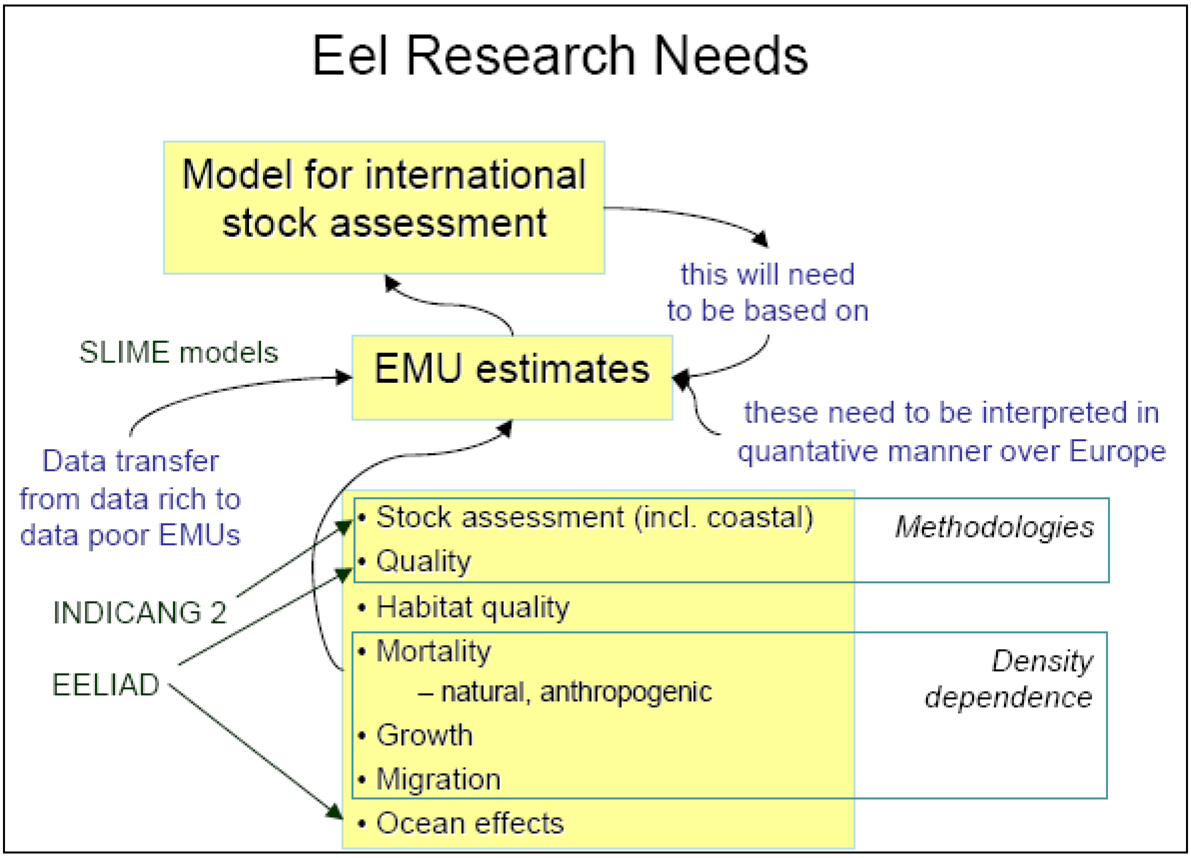



Figure 5: Flow diagram showing linkages between research needs (ICES 2008). (EMU= Eel Management Unit).

The three multinational research projects presented in figure 5 are briefly outlined below:

**SLIME** (Study Leading to Informed Management of Eels - http://www.diadfish.org/english/SLIME.htm)

The European Commission has initiated the development of a stock protection and restoration plan. Within this framework, the SLIME project tested quantitative models of eel stock dynamics, in spring 2006.

**INDICANG 1** (Indicateurs d'Abondance et de colonisation sur l'anguille européenne *Anguilla anguilla* - http://www.ifremer.fr/indicang/version_anglaise/introduction.htm )

INDICANG 1 developed indicators of stock status for glass, yellow and silver eel stages, and habitat quality. INDICANG 2 is an INTERREG (Atlantic Arc) project building on the outputs from INDICANG 1. Although not yet approved, INDICANG 2 intends to focus on testing the tools needed to support the post-evaluation of Eel Management Plans.

**EELIAD** (http://www.eeliad.com/index.html)

EELIAD is a scientific research project that aims to resolve some of the mysteries of eel biology, and to use this information to help conserve the European eel stock. The project will integrate and take advantage of significant recent improvements in techniques such as animal tracking, genetics and advanced mathematical modelling. The techniques will be combined in a large-scale field programme that will run between 2008 and 2011 and will be linked to studies and observations undertaken in other research and monitoring projects in freshwater and brackish environments to enable a comprehensive understanding of the life-cycle of eels to be developed.

There are few quantitative estimates of pristine (pre-1980) and current silver eel production to allow comparisons to be made between systems and there is few data on the importance of estuarine and coastal populations to overall production. Modelling will be needed to transfer estimates from data rich to data poor systems. Some approaches have been outlined by the ICES Working Group on Eels which complements those presented in previous working groups and in EU SLIME (ICES 2008).

**The European Eel Quality Database:** As there is a growing need to report on eel quality data, the EIFAC/ICES Working Group on Eels initiated in September 2007 the set up of a European Eel Quality Database to collate recent data on contaminants and diseases over the distribution area of the eel. It now represents the first comprehensive pan-European compilation of eel quality data, including data from over 3500 eels from approximately 550 sites over twelve countries (Belpaire et al., in prep). The database is coordinated by the Research Institute for Nature and Forest (Belgium) and includes data on eel quality elements, such as condition, contaminant concentrations and epidemiological parameters, in addition to the relevant descriptors of date and place of sampling and sample characteristics (eel life stage, number of individuals and morphometrics). The database will contain the eel quality data collected in the context of the monitoring within the eel management units, but will also contain data collected for a variety of reasons such as chemical monitoring in the biota for the WFD, monitoring of fisheries products for human consumption, academic research on chemical contamination, toxicology or disease epidemiology.

The EEQD provides a useful instrument for the compilation and scrutiny of these data, enabling the use of these results for the development of future eel management plans aimed at the restoration of the stocks. The WGEEL (2007) has recommended that the European Eel Quality Database should be further developed and maintained. Initiated in 2007, the database has indicated a number of shortcomings and future developments will be needed, especially regarding expansion of the quality elements recorded, harmonisation of the methodology, quality assurance, communication, and database design (Belpaire et al., in prep).

## 4. Evaluation of threats and impacts

A summary of the key anthropogenic activities carried out in inland waters, which can cause impacts to *A.anguilla* is given in Table 2.

**Table 2.** Summary of key threats and impacts to *A. anguilla*

| Type of impact | Cause of threat | Comment |
|---|---|---|
| Obstacles blocking access to upstream and downstream migration | Development: Building of dams and navigation weirs/lochs | Accessibility between inland waters and the sea is crucial for the natural occurrence and dispersal of European eels. Eels stocked in upstream rivers and streams can seldom reach the ocean on their spawning migration, due to a multiplicity of possible hazards, mostly electrical turbines, dams, weirs, and drained watercourses (OSPAR 2008). There is also evidence that eels are blocked or killed when they migrate through oxygen depleted estuaries, due to port activity and dredging. |
| Pollution by contaminants | Contamination by PCBs, brominated flame retardants, pesticides/herbicides, heavy metals and other endocrine disrupting compounds, cyanotoxins | There is an increasing amount of evidence that pollution by contaminants impairs the health of the eel, and – more specifically – its reproductive capacity. Due to their specific physiological and ecological traits, eels accumulate considerable amounts of (especially lipophilic) contaminants (Belpaire and Goemans, 2007a). Body burden is highly dependent of the environmental chemical pressure at the habitat where the eels grew up. Concentration levels in the fat of their muscles and gonads is a reflection of the actual concentrations in the environment (Belpaire *et al.*, 2008). Consequently, chemical body burden can attain high levels.<br>In the absence of quantitative dose-response studies on the effects of eel quality on the capacity of eel to migrate and spawn successfully, comparisons of the data in the EEQD with threshold values of toxic compounds in other fish species, indicated that the body burden of compounds such as PCBs, DDT and dieldrin in eels from many parts of Europe are so high that effects at the population level are likely to occur (ICES 2009a, in press).<br>Many chemicals have been demonstrated to exert detrimental effects on diverse physiological functions/processes in the eel (disturbances of the immune system, the reproduction system, the nervous system and the endocrine system; for a review: Geeraerts and Belpaire, 2009). Specific chemicals may affect lipid metabolism, and fat levels in eels from Belgium and The Netherlands decreased significantly by about one third (from ca. 20% to 13%) during the last 15 years, jeopardizing a normal migration and successful reproduction (Belpaire *et al.*, 2009). Both, the reduction of the lipid energy as a consequence of (specific) contaminants, and the mobilization of high loads of reprotoxic chemicals during migration, seem to be key elements decreasing the probability of a successful migration and normal reproduction (Geeraerts and Belpaire, 2009).<br>Hence, contaminants are believed to be an important issue in the decline of the species (Belpaire, 2008). |

| | | |
|---|---|---|
| Overfishing | Fishing at all life stages, poaching | European eel is subject to fishing at all continental life stages from juveniles to adults, and some estimates of total fishing mortality over the life cycle are very high (e.g. Dekker (2000) in FAO 2007), suggesting a high level of risk to the population. European eel has been commercially heavily exploited in fisheries, though catches in many areas have considerably decreased. Different life stages of eel are targeted in several countries. The youngest eel stages (glass eel and elvers) are heavily exploited as they supply a worldwide established eel aquaculture industry, discussed under section 2. Yellow and silver eels are also major targets for freshwater and coastal fisheries. The fishing yield of European eel represents more than half of the world eel fisheries on all eel species. According to FAO databases, annual averages in the 1990s were of the order of approx. 15,000 tons out of a world fisheries catch of some 29,000 tons (CITES 2007). There are various regional management measures currently undertaken to regulate European eel fisheries. Ringuet et al. (2002) listed the principal conservation measures in place for glass, yellow and silver eels. These include (in various different countries: a ban on commercial fishing of glass eels, gear regulations, quotas, closed seasons, licences for fishing/dealing, size limits, free gaps in weirs and requirements for elver passes. Illegal eel fishing is known to be carried out, and is particularly active in southern Europe (Ringuet et al. 2002). Glass eel poaching in France represents 20–30% of catches, and in many regions either equals or exceeds legal catches (Anon. 2006). |
| Larvae mortality | Climate change | A negative relationship of recruitment to the North Atlantic Oscillation (NAO) index and to an index of mid-water temperatures in the Sargasso sea has been demonstrated (Knights 2003) but is unable to explain the decline since 1990. However a comprehensive analysis including multidecadal climate change is lacking. Fluctuations arising from environmental variation are therefore not considered sufficient to account for most of the decline (FAO 2007). The parallel decline in European and American eels, both of which spawn in the Sargasso Sea, has been taken as another evidence that changes in ocean currents resulting from climate change may have interfered with larval transport leading to reduced recruitment in both stocks. While this does not exclude the need to reduce the mortality in some types of fisheries, it acknowledges the reality that restricting trade alone may not be sufficient to bring about recovery (CITES 2007). |
| Juvenile mortality | Power stations water intake | Long, thin fish are particularly vulnerable to passage through pumps and other moving machinery. Where cooling water intakes are present, small numbers of migratory eels are killed each year. Because of their large size the cooling water intakes of direct-cooled coastal power stations are almost certainly the most damaging. |

| | | |
|---|---|---|
| Diseases and Parasites | *Anguillicoloides crassus* parasite, viruses | In recent years, eels have been affected by parasites (e.g. the swim-bladder nematode *Anguillicoloides crassus*), viruses (*EVEX, EVE, HVA*) and other diseases. Effects were reviewed by WGEEL (2006). Parasite infections are not only a reflection of general health problems, but in extreme cases, such as with *Anguillicoloides crassus,* may cause debilitation and even mortality. *Anguillicoloides* infections have been shown to damage swim bladders and impair the swimming ability of infected eels. The impact of *Anguillicoloides* has not been evaluated at the stock level. This parasite, originating from East Asia (the original host is *Anguilla japonica*) was introduced in Europe in the early 1980s, probably through the uncontrolled import of infected eels from eastern Asia. In 1995 it also appeared in the United States, most likely due to uncontrolled aquaculture eel shipments. In Europe, eel populations are already from 30% to 100% infected with the nematode (ICES 2008). |
| Habitat destruction | Land reclamation, canals, embanking, | The INDICANG1 project has estimated that wetlands and backwaters, which are among the most suitable habitats for eels, where massively destroyed during the second half of the past century. This habitat destruction is responsible for increased mortality and sex ratio modification (sex determination is density dependant, i.e. when habitats are destroyed, eel population concentrate in the remaining habitats, as density is high the population is skewed to males which reduces the fitness of the overall population). Mortality due to habitat destruction probably causes mortality rate which is equivalent to fishing mortality or turbines. |

# 5. Existing Management measures

The European eel is listed on Annexes IIa & Va of the EC Habitats Directive and on Annex III of the Barcelona Convention. It was successfully nominated for Appendix II of CITES which entered into force in March 2009. It is listed as “critically endangered” under the IUCN Red List.

### International Legislation

**UNCLOS:** Catadromous species (spawning in the sea but often growing and maturing in inland waters) like the European eel are recognised under the United Nations Convention on the Law of the Sea (UNCLOS), under Article 67. In short, the following rules apply:

1. Coastal states/countries are responsible for management, but also states through the territory of which the species migrate are responsible for binding agreements concerning management measures.
2. Fishing at sea is allowed within the Exclusive Economic Zone but prohibited in the high seas.
3. Management must include provisions for secured immigration and emigration of the species.

(noted in CITES 2007, p14)

**CITES Appendix II:** In June 2007, the European eel was listed as an endangered species under Appendix II of the CITES convention. In general, such a listing includes those species that, despite not necessarily threatened with extinction, may become so unless trade is strictly regulated in order to avoid utilization which is incompatible with their survival. International commercial trade in Appendix II species is allowed, but is controlled. Parties may only grant a permit to export such species after it has been determined that the export will not be detrimental to the survival of the species (CITES 2007). Management can be summarised as follows:

With regard to glass eels (less than 12cm), the CITES Scientific Review Group (SRG) decided to accept national exports whose maximum levels are to be set along the following procedure for Member States intending to export glass eels:

- a baseline of catches, against which future quota reductions will be measured; is taken from the 2007/2008 fishing season which Member States have to report to the European Commission;
- the export levels for the 2008/2009 fishing season will be set at a max of 85% of the baseline which was based on 100 tonnes. As total catches in the season 2008/2009 were only 40t this led to a situation, where all glass eels could have been exported;
- the export levels for the 2009/2010 fishing season were set at a max of 43% of the baseline for those countries for which eel management plans are approved under Regulation 1100/2007 by the European Commission and set at zero for those countries for which management plans have not been approved. If the total catches of glass eel remain at 40 t or continue to decrease further, the export limit will exceed the total catch again, making this management measure inefficient.

The SRG will review the situation in 2010 for the fishing seasons 2010/2011 and 2011/2012; countries proposing further exports should report further data and good evidence in order to reconsider the situation before further exports are agreed.

The SRG decided that exports of other live eels and eel products can take place until the review of the situation in 2010, but need to be considered on a case by case basis by national CITES authorities based on the national eel management plans.

With regards to imports of eels and eel products, the SRG decided to apply a similar approach that such imports are in principle accepted only if they are from specimens exported by countries of origin with approved management plans based on suitable scientific advice.

Eels or eel-products being re-imported into the Community need to be derived from eels harvested and exported before the CITES listing came into force or from eels having being exported legally by the EU and/or from other non-EU exporting range states which have similar approved management plans based on suitable scientific advice in place. This requires close tracking, monitoring and reporting by the exporting countries by which the re-exported (aquaculture) products are linked to export documents originally approved by the EU or the other non-EU range states.

(CITES 2009)

### European Legislation

**COUNCIL REGULATION (EC) No 1100/2007 of 18 September 2007** establishing measures for the recovery of the stock of European eel

It applies to Community maritime waters and inland waters of EU member States that discharge into ICES areas III, IV, VI, VII, VIII, IX and the Mediterranean. Within this area Member States must:

- Designate “eel river basins” for which a separate Eel Management Plan (EMP) was to be submitted by the 31st December 2008. Failure to submit and adequate management plan on time results in a mandatory 50¨% reduction in fishing effort.

- The goal of the EMPs is to allow that at least 40% of the silver eel biomass escapes to the sea (measured with respect to undisturbed conditions[3]
- 60% of eels <12cm long are to be used in restocking, aiming to increase escapement of silver eels to sea.
- Maritime catches are to be reduced to 50% of average 2004-2006 catches, and will be phased in over a five-year period from when the regulation enters into force.
- Evaluations of national eel stock and management measures will be undertaken every 3 years until 2018 and every 6 years thereafter.

Until the national eel management plans (*cf.* Council Regulation (EC) No 1100/2007) have been approved by the Commission and are put in place, eel landings have to be reduced by 50% (COM(2005) 472 final). Fishing could continue where a Member State can reliably demonstrate that measures of similar effectiveness guaranteeing the 40% escape rate requirement are already in place. Fishing for glass eel could also continue if these eels are used for restocking rivers but not used for aquaculture. Seasonal closures have been applied locally in several areas. The effects of such closures to restrict fishing have not been evaluated. In some countries there are license systems that control the glass eel fisheries.

Perhaps the most obvious gap is the failure of the regulation to secure a fishery-independent glass eel recruitment data series. The reliance on catch monitoring focuses the relevant part of the regulation on commercial glass eel fisheries, which may change markedly, resulting in loss of individual data series. As outlined above, the reporting cycle of three years is at intervals too long for any rapid progress to be made on international scale stock assessment. Many of the data highlighted, while of supporting interest, are not core requirements (WGEEL 2008).

**COUNCIL REGULATION (EC) No 199/2008 of 25 February 2008** concerning the establishment of a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy

The EU data collection regulation (EU DCR) has also been updated and expanded recently to include both salmon and eels and extended to inland waters. This will have impacts at Community level relating specifically to the requirement for a multiannual Community programme for collection, management and use of biological, technical, environmental, and socio□economic data concerning:

a) commercial fisheries carried out by Community fishing vessels:
   i) within Community waters and commercial fisheries for eels and salmon in inland waters;
   ii) outside Community waters;

b) recreational fisheries carried out within Community waters and recreational fisheries for eels and salmon in inland waters;

c) aquaculture activities related to marine species, including eels and salmon, carried out within the Member States and the Community waters;

d) industries processing fisheries products□these to be defined in accordance with the procedure referred to in Article 27(2).

[3] It should be noted that ICES advice was 50%, due to the large uncertainties in ell management and biology (OSPAR 2008).

The cross compliance link between the Eel regulation and the DCR process is a useful provision for stock assessment purposes. The DCR driven data provision is however, dependent on continuation of commercial and recreational eel fisheries. There is no requirement for any fishery independent eel sampling in the DCR or for any sampling to continue where and when fisheries close. Continuation of commercial eel fishing is far from guaranteed given the continuing downward trends in catches, the possibility of approaching economic extinction, and the probability of widespread cuts in eel fishing activity as a consequence of Member States to meet the "40%" silver escapement targets required in the eel regulation. The DCR on its own will not provide a framework to estimate the size of the spawning stock as the programme does not provide estimates of eel abundance in small fisheries or in those waters not fished (ICES 2008).

**Other EU legislation**

***The Water Framework Directive (WFD)****:* The 2003 Action Plan for management of European Eel (COM 2003-573) considered the possibility to include eel as an indicator species for "good ecological status" in relation to "river continuity", *i.e.* as a biological quality element; This could build upon the currently existing quality element "composition, abundance and age-structure of ichthyofauna" (Annex V, items 1.1.1, 1.2.2 of the Directive) the interpretation of which is at the discretion of Member States. It should be noted that in those rivers where there is massive restocking, the eel cannot be considered as an appropriate indicator for "river continuity".

The WFD also requires the monitoring of a selection of priority substances in the aquatic phase, including lipophilic substances. There are strong arguments for measuring the latter in biota. Yellow eel is a good candidate because it is widespread, sedentary and accumulates many lipophilic substances in its muscle tissue. Several authors have described the indicative value of measured concentrations, yet few studies have investigated the extent to which the spectrum of contaminants present characterizes the local environmental pollution pressure. To evaluate the value of the pollution profile of an eel as a fingerprint of the chemical status of the local environment, two datasets were selected from the Flemish Eel Pollutant Network database. The results highlight the usefulness of eel as a bio-indicator for monitoring pollution with lipophilic chemicals like polychlorinated biphenyls and organochlorine pesticides in rivers (Belpaire *et al.*, 2008 in ICES 2008). In another study Belpaire and Goemans (2007b) assessed and discussed the possibility to use the eel as an indicator for the chemical status within the WFD. Both studies demonstrated that, as such, eel may be used effectively within the monitoring programme for a selection of priority substances referred to in the Water Framework Directive. Some countries reported planning reporting eel quality data within the WFD chemical status report. WGEEL 2009 has largely been in consensus that considering the status of eel stocks/populations it does not seem to be appropriate to take/kill a large number of specimens to assess the status of water bodies. Rather, the option should be considered to analyse individuals that are already available and being used for other examinations.

***The Common Fisheries Policy*** only applies to eel fisheries in fully marine areas.

***The EU Habitats Directive****:* Eels have a very wide ranging area, covering most European inland waters. For this kind of species, the Directive states that "sites will be proposed only where there is a clearly identifiable area representing the physical and biological factors essential to their life and reproduction". However, because eels are very widely distributed, it is difficult within this legal framework to argue that particular sites should receive enhanced protection over others.

## Other Contracting Parties' Regulations

In Norway, all freshwater fisheries and recreational sea fisheries of *A.anguilla* ceased on the 1$^{st}$ of July 2009. For 2009 a 50-ton quota was set for the commercial sea fisheries (80% reduction compared to

2004-2006), with a full ban implemented once the quota was reached through a separate national regulation on August 24th 2009. From 2010 onwards an annual quota of 50 tonnes has been set for monitoring purposes, whilst all fishing other than for scientific purposes will be entirely banned.

## 6. Conclusion on overall status

The European eel stock is facing an unprecedented level of decline. Managing a fish population as complex as that of the European eel poses an unprecedented challenge, and therefore faces some highly variable socio-economic and legislation constraints. Therefore, case-adapted management options with respect to usages, properties and histories must be considered to significantly increase all eel life stages.

Management of *A.anguilla* is likely to face major problems if there is no further data collection on recruitment or continental stock, after the halt of a significant portion of professional fisheries,. The absence of any internationally driven requirement to maintain a recruitment data series needs to be corrected, with reference to the recommendations of the EU contract 98/076: Establishment of a recruit monitoring system for glass eel. Also, in order to meet the EU regulation's aims, EU member States will have to estimate the yellow eels stocks in their inland and coastal waterbodies[4]. For silver eel production, the use of local freshwater protected areas appears to be a relevant way to reconcile these aspects and to respond to both global management constraints and local fisheries subsistence (Cucherousset et al., 2007), under the condition that a controlled quantity of silver eels can run safely to the sea. ). On the other hand, in saline waters (estuaries and coastal lagoons) the infection by the parasite *A. crassus* seems to decrease with salinity, which implies the lower part of estuaries should be classified as protected areas ((ICES 2009b in press, Neto et al. in press),

The need to develop an international monitoring network on eel quality is widely acknowledged, and OSPAR Contracting Parties should initiate harmonised monitoring strategies for eel. Guaranteeing further development of the European Eel Quality Database, harmonisation of methods, quality assurance, and setting up eel monitoring strategies over Europe will be a great challenge and will need pan-European cooperative work (Belpaire et al., in prep).

The first post evaluation of the EU Regulation is required by mid 2012. Timely development of stock wide assessment procedures is required, geared to the data becoming available, while indicating the progress towards recovery of the stock. The current legislative instruments including the Eel Regulation, DCR, CITES and WFD do not, either individually on in combination, contain sufficient provisions to ensure adequate data supply for such assessments (ICES 2008). Only a combination of several measures can be expected to see the eel population recover from its current critical state. Such measures have been identified and are well-known, and include control of exploitation and restoration of habitats (FAO 2007). As the European eel population is at present still considered as a panmictic species, management has to be applied to the whole area of distribution to be effective, so adoption of an efficient common scheme in the North-East Atlantic is urgent.

A stock restoration plan must be developed in the absence of fully adequate scientific information. Restoration measures cannot realistically target oceanic life stages. Protective measures are therefore restricted to the continental phases, while it is unclear whether they will address the causes of decline. However, excessive anthropogenic impacts on the stock must be curtailed irrespectively of the ultimate cause of decline. Whether these impacts are the cause of the global decline does not affect the need to take conservation measures (Dekker 2009).

[4] The target of the EU-Regulation is related to silver eel escapement. If this can be measured or otherwise calculated, no comprehensive monitoring of yellow eel stocks is necessary.

## 7. Action to be taken by OSPAR

### Action/measures that OSPAR could take, subject to OSPAR agreement

As set out in Article 4 of Annex V of the Convention, OSPAR has agreed that no programme or measure concerning a question relating to the management of fisheries shall be adopted under this Annex. However where the Commission considers that action is desirable in relation to such a question, it shall draw that question to the attention of the authority or international body competent for that question. Where action within the competence of the Commission is desirable to complement or support action by those authorities or bodies, the Commission shall endeavour to cooperate with them.

OSPAR should contact the European Commission to:

a. ensure that relevant part of European Institutions are notified of the listing under OSPAR, threats facing the species, and the willingness of OSPAR to co-operate in developing conservation measures;

b. request information on the effectiveness of any measures taken for the protection of this species;

c. encourage eel specific indicators to be included as part of the implementation of the Water Framework Directive (WFD) as an indicator of river connectivity and ecological and chemical status;

d. encourage the further development and support of the European Eel Quality Database

e. ask for support to monitor the European eel stock and evaluate the effectiveness of the management measures proposed in the EMPs.

*Role of OSPAR*

OSPAR should work with relevant Contracting Parties (see Table 3 below) to:

a. raise awareness of status and threats to the species among both management authorities, fishermen, retailers and the general public;

b. improve communication and information exchanges between *A. anguilla* researchers and authorities;

c. improve communication between research and management initiatives and results across the OSPAR region;

d. develop a stock-wide monitoring and evaluation program in which local targets, protective measures, the actual state of the stock, and the match between targets, tools and attainment are recorded at local management levels and reported to higher management levels, culminating in an up-to-date assessment of the state of the whole stock and the protection achieved (Dekker 2009).

e. encourage Contracting Parties to further develop the European Eel Quality Database;

f. Identify equivalent measures in non-Member States and promote a consistent approach.

OSPAR should recommend that relevant Contracting Parties (see Table 3 below):

a. organise a reporting scheme so that the accidental by-catch of European eels at sea is logged systematically in order to further knowledge on their distribution and feeding during the marine part of their life-cycle;

b. organise a fishery independent glass eel recruitment monitoring system

c. identify areas producing high quality spawners (large sized females, low contaminant and parasite burdens, unimpacted by hydropower stations) in order to maximise protection for these areas;

d. consider a licensing of fishers and dealers in areas where this is not already occurring

e. ensure connectivity between essential freshwater habitats and the sea by removing barriers and/or building fish passes, which will not only contribute to increase available habitat for the colonisation of river basins, but also to increase female production, as sex determination is dependent on density.

OSPAR should establish a mechanism by which Contracting Parties report back on the implementation of the above recommendations, and on the quality and quantity of European eel trade, so that the development of the necessary measures can be evaluated. As a first step Contracting Parties who have *A. anguilla* present in their coastal waters and river basins should make an assessment of the effectiveness of the regulations they already have in place for its protection, consider how those regulations might be made more effective through improved monitoring, control and surveillance and report the results to the OSPAR Commission.[5]

***Suggestions for further research***

OSPAR should emphasise to relevant scientific funding bodies and existing national monitoring programmes the following research needs with respect to *A. anguilla:*

a. further development of decision-support tools such as otolith microchemistry and biogeographical models, including a wider latitudinal range;

b. further data collection, harmonisation and collation to increase the baseline data collection where resources allow;

c. research relevant to the usefulness (cots/benefit relation) of stocking the European eel to habitats upriver from dams and weirs;

d. further tagging and telemetry studies regarding the European eel's migratory movement;

e. studies to get an overview of the quality of the eels over its distribution area and to assess the effects of contaminants and disease factors on lipid metabolism, condition, migration capacities and reproduction;

f. further studies on the benefits of freshwater protected areas;

g. further research on artificial breeding

[5] It should be noted that reporting is already mandatory and underway in EU member states with respect to EC Council Regulation (1100/2007).

**Table 3:** Summary of key priority actions and measures which could be taken for *Anguilla anguilla*. Where relevant, the OSPAR Commission should draw the need for action in relation to questions of fisheries management to the attention of the competent authorities. Where action within the competence of the Commission is desirable to complement or support action by those authorities or bodies, the Commission shall endeavour to cooperate with them.

| | | |
|---|---|---|
| **Key threats** | habitat alteration, pollution, activities that result in altered river flow rate, obstacles to migration, glass eel fisheries, poaching, diseases and parasites, climate change | |
| **Relevant Contracting Parties** | Iceland, UK, Ireland, Belgium, the Netherlands, Germany, Denmark, Norway, Sweden, France, Spain, Portugal | |
| **Other responsible authorities** | EC, FAO, RFMOs | |
| **Already protected?**<br>**Measures adequate?** | Habitat & Species Directive Annex IIa and Va<br>CITES Appendix II<br>Barcelona Convention Annex III<br>IUCN Red List Critically Endangered(A2bd+4bd) | One of the first steps contracting countries are recommended to take is an assessment of the effectiveness of the regulations they already have in situ, and how those regulations might be made more effective through improved monitoring, control and surveillance. |

### Brief summary of proposed monitoring system

The eel stock is scattered over a multitude of inland and coastal waters with divergent characteristics. Anthropogenic pressures, such as barriers to migration (including intakes and turbines), pollution, habitat loss, etc. will vary between River Basins and could affect the eel stock as much as the effects of fishing, especially poaching of glass eels. Current monitoring is based on national programmes. Several of the long time-series may be jeopardised in the near future due to changes in the local eel fisheries under the Eel Management Plans (EMPs). However, in light of the poor state of the stock and the high anthropogenic impacts, it is of utmost importance that time-series of recruitment and silver eel population are continued and are preferably supplemented.

If any fishery continues effort and yield will need to be carefully monitored. Assessment of the stock and evaluation of the EMPs will require the collection and compilation of a wide range of data sets. Current data collection programmes (EMPs, DCR, WFD, etc) will need to be extended, coordinated, integrated and funded to support eel assessment and management (WGEEL 2008).

Monitoring of the fisheries, the stock and the different accessible habitats is required. Monitoring the habitat of the eel should preferably be done by making use as much as possible of the habitat monitoring in the WFD (2003). However, further data collection programmes may be required.

As regards the stock, the following should be considered:

Recruitment

- Natural *vs.* restocking

Yellow eel

- As recruits
- Abundance, age, size, growth, mortality

Silver eel escapement

- Production vs. escapement
- Contaminants, pathogens

# Annex 1: Overview of data and information provided by Contracting Parties

| Contracting Party | Feature occurs in CP's Maritime Area | Contribution made to the assessment (e.g. data /information provided) | National reports References or weblinks |
|---|---|---|---|
| *Belgium* | Y | Y | |
| *Denmark* | Y | Y | http://search.fvm.dk/search.aspx?pckid=768965733&aid=260336&pt=6018936&addid=770492434&sw=eel+management+plan |
| *European Commission* | | | http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:060:0001:0012:EN:PDF<br>http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:248:0017:0023:EN:PDF<br>http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000L0060:EN:NOT<br>http://ec.europa.eu/energy/climate_actions/doc/2008_res_directive_en.pdf |
| *France* | Y | Y | http://www.ifremer.fr/indicang/seminaire-2007/pdf/perspectives_indicang2_soulier.pdf |
| *Germany* | Y | | |
| *Iceland* | Y | | |
| *Ireland* | Y | Y | http://www.dcenr.gov.ie/Natural/Inland+Fisheries+Division/Eel+management+Plan.htm |
| *Netherlands* | Y | Y | www.sportvisserijnederland.nl/include/downloadFile.asp?id |
| *Norway* | Y | Y | http://www.fdir.no/english/resource-management/propose-total-ban-on-all-catches-of-european-eel-in-norway<br>http://www.regjeringen.no/nb/dep/fkd/pressesenter/pressemeldinger/2009/nye-tiltak-for-a-betre-bestanden-av-al.html?id=570077 |
| *Portugal* | Y | Y | |
| *Spain* | Y | | |
| *Sweden* | Y | Y | http://www.fishsec.org/downloads/1233757502_69937.pdf |
| *UK* | Y | Y | http://www.defra.gov.uk/foodfarm/fisheries/documents/fisheries/emp/overview.pdf |

*A. anguilla* was nominated in 2008 by Germany and WWF. Contact persons:

- Sabine Christiansen, North-East Atlantic Marine Ecoregion Programme, Hongkongstr.7 D-20457 Hamburg, Germany
- Ronald Fricke, Icthyology, Staatliches Museum für Naturkunde, Rosenstein 1, D-70191 Stuttgart, Germany
- Christian Pusch, Bundesamt für Naturschutz, Außenstelle Insel Vilm, D-18581 Putbus, Germany

# Annex 2: References


Acou, A., Gabriel, G., Laffaille, P. and Feunteun, E. 2008. Differential production and condition indices of premigrant eels (Anguilla anguilla) in two small Atlantic coastal catchments of France. Pages 157-174 in J.M. Casselman and D.K. Cairns, editors. Eels at the edge: science, status and conservation concerns. American Fisheries Society, Symposium 58, Bethesda, Maryland.

Adam G., 1997. L'anguille européenne (Anguilla anguilla L. 1758) : dynamique de la sous-population du lac de Grand-Lieu en relation avec les facteurs environnementaux et anthropiques (Université Toulouse III / Cemagref). 353pp.

Albert V., Bjarni J. and Bernatchez L. 2006. Natural hybrids in Atlantic eels Anguilla anguilla, A. rostrata ): evidence for successful reproduction and fluctuating abundance in space and time. Molecular Ecology, 15: 1903-1916.

Anon 2006. Civelle: le braconnage se professionnalise. Journal Ouest France 18–19 novembre 2006.

Åström M. and Dekker W., 2007. When will the eel recover? A full life-cycle model. ICES Journal of Marine Science, 64: 1491–1498

Belpaire, C., Geeraerts, C., Evans, D., Ciccotti, E. and Poole, R. in prep. The European Eel QualityDatabase: toward a pan□European monitoring of eel quality. 10pp.

Belpaire, C., and Goemans, G., 2007a. Eels: contaminant cocktails pinpointing environmental contamination. ICES Journal of Marine Science 64: 1423-1436.

Belpaire, C. and Goemans, G., 2007b. The European eel (Anguilla anguilla) a rapporteur of the chemical status for the Water Framework Directive? Vie et Milieu – Life and Environment 57 (4), 235-252.

Belpaire, C., 2008. Pollution in eel. A reason for their decline? Ph.D. thesis Catholic University of Leuven, INBO.M.2008.2. Instituut voor Natuur- en Bosonderzoek, Brussels, 459 pages, III annexes.

Belpaire, C., Goemans, G., Geeraerts, C., Quataert, P. and Parmentier, K. 2008. Pollution fingerprints in eels as models for the chemical status of rivers. ICES Journal of Marine Science 65: 1483-1491.

Belpaire CGJ, Goemans G, Geeraerts C, Quataert P, and Parmentier K. 2009. Decreasing Eel stocks: Survival of the Fattest? Ecology of Freshwater Fish 18(2): 197-214(18)

Bonhommeau S., Blanke B., Treguier A-M., Grima N., Rivot E., Vermard Y., Greiner E. and Le Pape O., 2009. How fast can the European eel (Anguilla anguilla) larvae cross the Atlantic Ocean? Fisheries Oceanography 18(6): 371-385.

CITES 2007. Proposal: Inclusion of Anguilla anguilla (L). in Appendix II in accordance with Article II §2(a). Convention on International Trade in Endangered Species of wild flora and fauna. Fourteenth meeting of the Conference of the Parties, The Hague (Netherlands), 3-15 June 2007. CoP14, Prop. 18. Document accessed 8 Aug 2007: http://www.cites.org/common/cop/14/raw_props/E-DE04-Anguilla%20anguilla.pdf

CITES 2009. Short Summary of Conclusions of the 47th meeting of the Scientific Review Group on Trade in Wild Fauna and Flora - 12th March 2009.

Cucherousset J., Paillisson J-M., Carpentier A., Thoby V., Damien J-P., Eybert M-C., Feunteun E. and Robinet T., 2007. Freshwater protected areas: an effective measure to reconcile conservation and exploitation of the threatened European eels (Anguilla anguilla)? Ecology of Freshwater Fish 16: 528–538.

Dekker, W. 2000. The fractal geometry of the European eel stock. – ICES Journal of Marine Science, 57: 109–121.

Dekker W., 2003. Status of the European Eel Stock and Fisheries. Pages 237-254 in K. Aida, K.Tsukamoto and K.Yamauchi, editors. Eel biology. Springer-Verlag Tokyo.

Dekker W., 2009. A Conceptual Management Framework for the Restoration of the Declining European Eel Stock. Pages 3-19 in J.M. Casselman and D.K. Cairns, editors. Eels at the edge: science, status and conservation concerns. American Fisheries Society, Symposium 58, Bethesda, Maryland.

FAO 2007. Report of the second FAO Ad Hoc Expert Advisory Panel for the Assessment of Proposals to Amend Appendices I and II of CITES Concerning Commercially-exploited Aquatic Species.Rome, 26–30 March 2007. FAO Fisheries Report. No. 833. Rome, FAO. 2007. 133p.

Feunteun, E., Boury, P. and Robinet, T. ,2003. Estimation of the Production and Fishery Mortality of Silver Eels by the Loire River System, France. 133rd Annual Meeting of the American Fisheries Society, Quebec (Canada), “Worldwide decline of wild fish populations” August 2003.

Feunteun, E. 2007 in litt. to IUCN/TRAFFIC Analyses Team, Cambridge, UK.

Geeraerts, C., Belpaire, C., 2009. The effects of contaminants in European eel: a review. Ecotoxicology DOI 10.1007/s10646-009-0424-0

ICES 2006. Report of the 2006 session of the joint EIFAC-ICES Working Group on Eels, Rome, 23–27 January 2006. ICES CM 2006/ACFM: 16: 367 pp.

ICES 2008. Report of the Joint EIFAC/ICES Working Group on Eels (WGEEL), 3–9 September 2008, Leuven, Belgium. ICES CM 2008/ACOM:15. 212 pp.

ICES 2009a. Report of the Joint EIFAC/ICES Working Group on Eels (WGEEL), 7-12 September 2009, Göteborg, Sweden. ICES CM 2009/ACOM:XX. XXX pp. In press

ICES 2009b. Report of the Study Group on Anguillid Eels in Saline Waters (SGAESAW), 16-18 March 2009, Sackville, Canada and 3-5 September, 2009, Gothenburg, Sweden. ICES CM 2009/DFC:xx. xx pp, In press.

Knights, B., 2003. A review of the possible impacts of long-term oceanic and climate changes and fishing mortality on recruitment of anguillid eels of the Northern Hemisphere. Science of the Total Environment 310: 237–244.

Lecomte-Finiger, R. 1992. Growth history and age at recruitment of European glass eels (Anguilla anguilla) as revealed by otolith microstructure. Marine Biology. 114: 205–210.

Neto A.F., Costa J.L., Costa M.J. and Domingos I. In press. Epidemiology and pathology of Anguillicoloides crassus in the European eel, Anguilla anguilla, from the Tagus estuary (Portugal). Diseases of Aquatic Organisms

OSPAR 2008. Case Reports for the Initial List of Threatened and/or Declining Species and Habitats in the OSPAR Maritime Area. Biodiversity Series, 150pp.

OSPAR 2003. Criteria for the identification of species and habitats in need of protection and their method of application (the Texel-Faial Criteria). OSPAR Commission, London (Reference Number: 2003-13).

Ringuet S. Muto F. and Raymakers C., 2002. Eels: Their Harvest and Trade in Europe and Asia. Traffic Bulletin 19(2). 73pp. Published by: TRAFFIC East Asia- Japan.

Robinet T and Feunteun E., 2002. Sublethal Effects of Exposure to Chemical Compounds : A Role in the Decline of Atlantic Eels ? Ecotoxicology 11:265-277.

Robinet T., Acou A., Boury P. and Feunteun E., 2007. Concepts for characterizing spawning biomass of European eel (Anguilla anguilla) in catchments. Vie & Milieu 57:201-211.

Russel, I. C. and Potter E.C.E., 2003. Implications of the precautionary approach for the management of the European eel, Anguilla anguilla. Fisheries Management and Ecology 10: 395-401.

Tesch F-W., 2003. The eel. Blackwell Science, Oxford. 408pp.

Tsukamoto K., Nakai I. & Tesch W-V., 1998. Do all freshwater eels migrate? Nature 396: 635-636.

Wirth T. and Bernatchez L ., 2001. Genetic evidence against panmixia in the European eel. Nature 409: 1037-1040.

OSPAR COMMISSION

New Court
48 Carey Street
London WC2A 2JQ
United Kingdom

t: +44 (0)20 7430 5200
f: +44 (0)20 7430 5225
e: secretariat@ospar.org
www.ospar.org

**OSPAR's vision is of a clean, healthy and biologically diverse North-East Atlantic used sustainably**

ISBN 978-1-907390-20-3
Publication Number: 479/2010

© OSPAR Commission, 2010. Permission may be granted by the publishers for the report to be wholly or partly reproduced in publications provided that the source of the extract is clearly indicated.

© Commission OSPAR, 2010. La reproduction de tout ou partie de ce rapport dans une publication peut être autorisée par l'Editeur, sous réserve que l'origine de l'extrait soit clairement mentionnée.