CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

Twenty-second meeting of the Animals Committee
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INCLUSION OF *ANGUILLA ANGUILLA* IN APPENDIX II IN ACCORDANCE WITH ARTICLE II, PARAGRAPH 2 (A)
(Draft of April 2006)

1. The Annex to this document has been submitted by the Scientific Authority of Sweden.

Anguilla anguilla Proposal
Draft of April 2006 for CITES Consultation Process

CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES OF WILD FAUNA AND FLORA

Fourteenth Meeting of the Conference of Parties
2-15 June 2007

Amendment to CITES Appendix II (EU App. B)

A. PROPOSAL

Inclusion of *Anguilla anguilla* L. in Appendix II (EU App. B) in accordance with Article II §2(a).

Qualifying criteria (Conf. 9.24 (Rev. CoP13) Annex 2a)

A. It is known, or can be inferred or projected, that the regulation of trade in the species is necessary to avoid it becoming eligible for inclusion in Appendix I in the near future.

This species (the European eel) most likely comprises one single stock which is distributed in most coastal waters and freshwater ecosystems in all of Europe, northern Africa and the Mediterranean parts of Asia. For several decades the decline of the stock has been noted. In 2003 an International Eel Symposium provided evidence, based on the four longest glass eel collection series, that the recruitment of young eels to the continental stock had declined to as low as 1% of its former level in the late 1970s (Fig. 1). The ICES/EIFAC Eel Working Group (2006) analysed the trends of all glass eel collection series up until 2005 and found that the average decline was in the order of 95-99% in the period 1980 and until present. The need for radical management actions was proposed since eel does not fall under protection of any international law. The scientific community further argued that precautionary action be taken, e.g. by curtailing exploitation and limiting international trade. Export of juvenile eels (glass eels) for aquaculture in Asia (far outside its natural distribution area) comprised more than 50% of the total estimated landing of glass eel since the late 1990s untill today. The long and steady decline of this commercially exploited species clearly qualifies it for listing under this criterion.

B. It is known, or can be inferred or projected, that regulation of trade in the species is required to ensure that the harvest of specimens from the wild is not reducing the wild population to a level at which its survival might be threatened by continued harvesting or other influences.

The stock of *Anguilla anguilla* is outside safe biological limits. High market demand, despite very high market value, has caused opposition to sustainable management proposals in some EU Member States, mainly because different life stages of eel are targeted in several countries. The youngest eel stages (glass eel and elvers) are overexploited, as they are the basis of eel culture world wide; older eels are heavily exploited and their migration into and from rivers is impeded by dams and hydropower stations. Even if both current eel fisheries and eel culture in Europe is based on young eel mainly imported from France, Great Britain and Spain and traded within the EU, a substantial part of European glass-eel catches are traded on the Asian market, mainly to China and Japan. Some 90% of eel consumed in the world is based on eel culture, but like direct fishing, this is based on eel caught in the wild.

Without trade regulation the species will decline irreversibly both from a commercial and biological standpoint.

B. PROPONENT

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C. SUPPORTING STATEMENT

1. Taxonomy

1.1 Class: Osteichthyes
1.2 Order: Anguilliformes
1.3 Family: Anguillidae
1.4 Species: *Anguilla anguilla* Linné, 1758
1.5 Common names:

	English	eel
	Spanish	anguila, angula (= youngest life stage)
	French	anguille, pibale
	Swedish	ål
	Danish	ål
	Italian	anguilla
	German	Aal

2. Overview

2.1 The European eel occurs in Europe, northern Africa and the Mediterranean parts of Asia. It actually may occur in all ICES fishing areas in the north-east Atlantic except for the areas directly east of Greenland and the Spitsbergen area north of continental Norway (Fig. 2). Within its distribution area it can not be confused with any other species of fish with its elongated snake-liked body and smooth slimy skin. Before reaching sexual maturity the eel can reach a length of well over 1 m and a weight of several kilos. It can also attain a very high age, well over 50 years. The species most likely comprises one single stock spawning in the Sargasso Sea. The eggs hatch there and the larvae drift in a north by north-easterly direction until they reach the European coasts (after some 3 years) and transform through a number of stages to glass eels, elvers, yellow eel and finally into silver eel – the latter being the early sexually maturing stage which seeks to return to the Sargasso Sea to spawn and subsequently die.

2.2 The meat of *Anguilla anguilla* is highly valued in Europe and parts of east Asia. The human consumption preference varies throughout the eel´s distribution. In some countries the small, almost transparent glass eels and elvers are highly valued (200 – 1,000 euro/kg), in other countries various yellow eel size groups are sought after and in other countries (mainly in northern Europe) large silver eels, on their way to mature, fetch the best price (5-10 euro/kg). Seen in a global scale the glass eel/elver stage is by far the commercially most important life stage, because almost all ”meat production” of eel is based on aquaculture of wild caught young eel stages. The European aquaculture produces half the total supply in Europe while the Asian aquaculture produces almost all Asian supply. Asian eel culture is about tenfold the European production (Dekker 2003a).

2.3 All available information indicates that the current European fishery is not sustainable. Recruitment has been declining since the 1980s and reached a historical low in 2001 and has not improved since then. Eels are exploited in all life stages and fishing mortality is high. In addition to overfishing, other anthropogenic factors might have contributed to the sharp population decline: inland (freshwater) and coastal habitat loss, pollution, climate change, ocean current change and loss of upstream /downstream migration routes through for example hydroelectric power stations and other constructions.

2.4 According to ICES/EIFAC Working Group on Eels and ICES Advisory Committee on Fishery Management a recovery plan is urgently needed and the European Commission has requested ICES to evaluate what mitigative measures should be instituted to improve the situation. Considering the many uncertainties in eel management and the uniqueness of the single eel stock a precautionary reference point for eel must be stricter than universal provisional reference points. Exploitation should be reduced to as close to zero as possible until such a recovery plan is agreed on and implemented.

2.5 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 eel in fresh water or along the coasts. Some of the long-term series may also be terminated in the near future as a consequence of decreased turnover of local fisheries and the impossibility of addressing this large-scale stock decline at the local level. There are also inconsistencies between official statistics on eel landings and ICES estimates. A major revision of data bases is thus also required.

2.6 *Anguilla anguilla* meets the guidelines suggested by FAO for the listing of commercially exploited aquatic species. The species actually falls into FAO´s lowest productivity category of the most vulnerable species and the rate of decline is so rapid and steep as to qualify for Appendix I listing under these FAO guidelines. The latest IUCN Red List assessment for this species is (probably) that of Sweden (2005) which lists the European eel as ***Critically Endangered*** (CR).

2.7 An Appendix II (App. B) listing for *Anguilla anguilla* will regulate and monitor future international trade, hopefully ensuring that future fisheries will not be detrimental to the status of the wild stock and thus to the survival of the species. This legal measure will also complement (and reinforce) traditional eel management measures, and the internationally coordinated recovery plan that is currently being developed by the European Commission.

2.8 After listing according to the present proposal it is suggested that all trade in glass eel/elvers within the European Union be used to restock suitable freshwater habitats in order to increase the size of the future spawning stock, on which a sustainable fishery again can be based. Restocking has been applied by some countries for many decades but this has been done mainly to maintain fisheries rather than to improve the stock. Because artificial reproduction is still not possible for eel, all aquaculture and restocking is based on capture of wild eel. Even though there is some concern that disease and reduced genetic variability may result from restocking, this risk must be balanced against the potential benefit from this measure, and the risk of further stock decline due to a failure to take this action.
It has been estimated that present catches of glass eel in Europe cover only some 1/6 of the demand of the European market for re-stocking, not counting the aquaculture demand in Asia and Europe!

3. <u>Species characteristics</u>

3.1 Distribution

The European eel (*Anguilla anguilla*) occurs from the Atlantic coast of North Africa, in all of Europe (including the Baltic Sea) and in the Mediterranean waters of Europe, northern Africa and Asia. In addition the European eel also occurs in the Canary Islands, Madeira, the Azores and in Iceland (Schmidt 1909). The latter island is probably unique because it also harbours American eels (*Anguilla rostrata*). Furthermore, there is also evidence of interbreeding of the two eel species occurring there (Avise et al. 1990). It is important to realise that 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 larvae drift with the Gulf Stream and the North Atlantic Current to the continental shelf of Europe and North Africa thus closing the life history distribution of the European eel. 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). A recent study (Wirth and Bernatchez 2001) using 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 of course would have far-reaching implications for eel management. However, a more recent study (Dannewitz et al 2005) indicates a more subtle, temporal pattern, that might have appeared as a spatial pattern in the study of Wirth and Bernatchez, due to unsynchronised sampling in northern and southern areas. Whether a single panmictic stock or a species with as 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).

3.2 Habitat

Although the European eel is considered a temperate species it also occurs as spawning adults and newly hatched larvae in the *tropical waters* of the Sargasso Sea, in the *sub-tropical waters* of the Azores, the Canary Islands, Madeira, the Atlantic coast of north-western Africa and the African coast of the Mediterranean, and, in the frigid *arctic waters* of Iceland, Jan Mayen and northernmost Norway (Schmidt 1909). However, the high yield of eel production and fisheries in temperate areas is in contrast with the temperature preference of the species which ranges from 10-38 degrees centigrade, with an optimum around 22-23 degrees (Boetius and Boetius 1967, Sadler 1979, Dekker 2003b).
The northern distribution area has no sharp limit, the density of eels simply gradually fades out (Dekker 2003). The conventional view is that eels are catadromous, i.e. they spawn in salt (marine) habitat and then move into freshwater areas to grow as yellow eels and subsequently become sexually mature (silver eels) (Table 1). However, yellow eels can also be found in estaurine and coastal habitats throughout the area where glass eels and elvers occur naturally, and some may actually remain in marine habitat their entire life-cycle (Tsukamoto, Nakai and Tesch 1998, Daverat et al. 2006).

In summary, the European eel occurs in an extremely variable number of habitats during its life cycle: 1) spawning, newly hatched larvae and all marine developmental stages occur in the marine pelagic zone of the Atlantic Ocean, 2) glass eels, elvers, some yellow eels and some silver eels occur throughout their life in shallow marine coastal areas, 3) some glass eels, elvers, yellow eels and silver eels move into and/or grow in coastal lagoons and estuaries, 4) some glass eels, elvers, yellow eels and silver eels move into or grow in freshwater habitats, swim upstream brooks and rivers and further into ponds, lakes and reservoirs, where they may remain for decades before they ultimately swim downstream on their final spawning migration. Clearly, any habitat destruction occurring in any type of water body will negatively affect the European eel.

3.3 Biological characteristics

Some basic biological characteristics of the eel have been described above. Suffice it to repeat that most researchers still agree with the views of Schmidt (1909, 1925) that the European eel comprise a single panmictic stock which spawns in the Sargasso Sea. Although spawning has never been observed newly hatched larvae have been observed from a relatively small area of the Sargasso Sea (Schmidt 1922). Schmidt also followed the increase in size of the various developmental stages of these larvae (leptocephali) and thus could map their migration (actually drift with the currents) to the north-west African and west European coasts. The leptocephalus larvae metamorphose into glass eels when they arrive at the continental shelves of north-western Africa and Europe after a journey of approx. 3 years (Tesch 2003). Eventually, the glass eels become pigmented elvers as they either enter estuaries, brooks and rivers where they spend their growth phase as yellow eels, or actually spend their entire growth phase in either brackish or marine habitat (Daverat et al. 2006). The growth phase may last from 3 to up to at least 25 years, depending on sex and environmental conditions. On average males migrate at an age of 7-8 years and females at approx. 11 years of age (Tesch 1977). A female eel may attain a weight of more than 6 kg and a length of well over 1 meter whereas the males rarely exceed 45 cm in length (Wickström 2005). Eels are also long-lived fishes. In captivity an eel was recorded to have lived for 84 years. At the start of migration the gonads gradually mature and the eels migrate back to the Sargasso Sea to spawn and die. There is no evidence of any eel surviving spawning. A good overview of the life cycle and the major life stages of the European eel is given by Dekker (2000a). See also Fig. 3.

The gonads of eels are undifferentiated until a length of 15-25 cm (Kuhlmann 1975). In natural waters this size is attained in the yellow eel stage a few years after the glass eel stage (Tesch 1977). Some authors argue that sex differentiation is environmentally influenced (e.g. Parsons et al. 1977, Wiberg 1983) whereas others claim that different migratory behaviour of females and males account for the difference (D´Ancona 1958, Svärdson 1976). Holmgren (1996) in her doctoral thesis on sex differentiation and growth pattern in the European eel concludes that her results show that females may develop in any habitat type, but males should only develop if they experience good conditions for growth during the early gonad differentiation, which may be independent of the resources needed for growing to a large silver eel size. Yellow eels that migrate far up in river systems have probably not met this criterion and will thereby become females. This information is given because it has both management implications as well as economic significance. Eel farmers want to optimise early weight increase and will consequently favour male eels. On the other hand may young eels that have been stocked in natural lakes develop in either direction, depending on individual growth performance, before or after they enter the new environment (Holmgren 1996).

3.4 Morphological characteristics

The European eel is one of approx. 15 anguillid eel species in the world. They all resemble one another by being long, slender and snake like with almost cylindrical bodies covered with very small scales. Their skin is smooth and slimy. Eels lack ventral fins and the dorsal-, tail- and anal fins form a continuous fin from the mid section of the back to the anal opening. The gill openings are small. As described above the eel passes through a series of developmental stages during its life cycle: 1) the transparent leptocephalus marine stages, 2) the more cylindrical but still transparent glass eel, 3) the pigmented elver and then through 4) the long yellow eel period of the growing eel to 5) the migrating silver eel which has ceased to feed and spends its energy resources entirely on production of gonads and the long migration back to the Sargasso Sea. During the silver eel stage the eel changes its colour and appearance considerably. Whereas the "yellow eel" is grey/green/olive/brown on the back side and yellow/green/white on the ventral side, the silver eels turn into a more "marine appearance" with dark and even black back and a silvery or copper coloured ventral side. In addition the eyes become larger and the lateral line more pronounced (Wickström 2005). These differences between the yellow eel and silver eel stages occurs in both sexes.

3.5 Role of the species in its ecosystem

The role of the eel in its ecosystems is a many-facetted issue, because, as argued above, the eel belongs to so many different ecosystems during its life cycle. The marine larval stages of eel feed on microscopic plankton and very likely have no effect on the pelagic ecosystem in which they live for approx. 3 years. During the glass eel and elver stages probably larger prey may be taken because these stages are far more mobile than the younger ones. Finally during the yellow eel stage – the growth period – eels are opportunistic omnivorous predators. Chironomid larvae, worms, mussels, gastropods, insects, crustaceans (freshwater crayfish in particular), fishes and fish roe are consumed when available, even frogs and small rodents may be eaten. The only instance when a conspicuous effect of yellow eels on their ecosystem has been noted is when freshwater crayfish (*Astacus astacus*) have been present in the river or lake. After eels have been stocked some crayfish populations have been severely depleted by eel predation. Otherwise eels do not seem to affect significantly the recruitment of other species. This broad diet would indicate that eels were quite susceptible to other predators, but contrary to this hypothesis yellow eels show very high survival rates. Moriarty (1987) attributes this success of eels to avoidance of all predators (at all life stages), and also on high survival during sub-optimal conditions for growth. Even when glass eels are stocked into lakes where this eel stage would never occur naturally a very large percentage have managed to survive until they have been recaptured as yellow or silver eels (Tulonen and Pursiainen 1992).

4. <u>Status and trends</u>

4.1 Habitat trends

The environmental threats to eel habitat include barriers to upstream migration but also hydroelectric facilities were the turbines may seriously impair the downstream migration of silver eels causing high mortality. Eel ladders and bypasses may on the other hand mitigate both hazards. Another factor impairing the reproductive capacity of the eel is bio-accumulation of lipophilic contaminants and concentration levels in the fat of their muscles and gonads seems to be a reflection of the actual concentrations in the environment (ICES 2006). In general, due to the high energy costs of the spawning migration the adipose tissue energy stores are gradually depleted and the contaminants found in the adipose tissue may impair the success of reproduction. Pollution of the benthos is thus a threat to the yellow eel stage. Extensive and unregulated live transport of eel of all sizes is another potential danger, because parasites and viruses can spread both to wild populations and to dense populations in aquaculture. There is no general trend in a favourable direction for eel habitat but reduced emissions of some toxins will have beneficial effects in future, as will construction of fish ladders, bypasses and better grids at hydropower stations and other obstructions to eel migration.

4.2 Population size

4.2.1 Spawning stock

As mentioned above the natural spawning behaviour of the eel has never been observed directly nor do we exactly know the exact location, timing and abundance of eels in the spawning area. In addition, sampling methods have not been standardised (Moriarty and Dekker 1997) so comparison of stock density among catchments and countries is rarely appropriate. Despite this serious lack of knowledge management measures must be enforced to protect the spawning stock regardless of time, place and size. This management advice follows the precautionary approach - PA (ICES 1999). The management targets aim at protection and recovery of the spawning stock. In accordance with the PA measures should aim at protecting 30% of pristine spawner escapement and an extra safety margin has been recommended (ibid.) to protect 50% of this escapement.

Dekker (2000b) noted that the number of silver eels escaping to the ocean on their spawning migration is negligible in comparison with commercial landings. As a consequence, variation in fishing intensity will cause the mean age in the catch to vary, but will only affect the number of eels caught marginally (Dekker 2003b). Obviously, the commercial eel catch provides an index of stock size.
Estimation of the potential spawning stock should rely on historical data (Dekker 2003a). Because only information on recruitment is available estimation of the spawning stock must be based on modelling of population dynamics. Models of the continental phase of eel population dynamics have been developed following three lines: 1) the Leslie-matrix cohort-model approach (Gatto and Rossi 1979), 2) the Input-Output approach which directly relates juvenile recruitment abundance to migrating silver eels (Völlestad and Jonsson 1988), and 3) a number of models ranging from stage-structure and density dependence survival from one stage to the next to more complex size/age/stage structured models (e.g. De Leo and Gatto 1995, Dekker 1996, Reid 2001, Greco et al. 2003, Åström 2005).
These models of course differ in terms of mathematical complexity and usability. While site-specific analyses are needed to frame the eel life history in the continental phase, the generalised decline of eel recruitment requires a global assessment of meta-population viability.

The first attempt to calculate the size of the European eel stock was performed by Dekker (2000b). Dekker (2003) also calculated the dynamics of the eel population in the early 1990s (Fig. 4). Further research in this area is ongoing and will help to improve estimates of stock abundance both in the past and present situations (ICES 2006). It is hoped that these models can be adapted also to areas where little data is available.

4.2.2 Panmixia, recruitment and production

As mentioned above most eel biologists argue that the European eel comprises a single panmictic stock. Even though we know that this eel species is wide-spread and in drastic decline, available data on recruitment, stock and fisheries are still fragmentary. Obviously, almost all water bodies within its natural distribution contain, or have contained, eels in a few or all pigmented stages. This means that the eel population is fragmented into thousands of water bodies. Already in 1997 Moriarty and Dekker noted that “recruitment has steadily decreased since the early 1980s, fisheries have declined and man-made impacts on the habitats of this species have adversely affected production potentials." A few years later Dekker (2000) argued that the absence of sufficient data on the myriad of small local sub-stocks preclude a reliable stock assessment. However scanty the data on total population size compilation of FAO data-bases in the 1990s indicated that the world-wide production of anguillid species in fisheries in the order of 30,000 tonnes per year. Roughly one half of that catch comprised the European eel (Dekker 2003a). In order to improve assessment of the biological status of the eel, this species has been included in the EU Data Collection Regulation, but required sampling levels have only been tentatively indicated, however, only a few countries have included eels in the national sampling programmes.

Contrary to common belief it seems likely that more than 60% of eel production takes place in coastal marine habitats (Wickström and Westerberg 2006). Actually, some 80% of all eels leaving the Baltic have spent their entire life in salt water habitats. These authors (ibid.) also argue that this proportion may increase with declining recruitment. Consequently, it is necessary to include all marine eel fisheries in an European Eel Management Plan.

4.3 Population structure

As described above this species is highly migratory and comprises a series of developmental stages throughout its life cycle, which tends to segregate the species geographically by age. As a consequence, different nations within the eel´s distribution have developed fisheries which may target different age stages, actually covering both glass eels, elvers, yellow eels and silver eels. As a result it is unlikely that a natural population structure exists in the various regions where there is a fishery for the different life stages.

4.4 Population trends and geographic trends

4.4.1 General trends

The generation time for *Anguilla anguilla* defined as the average reproductive age of females varies between sub-populations but is approx. 11 years, in some northern sub-populations often 15-20 years and even older. The three-generation period against which declines must be assessed (Annex 5, CoP9.245, Rev. CoP13) is thus some 30-35 years upwards to 60 years.

Few data sets provide information on changes in the level of recruitment and those that are available relate to various stages of the recruitment into continental habitats (Dekker 2002). Time series from 19 rivers in 12 countries have been examined for trends. Data from eleven of those rivers are available for 2005 (ICES 2006, Table 2). National trends in glass eel, elver and "young eel" recruitment are shown in Fig. 5. The most conspicuous trend can be seen in the Norwegian River Imsa, where there is no fishery and no stocking, yet a drastic decline in elver recruitment.

Conspicuous downward trends occur in all time series in the last two and a half decades. This is a reflection of the rapid decrease after the 1970s (ibid. Fig. 6). Data collected in the last few years indicate that recruitment now (2006) is even lower than the minimum level of 2001. The low level of recruitment of 2001 was also synchronous with a smaller size of glass eels, which interpreted as a sign of adversory oceanic conditions. The most recent low recruitment levels, however, occured under more favourable oceanic conditions (NAO index), and mean glass eel length was not lowered. This indicates that most recent low recruitment figures are very unlikely to be caused by adversory oceanic effects (ICES 2006). If the current trend continues, the stock might reach the brink of extinction within a single generation (<10 years).(Dekker 2004) In October 2005, the EC proposed a "Council Regulation establishing measures for the recovery of the stock of European eel" (COM 2005, 472 final).

In northern areas no glass eels are found recruiting the river sub-populations because there the transition to the yellow eel stage happens long before they enter fresh-water habitats. Long-term data series from four northern rivers (1 Norwegian, 3 Swedish) are shown in Figure 7 (ibid.). In the first half of the 1990s a moderate recovery in glass eel recruitment was observed, which later in that decade can be seen as an increase in yellow eel recruitment.

4.4.2 Trends in re-stocking

Data on re-stocking are available from a number of countries. Glass eels and young yellow eels are reported separately. The yellow eel component varies in size (age) among countries and data are presented on a weight basis which then can be converted to numbers, using estimates of average individual weights of re-stocked eels. As an indication of the size variation obtained Denmark reports 3.5 g, 20 for Germany, 33 for the Netherlands and 90g for Sweden. An overview of the trends is shown in Fig. 8 (ibid.).
In European countries other than those combined in those Figures the following information can be given:
Latvia – during Soviet time, starting in the 1960s, roughly 30 million glass eels were stocked into 51 lakes. At present, only a few lakes are stocked and with a low number of glass eels.
Lithuania – re-stocking commenced already in the late 1920s. Since the 1960s some 50 million elvers and young yellow eels have been stocked.
Germany – no central data base for re-stocking.
Ireland – elvers are stocked in some drainages.
France – no central data base for re-stocking.
Spain – no central data base for re-stocking.
Italy – no central data base for re-stocking, but considerable local re-stocking.

4.4.3 Formal status of the eel stock

IUCN (International Union for the Conservation of Nature) has compiled criteria for ranking species in terms of risk of extinction. IUCN recommends that the English abbreviations of the so-called Red List Categories be used irrespective of the language used in compiling the national Red Lists. This practice makes the Red Lists of different countries easier to understand and also help comparison of the status of a species among different countries. The level observed since 1990 is below 20% of the level observed not more than three generations ago. The European eel therefore qualifies for the IUCN Red List of endangered species. Opportunities for protection and restoration of spawner escapement are fading.
The most extreme categories refer to the fact that a species is totally or regionally extinct. The second most severe condition is when a species is Critically Endangered (CR).).The criteria state that at least 2% of the total population resides within a country, and that its stock has declined by 80% or more over not more than 3 generations. Since these criteria are met (see above) Sweden has listed the eel on its national Red List as Critically Endangered (CR). So far, no other country has done so (ICES 2006).

5. <u>Threats</u>

As argued about concerning the trends in population size, recruitment and habitat quality the principal threat to this species is over-exploitation by fisheries targeting the various life stages. In addition, blocking of rivers by dams, pollution of waters and sediments and habitat alterations have adverse effect on recruitment and survival of the species. Two principal positive characteristics of the fish and the fisheries is 1) the natural very high survival rate of yellow eels in their various habitats, and 2) the fact that there are hardly any by-catches of eels in gear other than those targeting the species.

5.1 Directed fisheries

Cultural patterns in fishing, aquaculture and consumption determine much of the distribution of various fisheries methods. This is particularly true of glass eel exploitation which interferes with the relation between stock density and fishing yield. In addition, in the 20th century consumption patterns changed dramatically. In the early half of that century glass eel were consumed in England, Wales and Ireland, a tradition entirely lost today. A similar change occurred in France were glass eel were consumed locally, but are now exported to Spain and east Asia (Dekker 2003a). In north European countries, glass eel are caught and used for re-stocking rather than immediate consumption. In general, fisheries tend to adapt to stock abundance and market options rather cultural traditions.

As mentioned in the Overview, fisheries are directed to various stages of eel in different countries and regions, not only because of local food habits but also because of market prices and demands from the expanding aquaculture industry in Asia and elsewhere. In general, though, eels are important throughout Europe for the small-scale coastal fisheries (Fig. 9). This also applies to the freshwater fisheries, mainly in northern Europe. Even though the fisheries are small scale and local the market is becoming increasingly global and eel trade is substantial (Wickström 2006). It was stated above that fisheries methods targeting eel rarely yield high by-catches of other fish species. On the other hand, seals and birds may drown in eel-catching gear.

According to FAO data bases it was estimated that the entire catch of eels in Europe was approx. 5,000 tons in 2002. Unofficial sources, however, argue that catches of 30,000 tons annually were caught in the 1990s, a figure that by now may have declined to some 10,000 tons (Wickström 2006). This is in agreement with Moriarty and Dekker (1997) who propose that the annual European catch in the 1990s was some 20,000 tons. Moriarty and Dekker (ibid.) also state that more than 25,000 people in Europe acquire a substantial income from eel fisheries. A comparison of the change in eel catches in Europe between 1994 and 2004 is shown in Table 3.

The fishing yield of European eel amounts to more than half of the world eel fisheries on all eel species. Annual averages in the 1990s, according to FAO data bases, were of the order of approx. 15,000 tons out of a world fisheries catch of some 29,000 tons. The annual average aquaculture production of eel in the 1990s was approx. 208,000 tons, more than 90% of which were the "Japanese eel" (*Anguilla japonica*). In 2002 that figure had increased to more than 230,000 tons according to FAO data bases (160,000 tons by China alone). Also in Europe aquaculture production exceeds fishing yield (Table 4) with three countries accounting for the bulk of production (Fig. 10). All in all, aquaculture production accounts for some 90% of present eel production world wide. Obviously, the fishing of glass eel and elvers provide the bulk of aquaculture production. Commercial glass-eel fisheries are found from the south-western end of the distribution area to River Severn in the north and including the Mediterranean coasts of Spain and Italy. Outside of this area glass eels are also caught but mainly for re-stocking inland waters either to supplement natural eel production or to use traditional growing areas where eels no more ascend the rivers.

Glass-eel fisheries are, as mentioned above, very species specific and no by-catches are obtained. The fishing methods used include hand-held or ship-based nets, either fixed or being moved. A wide range of dipnet types are used, but also trawls, stow nets, and fykenets (e.g. Dekker 2002, Aubrun 1986, 1987, Weber 1986, Ciccotti et al. 2000).

Data from the mid 1990s (Moriarty and Dekker 1997, Dekker 2000b) are presented in Dekker (2003) to show the “use” of glass eels arriving to the European continent and its surrounding waters (Fig. 11). When converting the numbers given in Dekker´s (ibid.) diagram to percentages, the following picture emerges: 50% goes to aquaculture (43% to Asia and 7% to EU countries – mainly Italy), 18% is used for direct consumption (almost all by Spain), 10% is used for trap & transport within EU countries, 8% is traded for re-stocking between countries, and, finally, only 14% escapes as natural immigration.

Yellow and silver eels fisheries are found throughout Europe (Fig. 12). In central and northern Europe these life stages dominate the catches. Even if the glass-eel catches are marginal in weight they outnumber the yellow and silver eels catches by a factor of 30 (Dekker 2000). Downstream migrating silver eels have been fished for hundreds of years in central and northern Europe in fixed traps, both on small streams and in big rivers, but such directed fisheries have dwindled down all over the original area. However, the silver eel fisheries still dominate the fisheries in Scandinavia. The low density production of yellow eel in northern countries is turned to a highly profitable fishery on the silver eel stage, because they tend to concentrate their emigration from lake systems both in time and space. At intermediate densities in central Europe fisheries focus on the yellow eels stage with a “by-catch” of silver eels.
Fisheries on the yellow and silver eel stages apply a wide series of gear: fixed traps (fish houses), all kinds of nets, spears, pots, hooks (longlines) and fyke-nets (e.g. Gabriel 1999).

5.2 Incidental fisheries

The early life stages of the European eel are rarely caught as a by-catch in gear targeting other species of fish. Yellow eel on the other hand are sometimes caught on bottom-set long line hooks baited with worms or small fish. Both yellow and silver eels are also occasionally caught in small-meshed fyke-nets that are non-selective in terms of species of fish caught. Additionally, infrequent by-catches occur in marine bottom gears, such as otter trawls and beam trawls, but these by-catches largely remain unregistered. There is no data available on the percentage of the total catch that these by-catches account for, but an educated guess is that it is a marginal proportion.

6. Utilisation and trade

European eel are utilised as a highly valued human delicacy in most European countries. Some countries mainly consume the glass eel/elver stages, others eat small yellow eels, and still other countries eat the large yellow eels or only silver eels. Very fragmentary and unreliable data occur concerning eel trade, within Europe as well as globally. However, trade from Europe to Asia is almost entirely based on glass eel and used in aquaculture. According to Dekker (2003a) aquaculture production of European eel (which is based entirely on wild caught glass eel) exceeds the fishing yield of the species. In addition, an unknown amount of glass eel/elvers caught in Europe is exported to east Asia (China). The rise of aquaculture in Asia and in Europe has initiated a world wide trading web. It is obvious that this very small scaled fishery is in fact a world wide trade where the Asian demand determines the European prices. Bad recruitment of *Anguilla japonica* rises the value of the European glass eel fishing. Also, elsewhere in this report it was stated that the present number of glass eel caught in European waters is insufficient for European restocking needs, not to mention European and Asian aquaculture demands. Small yellow eels are also traded among European countries and

also within countries. This measure is mainly to supplement inland commercial fisheries focusing on silver eels and sometimes also on large yellow eels.
A CITES Appendix II (App. B) listing for *Anguilla anguilla* will regulate and monitor future international trade, hopefully ensuring that future fisheries will not be detrimental to the status of the wild stock and thus to the survival of the species. This legal measure will also complement (and reinforce) traditional eel management measures, and the internationally coordinated recovery plan that is currently being developed by the European Commission.

7. Legal instruments

Catadromous species (spawning in the sea but often growing and maturing in inland waters) like the European eel have special attention in international law. United Nations Convention on the Law of the Sea (UNCLOS) has a special Article (67) covering general principles for management of these species. 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 prohibited.
3) Management must include provisions for secured immigration and emigration of the species.

These measures at least point at the need for international co-operation in eel management. One such concrete environmental aspect is to make sure that rivers will not cause obstruction to natural eel migration, e.g. because of pollution and construction. Most natural migratory routes to inland waters are now within EU jurisdiction, but some part of the drainages will also affect third countries. These facts call for management to be co-ordinated by multilateral agencies like The European Inland Fisheries Advisory Commission (EIFAC), instituted already in 1957 by FAO, and ICES when scientific advice is warranted.

8. Species management

8.1 Management measures

At the 92st Statutory Meeting of ICES (2005) and at the 25th meeting of EIFAC (2005) it was decided that the **ICES/EIFAC Working Group on Eels** (WGEEL) would meet from 23–27 January 2006 to, among other things:
1) evaluate the effect of glass eel restocking on the restoration of the spawning stock in relation to the established rebuilding goals, considering options from no re-stocking to full re-stocking of all available glass eel (e.g. according to the stocking strategy indicated in Fig. 13),
2) discuss EU considerations regarding a management plan for European eel and comment in relation to the precautionary approach,
3) consider the feasibility of potential inclusion of spawner quality parameters in stock management advice, specifically focusing on the quantification of the impact of pollution and parasitism;
4) describe and advise on the tools for post-evaluation of the status of the stock and the impact of management measures on stock and fisheries,
5) continue work to expand the data bases and knowledge on eels, to provide a more complete basis for recovery plans of the stocks/populations.

8.1.1 Objective of recovery

The objective of recovery of the stock necessitates restoration of the spawning stock, for which the EC has proposed a target of 40% of the potential production under unfished, unpolluted and unobstructed conditions. A methodology for elaboration of this reference level is described in this report (WGEEL 2006), but actual implementation will require field data and analysis for each spatial management unit. Analysis of stock dynamics under different fisheries management regimes indicates that *recovery times may vary from 20 up to 200 years*, depending on the intensity of implemented fisheries restrictions. However, restrictions on fisheries alone will be insufficient, and management measures aimed at other anthropogenic impacts on habitat quality, quantity and accessibility will also be required (ibid.). Also, the development of national and international management plans will involve aspects related to the Common Fisheries Policy (CFP) as well as to the Water Framework Directive (WFD). The overall objective will have to be achieved by implementation of protective measures at a regional scale, presumably at the level of River Basin Districts (RBDs) as defined for the Water Framework Directive (WFD).

The current report (ibid.) constitutes just one step in an ongoing process of documenting the status of the European eel stock and fisheries and compiling management advice. As such, the Report does not present a comprehensive overview, but should be read in conjunction with previous reports (ICES, 2000; 2002; 2003; 2004; 2005a).
The structure of this report does not strictly follow the order of the Terms of Reference for the meeting (see above), since different aspects of subjects where covered under different headings, but chapter 4 (ibid.) discusses the objective of stock recovery, explores options for deriving management targets, and analyses the time span required for actual recovery.
Also chapter 7 (ibid.) analyses options for applying re-stocking of glass eel as a potential management measure, aiming at recovery of the stock.

8.1.2 Regulation proposed by the EC

The objective of this proposal is "to achieve a recovery of the stock of European eel to previous historic levels of adult abundance and the recruitment of glass eel", and to ensure the sustainable use (fishing) of the stock.
The principal element of the proposed Regulation is the establishment of eel management plans for each River Basin, including trans-boundary basins (as defined according to the Water Framework Directive). The objective of each River Basin management plan shall be to permit, "with high probability, the escapement to sea of at least 40% of the biomass of adult silver eel relative to the best estimate of the potential escapement in the absence of human activities affecting the fishing area or the stock".
When this proposal is approved, Member States that have not developed Management Plans, will not be permitted to allow fishing, landing or retention of eels for the first 15 days of each month, except for eels less than 12 cm which are captured for the sole purpose of stocking European inland waters with access to the sea, in order to increase the escapement of adult silver eels. This seasonal closure will remain in force for each river basin until the approval and implementation of a basin management plan. A further, short term, exemption is possible for those river basins where it can be demonstrated, and approved by the Scientific, Technical and Economic Committee for Fisheries (STEFC), that existing measures meet the River Basin Management Plan objective. However, this exemption is available only until the 30 June 2007, after which date management plans must be implemented also for these river basins.

According to the proposal, Management Plans should be communicated to the Commission by 31 December 2006, and plans approved by the STECF must then be put in place by 1 July 2007. Subsequent monitoring of the effectiveness and outcome of the plan should be communicated to the Commission by 31 December 2009.

8.1.3 Restocking

Restocking has been practised by some countries for decades, generally to maintain fisheries rather than improve the stock or recruitment (Fig. 14). There are potential risks when moving fish between rivers. Restocking may be beneficial to rebuilding the stock, but it is highly unlikely that the 40% objective set by the EC will be met in all European river basins by re-stocking alone. Only a combination of several measures can be expected to bring the stock out of its current critical state. The current glass eel catches are also insufficient to re-stock inland waters, and a further decline in glass eel recruitment could result in total loss of the option to use restocking as a measure (ibid.).

Another issue can also limit the value of restocking as a general measure to increase the size of the spawning stock. Westin (1998, 2003) stocked elvers in a small lake on the island of Gotland, then tagged all of them when they left the lake as yellow and silver eels. When recaptured mosty eels had spent a long time in the Baltic (up to 10 years), they had lost weight and also decreased in length and fat contant and recaptures appeared to be random along the coasts rather then concentrated around the Sound and the Belt area which are the natural places of recapture of eels leaving the Baltic. Westin (ibid.) concluded that the stocked eels lacked imprinting of directional cues and that their contribution to the spawning stock is almost nil. However, Limburg et al (2003) found silver eels leaving the Baltic Straits, which most likely were derived from re-stocking, as evidenced by the micro-chemistry of bone tissues (otolith).

8.1.4 Restoration of spawning stock

In order to restore the spawning stock above levels at which the suggested depensation is likely to occur, protective measures will have to be implemented. Noting the ongoing decline in the adult stock at current fishing effort (Fig. 15), also in relation to the decline in recruitment from which the current stock was derived, opportunities for protection and restoration are fading. All possible emergency measures to protect the stock from anthropogenic mortality must be implemented, the sooner the better. Beyond immediate measures, restoration plans will have to be developed and implemented, allowing the recovery of the European eel stock.

8.1.5 Long term targets

Given the many uncertainties in eel biology and management, the precautionary advice of ICES (2002) was that the European eel stock should be managed according to a precautionary target reference point of 50% of the potential maximum pristine spawner escapement. Since no further, specific information has been brought forward, the advice is continued.
While the proposal of the Council regulation is for a target escapement of at least 40% of the potential biomass of adult eel, the underlying reference status of the population, in terms of silver eel biomass, is not clearly defined.

8.1.6 The Precautionary Approach

In accordance with the Precautionary Approach, on top of the minimum spawning stock levels an extra safety margin has been recommended (Fpa and Bpa; advice to protect 50% of pristine spawner escapement; ICES 1999).

8.1.7 Main Recommendations by the EIFAC/ICES Working Group on Eels (January 2006)
The 2006 session of the EIFAC/ICES Working Group on Eels recommends that:

a) the rapid development and implementation of management plans is facilitated in a work programme of workshops and guidelines, i.a. for
- re-stocking practices,
- recruiting eel immigration passages,
- silver eel deflection schemes,
- monitoring and post-evaluation procedures, potentially in pilot projects,
- pollution and disease monitoring,
- development of models and tools for management of the stock;

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

c) management targets are set for spawner escapement with reference to the 1950s-1970s, either identifying the actual spawner escapement levels of that period in full, or 30-50% of the calculated spawner escapement that would have existed if no anthropogenic mortalities would have impacted the stock - and where adequate data are absent, with reference to similar river systems (ecology, hydrography);

d) under the implementation of the WFD eel specific extensions should be implemented as an indicator of river connectivity and ecological and chemical status.

8.1.8 Future focus of WGEEL (ibid.)

1) establishment of an international data base for data on eel stock and fisheries, as well as habitat related data, aiming at:
2) development of methodology, for assessment of the status of the eel population, the impact of fisheries and other anthropogenic impacts and of implemented management measures, at the international level;
3) response to specific requests in support of the development of the stock recovery plans, when made;
4) compilation of a comprehensive and realistic research agenda, aiming at elucidation of the causes of the decline in and quantification of their impacts on the stock (ocean and continent, anthropogenic and natural, etc).

8.2 Population monitoring and control measures
Management (above) and monitoring interconnected activities. This is why the European Commission has issued a Proposal for a Community Action Plan for the Management of European Eel (COM 2003, 573), in which the international objective of restoration of the spawning stock is made explicit. The challenge for the Community is the rapid design of a management system that ensures that local measures produce results in a consistent way across the various river basins, Member States, and adjacent countries. To this end, criteria for

sustainable management of eel fisheries will be employed, focusing primarily on recruitment of young eels to and escapement of silver eels from continental waters, and secondarily on stock abundance and anthropogenic impacts in continental waters.

Obviously, further assessment of the biological status of eel requires additional and consistent data. This is why the European eel has been included in the EU Data Collection Regulation (DCR), (Council Regulation 1543/2000 and Commission Regulations 1639/2001, 1581/2004). Required sampling levels have only been tentatively indicated, and few countries have actually included eel in their sampling programmes. The European Commission initiated a Workshop on National Data Collection for European Eel (September 2005), with the objective to specify minimum requirements on sampling levels for fishery-dependent and fishery-independent data.
From 2006 onwards, inland eel fisheries will be covered by the DCR and also non-commercial catches need to be included. This report (Dekker (Ed.) 2005) presented an overview of current monitoring, surveying and sampling for eel, discussed the appropriate spatial scale for management and monitoring, develops adequate sampling intensities for sustainable management of a large number (>100) of mutually independent geographical management units, and recommended minimum requirements for future sampling in each of these management units, for each of the life stages (ibid.).

The main conclusions of this meeting were (ibid.):

1. Registration of fishing capacity, effort and landings is present in most countries, but achieves an incomplete coverage. Inland waters (of smaller size) are most frequently missed; non-commercial fisheries are substantial and almost completely unregistered.

2. Catch composition sampling occurs presently in only a few countries, but can rather easily be extended to other countries/areas. There is considerable friction between the required sampling levels (15 samples per annum per spatial management unit), the number of intended spatial management units (WFD/River Basin Districts, >100), and the size of an overall acceptable sampling programme.

3. Recruitment surveys (glass eel, young yellow eel) are in operation in most of the distribution
area, but are often fishery dependent. Required coordination and harmonisation has been described before.

4. Spawner escapement surveys (silver eel) are required for evaluation of trends in the spawning stock, but not easy to implement in most areas.

5. Standing stock surveys (yellow eel) can replace silver eel surveys in unfished areas, or where silver eel monitoring is unachievable, and might provide early warning on the trends in the stock. Current practices easily allow for extensions into new areas. Coordination with and integration into WFD-monitoring is required.

6. Current monitoring data are rarely used for an assessment of the status of stock and fisheries, but the FP6-project SLIME (FP6-022488) will focus on further development of appropriate models.

7. Analysis of sampling precisions is only available in two cases; available data allow further analysis. Complications arise due to required and inherent stratification.

8. Development and implementation of national management plans will require considerable efforts. International harmonisation and exchange of methodologies can facilitate the developments.

At the WGEEL Meeting in January 2006 the monitoring objectives may be summarised as follows:
Recruitment monitoring:
It is essential that the existing recruitment indices be continued. The network of monitoring stations should be extended and strengthened to give a better coverage of spatial scale. Monitoring of glass eel gives two measures, not necessarily from the same monitoring station: firstly success of spawning escapement and oceanic larval migration and secondly, recruitment into individual catchments.
Yellow eel monitoring:
Monitoring the standing stock of yellow eel may give a useful proxy for compliance to established management targets. This may be obtained by CPUE values in the lower reaches and lakes in a catchment and where possible, the relationship between CPUE data and standing crop should be established. Together with data on size and age structure, this could provide input for modelling spawner escapement. Another approach to obtain a proxy for the standing stock is yellow eel densities (electro-fishing) in the upper parts of a catchment.
Silver eel monitoring:
Monitoring output of silver eel may be possible from mark recapture techniques. From such surveys, overall mortality in the continental phase may also be deduced. The number of case studies presently using this approach, however, is extremely limited.

8.3 Captive breeding and artificial propagation
No attempt at captive breeding of the European eel has been successful so far, and hence there is no artificial propagation.

8.4 Habitat conservation
The management measures enumerated above (8.1) to increase recruitment and spawning stock are all concerned with eel fisheries, monitoring and legal instruments. The environmental threats facing the various eel stages are discussed above (4.1). Suffice it to say that the mitigation measures that will have most positive effect on eel spawning stock are fairly long-term, and in the short time span now available for changing the trend, such measures will be too slow to prevent the eel from biological and thus commercial extinction.

8.5 Safeguards and control measures
These issues are covered above (6, 7).

9. <u>Information on similar species</u>

As mentioned above there are 15 species of so called anguillid species (genus *Anguilla*) in the world, all of which (as far as we know) spawn in tropical waters. The European eel does not overlap with any other eel species in the fishery areas of its distribution, but some overlap occurs in Icelandic rivers which also harbour American eel (*Anguilla rostrata*). The European eel has the largest distribution of any eel species and according to FAO data bases these eels account for roughly one half of ther world fishing yield but less than 10% of world aquaculture production. The Japanese eel (*Anguilla japonica*) on the other hand, with a fishing yield of roughly 10% of that of the European eel is used to produce an aquaculture output ten times the size of European aquaculture production.

10. Consultations

To be included later.

11. Additional remarks

Assessment of the European eel under FAO´s recommended criteria for CITES listing:
The European eel meets the guidelines suggested by FAO for the listing of commercially exploited aquatic species. The species falls into FAO´s lowest productivity category of the most vulnerable species and the rate of decline is so rapid and steep as to qualify for Appendix I listing under FAO guidelines because the eel population has declined to 20% or even less of the historic baseline (FAO 2001). FAO (ibid.) further recommend that even if a species is no longer declining, if populations (in this *the* population) have been reduced to near the extent-of-decline-guidelines, the species could be considered for Appendix II listing. The latest IUCN Red List assessment for this species is (probably) that of Sweden (2005) which lists the European eel as ***Critically Endangered*** (CR).

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Figures and Tables

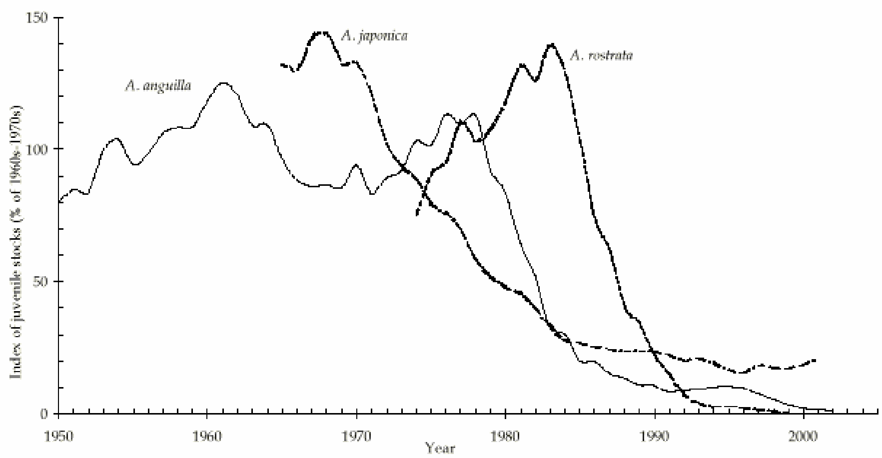


Figure 1 Time trends in juvenile abundance of the major eel stocks of the world. For *Anguilla anguilla*, the average trend of the four longest data series is shown, which trend appears to occur almost continent-wide; for *A. rostrata*, data represent recruitment to Lake Ontario; for *A. japonica*, data represent landings of glasseel in Japan.

(Dekker et al. 2003)

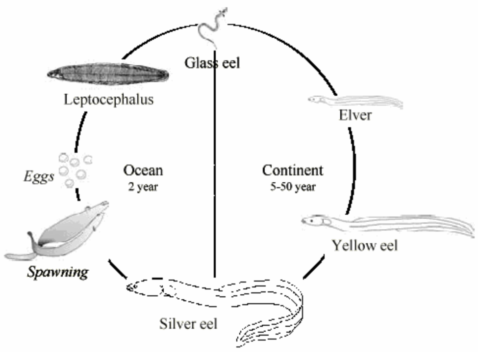


Figure 3 The life cycle of the European eel. The names of the major life stages are indicated; spawning and eggs have never been observed in the wild and are therefore only tentatively included.

(Dekker 2000a)

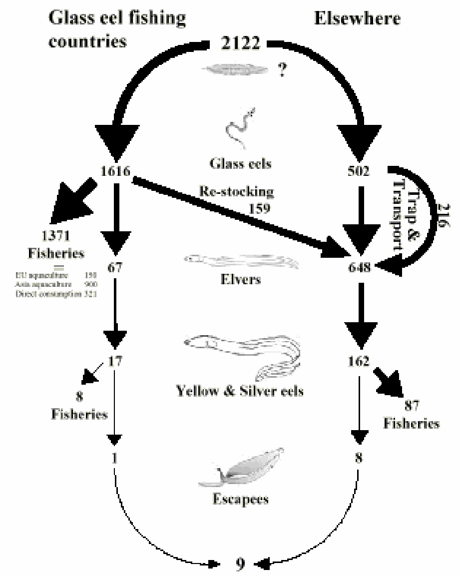


Figure 4 Dynamics of the European eel stock (numbers in millions), in the early 1990s. Estimates based on a cross-section in time, assuming a steady state. Countries with commercial glasseel exploitation to the left, other countries to the right.

(Dekker 2003a)

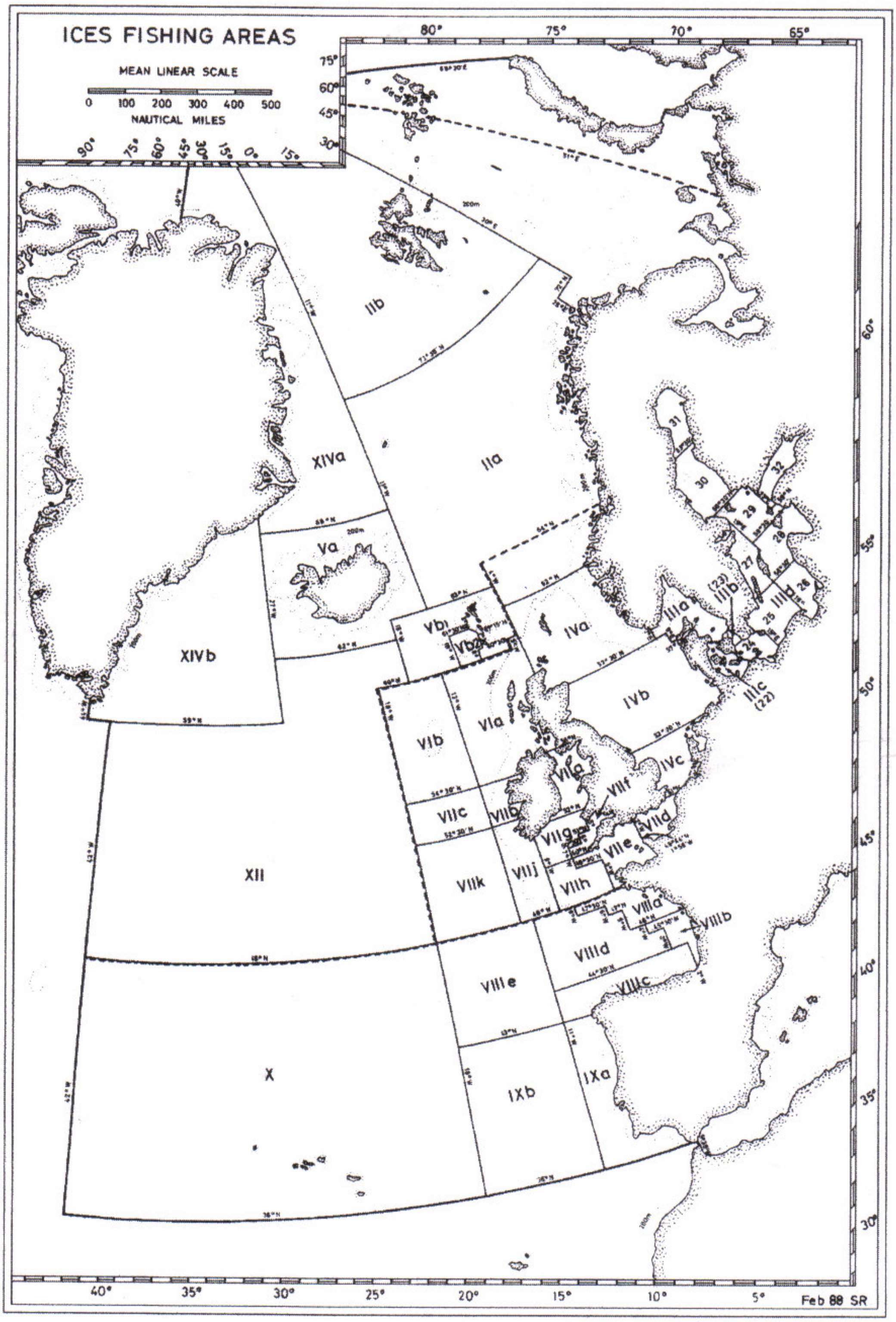
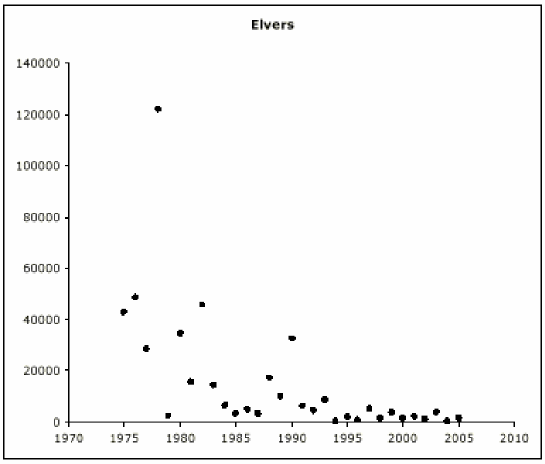
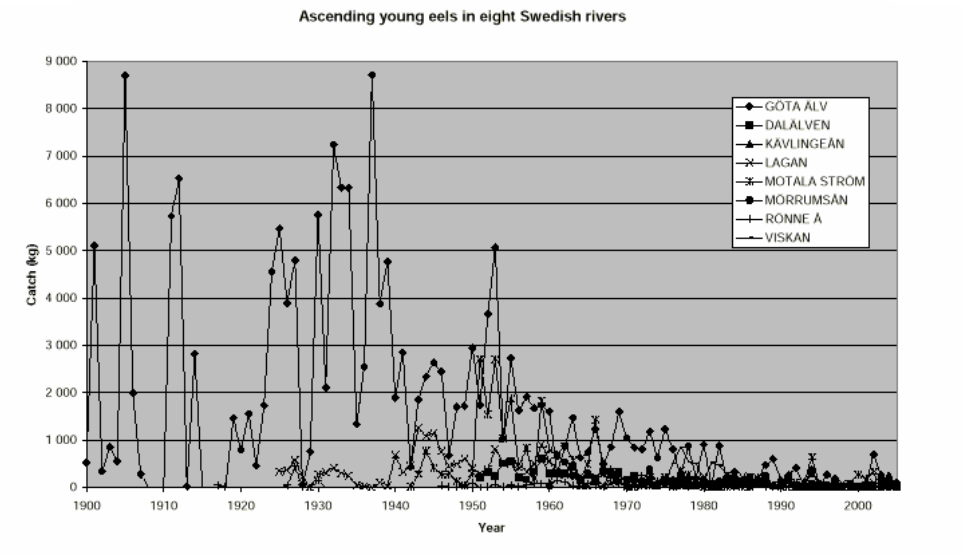


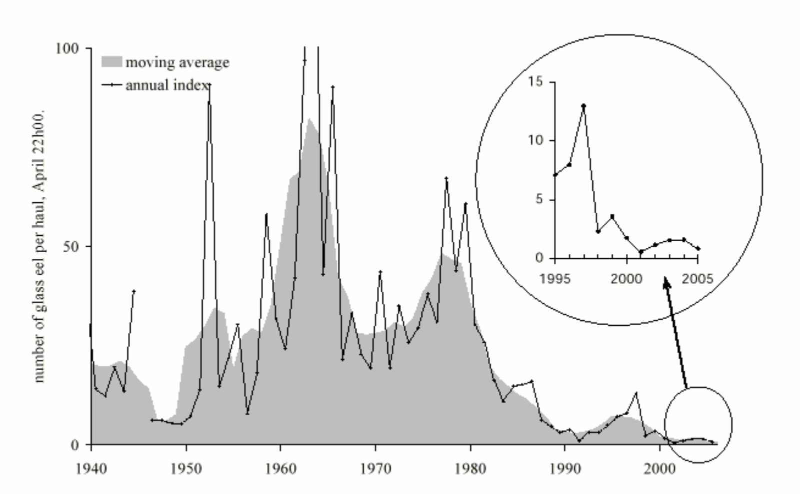
Figure 2 ICES fishing areas in the Atlantic Northeast.

Figure 5. (ICES WGEEL 2006, Annex 3: Eel stock and fisheries reported by country – 2005)



Total number of ascending elvers (number in trap) between 1975 and 2005 in the river Imsa.

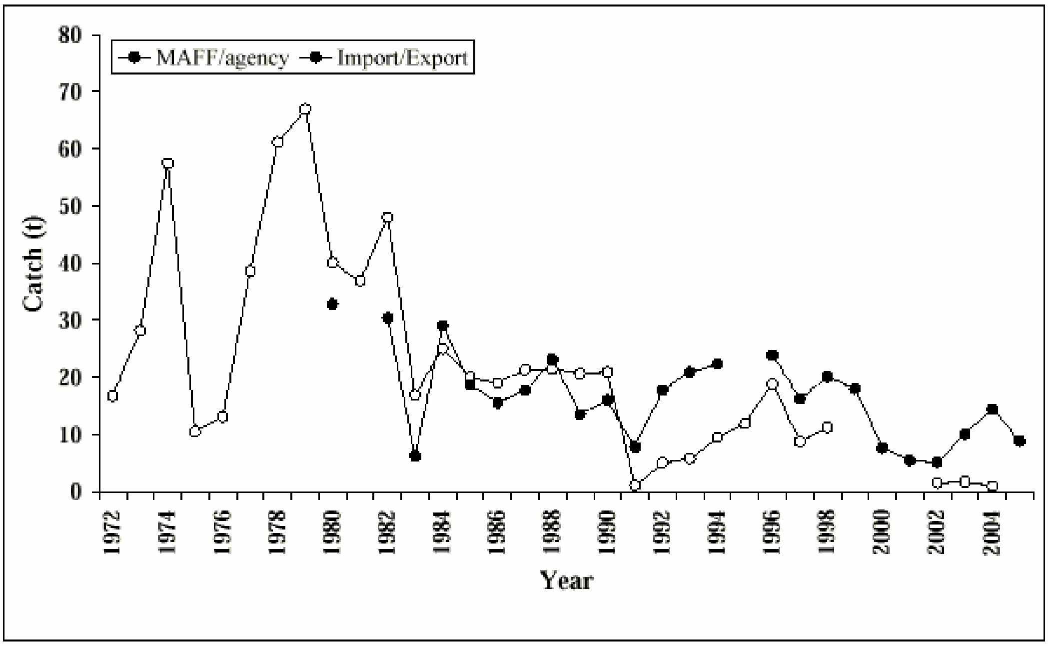


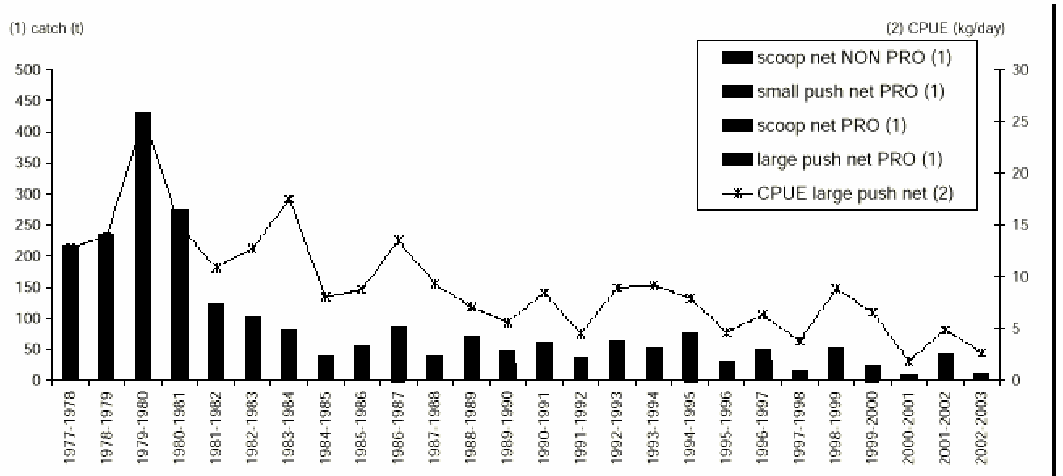


Time trend in the glass eel survey at Den Oever.

Figure 5. continued

England & Wales annual catch of glass eel (t) from MAFF/agency data and nett export estimates (Customs & Excise), 1972 – 2005





Cumulated capture of glass eel for professional and non professional fishermen, CPUE on the Gironde basin for1978-2003 (Source: Cemagref)

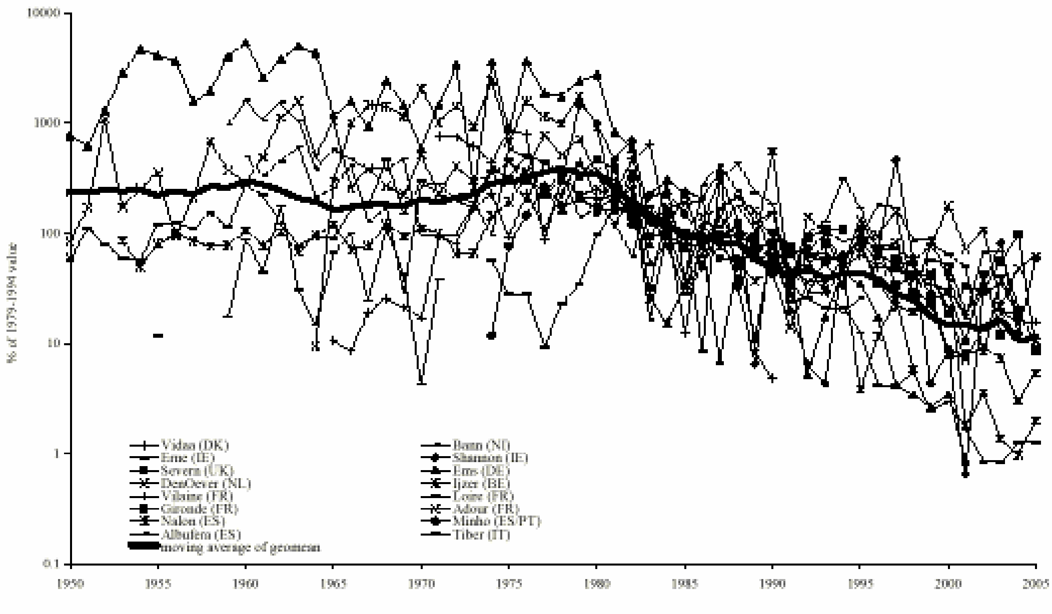


Figure 6 Time-series of monitoring <u>glass eel</u> recruitment in European rivers, for which data are reported for 2005. Each series has been scaled to its 1979–1994 average.

(ICES WGEEL 2005/2006)

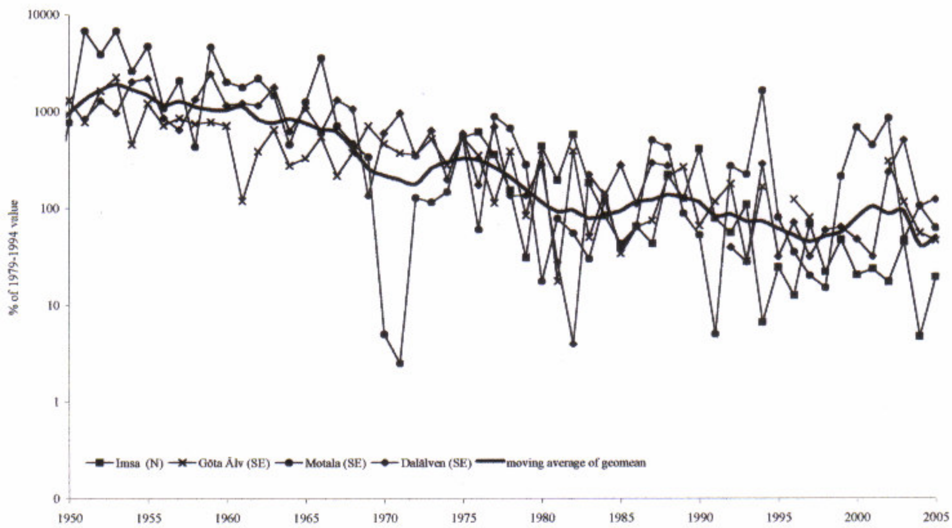


Figure 7 **Time-series of monitoring yellow eel recruitment (older than one year) in European rivers, for which data are reported for 2005. Each series has been scaled to the 1979–1994 average.**

(ICES WGEEL 2005/2006)

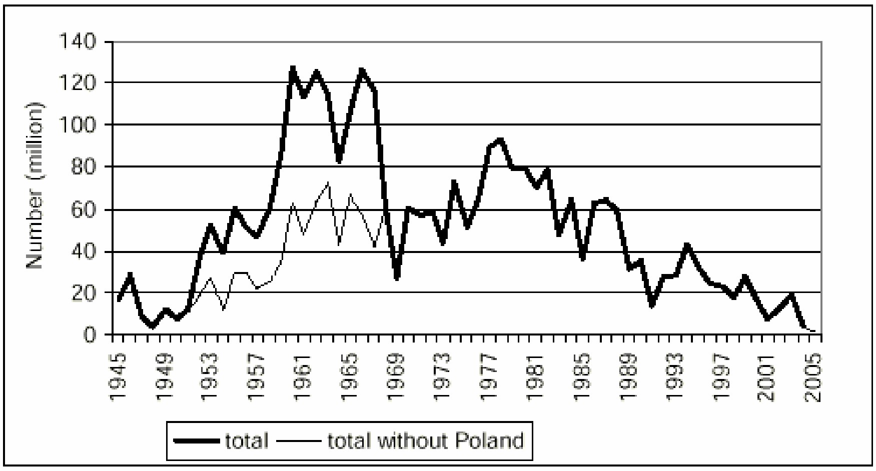


Figure 8 **Re-stocking of glass eel and young yellow eel in Europe (East Germany, Netherland, Denmark, Poland, Sweden, Northen Ireland, Belgium, Finland, Estonia), in millions re-stocked. The data series of Polish re-stockings was discontinued in 1968, while the re-stockings continued.**

(ICES WGEEL 2005/2006)

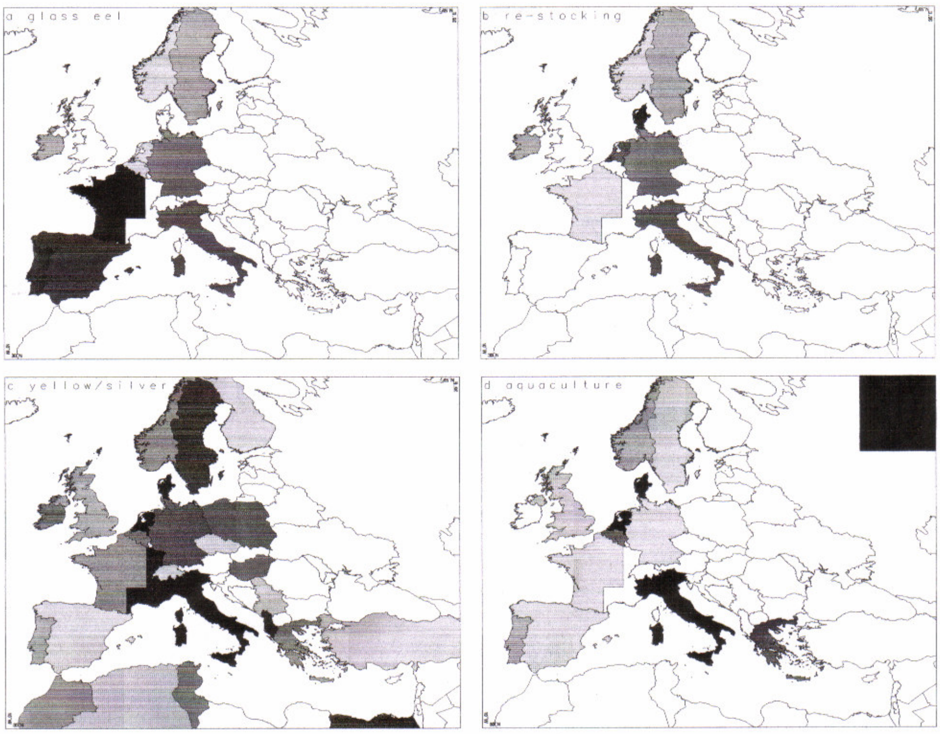


Figure 9 The spatial distribution in Europe of: a) Glass eel fisheries, b) Glass eel re-stocking, c) Yellow/silver eel fisheries and d) Aquaculture. The production of European eel in Asian aquaculture is shown in the top-right corner of panel d, in a square of equal surface area to Japan. Data from Moriarty (1997), adapted.

Legend for glass eel fisheries and re-stocking, g.km^{-2} land surface.

NA	0	>0	25	50	75	100	200	300	400	500	600	700	800	900	1000		
NA	0	>0	1	2	3	4	5	6	7	8	9	10	20	30	40	≥50	

Legend for yellow and silver eel fisheries, aquaculture, kg.km^{-2} land surface.

(Dekker 2000b)

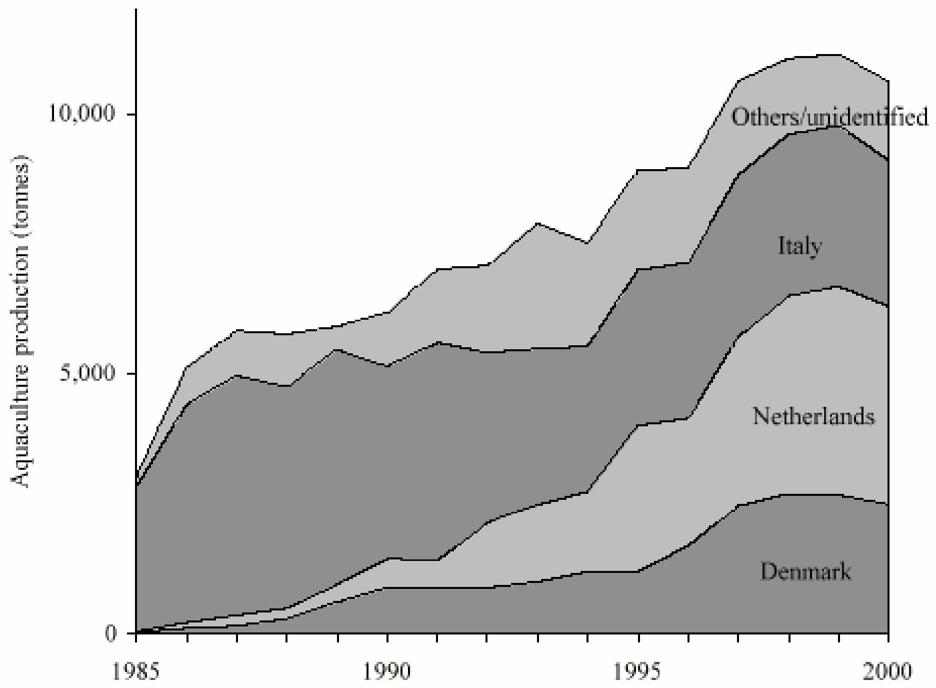


Figure 10 Production of eel aquaculture in Europe. Data from ICES (2002).

(Dekker 2003a)

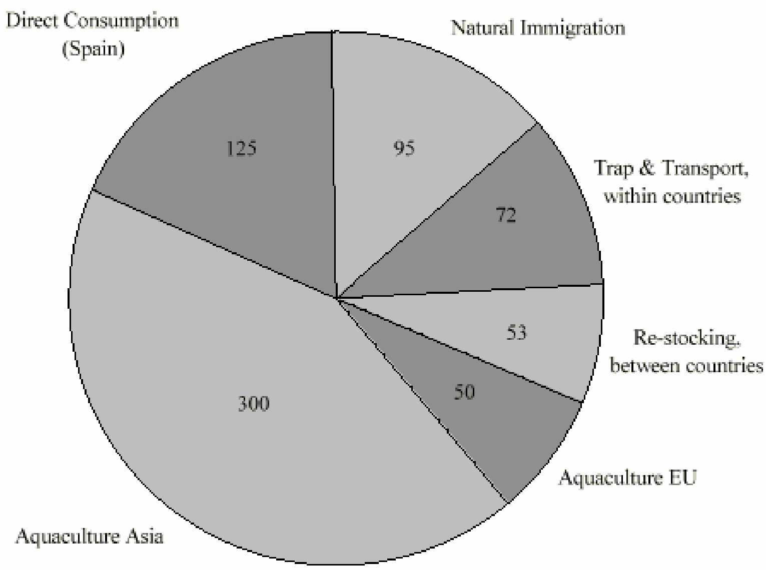


Figure 11 Disposition of glasseel landings. Numbers indicate quantities in tonnes per year. Data for the mid 1990s, from Moriarty and Dekker (1997) and (Dekker 2000).

(Dekker 2003a)

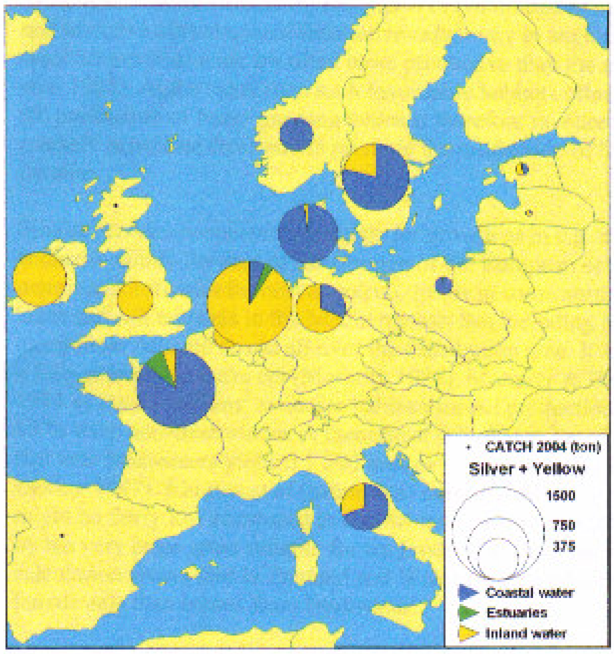


Figure 12 Catch by country and proportion of catch taken in Coastal, Estuarine and Inland water respectively. Data from UK and Ireland not divided according to catch environment.

(Wickström and Westerberg 2006)

Status of the European eel stock and fisheries

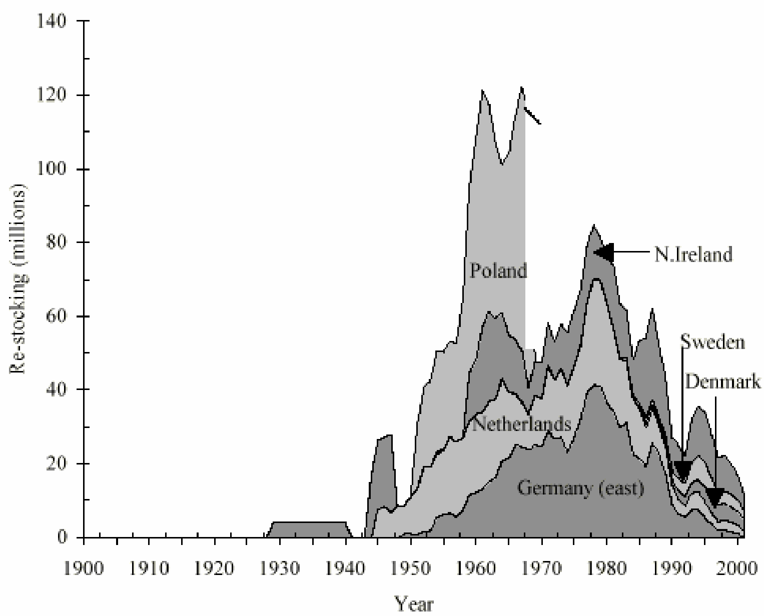


Figure 14 Re-stockings of glasseel during the 20th Century. Data from ICES (2002).

(Dekker 2003a)

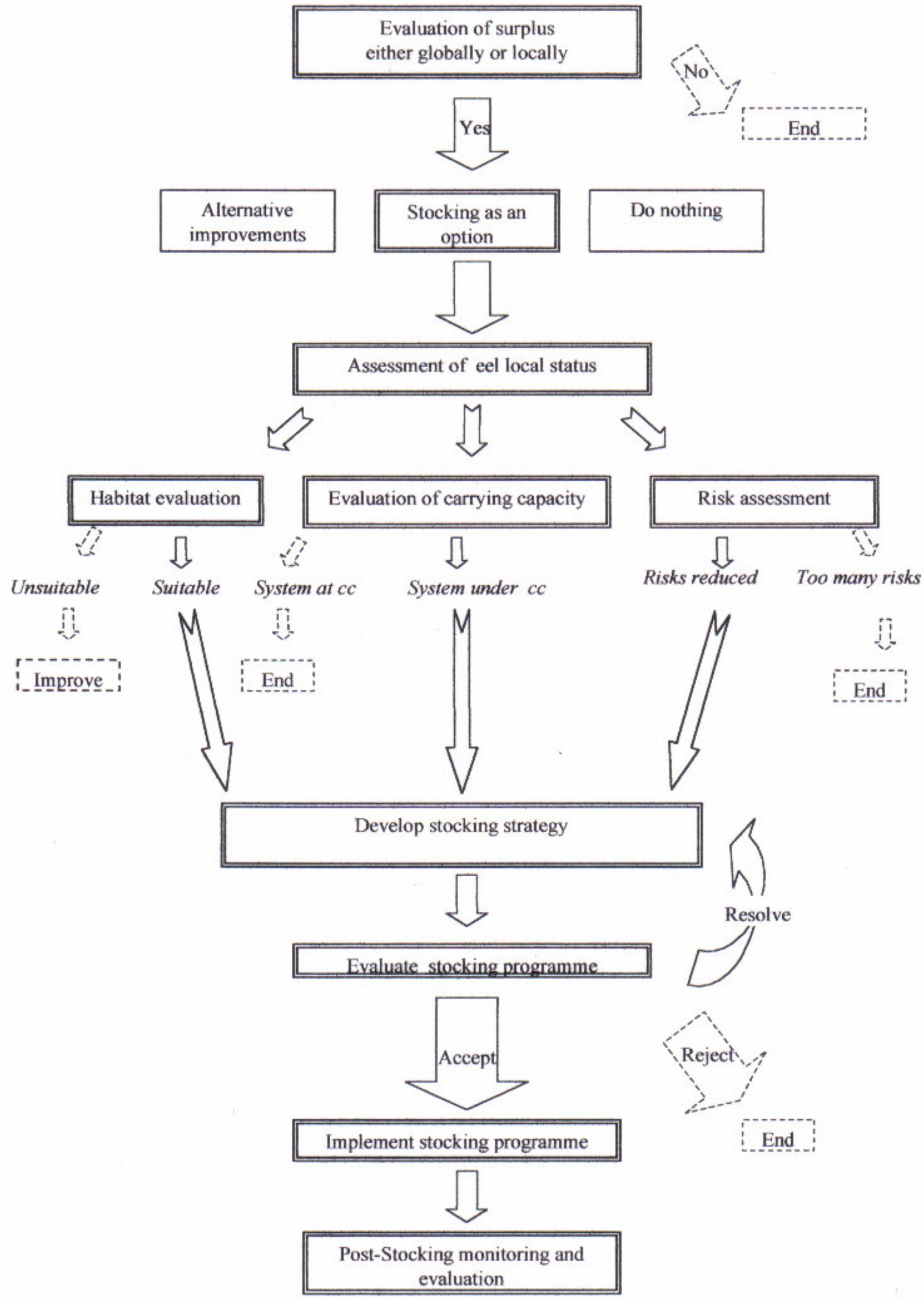


Figure 13 Stocking strategy – overview of decision process.

(ICES WGEEL 2005/2006)

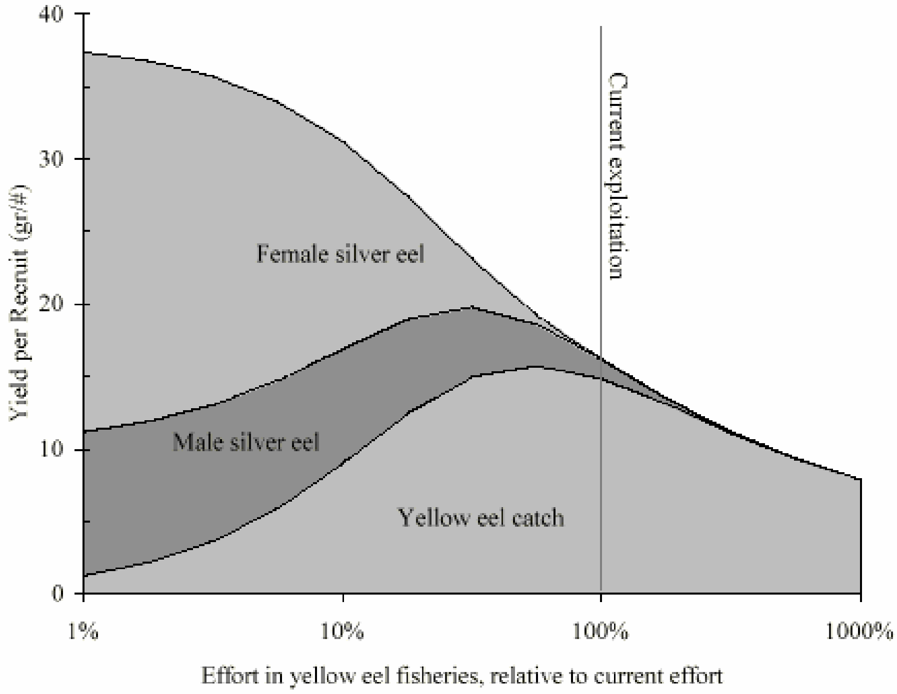


Figure 15 Yield per recruit for a mixed yellow and silver eels fishery as a function of fishing effort. Adapted from Dekker (2000).

(Dekker 2003a)

Table 1 **Surface area (thousands km^2) of eel habitat in freshwaters (Moriarty and Dekker 1997)**

COUNTRY	EEL HABITAT (1000 KM^2)
Sweden	19
Estonia (L. Peipsi)	4
Netherland	3.4
Germany	3
Italy	2.5
Poland	2.3
Ireland	2
Great Britain	1.9
France	1.7
Spain	0.7
Denmark	0.6
Portugal	0.3
Total	41.4

(ICES WGEEL 2005/2006)

Table 2 Recruitment data series. Part 1. Scandinavia and British Isles. The data units vary between data series; see the detailed Country Reports at the end of this report.

	N	S	S	S	S	DK	D	N.IRL.	IRL	IRL	UK
year	Imsa	Göta Älv	Viskan	Motala	Dalälven	Vidaa	Ems	Bann	Erne	Shannon	Severn
1950		2947		305			875				
1951		1744		2713	210		719				
1952		3662		1544	324		1516				
1953		5071		2698	242		3275				
1954		1031		1030	509		5369				
1955		2732		1871	550		4795		167		
1956		1622		429	215		4194				
1957		1915		826	162		1829				
1958		1675		172	337		2263				
1959		1745		1837	613		4654		244		
1960		1605		799	289		6215	7409	1229		
1961		269		706	303		2995	4939	625		
1962		873		870	289		4430	6740	2469		
1963		1469		581	445		5746	9077	426		
1964		622		181.6	158		5054	3137	208		
1965		746		500	276		1363	3801	932		
1966		1232		1423	158		1840	6183	1394		
1967		493		283	332		1071	1899	345		
1968		849		184	266		2760	2525	1512		
1969		1595		135	34		1687	422	600		
1970		1046		2	150		683	3992	60		
1971		842	12	1	242	787	1684	4157	540		
1972		810	88	51	88	780	3894	2905			
1973		1179	177	46	160	641	289	2524			
1974		631	13	58.5	50	464	4129	5859	794		
1975	42945	1230	99	224	149	888	1031	4637	392		
1976	48615	798	500	24	44	828	4205	2920	394		
1977	28518	256	850	353	176	91	2172	6443	131	1.02	
1978	12181	873	533	266	34	335	2024	5034	320	1.37	
1979	2457	190	505	112	34	220	2774	2089	488	6.69	40.1
1980	34776	906	72	7	71	220	3195	2486	1352	4.5	32.8
1981	15477	40	513	31	7	226	962	3023	2346	2.15	32
1982	45750	882	380	22	1	490	674	3854	4385	3.16	30.4
1983	14500	113	308	12	56	662	92	242	728	0.6	6.2
1984	6640	325	21	48	34	123	352	1534	1121	0.5	29
1985	3412	77	200	15.2	70	13	260	557	394	1.09	18.6
1986	5145	143	151	26	28	123	89	1848	684	0.95	15.5
1987	3434	168	146	201	74	341	8	1683	2322	1.61	17.7
1988	17500	475	92	170	69	141	67	2647	3033	0.15	23.1
1989	10000	598	32	35.2		9	13	1568	1718	0.03	13.5
1990	32500	149	42	21		5	99	2293	2152	0.47	16
1991	6250	264	1	2			52	677	482	0.09	7.8
1992	4450	404	70	108	10		6	978	1371	0.03	17.7
1993	8625	64	43	89	7		20	1525	1785	0.02	20.9
1994	525	377	76	650	72		52	1249	4400	0.29	21.1
1995	1950		6	32	8		40	1403	2400	0.40	
1996	1000	277	1	14	18		20	2667	1000	0.33	14.2
1997	5500	180	8	8	8		5	2533	1038	2.12	6.6
1998	1750		5	6	15		4	1283	782	0.28	8.1
1999	3750		2	85	16		3	1345	1246	0.02	8.2
2000	1625		14	270	12		4	563	1074	0.04	3.6
2001	1875		2	178	8		1	250	699	0.00	6.4
2002	1375	685	26.2	338.8	58.6		-	1000	112	0.18	5.7
2003	3775	261	44.13	19	126.7		-	1010	580	0.38	10.8
2004	375	125	5	42	26.4		-	308	269	0.06	19
2005	1550	105	25.8	24.8	30.9				836	0.04	

(continued)

Table 2 Recruitment data series; <u>continued</u>. Part 2: Mainland Europe. The data units vary between data series; see the detailed Country Reports at the end of this report.

	NL	B	F	F	F	F	F	E	P/E	IT	
	DenOever	Ijzer	Vilaine	Loire	Gironde (CPUE)	Gironde (Yield)	Adour	Nalon	Minho	Tiber	**Geomean** [1]
1950	7.15			86							**240**
1951	14.07			166							**239**
1952	90.95			121							**247**
1953	14.78			91				14,529			**243**
1954	22.06			86				8,318			**248**
1955	30.35			181				13,576			**223**
1956	7.96			187				16,649			**244**
1957	18.2			168				14,351			**230**
1958	58.11			230				12,911			**265**
1959	31.98			174				13,071			**264**
1960	24.23			411				17,975			**292**
1961	42.05			334				13,060			**278**
1962	97.01			185				17,177			**246**
1963	138.42			116				11,507			**210**
1964	43.17	3.7		142				16,139			**194**
1965	90.39	115	5	134				20,364			**168**
1966	21.71	385	4	253				11,974			**175**
1967	33.31	575	9	258				12,977			**187**
1968	22.94	553.5	12	712				20,556			**183**
1969	19.35	445	10	225				15,628			**180**
1970	43.76	795	8	453				18,753			**203**
1971	19.53	399	44	330				17,032			**194**
1972	34.99	556.5	38	311				11,219			**214**
1973	26	356	78	292				11,056			**230**
1974	29.62	946	107	557				24,481	1.642		**285**
1975	38.05	264	44	497				32,611	10.578	11	**290**
1976	30.96	618	106	770				55,514	20.048	6.7	**318**
1977	67.32	450	52	677				37,661	36.637	5.9	**360**
1978	43.97	388	106	526				59,918	24.334	3.6	**388**
1979	60.91	675	209	642	19.7	286.2		37,468	28.435	8.4	**352**
1980	30.54	358	95	525.5	25.9	404.8		42,110	21.32	8.2	**343**
1981	26.04	74	57	302.7	20	332.2		34,645	54.208	4	**263**
1982	16.42	138	98	274	15	123.3		26,295	16.437	4	**187**
1983	10.99	10	69	259.5	13.6	80.3		21,837	30.447	4	**148**
1984	14.76	6	36	182.5	19.2	82		22,541	31.387	1.8	**121**
1985	15.3	13	41	154	9.6	64.5		12,839	20.746	2.5	**97**
1986	16.05	26	52.6	123.4	10.6	45.2	8	13,544	12.553	0.2	**96**
1987	6.25	33	41.2	145	14	82.4	9.5	23,536	8.219	7.4	**83**
1988	4.67	48	46.6	176.6	10.9	33	12	15,211	8.001	10.5	**81**
1989	3.2	30	36.7	87.1	7.2	80	9	13,574	9	5.5	**59**
1990	3.9	218.2	35.9	96	5.6	48.1	3.2	9,216	6	4.4	**49**
1991	1.18	13	15.4	35.7	7.7	64	1.5	7,117	9	0.8	**42**
1992	3.12	18.9	29.6	39.3	3.7	41.7	8	10,259	10	0.6	**47**
1993	3.14	11.8	31	90.5	8.2	69.4	5.5	9,673	7.6	0.5	**40**
1994	5.01	17.5	24	94.6	8.7	45.8	3	9,900	4.7	0.5	**43**
1995	7.12	1.5	29.7	132.5	8.2	73.2	7.5	12,500	15.2	0.3	**44**
1996	7.97	4.5	23.2	80.8	4.8	30.7	4.1	5,900	8.7	0.1	**38**
1997	12.97	9.8	22.85	70.8	6.5	50.5	4.6	3,656	7.4	0.1	**29**
1998	2.31	2.3	18.9	60.7	4.3	25	1.5	3,273	7.4	0.13	**25**
1999	3.6		16	86.9	7.5	44.1	4.3	3,815	3.8	0.06	**18**
2000	1.76	17.85	14.45	79.9	6.6	25.1	10	1,330	1.2	0.07	**15**
2001	0.58	0.7	8.46	30	1.9	9	4	1,285	1.149	0.04	**15**
2002	1.17	1.4	15.9	42	4.9	36.8	6	1,569		0.02	**14**
2003	1.56	0.539	9.37	53	2.7	10.4	1.24	1,231		0.02	**16**
2004	1.57	0.381	7.49	27			2.67	506		0.03	**11**
2005	0.85	0.787	7.36				3.5	914		0.03045	**12**

[1]: The column **Geomean** presents the geometric mean of the three longest glass eel data series (Loire, Den Oever and Ems), after standardisation to their 1979-1994 level.

(ICES WGEEL 2005/2006)

Table 3 Comparison of the 1994 and 2004 estimates of eel catches, per country. Sources: Moriarty (1997) and Moriarty and Dekker (1997); recent Country Reports at the end of this report.

COUNTRY	GLASS EEL (TON)		YELLOW + SILVER EEL (TON)	
	1994	2004	1994	2004
France	300.0	173.9	2200	1078
Italy	0.5	0.0	900	446
Spain	150.0	4.0	100	34
England and Wales	18.0	14.4	293	183
Scotland	0.0	0.0	0	0
Ireland	3.0	0.7	1035	582
Poland	0.0	0.0	1137	75
Latvia	0.0	0.0	40	12
Estonia	0.0	0.0	47	39
Sweden	0.0	0.0	1130	572
Denmark	0.0	0.0	1780	530
Norway	0.0	0.0	472	240
Belgium	0.0	0.0	0	5
Netherlands	3.0	0.0	885	920
Germany	0.0	0.0	1198	416
Portugal	20.0	4.6	0	0

(ICES WGEEL 2005/2006)

Table 4 **Aquaculture production of European eel in Europe and Japan. Compilation of production estimates (tonnes) derived from reports of previous WG meetings, FAO, FEAP and others. Data for Sweden and the Netherlands have been revised.**

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Norway										120	200	200	200	200								
Sweden	12	41	51	90	203	166	157	141	171	169	160	139	161	189	204	222	273	200	167	170	158	
Denmark	18	40	200	240	195	430	586	866	748	782	1034	1324	1568	1913	2483	2718	2674	2000	1880	2050	1700	
Ireland																	100					
UK				20	30	0	0				25		25									
Germany												186	204	221	260	400	422	347	381	372	328	
Netherlands				100	300	200	600	900	1100	1300	1450	1540	2800	2450	3250	3500	3800	4000	4000	4200	4500	4500
Belgium/Lux.					30	30	125	125	125	125	150	140	150	150	40	20	50	55				
Spain	15	20	25	37	32	57	98	105	175	134	214	249	266	270	300	425	200	259				
Portugal	60	60	590	566	501	6	270	622	505	979	200	110	200	200	200	200						
Morocco							35	41	68	85	55	55	56	42	27	28	60	28				
Algeria					72	53	22	1	0	22	20	17	17	17	22	15	18	20				
Tunisia							150	151	250	260	108	158	147	108								
Italy	2600	2800	4200	4600	4250	4500	3700	4185	3265	3000	2800	3000	3000	3100	3100	3100	2750	2500	1900	1550		
Greece			6	4	10	54	94	132	337	341	659	550	312	500	500	300	600	735				
Turkey																						
Macedonia									1	0	70	83	60	72	60	50	32					
Yugoslavia	44	52	48	49	19	10	5	1	8	2	9	5	5	5	6	6	5	4				
Croatia								7	5	5	7	6	7									
Hungary					90	39	73	33		50		50			19	19						
Czech. Rep.									2	4	4	3	3	3	1	1	1	1				
Sum EU	1950	2229	3448	4729	5517	5159	6667	6098	6818	7721	7689	8935	9031	10646	11059	10839	10510	8435				
Japan		3000															10000					

(ICES WGEEL 2005/2006)