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Status of the eel stock in Sweden in 2011

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Foreword

The eel stock and fisheries in Sweden and elsewhere in Europe have been in decline for a long time. Already in the mid-seventies, our institute published reports showing that not only eel fishery landings declined, but also the quantities of young eels entering Swedish rivers. While more and more aspects of eel biology, fishery and stock management were unravelled over the years, the stock declined further and further. In 2007 the European Union has decided on a stock protection plan and a Swedish management plan followed at the end of 2008. Both restriction measures to reduce human impacts on the eel stock and active support to the stock have now become subject of political and societal debates among stakeholders and the government. It is within this framework of setting management targets that we present this report in which the underlying facts and figures of the state of the stock and the fishery are described. The authors aim to summarise an enormous amount of available information, spanning more than half a century, in order to facilitate the societal debate. I am happy to present this report, and hope it will serve its role in informing all having interests in and responsibilities for the future of the eel.

Joep de Leeuw

Head of Department

Summary

This report presents an overview of the eel stock in Sweden, as of spring 2011. The objective is to provide a comprehensive overview, avoiding scientific jargon as much as possible. Historical data series and recent distribution maps are shown, amongst others on recruitment, restocking, habitats and their productivity, fisheries, and the impact of hydropower generation. Indicators are derived for the state of the stock and for the impact of fishing and hydropower generation, before and after the implementation of the Eel Management Plan 2009.

This report is also available in Swedish (Aqua reports 2011:1).

Sammanfattning

Föreliggande rapport ger en översikt av ålens beståndssituation som den ser ut våren 2011. Syftet med rapporten är att presentera en utförlig men lättläst översikt. Vi har försökt att, i görligaste mån, undvika vetenskaplig jargong och fackuttryck. Historiska dataserier över rekrytering, utsättning, uppväxtarealer och deras produktivitet presenteras samt givetvis fiskets omfattning och effekter. Effekten av vattenkraftsproduktion redovisas också. Med hjälp av dessa bakgrundsdata har olika beståndsindikatorer tagits fram och som beskriver beståndsstatus och effekten av fisket samt vattenkraftsproduktionen, såväl före som efter implementeringen av 2009-års Ålförvaltningsplan.

Den här rapporten finns även på svenska (Aqua reports 2011:1).

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1 Introduction

In this introduction, we give a short account of the aim of this report, the background in eel stock management, the biology of the eel, a brief overview of the Swedish eel stock and fisheries, and the geographical area we are reporting on.

1.1 Aim of this status report

This report presents an overview of the eel stock in Sweden, as of spring 2011. We give a comprehensive and easy-to-read overview of the information available and assess the status of the stock. Most of the information presented here has been published before, but that was often in publications that are not easily available, and written in rather technical jargon.

The implementation of the European eel protection plan (2007) has given rise to much debate on the status of the stock and the effect of protective measures. Evaluation of the protection plan by midsummer 2012 will revive that discussion. In the current report, we provide information on observed trends and assess the status of the stock in non-technical wording. In doing so, we hope to inform all parties involved and to serve their debate.

The information presented has been updated in spring 2011. For most data series, this report covers the period up to and including 2010. For the assessment of the stock status, however, only partial updates were available; for other parts, an update is planned before the international evaluation in summer 2012. As a consequence, the presented stock assessment refers primarily to the situation prior to 2009, before the Eel Management Plan was implemented. Obviously, the 2012 evaluation will need a fully updated assessment.

Information will be presented primarily in graphs, maps and plots, which will allow easy communication of the observations. This will not allow presenting all detail and full justification (including scientific references). In this report, we prefer readability over completeness. At the end of this report, an overview of a few other information sources is presented; those sources give a more formal and technical presentation.

Finally, this report aims to present information, not to provide advice. Formal advice will be given separately, using the existing advisory procedures.

This report is available in two versions: in Swedish and in English.

1.2 Eel biology

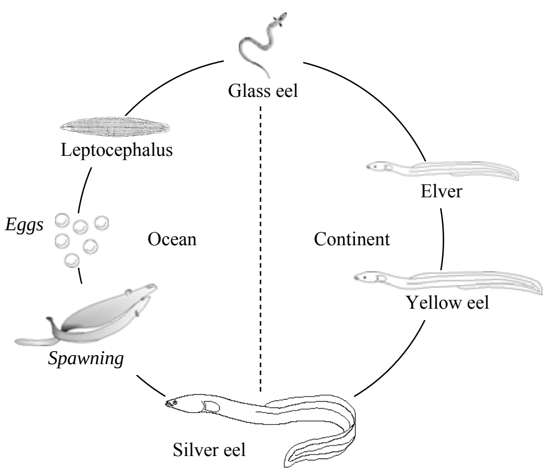


Figure 1 - Life cycle of the European eel. Names of the major life stages are indicated. Spawning and eggs have never been observed in the wild.

The European eel *Anguilla anguilla* (L.) is a weird animal. Although its life cycle is incompletely known, reproduction must take place somewhere in the Atlantic Ocean, presumably in the Sargasso Sea area where the smallest larvae have been found. Eels grow and mature in 2-50 years (average 10, max. >84). Females become about twice the age and size of males, but almost all eels in Sweden are found to be females. No-one has ever observed spawning adults or eggs in the wild. Aquaculture is exclusively based on rearing of wild caught (glass) eels.

Different life stages have specific names: the transparent youngsters coming to European coasts are called glass eels; in the growing phase, they are known as yellow eels; and when finally returning towards the ocean, they become silver eels. In the Baltic, it is the early yellow eel stage (elver), which migrates into

the rivers, though many of them can stay in coastal waters throughout their life too.

The European eel constitutes a single stock, distributed all over Europe, northern Africa and the Mediterranean parts of Asia. This wide distribution area, however, is effectively fragmented over thousands of river catchments, with little or no natural interaction in-between. The Bay of Biscay area receives approx. 90 % of all glass eel recruitment; yellow and silver eel are more evenly spread over the wide distribution area. They occur in coastal areas, estuaries, lagoons, rivers, lakes, marshes and ditches, and they migrate in-between throughout their life time. They can survive a wide range of environmental conditions (temperature, salinity, depth, trophic status, etc). Active transport by man (transporting mostly glass eels, sometimes yellow eels) has influenced the distribution considerably, both within rivers and over the continents.

Fisheries for eel are found all over the distribution area - often as target species, sometimes as valuable by-catch. Depending on the abundance and local circumstances, different countries may target glass eel, yellow eel or silver eel. In Sweden, the West Coast fishery targets mostly yellow eel, while the East Coast and inland fisheries catch predominantly silver eels.

1.3 Management of the European eel

The stock of the European eel has observed a decadal decline. Recruitment of glass eels from the Atlantic Ocean fell in the 1980s to about 10 % of former levels, followed by a further decline since 2000. Catches have gradually declined over the second half of the 20th century, down to approx 15 %. These trends have occurred over almost the entire distribution area. There are indications that other *Anguilla* species (American, Japanese, and both New Zealand eels) experience a comparable and possibly synchronous decline. Causes of the stock decline are not well known, but might include pollution, habitat loss, overexploitation, transfer of diseases, ocean climate change, and others.

In 2007, the European Union decided to implement a stock protection and recovery plan (EU Regulation 1100/2007). Based on this Regulation, all Member States developed a national Eel Management Plan for their part of the eel stock. The common objective of all those plans is to ensure the survival of 40 % of the eel relative to what would have survived from a healthy stock, in the absence of all anthropogenic impacts. In December 2008, Sweden submitted its Eel Management Plan.

In 2007, the Convention on International Trade in Endangered Species of Wild Fauna and Flora CITES included the European eel in Appendix II of this convention. From 2009 onwards, import and export of live eels and all eel products over the outer borders of the European Union is only allowed with a Non Detriment Finding, a certificate ensuring that the export (and thus the exploitation) is non-detrimental to the stock. In fall 2010, the European Union decided to implement a temporary ban on import/export over its outer borders. The implementation of the import/export ban affects the international markets, and indirectly all national management plans.

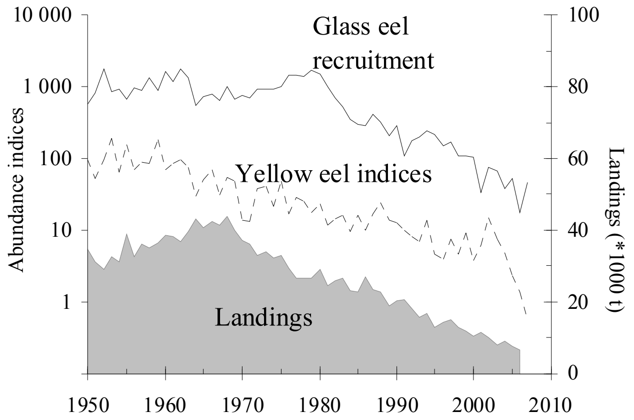


Figure 2 - Trends in abundance of glass eel, yellow eel and fishing yield (landings), averaged/summed over the whole of Europe. Note that abundance indices are plotted on logarithmic scale, while yield is on a linear scale.

The objectives of the EU Regulation are to protect and restore the stock. The Regulation sets a common target for the escapement of silver eels (i.e. those returning to the Ocean to spawn), at 40 % of the natural escapement (that is: in the absence of any anthropogenic impacts). Since current glass eel recruitment is far below natural levels (and assumed to be so due to anthropogenic impacts), return to the 40 % target level is not expected within 3-4 generations of eel (60-80 years) or much longer (200 years or more), even if all anthropogenic impacts are stopped.

Protection and restoration of the eel will require action in the field of fisheries, of habitat restoration, of (restricting the impact of) hydropower generation, of nature conservation, etc. The EU Regulation acknowledges that many anthropogenic factors have an impact on the stock, but it focuses on fisheries and mortality induced by hydropower generation; for other factors, one relies upon various other Regulations already in place (Water Framework Directive, Habitats Directive, Common Fishery Policy). It is assumed, that these other Regulations contribute adequately to the restoration process, and achieve the maximum effort feasible.

By midsummer 2012, Member States will report to the European Union on the implementation of their Eel Management Plans, and the effect it has had on stock and fisheries. That report will describe what protective measures have been taken, what effect these have had on the stock, and what status the stock has achieved in relation to the targets (40 % escapement of silver eels). The current report is written one year before midsummer 2012; though most of the information shown here will probably be duplicated in the 2012 report, this current status report is not intended to pre-empt the 2012 reporting.

1.4 The Swedish eel stock and fisheries

The eel stock in Sweden occurs from the Norwegian border in the Skagerrak on the west side, all along the coast to about Hälsingland (61°N) in the Baltic Sea, and in most lakes and rivers draining there. Further north, the density declines to very low levels, and these northern areas are therefore excluded from most of the discussions here. In the early 20th century, there were eel fisheries also in the northernmost parts of the Baltic Sea. Current day's distribution covers a multitude of habitat types: along open coasts, in sheltered coastal bays, in fast running rivers and stagnant lakes, in large basins and the smallest creeks, etc. In this report, all of these habitats will be considered. On the next page, we will briefly describe the main habitats and fisheries.

In most sections of this report, data will be presented for coastal areas and inland waters separately. That is a structuring by main habitat types, though within each area, there are still a wide range of habitats to be found. In the next section, we will discuss the administrative breakdown of areas to be considered.

The West Coast from the Norwegian border to Öresund, i.e. 320 km coastline in Skagerrak and Kattegat. Along this open coast there is a fishery for yellow eels, mostly using fyke nets (single or double), but also baited pots during certain periods of the year. The intention is to close the West Coast fisheries by 2012.

Öresund, i.e. a 110 km long Strait between Sweden and Denmark. In this open area both yellow and silver eels are caught using fyke nets and some large pound nets. The northern part of Öresund is the last place where silver eels originating from the Baltic Sea are caught on the coast, before they disappear into the open seas.

The South Coast from Öresund to about Karlskrona, i.e. a 315 km long coastal stretch of which more than 50 % is an open and exposed coast. Silver eels are caught in a traditional fishery using large pound nets. This area is traditionally named "Ålakusten" (eel coast), where there are activities, restaurants and tourism based on the eel and its fishery.

The East Coast further north, from Karlskrona to Stockholm. Along this 450 km long coastline yellow and silver eels are fished using fyke nets and large pound nets. North of Stockholm, catches exist almost exclusively of silver eels, and the abundance and quantities caught decline going further north.

Eels are found in most lakes, except in the high mountains and the northern parts of the country. Pound nets are used to fish for eel in the biggest lakes Mälaren, Vänern and Hjälmaren, and in some smaller lakes in southern Sweden. In inland lakes, restocking of young eels has contributed to current day's yield, while barriers and dams have obstructed the natural immigration of young eels. Traditional eel weirs (lanefiske) have been operated at several places, and some are still being used. Hydropower generation is known to impact the emigrating silver eel.

1.5 Geographical terminology

The areas covered in this report include in principle all surface waters in the Swedish territory. This comprises both inland and marine waters.

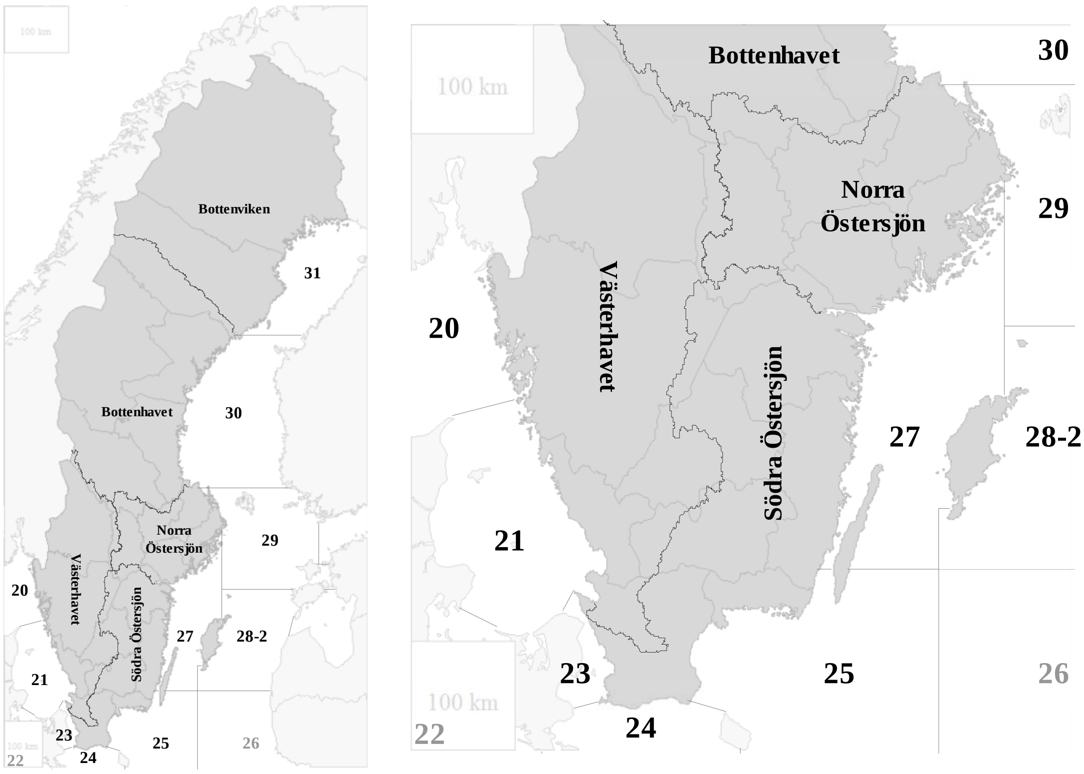


Figure 3 - These maps show the ICES subdivisions in coastal waters, and the River Basin Districts in inland waters. County borders are indicated in grey.

In relation to the Water Framework Directive, Swedish inland waters have been split into five River Basin Districts, named after the sea area to which they drain: Bottenviken, Bottenhavet, Norra Östersjön (Northern Baltic), Södra Östersjön (Southern Baltic) and Västerhavet (West Coast). This area coding for inland waters will be used here too.

For the coastal areas surrounding Sweden, the coding of the International Council for the Exploration of the Sea ICES is used, also for the inshore areas. The standard coding used by ICES indicates areas by sub-division numbers (e.g. SD-20); in this report, regional names have been assigned to each of these areas, to make the codes more easily understood. Some of these names apply well for the current focus on coastal areas, though they might be less applicable for a wider setting (e.g. SD 29 Ålandshavs coast, while SD 29 covers a large area of open sea beyond Ålandshav, which is not relevant for the current setting).

Historical landings data have first been reported by county (län), but later on a coarse coding was used, in which only three areas were distinguished: West Coast, South Coast and East Coast.

All in all, four different area codings have been used, diagrammatically shown in Figure 4. Unfortunately, the borders between the areas differ from coding to coding system, and historical data seldom allow exact reconstruction. Most data in this report are presented in a way that shows as much detail as possible, and therefore geographical categories may sometimes vary. In other cases, data were re-assigned to areas (mostly to river basin districts), and slight differences between borders neglected. As an example: the border between Halland and Skåne just north of Hemmeslöv, versus the border between ICES SD 21 (Kattegat coast) and 23 (Öresund) at Kullaberg, and the border between river basin districts Västerhavet and Södra Östersjön just east of Ängelholm; a difference of ca. 30 km (see the red arrow in Figure 4).

For consistency, all areas are indicated by their Swedish names, with a translation in parentheses.

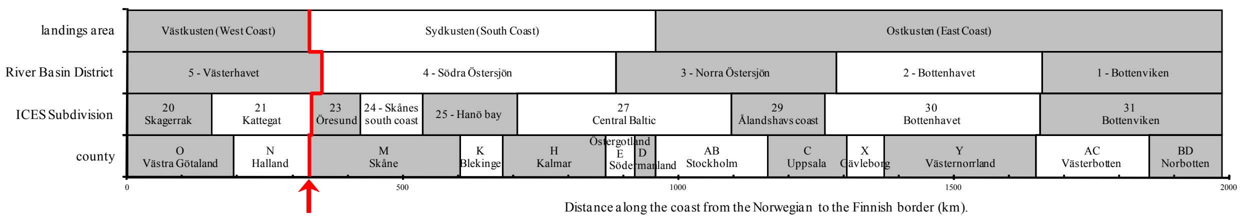


Figure 4 - Comparison of the different geographical codes that have been found in historical and contemporary data. The horizontal axis measures the distance along the coast. The red arrow points at Kullaberg, an example of mismatching borders.

2 Time trends, distribution, impacts

This chapter presents data on the abundance and trends in the eel stock, fisheries, hydropower related mortality and habitats. The focus in this chapter is on the observations, while the next chapters will concentrate on assessment of the stock status and the relation to management targets.

2.1 Eel stock

2.1.1 Recruitment of glass eel and young yellow eel

Recruitment of young eels coming from the sea into our rivers is monitored at several sites spread along the southern half of the coasts. At many places, dam owners (frequently hydropower companies) are obliged by the Water Rights Court to facilitate the migration of fish. For eel, this is often achieved by installing an eel pass with a collecting box at the most downstream dam, manually distributing the catch of young eels over upstream regions. Journals of the catch are kept, and these data have been used to quantify the recruitment. A typical example of an eel ladder leading into a collecting box is shown in Figure 5.

Figure 5 - Eel ladder and collecting box in the River Mörrumsån. The hydropower station is to the right; immigrating eels climb through the wooden boxes filled with wetted substrate (wetted by pipes), ending in the polyester container on top, from which the eels are collected, weighted and then transported upstream.

Nowhere on the coast do truly unpigmented glass eels enter into Swedish rivers; young yellow eels (bootlace eels) are found instead. However, the nuclear power plant at Ringhals takes in cooling water in front of the coast along the Kattegat, sucking in glass eel too. True glass eel are also caught in larval surveys in the Skagerrak/Kattegat. These data are not shown here; they confirm the general trend observed in Sweden and the rest of Europe.

A glass eel, fresh from the Ocean. | Following pigmentation they are called elvers.

Figure 6

The eels climbing the ladder in the River Viskan are mostly young eels, which arrived as glass eels on the coast earlier the same year. At all other stations, the eels consist of a mixture of age groups, varying in length from below 15 cm on average in River Göta Älv, to over 35 cm in River Dalälven. Apparently, it takes several years to reach the more northern rivers, and meanwhile, those eels have grown to a larger size.

Some of the data series are very old: the earliest starts in 1900 (River Göta Älv). In recent decades, all series (except the short series at Kävlingeån) have shown a prolonged decline, starting around 1980 for the youngest eels (Viskan, Ringhals) or much earlier (1940s). For many series, their historical peak occurred within ten years after the start of the series (e.g. Motala Ström starting in 1942, peak in 1951; Dalälven starting 1951, peak in 1959).

Figure 7 shows the time series from 1950 onwards, plotted on the map. In recent years, recruitment of young eels has been extremely low and declining at most stations. The normal (linear) scale of Figure 7 seems to suggest that recruitment has now stabilised at a very low level. Looking more closely at the recent data (Figure 8), it turns out that the decline continues at the same rate, declining by ca. 6 % per year on average.

In section 2.1.7, the introduction of young eel into rivers and lakes (restocking) will be discussed. Above, the catch of young eels along the coast was interpreted as an index for the natural stock. It is not absolutely impossible that some of the restocked eels might have ended up in the elver traps, but noting the locations for restocking and monitoring, this is not very likely. If so, the downward trend shown underestimates the true decline of the natural stock somewhat.

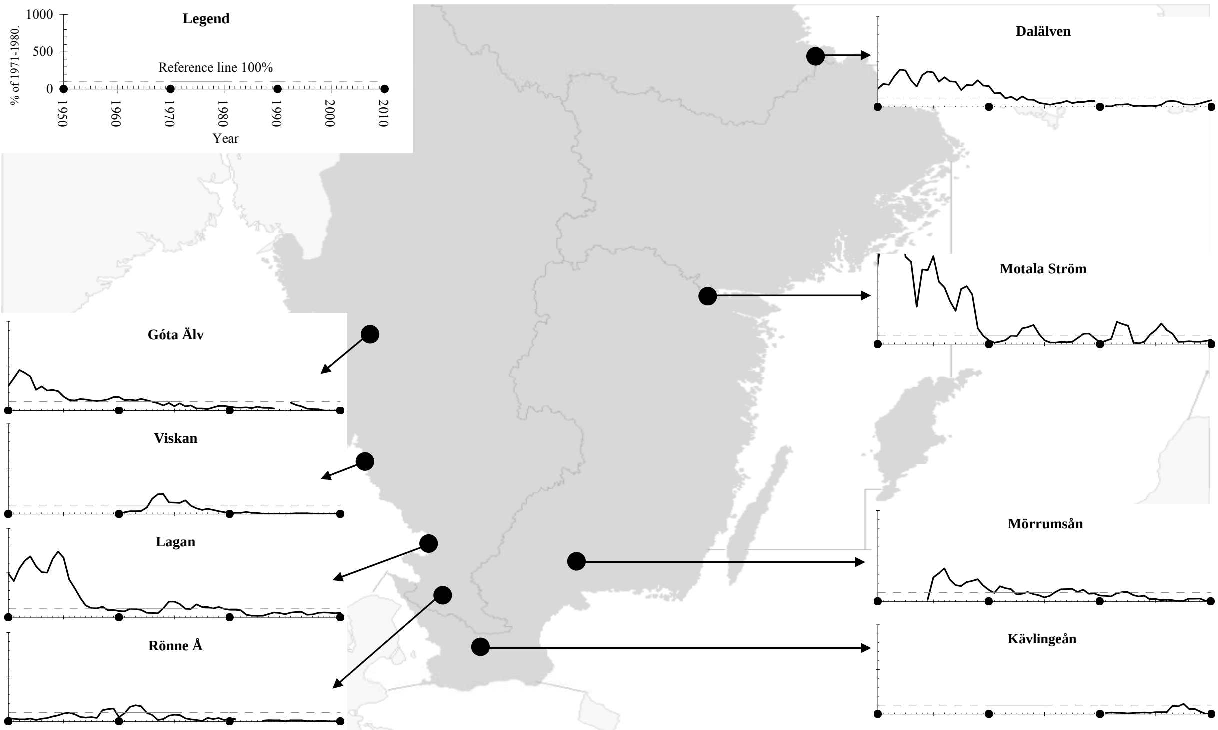


Figure 7 - Recruitment series of young eels immigrating into the rivers. Data are expressed as a percentage of the 1971-1980 mean; moving averages over three years; the vertical scales are linear.

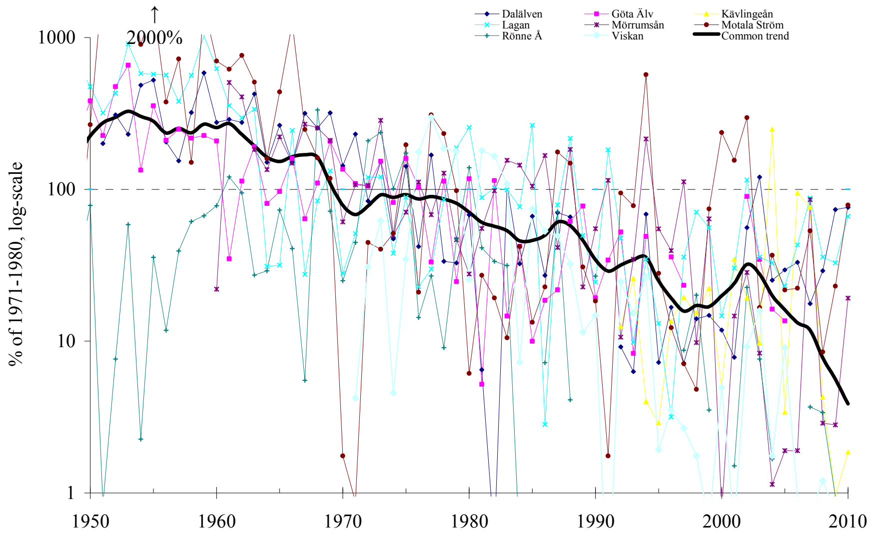


Figure 8 - Recruitment series of young eels immigrating into the rivers for the eight most consistent monitoring sites. Data are expressed as a percentage of the 1971-1980 mean and plotted on a logarithmic scale; no moving average. The common trend is indicated (geometric mean of all series).

2.1.2 Yellow eel abundance

Since the 1970s, standardised fykenet fishing has been applied to monitor the fish stocks around the nuclear power plants in Barsebäck (Öresund) and Ringhals (Kattegat). Since 2000, this program has been extended to four more areas at the West Coast. The catch per unit effort shows an increasing trend in Vendelsö (northern Halland), and catches in Barsebäck have been stable for a long time. At other places, results have been in the same order of magnitude as those in the longer time series. The results in these fishery-independent surveys have as yet shown no relationship to the declining recruitment, discussed above.

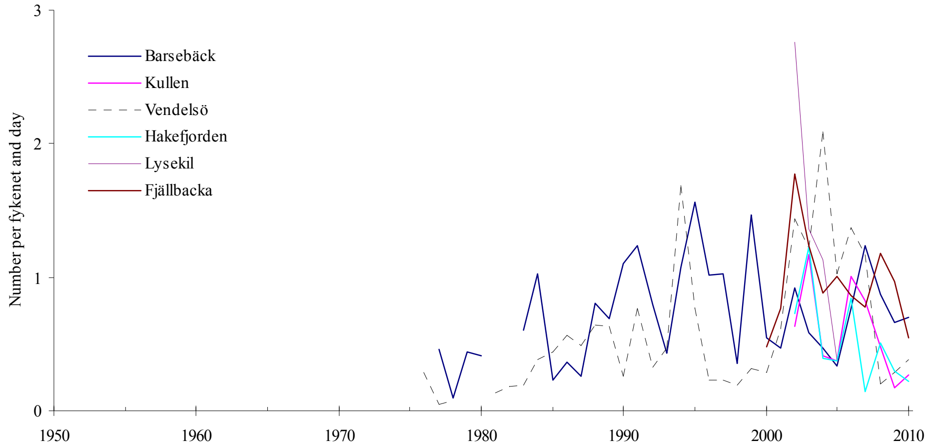


Figure 9 - Yellow eel catches per unit effort in the fykenet surveys along the coast.

In inland waters, electro-fishing surveys have been held in running waters, and data have been compiled in a central register (SERS, Swedish Electrofishing Register, SLU Institute of Freshwater Research, Örebro). Time trends can be shown from 1990 onwards. Figure 10 shows these trends by river basin district, but it should be noted that in grouping data by district, data on many different rivers have been pooled, which might have blurred specific local patterns. Going from the west into the Baltic, the average density of the stock declines, from ca. 2.5 eel per 100 m^2, down to only 0.05 eels per 100 m^2. In Västerhavet (West Coast) and in Södra Östersjön (Southern Baltic), a declining trend is observed over the years; in Norra Östersjön (Northern Baltic), densities are too low to detect any trend.

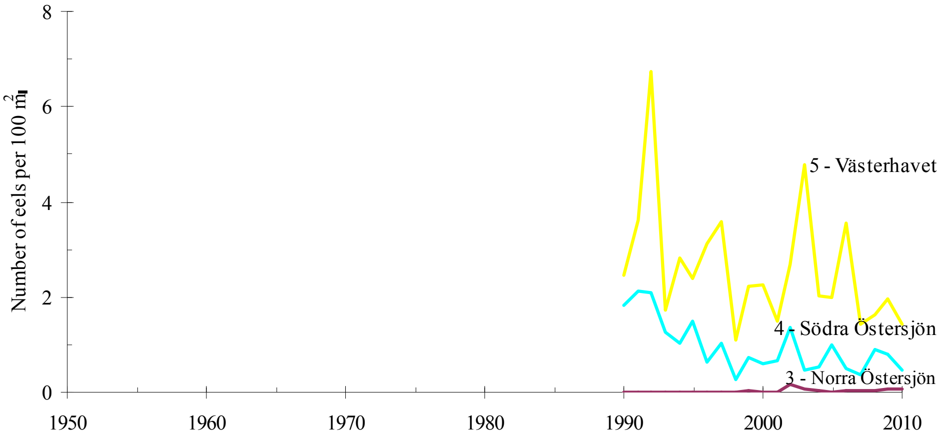


Figure 10 - Trend in electro-fishing survey catches in inland waters, by river basin district. Data before 1990 are absent and/or unreliable.

2.1.3 Growth

Annual growth for the yellow eel stage has been calculated as the difference between the final length (measured) and the glass eel length (fixed at 7.3 cm), divided by the number of years in-between, and averaged over all eels being sampled. In coastal waters, annual growth varied between 4.5 and 5.2 cm per year, with a tendency to grow a bit faster in the Baltic proper (Figure 11).

In the silver eel stage, eels feed and grow less or not at all. Thus, growth is effectively zero, strictly speaking. However, eels caught in the silver eel stage do have a length and an age, from which a mean growth over the preceding yellow eel phase can be calculated.

For silver eel in coastal waters, it is less certain than for yellow eel, that locally observed growth indeed reflects the local circumstances, since the silver eels might have come from different places. Observed growth rates showed little variation along the east and south coasts: mostly around 5 cm per year, which closely resembles the growth rate of yellow eel in the Baltic proper.

Growth of eel sampled as silver eel in inland waters varies between 3.6 and 5.5 cm per year, without a clear trend: growth can vary from lake to lake. In inland waters, local circumstances apparently determine the growth.

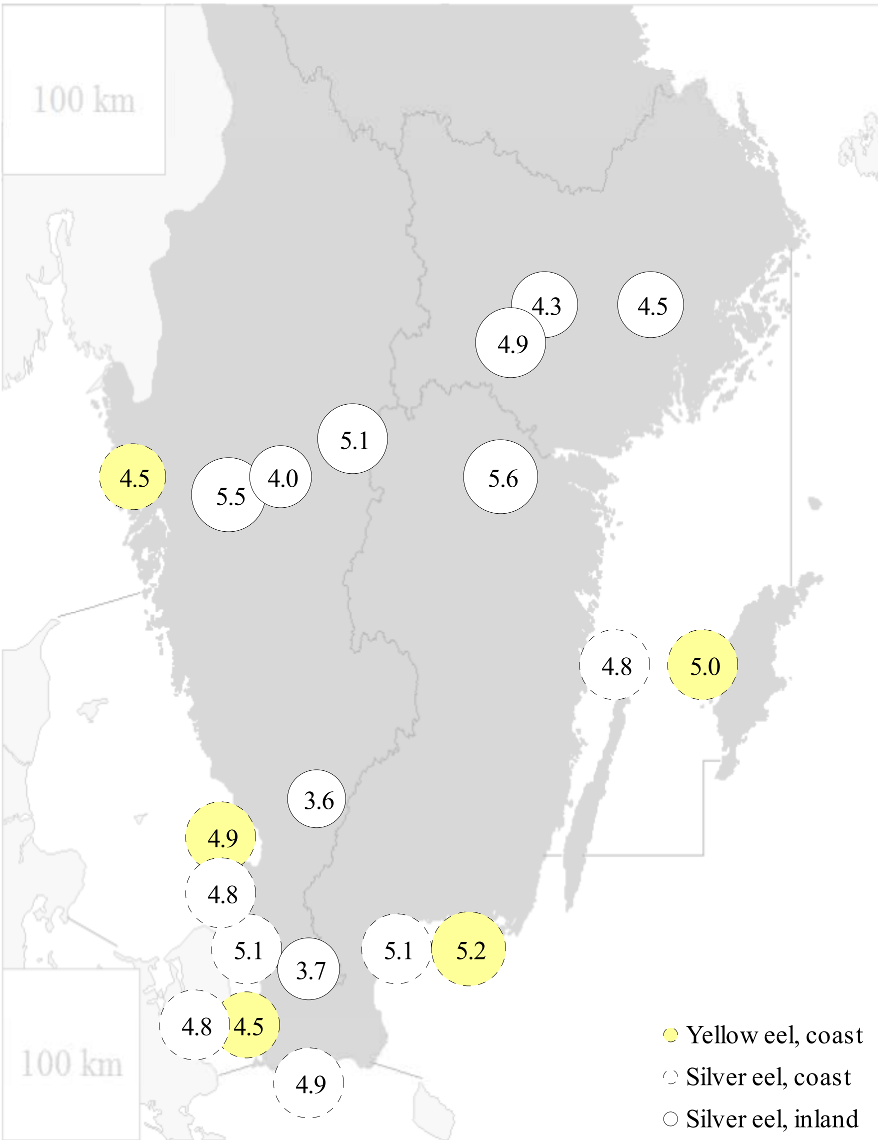


Figure 11 - Average growth rate in cm per year, measured from yellow and silver eels, in inland and coastal areas.

2.1.4 Predation by cormorants

There are not many data on predation on eel in general, and predation by cormorants in particular. Preliminary analysis of the stomach contents of cormorant that were shot shows considerable differences between areas and seasons. In a sample of 467 stomachs analysed from the West Coast, eel made up only 1 % of the consumed biomass outside the cormorant breeding season, and around 3 % in the cormorant breeding season. The latter value relates to only 10 % of the total number of stomachs analysed containing eel. The highest fraction of eel was found in 44 stomachs collected in winter time from the south coast. In that material, eel made up ca. 25 % of the stomach content, and some eels up to 70 cm in length were found. Eel did not occur in samples collected during the cormorant breeding season here, which is in contrast to the finding on the West Coast. In Mönsterås, northern Kalmarsund, only a single eel was found in nearly 200 stomachs being sampled, that was ca. 2 % of the diet outside the cormorant breeding season.

To assess the impact of cormorant predation on eel, detailed information on abundance and seasonality of the cormorant stock is required. That information is currently not (yet) available. According to the Swedish Ornithological Society, 45 000 breeding pairs occurred in 2006, and each bird consumed 0.3-0.5 kg of fish food per day. Using these figures, the total fish consumption by cormorants is considerable. Even a small percentage of eel in their diet would already constitute a significant impact on the eel stock, possibly in the order of 100 t.

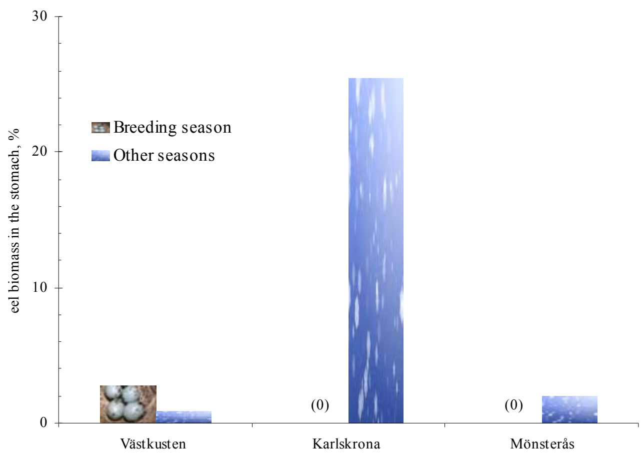


Figure 12 - The fraction of eel in the diet of cormorants, collected in coastal areas in 1999-2010 (preliminary data SLU, Institute of Coastal Research).

2.1.5 Silver eel size

Within the framework of various environmental monitoring programs, unsorted catches from a number of selected fishermen in the central Baltic and in Hanöbukten have been sampled for a long period. The average weight of individual silver eels in those data shows a remarkable increase over the decades; silver eels from the central Baltic have always been larger than those from southern areas (Figure 13). In the central Baltic, average weight has increased from 600-700 gr in the 1960s to 900-1000 gr in most recent decades. In Hanöbukten, average weight has increased from 400 to 800 gr over the same period. In the earlier years, that average weight was so low, that some of those eels might have been male.

During some years, a minimum legal size applied to the catch of silver eel, but that is unlikely to have affected the observed trend (1984-1993: a size corresponding to 0.150 kg in Hanöbukten and 0.250 kg elsewhere; since 2007: 0.450 kg at all sites. See Figure 36 on minimum legal length).

Analysis of eels sampled from commercial catches in 2005-2010 confirms the size difference between central and southern Baltic, and shows that the trend towards smaller silver eels even continues into the Öresund (Figure 14). Bigger eels are found in lakes, the longest average (Lake Ymsen) being nearly 90 cm, more than double the weight of the eels in Öresund.

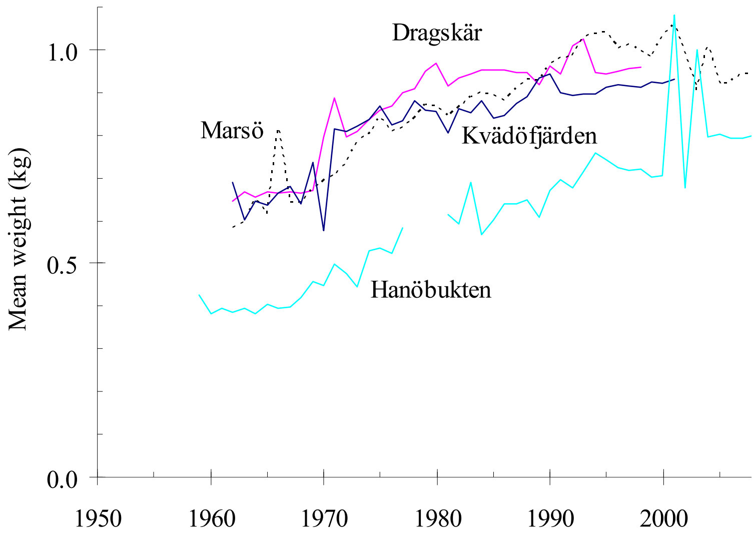


Figure 13 - Average weight of silver eels, as recorded in fishermen journals collected at four sites in the Baltic.

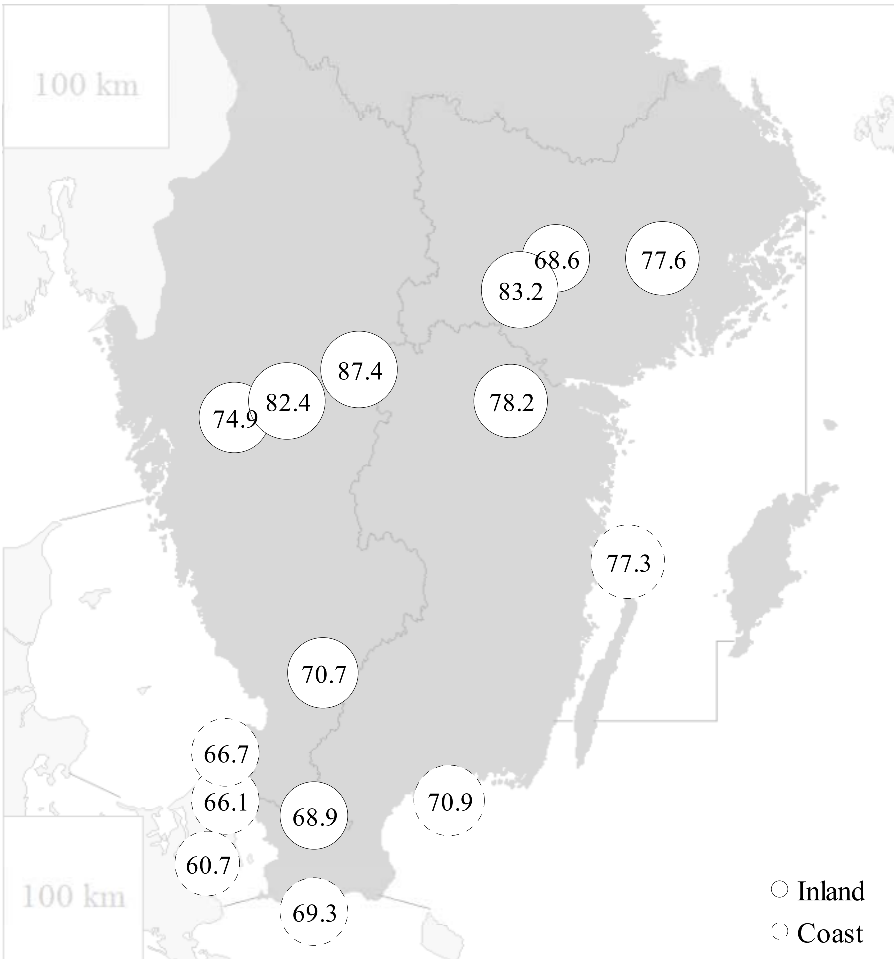


Figure 14 - Average length (cm) of silver eels, in inland and coastal areas.

2.1.6 Silver eel quality

The contribution of silver eels to the spawning process might be compromised by parasites or pollutants. The prevalence of the swimbladder parasite *Anguillicoloides crassus* has been monitored in samples taken from commercial catches, in inland and coastal areas. First observed in 1987, it is now found in most waters, at a stable level. The prevalence in yellow eel is generally lower in marine areas along the West Coast, going up from 6 % in Skagerrak and 13 % in the southern Kattegat, to more than 50 % in both Baltic areas (Figure 15). Silver eels are less infected in general, and differences between sites are smaller. In inland waters, prevalence is generally much higher (79-94 %), although only 27 % of the eels in Lake Hjälmaren is infected.

Other aspects of eel quality, including pollution and fat content, have been shown to be of importance too, but for these aspects, there are no quantified data series available.

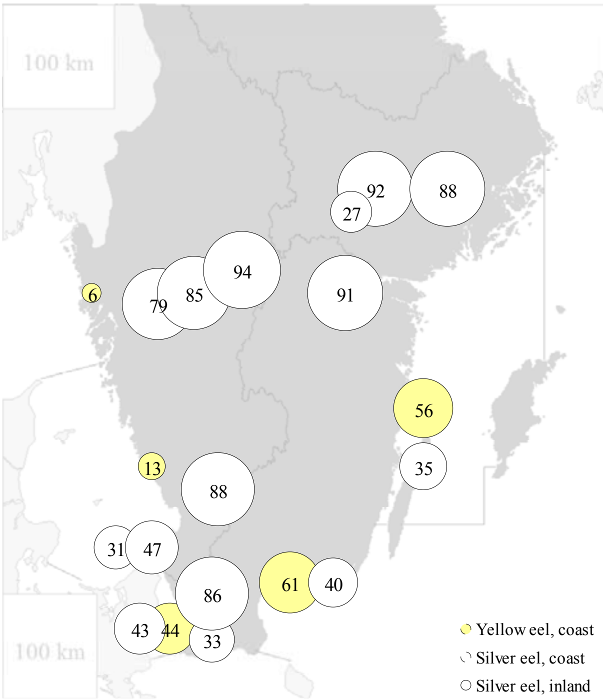


Figure 15 - Prevalence (%) of the swimbladder parasite *Anguillicoloides crassus* in yellow and silver eel, in the 2000s.

2.1.7 Restocking

Restocking of eels purchased abroad and transport of young eels from one area to another has a long tradition in Sweden. Already in the beginning of the 20th century, eels were imported from England, but it was only since 1950 that a more regular programme was put in place. Four different types of restocking material have been applied (Figure 16):

Young eels immigrating into our rivers have been trapped at barriers and transported upstream *within the same river catchment*. Since these eels remained within the river of their own choice, these transports are no further considered in this section; in section 2.1.1, these catches are interpreted as recruitment indices.

Glass eel purchased abroad (elvers, yngel). In the early 1970s, these were imported from France, but later on England was favoured; in 2010, only French glass eels were purchased. The glass eels are quarantined (and fed) in indoor aquaculture facilities; a few weeks later, outdoor restocking occurs at an average weight of 1 gr (10 cm length). At the moment of outdoor stocking, they have passed the glass eel stage, and are now fully pigmented elvers.

Young eels of approximately 5 gr (15 cm length) were trapped in the river Göta Älv near Trollhättan, and transported to other rivers in Sweden for restocking.

Bootlace eels (sättål) of ca. 90 gr (40 cm length) were caught along the West Coast and transported to the East Coast or inland waters for restocking.

To enable comparison between these different categories of material, all historical data series have been transformed to a common unit of "glass eel equivalents", that is: the number of true glass eels, that would be required under natural circumstances to produce the same number of eels of the size actually restocked. The conversion is based on the average size and age of the restocked eels, and the expected number of eels that died between the glass eel stage and the restocking event. Each elver (yngel) is worth 1.07 glass eel equivalents; each bootlace (sättål) equals 2.29 glass eel equivalents; and each eel from Trollhättan conforms to 1.32 glass eel equivalents. Figure 16, Figure 17 and Figure 18 (below) are uniformly expressed in these units.

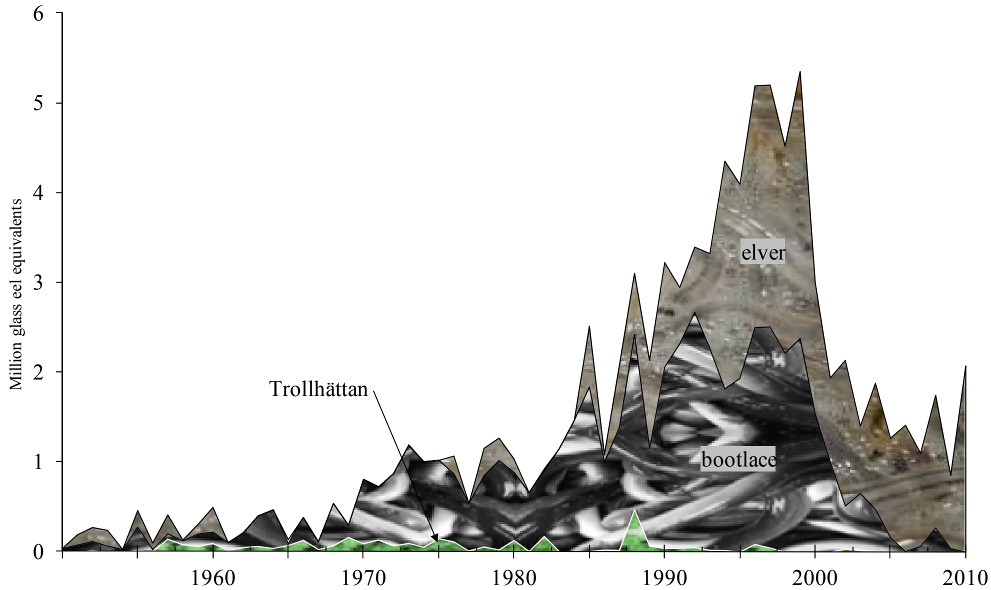


Figure 16 - Quantity and 'type' of eel used for restocking since 1950.

Until the 1990s, the transport of eels from the West Coast to the East Coast has dominated the restocking programmes; recently, quarantined glass eel (elver) restocking is the only action left. Trollhättan eel has always been a small quantity, and this transport has ended completely in 2005.

Figure 17 shows the trend in restocking inland waters. Until 1970, less than 0.5 million glass eel equivalents were restocked each year. From 1970 to 1990 the quantity gradually increased to 1.5 million per year, reached 2-3 million in the 1990s, and then went rapidly down to about 1 million again. In 2010 and 2011, nearly 2 million equivalents were restocked each year.

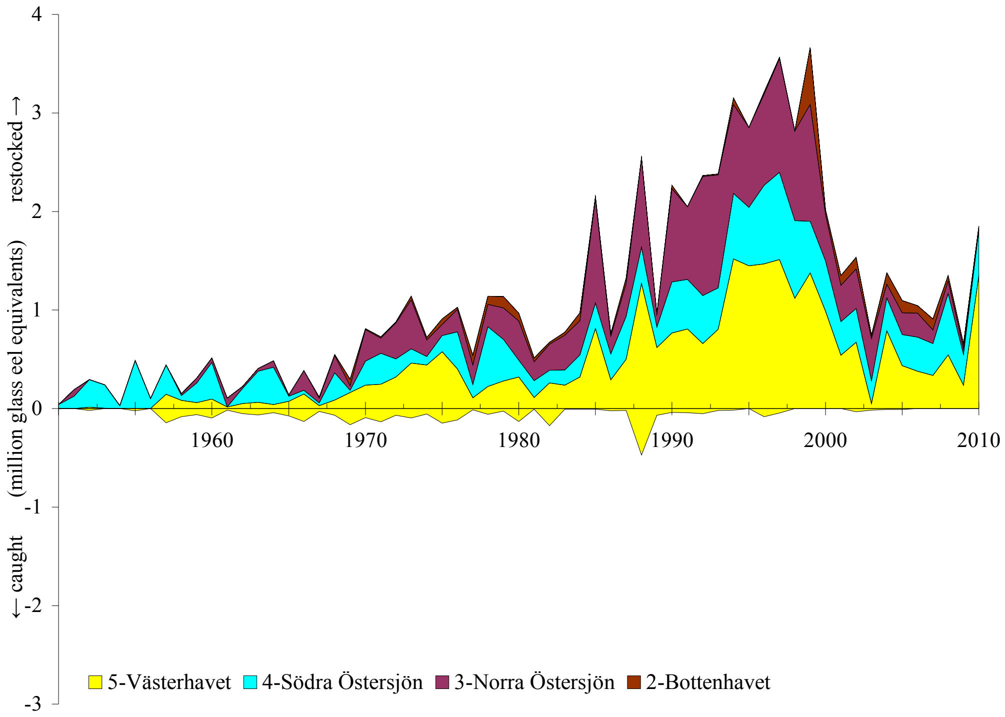


Figure 17 - Restocking in <u>inland</u> waters, by river basin district. Note that the catch of eels for restocking (in fact Västkusten – West Coast only) is shown below the horizontal axis, while release of eels is shown above.

In coastal waters (Figure 18), bootlace eels were caught along the West Coast and restocked along the East Coast. Since 2000, this transport has gradually come to a halt, and net restocking into coastal waters along the East Coast is now small in comparison to the inland restocking.

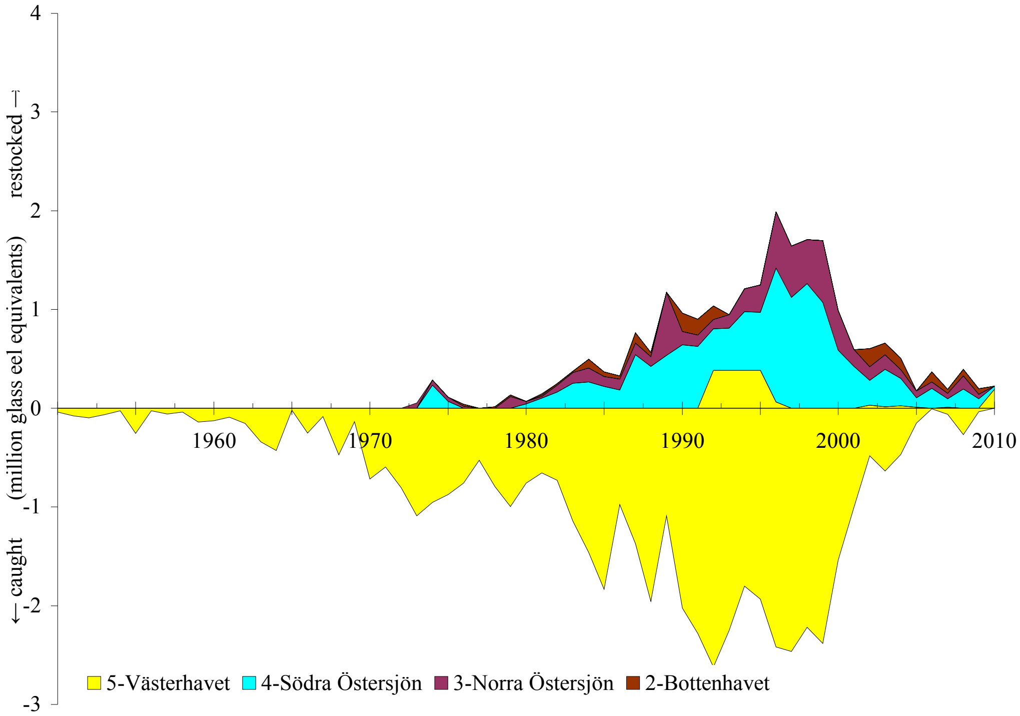


Figure 18 - Restocking in coastal waters, by river basin district. Note that the catch of eels for restocking (in fact Västkusten – West Coast only) is shown below the horizontal axis, while release of eels is shown above.

2.2 Fisheries

2.2.1 Fishing capacity, licenses, effort

Since 1999, coastal fishermen submitted monthly reports on their activities. These reports do not allow to reconstruct fishing capacity and/or effort, but the number of companies actually landing eel can be counted. Figure 19 shows these trends per river basin district. In recent years, the number of companies has gone down, primarily in Västerhavet (West Coast) and in Bottenhavet. Since 2006, a minimal landing of 400 kg per year is required to obtain a license. This has increased the number of companies reporting, especially in Södra Östersjön (Southern Baltic), but otherwise, the number of companies shows a downward trend here too.

For inland waters, no such time series on fishing capacity or effort exist.

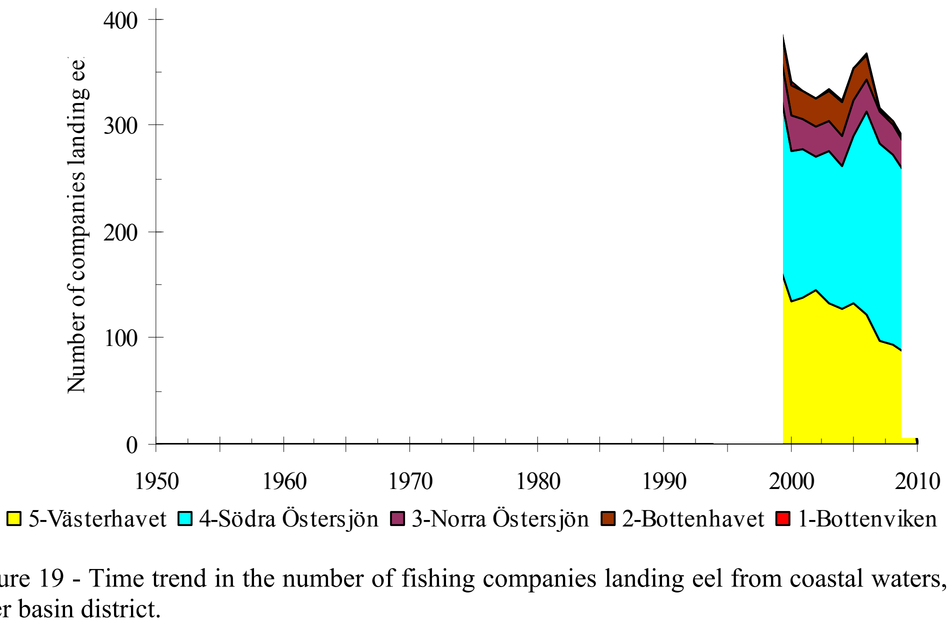


Figure 19 - Time trend in the number of fishing companies landing eel from coastal waters, by river basin district.

2.2.2 Catch and landings

Statistics of catch and landings of commercial fisheries have been kept since 1914, but the time series are far from complete, and the reporting system has changed several times. Until the 1980s, statistics were based on detailed reports by fishery officers (fiskerikonsulenter); since that time, sales slips from traders have been collected by the Swedish Statistical Bureau SCB. For the sales slips, the reported county refers to the home address of the trader, not to the location of fishing. In recent years, individual fishers have reported their landings directly to the responsible agencies. Where data series overlapped, precedence has been given here to the more detailed individual reports.

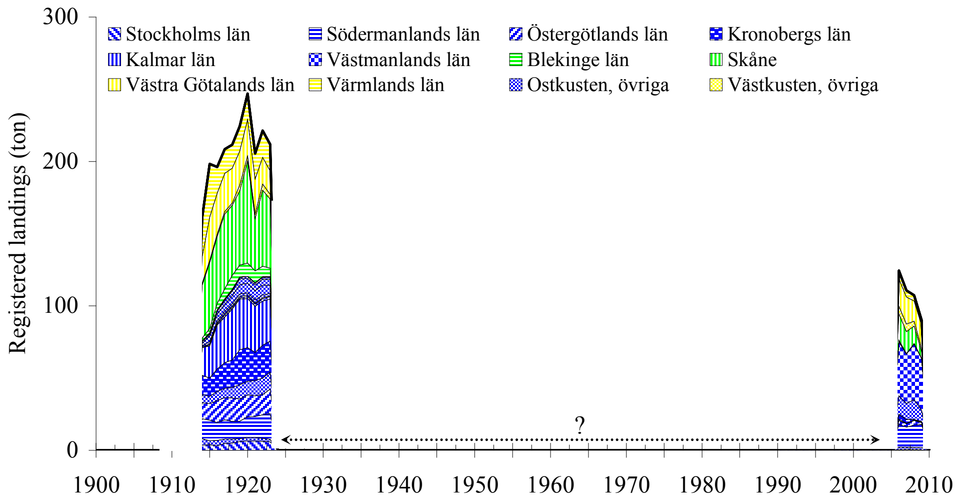


Figure 20 - Landings from inland waters, by county. For the period between 1924 and 2006, no records exist. Note that the vertical scale differs from that in Figure 22.

Figure 20 shows the landings from inland waters grouped by county, while Figure 21 shows the same information grouped by lake. Clearly, the total landings from inland waters have declined considerably over the 20th century, but at the same time the landings from the great lakes have increased, now making up more than 75 % of the total inland catches.

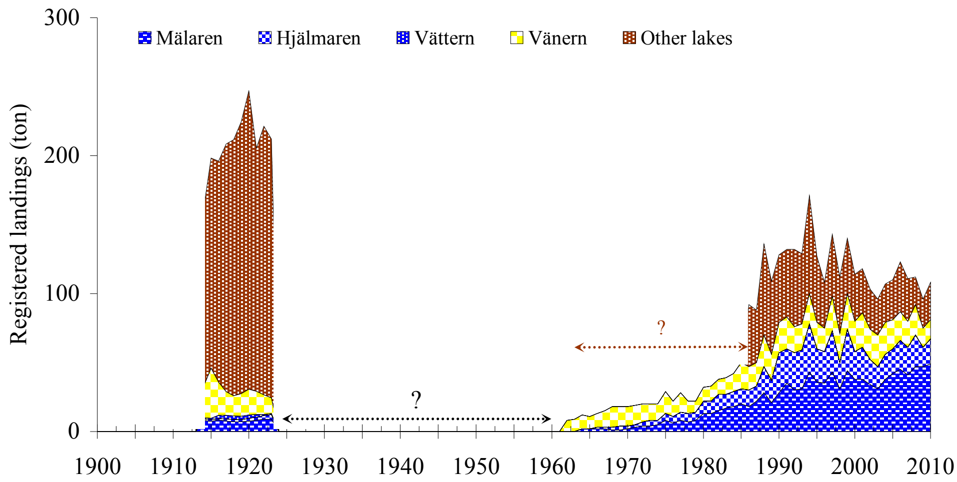


Figure 21 - Landings from inland waters, for each of the great lakes, and for the sum of all smaller lakes. Note that the vertical scale differs from that in Figure 22.

Landings from coastal areas have been nearly ten times higher than those from inland waters in the past, and they are now about five times higher. Figure 22 shows the trend over the 20th century. The decline since the 1950s has been most pronounced on Ostkusten (East Coast) and Sydkusten (South Coast).

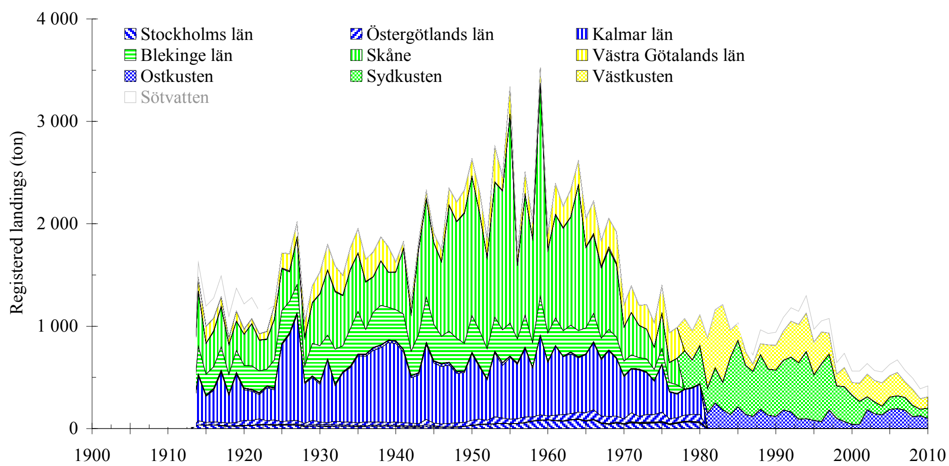


Figure 22 - Landings from coastal waters, by region. Until approx. 1980, statistics were reported by county; since then, only major parts of the coast are indicated. Some counties had such a small catch, that they seem to disappear in the figure; these have been left out from the legend. Note that the vertical scale differs from that in Figure 20 and Figure 21; for comparison, the total inland landings have been added here in grey.

2.2.3 Catch Per Unit Effort

The catch per unit of effort can be used as an indicator for abundance. Fishermen in the central Baltic have provided detailed records of their catches for several decades in a monitoring program related to the nuclear power plant in Oskarshamn. On one site in southern Östergotlands archipelago (Figure 23), no change in the catch of yellow or silver eel per unit effort has been observed since the mid-1970s, though the fishing effort in the 1990s was considerably lower than before. No such decline in effort occurred on a site in northern Kalmar county; no significant change in yellow eel catch occurred here, but catches of silver eel have increased. This might be related to an increased focus on silver eel in recent years.

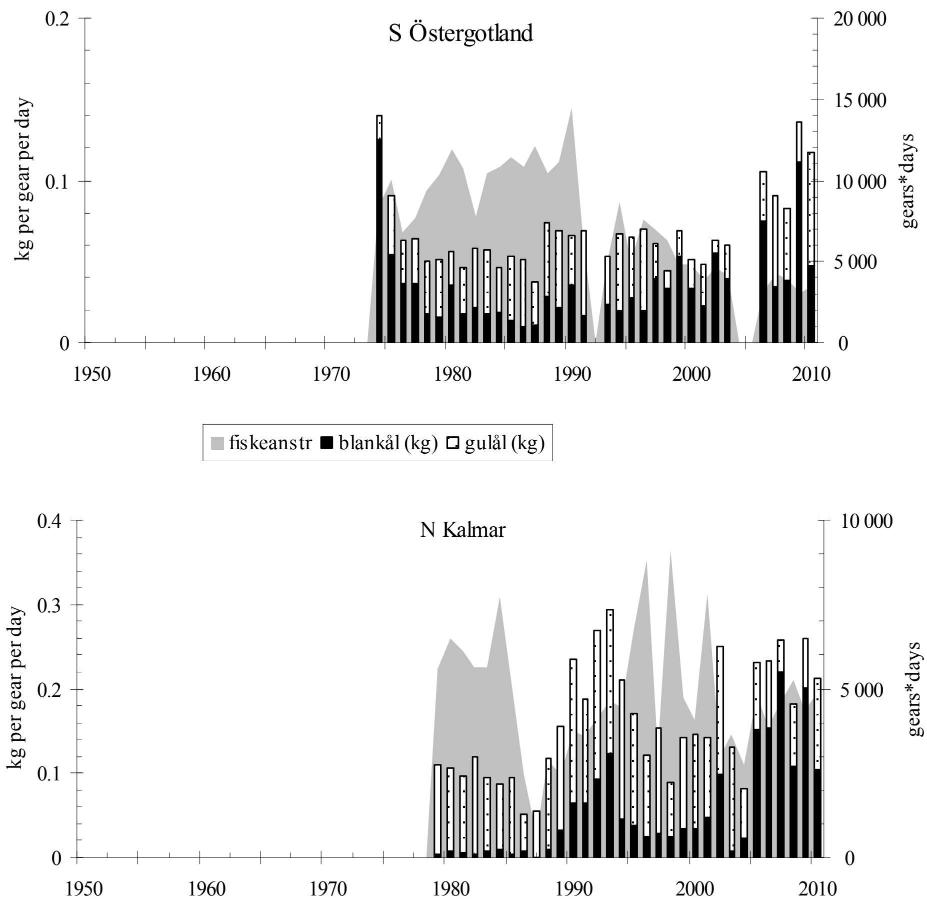


Figure 23 - Catch per Unit of Effort for yellow and silver eel, and total annual fishing effort, in fisheries with (small) fykenets in two areas in the central Baltic.

The catch per unit effort for the poundnet fishery on silver eel in the central Baltic has declined considerably in the 1960s (Figure 24), but has stabilized thereafter. Two of the series ceased around 2000, and the same happened to some of the series in Hanöbukten in the 1990s. In recent years, however, some of the original series resumed, and catches at these sites have been relatively high recently, compared to the 1980s. Note that the reported sites are not that representative for the whole fishery.

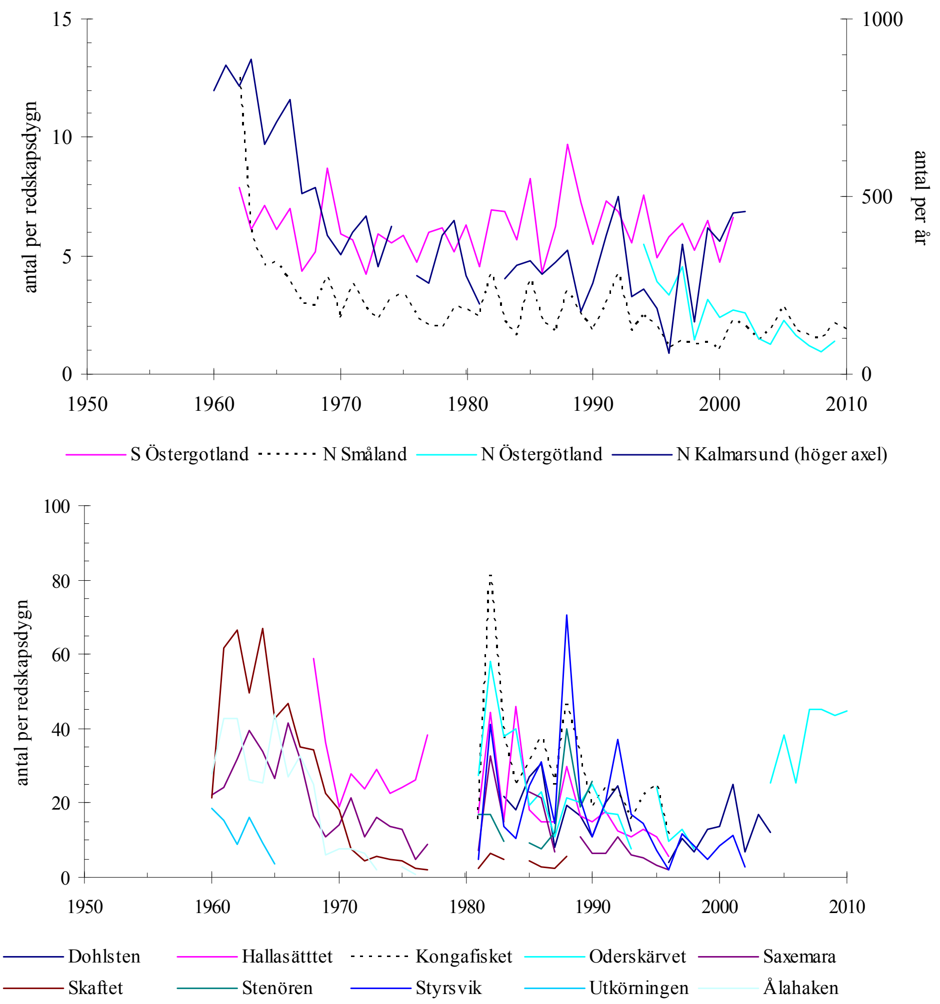


Figure 24 - Catch per unit of Effort in the poundnet fishery for silver eel at four sites in the central Baltic (top) and ten sites in Hanöbukten (below).

2.2.4 Length- and age-composition of the catch

Length compositions of yellow eels caught in fykenets sampled in the 2000s along Västkusten (West Coast) and in the Öresund are quite comparable (Figure 25): the interval between 40 and 50 cm dominates the catch, and frequencies decline with length to almost zero around 70 cm. The difference between the early and the late 2000s in Skagerrak area and in Öresund might have been related to a change in legal size (section 5.4), or changing sampling sites. Sampling in the central Baltic focused on unsorted catches. Here, the most abundant size class is 50-60 cm, and larger eels are considerably more abundant than on the West Coast, while the smaller eels (< 40 cm) are relatively scarce.

For the average size of silver eels, there is a clear trend going from the central Baltic towards Öresund, finding smaller and smaller sizes. In the central Baltic, few eels are shorter than legal size (65 cm in 2010), while in Skåne, 40 % of the catch is below legal size; here, they are even a bit shorter than in the (northern) Öresund, while in Öresund a legal size of 40 cm applied (2010).

Catches in inland waters consist predominantly of silver eels; their lengths vary from the legal size (was 65 cm) to 100 cm or more. There is a slight tendency for northern lakes to produce larger eels, but otherwise, the length composition varies from lake to lake without any clear pattern.

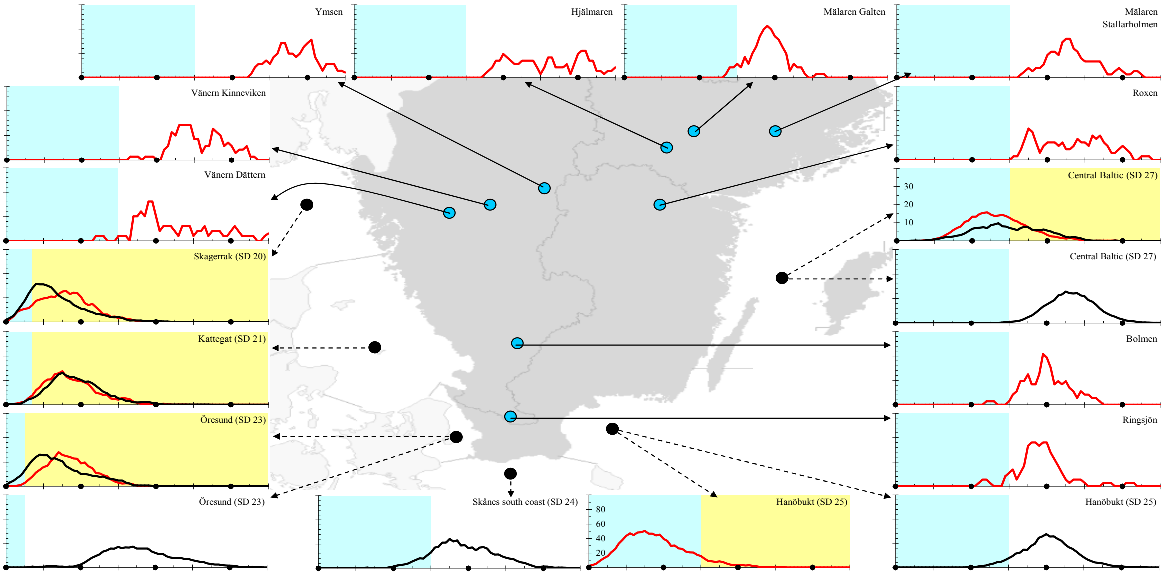
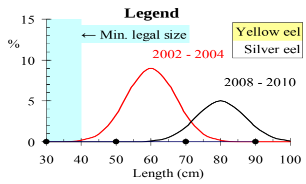


Figure 25 - Length composition of (sorted or unsorted) commercial catches. All observations have been scaled to 100 % over the length classes above the local legal size. The shadowed areas mark lengths under legal-size in 2003. Moving averages over 3 cm; vertical scales for all plots 0-15 %, except where otherwise indicated.



For yellow eel, the age composition from commercial catches does not show marked differences between coastal areas (Figure 26). Most yellow eels are between five and fifteen years old, all between the inner Baltic and the Skagerrak coast. Differences between years of sampling are small too. Only in Öresund were recently observed eels much younger than in other areas.

For silver eel, the age composition varies considerably between the Baltic and Öresund (Figure 26). Samples from poundnets taken in the 2000s have shown eels between 5 and 25 years old. In the central Baltic and Hanöbukten, ages vary between 10 and 20 years, while along the southern coasts of Skåne and in Öresund the eels are a bit younger. A relatively large share of the eels from Öresund was ten years or younger, in both sampling periods.

Silver eel age in inland waters is dominated by age groups between 10 and 20 years old, but the oldest eels can be over 30 years.

In over 6000 yellow eels sampled in 2006-2010, females were absolutely dominating. Males were lacking completely in the central Baltic. The relatively largest share of males was found along Skagerrak coast, where approx 4 % of 2500 yellow eels analysed was male. In the other areas, less than 1 % was male.

In nearly 5000 silver eels sampled in 2007-2010 along the coast, only 19 males were found; most of them in Öresund, where they make 1.8 %. This will be an overestimate, since sampling in recent years was length-stratified, with a fixed number of eels per cm. Only three males were found along the Baltic coast, all on Skånes south coast.

In inland waters, catches consisted of female eels only, which will relate to the high legal size (males rarely become bigger than 50 cm, legal size was 65 cm). In scientific surveys, a few males have been observed, but the total number is still extremely low.

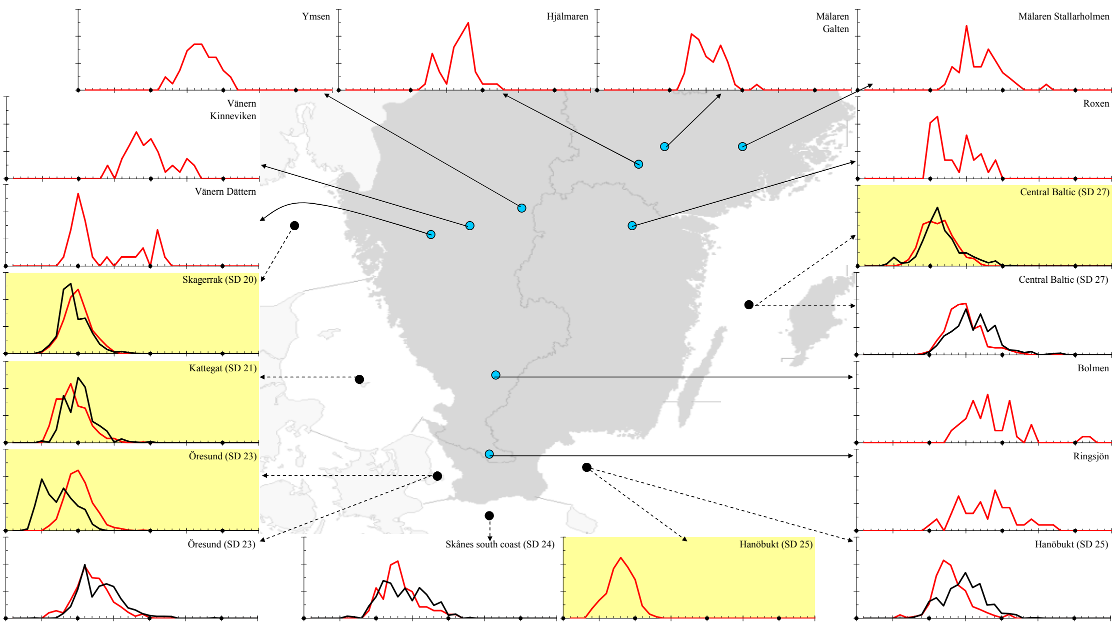
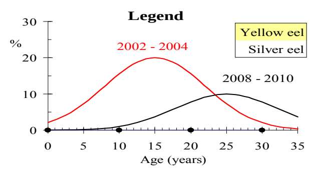


Figure 26 - Age composition of yellow and silver eel from commercial catches, taken from poundnets. Most samples were unsorted for the legal size. (No moving average; vertical scale for all plots 0-30 %)



2.2.5 Mark-recapture

Figure 27 - Silver eels with Carlin tags.

Since the early 1900s, information on the silver eel migration and fisheries has been obtained by means of mark-recapture experiments. A number of silver eels is caught, a tag is inserted in their back, and then they are released again. Fishers catching a marked eel were asked to return the tag and the eel, and were given a reward. Here, we discuss the coastal tagging only. Figure 28 shows the areas where recent releases have been done; Figure 29 shows the trend in the number of tags released since 1900. Section 4.1.2 (below) will discuss the number of tags returned, and the impact of silver eel fishing.

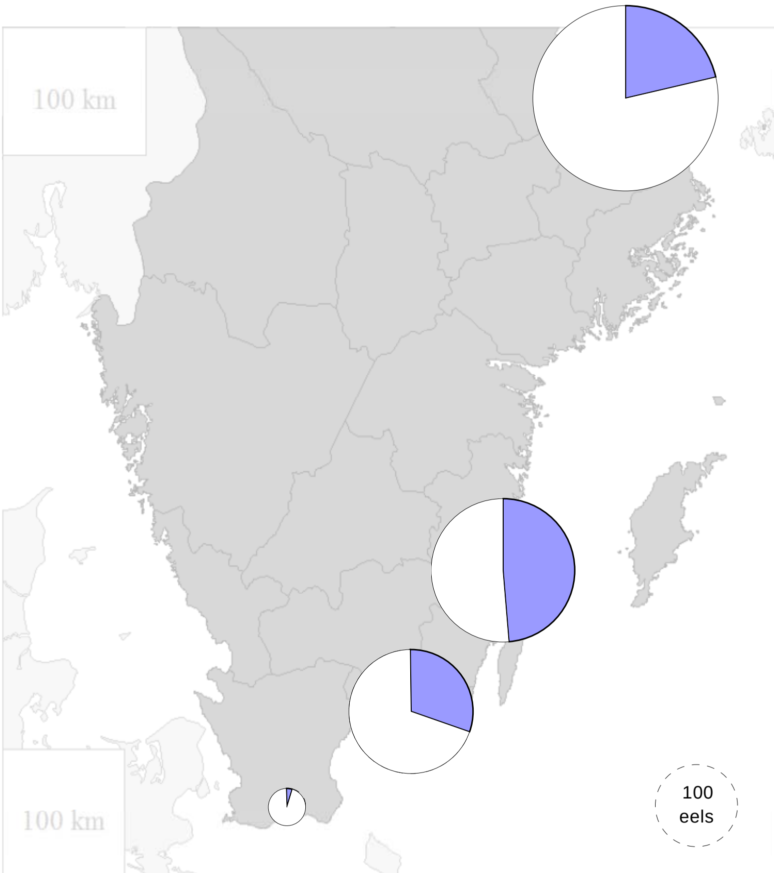


Figure 28 - Number of silver eels tagged (bubble size) and number recaptured (sector) by county in which they were released. This map shows the number of eels being tagged since the year 2000.

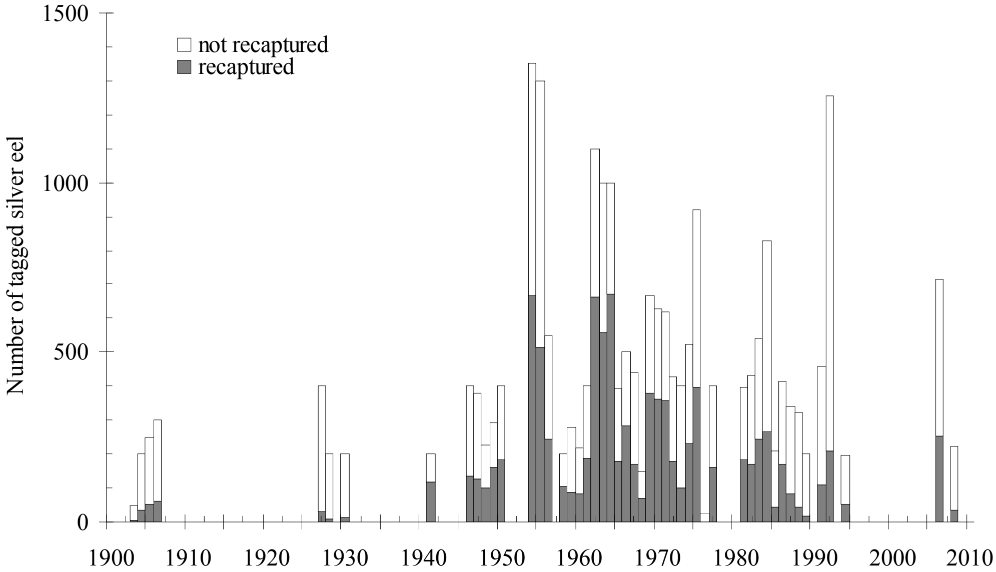


Figure 29 - The time trend in the number of silver eels tagged and recaptured.

2.3 Recreational fisheries

Until 2007, the recreational fishery made an impact upon the eel stock (Table 1). More than 95 % of the catch on the West Coast consisted of yellow eel, while in the Baltic, less than 20 % of the catch in number was yellow eel. In inland waters, only silver eel was caught. Since 2007, any landing of eel by non-commercial fishers is forbidden. Because of this, the recreational fishery is excluded from the stock assessment in chapter 4.

Table 1 - Estimated recreational catch by area, in tons per year. Since 2007, landings are allowed only to licensed commercial fishermen.

	Västerhavet (West Coast)	Insjö (Inland)	Ostkusten (East Coast)	Total
2005	18	66	166	250
2006	10	38	233	281

3 Inland eel production and the impact of hydropower generation

The generation of hydropower in Swedish rivers and the fishery in Swedish lakes have an impact on the eel stock in inland waters. The coastal fishery impacts the eel produced in Swedish coastal waters, but might also impact the eels from other countries on their way out of the Baltic. This chapter focuses on the inland production; section 4.1 will discuss the impact of coastal fishing.

This chapter discusses the amount of habitat available, the productivity of those habitats, their accessibility from the sea, and the impact of hydropower generation on the emigrating silver eel.

3.1 Habitat

The eel stock occurs in coastal waters, rivers and lakes. The abundance of the stock is related to the distance to the sea, the presence of migration obstacles, the ambient temperature and the remoteness of the entrance to the Baltic. Figure 30 presents the surface area available, without correction for related factors.

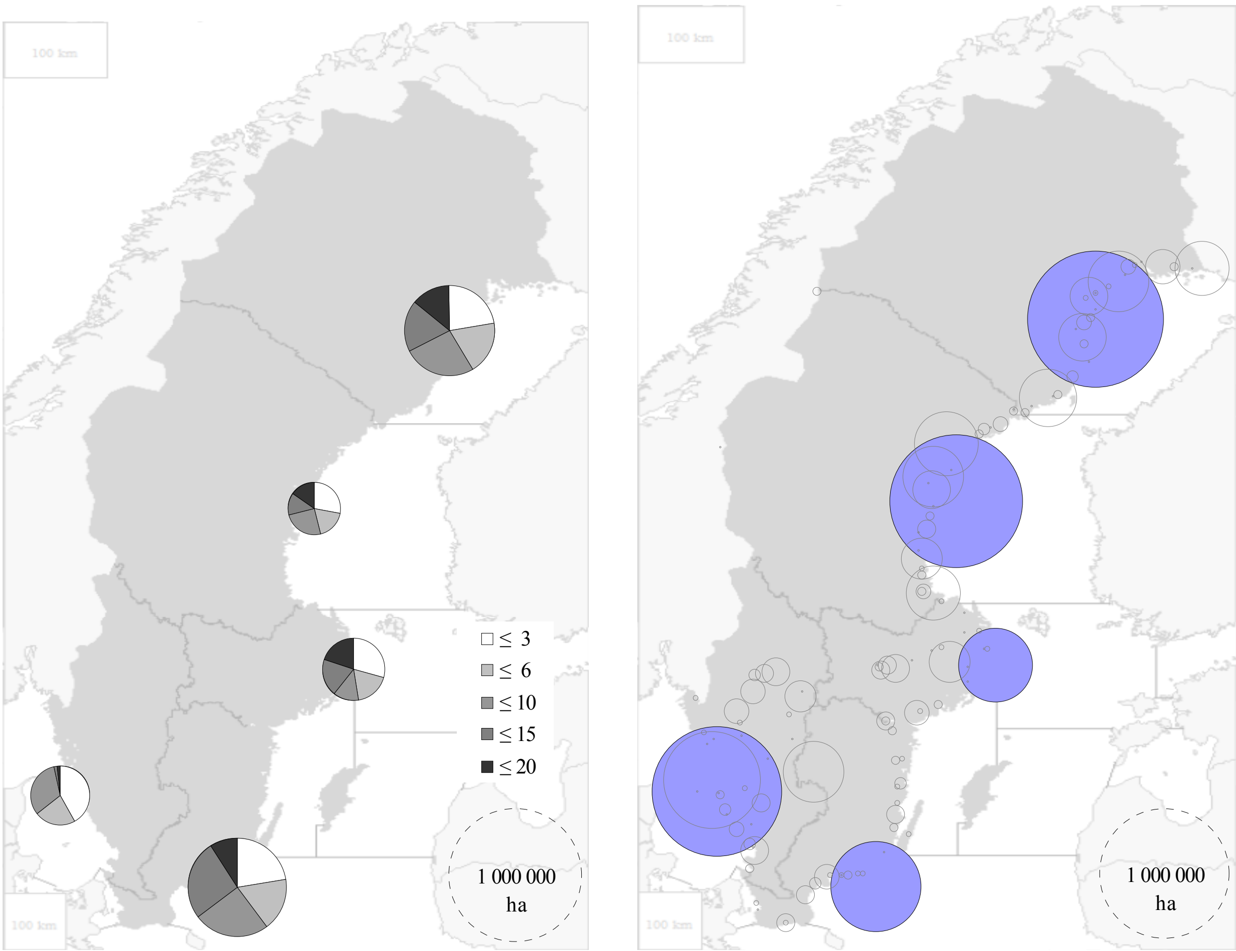


Figure 30 - Surface area of habitats by river basin district.
Left: coastal habitats by depth zone, right: inland waters,
colour=river basin district totals, gray=individual catchments.

3.2 Productivity of inland waters

The biological production of eel in inland waters is estimated in the Eel Management Plan on the basis of the surface areas of habitats (section 3.1) and the relation between known productivity (local fishing yield, section 2.2.2) and temperature, nutrients and distance to the sea/Skagerrak; potential effects of restocking have not been included (see Section 2.1.7). Production has been estimated for 32 500 individual lakes; Figure 31 shows the sums per river basin district. The total productivity is estimated at nearly 350 tons. Approximately 42 % of this comes from lakes draining to Västkusten (West Coast); less than 10 % from lakes draining to Bottenviken and Bottenhavet; 21 % from lakes draining to Norra Östersjön (Northern Baltic) and 27 % from lakes draining to Södra Östersjön (Southern Baltic). Because of the low production in Bottenviken and Bottenhavet, these northerly areas have not been taken into account in the remainder of this report.

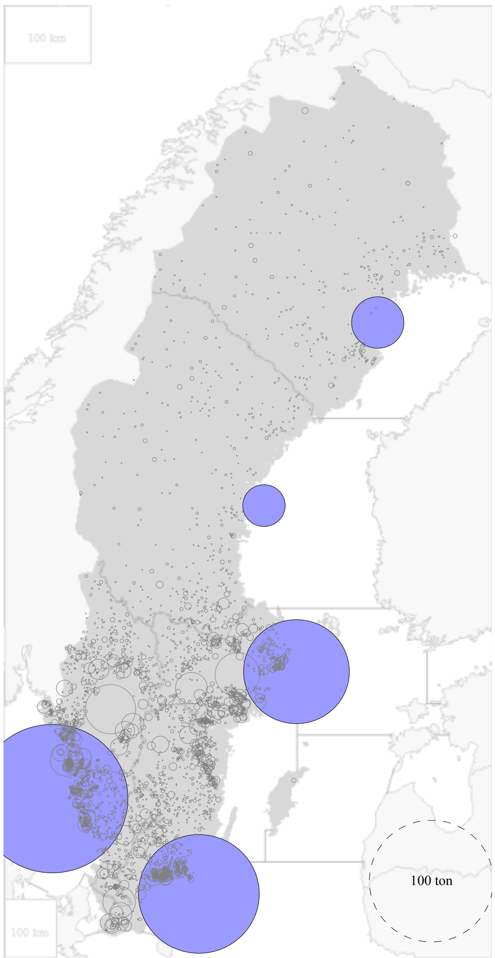


Figure 31 - Productivity of inland waters, predicted from water surface area, temperature, phosphorus content and distance to the sea/Skagerrak. This map shows the estimated total productivity per area, in ton per year. (colour=river basin district totals, gray=individual lakes, but lakes with a production < 10 kg have been left out).

3.3 The impact of hydropower generation

During their return migration towards the sea, many silver eel encounter barriers in the river, including hydropower stations. Eels often can find their way through the hydropower station, but a large percentage of them do not survive; they can be caught on grids and screens or cut in pieces while passing the turbines, etc. The Eel Management Plan estimates that 70 % of the silver eels die upon passing a hydropower station on average, which makes a total of more than 90 % mortality for an average silver eel that has to pass several power stations in a row before reaching the sea. The Eel Management Plan estimates the impact of hydropower generation, based on estimates of the number of silver eels produced in inland waters (see section 3.2, above). The total impact all over Sweden is estimated at nearly 300 000 silver eels (in number), half of which comes from only 11 rivers. The numbers of silver eels for those 11 rivers are shown in Figure 32.

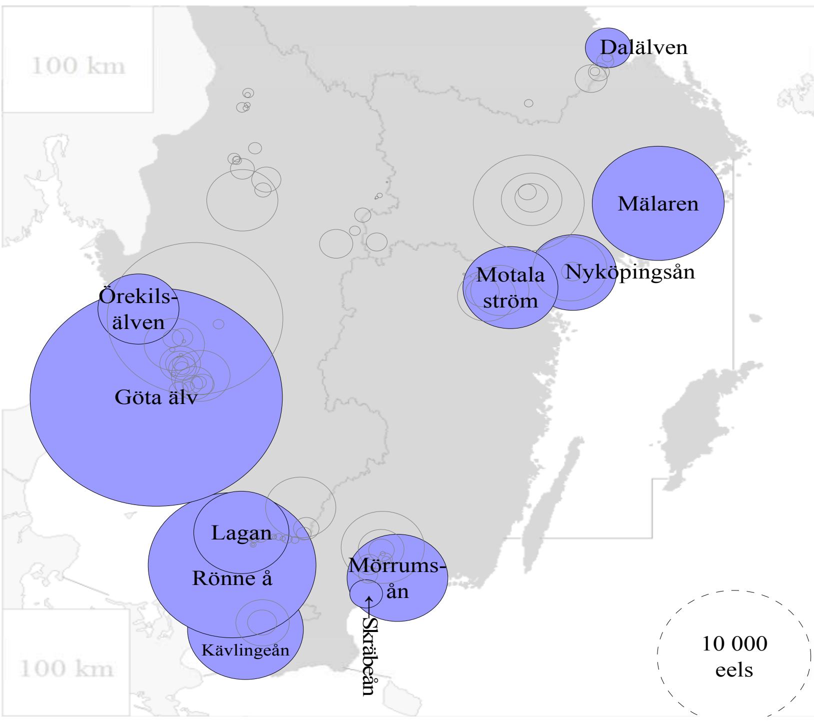


Figure 32 - Estimated number of silver eels lost due to hydropower mortality, for the top-11 rivers. (colour: river catchment totals plotted at the river mouth; gray: individual power stations).

4 Stock assessment

In the previous chapters, time series and abundance estimates were presented in the way they were observed: biomasses, numbers, densities, surface areas, etc. In this chapter, these data are summarised and indices for the status of the stock derived. In the next chapter, the limits and targets set in the European Eel Regulation and the Swedish Eel Management Plan will be discussed, and the observed state of the stock contrasted. In these two last chapters the discussions will become somewhat more complex; the required jargon is summarised in the text box at the bottom of this page.

Symbols & notation used in stock assessment

$B_{current}$ the biomass of silver eel escaping to the ocean to spawn, under the current anthropogenic impacts and low recruitment.

B_{best} the biomass of silver eel that might escape, if all anthropogenic impacts would be absent at current low recruitment.

B_0 the biomass of silver eel at natural recruitment and no anthropogenic impacts (pristine state).

Mortality can be expressed as a percentage dying each year, or as an instantaneous mortality rate. Technically speaking, the rate is equal to the negative of the logarithm of the percentage surviving. In fisheries, the mortality rate is proportional to the fishing effort. Higher percentages conform to higher mortality rates. Percentages can not exceed 100%, while mortality rates are unbounded. The text and tables apply both units.

A Total anthropogenic mortality, per year. This includes fisheries, hydropower mortality, and other possible factors.

$\sum A$ Total anthropogenic mortality rate, summed over the whole life span.

%SPR Percent spawner per recruit, that is: current silver eel escapement $B_{current}$ as a percentage of current potential escapement B_{best}.

4.1 Fisheries mortality

4.1.1 Yellow eel fisheries

On Västkusten (West Coast) during the years prior to 2009 (i.e. the period of years analysed in the Eel Management Plan), the total catch has been 192 t on average, almost exclusively consisting of yellow eel. The length composition of the catches gives an indication of the fishing mortality: older/longer eels have become less abundant than the younger ones, and the difference between them indicates how intense the fishery must have been. Analysis of length frequency data indicates that the fishery exerted a fishing mortality of ca. 27 % per year (A=0.31), that is ca. 85 % over the whole life time (ΣA=1.86).

On Ostkusten (East Coast) during the years prior to 2009, the total catch has been nearly 400 t, less than 10 % of which was yellow eel. Although the length distribution indicates a rather high mortality (only locally?), the landings are so small in comparison to other mortalities, that the Baltic yellow eel fishery is effectively ignored in this assessment.

In inland waters during the years prior to 2009, the total catch per year has been 115 tons, of which ca. 40 % is caught in lakes draining to Västkusten (West Coast) and 60 % in lakes draining to Ostkusten (East Coast). Less than 25 % of this catch is yellow eel. The length frequency distribution indicates that the yellow eel fishery exerts a fishing mortality of ca. 1 % per year (A=0.01), that is ca. 6 % over the whole life time (ΣA=0.06), but this mortality may vary considerably from area to area. There is as yet no information to differentiate between fishing mortality in east and west inland waters.

Recreational fisheries on yellow eel are banned since 2007; thus, they are excluded here.

4.1.2 Silver eel fisheries

In inland waters during the years prior to 2009, the total catch per year has been 115 tons, of which ca. 40 % is caught in lakes draining to Västkusten (West Coast) and 60 % in lakes draining to Ostkusten (East Coast). Approximately 75 % of this catch is silver eel. The total production of silver eel in inland waters is estimated at ca. 282 t. The fishery thus catches ca. 30 % of the silver eel (ΣA=0.28). There is as yet no information to differentiate between fishing mortality in eastern and western river basin districts.

On Ostkusten (East Coast) during the years prior to 2009, the total catch has been circa 400 t, consisting for 90 % or more of silver eel. Silver eel tagging experiments in the 1960s indicated that almost 50 % of the tagged eel were recaptured; recent tagging experiments showed a return rate of only 30 %. The tag return rate prior to 2009 was interpreted as a fishing mortality of 30 % (A=0.44). However, closer inspection of the data shows that average fishing mortality is probably much lower, in the order of 10 % (A=0.10). The difference between these estimates is explained as follows: The tagging experiments often released silver eel in a far northern position, further north than most of the eel actually occur. Of these northern eel, 30 % is recaptured indeed, but this is a rather exceptional situation. Most of the silver eel along the Baltic coast is derived from other countries in the Baltic, and most of these eels hit the Swedish coast only on the southern shores. For those eels on the southern shores, the mortality in the Swedish silver eel fishery is probably much lower than considered before, but the mortality in their area of origin should also be taken into account. In 2010, a start has been made to assess the interaction between eel stocks in different Baltic countries, but this has not yet resulted in quantitative estimates. Following the guidelines of the EU Regulation, only the national impacts will be considered here.

Pending the completion of the analysis of the historical tagging data, both the estimate in the Eel Management Plan (30 %, A=0.44) and the more detailed recent estimate (10 %, A=0.10) will be shown in parallel.

Recreational fisheries on silver eel are banned since 2007; hence, they are excluded here.

4.2 Hydropower mortality

The impact of hydropower generation on the emigrating eel stock is assessed on the basis of the productivity of inland waters, in combination with an estimated mortality of 70 % per hydropower station, corresponding to over 90 % mortality for an average eel going down several hydropower stations. The total impact of hydropower is estimated at 270 t, of which 58 % comes from rivers draining to Ostkusten (East Coast), i.e. 157 t and 42 % comes from rivers draining to Västkusten (West Coast), 113 t.

4.3 Overview of stock indicators

The information presented above is summarised here, in order to prepare for the assessment against the limits and targets of the management plans in the next chapter.

The first table (Table 2) shows stock indicators in terms of weight, of biomass, expressed in tons. This comprises: the estimated production of eel in inland waters, the catch of yellow and silver eel taken by the fisheries in inland and coastal waters, the estimated amount of eel killed by hydropower, and finally the estimated escapement of silver eel towards the ocean.

The escapement for the whole of Sweden is completely dominated by the silver eel migrating along the Baltic coast. The uncertainty about the actual size of this stock component is fully reflected in the estimated totals. Assuming an average impact of the coastal fishery of 30 % (as in the Eel Management Plan), total escapement comes at 722 t; the more recent estimate of 10 % results in a total escapement of 3 407 t. A large share of the escaping silver eels will have grown in other Baltic countries. Only on their way out of the Baltic, they become vulnerable to the Swedish coastal fisheries, but otherwise, they belong to other countries' stock.

The information in this table is derived from different sources: production estimates from a statistical model analysing fishing yields, the fisheries catch from landings statistics, the escapement from mortality models using length-composition data and/or mark-recapture models, while the preliminary estimate of cormorant predation has as yet been left out here. Combining these estimates into a single table, it is clear that the match between the sources of information is unsatisfactory.

Table 2 - Estimates of habitat productivity, impact of fishing and hydropower, and silver eel escapement, expressed in terms of biomass (tons per year). This table gives the quantity of eel being produced/fished/killed/escaping in the current situation, i.e. at current low recruitment. Data from the Eel Management Plan, or derived from that.

Biomasses in ton per year	West Coast	Inland west	Inland east	Baltic coasts	Total
Potential production	436	132	151	1 413	2 132
Fisheries					
Yellow eel	190	12	17	40	259
Silver eel	2	35	52	350	438
Hydropower mortality					
Silver eel	-	113	157	-	270
Escapement					
Silver eel, c.f. EMP	68	5	7	642	722
Silver eel, c.f. updates				3 328	3 407

Biomass-indicators (Table 2) reflect the distribution of the stock over different areas (inland versus coast, east versus west), but do not reflect the impact of fishing and hydropower mortality appropriately: low figures indicate a low impact, and/or a declining stock abundance (low recruitment!), and/or an area of natural low stock abundance. The next table (Table 3) shows stock indicators in terms of mortality (percentages and mortality rates), that is: the impact (of fishing and hydropower) relative to the biomass of the stock component they are impacting. This table shows what percentage is caught/impacted, irrespective of the (current) stock abundance. Unlike biomasses, mortality percentages can not simply be averaged/summed over stock components and impacts; mortality rates are additive over impacts, but can not straightforwardly be averaged over areas.

Mortality in inland areas is dominated by hydropower, while the coastal areas are dominated by fishing. As for the biomasses, the overall average mortality for the whole of Sweden reflects the uncertainty in the size of the Baltic coast stock component.

Table 3 - Estimates of the impact of fishing and hydropower in mortality terms. This table gives the impact of fishing and hydropower as a percentage of the stock being impacted, resp. as an instantaneous mortality rate. Data from the Eel Management Plan, or derived from that; impact estimate for Baltic fishery updated.

Mortality, in percentage and rate	West Coast	Inland west	Inland east	Baltic coasts EMP	Baltic coasts updated	Average EMP	Average updated
Fisheries							
Percentage mortality %	84	29	29	35	10		
ΣA, cumulative mortality rate	1.86	0.34	0.34	0.44	0.10		
Hydropower mortality							
Percentage mortality %	-	96	96	-	-		
ΣA, cumulative mortality rate		3.19	3.19				
Total							
Percentage mortality %	84	97	97	35	10	60	24
ΣA, cumulative mortality rate	1.86	3.52	3.55	0.44	0.10	0.93	0.28

The evaluation framework developed by the International Council for the Exploration of the Sea ICES is based on $B_{current}$, B_{best}, B_0, and ∑A. These four values have been technically defined in the text-box at page 39. $B_{current}$ is the biomass of the silver eel currently escaping; this is a real amount of eels, which can in principle be measured. B_{best} indicates what potential the current stock has; it quantifies what part of the total European population is now found in Sweden. B_0 represents the pristine population, and serves as a reference for protection. The ratio of B_{best} to B_0 indicates how far the population has declined, while the ratio of $B_{current}$ to B_{best} (that is: %SPR) measures how far anthropogenic impacts reduce the current stock. To enable a recovery, it is required that $B_{current}$ is at least 40% of B_{best}. Finally, ∑A is a measure of anthropogenic impacts, as %SPR; when protective measures are taken, $B_{current}$ might react slowly (e.g. restocked eels silver only after many years), while ∑A reacts immediately. And for fisheries, ∑A is directly proportional to the effort.

Table 4 shows these values for the Swedish eel stock. For the fishery on the Baltic coast, both the estimate used in the Eel Management Plan and the more recent estimate is shown. For B_0, the biomass of silver eel escaping to the ocean from a healthy stock without anthropogenic impacts, the Eel Management Plan discusses an estimate based on historical landing records from the fishery, but it is noted that this estimate is quite uncertain. Table 4 follows the same lines, and it is noted again that the estimates are uncertain.

Table 4 - Stock status indicators: estimates of the biomass of silver eels that currently escapes ($B_{current}$), that could currently escape if no anthropogenic impacts existed (B_{best}), and that would escape if the stock was in a healthy condition (B_0). Data from the Eel Management Plan, or derived from that; Baltic fishery updated.

Stock indicators (tons, percentage, rate)	West Coast	Inland, west	Inland, east	Baltic coasts EMP	Baltic coasts updated	Total / Average EMP	Total / Average updated
B_{2009}	68	5	7	642	3 328	722	3 407
B_{best}	436	164	233	992	3 678	1 825	4 510
B_0	526	403	559	6 453	23 920	7 940	25 407
%SPR percentage survival %	16	3	3	65	90	40	76
ΣA cumulative mortality rate	1.86	3.52	3.55	0.44	0.10	0.93	0.28

4.4 The contribution of restocking and transport to the inland stock

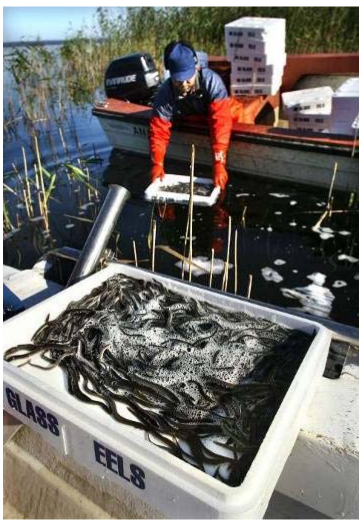
To what extent has the restocking of glass eels purchased abroad, and the trap and transport of young eels from river mouths upstream of barriers, contributed to the existing stock? And to what extent can increased restocking contribute to the restoration of the inland stock?

From the 1910s/1920s until the 2000s, the commercial catch in smaller lakes and rivers ("other lakes", Figure 21) has declined from 180 t to ca. 30 t per year - only 15 % of the historical catch remains. Declining natural recruitment and obstructed migration routes probably have contributed to this decline, though a decline in exploitation pressure due to ongoing urbanisation might also have occurred. During the same period, the commercial catches in the great lakes (sum of Mälaren, Hjälmaren, Vättern and Vänern, Figure 21) increased from 30 t to 80 t per year. Assuming that recruitment decline and migration obstructions have affected the natural recruitment into the great lakes to the same degree as the smaller lakes, one would expect a catch of ca. 15 % of the historical 30 t, that is: only 5 t per year. Are the remaining 75 t of restocked origin? Or is there reason to assume that urbanisation affected the smaller lakes more than the great lakes?

During their migration into our water, eels build up their bones; afterwards "reading" the chemical composition of their bones (the Strontium content in comparison to the Calcium content) provides evidence on their individual history, in particular whether they resided in marine, brackish or fresh water. Were they gradually moving from the sea into inland waters (natural immigrants), or were they suddenly transported from estuaries into fresh water (restocked and/or transported eels)? Detailed analysis of eels from commercial catches in the great lakes has shown, that approximately 95 % of them show a Strontium pattern that indicates a restocking/transport background, and only 5 % show a natural recruitment pattern. That supports the inference made above, that the majority of catches is made from eels of restocking/transporting origin.

In the 1990s, the number of eels restocked/transported into the great lakes has varied around an average of 3 million glass eel equivalents (see section 2.1.7). Assuming a growth rate of 4.5 cm per year (see section 2.1.3) and a natural mortality of 13 % (that is a common assumption), one would expect an annual production of these restocked/transported eels of ca. 220 t of silver eel coming somewhere between the years 2000 and 2015, about one-third of which will be / has been caught (section 4.1.2) – that is 70 t per year. This indicates that the “observed” yield of eels derived from restocking agrees well with the expected quantity. The level of restocking has declined since 2000, but the later restockings have as yet not phased into the commercial fishery.

According to the Eel Management Plan, restocking quantities are to be increased to 2.5 million glass eels. This is expected to increase the production by 185 thousand silver eels, corresponding to between 80 and 160 t of silver eels. What contribution this can make to the overall escapement is hard to express, since historical restockings were made to waters above hydropower stations, which were exploited by the fishery; recent restocking has focused on unexploited, unobstructed rivers on the West Coast. Without fishery and hydropower impacts, the contribution of restocking would be 25 % of B_{best} for the inland stock (B_{best}: the silver eel escapement from the current stock, assuming no impacts from fisheries or hydropower); expressed as a (negative) mortality rate, this comes at -0.22 for the whole inland stock.



These preliminary estimates of the effect of restocking/transporting are tentatively included in the predicted effect of the management measures in the Eel Management Plan (shown by the arrows in Figure 37 and Figure 38). Recent restocking is actually focused on rivers draining to the west, and therefore, the expected effect is shown focused on that area only. Since the natural stock in the westward-draining rivers is only a part of the total inland stock, this focus on these rivers increases the percent-wise (positive) impact restocking has locally, and thus enlarges the expressed (negative) mortality effect for restocking (that is a mathematical issue, not a biological effect). Comparing east to west for inland areas in Figure 37 and Figure 38 shows exactly the effect the increased restocking is expected to have. For the overall effect on the whole Swedish stock, the effect is too small to be visible in these figures.

5 Stock status and management targets

The previous chapters have described the status of the stock and the trends observed. This chapter will discuss the background of the management targets, and will discuss the current status of the stock in relation to these.

5.1 The limits/targets of the EU Eel Regulation

The objectives of the EU Regulation are to protect and restore the stock. The Regulation sets a common target for the escapement of silver eels, at 40 % of the natural escapement. Before discussing the state of the eel stock (below), we first illustrate the objectives and target in more general terms.

5.1.1 A general stock-recruitment relation

Consider a fish of any species. Under natural circumstances, the number of young fish surviving is much lower than the number that were initially born. Basically, this is just bad luck for most young-borns: a high percentage will die under all circumstances. However, when shortage of food or lack of space is involved, the risk of dying may depend on the abundance of the fish stock (density dependence). If there are more youngsters in a particular year, they will not find more food, and thus some more will have to die; fewer youngsters in another year will find plenty of food and space, and

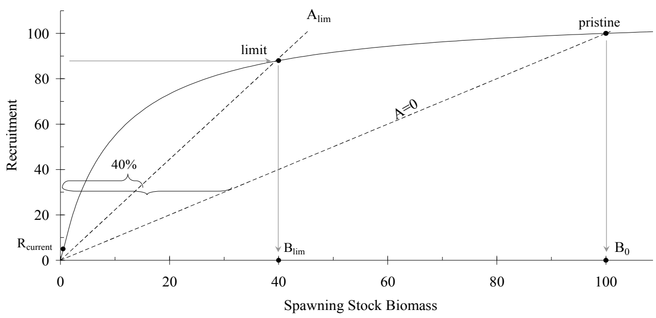


Figure 33 - Hypothetical Stock-Recruitment relationship. The drawn line indicates what recruitment is produced at what spawning stock size; the dashed lines indicate what spawning stock can be derived from a given recruitment, at no fishery (A=0) or at maximal, just sustainable fishery (Alim). Both Recruits and Spawning Stock Biomass are given in arbitrary units. The EU Regulation sets the minimum target at 40% of the pristine spawning stock biomass, which will keep recruitment close to its maximum.

survival will improve.

At very low adult density, however, the number of offspring produced is simply too low. Any youngster born finds enough space and food to survive, but few youngsters will remain few youngsters. In this case, the number of youngsters depends on the adult stock abundance. The fewer adults there are, the fewer eggs will be produced, and the fewer youngsters will be born – each of them finding enough food and space to survive.

Shortage of food or space at high abundance and insufficient youngsters at low abundance - a critical threshold can be found at intermediate levels. Above this critical threshold, the number of youngsters surviving is at its maximum; below this critical threshold, the next generation is limited by the number of adults reproducing. In practice, a really sharp critical level can not be found, but many commercial fish stocks have shown a break-point around 30 % of the pristine stock size. Thus, reducing the adult stock to about 30 % of its natural abundance does not markedly affect the number of youngsters surviving, but further reductions to the adult stock limits the new generation.

5.1.2 A stock-recruitment relation for the eel?

For eel, the international scientific advice assumes that a likewise relation between adult stock and youngster generation also holds, even though no evidence for that is available. Because of the many uncertainties specifically for eel, an extra safety-margin of 20 % was added in the advice: the scientific advice was to protect a spawning stock biomass of 50 % of the natural, pristine condition. The EU Regulation decided on a final level of 40 %, halfway the safety margin. In this report, the 40 % limit of the EU Regulation will be shown.

Current recruitment of glass eel from the ocean is at 1-10 % of the historical level. This low recruitment leads to a low adult stock, and in turn a low number of adults returning to the ocean. Under these circumstances, it is highly unlikely that the 40 % adult stock can be maintained: low recruitment is now limiting the number of adults and the stock is most likely suffering from reduced reproductive capacity.

5.1.3 Biomass and mortality

At low spawning stock biomass, the focus shifts from the absolute abundance of the stock towards the survival of individual youngsters. If less than 40 % survives (relative to the survival under natural conditions), it would not be possible to maintain a healthy stock, even if the adult stock would have been healthy initially. If more than 40 % survives, even a low stock might have some capability to recover, though it may take a long time. Hence, there is a critical threshold for survival, corresponding to the 40 % adult stock abundance. If less than 40 % of the youngsters survives (relative to natural circumstances, without anthropogenic impacts), the stock is not likely to recover. Above the 40 % survival, we expect a recovery. The higher the survival, the faster the recovery is expected to be. Because of the stock currently being so low, the scientific advice is to improve survival beyond the 40% level (the wording in the scientific advice was: “mortality be reduced to the lowest possible level”), which intends to achieve a recovery of the stock within a foreseeable future (decades rather than centuries). Once more, the 40 % is probably not an exact value, and estimates of survival are definitely not that precise, but the target for survival is 40 %.

Survival of whom? In nature, survival of wild animals is generally low: the vast majority of all animals die at a young age, due to natural causes (the bad luck, mentioned above). The 40 % survival target is not saying that nature should be a bit less harsh, but that anthropogenic impacts (coming on top of nature) must be limited. The actual escapement should come at 40 % of the escapement-without-anthropogenic-impacts. It is the ratio

of the actual biomass of silver eels escaping ($B_{current}$) to the calculated biomass without anthropogenic impacts (B_{best}) that should come at 40 %. For glass eel fisheries in southern Europe, for instance, natural mortality of overabundant glass eels might be very high even under natural conditions; it is the added fishing impact that counts, not the net survival of these individuals.

5.2 The Precautionary Diagram

For the international advice on fish stock management, ICES (2004) applies a traffic light colouring scheme, signalling the status of the stock and the impact of exploitation. The information on the stock status and the reference points are presented in a so-called Precautionary Diagram (Figure 34), in which the criteria and status are summarised. This diagram presents the status of the stock (horizontal, low versus high spawning stock biomass determining whether the stock has full reproductive potential) and the impact of fishing (vertical, low versus high anthropogenic mortality determining whether the exploitation is sustainable or not). Obviously, the green zone is the recommended status, the red zone indicates unsustainable conditions, and the orange zones show various intermediate risk-zones. For the case of the eel, a slightly modified diagram is used, but the basic colour coding is kept.

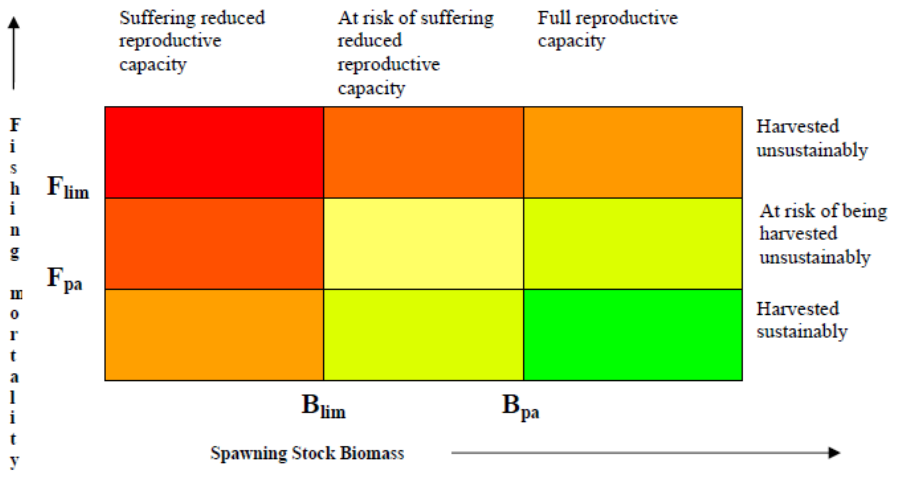


Figure 34 - This “precautionary diagram” is used to summarise the state of the stock (horizontal) and the anthropogenic impacts (vertical).

5.3 The aims of the Swedish Eel Management Plan

The Swedish Eel Management Plan subscribes to the objectives of the European Eel Regulation and emphasises a rapid increase of silver eel escapement, to a level at which the stock decline is expected to stop and turn into an increase. To this end, the impact of fishing and of hydropower is to be restricted and (extra) young eels to be restocked.

In the past decades, the European eel stock has been declining by approx. 15 % per year, that is: about one order of magnitude per generation. Every five years, the number of young eels entering our waters halved. To stop this decline, a reduction in anthropogenic impacts is required, counterbalancing the decline. Thus, the decline rate of the stock indicates what reduction in anthropogenic impacts is required (15 % mortality per year), and by contrasting to the historical impacts, what remaining anthropogenic impact is sustainable. European wide, the average anthropogenic impact was estimated at 96 % per generation, 17 % per year (the glass eel fisheries around the Bay of Biscay had a higher impact, and a much more complex calculation). To compensate for the decline observed, a major reduction in anthropogenic impacts is required. According to the Eel Management Plan, anthropogenic impacts should reduce the current best achievable escapement by not more than 10 – 20 % (in technical terms: $B_{current} \geq 0.8 * B_{best}$ for yellow eel and $B_{current} \geq 0.9 * B_{best}$ for silver eel dominated areas). This requires that the existing impact of hydropower and of fishing is reduced by approx. 50 %.

Figure 35 (below) summarises the stock indicators and management targets of the Eel Management Plan. In this figure, all quantities are expressed as (the equivalent of) numbers of silver eels, while above the same quantities have been expressed in terms of weight (biomass in tons). This change in units makes a considerable difference only for the West Coast fishery, targeting smaller sizes than all other impacts.

If no fishing occurred and hydropower would have no impact, escapement from the current stock is calculated in the Eel Management Plan at slightly less than 3 million silver eels (second line in Figure 35, best achievable). An anthropogenic impact on the natural stock of less than 0.4 million silver eels will be within the limits (third line, limit impact). Continuation and extending the restocking programme will add another 0.5 million, making a total of 0.9 million. The 2008 impact was estimated at 1.7 million; the target for 2012 is to reduce the impacts to 0.9 million silver eels. According to the Eel Management Plan, this will require a 50 % reduction in fishing and hydropower impact.

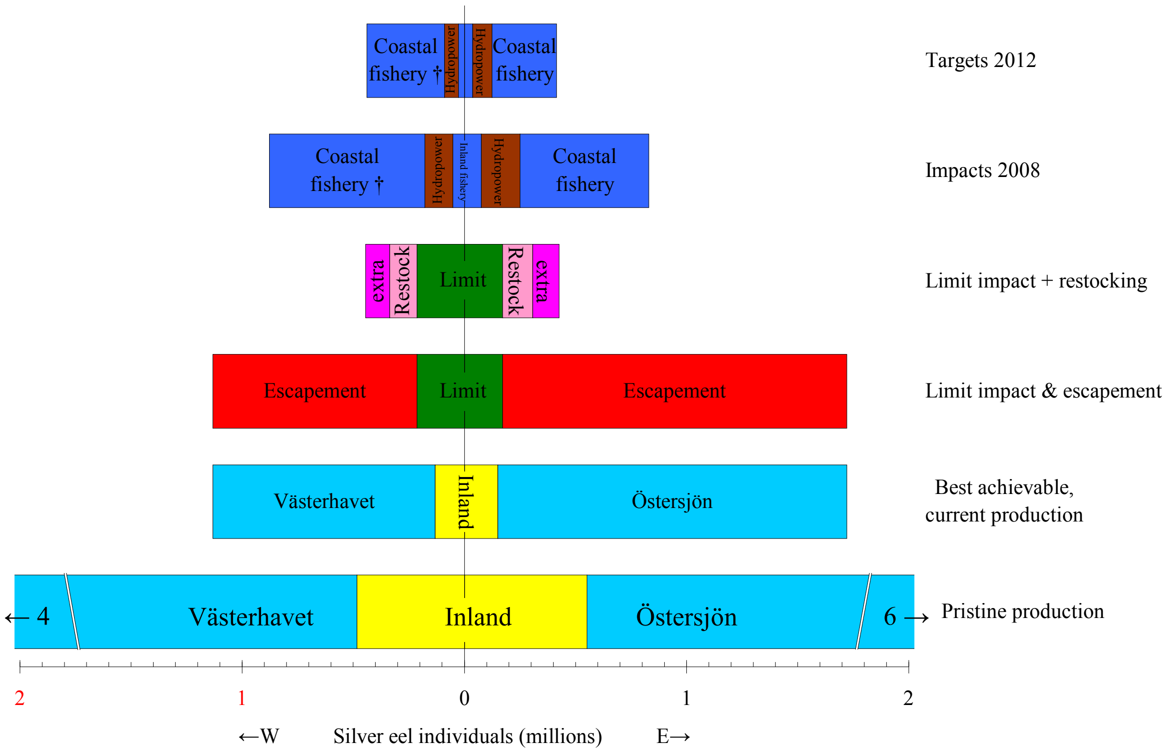


Figure 35 - Summary of the stock status indicators and management targets of the Eel Management Plan. The West Coast and the inland waters draining towards the west have been plotted to the left, the east to the right. Explanation in the text. All quantities expressed as (the equivalent of) number of silver eels. † For the West Coast fishery, the impact in numbers is high in comparison to the weight being landed, because of the smaller average size in the catch.

5.4 Management measures

Fiskeriverket has been the responsible agency for fisheries management in Sweden, but was superseded by the new Havs- och Vattenmyndigheten in 2011. Fiskeriverket has communicated rules and restrictions in a series of publications, called Fiskeriverkets författningssamling (FIFS).

There are two basic publications that regulate the eel fishery: “Fiskeriverkets föreskrifter om fiske i Skagerrak, Kattegatt och Östersjön (FIFS 2004:36) [Fiskeriverket’s directions for fisheries in Skagerrak, Kattegatt and the Baltic] ” and ”Fiskeriverkets föreskrifter om fiske i sötvattensområdena (FIFS 2004:37) [Fiskeriverket’s directions for fisheries in fresh water]”.

Fiskeriverkets författningssamling

ISSN 1102-6081

FIFS 2004:36
Utkom från trycket
den 15 november 2004

**Fiskeriverkets föreskrifter
om fiske i Skagerrak, Kattegatt och Östersjön;**

beslutade den 15 oktober 2004.

Med stöd av 2 kap. 3, 7 och 12 §§ samt 6 kap. 2 och 8 §§ förordningen (1994:1716) om fisket, vattenbruket och fiskerinäringen föreskriver Fiskeriverket följande.

1 kap. Tillämpningsområde och allmänna bestämmelser

Geografiska avgränsningar

1 § Dessa föreskrifter avser såväl yrkesmässigt som icke yrkesmässigt fiske i *Skagerrak, Kattegatt* och *Östersjön* inom Sveriges sjöterritorium och Sveriges ekonomiska zon samt, när så särskilt anges, fiske från svenska fartyg utanför den ekonomiska zonen. Föreskrifterna gäller även för utländska medborgare och utländska fartyg som har rätt att fiska i Sveriges sjöterritorium eller i Sveriges ekonomiska zon om inte annat följer av EG:s förordningar om den gemensamma fiskeripolitiken[1] eller av internationella överenskommelser.

Föreskrifterna gäller som komplettering till föreskrifter om fiske i EG:s förordningar om den gemensamma fiskeripolitiken. I fall där en bestämmelse reglerar samma sak som föreskrivs i en EG-förordning skall bestämmelsen tillämpas på yrkesmässigt fiske endast om den innebär en skärpning i förhållande till vad EG föreskriver. Bestämmelserna om återutsättningsskyldighet m.m. i 8 § gäller dock för yrkesmässigt fiske endast med avseende på nationella svenska föreskrifter.

Vid yrkesmässigt fiske i Östersjön innanför de baslinjer som anges i 4 § lagen (1966:374) om Sveriges sjöterritorium och i förordningen (1966:375) om beräkning av Sveriges sjöterritorium skall, om inte annat anges, tillämpas de föreskrifter om fiske som enligt EG:s förordningar om den gemensamma fiskeripolitiken gäller i Östersjön utanför och in till baslinjerna.

Föreskrifterna skall inte tillämpas i den mån de strider mot lagen (1971:850) med anledning av gränsälvsöverenskommelsen den 16 september 1971 mellan Sverige och Finland, kungörelsen (1971:1018) om tillämpning av stadgan för fisket inom Torne älvs fiskeområde eller föreskrifter utfärdade med stöd av lagen (1997:201) om befogenhet att besluta om fisket inom Torne älvs fiskeområde[2].

2 § De i 1 § första stycket nämnda havsområdena avgränsas enligt följande.

Skagerrak: Söderut av en rät linje från Skagens fyr till fyren Tistlarna och därifrån vidare till den närmast belägna svenska kusten vid Vallda Sandös västra udde samt västerut av en rät linje genom Hanstholms fyr och Lindesnes fyr.

[1] Jfr rådets förordning (EG) nr 2371/2002 av den 20 december 2002 om bevarande och hållbart utnyttjande av fiskeresurserna inom ramen för den gemensamma fiskeripolitiken (EGT nr L 358, 31.12.2002, s. 59, Celex 32002R2371).
[2] Jfr förordningen (FIFS 1997:12) om fisket i Torne älvs fiskeområde.

1

The prime measures to regulate eel fishing are a minimal legal size, a restricted fishing season and a limit to the number of gears used. Since fishing operations differ between inland and coastal areas, measures have been differentiated betweens these areas.

As of today (2011), the following rules apply:

- Fishing for eel is forbidden in general, with the following exceptions:
  - Areas upstream of the third migration barrier are free. It is considered unlikely that eels from these areas can migrate safely towards the sea. These areas have explicitly been listed. A minimum size of 70 cm applies, and selling the catch is prohibited.
  - Elsewhere, fishermen may apply for a permit, if they comply with specified requirements. The permit may set additional restrictions.
- Licensed fishers are allowed to catch 8,000 kg per year at maximum.

- In inland areas, the fishery should not last for more than 120 days.
- In the Baltic (including Öresund), the fishery should either take place between 1st of May and 14th of September, or during a continuous period of 90 days maximally.
- On the West Coast (Skagerrak and Kattegatt), eel fisheries are allowed with movable gear between 1st of May and 14th of September, with 400 fykenets (800 cod ends) or eel pots at maximum.
- In Skagerrak and Kattegatt north of 56°25'N, the capture of silver eel is forbidden.
- South of 56°25'N in the Kattegatt, non-moveable gear can be allowed. Fisheries with fixed or moveable gears are restricted to a continuous period of 60 days at maximum.
- A fixed gear, which has not been registered with Fiskeriverket as fishing for eel, should stand open or have two circular escape openings of minimal 60 mm (inland waters and the Baltic) or 75 mm (West Coast) diameter, placed on opposite sides of each cod-end.
- The minimum legal size for eel in inland waters and the Baltic (excluding the Öresund) is 70 cm; on the West Coast and in the Öresund it is 45 cm.

In addition to this, there are more rules and many more details, which we will omit here.

Below, we will summarise the most prominent changes in legislation since 1994. In the Swedish version of this report, the exact wording of the legislation is shown, but no attempt is made to give a translation here.

In various areas and over the years, a range of different minimum legal sizes has been applied. These are summarized in Figure 36.

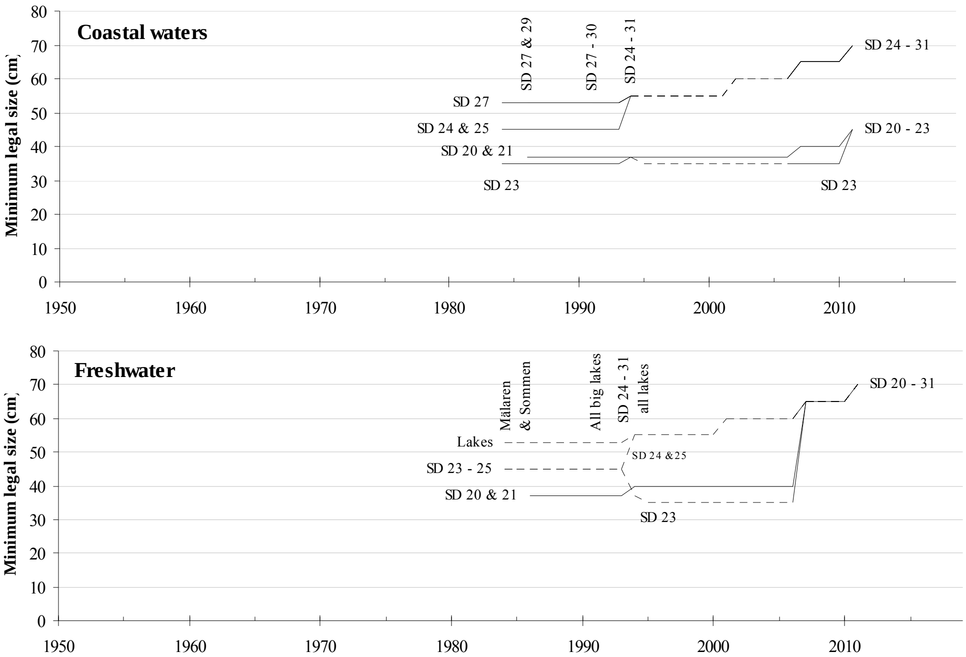


Figure 36 - Minimum legal size limits by area (ICES subdivision) and year. Until 2007, inland waters above the third migration barrier were exempted. Dashed lines: silver eels exempted, except in lakes (i.e. size limits did apply to silver eels in lakes).

In May 2007 (FIFS 2007:5), the general ban on eel fishing was introduced, except when licensed or fishing above the third migration barrier from the sea. Licenses were only provided to fishers who could proof an earlier annual catch of 400 kg or more. A limit to the number of fykenets of 500 was set. For coastal areas, this number was reduced to 400 (800 cod-ends) in 2009 (for non-professionals, the limits are 6 fykenets, 12 cod-ends); all nets must be lifted at least every third day. Additionally, an obligation to have escape openings of 60 mm diameter was introduced (for *ålkistor* and *ållanor*, this obligation holds only since 2011; for fyke nets at < 10 m depth on the West Coast, 75 mm diameter applies; for Bottenhavet and Bottenviken, the obligation holds only since 2009; a mesh size of > 60 mm may replace the escape openings). Escape openings are not required when fishing for eel with a license. Finally, specific rules were set for eel fishing in protected areas (license requirement, though fykenets < 60 cm in height and *åltina* are still allowed between May 1st and

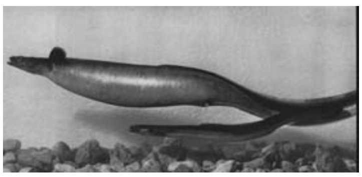
September 14th) and regional licenses were required for trammel nets fishing for eel (mostly in Blekinge).

From 2008 onwards, no new licenses were allowed, though existing licenses could be continued.

Since 2011, eels caught upstream of the third migration barrier are not allowed to be sold. Elsewhere, an annual limit of 8 tons per fisher was introduced.

5.5 The stock status in relation to the targets

In the preceding chapters, the Swedish eel stock has been characterised and time trends presented. In this chapter, the objectives and targets of the EU eel protection plan have been clarified, and the specific targets of the Swedish Eel Management Plan summarised. In this section, the state of the stock will be contrasted with the targets. This involves the comparison of the actual state of the stock to the state it is intended to have, comparing the observed mortalities to the targets set in the management plans. To this end, the precautionary diagram introduced in section 5.2 will be used, in a modified version. Figure 37 (below) presents the status for four parts of the stock: the inland and the coastal parts, for (rivers draining to) Västkusten (West Coast) and Ostkusten (East Coast) separately. On the horizontal axis, the status of the stock is plotted (low versus high spawning stock biomass determining whether the stock is in good condition or not; logarithmic scale, percent of pristine biomass) and on the vertical axis the impact of fishing and hydropower generation (low versus high mortality determining whether the management regime is sustainable or not; mortality rates are logarithmic by definition). The diagrams below plot the most recent stock assessment, presented in the Eel Management Plan (2009) - with the exception of the silver eel fishery on the East Coast, for which the 2009-version and an updated assessment are presented separately.



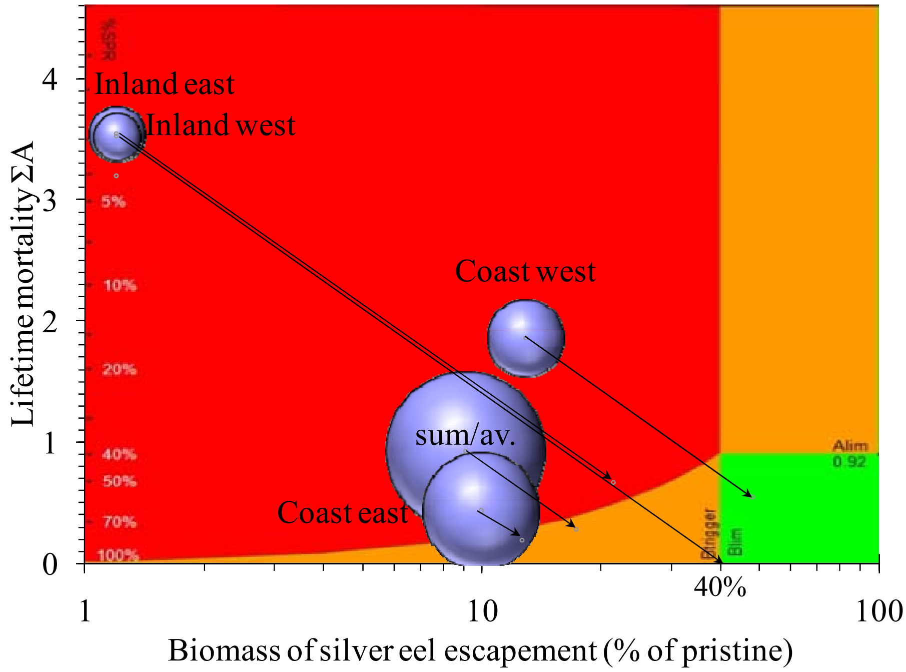


Figure 37 - Precautionary Diagram summarising the state of the stock as described in the Eel Management Plan (position of the symbols) and the effect the planned management measures will have (end-point of the arrows). Bubble size indicates B_{best}; sum/av. indicates the sum or average. This figure is explained in the text; the green zone is the recommended status, the red zone indicates unsustainable conditions.

The background colours in these diagrams reflect the target of the EU Regulation (the target in the green zone) and the precautionary advice given by ICES (a much lower mortality, to recover the stock)[1]. For each part of the stock (and for the whole of Sweden), the status of the stock is represented by a bubble. The position of the bubble indicates the status of the stock in 2006-2008 relative to the biomass (horizontal) and mortality (vertical) targets, while the size of the bubble indicates the relative importance of that part of the stock (B_{best}, the potential production from the current stock, if no anthropogenic impacts would have occurred). Additionally, each bubble has an arrow,

[1] The orange zones bordering the red area in the ICES precautionary diagram reflect statistical uncertainty in the stock assessment. For eel stock assessments, the magnitude of the statistical uncertainties is simply unknown, and therefore, these in-between zones have been left out.

indicating what effect the planned measures of the Eel Management Plan is expected to have – that is: where the bubble is supposed to be in 2012.

The first diagram is based on the data and estimates of the Eel Management Plan (2009); the second diagram uses the recently updated estimate of the impact by the East Coast fishery. As indicated before, this update changes our view on the size and status of the whole Swedish stock considerably. However, this updating does not yet take into account the origin of the coastal stock, in particular the anthropogenic impacts in their countries of origin.

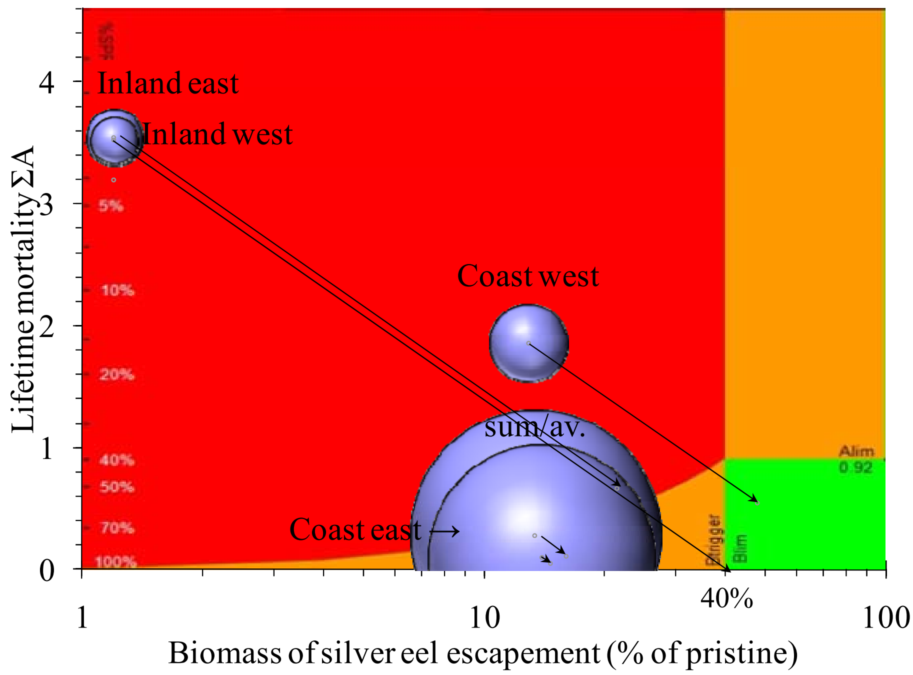


Figure 38 - Precautionary Diagram, using an updated estimate for the East Coast fishery (updating the position and size of the symbols for East Coast and the sum/average). Otherwise, this diagram copies the previous diagram (Figure 37).

The arrows in these diagrams indicate what effect the implementation of the Eel Management Plan is expected to have. Looking at the end-point of the arrows, it becomes obvious that it will not be possible for all areas to reach the green zone, that is: the stock will not restore to the required level. Even stronger: in most areas, it is even impossible to reach the green zone, whatever severe actions are taken. If adequate protection is achieved for the whole European population, only then may recruitment increase again, and only then will it be possible to reach the national targets. The green zone being unreachable now, that is just another way of expressing what was said before in Section 1.3: it will take more than one eel generation to restore the stock.

Finally, these diagrams apply a methodology developed in 2010 to data and estimates derived before 2009. An update of the full assessment and a consistent application of this methodology are planned in preparation of the reporting to the European Union by midsummer 2012.

6 Further reading

In this report, we have avoided jargon, terse statistical testing and detailed referencing to the original sources of information; the focus is on communicating the information in a readable format. For the interested reader, however, this final section gives a short introduction to the more specialised literature. Only a minimal number of references have been included here.

EU Council Regulation (EC) No 1100/2007 of 18 September 2007 establishing measures for the recovery of the stock of European eel. Official Journal of the European Union L 248/17. 7 pp.
The official text of the European Eel Regulation, describing the recovery programme for the eel.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:248:0017:0023:EN:PDF (English)
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:248:0017:0023:SV:PDF (Swedish)

Anonymous 2008 Förvaltningsplan för ål. Bilaga till regeringsbeslut 2008-12-11 Nr 21 2008-12-09 Jo2008/3901 Jordbruksdepartementet. 62 pp.
The official text of the national Eel Management Plan, in Swedish; the English version is a translation. It gives a lengthy presentation of the status of the stock, and describes the line of reasoning for setting targets and planning management measures.
https://www.fiskeriverket.se/download/18.7c5197de123343f05d280007183/%C3%85l_f%C3%B6rvaltningsplan_bilagor_beslut_20081211.pdf (Swedish original)
http://www.fishsec.org/downloads/1233757502_69937.pdf (English translation)

FAO European Inland Fisheries Advisory Commission; International Council for the Exploration of the Sea. Report of the 2010 session of the Joint EIFAC/ICES Working Group on Eels. Hamburg, Germany, from 9 to 14 September 2010. EIFAC Occasional Paper. No. 41. ICES CM 2010/ACOM:18. Rome, FAO/Copenhagen, ICES. 2010. 721p.
The Working Group on Eels is jointly organised by the European Inland Fisheries (and Aquaculture) Advisory Commission and the International Council for the Exploration of the Sea. This Working Group on Eels meets almost every year. The report discusses specific requests by the parent organisations, and includes an annual update on the status of the stock. The text is technical in nature, and individual reports do not present a complete overview. The latest reports (2010) can be found at:
http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=75

Wickström H., Andersson J., Dekker W. & Florin A-B. 2010, Report on the eel stock and fishery in Sweden 2009/'10. 52 pp. In: EIFAC/ICES (2010), presented above.

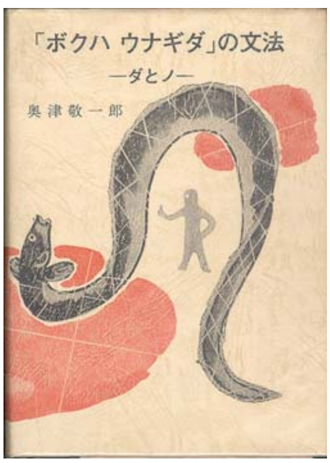
The annual report of the EIFAC/ICES Working Group on Eels (above) includes an Annex, in which the status of the eel stock in individual countries is presented (in 2010: 15 countries all over Europe). This "Country Report" contains a lengthy listing of available data series, which have been summarised in the current report, and a preliminary discussion of the stock status in relation to management targets. The text is rather technical in nature. The latest reports (2010) can be found at:

http://www.ices.dk/workinggroups/ViewWorkingGroup.aspx?ID=75

Dekker W. 2008. Coming to Grips with the Eel Stock Slip-Sliding Away. pages 335-355 in M.G. Schlechter, N.J. Leonard, and W.W. Taylor, editors. International Governance of Fisheries Eco-systems: Learning from the Past, Finding Solutions for the Future. American Fisheries Society, Symposium 58, Bethesda, Maryland.

This publication provides an overview of the status of the international eel stock, the long period of decline, the scientific advice, the development of the EU Regulation and the CITES listing of the European eel, and the political debates involved. The text is complex, but not highly technical.

http://documents.plant.wur.nl/imares/aal-dekker.pdf



7 Illustrations

The illustrations are courtesy of the following persons and organisations:

Anders Asp, SLU Drottningholm: front and back cover

Authors: pp. 2, 3, 5, 7, 10, 21, 30, 27, 35, 39, 40, 41, 48, 49, 50, 56.

Inge Boetius, Copenhagen: p. 58.

Robert Rossell, Belfast: p. 51.

Scandinavian Silver Eel SA, Helsingborg: pp. 46, 47.

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Uwe Kils, New York: p. 6.

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