Report on the eel stock and fishery in the Netherlands 2008

NL.A Authors

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NL.B Introduction

NL.B.1 Status of this report

In 2002 (ICES 2003), the EIFAC/ICES Working Group on eels recommended that member countries should report annually on trends in their local populations and fisheries to the Working Group. In 2003 (ICES 2004), detailed data reports per country were annexed to the working group report, which have subsequently been updated, refined and restructured to match the set-up of the EU Data Collection Regulation. FAO/ICES (2007) is the most recent version. This report on the status of and trend in the eel stock in the Netherlands updates the information presented before.

NL.B.2 General overview of fisheries

Eel fisheries in the Netherlands occur in coastal waters, estuaries, larger and smaller lakes, rivers, polders, etc. The total fishery involves just over 200 companies, with an estimated total catch of nearly 1000 tonnes. Management of eel stock and fisheries has been an integral part of the long tradition in manipulating water courses (polder construction, river straightening, ditches and canals, etc.). Governmental control of the fishery is restricted to on the one hand a set of general rules (gear restrictions, size restrictions, for course fish: closed seasons), and on the other hand site-specific licensing. Within the licensed fishing area, and obeying the general rules, fishers are currently free to execute the fishery in whatever way they want. There is no existing general registration of fishing efforts or landings required. In recent years, licensees in state-owned waters are obliged to participate in so-called Fish Stock Management Committees [‘Visstand Beheer Commissies’ VBC,], in which commercial fisheries, sports fisheries and water managers are represented. The VBC is responsible for the development of a regional Fish Stock Management Plans. The Management Plans are currently not subject to general objectives or quality criteria.

NL.B.3 Spatial subdivision of the territory

The fishing areas can be categorized into five groups (see also Figure NL.1):

The Waddensea; 53ºN 5ºE; 2591 km^2. This is an estuarine-like area, shielded from the North Sea by a series of islands. The inflow of seawater at the western side mainly consists of the outflow of the river Rhine, which explains the estuarine character of the Waddensea. The fishery in the Waddensea is permitted to license holders and assigns specific fishing sites to individual licensees. Fishing gears include fykenets and poundnets; the traditional use of eel pots is in rapid decline. The fishery in the Waddensea is obliged to apply standard EU fishing logbooks. Landings statistics are therefore available from 1995 onwards; <50 tons per year.

Lake IJsselmeer; 52º40'N 5º25'E; now 1820 km^2. Lake IJsselmeer is a shallow, eutrophic fresh-water lake, which was reclaimed from the Waddensea in 1932 by a dike (Afsluitdijk), substituting the estuarine area known as the Zuiderzee. The surface of the lake was stepwise reduced by land reclamation, from an original 3470 km^2 in 1932, to just 1820 km^2 since 1967. In preparation for further land reclamation, a dam was built in 1976, dividing the lake into two compartments of 1200 and 620 km^2, respectively, but no further reclamation has actually taken place. In managing the fisheries, the two lake compartments have been treated as a single management unit. The discharge of the river IJssel into the larger compartment (at 52º35'N 5º50'E, average 7 km^3 per annum, coming from the River Rhine) is sluiced through the Afsluitdijk into the Waddensea at low tide, by passive fall. Fishing gears include standard and summer fykenets, eel boxes and longlines; trawling was banned in 1970. Licensed fishers are not spatially restricted within the lake, but the number of gears is controlled by a gear-tagging system. The registered landings at the auctions are assumed to cover some 80% of the actual total.

Main rivers; 180 km^2 of water surface. The Rivers Rhine and Meuse flow from Germany and Belgium respectively, and constitute a network of dividing and joining river branches in the Netherlands. Traditional eel fisheries in the rivers have declined tremendously during the 20th century, but following water rehabilitation measures in the last decades is now slowly increasing. The traditional fishery used stow nets for silver eel, but fykenet fisheries for yellow and silver eel now dominates. Individual fishers are licensed for specific river stretches, where they execute the sole fishing right. No registration of efforts or landings is required.

Zeeland; 965 km^2. In the Southwest, the Rivers Rhine, Meuse and Scheldt (Belgium) discharge into the North Sea in a complicated network of river branches, lagoon-like waters and estuaries. Following a major storm catastrophe in 1953, most of these waters have been (partially) closed off from the North Sea, sometimes turning them into fresh water. Fishing is licensed to individual fishers, mostly spatially restricted. Fishing gears are dominated by fykenets. Management is partially based on marine, partly on fresh-water legislation.

Remaining waters; inland 1340 km^2. This comprises 636 km^2 of lakes (average surface: 12.5 km^2); 386 km^2 of canals (> 6 m wide, 27 590 km total length); 289 km^2 of ditches (< 6 m wide, 144 605 km total length); and 28 km^2 of smaller rivers (all estimates based on areas less than 1 m above sea level, 55% of the total surface; see Tien and Dekker, 2004 for details). Traditional fisheries are based on fykenetting and hook and line. Individual licenses permit fisheries in spatially restricted areas, usually comprising a few lakes or canal sections, and the joining ditches. Only the spatial limitation is registered. Eight small companies operating scattered along the North Sea coast have been added to this category.

The Water Framework Directive subdivides the Netherlands into four separate River Basin Districts, all of which extend beyond our borders. These are:

a) the <u>River Ems</u> (Eems), 53º20'N 7º10'E (=river mouth), shared with Germany. This RBD includes the northeastern Province Groningen, and the eastern part of Province Drente. Drainage area: 18 000 km^2, of which <u>2400 km^2</u> are in the Netherlands.

b) the River Rhine (Rijn), 52º00'N 4º10'E, shared with Germany, Luxemburg, France, Switzerland, Austria, Liechtenstein. Drainage area: 185 000 km^2, of which 25 000 km^2 in the Netherlands, which is the major part of the country.

c) the River Meuse (Maas), 51º55'N 4º00'E, shared with Belgium, Luxemburg, France and Germany. Drainage area: 35 000 km^2, of which 8000 km^2 are in the Netherlands.

d) the River Scheldt (Schelde), 51º30'N 3º25'E, shared with Belgium and France. Most of the southwestern Province Zeeland used to belong to this RBD, but water reclamation has changed the situation dramatically. Drainage area: 22 000 km^2, of which 1860 km^2 are in the Netherlands.

Within the Netherlands, all rivers tend to intertwine and confluent. Rivers Rhine and Meuse have a complete anastomosis at several places, although a large part of the outflow of the River Meuse is now redirected through former outlets of the River Scheldt. Additionally, the coastal areas in front of the different RBDs constitute a confluent zone. Consequently, sharp boundaries between the RBDs cannot be made-neither on a practical nor on a juridical basis. In the following, we will subdivide the national data on eel stock and fisheries by drainage area on a preliminary assumption that water surfaces and fishing companies are approximately equally distributed over the total surface, and thus, totals can be split up over RBDs proportionally to surface areas.

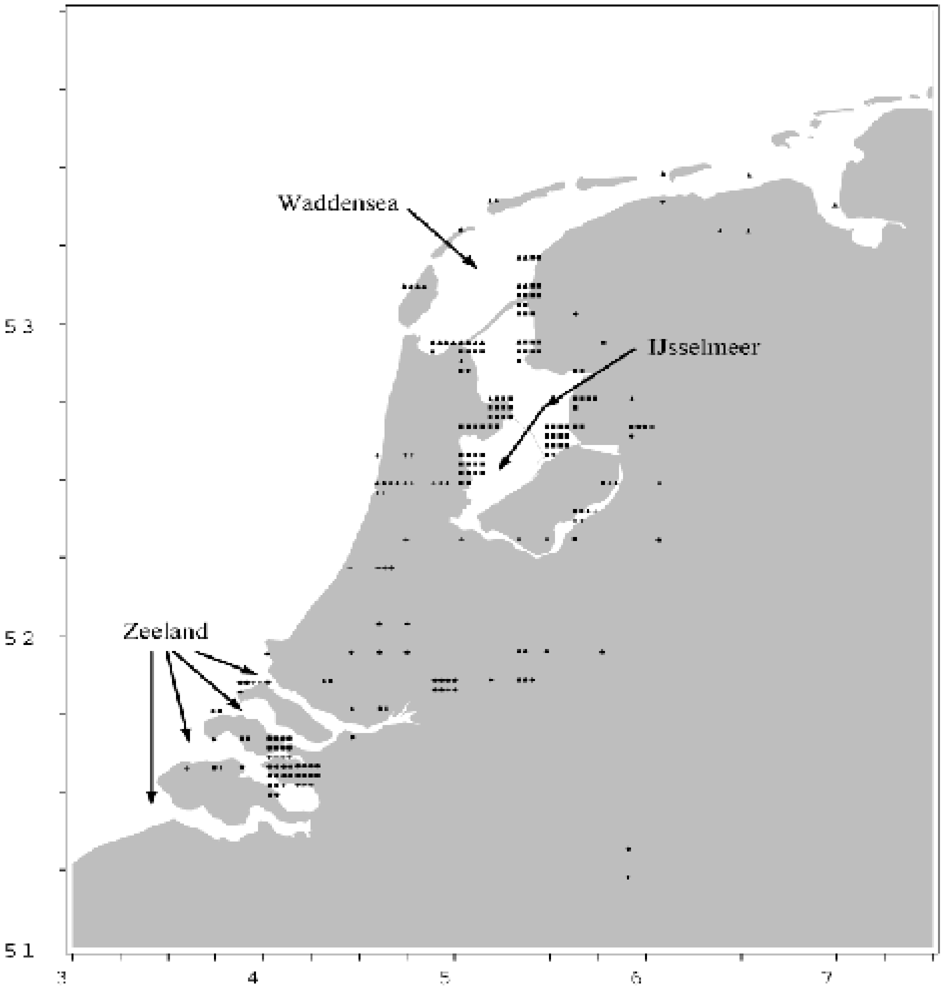


Figure NL.1 Distribution of eel fishery companies in the Netherlands (2005). Home addresses of companies have been grouped in a 10*10 km grid. Within each grid cell, individuals are listed in artificially created rows. Symbols indicate the fishing areas: ▲ Waddensea; ■ IJsselmeer; ⬟ Rivers; ⬢ Zeeland; + Others.

Table NL.a Overview of water surface, number of commercial companies and their annual landings (2004), by fishing area. Estimates in Italics have been broken down by RBD, assuming that catches are proportional to the number of fishing companies.

		Surface	Number of	Estimated landings (t)		Data source
Area	RBD	(km2)	companies	yellow eel	silver eel	
Waddensea	Rhine	2591	25	37	-	EU logbooks
	Ems	38	2	3	-	EU logbooks
IJsselmeer	Rhine	1820	85†	240	40	Auction statistics
Rivers	Rhine	120	21	46	91	Informed guess
	Meuse	60	2	4	9	Informed guess
Zeeland	Meuse	535	43	75	?	(EU logbooks)
	Scheldt	428	0	0		
Others	Rhine	900	56	222	133	Informed guess
	Ems	86	2?	9	5	Informed guess
	Meuse	288	1?	4	2	Informed guess

	Scheldt	67	0		
Sum		6528	237	640	280

† 85 licenses, owned by 68 companies.

NL.C Fishing capacity

Table NL.a lists the number of fishing companies having a specific eel fishing license, by fishing area. Most licenses are linked to a specific ship. For marine waters and Lake IJsselmeer, a register of ships is kept, but for the other waters, no central registration of the ships being used is available. Registration of the number of gears owned or employed is lacking. For Lake IJsselmeer, a maximum number of gears per company is enforced (authenticated tags are attached to individual gears), but the actual usage is often much lower, among others because restrictions apply on the combinations of types of fishing gears (e.g. no fykenets and gillnets should be operated concurrently, because perch and pikeperch are the target species of the gillnetting, although landing perch and pikeperch from fykenets is prohibited).

NL.D Fishing effort

For most of the country, fishing capacity is unknown. In areas where fishing capacity is known, no record is kept of the actual usage of fishing gears. Consequently, no information is available on fishing effort. For Lake IJsselmeer, an estimate of the number of gears actually used is available for the years 1970–1988 (Dekker, 1991). In the mid 1980s, the number of fykenets was capped, and reduced by 40% in 1989. In 1992, the number of eel boxes was counted, and capped. Subsequently, the caps have been lowered further in several steps, the latest being a buy-out in 2006. Because the number of companies has reduced at the same time, the nominal fishing effort per company has not reduced at the same rate, and underutilization of the nominal effort probably still exists. The effort in the longline fishery is not restricted, other than by the number of licenses.

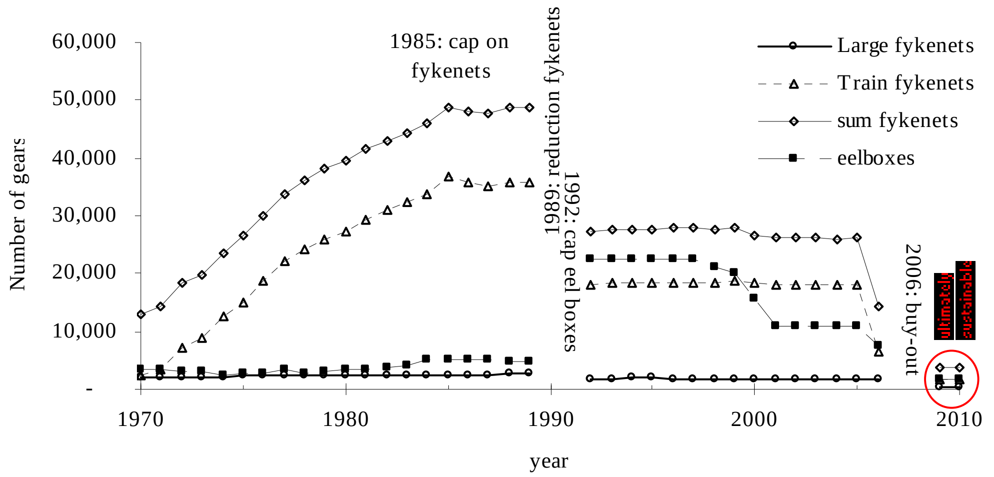


Figure NL.2 Trends in the nominal number of fishing gear employed in the eel fishery on Lake IJsselmeer. Information before 1989 is based on a voluntary inquiry in 1989 (Dekker, 1991); after 1992, the licensed number of gear is shown. The reduction in-between is realistic.

For the years 2009–2010, the maximal effort level that would lead to an ultimate recovery of the eel stock is tentatively indicated.

NL.E Catches and landings; restocking; aquaculture

NL.E.1 Catches and landings, commercial fisheries

NL.E.1.1 Catches and landings from marine waters

Catches and landings in marine waters are registered in EU logbooks, but these do not allow for a break down by RBD. Registrations are available for the years since 1995. Up to 2001, ships with a total length (LOA) ≥15 m were obliged to report all their eel catches, but smaller ones were not; since 2001, ships with a total length ≥10 m are obliged to report their eel catches, if their landings per day exceeded 50 kg per species. That is: in 2001 the number of ships potentially reporting rose, but the actual reporting per ship declined. This change in the regulations was partly driven by changing practices, and vice versa. In practice, the abrupt change in the regulations in 2001 led to a gradually changing reporting practice, before and after 2001. Overall, the number of ships reporting in a year declined from 130 before 2001 to 59 thereafter, although the average landing per ship increased from 230 kg/ship/year before 2001 to 436 kg/ship/year thereafter.

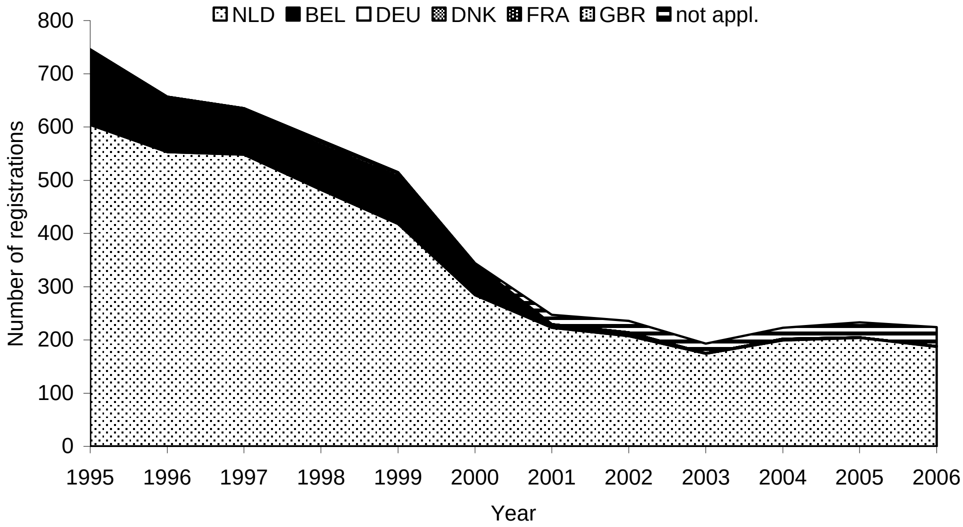


Figure NL.3 Time trend in the number of registered eel landings from marine waters in Dutch harbours by country of origin of the ship.

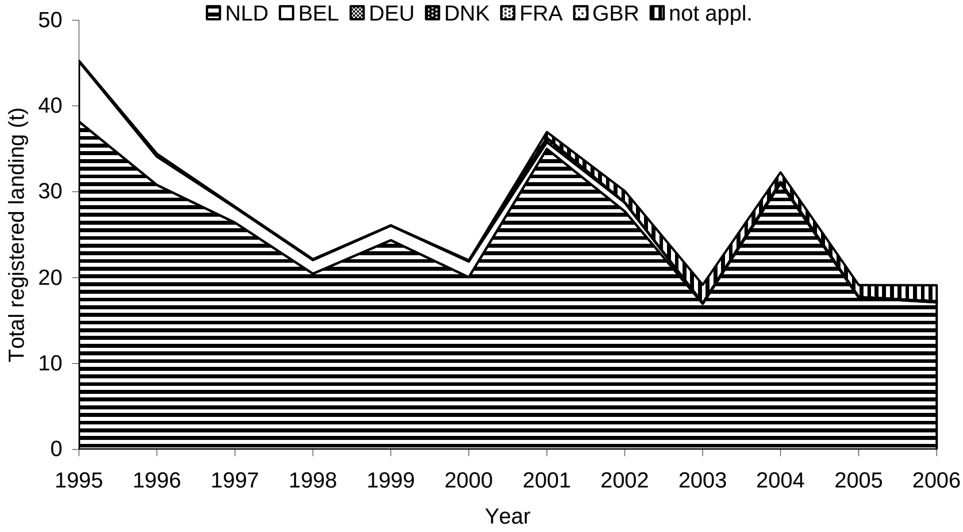


Figure NL.4 Time trend in the total registered landings from marine waters in Dutch harbours by country of origin of the ship.

Nearly 40% of the landings stems from fykenets, recorded as "Miscellaneous gear" or "not applicable". For these fishers, the eel catches is a target species. 50% of the landings stems from bottom trawls (main target is flat fish) and shrimp trawls, for which eels represents a bycatch. The highest monthly catch is recorded from a midwater otter trawl. This concerns a single data record only. It seems likely, that this is a recording error, but over the years there are seven records of (considerable) eel catches from midwater trawls in total.

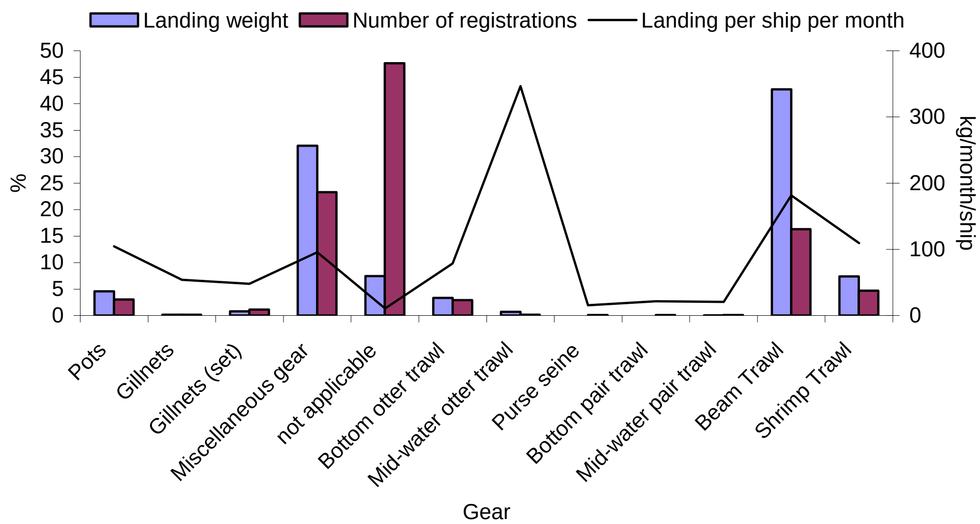


Figure NL.5 Breakdown of eel landings by fishing gear. The categories "Miscellaneous gear" and "not applicable" presumably represent fykenet catches.

The available dataset has a temporal resolution of month and year. Consequently, the effect of the change in daily exemptions in 2001 can not be analysed in full detail. Figure NL.7 shows the cumulative frequency distribution of monthly catches per ship by year. Monthly landings per ship range from 1 kg to just over 6 tons per ship per month. Despite the exemption for daily catches below 50 kg in 2001, the landing per ship per month declines over the years. Median registered landings per ship per month were 1124 kg before 2001 and 344 kg thereafter, corresponding to an average daily landing of 56 resp. 17 kg. Strict application of the exemption (obligation to report landings of 50 kg per species per day, corresponding to 1000 kg/month) would result in loss of information on 50% of the registered landings in the years before 2001, and 80% thereafter (and more than that of the total landings, registered and unregistered), and all information would be lost in the two most recent years.

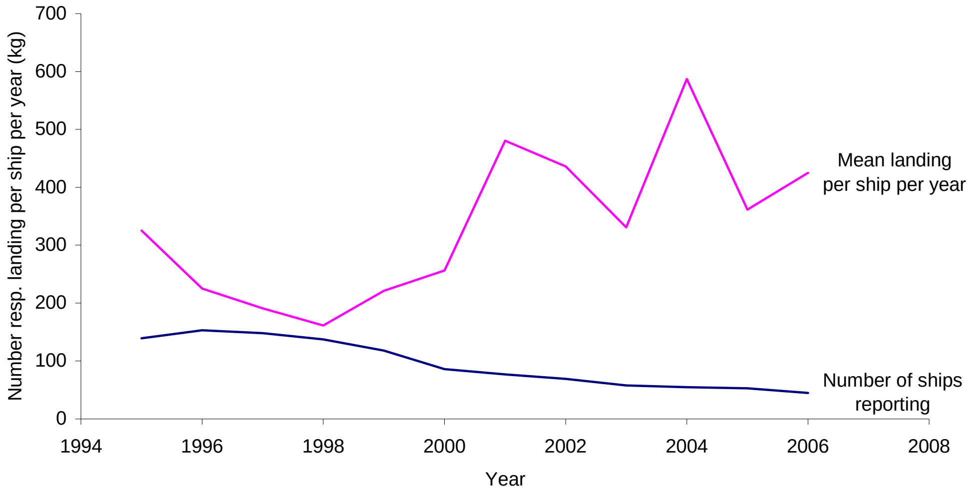


Figure NL.6 Time trend in the number of ships reporting, and the average reported landing per ship per year.

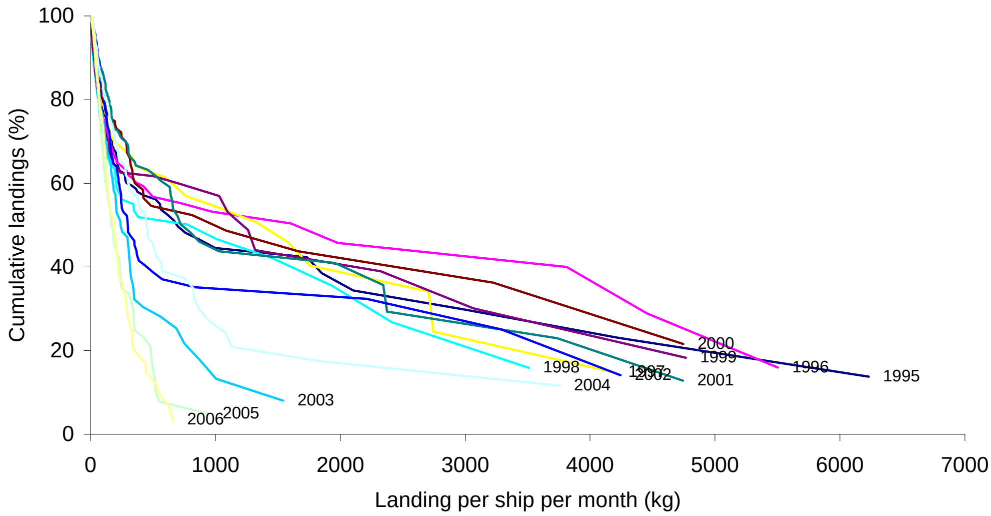
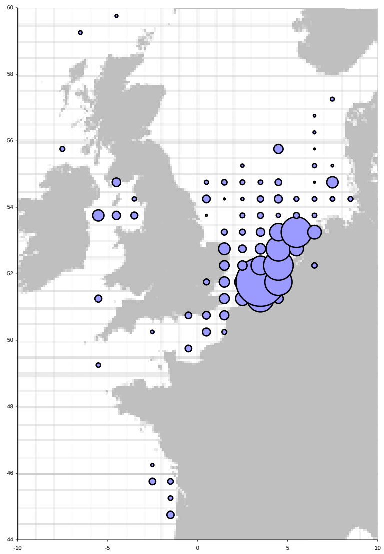


Figure NL.7 Cumulative frequency distribution of the landings per ship per month and year.

Recorded landings of eel from marine waters in Dutch harbours are coming from fishing areas along the Dutch coast, from the Irish Sea, north of Scotland, the English Channel, the Bay of Biscay, the German Bight and the southern North Sea. The major part of the landings (96%) comes from Dutch coastal areas, predominantly the Wadden Sea and the Zeeland area. Over the years, the dominance of Zeeland landings increases.



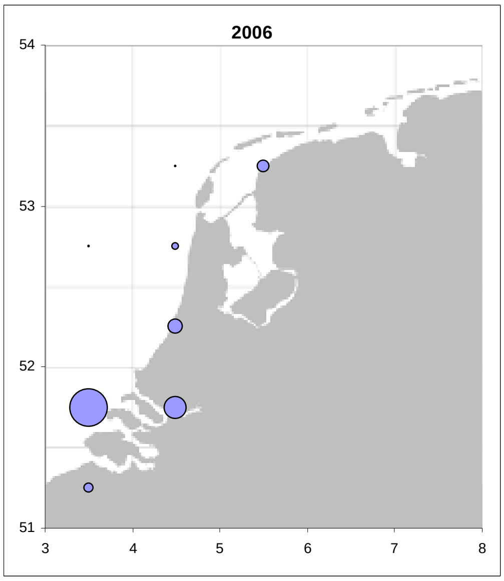


Figure NL.8 Spatial distribution of registered eel landings from marine waters in Dutch harbours. The area of each symbol depicts the square root of the landings per ICES rectangle, summed over the available data years (the radius thus corresponds to the fourth root of the landings).

Figure NL.9 Spatial distribution of registered eel landings in ICES rectangles adjacent to the Dutch coast (96% of the total). The area of each symbol is proportional to the landings (the radius to the second root of the landings).

A preliminary estimate of recreational catches in marine waters is presented in Table NL.c, below.

NL.E.1.2 Catches and landings from Lake IJsselmeer

For Lake IJsselmeer, statistics from the auctions around Lake IJsselmeer are now kept by the Fish Board (Table NL.b); before 1994, the government kept statistics. These statistics are broken down by species, month, harbour and main fishing gear; the quality of this information has deteriorated considerably over the past decade, as a consequence of misclassification of catches, and the trading of eel from other areas at the IJsselmeer auctions.

Table NL.b Landings in tons per year, from the auctions around Lake IJsselmeer, Rhine RBD. Only landings recorded at the auctions are included; other landings are assumed to represent a minor and constant fraction. Figures in italics are suspect, as a consequence of misclassification of catches and trade from areas outside Lake IJsselmeer at the IJsselmeer auctions.

DECADE YEAR	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
0	324	620	1157	838	3205	4152	2999	1112	641	472	368
1	387	988	989	941	4563	3661	2460	853	701	573	381
2	514	720	900	1048	3464	3979	1443	857	820	548	353
3	564	679	742	2125	1021	3107	1618	823	914	293	279
4	586	921	846	2688	1845	2085	2068	841	681	330	245

5	415	1285	965	1907	2668	1651	2309	1000	666	354	234
6	406	973	879	2405	3492	1817	2339	1172	729	301	230
7	526	1280	763	3595	4502	2510	2484	783	512	285	130
8	453	1111	877	2588	4750	2677	2222	719	437	323	
9	516	1026	1033	2108	3873	3412	2241	510	525	332	

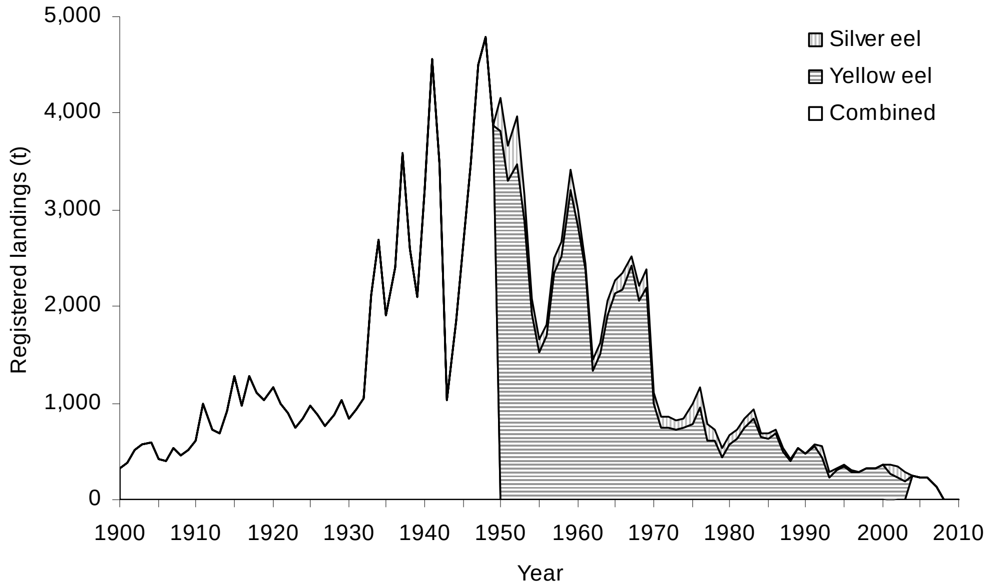


Figure NL.10 Time trend in the landings from Lake IJsselmeer.

NL.E.1.3 Catches and landings from inland waters outside Lake IJsselmeer

For the inland areas outside Lake IJsselmeer, no detailed records of catches and landings are available. Dekker, 1998 gave a rough estimate, which was subsequently refined on the basis of new information, and personal communication with individual fishers and their organizations. The resulting figures (Table NL.a) probably give a reasonable estimate of the actual landings, but obviously do not allow for an analysis of time-trends. Overall, only one-third of the total landings are accurately documented.

NL.E.2 Catches and landings, recreational fisheries

Recreational catches of eel are not systematically recorded, and the order of magnitude is not well known. Inquiries related to angler licensing indicate that 350 000 out of 913 000 male anglers fish for eels (in 2003); 57 500 of them take eels back home, in an average annual quantity of 18 specimens, approx. 1 kg per capita per annum. The number of female anglers is much lower, but not exactly reported. The total quantity of eels taken home has recently been analysed (Vriese, Klein Breteler, Kroes and Spierts, 2008), coming to an order of magnitude of 200–400 t per annum. Circumstantial evidence indicates that the true figure is probably close to the lower bound of 200 t.

Additionally, some 1000 individuals are licensed for recreational use of 2 fykenets per license in coastal waters. Assuming 50 fishing days per year, and a daily catch of 0.5 kg per fyke, their catch will be in the order of 25 t.

A preliminary breakdown of catches by the type of fishers is given in Table NL.c.

Table NL.c Breakdown of commercial and recreational fishing and landings by the type of fisher. Data from Vriese *et al*., 2008; Dekker *et al*., 2008 and guestimates.

	Individual catch kg/year	Number of individuals	Total catch tonne/year
Full time commercial	7700	100	770
Part time commercial	1000	150	150
Poaching	?	?	?
Recreational (small fykes)	25	1000	25
Snigglers†	2.650	3773	10
Eel anglers	0.863	95 000	82
Other anglers	0.100	1 000 000	100
Non-anglers		15 898 977	
Totals		17 000 000	> 1,227

† Translation: sniggle=peur.

In summer 2008, the prime organization of recreational fishers (Sport Visserij Nederland) has announced a voluntary ban on eel landing from 2009 onwards. According to this decision, no eel should be taken, though catch-and-return will remain allowed. This is a voluntary restriction, not translated into law.

NL.E.3 Restocking

Glass eel and young yellow eel are used for re-stocking inland waters since time immemorial, mostly by local action of stakeholders. Although a minimum legal size for capture, holding and transport of eels is set in a byelaw, the existing practice of short-range transports has never been prosecuted. Since World War II, the Organisation for the Improvement of Inland Fisheries OVB has organized a re-stocking programme, importing glass eels from France and England, and buying yellow eel from commercial fishers fishing in the Waddensea.

Data on re-stocking quantities are listed in table NL.c.

In recent years, the OVB has merged with the major anglers organization, and subsequently handed over the glass eel importing to the Organisation of Professional Fishermen CvB. Information on recent glass eel imports was made available by the CvB. Restocking of young eel is no longer organized centrally, although trade of small eels (undersized) still occurs. The listed estimates are probably a minimum, not including unregistered trade. Because the government does not keep track of imports and re-stockings anymore, it is not known anymore whether re-stocking has been practised by other parties.

In the earlier decades, young yellow eels were derived from fisheries for wild eel in the Wadden Sea; in recent years, the catches in the Wadden Sea have dropped to almost nothing, and young yellow eels are derived from the aquaculture industry, i.e. eels derived from imported glass eel (England, France).

Table NL.c Re-stocking of glass eel and young yellow eel in the Netherlands, in millions re-stocked†.

DECADE	1940		1950		1960		1970		1980		1990		2000	
Year	Glass eel	young yellow eel	glass eel	young yellow eel	glass eel	young yellow eel	glass eel	young yellow eel	glass eel	young yellow eel	glass eel	young yellow eel	glass eel	young yellow eel
0			5.1	1.6	21.1	0.4	19.0	0.2	24.8	1.0	6.1	0.0	2.8	1.0
1			10.2	1.3	21.0	0.6	17.0	0.3	22.3	0.7	1.9	0.0	0.9	0.1
2			16.9	1.2	19.8	0.4	16.1	0.4	17.2	0.7	3.5	0.0	1.6	0.1
3			21.9	0.8	23.2	0.1	13.6	0.5	14.1	0.7	3.8	0.2	1.6	0.1
4			10.5	0.7	20.0	0.3	24.4	0.5	16.6	0.7	6.2	0.0	0.3	0.1
5			16.5	0.9	22.5	0.5	14.4	0.5	11.8	0.8	4.8	0.0	0.1	0
6	7.3		23.1	0.7	8.9	1.1	18.0	0.5	10.5	0.7	1.8	0.2	0.582	0
7	7.6	1.6	19.0	0.8	6.9	1.2	25.8	0.6	7.9	0.4	2.3	0.4	0.216	0
8	1.9	2.0	16.9	0.8	17.0	1.0	27.7	0.8	8.4	0.3	2.5	0.6	0	0.230
9	10.5	1.4	20.1	0.7	2.7	0.0	30.6	0.8	6.8	0.1	2.9	1.2		

†Conversion from weight into numbers: it was assumed that there are 3000 glass eels per kg, resp. 30 young yellow eels per kg.

NL.E.4 Aquaculture

Different sources reported slightly diverging results for the Dutch aquaculture industry (Table NL.d).

Table NL.d Aquaculture production in the Netherlands, as reported by different sources.

Aquaculture production (tons/year)	Data source			
	FEAP	wgeel2003	FAO Fishstat	Nevevi
1985		20	20	
1986		100	100	
1987		200	200	100
1988		200	200	300
1989		350	350	200
1990		550	500	600
1991		520	550	900
1992		1250	520	1100
1993		1487	1250	1300
1994		1535	1487	1450
1995		2800	1535	1540
1996	1800	2443	2800	2800
1997	1800	3250	2443	2450
1998	3250	3800	2634	3250
1999	3800	4000	3228	3500
2000	4000	3800	3700	3800
2001	4000	3228	4000	4000
2002	4000		3868	4000
2003			4200	4200
2004			4500	4500
2005			4000	4500
2006				4200
2007				4000
2008				?? 3600

Nevevi is the national organization of fish farmers; one would expect their own estimates to be the best.

NL.F Catch per unit of effort

Data on catch per unit of effort are only available within the framework of a stock monitoring programme in State controlled waters. Starting in 1993, the fish assemblage in the main rivers and linked waters (see Figure NL.11) has been monitored, by means of logbook registration of commercial catch and bycatch, in a restricted number of fykenets (four large fykenets or two pairs of summer fykenets per location), mostly on a weekly basis. For eel, the number of yellow eels and silver eels caught is recorded. Results demonstrate a slowly declining trend over the years, but the year-to-year and site-to-site variation is considerable. There is no formal application of these data in eel fisheries management, but the results have frequently been quoted in the debate on the status of the eel stock.

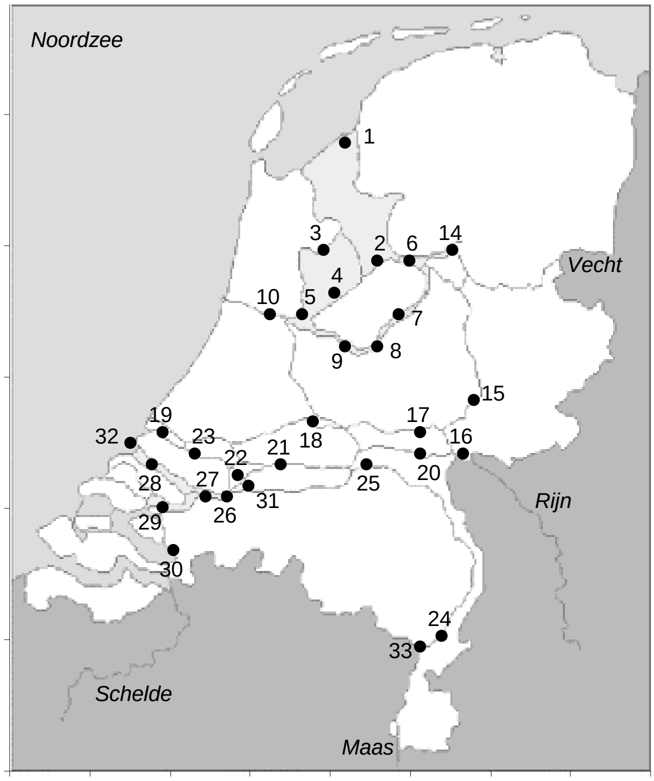


Figure NL.11 Sampling sites for the four fyke monitoring of commercial catches and bycatch.

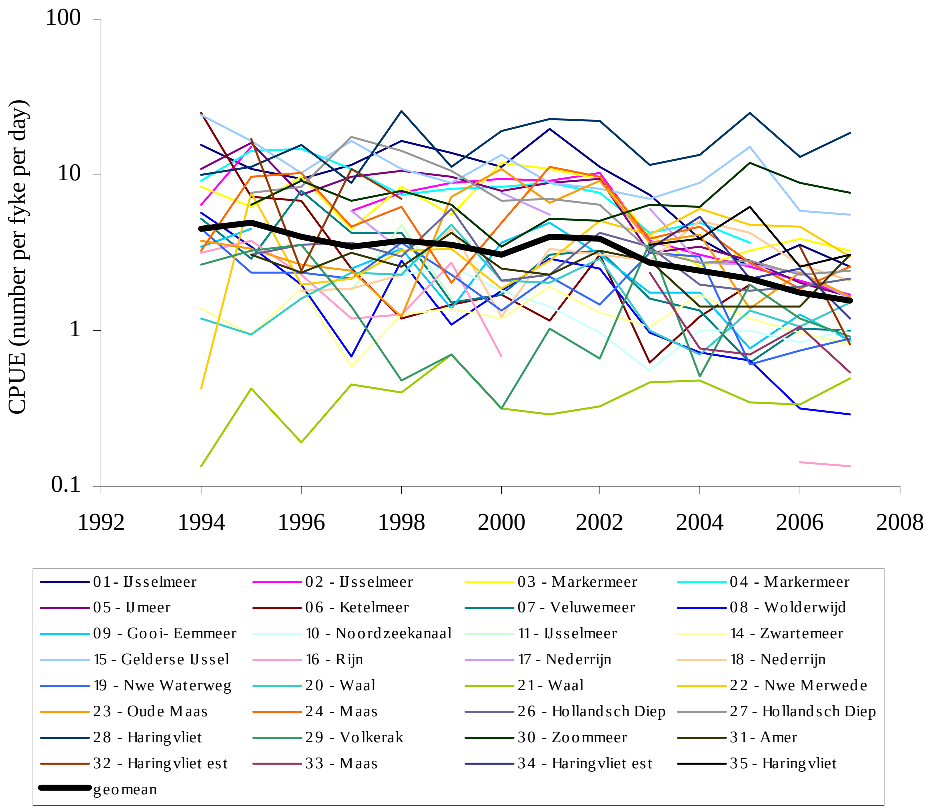


Figure NL.12 Time trends in the four fyke monitoring of commercial eel catches per sampling site. The geometric mean has been calculated for the available data in each year.

NL.G Scientific surveys of the stock

NL.G.1 Recruitment surveys

Recruitment of glass eel in Dutch waters is monitored at Den Oever and 11 other sites along the coast (see Dekker, 2002 for a full description).

2008 is the lowest season on record, though 2006 was just a bit more. Immigration in 2008 started a bit earlier than on average, and ended early May; the season was definitely not as early as the poor 2006 season. The glass eels had a low total length, in the same order as in recent years (Figure NL.14).

The data at the other sites (Figure NL.15) confirm the overall trend, though individual series may deviate.

Table NL.f Number of glass eel caught per lift net haul in Den Oever. All observations in a year have been corrected for time of day and month of sampling, and averaged.

DECADE YEAR	1930	1940	1950	1960	1970	1980	1990	2000
0		17.36	8.34	29.45	53.67	37.73	4.63	2.10
1		15.19	17.11	50.54	23.78	31.72	1.40	0.70
2		24.50	109.68	117.95	42.56	20.00	3.76	1.38
3		16.05	17.88	168.81	30.35	13.36	3.75	1.87
4		46.93	26.85	52.73	35.51	17.91	6.12	1.88

5		19.05	37.12	109.57	46.09	18.61	8.50	1.02
6		7.73	9.76	26.35	37.66	19.70	9.65	0.43
7		7.60	21.71	40.16	84.32	7.65	15.46	1.35
8	20.62	6.55	70.90	27.47	53.54	5.62	2.77	0.36
9	46.29	6.46	38.83	23.59	74.46	3.90	4.10	

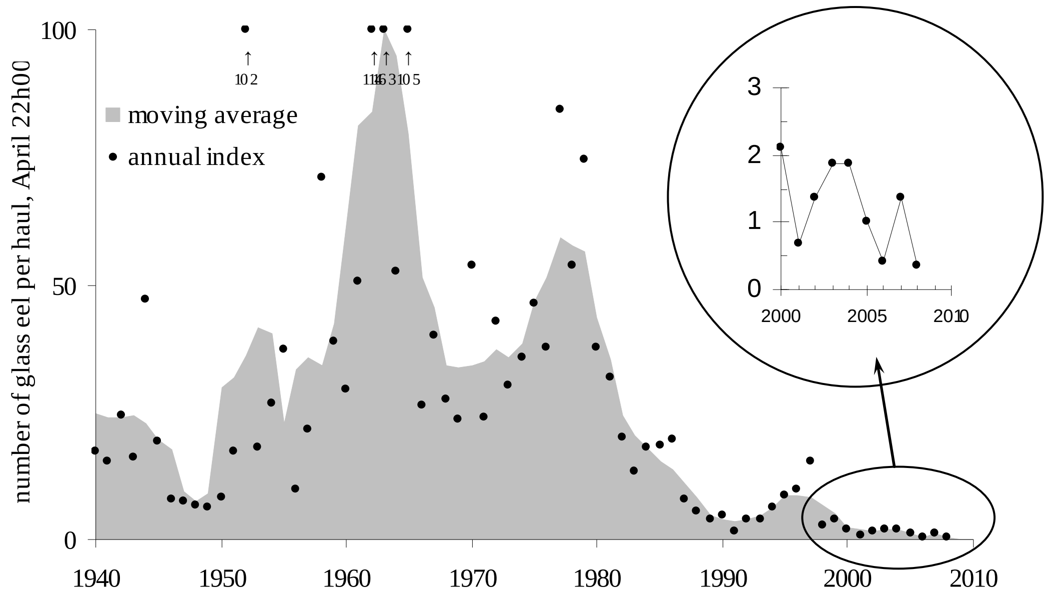


Figure NL.13 Time trend in the glass eel survey at Den Oever.

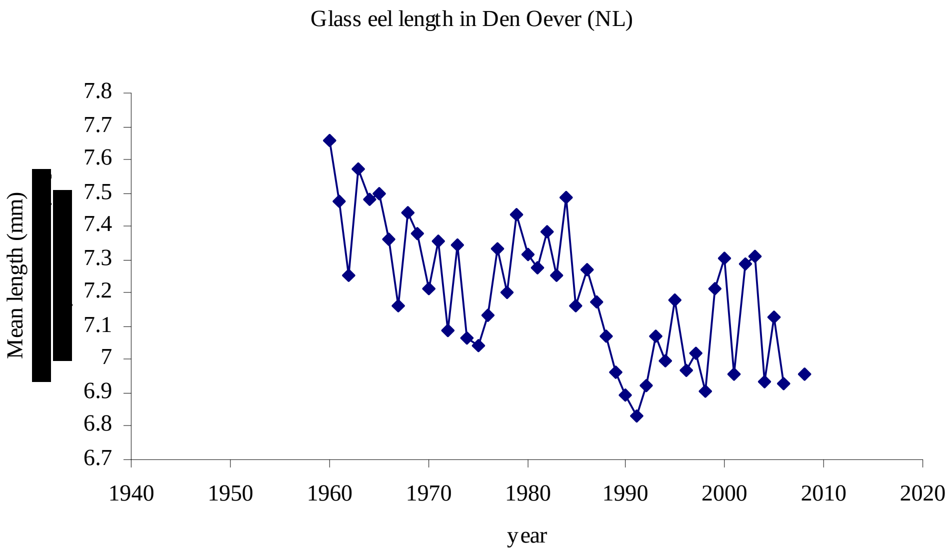


Figure NL.14 Time trend of the length of the glass eel sampled in Den Oever. The measurements have been corrected for the date of sampling within the season, and for the average timing of each season within each year. (Data for 2006 currently unavailable).

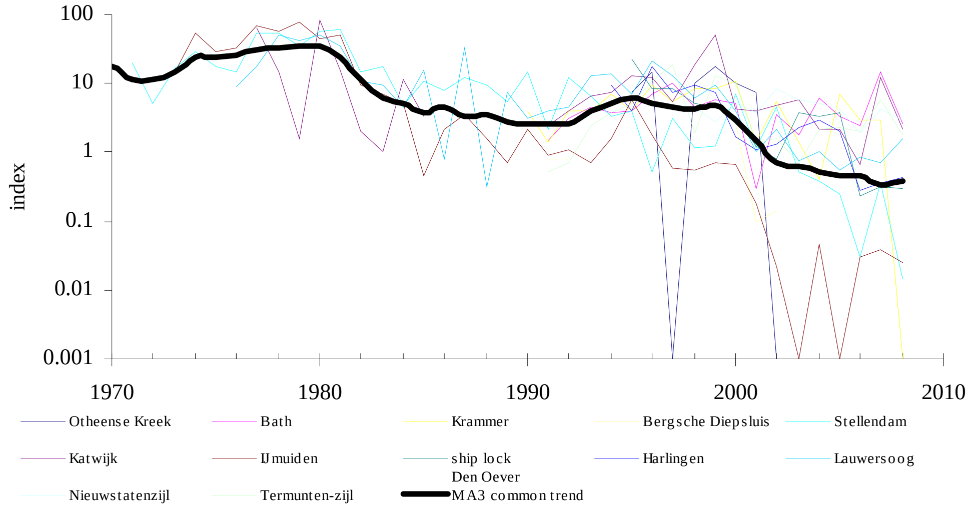


Figure NL.15 Long-term trends in the glass eel catches in the experimental fisheries at various places along the Dutch coast.

Table NL.g Annual indices of glass eel recruitment at places in the Netherlands, other than Den Oever. Annual indices are expressed as the mean catch per lift net haul, at whatever time in the night. Most hauls are made in the evening, just in the dark.

	Otheense Kreek	Bath	Krammer	Bergsche Diepsluis	Stellendam	Katwijk	IJmuiden	ship lock Den Oever	Harlingen	Lauwersoog	Nieuwstatenzijl	Termunten-zijl
Year / RBD	Scheldt	Scheldt	Meuse	Meuse	Meuse	Rhine	Rhine	Rhine	Rhine	Rhine	Ems	Ems
1969							47.30					
1970							31.50					
1971					15.40							
1972					4.10							
1973					13.10		32.80					
1974					22.80		119.30					
1975					13.90		66.80					
1976					11.30		73.10			14.40		
1977					42.10	130.25	159.20			28.40		
1978					42.10	30.23	131.70			83.90		
1979					27.30	3.23	176.00			66.20		
1980					45.10	171.60	101.50			80.30		
1981					47.30	31.65	113.90			55.10		
1982					11.30	4.13	20.80			17.40		
1983					14.30	2.10	15.60			15.10		
1984					3.80	23.62	11.40			7.10		
1985					8.70	6.67	1.00			25.20		
1986					6.40		4.70			1.30		
1987					9.80	14.00	7.70			52.00		
1988					7.60		3.50			0.50		
1989					4.40	3.67	1.60			12.10		
1990			0.30		11.30		4.70			5.00		
1991		5.90	0.10	1.41	1.70	5.10	2.00			6.30		0.30
1992		12.30	0.30	1.38	9.90	8.20	2.50		14.80	7.30		0.40
1993		17.50	0.30		5.20	13.50	1.60			20.80		1.40
1994		14.60	0.50	7.94	2.70	15.10	3.60		16.00	22.50		2.20
1995	0.50	15.70	0.30		3.20	27.10	13.10	27.80	6.80	11.60		3.00
1996	1.00	26.80	0.70		0.40	25.40	4.00	10.20	29.70	34.40	24.00	6.00
1997	0.00	40.40	0.40	33.33	2.50	10.90	1.30	10.20	12.40	20.90	21.00	10.60
1998	0.70	18.30	0.60		0.90	38.80	1.20	6.50	15.40	9.90	19.90	1.10
1999	1.20	23.10	0.60		1.00	101.30	1.60	5.60	12.70	15.10	11.80	7.50
2000	0.70	20.10	0.80	4.36	5.60	8.80	1.50	4.00	2.80	6.60	23.30	5.70
2001	0.50	(1.2†)	0.10	0.17	0.90	8.10	0.40	1.50	1.80	1.70	16.10	0.80
2002	0.00	13.60	0.40	0.25	3.70	9.80	0.05	1.00	2.20	3.40	35.30	0.90
2003	0.00	7.00	0.10		0.40	11.80	0.00	4.70	3.80	1.20	25.50	0.40
2004	0.00	(24.9†)	0.03		0.30	4.50	0.11	4.10	(4.9†)	1.70	21.70	1.20
2005	0.00	13.40	0.50		0.20	4.40	0.00	4.60	3.30	0.90	18.20	1.30
2006	0.00	9.70	0.21		0.02	1.33	0.07	0.28	0.48	1.39	8.33	1.13
2007‡	0.00	55.86	0.22		0.29	24.77	0.09	0.38	0.59	1.13	18.11	3.26
2008	0.00	10.49	0.00	3.91	0.01	4.31	0.06	0.38	0.71	2.54	12.36	1.00

†Sampling only took place in part of the season.

‡ Very early season (warm spring), sampling stopped early (start of May) --> low number of empty samples.

NL.G.2 Yellow eel stock surveys

NL.G.2.1 Yellow eel stock surveys in Lake IJsselmeer

Figure NL.16 presents the trends in cpue for the yellow eel surveys in Lake IJsselmeer, using the electrified trawl. The long-term trend in this survey has been analysed by Dekker, 2004a, in a wider setting, using more sources of information. In that long-term analysis, a smooth function over the years was fitted to the data. Figure NL.16 presents the raw data per year.

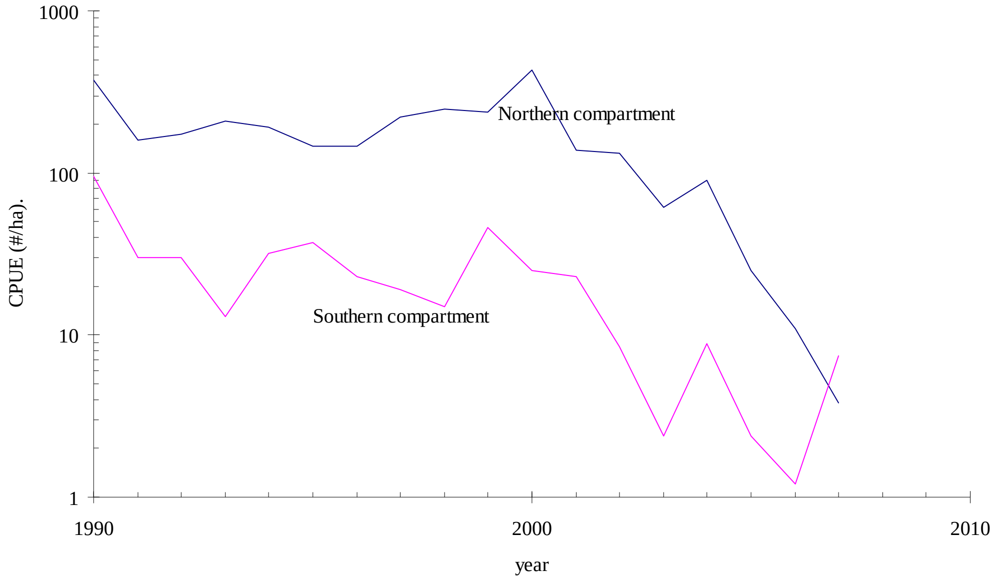


Figure NL.16 Cpue trends in Lake IJsselmeer stock surveys, in number per hectare swept-area, using the electrified trawl. Note: The northern and southern compartments are separated by a dyke.

NL.G.2.2 Yellow eel stock surveys in the Main Rivers

Figure NL.17 presents the trends in the Main Rivers survey, for the common trawl and the hand-held electric dipnet, for the main stream, the shore area, and the oxbow and other adjacent waters separately. None of these series demonstrates a clear upward or downward trend.

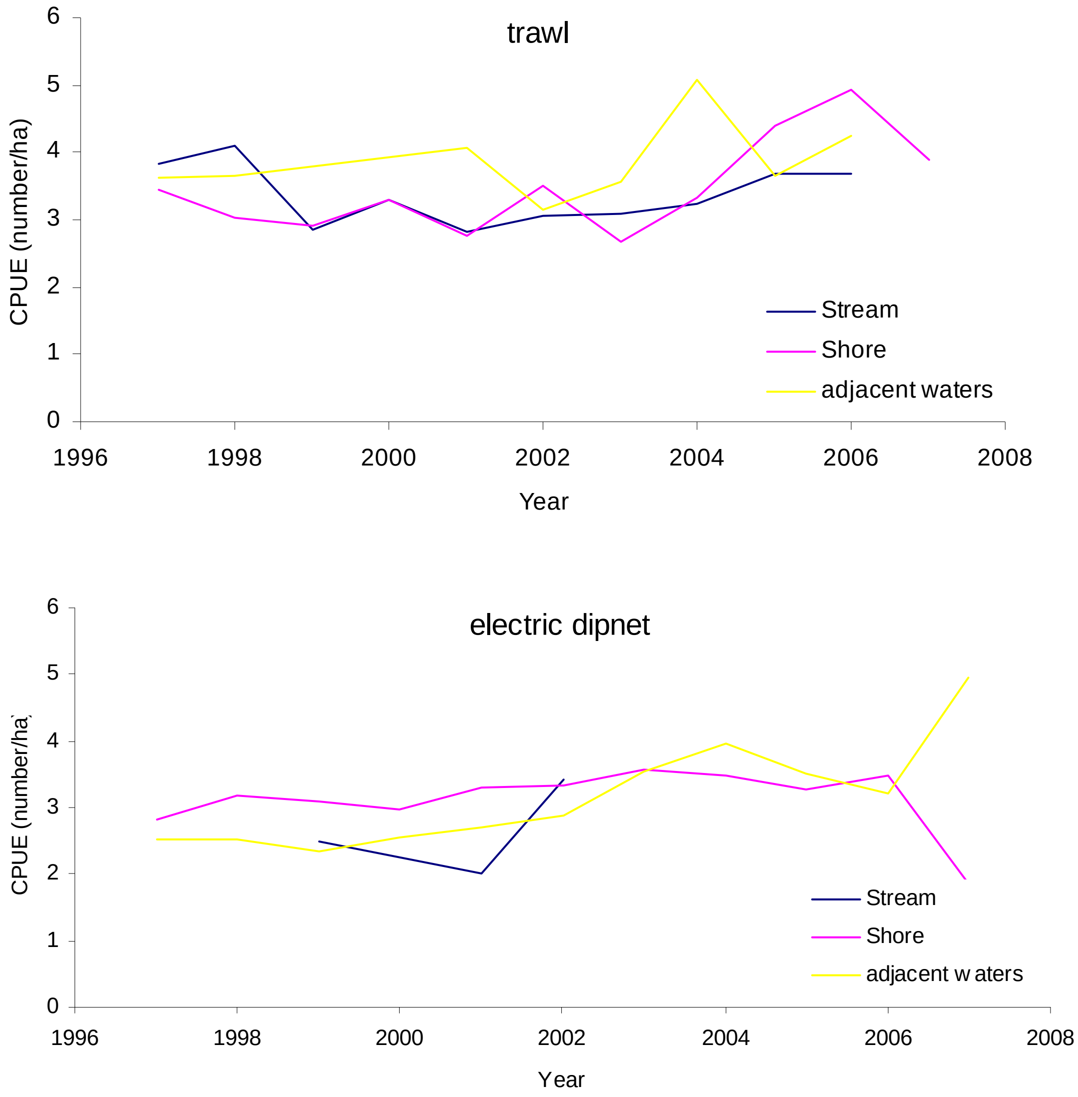


Figure NL.17 Trends in cpue in numbers per hectare, for the trawl (top) and electric dipnet (bottom), in the Main River surveys.

NL.G.2.3 Yellow eel stock surveys in coastal waters

The number of eels caught in coastal surveys (Dutch Young Fish Survey) is presented in Figure NL.18. Until the mid-1980s, considerable catches of eel were observed. Since that time, a gradual decrease is observed.

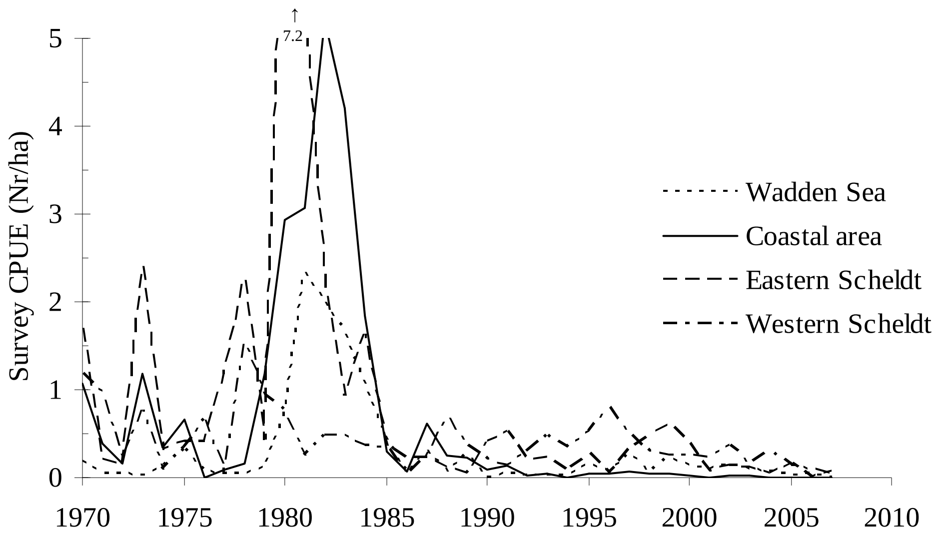


Figure NL.18 Trends in coastal survey cpue. Most of the Wadden Sea belongs to RBD Rhine; Eastern Scheldt is mixed Scheldt and Meuse; Western Scheldt belongs to RBD Scheldt (with an extra inflow from Meuse), Coastal area belongs to RBD Rhine.

Overall, the yellow eel surveys are not representative for the whole River Basin Districts or the Country, especially because the smaller water bodies (canals, polders, regional lakes) are not surveyed; these waters cover nearly 25% of the total water surface, but probably constitute the preferred eel habitat. Lake IJsselmeer is extremely overexploited; although fisheries in the remainder of the country are less severe, resulting in larger average sizes being exploited. The Main Rivers Surveys are probably reasonably representative for the rivers. However, Lake IJsselmeer and the Main Rivers differ substantially, and it is not quite clear how the two should be weighted, and how the uncovered waters relate.

NL.G.3 Silver eel surveys

There are no routine surveys for silver eel in the Netherlands.

In 2004–2007, the German states North Rhine-Westphalia and Rhineland-Palatinate, and the Netherlands have executed a silver eel tagging study in the Rhine, in order to:

- quantify the female part of the whole downstream migrating Rhine silver eel population independently from fisheries,
- determine the relevance of the different migration routes of these female migrants in the Lower Rhine, the mortalities during downstream migration and the escapement to the sea.

Results have been reported in

Klein Breteler, J., Vriese, T., Borcherding, J., Breukelaar, A., Jørgensen, L., Staas, S., de Laak, G., and Ingendahl, D. 2007. Assessment of population size and migration routes of silver eel in the River Rhine based on a 2-year combined mark-recapture and telemetry study. ICES Journal of Marine Science, 64: 1–7.

NL.H Catch composition by age and length

NL.H.1 Long term trends in length compositions

For Lake IJsselmeer, the landings are regularly sampled at the auctions. Results have indicated extreme overfishing. Because the catch composition did not change much over the years (see Figure NL.27), results have not been reported in detail for the past years.

In most recent years, length frequency distributions of commercial catches from Lake IJsselmeer have revealed a remarkable shift upwards (Figure NL.19). This shift is observed consistently in all gears, and in several years in a row. This upward shift might be the result of the effort reductions in 2005, of the further decline in recruitment since 2000 now progressing into the commercial sizes (corresponding to a sharp drop in commercial yield now observed), or of increased dependence on eels from other habitats (outside Lake IJsselmeer and/or hitherto unexploited habitats, such as dykes), which are less overexploited.

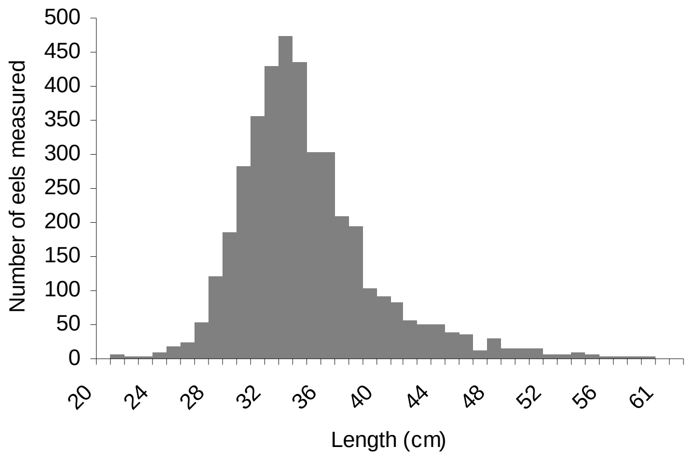


Figure NL.19 Length frequency of fykenet catches in Lake IJsselmeer, in 2006.

NL.I Other biological sampling

NL.I.1 Length and weight and growth (DCR)

For Lake IJsselmeer, the market sampling described under NL.H comprises measurements of length, weight, sex, maturity, liver weight, stomach content weight, parasitism (*Anguillicola crassus*), and otolith collection; see under NL.H. In addition to the market sampling, an annual sample of 100 specimens is collected during autumn stock survey on Lake IJsselmeer; see NL.G.2. This survey sampling conforms to the protocol for market samples (NL.H). For market and survey samples, otoliths are collected and stored dry, but no age reading is performed.

For all other areas, no biological sampling of catches is performed.

NL.I.2 Parasites

The market sampling for Lake IJsselmeer collects information on the percentage of eels demonstrating *Anguillicola* infection (Figure NL.11, based on inspection of the swimbladder by the naked eye). Following the initial break-out in the late 1980s, infection rates have stabilized between 40 and 60%, while the number of parasites per infected eel fluctuates between 4 and 6. In recent years, the infection rate and the parasite burden are slightly decreasing.

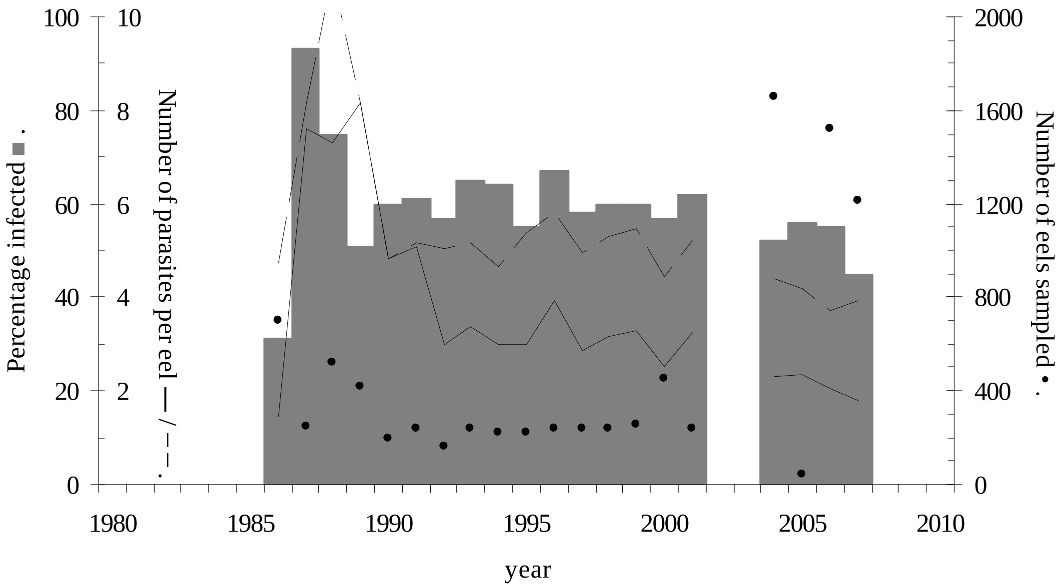


Figure NL.20 Trend in *Anguillicola* infections in Lake IJsselmeer eel.

NL.I.3 Contaminants

For a recent overview of contamination in eel in the Netherlands, see Hoek-Nieuwenhuizen and Kotterman, 2007 and Hoogenboom *et al.*, 2007.

Nl.I.3.1 Spatial pattern

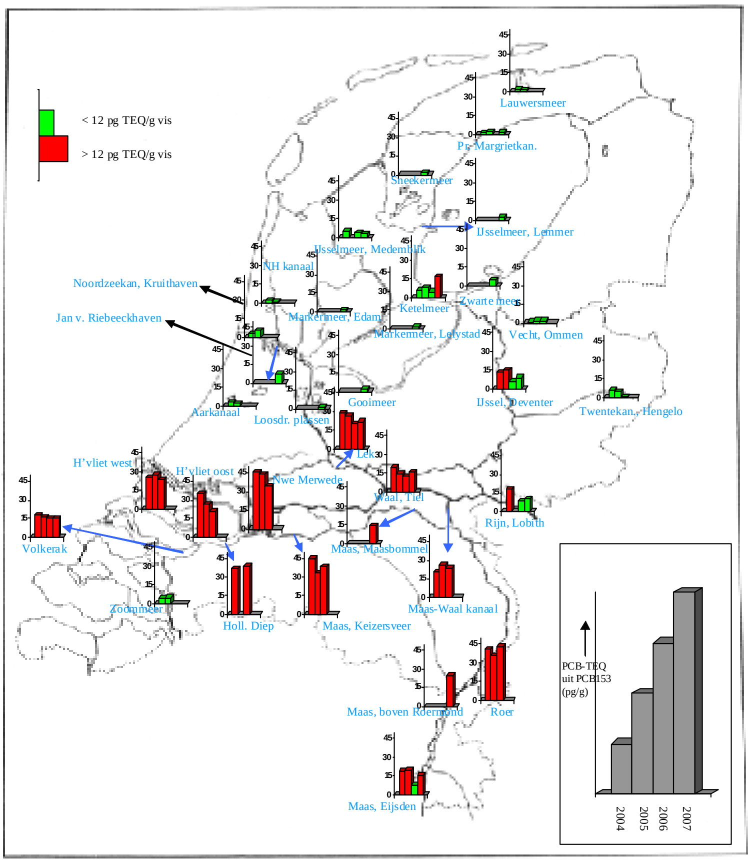


Figure NL.21 Temporal trend in PCB in eel (from Kotterman, 2007).

NL.I.3.2 Temporal trend

The temporal trend differs substantially between sampling locations, but overall a decline is observed. Figure NL.22 shows the trend in eels derived from Lake IJsselmeer.

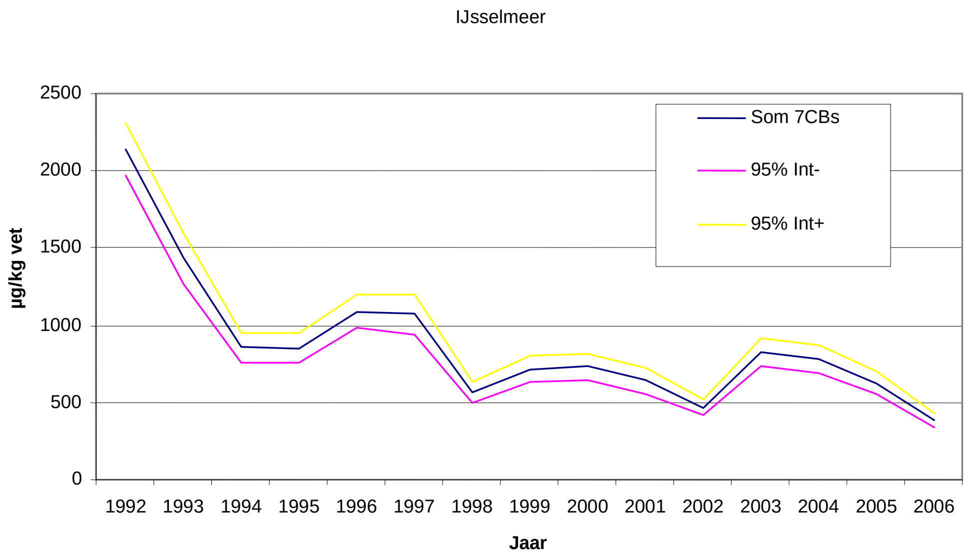


Figure NL.22 Temporal trend in PCB in eel (from Kotterman, 2007).

NL.I.4 Predators

Predation of eel by cormorants (*Phalacrocorax carbo*) is much disputed among eel fishers and bird protectionists. The number of cormorant breeding pairs increased rapidly until the early 1990s, then stabilized (Figure NL.23), remaining stable in recent years. For Lake IJsselmeer, food consumption has been well quantified (van Rijn and van Eerden, 2001; van Rijn, 2004); eel constitutes a minor fraction here. In other waters, neither the abundance, nor the food consumption is accurately known, but predation on eel appears to be a bigger issue here.

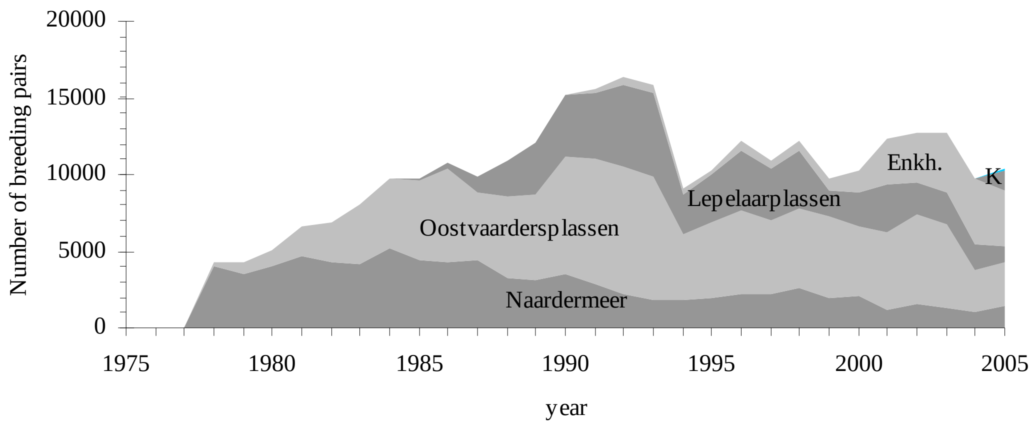


Figure NL.23 Trend in the number of breeding cormorants around Lake IJsselmeer, by breeding place. The breeding places are ordered from south (bottom) to north (top). Enkh=Enkhuizer Zand (de Ven), K=Kreupel.

NL.J Other sampling

NL.K Stock assessment

The basic results of the monitoring programmes in Lake IJsselmeer and the main rivers, the landings statistics and age-and-length sampling of the catch in Lake IJsselmeer are reported to the Ministry of Fisheries in annual status reports; salient details are published in the fishing press.

Dekker, 1996, 2000c developed a VPA-type assessment model for the eel fisheries on Lake IJsselmeer. This model has been applied to data from Lough Derg (Ireland) in the context of FP6-project 022488 SLIME (Dekker *et al*., 2006).

Growth in eel demonstrates considerable inter-individual variation; individual year classes overlap almost completely in length. Additionally, fisheries, predation mortality (cormorants) and silvering are length-, rather than age-specific. The traditional age-structure of the VPA was therefore replaced by a length-structuring; a length-length transition matrix then replaces the conventional ageing process. Unfortunately, the retrospective application of this deterministic model yielded numerically unstable results (small glitches in the data causing huge shifts in outcome). Dekker, 2004a replaced the deterministic model by a statistical analysis, and included landings and catch-composition data as well as stock survey data. Although this cleared the numerical instability problem, results no longer match the status of the stock in individual years precisely, but reflect the overall trend over the years.

Initial assessment of the status of Lake IJsselmeer eel fishery indicated extremely severe overexploitation ($F \approx 1.0$; Dekker, 1996, 2004a). A 50% reduction in the nominal fishing effort in 1989 resulted in an effective drop in fishing mortality of only 25%. Although assessments were still available, further effort reductions in the 1990s have only loosely been related to monitoring and catch sampling results. In the mid-1990s, the quality of the landing statistics deteriorated, following the transfer of the registration from the Ministry of Fisheries to the Fish Board. Subsequently, the annual assessments have been discontinued. The latest formal management advice dates back to 2000 (an 80% reduction in fishing effort is required to obtain the maximal sustainable yield). Current fishing effort is in the order of 50% of that in 2000, and thus still well above the level of maximum sustainable yield. However, Dekker *et al*., 2008 indicated that the fishing level F_{max} establishing the maximum sustainable yield MSY, is above the level at which the eel stock can be expected to recover (that is: F_{max} still establishes recruitment overfishing): only a further reduction in effort will be in accordance with the EU Eel Regulation. A preliminary estimate of the maximum acceptable effort is indicated in Figure NL.2, for the years 2009–2010.

NL.L Sampling intensity and precision

NL.L.1.1 Recruitment surveys

The glass eel survey at Den Oever collects between 200 and 500 hauls per year. The statistical properties of these data have been analysed by Dekker, 1998, 2004c, including the relation to environmental influences and sampling conditions. Above all, the relation between precision and (expected) mean catch determines the overall precision of the individual observations. Additionally, the number of observations per year is among others determined by the average catch: after several weeks without any glass eel, the motivation to continue sampling obviously declines, and the sampling programme is then closed. A lower precision of individual observations in combination with a smaller number of observations per year, results in a drastically expanded confidence limits of the annual mean.

(Since 2004, the sampling is no longer done by sluice personnel while on duty, but by people specifically hired for the job. They replaced the two-hourly sampling by hourly sampling, but did not extend the sampling season).

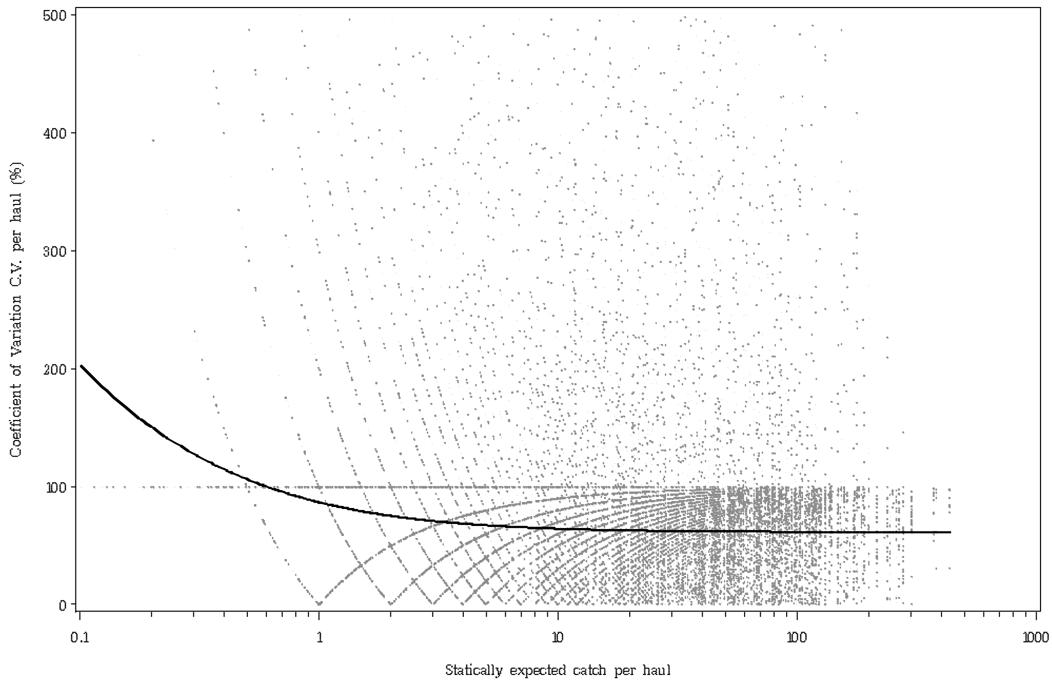


Figure NL.24 Relation between the statistically expected catch (horizontal) and the coefficient of variation (vertical) for the glass eel sampling at Den Oever. The dots represent the individual observations (one haul at a specific hour at a specific day), the line the functional relationship between residual and expectation (Var ∞ mean^2+mean). Because the number of glass eels caught is an integer number (0, 1, 2, etc.), observations with 1½ or 2⅜ glass eels are lacking. Consequently, all observations of exactly 1 glass eel form a conspicuous V-shaped line (hitting the x-axis at 1), and all observations of exactly 2 glass eels too (hitting the x-axis at 2), etc. with no observations in between. The zero observations are on the horizontal line at CV=100%.

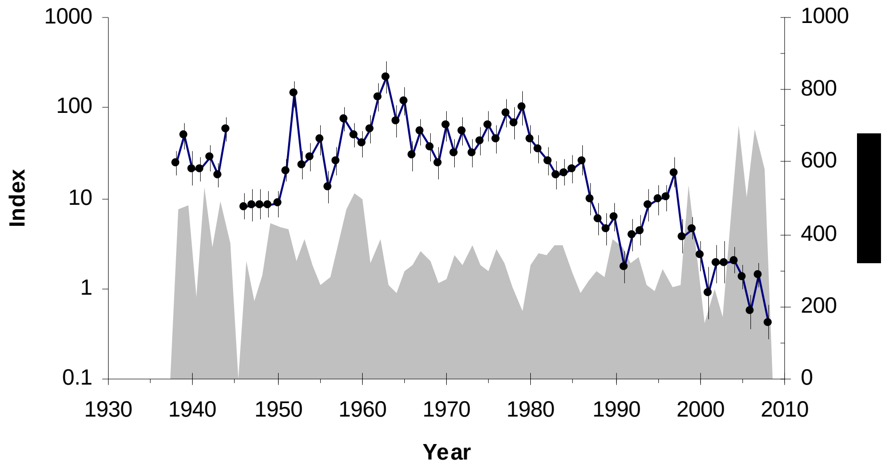


Figure NL.25 Time series of the recruitment series in Den Oever, presenting the index and confidence intervals (± 1 SD).

NL.L.1.2 Yellow eel surveys

The precision of the yellow eel surveys in Lake IJsselmeer has been analysed by Dekker, 1998. The same data contributed to the comprehensive analysis of historical data by Dekker, 2004a.

The precision of the yellow eel surveys in the main rivers has been analysed by Winter *et al.*, 2006.

NL.L.1.3 Length composition from market sampling

The spatial and temporal variation in market sampling of length compositions has been described by Dekker, 2005 before, leading to the following results:

NL.L.1.3.1 Spatial variation

The spatial variation in mean length of fykenet catches was analysed by Dekker, 2000a. For Lake IJsselmeer, the mean length varied irrespective of the distance between samples, while for other inland waters, the variation increased considerably from a distance of 10 km upwards (Figure NL.26).

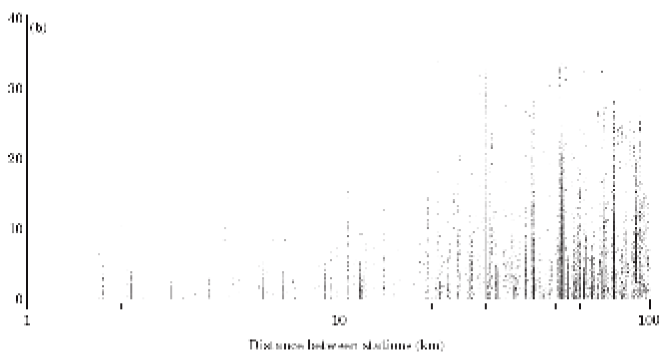


Figure NL.26 Variogram of mean length of yellow eel in fykenets, outside Lake IJsselmeer (Dekker, 2000a). The vertical axis demonstrates the difference in mean length between two samples, the horizontal axis the spatial distance between the two samples.

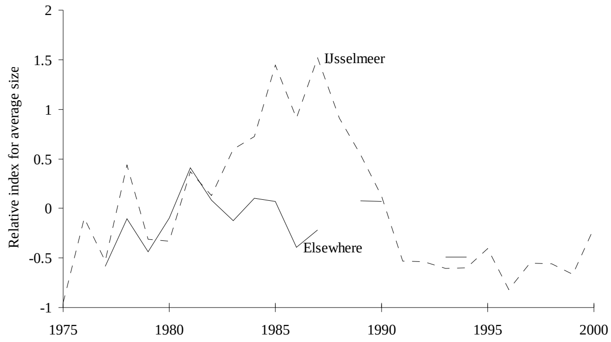


Figure NL.27 Relative change in size composition of eel landings. Positive values indicate a shift towards larger size classes. In Lake IJsselmeer, effort reductions and the recruitment failure in the 1980s initially shifted the length composition gradually to higher values. When the low recruitment had progressed into even the largest size classes, the mean size restored to normal values. Elsewhere, the data demonstrated less variability. Presumably, sampling ceased before the 1980s recruitment failure had progressed into the exploited length classes.

NL.L.1.3.2 Temporal variation

The temporal variation in length composition of Lake IJsselmeer eel catches was analysed by Dekker, 2000c in a VPA-type deterministic model, and in combination with survey data by Dekker, 2004a in a statistical model. However, the statistical properties of the sampling protocol were not highlighted.

Re-analyses of the length compositions of market samples from Lake IJsselmeer (Table NL.d), using the multinomial model of Dekker, 2004a indicates that 40% of the explained variance is accounted for by gear type and market selections, while the remaining 60% is related to temporal variation. The unexplained variance, however, is much larger, as usual. The temporal variation is largely as a consequence of year-to-year differences in length composition (Table NL.d, Figure NL.27**)**. From 1975 until 1987, a gradual shift towards larger sizes was observed; between 1987 and 1989, a rapid decrease occurred (Figure NL.27).

The quarterly and monthly variation in length composition is much smaller than the interannual variation, and very inconsistent over the years (interactions year*quarter and year*month exceed the main effects quarter and month).

Table NL.d Temporal resolution of market samples. Analysis of variance (type 1) in the length composition of market samples of legal sized eels from Lake IJsselmeer. Data since 1975; 1811 samples; 19 657 eels. See Dekker, 2004a for details on the data and statistical model.

SOURCE	DEVIANCE	D.F.	MS	F	P
gears	4200	5	840.08	632.31	<.0001
market selection	2020	2	1010.02	760.23	<.0001
√mesh	5	1	4.57	3.44	0.0637
year	6310	25	252.40	189.97	<.0001
quarter	32	3	10.81	8.14	<.0001
month	160	6	26.74	20.12	<.0001
year*quarter	1064	49	21.71	16.34	<.0001
year*month	1243	88	14.13	10.63	<.0001
explained	15 035	179	83.99	63.22	<.0001

residual	25 877	19 477	1.33
total	40 912	19 656	2.08

NL.L.1.3.3 Comparison of spatial and temporal variation

The variogram of Figure NL.26 (Dekker, 2000a) is based on sample mean lengths, grouped by decade. Re-analysing the same data, using the multinomial model of Dekker, 2004a allows a comparison of temporal and spatial variation. Figure NL.26 indicates that spatial processes apply at a spatial scale in the order of 10 km. Grouping the data in 10*10 km grid cells, and dropping the decadal grouping, results in a moderately sized model (Table NL.e). The spatial variation in length composition of the catches exceeds the temporal variation by more than a factor 20. However, this dataset was not designed for comparison of spatial and temporal variation; consequently, the colinearity is relatively large. The interaction between year and spatial grid, however, is relatively small, indicating that the time-trend was largely shared by all areas.

Table NL.e Comparison of temporal and spatial variation in market samples. Analysis of variance (type 3) in the length composition of market samples of legal sized eels, from areas outside Lake IJsselmeer. Data since 1975; 330 samples; 9871 eels. See Dekker, 2000a for details on the data, and Dekker, 2004a for details on the statistical model.

SOURCE	DEVIANCE	D.F.	MS	F	P
10*10 km grid	3876	27	143.55	106.37	<.0001
year	174	14	12.44	9.22	<.0001
colinearity	1738				
grid*year	645	28	23.03	17.88	<.0001
explained	5789	43	134.62	99.75	<.0001
residual	13 62	9827	1.35		
total	19 51	9870	1.93		

NL.L.1.3.4 f estimates

The analyses of variance presented in Table NL.d and Table NL.e are based on all historically available information. Therefore, these analyses are not fully representative for data collection under the Data Collection Regulation. However, the results do give an indication of the precision achieved (Figure NL.28). This indicates that the relative abundance of length classes can be estimated with a precision of slightly less than 10% for Lake IJsselmeer, respectively slightly less than 15% elsewhere. However, the consequence of this acquired precision on the assessment of the status of the stock and fisheries is not clear yet.

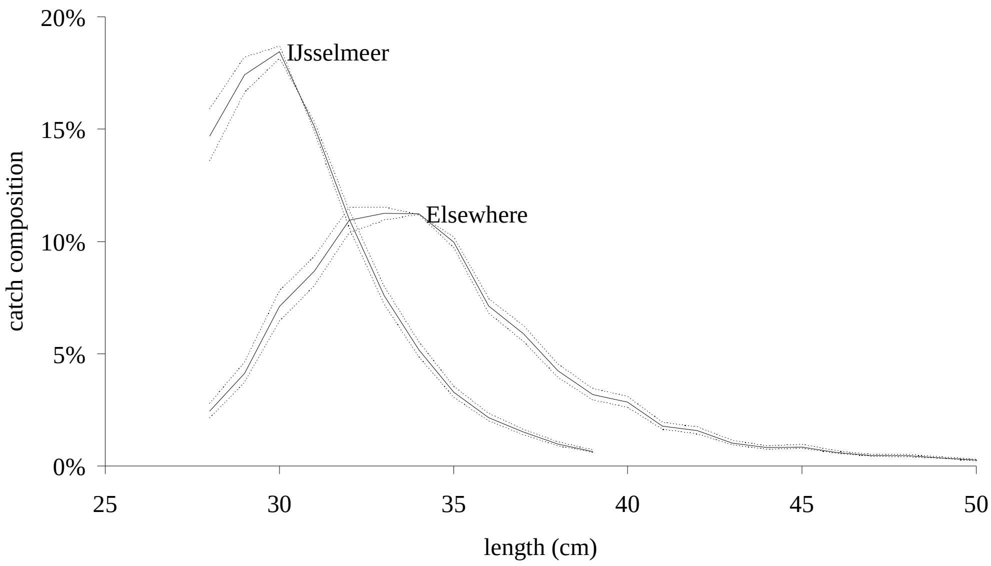


Figure NL.28 Average length composition of fykenet catches, with confidence intervals (±1 std), for Lake IJsselmeer and Elsewhere, based on the entire historical datasets. The presented length distributions conform to the situation in 1990.

Summarising the above findings:

1. the length composition of catches varies considerably between gears and market selections,
2. spatial variation at a 10-km scale plays a dominant role, but not in Lake IJsselmeer,
3. year-to-year variation is considerable, including gradual trends and sudden transitions,
4. within-year variation is small and inconsistent over the years,
5. spatial differentiation in time-trends appears to be weak, and
6. about 2/3 of the total variance remains unexplained.

NL.M Standisation and harmonization of methodology

Techniques and methods are standardized within the (marine and fresh water) institute, and are up to international quality standards (ISO 9000, DCR requirements). Eel specific topics are:

- Spatial distribution in scattered water bodies. Only the major water bodies (Lake IJsselmeer, main rivers) are sampled. For management of the stock and fishery, the existing policy is to decentralize responsibility to regional committees, but this policy will for the time being not be applied for the implementation of the eel management plan. Research is underway, to develop a regional approach to sustainable eel management.
- Ageing of eel: no ageing is performed yet.

NL.N Overview

The availability of data on eel stock and fisheries presented in this report is summarized in Table NL.f. Over all, the larger, State owned waters are reasonably documented, but the smaller regional waters are not. Within the framework of the development of a national eel management plan, research projects have been suggested, developing an adequate data collection framework for the regional waters too.

Table NL.f Overview of the data collection by area, described in this report. + = present, - = absent, +/- = incompletely present, (+) = present, but inadequate.

Area Item	Waddensea	IJsselmeer	Main Rivers	Zeeland, waters: open	closed	Smaller inland waters (lakes, polders, small rivers)
C capacity	+	-	-	+	-	-
D effort	+	+/-	-	+	-	-
E catch	+	+	-	+	-	-
F cpue	-	(+)	(+)	-	-	-
G surveys	+	+	+	+	-	-
H age/length	-	+	-	-	-	-
I sex, growth	-	+/-	-	-	-	-
J other sampling						
K assessment	-	(+)	-	-	-	-
L precision		+				
M methodology						

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