# De toestand van de Nederlandse aalstand en aalvisserij in 2010

M. de Graaf en S.M. Bierman

Rapport C143/10

IMARES Wageningen UR

(IMARES - Institute for Marine Resources & Ecosystem Studies)

Opdrachtgever: Ministerie van Economische Zaken, Landbouw en Innovatie
Directie Agroketens en Visserij
Postbus 20401
2500 EK Den Haag

BAS code: WOT-05-406-090-IMARES-5

Publicatiedatum: 18 november 2010

**IMARES** is:

- een onafhankelijk, objectief en gezaghebbend instituut dat kennis levert die noodzakelijk is voor integrale duurzame bescherming, exploitatie en ruimtelijk gebruik van de zee en kustzones;
- een instituut dat de benodigde kennis levert voor een geïntegreerde duurzame bescherming, exploitatie en ruimtelijk gebruik van zee en kustzones;
- een belangrijke, proactieve speler in nationale en internationale mariene onderzoeksnetwerken (zoals ICES en EFARO).

Referentie:
de Graaf M, Bierman S. 2010 De toestand van de Nederlandse aalstand en aalvisserij in 2010.
IMARES rapport C143/10, 71 pp.

P.O. Box 68
1970 AB IJmuiden
Phone: +31 (0)317 48 09 00
Fax: +31 (0)317 48 73 26
E-Mail: imares@wur.nl
www.imares.wur.nl

P.O. Box 77
4400 AB Yerseke
Phone: +31 (0)317 48 09 00
Fax: +31 (0)317 48 73 59
E-Mail: imares@wur.nl
www.imares.wur.nl

P.O. Box 57
1780 AB Den Helder
Phone: +31 (0)317 48 09 00
Fax: +31 (0)223 63 06 87
E-Mail: imares@wur.nl
www.imares.wur.nl

P.O. Box 167
1790 AD Den Burg Texel
Phone: +31 (0)317 48 09 00
Fax: +31 (0)317 48 73 62
E-Mail: imares@wur.nl
www.imares.wur.nl



IMARES is onderdeel van Stichting DLO
KvK nr. 09098104,
IMARES BTW nr. NL 8113.83.696.B16



A_4_3_1-V11.2

## Inhoudsopgave

## Uitgebreide Nederlandse samenvatting

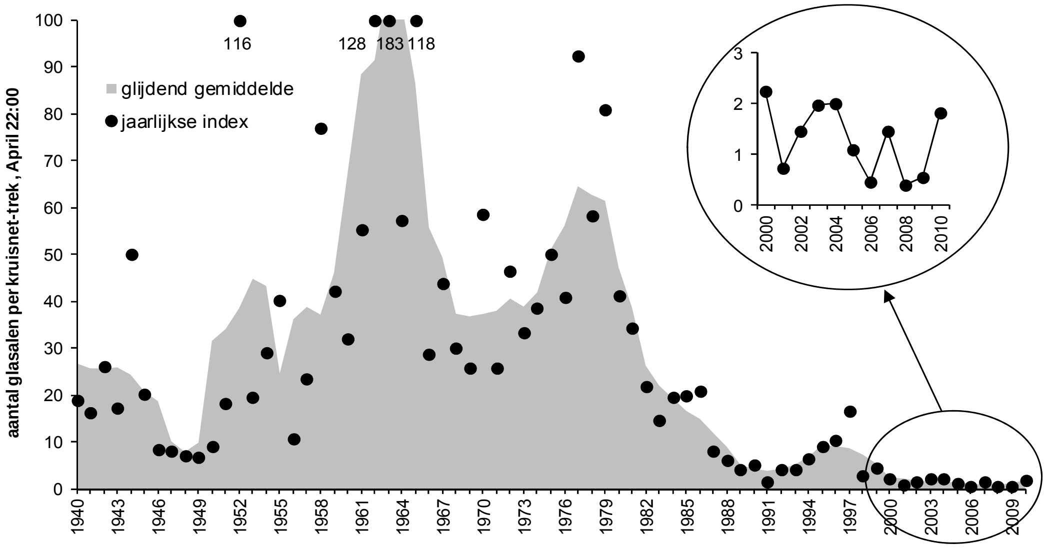
In dit rapport wordt een uitgebreid, Engelstalig overzicht gegeven van de toestand van de aal in Nederland, zoals dat jaarlijks aan de aalwerkgroep van EIFAC/ICES wordt gepresenteerd. In deze Uitgebreide Samenvatting wordt een Nederlandstalige, verkorte presentatie van de inhoud gegeven, met de nadruk op de meest recente gegevens. Het Engelstalige overzicht beoogt compleet en gedetailleerd te zijn - hier staat de leesbaarheid en toegankelijkheid voorop.

## Kader

In 2002 (ICES 2003) deed de gezamenlijke aalwerkgroep van de Internationale Raad voor het Zeeonderzoek ICES en de Europese Adviesraad voor de Binnenvisserij EIFAC de aanbeveling dat deelnemers jaarlijks aan de werkgroep zouden rapporteren over de toestand van de aalstand en aalvisserij in hun land. Deze rapportages konden dan vervolgens door de werkgroep gebruikt worden als uitgangspunt voor het internationale bestandsoverzicht en de daarop gebaseerde advisering. In 2003 (ICES 2004) werden gedetailleerde rapporten voor elk van de deelnemende landen opgesteld, die aan het (internationale) rapport van de werkgroep werden toegevoegd. In de jaren daarna zijn deze landenrapporten telkens bijgewerkt en aangevuld. Onderliggend rapport bevat het overzicht van de toestand van de aalstand in Nederland dat in de zomer van 2010 is opgesteld. De tijdreeksen in dit rapport lopen tot en met 2009, met uitzondering van de glasaalintrek waarvoor gegevens tot en met het voorjaar van 2010 beschikbaar waren. Verder wordt eenmalig aandacht besteed aan het Recreatieve Visserij Programma en aan de proeven met lichtvallen die zijn uitgevoerd tijdens de glasaalintrek in 2010. De gerapporteerde gegevens zijn merendeels verzameld in het kader van Wettelijke onderzoekstaken (WOT); de analyse en rapportage heeft ook in dat kader plaatsgevonden.

## Trends in glasaalintrek

De intrek van jonge aal (glasaal) uit zee naar onze binnenwateren wordt bemonsterd op 12 plaatsen langs de kust. In Den Oever is sinds 1938 een intensief programma uitgevoerd, elders is tussen 1970 en 1995 een netwerk van vrijwilligers opgezet. De resultaten tonen een sterke afname sinds 1980 en het glasaal niveau is momenteel minder dan 5 % van het vroegere niveau. De laatste tien jaar is de intrek van een vergelijkbaar laag niveau.




**Figuur 1:** Trend in de aanwas van glasaal bij Den Oever.

## Lichtvallen

Door de zeer sterke afname van de glasaal verkeert de jaarlijkse kruisnet bemonstering in ernstige problemen (Dekker 2004c). De kosten van het huidige arbeidsintensieve kruisnetprogramma zijn hoog en de sterke afname van de glasaalvangsten hebben negatieve gevolgen voor de statistische betrouwbaarheid van de gegevens en voor de motivatie van de betrokken medewerkers in het veld. Dekker (2004c) concludeerde dat de ontwikkeling van een nieuwe, betrouwbare en betaalbare methode om de jaarlijkse glasaalmonitoring uit te voeren belangrijk is voor het beheer van de in zorgwekkende toestand verkerende aalstand.

Leijzer et al. (2009) hebben een aantal hevel constructies en een simpele lichtval getest in het veld naar aanleiding van de aanbevelingen van Dekker (2004). Uit dit onderzoek is duidelijk gebleken dat lichtvallen het meeste perspectief bieden als alternatief voor het traditionele kruisnet in de jaarlijkse glasaalmonitoring. De lichtval (Fig. 2 links) beschreven in Leijzer et al. (2009) was goedkoop, makkelijk hanteerbaar door één persoon en de vangsten toonde vergelijkbare trends met de vangsten van de kruisnetten. Leijzer et al. (2009) concludeerden echter dat voordat het kruisnet in de jaarlijkse glasaalbemonstering kan worden vervangen door een lichtval deze methode nog verder zal moeten worden ontwikkeld.

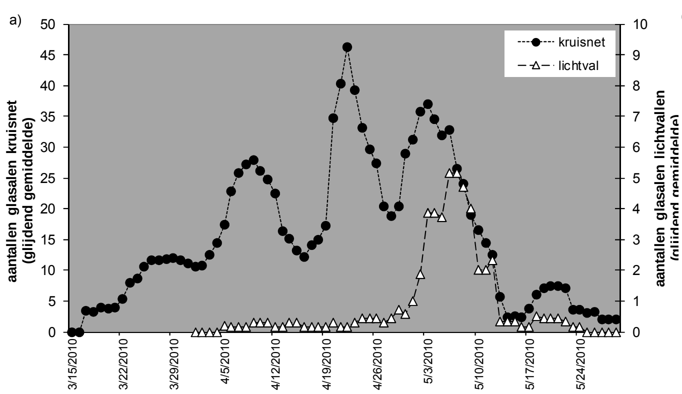
**Figuur 2:** De twee typen lichtvallen die gebruikt zijn tijdens de glasaalintrek in 2010.

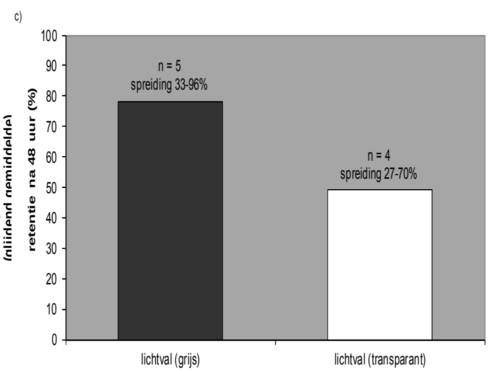
In 2009 was er bijna geen verschil tussen de lichtvallen en het kruisnet in het temporele patroon van de aanwas aan glasaal (Fig. 3b). Echter in 2010 was er in april een groot verschil tussen de twee methoden, de pieken in aanwas werden niet met de lichtvallen waargenomen (Fig. 3a).

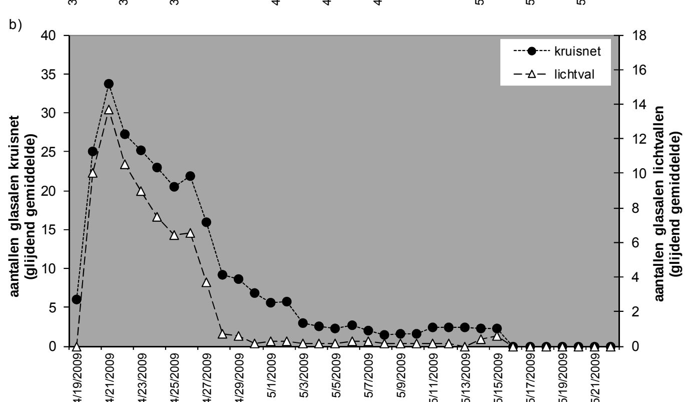
Beiden typen lichtvallen werden gevuld een aantal malen met 15-20 glasalen en na 48 uur werd genoteerd hoeveel glasalen er nog in de lichtval aanwezig waren (retentie). Helaas was het vrij gemakkelijk voor de glasalen om uit de lichtvallen te ontsnappen (Fig. 3c). Dit onverwachte resultaat toont echter duidelijk aan dat de huidige lichtvallen niet geschikt zijn als een betrouwbare alternatieve methode voor de Glasaal Index die gebaseerd is op absolute aantallen.

Een probleem van het huidige kruisnetprogramma is de toename in het percentage nul-vangsten (<5% 1960-1980 en 30-40% de laatste jaren) en het negatieve effect op de betrouwbaarheid van de data. Ook hier lijken de lichten geen oplossing te kunnen bieden. In 2009 en 2010 was het percentage nul-vangsten van de lichtvallen aanzienlijk hoger (80 tot 90% nul-vangsten) in vergelijkt tot de vangsten met het kruisnet.

De huidige lichtvallen lijken dus geen goed alternatief te zijn voor de kruisnetbemonstering en kunnen hoogstens gebruikt worden om een indruk te krijgen van relatieve patronen in de aanwas van glasalen.



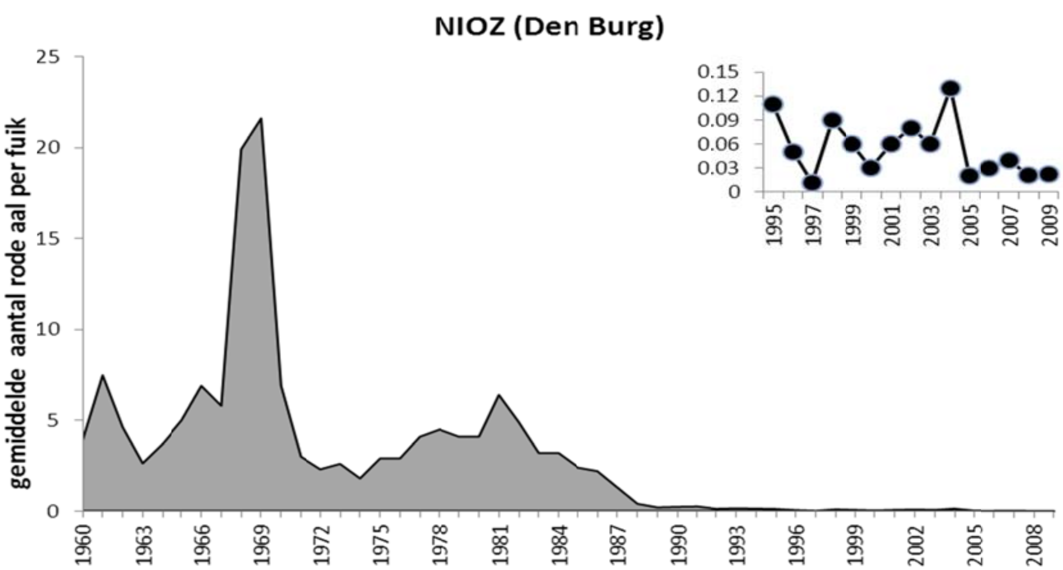




**Figuur 3:** Vergelijking in temporele patronen in de aanwas van glasaal tussen bemonstering met het kruisnet en de lichtvallen in 2010 (a) en 2009 (b). De onverwacht lage retentie van glasalen door beiden typen lichtvallen (c).

## Trends rode aal

In Vollenhove is eind jaren 1950 een aalval opgesteld, om jonge aal (rode aal) te vangen, en over de dijk in de binnenwateren te kunnen uitzetten. De gegevens vanaf 1976 zijn nog bewaard. Deze tonen dat de aantallen overgezette rode aal een vergelijkbare daling hebben meegemaakt als de glasaal in Den Oever in de jaren na 1980.

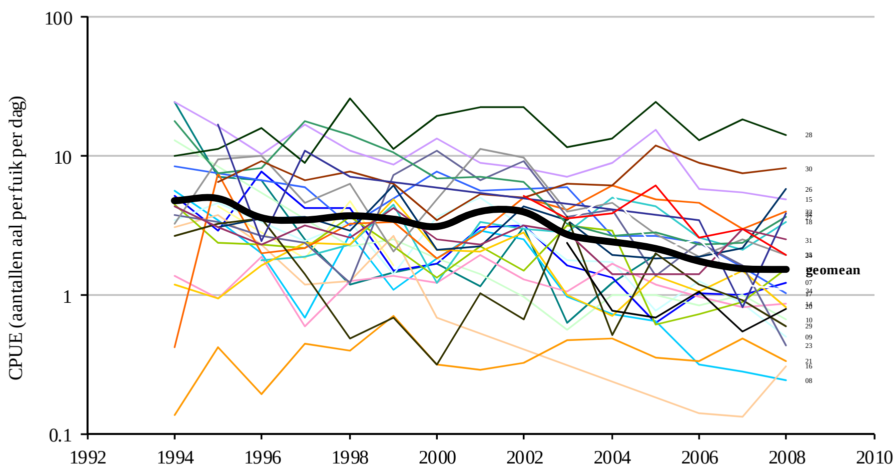
Sinds 1960 worden de vangsten rode aal in de haven van Den Burg door medewerkers van het NIOZ nauwkeurig bijgehouden. Deze zeldzame tijdsserie (Fig. 4) is dit jaar toegevoegd aan het jaarlijkse aalrapport. Deze nieuwe dataset toont ook een duidelijk afname van de rode aal populatie sinds de jaren tachtig.



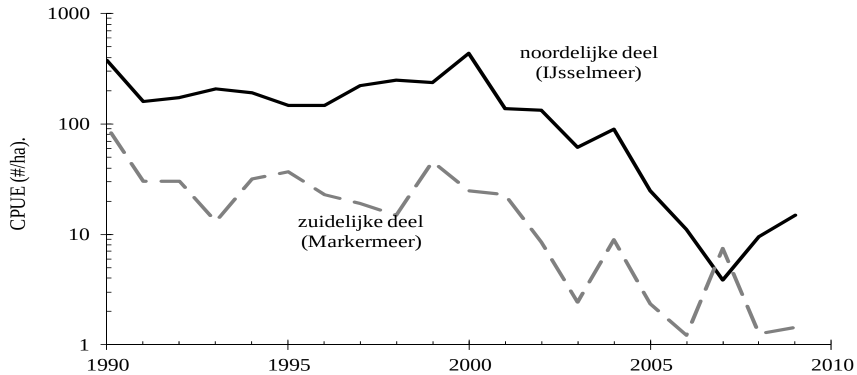

**Figuur 4:** Trend in de hoeveelheden rode aal in de NIOZ fuik.

## Trends rode en schieraal

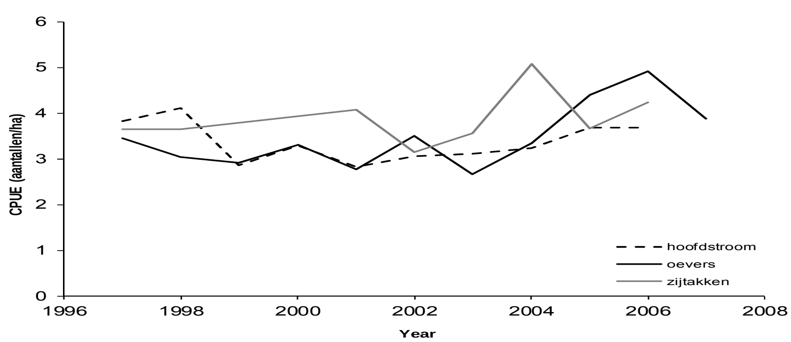
Onafhankelijke bestandsopnames bevestigen de sterk dalende trends voor de intrek van glasaal en de aanlandingen. Registratie van de vangst per fuik per etmaal door een geselecteerde groep vissers toont een gestage achteruitgang tot ca. 30 % van de vangst sinds het begin van de registraties in 1994 (Fig. 5). De invoer van de gesloten periode vanaf 2009 heeft echter gezorgd voor een trendbreuk in deze serie. De bestandsopname met de electrostramienkor in IJsselmeer/Markermeer toont een scherpe afname aan rode aal sinds 2000 (Fig. 6). Een uitzondering vormt echter de bemonstering van de Grote Rivieren. De opnames aan boord van onderzoeksschepen lieten namelijk in dezelfde periode eerder een lichte stijging zien dan een afname (Fig. 7).




**Figuur 5:** Trend in de aalvangsten op basis van het fuikenmonitoringsprogramma in samenwerking met een groep aalvissers. Het meetkundig gemiddelde (geomean) toont een geleidelijke afname sinds 1994. De gekleurde lijnen zijn de individuele trends voor de verschillende locaties.



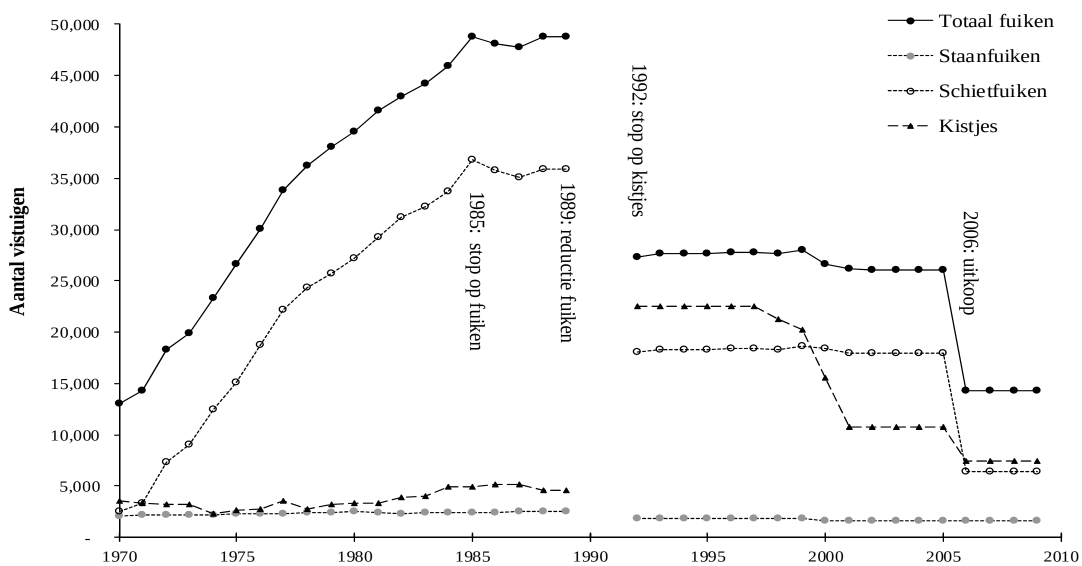

**Figuur 6:** Trend in de hoeveelheid (aantallen per ha) aal in het IJsselmeer en Markermeer op basis van de vangst met de electrostramienkor.




**Figuur 7:** Trend in de hoeveelheid (aantallen per ha) aal in op de Grote Rivieren op basis van de vangst met de electrostramienkor.

## Visserij

De visserij op aal in Nederland is nauwelijks gedocumenteerd; het aantal vergunningen is bekend, maar van de aantallen vistuigen, het gebruik daarvan en de vangsten zijn slechts schattingen beschikbaar, en deze schattingen verouderen nu snel. Invoering van de Europese Aalverordening en het Nederlandse Aal Beheersplan zal de documentatie naar verwachting snel verbeteren. De eerste stap is gezet met de invoering van de verplichte vangstregistratie voor aalvissers per 1/1/2010. Een nadeel van de huidige registratie is dat rode aal en schieraal vangsten gecombineerd worden geregistreerd en dat vistuig en visserijinspanning niet worden gedocumenteerd. Eind 2010 zal het Ministerie van EL&I een eenmalige, landelijke inventarisatie uitvoeren naar het aanwezige vistuig in de aalvisserij.




**Figuur 8:** Trend in de nominale hoeveelheden vistuig binnen de aalvisserij op het IJsselmeer.

Op het IJsselmeer is het aantal te gebruiken vistuigen gelimiteerd door merkjes, die aan de vistuigen bevestigd dienen te worden. Dit aantal is in de periode 1970-1985 sterk toegenomen; daarna is het aantal stapsgewijs verminderd. Na de laatste grote beperking in 2006 liggen de aantallen voor de meeste vistuigen nu nog steeds hoger dan in 1970. Alleen voor staanfuiken heeft er in de jaren 1970-1980 vrijwel geen groei plaatsgevonden, terwijl er later wel reducties zijn doorgevoerd. Daarmee ligt het aantal grote fuiken in 2009 een kwart lager dan in 1970. Het is momenteel ook niet duidelijk welk deel van de "merkjes" ook daadwerkelijk wordt ingezet tijdens de visserij.

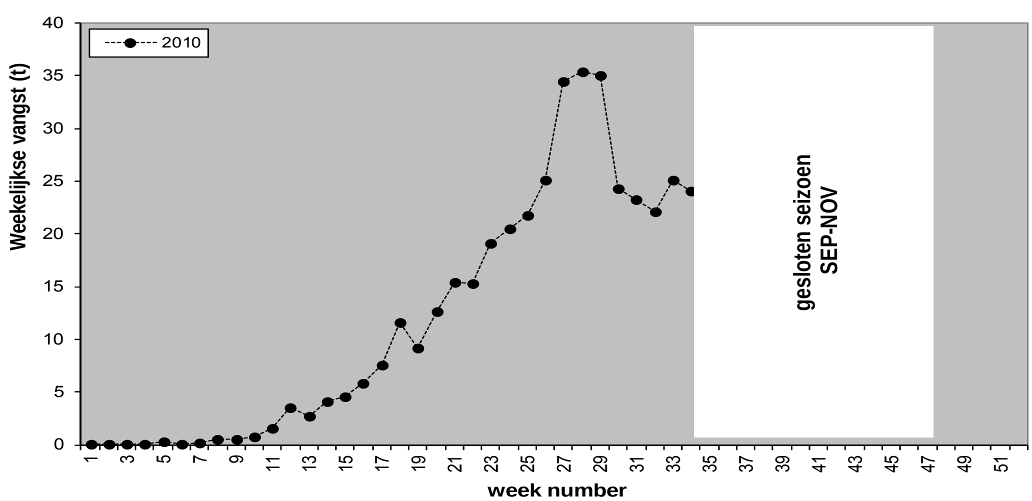
## Aanlanding

De visserij op aal in Nederland vindt plaats in meren, rivieren, kanalen en kustwateren, met de grootste concentraties in de wateren in de lagere delen van ons land. Voor de Zuiderzee/IJsselmeer zijn gegevens beschikbaar over de aanvoer op de afslagen sinds 1880. De aanlandingen van de Zuiderzee toonden in de periode 1880-1932 een lichte stijging van 300 naar 1000 t. Bij de afsluiting van het IJsselmeer namen de aanlandingen plotseling toe tot ca. 2500 t, om daarna verder te stijgen tot rond 3500 t in de jaren

1940-1955. Sinds 1950 heeft de aanvoer sterk gefluctueerd, maar is wel een gestage daling opgetreden tot minder dan 400 t sinds 2000, en nog maar 42 t in 2009.


**Figuur 9:** Trend in de geregistreerde aanlanding van aal op alle IJsselmeerafslagen. In 2009 is de aalvisserij gedurende oktober en november gesloten.

Tot voor kort waren er geen betrouwbare aanlandingsgegevens van de wateren buiten het IJsselmeer. Op 1 januari 2010 heeft LNV een verplichte vangstregistratie ingevoerd voor alle aalvissers op de binnenwateren (IJsselmeer en Rivieren). De wekelijkse aalvangsten (rode aal en schieraal gecombineerd) worden per VBC gebied opgenomen in de database van het Ministerie. Vistuig en visserijinspanning worden niet geregistreerd.




**Figuur 10:** Verloop van de wekelijkse aanlandingen aal in de binnenwateren in 2010.

## Recreatieve visserij

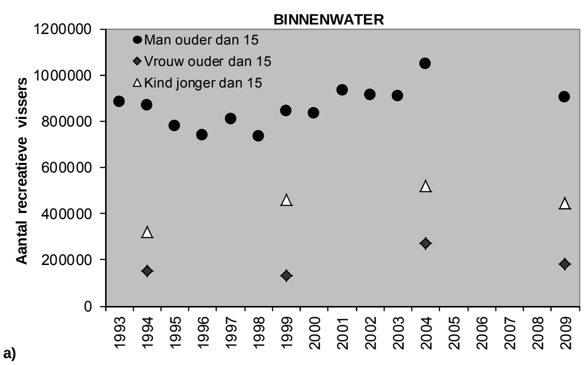
De Nederlandse overheid zijn verplichtingen opgelegd door de Europese Commissie met betrekking tot het verzamelen van gegevens over de omvang van de vangsten in de recreatieve visserij op aal, kabeljauw, haaien en roggen. Het verzamelen van deze gegevens voor aal is ook een onderdeel van het Nederlandse Aalherstelplan. In het najaar van 2009 is een aanvang gemaakt door IMARES in samenwerking met Sportvisserij Nederland. Het Recreatieve Visserij Programma bestaat uit twee verschillende fasen; de *Screening Survey* en de *Diary Survey*.

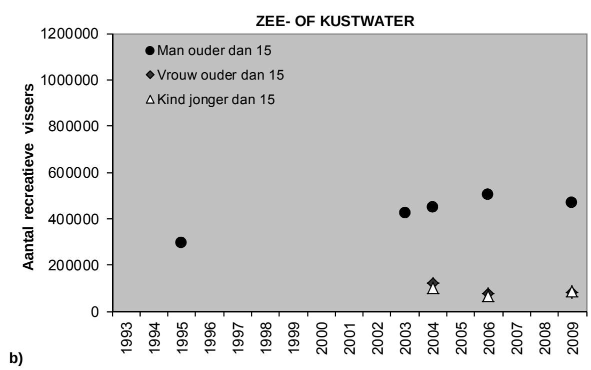
*Screening Survey*

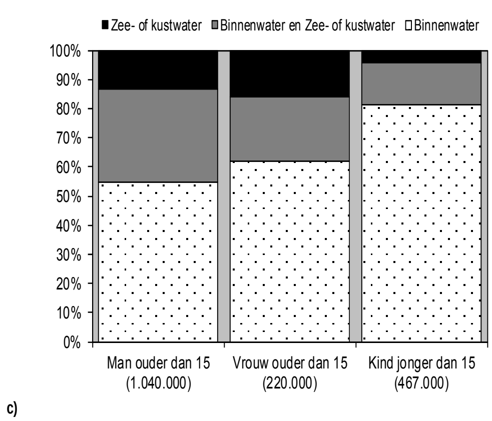
De bedoeling van een *Screening Survey* is om het aantal recreatieve vissers onder de bevolking te bepalen, een demografisch profiel van vissende huishoudens op te stellen en om representatieve kandidaten te selecteren voor vervolgonderzoek tijdens de tweede fase, de *Diary Survey*. In landen waar alle recreatieve vissers geregistreerd zijn is deze stap betrekkelijk eenvoudig. In Nederland waar slecht een deel van de recreatieve vissers zijn geregistreerd moet echter een steekproef van de gehele bevolking worden genomen om het aantal recreatieve vissers te bepalen.

In december 2009 zijn in samenwerking met TNS NIPO 57.730 huishoudens benaderd om een schatting te maken van het aantal recreatieve vissers in Nederland. De korte *Screening Survey* bestond uit slechts een paar vragen het wel of niet recreatief vissen in binnenwater en zee-of kustwateren, een grove indicatie van het aantal vistrips per jaar en het gebruikte vistuig.

Over het algemeen is het aantal recreatieve vissers in Nederland redelijk stabiel gebleven sinds het begin van de jaren '90. In 2009 waren er ongeveer 1.7 miljoen recreatieve vissers in Nederland een lichte daling ten opzichte van de laatste peilingen in 2004 (binnenwater) en 2006 (zee- of kustwater) (Fig. 11). Het overgrote deel van de vissers zijn mannen ouder dan 15 jaar. Vissen in het binnenwater is veruit het populairst vooral bij kinderen jonger dan 15 jaar (Fig. 11). Slechts een klein aantal vissers (10%) vist alleen in zee- of kustwateren.



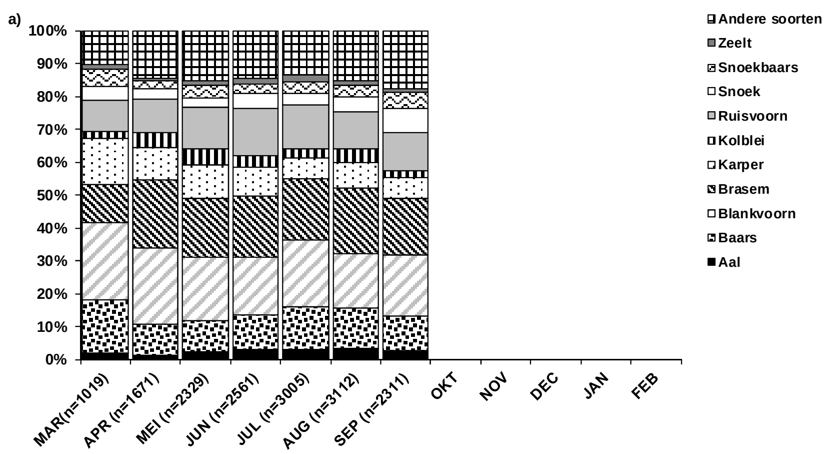

**Figuur 11**. Aantallen recreatieve vissers in binnenwater (a) en zee- of kustwater (b) sinds begin jaren '90. De aantallen vissers kunnen niet bij elkaar worden opgeteld om het totale aantal recreatieve vissers te bepalen aangezien een deel van de vissers zowel in binnenwater als zee- of kustwater vist zoals weergegeven voor 2009 (c). (Bronnen participatie van voor 2009 TNS NIPO in opdracht van Sportvisserij Nederland; kust- en zeewater 4000 huishoudens in 1995 en 2003, 11.540 huishoudens in 2004 en 30.000 huishoudens in 2006; binnenwater 4000 huishoudens tussen 1993-2003 en 7000 in 2004).

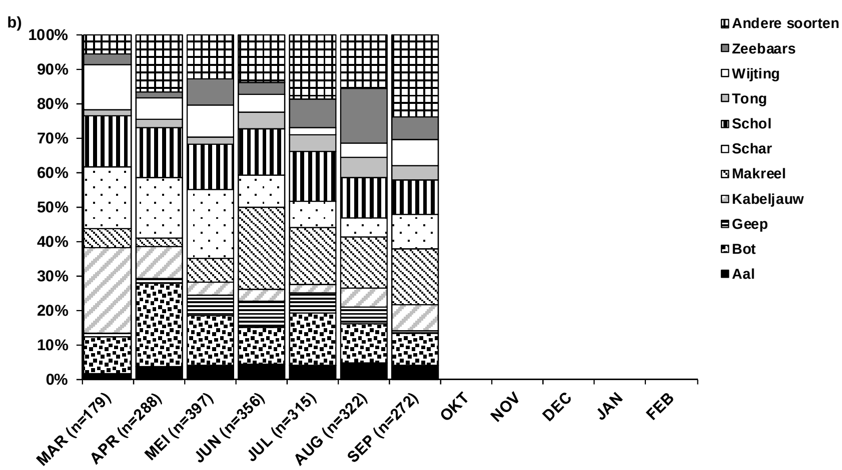
*Diary Survey*

Een selectie van recreatieve vissers wordt gevraagd om deel te nemen aan een *Diary Survey* om zeer gedetailleerde gegevens te verzamelen over inspanning, vangsten en/of uitgaven of beleving van individuele vistrips. Het belangrijkste is dat de deelnemers aan de *Diary Survey* zeer regelmatig (minimaal 1 keer per maand) benaderd worden. De deelnemers houden vaak een logboek bij als geheugensteuntje maar het belangrijkste is het regelmatige contact met de deelnemers waarbij de informatie wordt overgedragen van de deelnemer naar de medewerker van het onderzoeksprogramma.

Met behulp van de Screening Survey zijn 2000 recreatieve vissers (500 binnenwater, 500 zee- of kustwater en 1000 binnenwater en zee-of kustwater vissers) geselecteerd en uitgenodigd om deel te nemen aan de *Diary Survey*. Tijdens de *Diary Survey* wordt aan de deelnemers gevraagd om voor een periode van 12 maanden per vistrip een zeer gedetailleerde vangstregistratie (inclusief motivatie en uitgaven) bij te houden in een logboek. De *Diary Survey* is in maart 2010 van start gegaan.

Gemiddeld wordt er 3.5 vis per vistrip gevangen in zowel de binnenwateren als de zee- of kustwateren. Tijdens ongeveer 65% van de vistrips wordt ook daadwerkelijk vis gevangen. De soortensamenstelling van de vangsten in binnenwateren en zee- of kustwateren van de deelnemers aan het logboekprogramma staan weergegeven in Figuur 12.

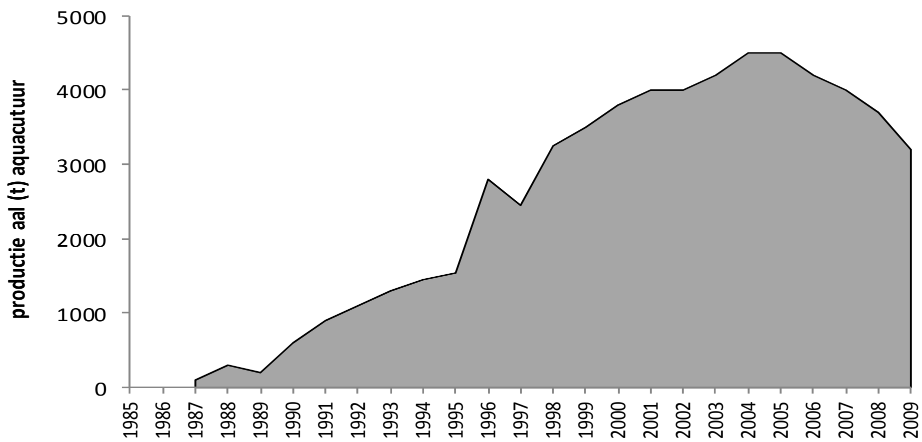



**Figuur 12**. Soorten samenstelling van de vangsten door recreatieve vissers in binnenwateren (a) en zee- of kustwateren (b).

## Productie aal aquacultuur

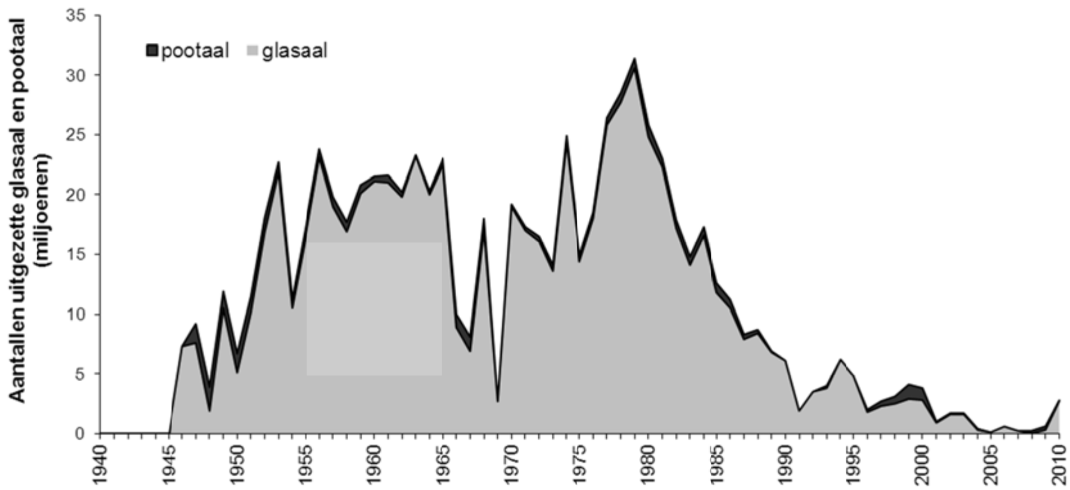
De grootste hoeveelheid aal (~90%) in Nederland wordt geproduceerd in intensieve kwekerijen. Hierin wordt uit Frankrijk/Engeland geïmporteerde glasaal opgekweekt onder gecontroleerde omstandigheden. De totale productie sinds 1985 is gestegen tot meer dan 4 000 t, maar sinds 2005 neemt de productie weer af. Buiten Nederland, is de intensieve kweek vooral van belang in Denemarken, waar ook sprake is van een sterk dalende productie (nu ca. 1700 t), en een meer extensieve vorm in Italië (ca. 1000 t). Kunstmatige voortplanting van de aal voor commerciële doeleinden is tot op heden niet mogelijk.




**Figuur 13:** Trend in de hoeveelheden aal die worden geproduceerd door de aquacultuur sector.

## Uitzet van glasaal en pootaal

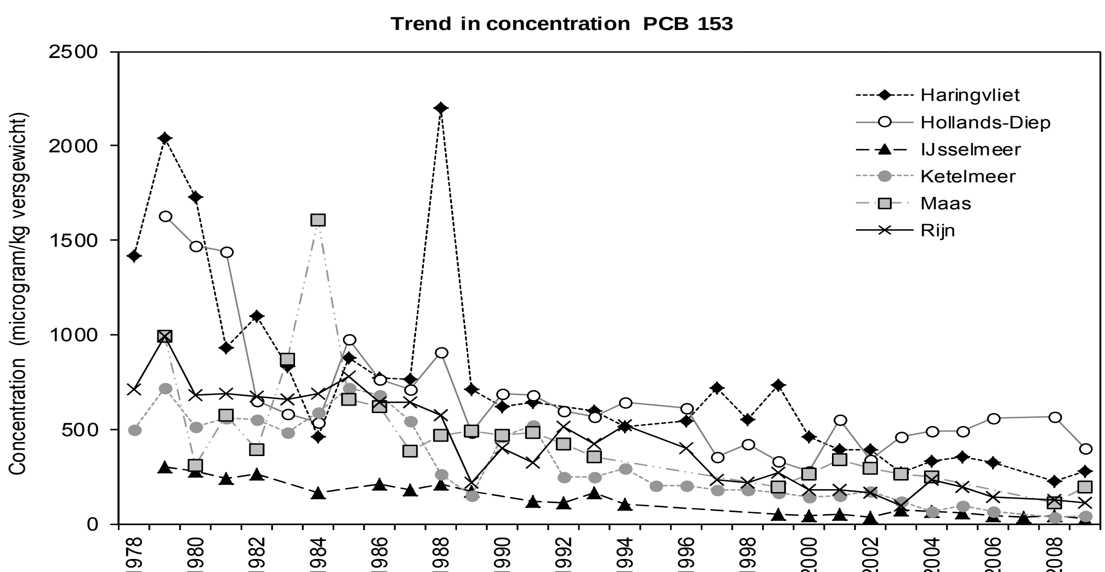
Sinds de jaren 1950 is er op grote schaal glasaal uit de omgeving van de Golf van Biskaje aangekocht en uitgezet in de binnenwateren. Daarnaast is jonge rode aal (pootaal) uitgezet. Deze pootaal werd voornamelijk gevangen in de kustzone en/of de benedenloop van de rivieren. In recente jaren heeft de uitzet van gekweekte aal (opgekweekt uit glasaal van Frankrijk/Engeland) de overhand. De uitzet van glasaal heeft min of meer gelijke tred gehouden met de natuurlijke intrek; in 2009 werd nog maar ca. 0.3 miljoen glasalen uitgezet. Voorheen was het aantal uitgezette pootaal verwaarloosbaar klein ten opzichte van de glasaal. Deze hoeveelheid is in tegenstelling tot de glasaal echter maar weinig afgenomen, waardoor de hoeveelheden uitgezette glasaal en pootaal de laatste paar jaren ongeveer even grootwaren. Sinds de opheffing van de OVB in 2005, wordt de aanvoer van glasaal en pootaal voor uitzet niet meer centraal geregistreerd. De latere cijfers zijn gebaseerd op opgave van de belangrijkste initiatiefnemers, maar mogelijk zijn kleinere partijen gemist. In 2010 heeft de Combinatie van Beroepsvissers de uitzet gecoördineerd van de door het Ministerie van EL&I aangekochte glasaal (ca. 1000 kg = ~3 miljoen stuks) ter bevordering van het herstel van de aalstand.




**Figuur 14:** Trend in de hoeveelheden uitgezette glasaal en pootaal.

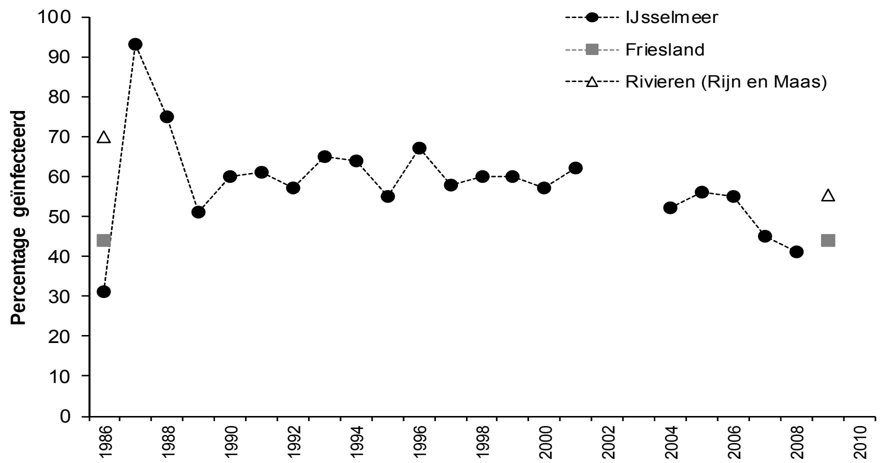
## Vervuiling en ziektes

In het kader van de monitoring van voedselkwaliteit, zijn sinds eind jaren 1970 de gehaltes van vervuilende stoffen in aal bepaald. Na de sterke vervuiling in de jaren daarvoor, is een gestage daling in de gehaltes van PCBs en dioxines in aal waargenomen. Hieronder wordt een enkel voorbeeld (PCB 153) getoond; PCB 153 is een goede indicator voor de andere PCBs.



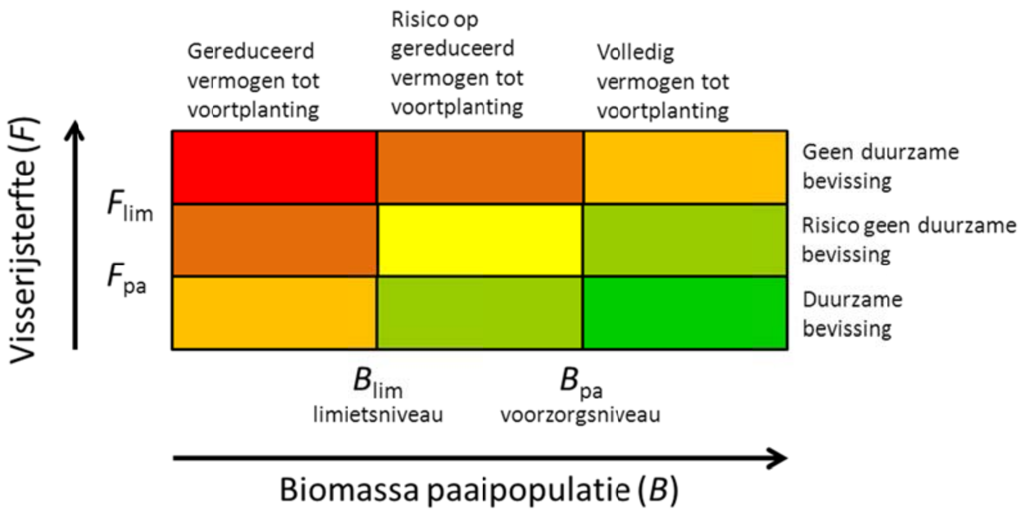

**Figuur 15:** Trend in PCB 153 in rode aal (elk punt is het gemiddelde van 25 alen).

Sinds de jaren 1980 komt in Europa een Aziatische parasiet voor in de zwemblaas van Europese alen. Na een snelle verspreiding in midden jaren 1980, is de infectie nu alom aanwezig.




**Figuur 16:** Trend in *Anguillicola* infecties in aal uit het IJsselmeer, Friesland en de Grote Rivers (Rhine and Meuse) op basis van visuele insectie met het blote oog.

De EU Verordening 1100/2007 verplicht de Lidstaten om een beheersplan voor de Europese aal (*Anguilla anguilla*) op te stellen (2009), beschermingsmaatregelen te nemen (2010), de ontwikkeling van het bestand te monitoren (voortgaand) en in 2012 te evalueren en rapporteren.




**Figuur 17:** Het ICES Precautionary Approach Diagram waarin schematisch de status van vispopulaties (horizontale as) en de impact van de visserij (vertikale as) in relatie tot limietsreferentiepunten en voorzorgsreferentiepunten wordt weergegeven. $F_{pa}$ = visserijsterfte waarboven het vermogen van een populatie om zichzelf in stand te houden in gevaar is; $F_{lim}$ = visserijsterfte waarboven het vermogen van een populatie om zichzelf in stand te houden in gevaar is en beschermende maatregelen vereist zijn. $B_{pa}$ = biomassa van de paaipopulatie waaronder het vermogen van een populatie om zichzelf in stand te houden in gevaar is; $B_{lim}$ = biomassa van de paaipopulatie waaronder het vermogen van een populatie om zichzelf in stand te houden in gevaar is en beschermende maatregelen vereist zijn.

Aangezien visserijonderzoek een relatief onzekere wetenschap is, staat het zich een beeld kunnen vormen van en het omgaan met onzekerheden aan de basis van succesvol beheer van vispopulaties zoals de aal. Om deze onzekerheden te kunnen meenemen en weergeven in adviezen over de status van vispopulaties heeft ICES een kader voor een voorzorgsbenadering ontwikkeld (Fig. 17; ICES 1996). Het kader bestaat uit limietreferentiepunten (LRP) die een status van de populatie weergeven die moet worden voorkomen en voorzorgsreferentiepunten (PRPs) die het risicio weergeven om de LRPs te overschrijden. De lRPs en PRPs worden omschreven in termen van visserijsterfte (F) en biomassa van de paaipopulatie (B).

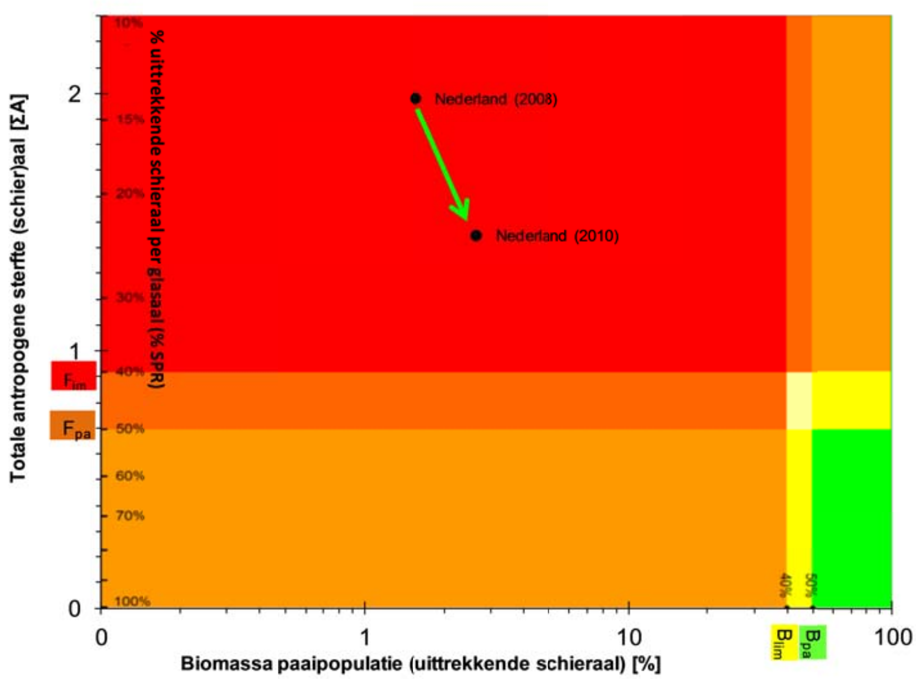
De limietreferentiepunten zijn in principe gebaseerd op wetenschappelijk onderzoek terwijl beslissingen over voorzorgsreferentiepunten (het definiëren van acceptabele risiconiveaus) de verantwoordelijkheid zijn van “de gemeenschap”. Op deze manier wordt er een scheiding aangebracht in de verantwoordelijkheden van de wetenschapper en de beheerder en kunnen de onzekerheden in een advies worden overgebracht.

Een aangepaste vorm ontwikkeld door Dekker (2010) van de ICES voorzorgsbenadering (Fig. 18) is tijdens de ICES meeting SGIPEE (Study Group International Post-Evaluation for the European Eel), overgenomen voor de (inter)nationale toestandsbeoordeling van aal. De horizontale as geeft aan hoe dicht de bestaande biomassa aan uittrekkende schieraal van de geschatte natuurlijke situatie afligt (13.000 t = 100%). Aangezien de huidige status van de uittrekkende biomassa aan schieraal ver verwijderd is van de geschatte natuurlijke situatie is, wordt de horizontale as logaritmisch weergegeven. Op de verticale as is visserij mortaliteit vervangen door de opeenhopende sterfte door menselijk handelen (antropogene sterfte factoren zoals visserij, gemalen, waterkrachtcentrales) gedurende de glasaal, rode aal en schieraal (inclusief migratie) fase. De verticale as geeft aan in welke mate het huidige bestand beschermd wordt vergelijk met de situatie waarin er geen antropogene sterfte (0%) is en de uittrek aan hoeveelheden schieraal per glasaal maximaal is (100%).

Om de toestand van de aal te bepalen en de ex-post evaluatie van het Nederlandse Aalbeheerplan te kunnen uitvoeren zijn er drie schattingen noodzakelijk :

(1) De geschatte biomassa uittrekkende schieraal onder 'pristine' condities ($B_{pristine}$). $B_{pristine}$ voor Nederland is gegeven in het Nederlandse Aalbeheersplan.
(2) De geschatte biomassa uittrekkende schieraal onder 'current best' ($B_{best}$) condities. Een schatting van $B_{best}$ wordt gemaakt door alle antropogene sterfte op nul te zetten bij het **huidige recruitment niveau**.
(3) De actuele geschatte biomassa aan uittrekkende schieraal ($B_{current}$).

In Figuur 18 is een grafische presentatie gegeven van toestand van de aal populatie en de toetsing van het Nederlandse Aalbeheerplan gebaseerd op de huidige beschikbare gegevens. In deze figuur wordt in horizontale richting de toestand van het bestand (biomassa uitrekkende schieraal, ratio $B_{current}/B_{pristine}$) geclassificeerd, terwijl in verticale richting de impact (sterfte door menselijke handelingen, ratio $B_{current}/B_{best}$) wordt aangegeven.




**Figuur 18:** Het voor aal aangepaste ICES Precautionary Approach Diagram waarin schematisch de toestand van de aalpopulatie uitgedrukt in biomassa uittrekkende schieraal (horizontale as) en de impact van menselijk handelen (vertikale as) in relatie tot limietsreferentiepunten en voorzorgsreferentiepunten wordt weergegeven voor (2008) en na (2010) de implementatie van het Nederlandse Aalbeheerplan.

In de eerste plaats toont de voorlopige evaluatie dat zowel voor als na de implementatie van het Aalbeheerplan de status van de aal in Nederland in een situatie (hoge sterfte, lage biomassa) verkeerd die moet worden voorkomen. De implementatie van het huidige Aalbeheerplan (gesloten seizoen) lijkt echter wel een (matig) positief effect op de toestand van de aal te hebben en heeft een daling van de antropogene sterfte en een verhoging van de biomassa aan uitrekkende schieraal tot gevolg.

Bovenstaande evaluatie zal worden uitgevoerd voor alle Eel Management Units om tot een toestandsbeoordeling te komen van de gehele Europese aal populatie. Echter elk Eel Management Unit heeft de verantwoordelijkheid “om zijn eigen broek op te houden” en te streven naar toestand van de biomassa aan uitrekkende aal waarbij het vermogen van de populatie om zichzelf in staat te houden niet in gevaar is (groene zone in figuur 18).

In 2012 zal Nederland vermoedelijk vooral worden afgerekend op de voortgang met betrekking tot de vermindering van de antropogene mortaliteit (verticale as) en niet zozeer op een toename in de biomassa uittrekkende schieraal (horizontale as). Maatregelen tot vermindering van de antropogene sterfte relatief makkelijk en snel te nemen en hebben direct een meetbare verbetering tot gevolg. Een afname van de mortaliteit (verticale as) geeft dus een goede indicatie van de daadkracht en voortvarendheid van een beheerder.

Het maximale wat Nederland op de korte termijn zou kunnen bereiken is het reduceren van de antropogene sterfte tot nul. Dit is echter **geen** garantie voor het bereiken van het limietsreferentiepunt voor de biomassa aan uittrekkende schieraal. Het reduceren van de antropogene mortaliteit kan alleen maar de biomassa aan uittrekkende schieraal verhogen tot het niveau wat past bij de huidige aanwas aan glasaal. Voor het bereiken van het limietsreferentiepunt voor de biomassa aan uittrekkende schieraal is Nederland afhankelijk van een sterke toename in de aanwas van glasaal. Het is echter onwaarschijnlijk dat een verhoging van de uittrek aan Nederlandse schieraal direct zal leiden tot een verhoging van de aanwas van glasaal in Nederland. De toename van glasaal in Nederland zal grotendeels afhangen van het gezamenlijke succes van het uitvoeren van alle Aalbeheerplannen in de verschillende landen. Daarnaast zal een toename in de biomassa aan uittrekkende schieraal (horizontale as) door een verhoging van de aanwas van glasaal gezien de lange levenscyclus van aal pas over 5 tot 15 jaar zichtbaar worden.

Het inzichtelijk maken van de verschillende menselijke sterfte factoren (visserij en mortaliteit tijdens de uittrek vanuit polders en rivieren) en het voeren van beleid gericht op het reduceren van sterfte heeft dan ook veruit de hoogste prioriteit.

## Overige informatie

Alle hierboven gepresenteerde informatie wordt in het Engelstalige rapport nader gedocumenteerd en toegelicht.

## Conclusie

In dit rapport wordt een up-to-date overzicht gegeven van de beschikbare informatie over de toestand van de aal en de aalvisserij in ons land, op basis van de in zomer 2010 beschikbare informatie. Alle informatie wijst erop dat het bestand zich al enige jaren op een historisch dieptepunt bevindt.

De komende jaren zal er gezamenlijk moeten worden gewerkt aan het verkrijgen van de meest betrouwbare schattingen van verschillende bronnen van sterfte (poldergemalen, waterkrachtcentrales, beroepsvisserij en recreatieve visserij) en de huidige biomassa van uittrekkende schieraal (Rode Aal Model).

Gezien de historisch lage intrek aan glasaal, lage biomassa aan uittrekkende schieraal, hoge sterfte door menselijk handelen en lange levenscyclus van aal, is de kans op een spoedig herstel van de aalstand uiterst klein. Nederland heeft echter wel de mogelijkheid om op korte termijn de sterfte door menselijk handelen aanzienlijk te verlagen door de visserij (eventueel decentraal) te sturen op mortaliteit. Het ontwikkelen van een “trap-and-transport” systeem in samenwerking met vissers en beheerders van kunstwerken (gemalen en waterkrachtcentrales) om aal over barrières te helpen is een andere mogelijkheid.

## Bijlage A Report on the eel stock and fishery in the Netherlands 2010

Het hieronder weergegeven rapport is als bijlage opgenomen in het rapport van de EIFAC/ICES Working Group on Eels. In het EIFAC/ICES rapport is voor elk deelnemend land een dergelijke bijlage te vinden. De hoofdstukindeling is in grote lijnen uniform voor alle landen; waar geen informatie beschikbaar was, of een hoofdstuk niet relevant, is dat als zodanig vermeld.

# Report on the eel stock and fishery in the

# **Netherlands**

# **2010**

### NL. 1 Authors

**Martin de Graaf**

IMARES, Institute for Marine Resources & Ecosystem Studies, PO Box 68, 1970 AB IJmuiden, the Netherlands

Tel. +31 317 486 826. Fax: +31 317 487 326, martin.degraaf@wur.nl

**Stijn Bierman**

IMARES, Institute for Marine Resources & Ecosystem Studies, PO Box 68, 1970 AB IJmuiden, the Netherlands

Tel. +31 317 481 222. Fax: +31 317 487 326, stijn.bierman@wur.nl

**Reporting Period:** This report was completed in August 2010, and contains data up to 2009 and recruitment data for 2010.

**Contributions**: The following persons and institutions provided information for this report: Arjan Heinen (Combinatie van Beroepsvissers; stocking data), Jan Meijer (Bond van Binnenvissers van Noordwest Overijssel; yellow eel data at Stroink), Pim Wilhelm (Nederlandse Vereniging van Viskwekers; eel aquaculture prodduction). Jaap van der Meer (NIOZ: yellow eel data NIOZ fyke), Michiel Kottermen (IMARES; eel contaminants) and last but not least Willem Dekker. Part of the text of the 2010 report is taken from the 2009 report written by Willem Dekker.

# NL. 2 Introduction

## NL.2.1 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 (2010) 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 and provides some additional information on developments of catch estimates of eel by the new Recreational Fisheries Programme and the result of a pilot study examining the use of light traps in glass eel monitoring.

## NL.2.2 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 approx. 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, fishermen are currently free to execute the fishery in whatever way they want. There is no general registration of fishing efforts or landings yet. In recent years, license holders 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 VBCs are regional committees which are 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.2.3 Spatial subdivision of the territory

The fishing areas can be categorised into 5 groups:

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 fresh water 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 fyke nets and pound nets; 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. There are 21 companies having a commercial license for fishing eel, and the total number of fyke nets is estimated at 400.
2. Lake IJsselmeer; 52º40'N 5º25'E; now 1820 km$^2$. Lake IJsselmeer is a shallow, eutrophic freshwater lake, which was reclaimed from the Waddensea in 1932 by a dike (Afsluitdijk), substituting the estuarine area known before as the Zuiderzee. The surface of the lake was stepwise reduced by land reclamation, from an original 3 470 km$^2$ in 1932, to just 1 820 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 fyke nets, eel boxes and long lines; trawling is banned from 1970 onwards. Licensed

fishermen are not spatially restricted within the lake. 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. There are 70 fishing licenses, owned by ca. 30 companies. The total number of gears allowed in 2009 was: fixed fykes 1579, train fykes 6386, eel boxes 7415 and unknown numbers of longlines.

3. 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 20$^{th}$ century, but following water rehabilitation measures in the last decades, is now slowly increasing. The traditional fishery used stow nets for silver eel, but fyke net fisheries for yellow and silver eel now dominates. Individual fishermen are licensed for specific river stretches, where they execute the sole fishing right. No registration of efforts or landings is required. There are 28 fishing companies, using an estimated number of 318 fixed fykes, 2433 train fykes, 551 eel boxes, and unknown quantities of other gears (electric dipnet, longlines, etc).
4. 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 fishermen, mostly spatially restricted. Fishing gears are dominated by fyke nets. Management is partially based on marine, partly on fresh water legislation. There are 27 companies, using an estimated number of 174 fixed fykes, 233 train fykes, and unknown numbers of eel pots.
5. 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 fyke netting 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. There are approx 100 companies, using unknown quantities of gears of all types.

The Water Framework Directive subdivides the Netherlands into 4 separate River Basin District, all of which extend beyond our borders. These are:

a. the River Ems (Eems), 53º20'N 7º10'E (=river mouth), shared with Germany. This RBD includes the north-eastern Province Groningen, and the eastern part of Province Drente. Drainage area: 18,000 km$^2$, of which 2,400 km$^2$ 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 8,000 km$^2$ in the Netherlands.
d. the River Scheldt (Schelde), 51º30'N 3º25'E, shared with Belgium and France. Most of the south-western Province Zeeland used to belong to this RBD, but water reclamation has changed the situation dramatically. Drainage area: 22,000 km$^2$, of which 1,860 km$^2$ in the Netherlands.

Within the Netherlands, all rivers tend to intertwine and confluent. Rivers Rhine and Meuse have a complete anastomosis at several places, while 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. This report will subdivide the national data on a pragmatic 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.

**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 | ESTIMATED LANDINGS (T) | | DATA SOURCE |
|---|---|---|---|---|---|
| Area | RBD | (km$^2$) | yellow eel | silver eel | |
| Waddensea | Rhine | 2591 | *37* | - | EU logbooks |
| | Ems | 38 | *3* | - | EU logbooks |
| IJsselmeer | Rhine | 1820 | 240 | 40 | Auction statistics |
| Rivers | Rhine | *120* | *46* | *91* | Informed guess |
| | Meuse | *60* | *4* | *9* | Informed guess |
| Zeeland | Meuse | 535 | 75 | ? | (EU logbooks) |
| | Scheldt | 428 | 0 | | |
| Others | Rhine | 900 | *222* | *133* | Informed guess |
| | Ems | 86 | *9* | *5* | Informed guess |
| | Meuse | 288 | *4* | *2* | Informed guess |
| | Scheldt | 67 | | | |
| Sum | | 6528 | 640 | 280 | |

### NL.2.4 Dutch Eel Management Plan

The Ministry of Economic Affairs, Agriculture and Innovation (responsible for fisheries) has submitted an Eel Management Plan (MinLNV 2008); the initial version (December 2008) has been replaced by a second version (April 2009), which in turn has been replaced by a new decision in July 2009 (decision published 14 July 2009, approved by EU on 20 October 2010). Major elements of this plan are:

1. One single Eel Management Plan for the whole territory, including coastal areas.
2. Target escapement for Lake IJsselmeer estimated at 3080 t (length structured model, auction statistics), for the whole country at 4000-6000 t (historical landings per surface area, 1950s data, recent surfaces). Following the initial version of the EMP, the calculations have been reviewed by a committee, and targets are now set at 2600-8100 t, "most probably lower than the previous" calculations.
3. Current escapement is estimated at 400 t, half of which is silver eels from upstream, only passing through Dutch territory.
4. Fisheries for yellow and silver eel currently occurs in almost all waters, see previous section. Relative impact on the stock is unknown.
5. Other mortalities are omnipresent, but unquantified. Minimum estimates (including fishing) are: 1000 t for yellow eel, and 345 t for silver eel.
6. Restocking of approx 0.2 million individuals (mostly bootlace); future restocking of 1 – 1.6 t of glass eel is foreseen.

7. Management measures planned as follows:

   a. Reduction of mortality at pumping stations. Within the framework of the WFD, a budget of 200 M€ is available.

   b. The hydropower industry will be asked to reduce mortality by 35%. On new installations, a migration passage is obligatory.

   c. Fishery-free zones near barriers and sluices, presumably extending 500 m up- and downstream.

   d. Release of angler catches; this is a voluntary measure by the sport fisheries.

   e. Ban on recreational fishing (a few fyke nets per person) in coastal areas from 2011.

   f. Stop on sniggle licenses in state owned waters.

   g. For the fishery, version 1 of the EMP set a closed season in Sept+Oct (yellow & silver eel, total ca. 50% of the annual catch).; version 2 decided to trap and transport 157 t of silver eels (of which 50 t from unpolluted waters) for release into the sea, but no closed season; and the July 2009 decision returns to a closed season (2009: Oct+Nov; 2010 onwards: Sept+Oct+Nov).

   h. The time until recovery depends very much on the immigration of glass eels in the years to come. Assuming that glass eel recruitment will have recovered by 2027, the targets set for silver eel escapement will be met.

## NL.3 Time Series Data:

### NL.3.1 Recruitment Series and associated effort

#### NL.3.1.1 Glass eel

##### *NL.3.1.1.1 Commercial*

Glass eel fishing is forbidden.

##### *NL. 3.1.1.2 Recreational*

Glass eel fishing is forbidden.

##### *NL.3.1.1.3 Fishery Independent*

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).

In Den Oever (Figure NL.1), 2010 recruitment was higher than 2009 and similar to levels observed during the first part of the decade. The 2009 immigration season started as usual, but ended early in the beginning of May. The glass eels had a low total length, in the same order as in recent years (Figure NL.2).

The data at the other sites (Figure NL.3) confirm the overall trend, though individual series may deviate.

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

| DECADE YEAR | 1930 | 1940 | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | 18.19 | 8.71 | 30.95 | 56.64 | 39.66 | 4.88 | 2.18 | 1.81 |
| 1 | | 15.79 | 17.77 | 53.17 | 25.01 | 33.32 | 1.47 | 0.72 | |
| 2 | | 25.52 | 113.86 | 124.33 | 44.78 | 21.01 | 3.94 | 1.44 | |
| 3 | | 16.71 | 18.82 | 178.02 | 32.03 | 14.07 | 3.95 | 1.95 | |
| 4 | | 48.72 | 28.15 | 55.50 | 37.26 | 18.80 | 6.37 | 1.96 | |
| 5 | | 19.78 | 38.94 | 115.22 | 48.44 | 19.41 | 8.85 | 1.07 | |
| 6 | | 8.03 | 10.22 | 27.71 | 39.63 | 20.56 | 10.06 | 0.45 | |
| 7 | | 7.89 | 22.79 | 42.33 | 88.85 | 7.96 | 16.11 | 1.41 | |
| 8 | 21.63 | 6.82 | 74.50 | 28.91 | 56.32 | 5.91 | 2.88 | 0.38 | |
| 9 | 48.53 | 6.72 | 40.83 | 24.82 | 78.36 | 4.10 | 4.35 | 0.53 | |

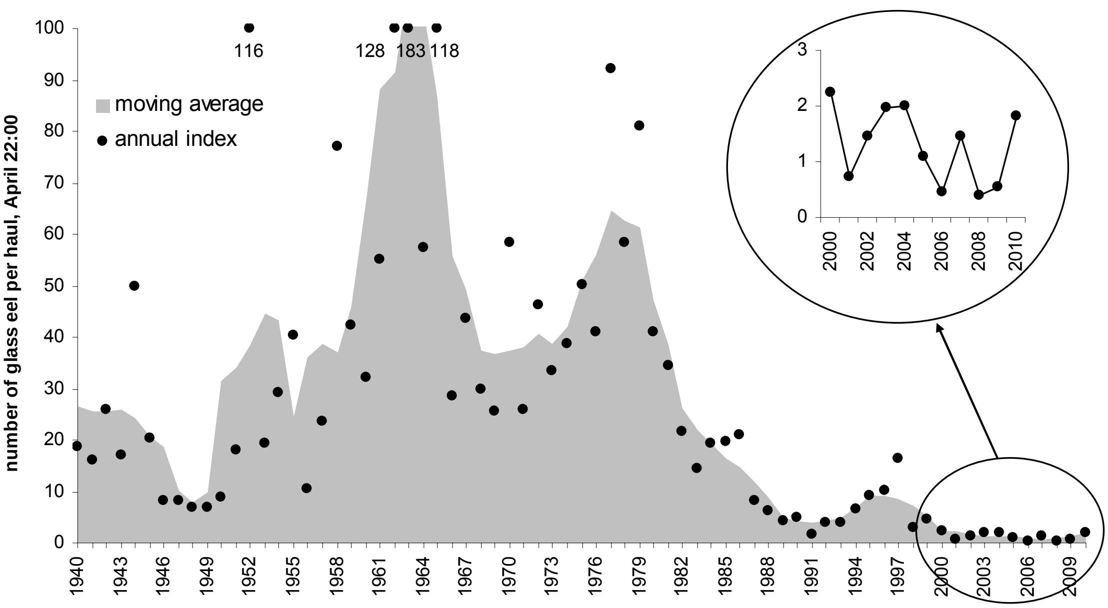



**Figure NL.1** Time trend in the glass eel survey at the sluices in Den Oever.

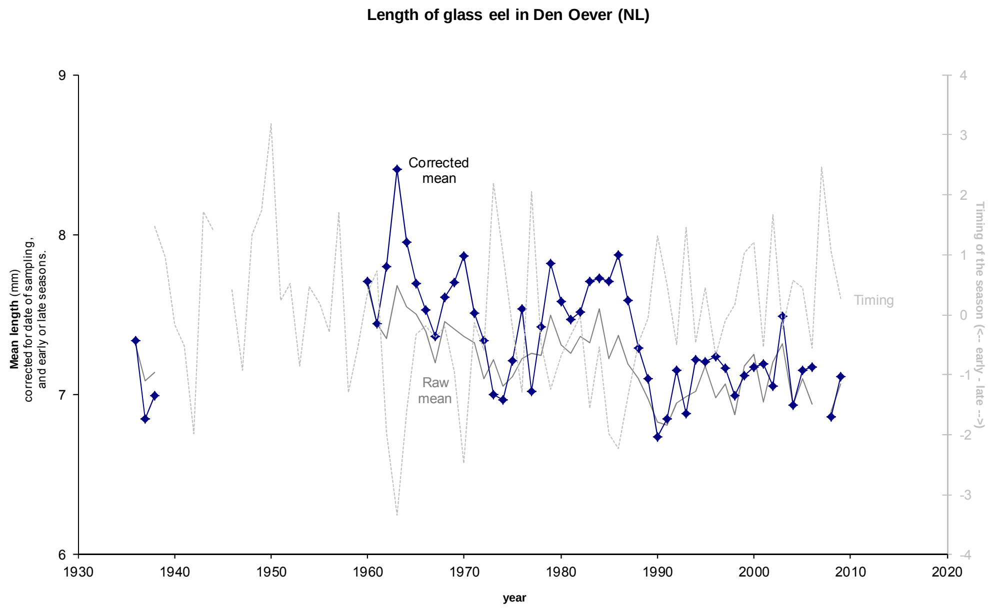



**Figure NL.2** Time trend of the length of the glass eel sampled in Den Oever. The measurements have been corrected for the date of sampling within the season, and for the average timing of each season within each year. (Timing for 2006 currently unavailable).

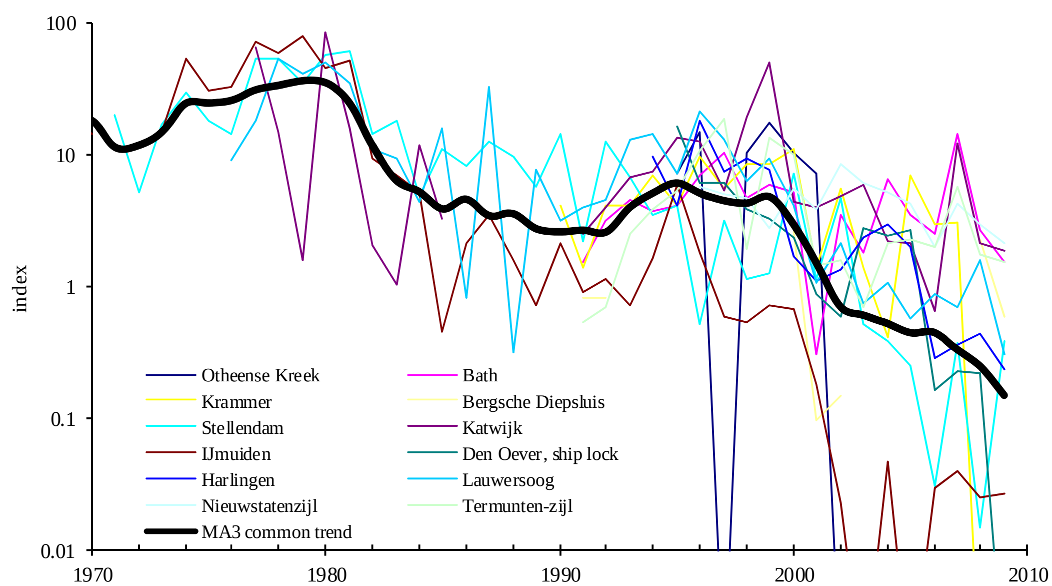



**Figure NL.3** Long-term trends in the glass eel catches in the experimental fisheries at various places along the Dutch coast. MA3 indicates the moving average of the geometric mean of all series, averaged over three years.

**Table NL.c** 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 | Den Oever, ship lock | Harlingen | Lauwersoog | Nieuwstatenzijl | Termunten-zijl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RBD | Scheldt | | Meuse | | | Rhine | | | | | Ems | |
| 1969 | | | | | | | 47.3 | | | | | |
| 1970 | | | | | | | 31.5 | | | | | |
| 1971 | | | | | 15.4 | | | | | | | |
| 1972 | | | | | 4.1 | | | | | | | |
| 1973 | | | | | 13.1 | | 32.8 | | | | | |
| 1974 | | | | | 22.8 | | 119.3 | | | | | |
| 1975 | | | | | 13.9 | | 66.8 | | | | | |
| 1976 | | | | | 11.3 | | 73.1 | | | 14.4 | | |
| 1977 | | | | | 42.1 | 130.25 | 159.2 | | | 28.4 | | |
| 1978 | | | | | 42.1 | 30.23 | 131.7 | | | 83.9 | | |
| 1979 | | | | | 27.3 | 3.23 | 176 | | | 66.2 | | |
| 1980 | | | | | 45.1 | 171.60 | 101.5 | | | 80.3 | | |
| 1981 | | | | | 47.3 | 31.65 | 113.9 | | | 55.1 | | |
| 1982 | | | | | 11.3 | 4.13 | 20.8 | | | 17.4 | | |
| 1983 | | | | | 14.3 | 2.10 | 15.6 | | | 15.1 | | |
| 1984 | | | | | 3.8 | 23.62 | 11.4 | | | 7.1 | | |
| 1985 | | | | | 8.7 | 6.67 | 1 | | | 25.2 | | |
| 1986 | | | | | 6.4 | | 4.7 | | | 1.3 | | |
| 1987 | | | | | 9.8 | 14.00 | 7.7 | | | 52 | | |
| 1988 | | | | | 7.6 | | 3.5 | | | 0.5 | | |
| 1989 | | | | | 4.4 | 3.67 | 1.6 | | | 12.1 | | |
| 1990 | | | 0.3 | | 11.3 | | 4.7 | | | 5 | | |
| 1991 | | 5.9 | 0.1 | 1.47 | 1.7 | 5.10 | 2 | | | 6.3 | | 0.3 |
| 1992 | | 12.3 | 0.3 | 1.38 | 9.9 | 8.20 | 2.5 | | 14.8 | 7.3 | | 0.4 |
| 1993 | | 17.5 | 0.3 | | 5.2 | 13.50 | 1.6 | | | 20.8 | | 1.4 |
| 1994 | | 14.6 | 0.5 | 7.94 | 2.7 | 15.10 | 3.6 | | 16 | 22.5 | | 2.2 |
| 1995 | 0.5 | 15.7 | 0.3 | | 3.2 | 27.10 | 13.1 | 27.8 | 6.8 | 11.6 | | 3 |
| 1996 | 1 | 26.8 | 0.7 | | 0.4 | 25.40 | 4 | 10.2 | 29.7 | 34.4 | 24 | 6 |
| 1997 | 0 | 40.4 | 0.4 | 33.33 | 2.5 | 10.90 | 1.3 | 10.2 | 12.4 | 20.9 | 21 | 10.6 |
| 1998 | 0.7 | 18.3 | 0.6 | | 0.9 | 38.80 | 1.2 | 6.5 | 15.4 | 9.9 | 19.9 | 1.1 |
| 1999 | 1.2 | 23.1 | 0.6 | | 1 | 101.30 | 1.6 | 5.6 | 12.7 | 15.1 | 11.8 | 7.5 |
| 2000 | 0.7 | 20.1 | 0.8 | 4.36 | 5.6 | 8.80 | 1.5 | 4 | 2.8 | 6.6 | 23.3 | 5.7 |
| 2001 | 0.5 | (1.2[†]) | 0.1 | 0.17 | 0.9 | 8.10 | 0.4 | 1.5 | 1.8 | 1.7 | 16.1 | 0.8 |
| 2002 | 0 | 13.6 | 0.4 | 0.25 | 3.7 | 9.80 | 0.05 | 1 | 2.2 | 3.4 | 35.3 | 0.9 |
| 2003 | 0 | 7 | 0.1 | | 0.4 | 11.80 | 0 | 4.7 | 3.8 | 1.2 | 25.5 | 0.4 |
| 2004 | 0 | (24.9[†]) | 0.03 | | 0.3 | 4.50 | 0.105 | 4.1 | (4.9[†]) | 1.7 | 21.7 | 1.2 |
| 2005 | 0 | 13.4 | 0.5 | | 0.2 | 4.40 | 0 | 4.6 | 3.3 | 0.9 | 18.2 | 1.3 |
| 2006 | 0.00 | 9.70 | 0.21 | | 0.02 | 1.33 | 0.067 | 0.28 | 0.48 | 1.39 | 8.33 | 1.13 |
| 2007‡ | 0.00 | 55.86 | 0.22 | | 0.29 | 24.77 | 0.089 | 0.38 | 0.59 | 1.13 | 18.11 | 3.26 |
| 2008 | 0.00 | 10.49 | 0.00 | 3.91 | 0.012 | 4.31 | 0.056 | 0.38 | 0.71 | 2.54 | 12.36 | 1.00 |
| 2009 | 0.00 | 5.94 | 0.00 | 1.00 | 0.31 | 3.79 | 0.059 | 0 | 0.38 | 0.49 | 8.95 | 0.88 |

[†]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.3.1.2 Yellow Eel Recruitment

##### *NL.3.1.2.1 Commercial*

No commercial data series on recruitment exist.

#### *NL.3.1.2.2 Recreational*

No recreational data series on recruitment exist.

#### *NL.3.1.2.3 Fishery Independent*

At various places in the Netherlands, facilities have been built to allow glass eel and yellow eel to migrate through or over dykes and sluices. Some of these places monitor the quantities of eel being caught and transported, but these data series are currently too short to be used as time series. There is one noticeable exception: for the eel trap at pumping station Stroink in Vollenhove (52º42’16N 5º28’22E), records have been kept since the late 1950s, but unfortunately, the data prior to 1976 have been lost. The remaining data (Figure NL.4, Table NL.d) show a sharp decline in the late eighties, comparable to the trend in Lake IJsselmeer eel stock, to which the pumping station drains. Until the early 1990s, the trap was of the conventional type (a ramp filled with willow twigs; c.f. Dekker 2002, p. 27), thereafter a new type has been added/replacing (stainless steel kind of fyke net funnel into a hard cover box; see Dekker 2002, p. 253).

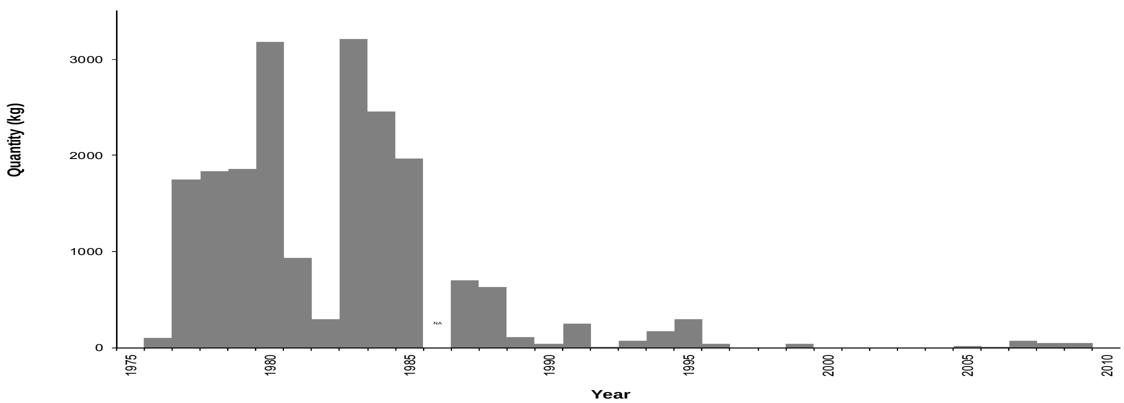



**Figure NL.4** Time series of the quantity of yellow eel caught in the eel trap at Stroink, Vollenhove.

**Table NL. d**Annual catches of bootlace eel in the eel trap at Stroink, Vollenhove, in kg per year.

| Decade Year | 1970 | 1980 | 1990 | 2000 |
|---|---|---|---|---|
| 0 | | 3180 | 41 | 0 |
| 1 | | 935 | 250 | 0 |
| 2 | | 300 | 5 | 0 |
| 3 | | 3213 | 75 | 0 |
| 4 | | 2455 | 175 | 0 |
| 5 | | 1972 | 300 | 21 |
| 6 | 100 | #N/A | 40 | 3 |
| 7 | 1750 | 703 | 0 | 70 |
| 8 | 1840 | 628 | 0 | 50 |
| 9 | 1860 | 110 | 40 | 50 |


**Figure NL.5** Time series of the mean catch per fyke (numbers) of yellow eel at NIOZ (data from van der Meer, in prep.).

### NL. 3.2 Yellow Eel Landings

No reliable long term time series of yellow eel landing exist; total landings of yellow and silver eel combined, have been reported. However, data from auctions around Lake IJsselmeer did report yellow and silver eel separately, but information in recent years (early 1990s onwards) is unreliable: yellow eel from eel boxes and silver eel from all gears have been combined; see section NL 6.2.1 for details. An obligatory catch registration system was introduced in the Netherlands in January 2010 by the Ministry of Economic Affairs, Agriculture and Innovation. However, weekly catches of eel are reported but yellow eel and silver eel catches are combined in this program and no information on effort and gears is reported.

### NL.3.3 Silver Eel Landings

No reliable long term time series of yellow eel landing exist; total landings of yellow and silver eel combined, have been reported. However, data from auctions around Lake IJsselmeer did report yellow and silver eel separately, but information in recent years (early 1990s onwards) is unreliable: yellow eel from eel boxes and silver eel from all gears have been combined; see section NL 6.2.1 for details. An obligatory catch registration system was introduced in the Netherlands in January 2010 by the Ministry of Economic Affairs, Agriculture and Innovation. However, weekly catches of eel are reported but yellow eel and silver eel catches are combined in this program and no information on effort and gears is reported.

### NL.3.4 Aquaculture Production

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

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

| | 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 | | | | 3700 |
| 2009 | | | | 3200 |
| 2010 | | | | |

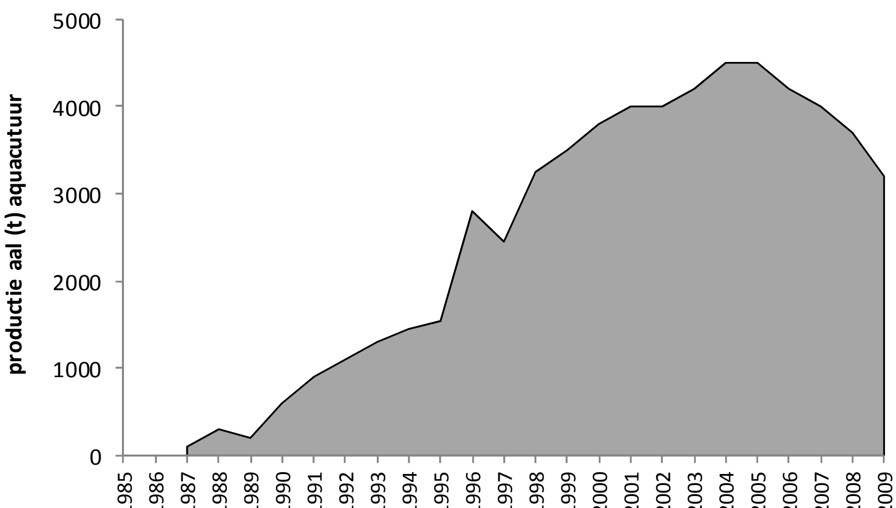



**Figure NL. 6** Trend in aquaculture production in the Netherlands.

## NL.3.5 Stocking

### NL.3.5.1 Amount Stocked

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 fishermen fishing in the Waddensea. Data on re-stocking quantities are listed in Table NL. f.

In recent years, the OVB has merged with the major anglers organisation, 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 organised centrally, although trade of small eels (undersized) still occurs. The listed estimates are probably a minimum, not including unregistered trade. Since there is no administration of imports and re-stockings anymore, it is unknown to what extend re-stocking has been practiced by other parties. In 2009, more than 0.3 million glass eels and 0.3 million yellow eels have been re-stocked by some 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.f** Re-stocking of glass eel and young yellow eel in the Netherlands, in millions re-stocked†. GE = glass eel, YYE = young yellow eel.

| DECADE | 1940 | | 1950 | | 1960 | | 1970 | | 1980 | | 1990 | | 2000 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Year* | *GE* | *YYE* | *GE* | *YYE* | *GE* | *YYE* | *GE* | *YYE* | *GE* | *YYE* | *GE* | *YYE* | *GE* | *YYE* |
| *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 | *0.58* | *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 | *0.22* | *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* | *0.23* |
| *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 | *>0.3* | *>0.3* |

| DECADE | 2010 | |
|---|---|---|
| *Year* | *GE* | *YYE* |
| *0* | *2.7* | *0.06* |
| *1* | | |
| *2* | | |
| *3* | | |
| *4* | | |
| *5* | | |
| *6* | | |
| *7* | | |
| *8* | | |
| *9* | | |

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

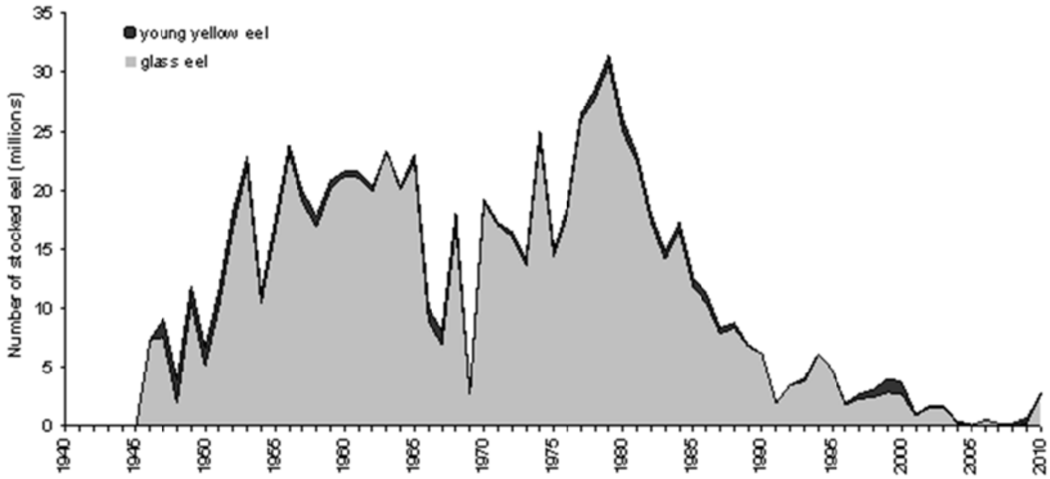



**Figure NL. 7** Trend in stocking of glass eel and young yellow eel in the Netherlands.

#### Catch of Eel <12 cm and proportion retained for restocking

Catch and retain of eels < 28 cm is illegal. There is no organised trap and transport of undersized eels.

## NL.4 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 vessel. For marine waters and Lake IJsselmeer, a register of vessels 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). The actual usage is often much lower, amongst others since restrictions apply on the combinations of types of fishing gears (e.g. no fyke nets and gill nets should be operated concurrently, since perch and pikeperch are the target species of the gill netting, while landing perch and pikeperch from fyke nets is prohibited).

## NL.5 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 fyke nets 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. Since the number of companies has reduced at the same time, the nominal fishing effort per company has not reduced at the same rate, and underutilisation of the nominal effort probably still exists. The effort in the longline fishery is not restricted, other than by the number of licenses.

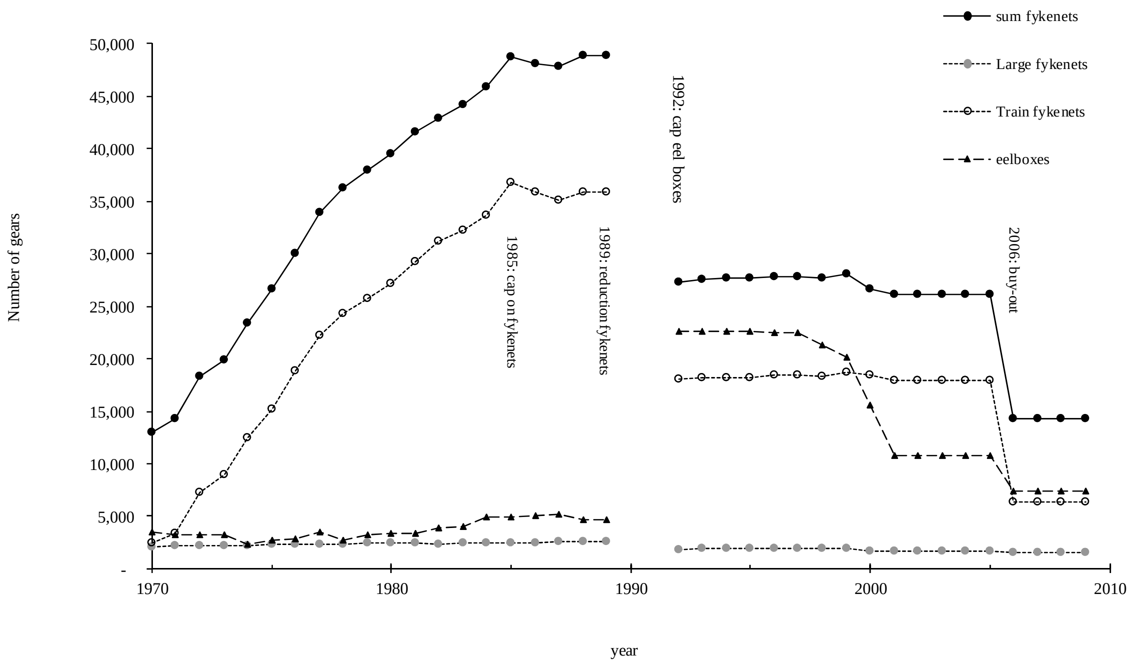



**Figure NL.8** Trends in the nominal number of fishing gear employed in the eel fishery on Lake IJsselmeer. Information before 1989 is based on a voluntary inquiry in 1989 (Dekker 1991); after 1992, the licensed number of gear is shown. The reduction in-between is realistic.

A tentative overview of the number of gears for the whole country is presented in Table NL. g based on inquiries, interviews and voluntary reporting by fishermen. The Ministry of Economic Affairs, Agriculture and Innovation is planning to conduct a survey of eel fishing gears towards the end of 2010.

**Table NL.g** Overview of the number of fishing gears used. Information from inquiries in 2007. Data from Dekker et al. 2008.

| | IJsselmeer/ Markermeer | Rivers | Coastal waters | Elsewhere | Coastal, recreational | Total |
|---|---|---|---|---|---|---|
| Large fyke nets | 1,579 | 155 | - | + | | >1734 |
| Pound nets | | 163 | 574 | + | | >737 |
| Train fyke nets | 6,386 | 2,433 | 233 | + | | >9052 |
| Small fyke nets | | 51 | | + | 1,956 | >2007 |
| Boxes, pots | 7,415 | 551 | + | + | | >7966 |
| Long lines, hook & line | + | + | + | + | | + |
| Electro-dipnet | | + | - | + | | + |
| Otherwise | | | | + | | + |
| Number of companies | 73 | 28 | 48 | ca. 100 | 978 | ca. 250+978 |

## NL.6 Catches and Landings;

### NL.6.1 Glass Eel

Glass eel fishing is forbidden, no available data.

### NL.6.2 Yellow Eel

#### NL.6.2.1 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.h); 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, due to misclassification of gears, and the trading of eel from other areas at IJsselmeer auctions.

**Table NL.h** 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, due to 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* | *122* |
| 9 | 516 | 1026 | 1033 | 2108 | 3873 | 3412 | 2241 | 510 | 525 | *332* | *42* |

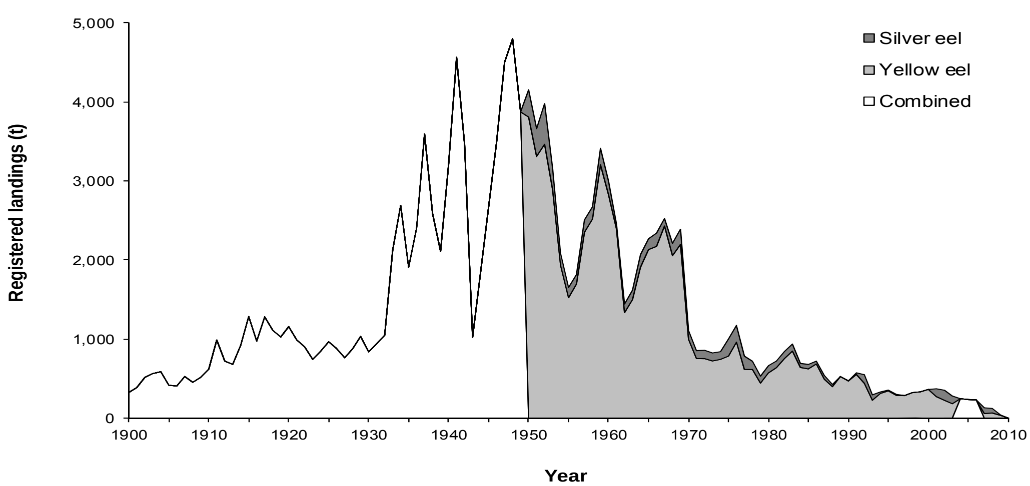



**Figure NL.9** Time trend in the landings from Lake IJsselmeer.

### NL.6.2.2 Catches and Landings from inland waters outside Lake IJsselmeer

For the inland areas outside Lake IJsselmeer, no detailed records of catches and landings were available until 2010. In January 2010 the Ministry of Economic Affairs, Agriculture and Innovation introduced an obligatory catch recording system for inland eel fishers (IJsselmeer and Rivers). Fishermen are required to report their weekly eel catches for each of the 43 so-called Fish Stock Management Committees ['Visstand Beheer Commissies' VBC].

**Table Table NL.i** Reported landings of inland fishermen in tons per year (data the Ministry of Economic Affairs, Agriculture and Innovation). * Data for 2010 up to week 35

| DECADE YEAR | 2010 |
|---|---|
| 0 | 471* |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |

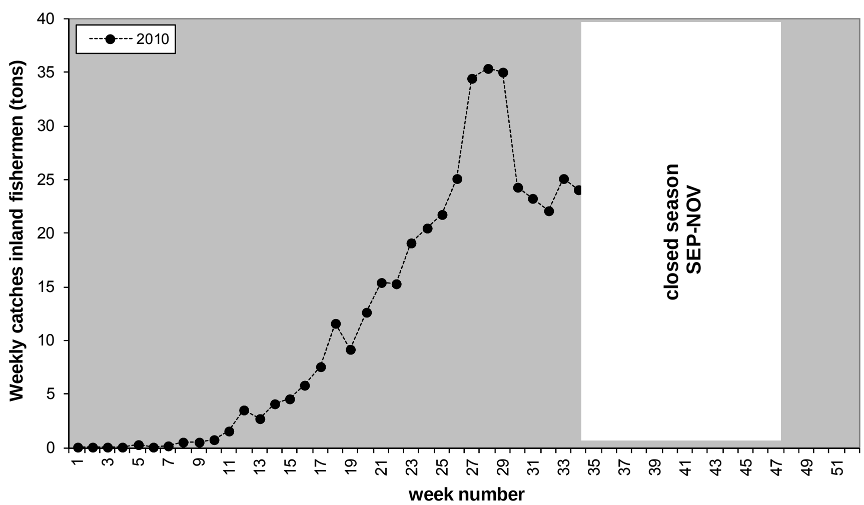



**Figure NL.10** Weekly catches in tons of eel (yellow eel + silver eel) by inland fishers during the 2010 season.

### NL.6.2.3 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 & 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 fyke nets 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.j.

**Table NL.j** 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 ton/year |
|---|---|---|---|
| Full time commercial | 7700 | 100 | 770 |
| Part time commercial | 1000 | 150 | 150 |
| Poaching | ? | ? | ? |
| Recreational (small fykes) | 25 | 1000 | 25 |
| Sniggers[†] | 2.650 | 3,773 | 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.

Since 2009 it is mandatory for all recreational fishers in inland waters where the fishing rights are with the recreational fishers (clubs, federations etc) and marine waters (federal regulation), to release eel back in the water immediately upon capture.

Details of the new Recreational Fisheries Programme which was started in 2009 will be described in Section **NL. 12.1**.

### NL.6.3 Silver Eel

See 6.2 Yellow Eel

### NL.6.4 Marine Fishery

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; data prior to 1984 are presented in the 2009 Country Report. Until 2001, vessels with a total length (LOA) ≥ 15 m were obliged to report all their eel catches. This obligations did not apply top smaller vessels. From 2001 onwards, vessels with a total length ≥ 10 m are obliged to report their eel catches, if their landings per day exceeded 50 kg. 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. Overall, the number of ships reporting in a year declined from 130 before 2001 to 59 thereafter, while the average landing per ship increased from 230 kg/ship/year before 2001 to 436 kg/ship/year thereafter.

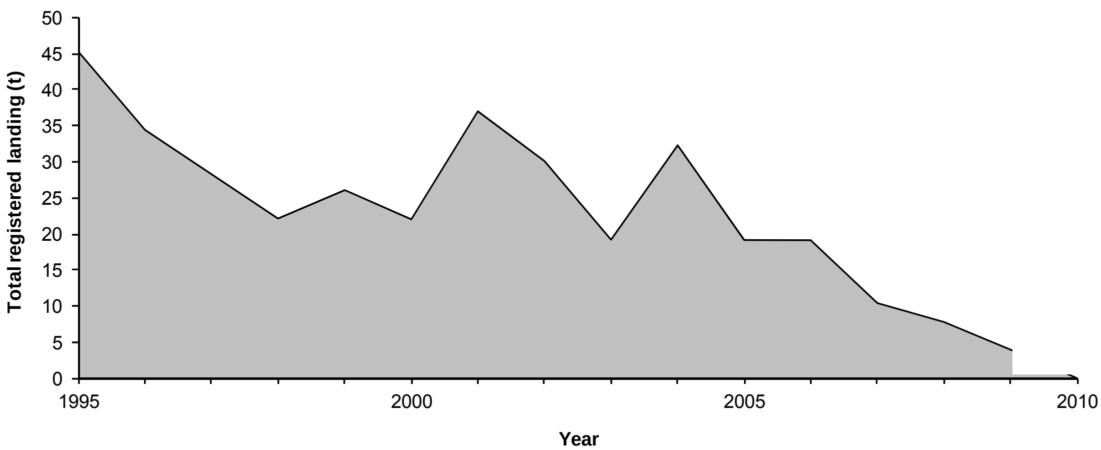



**Figure NL**.11 Time trend in the total registered landings from marine waters in Dutch harbours.

## NL.7 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 (Figure NL.12) has been monitored, by means of logbook registration of commercial catch and by-catch, in a restricted number of fyke nets (4 large fyke nets or 2 pairs of summer fyke nets per location), mostly on a weekly basis. For eel, the number of yellow eels and silver eels caught is recorded. Results show a slowly declining trend over the years down to about ⅓ of the earlier value, 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 perceived lack of a declining trend has frequently been quoted in the debate on the status of the eel stock. The closed season (Sep-Oct) in 2009 caused an interruption of this time series.

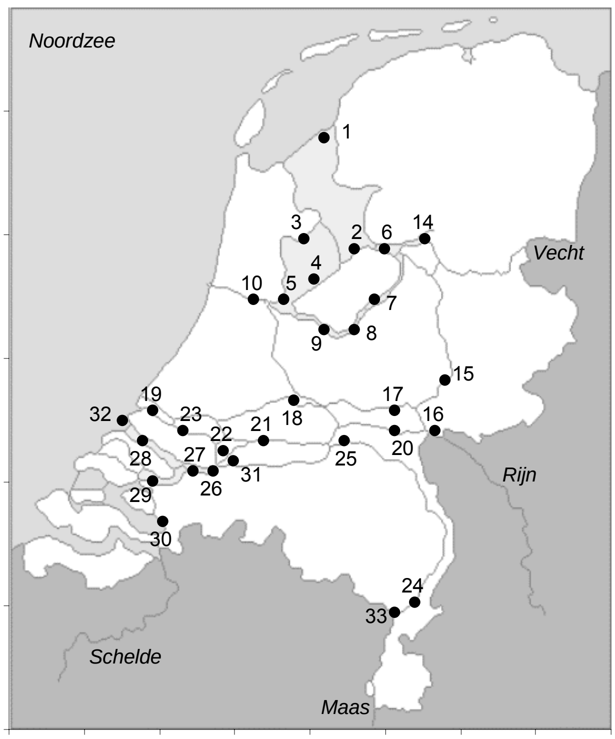



**Figure NL.12** Sampling sites for the 4-fyke monitoring of commercial catches and by-catch

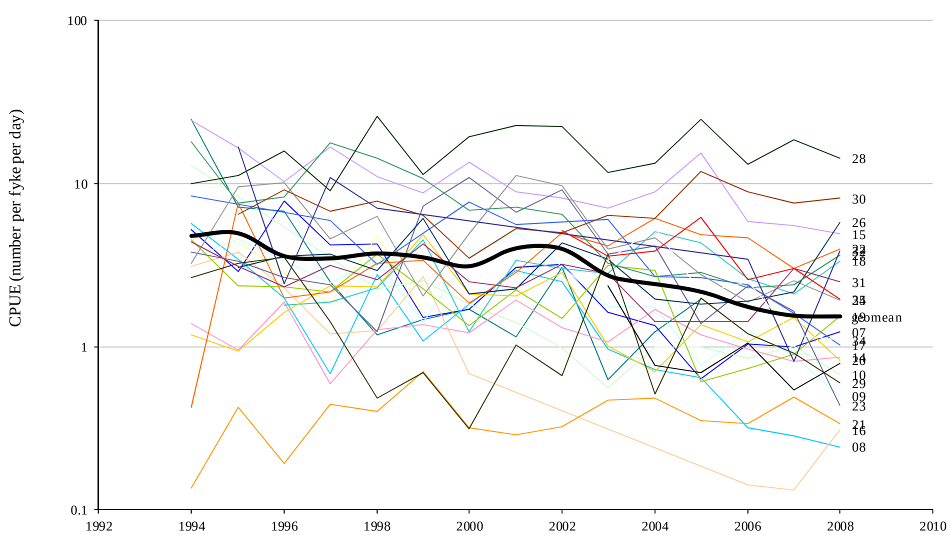



**Figure NL.13** Time trends in the 4-fyke monitoring of commercial eel catches per sampling site. The geometric mean (thick line) has been calculated for all available data in each year, irrespective of the spatial coverage.

## NL.8 Other Anthropogenic Impacts

Nothing to report under this heading.

## NL.9 Scientific surveys of the stock

### NL.9.1 Recruitment surveys

### NL.9.2 Yellow eel stock surveys

#### NL.9.2.1 Yellow eel stock surveys in Lake IJsselmeer

Figure NL.14 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.14 presents the raw data per year.

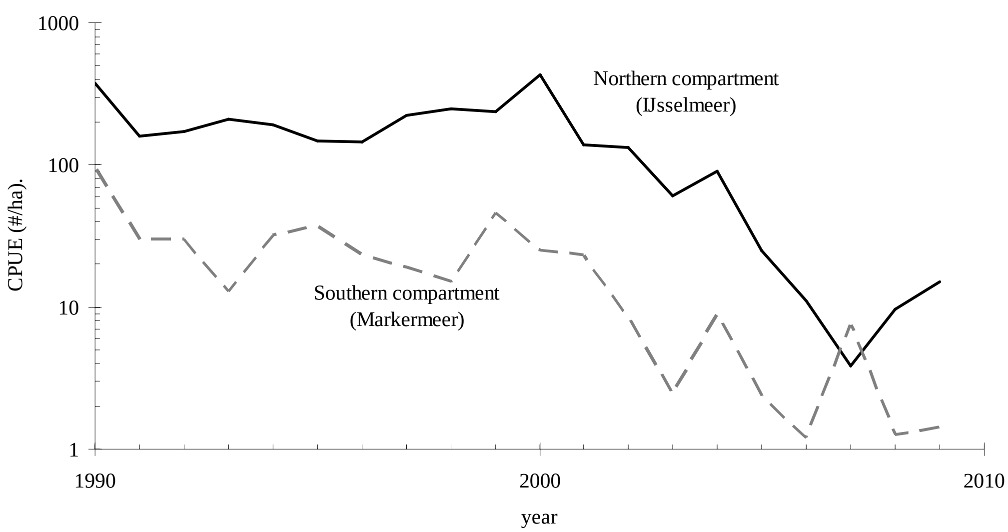
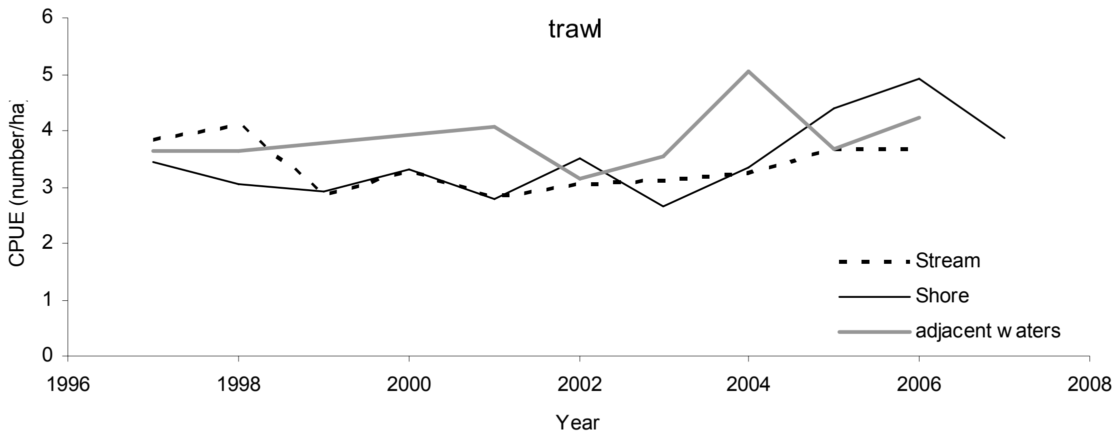



**Figure NL.14** CPUE trends in Lake IJsselmeer stock surveys, in number per hectare swept area, using the electrified trawl. Note: The northern and southern compartments are separated by a dyke.

### NL.9.2.2 Yellow eel stock surveys in the Main Rivers

Figure NL.15 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 shows a clear upward or downward trend.

Starting in 2008, the execution of these surveys has been granted to another consortium. The basic data are not yet available. The report published by that consortium (Kessel et al. 2008) seems to indicate that the eel stock has declined from 2007 to 2008 by an order of magnitude. This result is so unlikely, that for the time being no update of the data series is presented here.



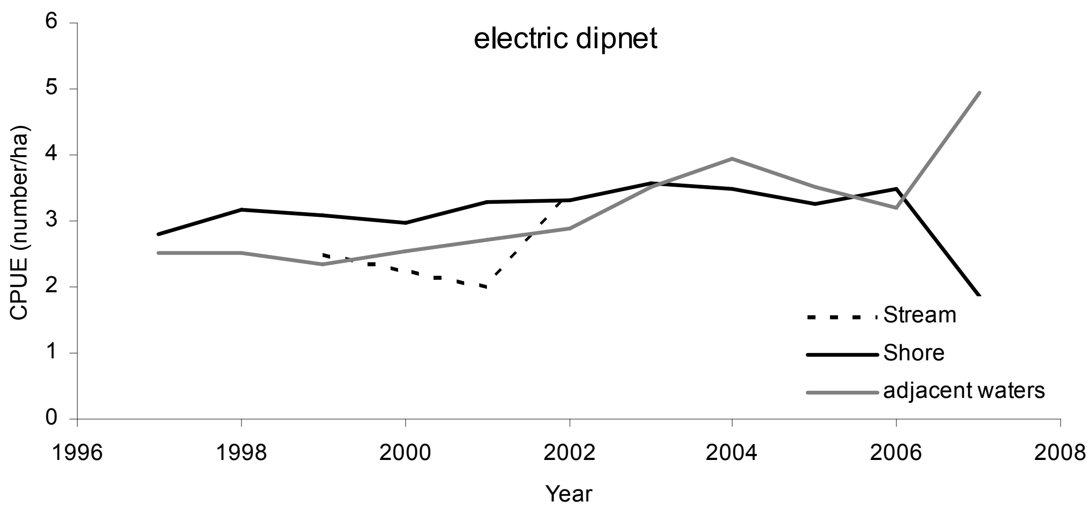




**Figure NL.15** Trends in CPUE in numbers per hectare, for the trawl (top) and electric dipnet (bottom), in the Main River surveys.

### NL.9.2.3 Yellow eel stock surveys in coastal waters

The number of eels caught in coastal surveys (Dutch Young Fish Survey) is presented in Figure NL.16. Until the mid-1980s, considerable catches of eel were observed. Since that time, a gradual decrease is observed.

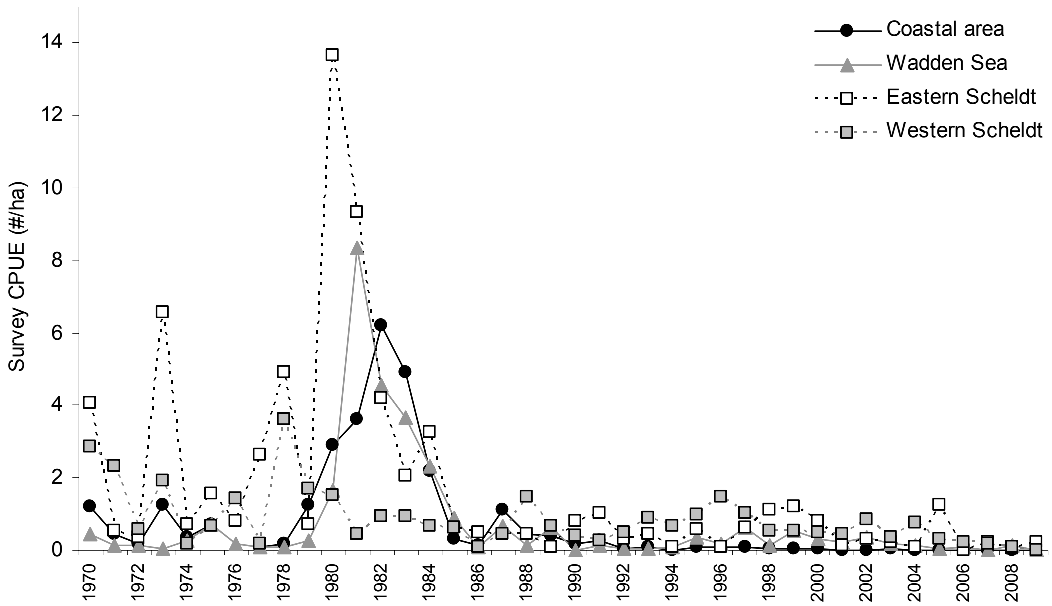



**Figure NL.16** Trends in coastal survey CPUE. Most of the Wadden Sea belongs to RBD Rhine; Eastern Scheldt is mixed Scheldt and Meuse; Western Scheldt belongs to RBD Scheldt (with an extra inflow from Meuse), Coastal area belongs to RBD Rhine.

A more elaborate statistical analysis of the abundance and length composition of the eel stock in coastal waters is presented in Dekker (2009b).

Overall, the yellow eel surveys are not representative for the whole River Basin Districts or the Country, especially since 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, while fisheries in the remainder of the country is 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.9.3 Silver eel surveys

There are no routine surveys for silver eel in the Netherlands. Ad hoc estimates based on tagging and/or transponder experiments are available from

- Klein Breteler, J., Vriese, T., Borcherding, J., Breukelaar, A., Jo¨rgensen, 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.

- Winter, H. V., Jansen, H. M., and Breukelaar, A. W. 2007. Silver eel mortality during downstream migration in the River Meuse, from a population perspective. – ICES Journal of Marine Science, 64(7):1444-1449.

A Silver Eel Index is currently being designed and is expected to be implemented in the autumn of 2011.

## NL.10 Catch composition by age and length

### NL.10.1 Long term trends in length compositions

For Lake IJsselmeer, the landings are regularly sampled at the auctions. Results have indicated extreme overfishing. Since the catch composition did not change much over the years (see Dekker 2004b), 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 shown a remarkable shift upwards (Figure NL.17). 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.

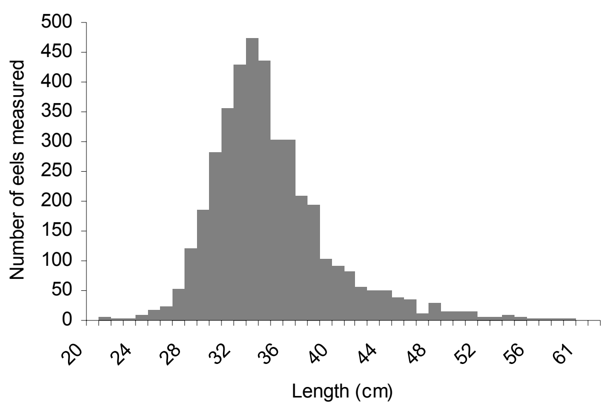



**Figure NL.17** Length frequency of fyke net catches in Lake IJsselmeer, in 2006.

## NL.11 Other biological sampling

### NL.11.1 Length & Weight & Growth (DCR)

For Lake IJsselmeer, the market sampling comprises measurements of length, weight, sex, maturity, liver weight, stomach content weight, parasitism (*Anguillicola crassus*), and otolith collection. In addition to the market sampling, an annual sample of 100 specimens is collected during the autumn stock survey on Lake IJsselmeer. This survey sampling conforms to the protocol for market samples. 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 has been performed. A pilot study has been started up in 2009, sampling two restricted areas (province Friesland 53ºN 5º45'E, main rivers), which will give insight in the statistical requirements of further sampling (see Section **NL. 14**). This programme continued in 2010, and will be implemented as a country-wide programme in 2011.

### NL.11.2 Parasites

The market sampling for Lake IJsselmeer collects information on the percentage of eels showing *Anguillicola* infection (Figure NL.18, based on inspection of the swim bladder by the naked eye). Following the initial break-out in the late 1980s, infection rates have stabilised between 40 and 60%. In recent years, the infection rate is slightly decreasing. As part of the extended market sampling program in 2009, data on *Anguillicola* infectionrates was also collected in two other areas (Friesland and Rivers). In both areas the infection rate was similar to the levels observed in Lake IJsselmeer over the past years.

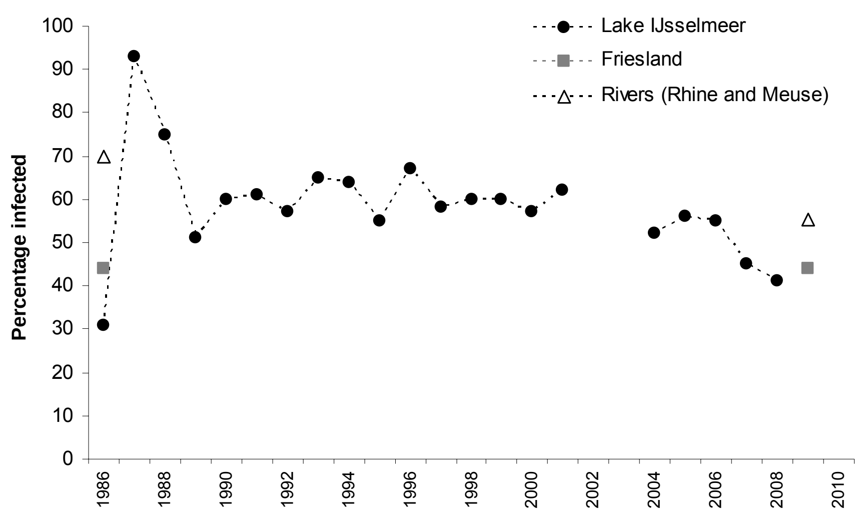



**Figure NL.18** Trend in *Anguillicola* infections in Lake IJsselmeer eel, Friesland and Rivers (Rhine and Meuse). Based on visual inspection by the naked eye.

### NL.11.3 Contaminants

In the 2009 country report some overviews were given for PCB contamination levels in eel in the Netherlands (see Hoek-van Nieuwenhuizen & Kotterman (2007) and Hoogenboom et al. (2007). The current eel monitoring has continued in 2009, and the last data have been added to Figure 20.

The situation has not changed over the years; waterways with input from the river Rhine or Meusse are more heavily polluted than waters without. Sedimentation areas of these rivers have the highest PCB concentrations. Of the analysed organic contaminants, PCBs are considered the most important contaminant, observed in the highest concentrations.

### NL.11.3.1 Spatial trend

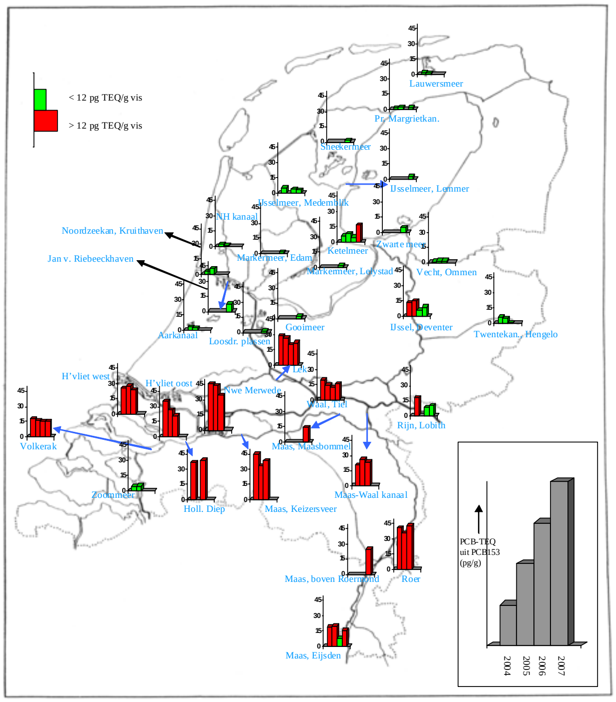



**Figure NL.19** Temporal trend in PCB in eel (from Hoek-van Nieuwenhuizen & Kotterman 2007).

### NL.11.3.2 Temporal trend

The temporal trend differs substantially between sampling locations, but overall a decline is observed. Figure NL.20 shows the trend in eels derived from Lake IJsselmeer and several places in the main rivers.

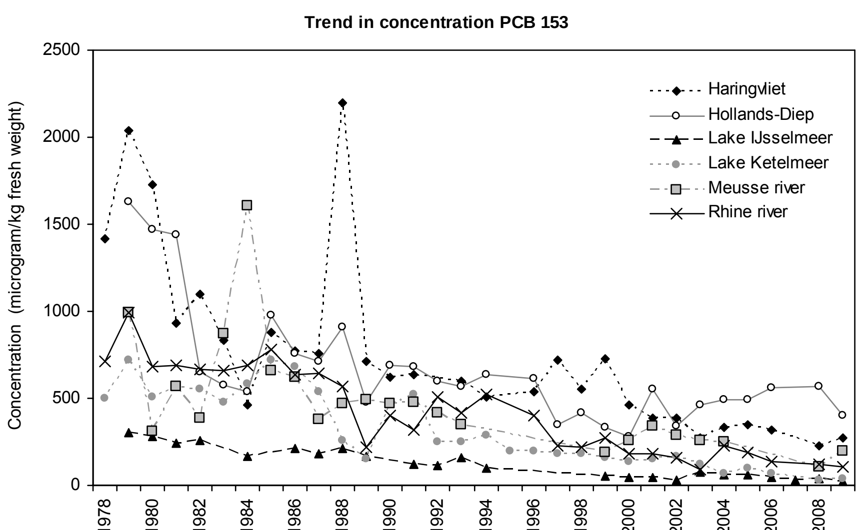



**Figure NL.20** Temporal trend in PCB in eel (data from IMARES and RIKILT).

As shown in the Figure NL.20 it is clear that a substantial decrease in PCB concentrations has been achieved, however, the current rate of decline is low. The major reduction has been achieved in the eighties and nineties. Compared to industrial contaminants like hexachlorobenzene (HCB) and hexachlorbutadiene (HCBD), both regulated also in the Water Framework Directive (WFD), the extent of decrease in PCBs is low. HCB and HCBD have declined from levels comparable to PCB153 around 1980 to levels as low as 10-20 µg/kg fresh weight in the more polluted areas of the Dutch rivers at the year 2000. This is a residual concentration of only 0.1 %. All these compounds are not being produced any more, but PCBs are clearly more persistent. This could be due to the higher amount produced, lower volatility and higher affinity to particles (organic matter). This results in a slower release to the environment where it can be taken up in the food chain, whereas other chemicals like HCB are washed out more quickly. In fact, the current PCB levels of suspended particulate matter (the future sediment) indicate that PCBs levels in eel will decrease only very slowly in the near future, if any.

### NL.11.4 Predators

Predation of eel by cormorants (*Phalacrocorax carbo*) is much disputed amongst eel fishermen and bird protectionists. The number of cormorant breeding pairs increased rapidly until the early 1990s, and then stabilised (Figure NL.21), remaining stable in recent years. For Lake IJsselmeer, food consumption has been well quantified (van Rijn & 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.

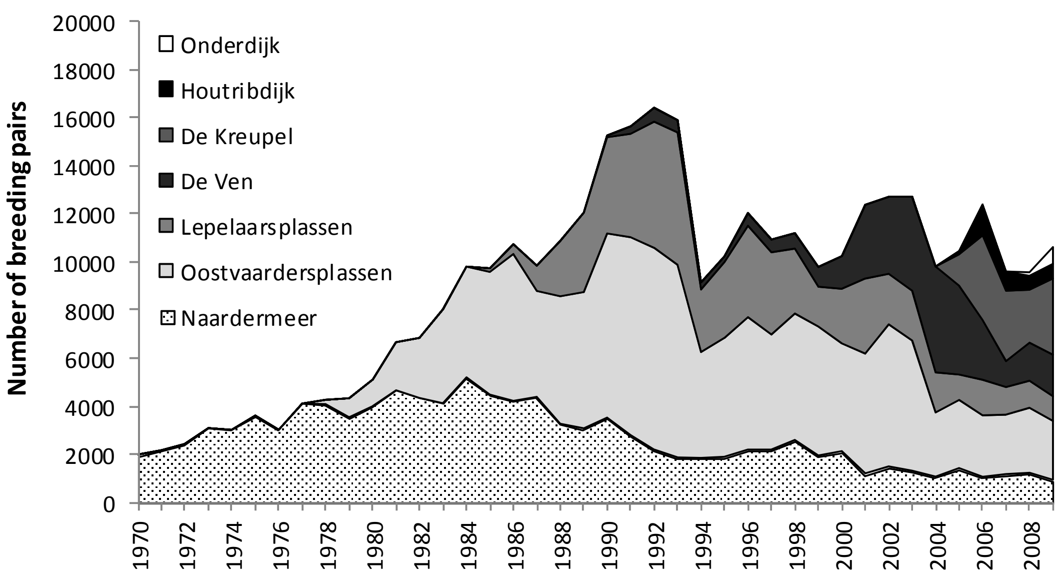



**Figure NL.21**. Trend in the number of breeding cormorants around Lake IJsselmeer, by breeding place. The breeding places are ordered from south (bottom) to north (top).

## NL.12 Other sampling

### NL.12.1 Recreational Fisheries Programma

Recently the EU installed additional regulations, which obliges Member States to estimate and report recreational catches of cod, eel, salmon, seabass, bluefin tuna, sharks and rays in European waters. To fulfil the requirements of the EU regulations, the Netherlands has implemented a Recreational Fisheries Programme to estimate the recreational catches of cod, eel, sharks and rays.

To collect data on fishing participation (e.g. "Have you fished in the past 12 months?"), assessing attitudes or awareness and/or socioeconomic and demographic profiling of recreational fishers, phone or mail recall surveys are straightforward, easy to administer and relatively cost-effective.

However, if detailed information on effort (e.g. "How many days have you fished in the past 12 months?"), catch (e.g. number or size) and/or economic activity is required, recall surveys are of limited applicability due to the impacts of recall bias, non-response bias, digit preference and/or prestige bias (Pollock et al 1994; Lyle et al 2002; Henry and Lyle 2003; Baharthah 2006).

The survey comprises of two components following Lyle et al. (2002) and Henry and Lyle (2003):

(1) **Screening Survey**: identify fishing households, profile fishing households, select participants for a follow-up, and

(2) **Diary Survey**: monitoring fishing (and economic) activity through regular contact (monthly) by survey interviewers.

Furthermore, an 'on-site' sampling program has been implemented to provide additional independent data on catch, size and species composition of recreational fishers along the coast, charter boats and private boats.

In principle the programme will cover all types of recreational fishery in the Netherlands and the information described below will become available for all species caught in recreational fisheries in fresh and marine waters. For eel, also information will become available on the ration caught in marine and fresh water. Screening Surveys (2009, 2011, etc) and 12 month Diary Surveys (2010, 2012 etc) are planned every other year. In 2011, priority will be given to the estimation of recreational catches of North Sea cod. In principle, new estimates of cod, eel and shark catches will be available in 2011, 2013 and so on.

*Screening Survey*

The demographics of the frame population (56,730 households) is selected and maintained by one of the largest commercial marketing companies in the Netherlands (TNS-NIPO) to ensure its frame population does not deviate from the demographics of the whole Dutch population as determined by the Central Bureau of Statistics. The Screening Survey was offered 'blind' to the 56.730 households towards the end of December 2009. Every month the commercial marketing company (TNS-NIPO) sends a questionnaire about a range of divers topics (social, politics, products) to the households in its database. The households do not know what the topics are when they start filling in the online questionnaire and they are not allowed to skip topics or pick and choose topics. The general (including questions on recreational fisheries) online survey of TNS-NIPO in December 2009 was completed by 45.518 households (109.264 people). Preliminary results of the 2009 Screening Survey showed that around 1.7 million people (predominantly males older than 15 years) participated in recreational fishing (Figure NL.22). The number of recreational fishermen has remained relatively stable since the mid 1990s.

*Diary Survey*

During the Screening Survey, people were not only asked if they had participated in freshwater and/or marine recreational fisheries and if they wanted to participate in a 12 month Diary Survey but also to indicate roughly how often they had fished in the past 12 months to determine the level of fishing 'avidity' (1-5, 5-10, 10-25, 25-50, >50 annual fishing trips). As expected the level of avidity was higher among the people that indicated to be willing to participate in the 12 month Diary Survey compared to the avidity of all the people in the screening survey. To avoid this type of bias (overestimation of the catch because the participants of the Diary Survey are more fanatic than the average recreational fisher), the demographics (including avidity) of the 2000 people selected for the Diary Survey was similar to the demographics of the recreational fishers as determined during the Screening Survey. Participants of the Diary Survey were asked to maintain to carefully maintain a logbook. Since March 2010 the 2000 participants are approached on a monthly base by staff of TNS-NIPO and requested to transfer the data recorded in their logbooks to online questionnaires. Participants of the Diary Survey record per fishing trip detailed information on the fishing location, gear, catches (species, size), ratio kept-retained, reason released, motivation and satisfaction and expenditure. Preliminary results of the Diary Survey show that a small percentage of eel are caught (and released) by recreational fishermen in both inland and marine waters (Figure NL.23).

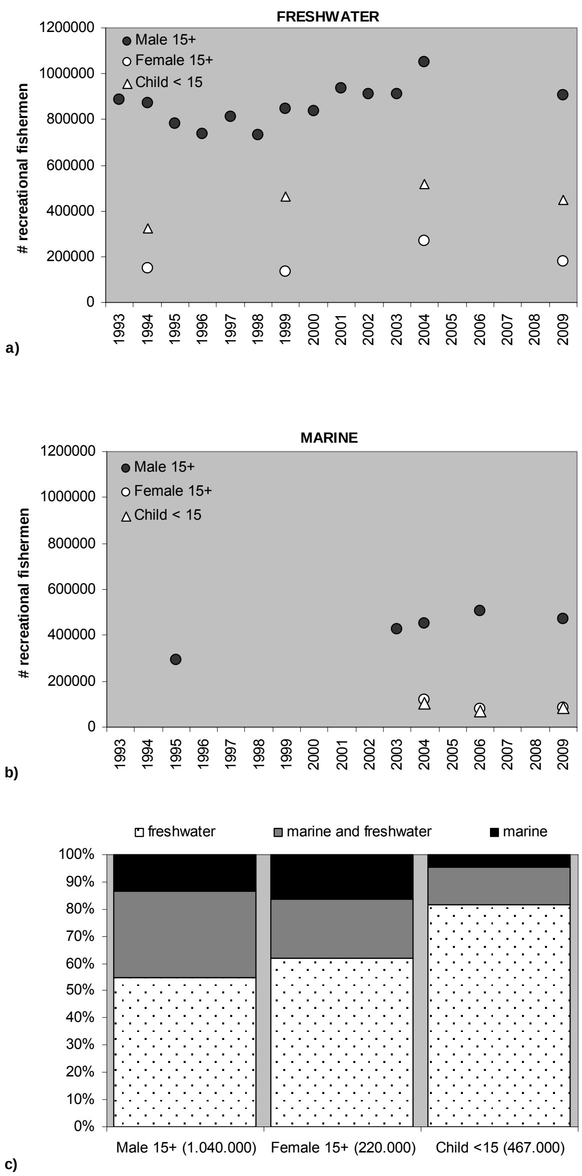
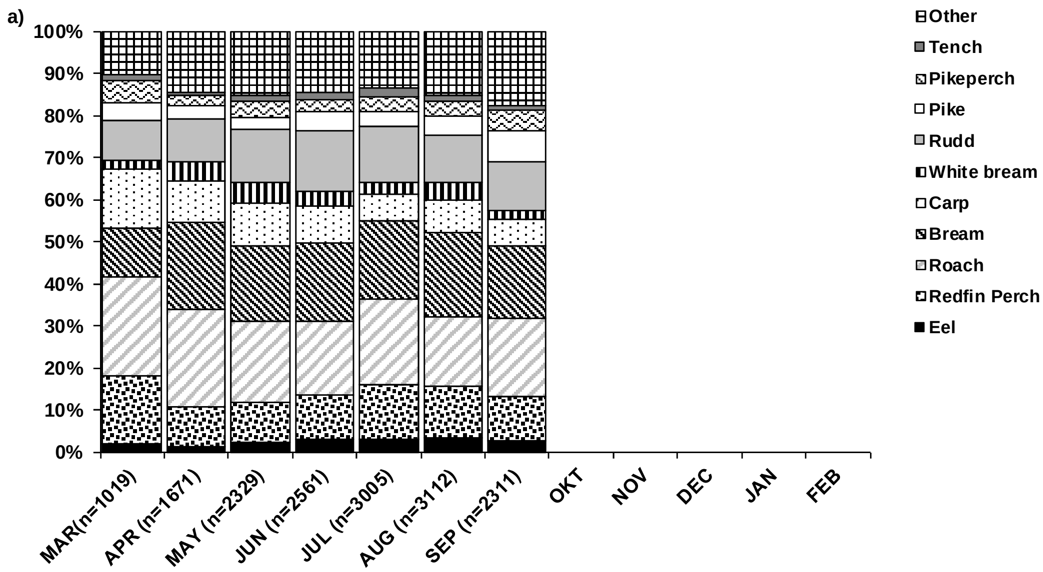



**Figure NL.22** Number of recreational fishermen in inland (a) and marine (b) waters since the 1990s and (c) the distribution of recreational fishers that fish only in inland waters, only in marine waters or fish in both types of water for each of the major demographic groups.



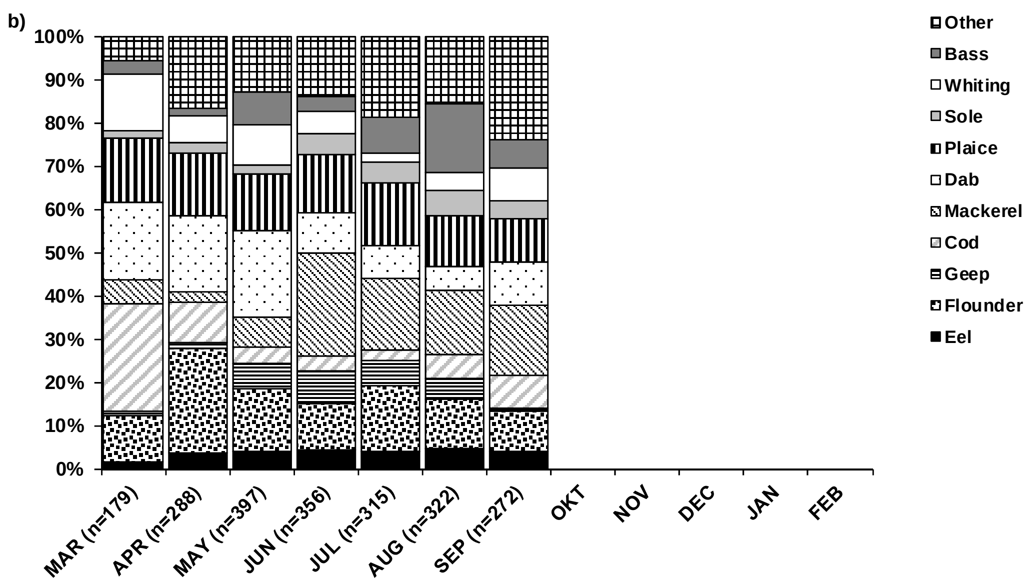




**Figure NL.23** Species composition of the recreational fisheries in inland waters (a) and marine waters (b) based on preliminary results of the diary survey of 2000 fishers.

### NL.12.2 Use of light traps in glass eel monitoring

**Figure NL.24** The two types of light traps used during the pilot studies in 2009 (left) and 2010 (left and right) to collect glass eel.

Glass eel recruitment has been monitored at Den Oever since 1938 using a lift net. Due to the dramatic decline of glass eel recruitment, the annual lift net glass eel monitoring program is in serious trouble (Dekker 2004c). Cost of the current labour-intensive lift net programme are high and the drastic decline of the glass ell catches have serious negative consequences for the statistical reliability of the collected data and for the motivation of the participating field staff. Dekker (2004) concluded that the development of a new, reliable and cost-effective method which provides a higher resolution at the low glass eel recruitment level was of utmost importance for the management of the depleted eel stocks.

Leijzer et al (2009) tested several methods to monitor glass eel and their results indicated that light traps could maybe provide an alternative for lift nets in the glass eel recruitment programme. The light trap (Figure NL.24 left) developed by Leijzer et al (2009) was cheap, easy to handle by one person. Also in the initial experiments the catches showed similar temporal patterns as the lift nets. Leijzer et al (2009) concluded, however, that before light traps could be deployed in the field the method required further fine tuning (size and shape, light intensity, optimal position in the water column).

In 2009 glass eel recruitment patterns were similar at Den Oever were similar between the two methods (Figure NL.25b). However, in 2010 the light traps appeared to have failed completely to pick up some of the earlier peaks in glass recruitment in April 2010 (Figure NL.25a). In order to determine the usefulness of light traps to deliver reliable data on absolute numbers of glass eel several retention experiments were conducted. Both types of light traps were filled with 15-20 glass eels and after 48 hours the number of remaining glass eels was determined. Unfortunately the ability of both types of light traps to retain glass eels was low (Figure NL.25c). This unexpected result makes light traps less attractive and suitable to replace the lift nets at several of the locations in the glass eel monitoring program.

A second problem with the traditional lift net program was the increase in the percentage of zero catches (<5% 1960-1980 to 30-40% in recent years) and its negative effect on the reliability of the data. Again, the type of light traps used in these trials will not improve this issue of increasing percentage of zero-catches at low glass eel densities. In 2009 and 2010 the percentage of zero-catches of light traps were even higher at 80 to 90%

The result of the pilot studies with the two types of light traps clearly demonstrate that these types light traps could, at most, be used to determine relative seasonal patterns in recruitment of glass eel but are no improvement on the current lift net program.

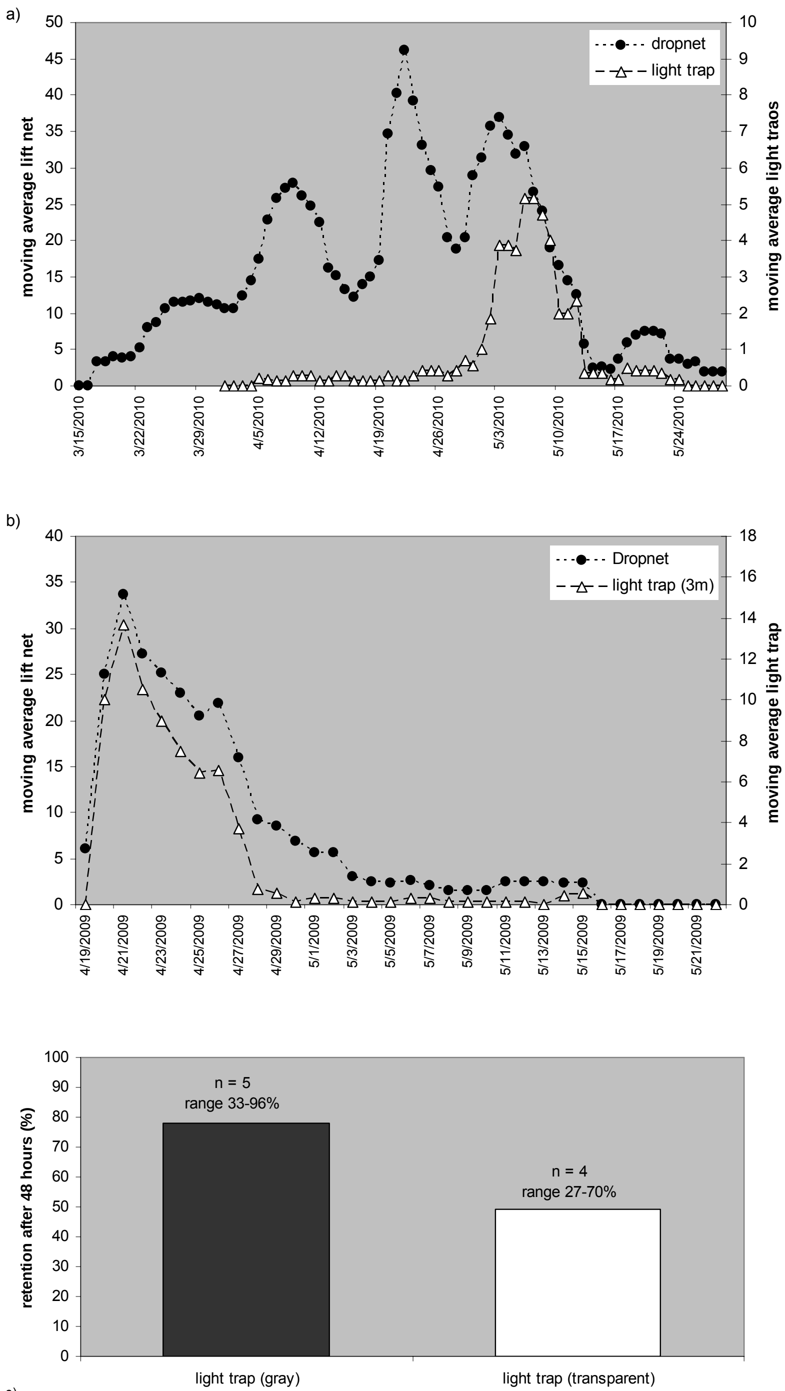



**Figure NL.25** Comparison of seasonal changes in glass eel recruitment observed with lift nets and light traps in 2010 (a) and 2009 (b). Retention of glass eels in both types of light traps in 2010 (c).

## NL.13 Stock assessment

### NL.13.1 Local 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 shows 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 (reducing F to 0.08) would be a further reduction of fishing gear by 75% of recent effort (since 2006), resulting in 400 fykes, 1600 summer fykes and 1850 eel boxes, or another combination with the same effect.

### NL.13.2 International stock assessment

#### NL.13.2.1 Habitat

An overview of habitats available is presented by Dekker et al. (2008), based on the information in Tien & Dekker (2004, 2005), complemented with data from various sources. The summarising table is reproduced here in Table NL.k.

**Table NL.k** Overview of available water surface in the Netherlands, in hectares.

| Province | Ditches † | Canals † | Lakes ‡ | Rivers | Coastal waters | sum |
|---|---|---|---|---|---|---|
| Friesland | 5,345 | 7,057 | 9,454 | | - | 21,856 |
| Groningen | 2,003 | 2,040 | 6,905 | | 3,843 | 14,791 |
| Drenthe | 657 | 503 | - | | - | 1,160 |
| Overijssel | 1,516 | 1,985 | 1,872 | | - | 5,372 |
| Gelderland | 831 | 733 | - | | - | 1,564 |
| Flevoland | 3,115 | 4,959 | - | | - | 8,074 |
| Utrecht | 1,699 | 2,349 | 2,699 | | - | 6,747 |
| Noord-Holland | 5,227 | 7,938 | 1,243 | | - | 14,408 |
| Zuid-Holland | 4,843 | 6,935 | 7,454 | | - | 19,232 |
| Zeeland | 2,421 | 2,873 | 17,871 | | 95,745 | 118,909 |
| Noord-Brabant | 1,247 | 1,241 | - | | - | 2,488 |
| Limburg | - | - | - | | - | - |
| | | | | | | |
| Larger water bodies | | | | | | |
| Randmeer | | | 16,110 | | - | 16,110 |
| IJsselmeer/Markermeer | | | 169,150 | | - | 169,150 |
| Rijn & Maas | | | | 18,067 | - | 18,067 |
| kleinere rivieren | | | | 2,800 | - | 2,800 |
| Waddenzee, incl Eems | | | - | | 259,214 | 259,214 |
| Zeeuwse Delta | | | 17,871 | | 95,745 | 113,616 |
| | | | | | | |
| sum | 28,905 | 38,610 | 232,758 | 20,867 | 358,802 | 679,942 |

†For ditches and canals, only the areas less than 1 m above sea level have been considered.

‡Fresh water areas in the south-western delta have been included under Lakes, the saline waters under Coastal Waters.

### NL.13.2.2 Silver eel production

The IJsselmeer eel stock constitutes approx. 30% of the total stock in the Netherlands (see Table NL.a), and is well documented. For the rest of the country, information is scarce or lacking. Consequently, estimates of silver eel production can only be given for Lake IJsselmeer. According to Dekker et al. (2008), historical landings were in the order of 3000 t, 10% of which was made up of silver eel. Based on the assessment of Dekker (1996, 2000c) of the stock in the early 1990, assuming a linear relationship between recruitment and production, the historic potential production is estimated at approx. 7700 t, 10% of which is made up of males. This historic extrapolation is in reasonable agreement with the historic landings. The actual escapement in the early 1990s was estimated by Dekker (1996, 2000c) to be approx 11 t; current escapement will be somewhat lower, because of declining recruitment; indeed, landings declined in parallel with recruitment. Recent information on silver eel landings is unreliable, due to misclassifications of life stages and/or the trading of eel from other areas at IJsselmeer auctions. According to these statistics, approx. 50% of the current landings (120-130 t) is made up of silver eel.

For the remainder of the country, Klein Breteler (2008) provided an estimate of potential production, based on historic landings per ha of 4 (coastal waters) to 25 (rivers) kg/ha, a minimum production of 10,000 – 15,000 t is derived.

#### NL.13.2.2.1 Historic production (*$B_0$ = 13.000 t*)

**Table NL.I:** Overview of the different estimations of $B_{pristine}$ , $B_{lim}$ , $B_{current}$ and $B_{best}$ for eel in Lake IJsselmeer and the Netherlands.

| **Lake IJsselmeer** | | | | | **Netherlands** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $B_{pristine}$ | $B_{lim}$ | $B_{current}$ | $B_{best}$ | | $B_{pristine}$ | $B_{lim}$ | $B_{current}$ | $B_{best}$ | |
| | | | 770 t | Dekker 2000 | | | | min. 1455 t | Dekker et al. 2008b (Table NL. n) |
| 7700 t | 3080 t | 11 t (1990) | | Dekker et al 2008a | 10.000-15.000 t | 4.000-6.000 t | 200 t | | Klein Breteler 2008 |
| | | | | | | 221 t | | | Combinatie van Beroepsvissers 2008 |
| | | | | | | 2.600-8.100 t "probably lower" | | | Eijsackers et al. 2009 |
| | | | | | | 2600-8100 t "probably lower" | | | Nederlandse Aalbeheerplan Juli 2009 |
| | | | | | 13.000 t | 5.200 t | | | ICES 2009 |

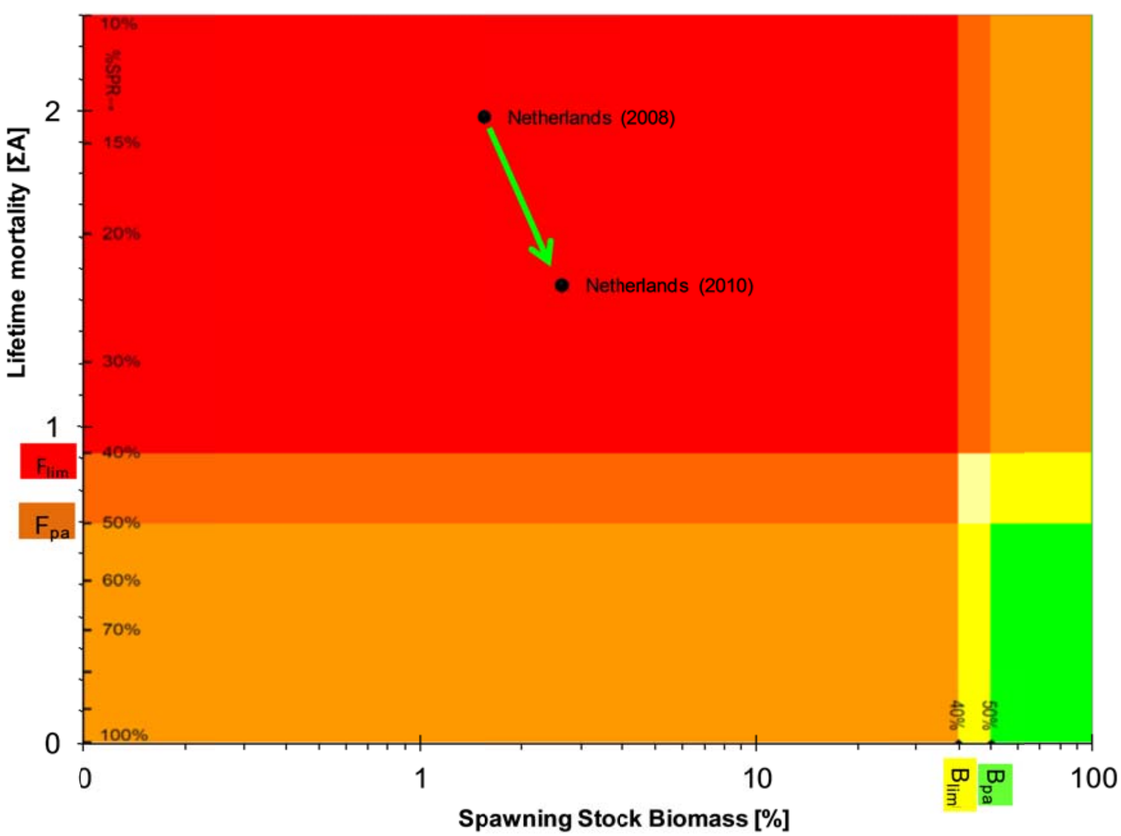



**Figure NL.26** Modified Precautionary Diagram for Lake IJsselmeer and the Netherlands (data from Table NL.I)

#### NL.13.2.2.2 Current production (*$B_{best}$ = 1455 t*)

$B_{best}$ = 200t (current escapement) + 1255 t (anthropogenic mortalities; Table NL.n) = 1455 t.

#### NL.13.2.2.3 Current escapement (*$B_{post(2009)}$ = 340 t*)

Bpost/2010 is 200 t plus the estimated increase in escapement due to the closed season (target 50% reduction in fishing mortality), therefore $B_{post}$(2010) = 200 t + 50% 280 t silver eel catches (Table NL.n) = 340 t.

#### NL.13.2.2.4 Production values

Combining the information on production from Table NL.a with the data on water surfaces from Table NL. k, estimates of productivity result in Table NL.m..

**Table NL. m** Production values by water type. Data derived from Dekker et al (2008).

| | IJsselmeer/ Markermeer | Rivers | Coastal waters | Other waters | Total |
|---|---|---|---|---|---|
| Number of fishing companies | 73 | 28 | 48 | ca. 100 | 249 |
| Surface area, ha | 169,150 | 20,867 | 354,959 | 134,966 | 679,942 |
| Landings, tons | 280 | 150 | 115 | 375 | 920 |
| Surface area per company, ha | 2,317 | 745 | 7,395 | 1,350 | 2,731 |
| Landings per company, kg | 3,836 | 5,357 | 2,396 | 3,750 | 3,695 |
| Landings per surface area, kg/ha | 1.66 | 7.19 | 0.32 | 2.78 | 1.35 |

#### NL.13.2.2.5 Impacts

Vriese et al. (2007) and Dekker et al. (2008) estimated quantities of eel impacted by anthropogenic impacts, from which the summary in Table NL.n is compiled. In the majority of cases, the relative impact on the stock is unknown. For Lake IJsselmeer fishery, current fishing mortality $F \approx 0.33$ per annum (Dekker et al. 2008). For hydropower generation in the main rivers, the impact on the silver eel is estimated at $H \approx 16 - 34$ % per run. For all other factors and other areas, the relative impact is unknown, and consequently, the interaction and overlap between different mortality sources can not be assessed.

**Table NL.n** Estimated quantities of eel, by anthropogenic impact. Data from Vriese et al. (2007) and Dekker et al. (2008).

| Impact | Yellow eel | Silver eel | Yellow & Silver |
|---|---|---|---|
| Cormorants | 50 | 0 | 50 |
| Barriers | ? | ? | ? |
| Pumping stations | 50 | 40 | 90 |
| Parasites | ? | ? | ? |
| Pollution | ? | ? | ? |
| Inland fishery | 640 | 280 | 920 |
| Marine fisheries | 20 | 0 | 20 |
| Sports fishing | 200 | 0 | 200 |
| Hydropower | 4 | 15 | 19 |
| ***Total*** *(min. est.)* | *970* | *335* | *1305* |

#### NL.13.2.2.6 Stocking requirements < 20 cm

The Dutch EMP mentions a budget of 300 k€, but additional budget may become available from private sources. It is unclear what quantities of eel will be purchasable for this budget, while a turbulent price development is expected, because of the implementation of CITES restrictions and the impact of restocking programmes on the glass eel market.

#### NL.13.2.2.7 Data quality issues

Nothing to report.

## NL.14 Sampling intensity and precision

Dekker (2008) gave an overview of analyses of sampling intensity and precision of sampling programmes based on historical (up to present) data, repeated below. In 2009, a statistical pilot study is being conducted for sampling commercial catches outside Lake IJsselmeer. To this end, samples of 100-200 eels are taken from the catch of some ten fishers each month in the province of Friesland (53ºN 5º45'E); a parallel programme was started up in 2010 in the main rivers.

### NL.14.1 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 amongst 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 lower 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).

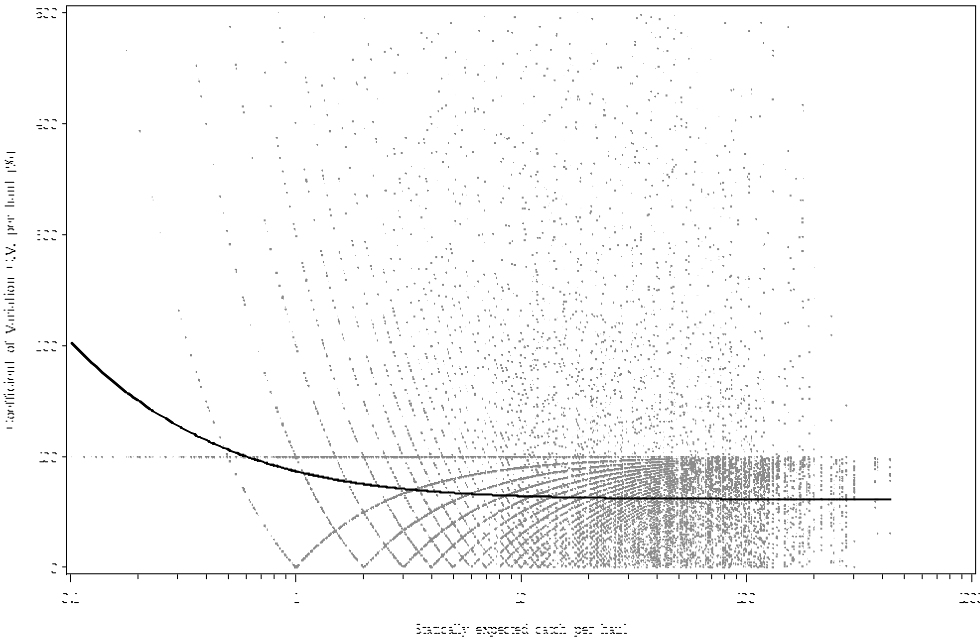


**Figure NL.27**. Relation between the statistically expected catch (horizontal) and the coefficient of variation (vertical) for the glass eel sampling at Den Oever. The dots represent the individual observations (one haul at a specific hour at a specific day), the line the functional relationship between residual and expectation (Var ∞ $mean^2$+mean). Since 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%.

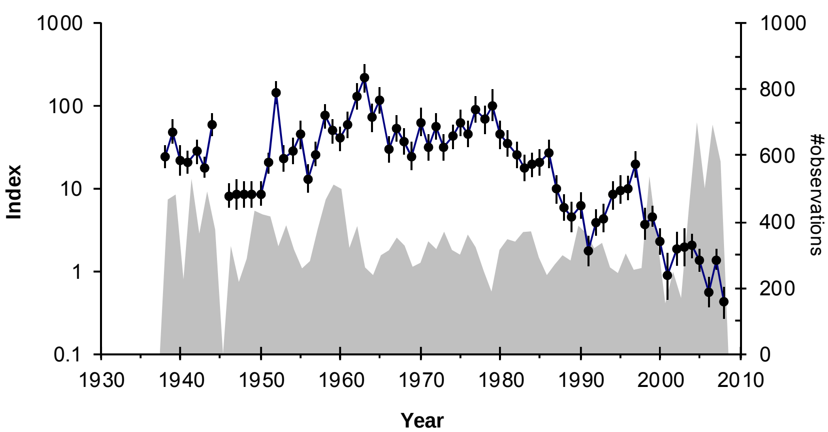



**Figure NL.28**. Time series of the recruitment series in Den Oever, presenting the index and confidence intervals (± 1 SD).

### NL.14.2 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.14.3 Length composition from market sampling: Lake IJsselmeer

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

#### NL.14.3.1 Spatial variation

The spatial variation in mean length of fyke net 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.29).

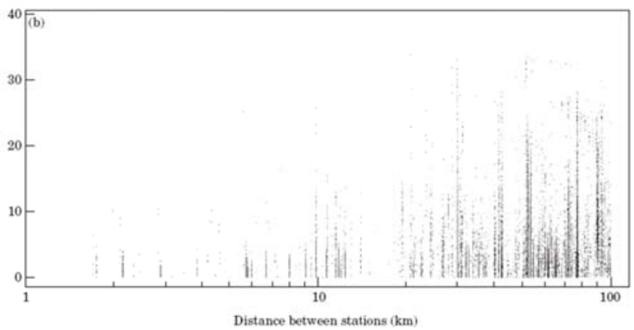



**Figure NL.29** Variogram of mean length of yellow eel in fyke nets, outside Lake IJsselmeer (Dekker 2000a). The vertical axis shows the difference in mean length between two samples, the horizontal axis the spatial distance between the two samples.

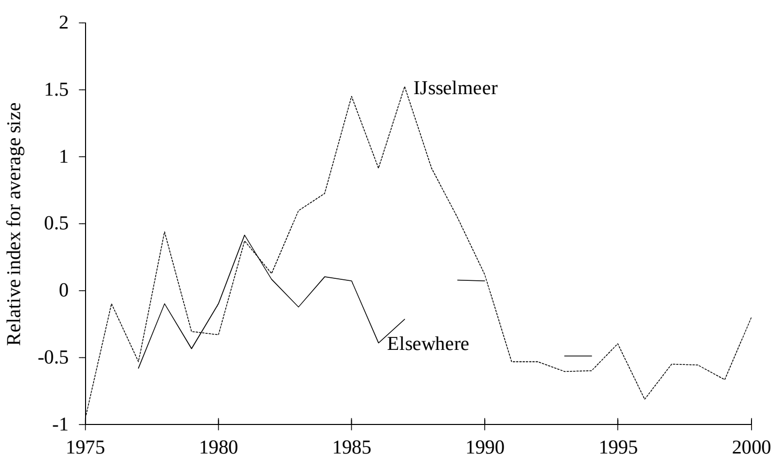



**Figure NL.30** Relative change in size composition of eel landings. Positive values indicate a shift towards larger size classes. In Lake IJsselmeer, effort reductions and the recruitment failure in the 1980s initially shifted the length composition gradually to higher values. When the low recruitment had progressed into even the largest size classes, the mean size restored to normal values. Elsewhere, the data showed less variability. Presumably, sampling ceased before the 1980s recruitment failure had progressed into the exploited length classes.

### NL.14.3.2 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.o), 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 due to year-to-year differences in length composition (Table NL.o, Figure NL. 30**)**. From 1975 until 1987, a gradual shift towards larger sizes was observed; between 1987 and 1989, a rapid decrease occurred (Figure NL. 30).

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

**Table NL.o** 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; 19657 eels. See Dekker (2004a) for details on the data and statistical model.

| source | deviance | df | 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 | 15035 | 179 | 83.99 | 63.22 | <.0001 |
| residual | 25877 | 19477 | 1.33 | | |
| total | 40912 | 19656 | 2.08 | | |

### NL.14.3.3 Comparison of spatial and temporal variation

The variogram of Figure NL. 29 (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.29 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.p). The spatial variation in length composition of the catches exceeds the temporal variation by more than a factor 20. However, this data set 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.p** 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 | df | 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 | 13262 | 9827 | 1.35 | | |
| total | 19051 | 9870 | 1.93 | | |

#### NL.14.3.4 Precision of estimates

The analyses of variance presented in Table NL.o and Table NL.p 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.31). 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.

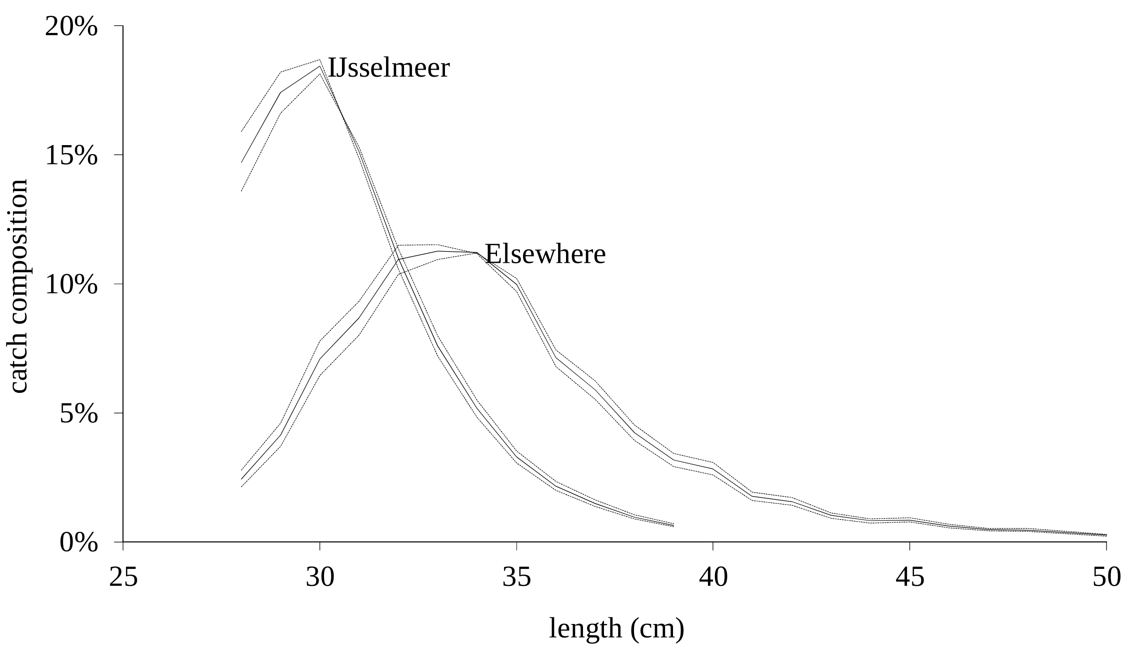


**Figure NL.31** Average length composition of fyke net catches, with confidence intervals (±1 std), for Lake IJsselmeer and Elsewhere, based on the entire historical data sets. The presented length distributions conform to the situation in 1990.

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.

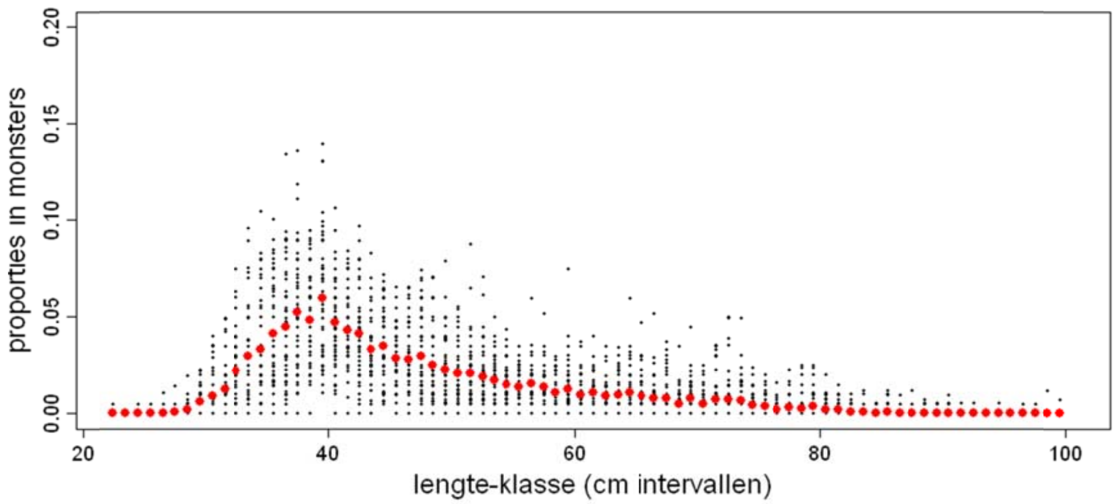
### NL.14.4 An evaluation of the strategy of the Dutch market sampling program for eel

The Netherlands are required, as described in the Data Collection Framework (DCF) directive of the European Union, to monitor the catches and effort of eel fishermen, as well as perform biological market sampling in order to estimate the biological composition of the catches, most notably the length frequency composition. The DCF requires that sampling programs are set up in such a way that length frequency distributions (LFs) can be estimated with a particular precision level. In order to determine the precision with which LFs can be estimated a pilot project was set up in 2009 in the Netherlands, to determine the sampling intensity. In two areas, Friesland and the Rivierengebied, monthly samples of unsorted landings on a number of locations were taken.

#### NL.14.4.1 Estimation of precision levels of length frequency distributions

In order to be able to estimate the CV of the LFs, several choices have to be made. The most important choice is the level of detail that is required, in terms of the width of the length class intervals. The LFs will become increasingly smooth (and thus The CVs decrease) for increasing widths of length intervals. This has not been defined in the DCF. We have chosen a length class width interval of two centimeters, given that it is possible that such detailed information is necessary in order to parameterize stock assessment models which include growth. Furthermore, in order to compute the CVs of the whole catch, it is necessary to have an overview of the sampling frame: the combinations of months by locations with eel catches. This sampling frame will however not be available until later in 2010. The statistical methodology which was used to estimate the CVs is given in Appendix A.

An graphical representation of the LFs and the uncertainty surrounding these is given in Figure NL.32 and Figure NL33. The estimated CVs of the LFs for various widths of length class intervals are given in Table NL.q. For Friesland, and widths of length classes of two centimeters, the estimated CV is 9.3%, which is high enough to comply with the demands of the DCF (the DCF requires a maximum of 12.5%). However, for the Rivierengebied, the estimated precision falls just short with 13.5%. However, given that a greater number of months are planned to be included in the sampling program next year, the expectation is that the precision levels will be sufficient next year.




**Figuur NL.32** Estimated Length frequency distributions for Friesland. On the horizontal axis length class intervals of one centimeter are given. On the vertical axis, proportions as given in the samples.

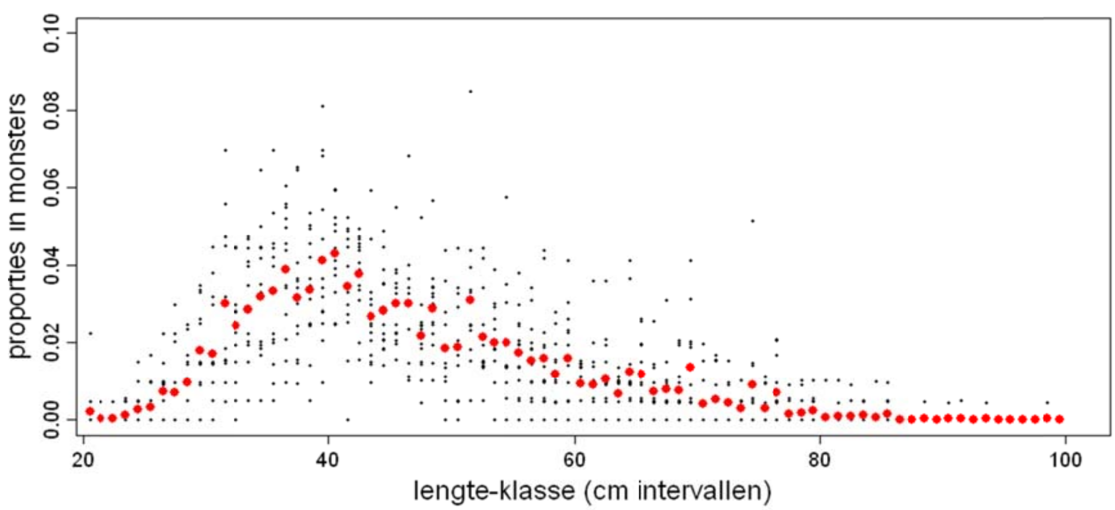



**Figure NL.33** Estimated Length frequency distributions for the Rivierengebied. On the horizontal axis length class intervals of one centimeter are given. On the vertical axis, proportions as given in the samples.

**Table NL.q** Estimated coëfficients of variation of the length frequency distributions , for three widths of length intervals (1, 2 and 3 centimeters). for the areas of Friesland and the Rivierengebied. The length-frequency distributions become increasingly smooth (and thus The CVs decrease) for increasing widths of length intervals.

| Lengte-klasse | Friesland | Rivierengebied |
|---|---|---|
| 1 cm | 10.9% | 17.3% |
| **2 cm** | **9.3%** | **13.5%** |
| 3 cm | 8.3% | 12.6% |

### NL.14.4.2 A simulation study for the evaluation of the sampling strategy

Using the data collected during the pilot study, a simulation study was done to evaluate expected precision levels for various sampling strategies. The sampling strategies varied in the numbers of locations that were included in the survey, as well as the number of eels per sample at each location visit. The simulation study was done by using the length data of eels of the pilot study, and sampling location by month combinations at random with replacement. The sample sizes at each location by month combination was varied from 100 to 200 eels per sample. The results are given in Table NL.r, and indicate that precision increases rapidly with increasing numbers of locations. Instead, precision levels depend to a lesser extent upon the numbers of eels per sample at each location visit. This conclusion is strengthened by a closer investigation of the sources of variation of the data which revealed that month and location effects are important (van Keeken et al. 2009). Thus, our recommendation for the sampling program is to keep the same numbers of locations, or reduce this only slightly, whereas the numbers of eels sampled per location can be halved. This is in line with sampling theory, in which a rule of thumb is that increasing the number of primary sampling units (locations by month visits in this example) will have a larger effect on precision than increasing the number of secondary sampling units (numbers of eels per sample).

**Table NL.r** The results of the simulation study to evaluate expected precision levels for various combinations of sample sizes of primary (location by month visits) and secondary (numbers of eels per sample at each location visit) sampling units. Given are CVs of the length frequency distributions.

| | No. locations | | | | | |
|---|---|---|---|---|---|---|
| **No. eels** | **5** | **6** | **7** | **8** | **9** | **10** |
| **100** | 16.1 | 14.8 | 13.7 | 12.9 | 12.2 | 11.5 |
| **125** | 15.3 | 14.0 | 13.0 | 12.3 | 11.5 | 10.9 |
| **150** | 14.7 | 13.6 | 12.5 | 11.8 | 11.1 | 10.6 |
| **175** | 14.5 | 13.3 | 12.3 | 11.6 | 10.9 | 10.3 |
| **200** | 13.4 | 12.3 | 11.4 | 10.7 | 10.1 | 9.6 |

### NL.14.4.3 Statistical Methodology which was used for estimating the precision levels

The target population are the total catches in the area of interest, whilst the sampling frame is defined as combinations of access points by access times. Access points in this context are eel fishery locations, whilst access times are periods during which eel catches are kept in order for a sample of sufficient size to be taken (usually a few days). The sampling strategy was to take a clustered (multi-stage) sample, where combinations of access points and times were spaced systematically throughout the fishing season. Then, at each period at each location, a cluster of (if possible) 200 eels were sampled. Here, we use the well-known result from statistical practice that the between-cluster variance estimator is an unbiased estimator of the variance of a linear statistic such as the estimator of the population mean (Cochran 1977; Williams 2000; Woodruff 1971; Pennington 2002).

Let j be an indicator for the length-class, and i an indicator for location. Then:

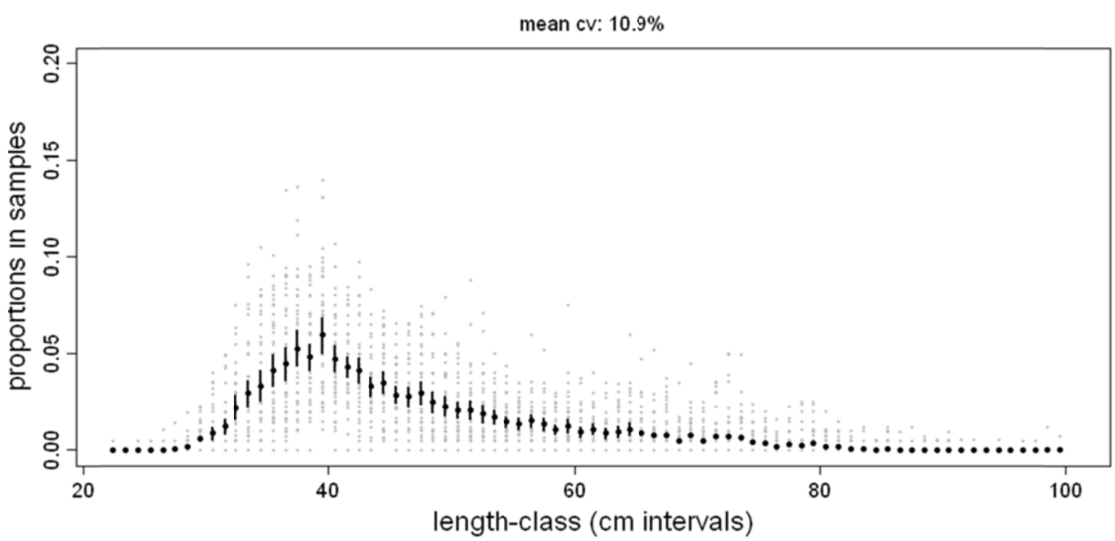
$$\sigma_j = \sqrt{\frac{\sum_i^{n_i} \left( p_{j,i} - \hat{p}_j \right)^2}{(n_i - 1) n_i}}$$

provides an estimate of the standard error of the mean proportion of length class j.

Then, let set A denote the length classes which together constitute the 90% Highest Density Interval of the mean length-frequency, and $N_A$ the number of length classes in set A. Then the average coefficient of variation in the 90% HDI is given by:

$$\overline{CV} = \frac{1}{N_A} \sum_{\in A} \frac{\sigma_j}{\hat{p}_j}$$

Example given, for length intervals of one centimeter:



## NL.15 Standardisation and harmonisation of methodology

### NL.15.1 Survey Techniques

***Glass Eel Monitoring***

| Gear | Location | Frequency | Time | Period |
|---|---|---|---|---|
| liftnet (1x1m; mesh 1x1mm) | Den Oever | daily | 5 hauls every 2 hours between 22:00-5:00 | ~Mar-May |
| | 10 other locations along the coast | weekly | 2 hauls at night time | |

***Passive Monitoring Program: Main Rivers and Lake IJsselmeer***

| Gear | Location | Frequency | Period |
|---|---|---|---|
| Summer fykes (4) (stretched mesh 18-20mm)<br>Fykes (4) (stretched mesh 18-20mm) | 34 locations in main rivers, estuaries and lakes | continuous | ~May-Sep |

***Active Monitoring Program: Main Rivers***

| Gear | Location | Frequency | Period |
|---|---|---|---|
| bottom trawl (channel; 3m beam; 15mm stretched mesh) | ~50 locations in main rivers | 10 min trawl, ~1000m transect | ~May-Sep |
| Electrofishing (shore area) | | 20 min, 600m transect | |

.

***Active Monitoring Program: Lake IJsselmeer***

| Gear | Location | Frequency | Period |
|---|---|---|---|
| Electrotrawl (open water; 3m beam; 2mm bar mesh) | 20 locations in Lake IJsselmeer, 10 locations in Lake Markermeer, | 2 hauls per location, 10 min trawl, ~1000m transect | Oct-Nov |
| Electrofishing (shore area)<br>Beach seine (shore area; 18mm stretched mesh; length 20m ) | 7 locations in Lake IJsselmeer, 7 locations in Lake Markermeer, 1-3 habitats per location (sand, vegetation, rock) | 2-3 sites per habitat per location | Aug-Sep |

### NL.15.2 Sampling commercial catches

| Area | No. eels for Length-frequency | Sampling frequency | Locations | Biology (sex, life stage, parasites) | Period |
|---|---|---|---|---|---|
| Friesland | 150-200 eels per sample | monthly | 10 | 2 eels per 10 cm size class | Apr-Aug |
| Main Rivers | 150-200 eels per sample | monthly | 8 | 2 eels per 10 cm size class | Apr-Aug |
| Lake IJsselmeer | 1200 (total per year) | May-June Aug-Sep | 1 (samples collected for each fishing gear: summer fyke, fyke, eelbox, long line) | 350 | Apr-Aug |
| Lake Markermeer | 800 (total per year) | May-June Aug-Sep | 1 (samples collected for each fishing gear: summer fyke, fyke, eelbox, long line) | 250 | Apr-Aug |

#### NL.15.3 Sampling

Nothing to report in this section.

#### NL.15.4 Age analysis

At present no age analysis is being conducted.

#### NL.15.5 Life Stages

Life stages (yellow, silvering, silver) are visually determined based on colouration of body and fins and eye diameter. Criteria for life stages are at present not formally described.

#### NL.15.6 Sex determination

Sex is determined by macroscopic examination of the gonads.

### NL.16 Overview, conclusions and recommendations

The availability of data on eel stock and fisheries presented in this report is summarised in Table NL.s. Overall, the larger, State owned waters are reasonably documented, but the smaller regional waters are not yet. Within the framework of the implementation of the national EMP, various extensions are being developed.

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

| Area<br>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 | | | | | | |

In conclusion: this report provides an update of all data series regarding the eel stock in the Netherlands. Almost all data series show a further decline of the stock and fishery; anthropogenic impacts are high, or undocumented. In 2010 the highly important catch registration for inland fishers was introduced by the Ministry of Economic Affairs, Agriculture and Innovation. In 2011 a range of new eel projects will be implemented including a Silver Eel Index, Red Eel Model, eel ageing and nation wide catch sampling programme.

### Literature references

This list of references has been extended with some recent and relevant publications.


Ăström M. and Dekker W. 2007 When will the eel recover? A full life-cycle model. ICES Journal of Marine Science, 64: 1–8.

Belpaire C.G.J. , G. Goemans, C. Geeraerts, P. Quataert, K. Parmentier, P. Hagel, J. De Boer 2008 Decreasing fat levels : survival of the fattest ? Ecology of freshwater fish 18(2): 197-214.

Bult T. P. and Dekker W. 2007 Experimental field study on the migratory behaviour of glass eels (*Anguilla anguilla*) at the interface of fresh and salt water. ICES Journal of Marine Science, 64: 1396–1401.

Combinatie van beroepsvissers. 2008 Mogelijkheden voor Aalherstel in Nederland – optimalisatie van de uittrek van kansrijke schieraal, 15p.

Dekker W. 1991 Assessment of the historical downfall of the IJsselmeer fisheries using anonymous inquiries for effort data. *In*: Cowx I.G. (ed.) Catch Effort sampling strategies, their application in freshwater management. Fishing News Books, Oxford. pp. 233-240.

Dekker W. 1996 A length structured matrix population model, used as fish stock assessment tool. *In*: I.G. Cowx [ed.] Stock assessment in inland fisheries. Fishing News Books, Oxford, 513 pp.

Dekker W. 1998, Glasaal in Nederland beheer en onderzoek. [Glass eel in the Netherlands: management and research] RIVO-rapport 98.002, 36 pp.

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

Dekker W. 2000b A Procrustean assessment of the European eel stock. ICES Journal of Marine Science 57: 938-947.

Dekker W. 2000c Impact of yellow eel exploitation on spawner production in Lake IJsselmeer, the Netherlands. Dana 12: 17-32.

Dekker W. (ed.) 2002 Monitoring of glass eel recruitment. Report C007/02-WD, Netherlands Institute of Fisheries Research, IJmuiden, 256 pp.

Dekker W. 2004a What caused the decline of Lake IJsselmeer eel stock since 1960? ICES Journal of Marine Science 61: 394-404

Dekker W. 2004b Slipping through our hands - Population dynamics of the European eel. PhD thesis, 11 October 2004, University of Amsterdam, 186 pp.

Dekker W. 2004c Monitoring van de glasaalintrek in Nederland [Monitoring of glass eel immigration in the Netherlands]. RIVO report C005/04, 33 pp.

Dekker W. 2004d De aal en aalvisserij van het IJsselmeer [The eel and eel fisheries on Lake IJsselmeer]. RIVO report C002/04, 24 pp.

Dekker W. (ed.) 2005 Report of the Workshop on National Data Collection for the European Eel, Sånga Säby (Stockholm, Sweden), 6 – 8 September 2005. ftp://ftp.wur.nl/imares/Willem%20Dekker/DCR-eel-long.pdf

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.

Dekker W. 2009a A conceptual management framework for the restoration of the declining European eel stock. Pages 3-19 *in* J.M. Casselman & D.K. Cairns, editors. Eels at the Edge: science, status, and conservation concerns. American Fisheries Society, Symposium 58, Bethesda, Maryland.

Dekker W. 2009b Bottom trawl surveys in the southern North Sea. Working document presented to the Study Group on Anguillid Eels in Saline Waters, Goteborg Sweden, 3-5 September 2009, 11 pp.

Dekker W. and Willigen J.A. van 2000 De glasaal heeft het tij niet meer mee! [The glass eel no longer has the tide in its favour] RIVO Rapport C055/00, 34 pp.

Dekker W., Deerenberg C. & Jansen H. 2008 Duurzaam beheer van de aal in Nederland: Onderbouwing van een beheersplan. [Sustainable management of the eel in the Netherlands, support for the development of a management plan] IMARES report C041/08, 99 pp.

Dekker W., Pawson M., Walker A., Rosell R., Evans D., Briand C., Castelnaud G., Lambert P., Beaulaton L., Åström M., Wickström H., Poole R., McCarthy T.K., Blaszkowski M., de Leo G. and Bevacqua D. 2006 Report of FP6-project FP6-022488, Restoration of the European eel population; pilot studies for a scientific framework in support of sustainable management: SLIME. 19 pp. + CD, http://www.DiadFish.org/English/SLIME.

Eijsackers H., Nagelkerke L.A.J., Van der Meer J., Klinge M. & Van Dijk J., 2009. Streefbeeld Aal. Een deskundigenoordeel. Een advies op verzoek van de minister van LNV, 17 p + 8 bijlagen.

FAO European Inland Fisheries Advisory Commission; International Council for the Exploration of the Sea. 2009. Report of the 2009 session of the Joint EIFAC/ICES Working Group on Eels. Götenborg, Sweden, 7-12 September 2009. EIFAC Occasional Paper. No. 45. ICES CM 2009/ACOM:15. Rome, FAO/Copenhagen, ICES. 2010. 139p.

Henry GW, Lyle JM (2003) The national recreational and indigenous fishing survey. FRDC Project No. 99/158. NSW Fisheries Final Report Series No. 48, pp 188.

Heuvel-Greve M. van den, L. Osté, H. Hulsman, M. Kotterman (2009). Aal in het Benedenrivierengebied - 1. Feiten: Achtergrondinformatie, trends, relaties en risico's van dioxineachtige stoffen, PCB's en kwik in aal en zijn leefomgeving. Deltares-rapport Q4736/1002515.

Hoek-van Nieuwenhuizen, M. van; Kotterman, M.J.J. 2007 Biologische Monitoring Zoete Rijkswateren: Microverontreinigingen in rode aal, 2006. Report IMARES C001/07.

Hoogenboom L.A.P., Kotterman M.J.J., Hoek-van Nieuwenhuizen M., van der Lee M.K. & Traag W.A. 2007, Onderzoek naar dioxines, dioxineachtige PCB's en indicator-PCB's in paling uit Nederlandse binnenwateren. Rikilt report 2007.003, 34 pp.

ICES 1996 Report of the comprehensive fishery evaluation working group. ICES Document CM 1996 / Assess: 20. 68 pp.

ICES 2003 International Council for the Exploration of the Sea. Report of the ICES/EIFAC Working Group on Eels. ICES C.M. 2003/ACFM:06.

ICES 2004 International Council for the Exploration of the Sea. Report of the ICES/EIFAC Working Group on Eels. ICES C.M. 2004/ACFM:09, 207 pp.

ICES 2005 International Council for the Exploration of the Sea. Report of the ICES/EIFAC Working Group on Eels. ICES C.M. 2005/ I:01.

ICES 2009. Review Service: Evaluation of the eel management plans.

Kessel, N. van, M. Dorenbosch, F. Spikmans, J. Kranenbarg & B. Crombaghs 2008. Jaarrapportage Actieve Vismonitoring Zoete Rijkswateren. Samenstelling van de visstand in de grote rivieren gedurende het winterhalfjaar 2007-2008. Natuurbalans - Limes Divergens BV & Stichting RAVON, Nijmegen. 77 pp.

Klein Breteler J.G.P., 2008. Herstel van de Aalstand II. Bouwen aan een beheerplan. Het streefbeeld, de huidige uittrek, een nadere verkenning van de mogelijke maatregelen en een protocol voor het uitzetten van aal. VIVION BV, Utrecht. Projectnummer VIVION 08.002a, 118 p.

Le Cren, E. D., 1951: The length–weight relationship and seasonal cycle in gonad weight and condition in the perch (Perca fluviatilis). J. Anim. Ecol. 20, 201–219.

Leeuw, J.J. de, Dekker W. & Buijse A.D. 2008 Aiming at a moving target, a slow hand fails! 75 years of fisheries management in Lake Ijsselmeer (the Netherlands). Journal of Sea Research 60(1-2): 21-31.
Leijzer TB, Dijkman Dulkes HJA, van der Heul JW, van Willigen. 2009. Het ontwikkelen van een glasaalval ten behoeve van monitoring.
Lyle JM, Coleman APM, West L, Campbell D, Henry GW (2002) New large-scale survey methods for evaluating sport fisheries. In: Recreational fisheries: ecological, economic and social evaluation, TJ Pitcher, C Hollingworth (eds), pp 207-226. Blackwell Science.
MinLNV, 2008. The Netherlands Eel Management Plan. Ministry of Agriculture, Nature Management and Food Quality. 48 pp. Version 1 April 2009: www.minlnv.nl/cdlpub/servlet/CDLServlet?p_file_id=33465 ; update 14 July 2009: http://www.minlnv.nl/portal/page?_pageid=116,1640333&_dad=portal&_schema=PORTAL&p_news_item_id=24505
Nash, R. D. M., A. H. Valencia, and A. J. Geffen. 2006. The origin of Fulton's condition factor—setting the record straight. Fisheries 31:236–238.
Pollock KH, Jones CM, Brown TL (1994) Angler survey methods and their application in fisheries management. American Fisheries Society, Special Publication 25, Bethesda, Maryland.
Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. No. 191.
Tien N. and Dekker W. 2004 Trends in eel habitat abundance in the Netherlands during the 20th century. ICES C.M. 2004/S:12 (mimeo).
Van Rijn S. & M.R. van Eerden 2001 Aalscholvers in het IJsselmeergebied: concurrent of graadmeter? [Cormorants in the IJsselmeer area: competitor or indicator?] RIZA rapport 2001.058
Van Rijn S. 2004 Monitoring Aalscholvers in het IJsselmeergebied [Monitoring cormorants in the IJsselmeer area]. Voortgangsverslag 2004. RIZA werkdocument 2004.187x
Vriese, F.T., J.P.G. Klein Breteler, M.J. Kroes & I.L.Y. Spierts, 2007. Duurzaam beheer van de aal in Nederland - Bouwstenen voor een beheerplan [Sustainable management of the eel in the Netherlands, building blocks for a management plan]. VisAdvies BV, Utrecht. Projectnummer VA2007_01, 174 pagina's en bijlagen.
Winter H.V., Dekker W., Leeuw J.J. de 2006 Optimalisatie MWTL vismonitoring [Optimisation of fish monitoring in the national monitoring programme of State owned waters]. IMARES Report C052/06. 46 pp.

IMARES beschikt over een ISO 9001:2008 gecertificeerd kwaliteitsmanagementsysteem (certificaatnummer: 57846-2009-AQ-NLD-RvA). Dit certificaat is geldig tot 15 december 2012. De organisatie is gecertificeerd sinds 27 februari 2001. De certificering is uitgevoerd door DNV Certification B.V. Het laatste controlebezoek vond plaats op 22-24 april 2009. Daarnaast beschikt het chemisch laboratorium van de afdeling Milieu over een NEN-EN-ISO/IEC 17025:2005 accreditatie voor testlaboratoria met nummer L097. Deze accreditatie is geldig tot 27 maart 2013 en is voor het eerst verleend op 27 maart 1997; deze accreditatie is verleend door de Raad voor Accreditatie.

## Verantwoording

Rapport C143/10
Projectnummer: 4301209022

Dit rapport is met grote zorgvuldigheid tot stand gekomen. De wetenschappelijke kwaliteit is intern getoetst door een collega-onderzoeker en het betreffende afdelingshoofd van IMARES.

Akkoord: drs. F.A. van Beek
Onderzoeker

Handtekening:

Datum: 18 november 2010

Akkoord: Dr. J. Asjes
Hoofd afdeling Vis

Handtekening:

Datum: 18 november 2010