# Report on the eel stock and fishery in the Netherlands 2013

Martin de Graaf and Charlotte Deerenberg

Report number C003/15



IMARES Wageningen UR

(IMARES - Institute for Marine Resources & Ecosystem Studies)

Client: Ministerie van EZ
Postbus 20401
2500 EK Den Haag

WOT-05-406-007-IMARES

Publication date: 23 January 2015

IMARES WAGENINGEN UR

**IMARES vision:**

- 'To explore the potential of marine nature to improve the quality of life'.

**IMARES mission:**

- To conduct research with the aim of acquiring knowledge and offering advice on the sustainable management and use of marine and coastal areas.

**IMARES is:**

- An independent, leading scientific research institute.

Recommended format for purposes of citation: de Graaf, M. & Deerenberg, C. 2014. Report on the eel stock and fishery in the Netherlands 2013. IMARES Report C003/15, pp. 56.

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

© 2014 IMARES Wageningen UR

IMARES, institute of Stichting DLO is registered in the Dutch trade record nr. 09098104, BTW nr. NL 806511618

The Management of IMARES is not responsible for resulting damage, as well as for damage resulting from the application of results or research obtained by IMARES, its clients or any claims related to the application of information found within its research. This report has been made on the request of the client and is wholly the client's property. This report may not be reproduced and/or published partially or in its entirety without the express written consent of the client.

## Contents


1. Nederlandse samenvatting ..... 6
   - 1.1 Trend glasaal ..... 6
   - 1.2 Trend (rode) aal Waddenzee ..... 7
   - 1.3 Trend (rode) aal IJsselmeer/Markermeer ..... 7
   - 1.4 Trend schieraal ..... 8
   - 1.5 Trend aalvangsten beroepsvisserij ..... 8
   - 1.6 Trend aalvangsten recreatieve visserij ..... 11
   - 1.7 Trend aquacultuur ..... 11
   - 1.8 Trend uitzet glasaal en pootaal ..... 12
   - 1.9 Trend vervuiling ..... 14
   - 1.10 Trend zwemblaasparasiet ..... 14

2. Introduction ..... 15
   - 2.1 General overview fisheries ..... 17
   - 2.2 Spatial subdivision of the territory ..... 17

3. Time-series data ..... 20
   - 3.1 Recruitment ..... 20
     - 3.1.1 Glass eel recruitment ..... 20
     - 3.1.2 Commercial ..... 20
     - 3.1.3 Recreational ..... 20
     - 3.1.4 Fishery independent ..... 20
     - 3.1.5 Yellow eel recruitment ..... 22
     - 3.1.6 Commercial ..... 22
     - 3.1.7 Recreational ..... 22
     - 3.1.8 Fishery independent ..... 22
   - 3.2 Yellow eel landings ..... 23
     - 3.2.1 Commercial ..... 23
     - 3.2.2 Recreational ..... 24
   - 3.3 Silver eel landings ..... 25
     - 3.3.1 Commercial ..... 25
     - 3.3.2 Recreational ..... 26
   - 3.4 Aquaculture production ..... 26
     - 3.4.1 Seed supply ..... 26
     - 3.4.2 Production ..... 27
   - 3.5 Stocking ..... 27
     - 3.5.1 Amount stocked ..... 27
     - 3.5.2 Catch of eel <12 cm and proportion retained for restocking ..... 28
     - 3.5.3 Reconstructed Time Series on Stocking ..... 28
   - 3.6 Trade in eel ..... 28

4. Fishing capacity ..... 29

5. Fishing effort ..... 30
   - 5.1 Glass eel ..... 30

5.2 Yellow eel ..... 30
5.3 Silver eel ..... 31
5.4 Marine fishery ..... 31

6. Catches and landings ..... 32
6.1 Glass eel ..... 32
6.2 Yellow eel ..... 32
6.2.1 Catches and/or landings from Lake IJsselmeer/Markermeer ..... 32
6.2.2 Catches and/or landings from other areas ..... 32
6.3 Silver eel ..... 33
6.4 Marine fishery ..... 33
6.5 Recreational Fishery ..... 34
6.6 Bycatch, underreporting, illegal activities ..... 34
6.6.1 Bycatch ..... 34
6.6.2 Underreporting and illegal catches ..... 34

7. Catch per unit of effort ..... 36

8. Other anthropogenic and environmental impacts ..... 37
8.1 Assisted migration of silver eel ..... 37

9. Scientific surveys of the stock ..... 38
9.1 NL.G.1 Recruitment surveys, glass eel ..... 38
9.2 NL.G.2 Stock surveys, yellow eel ..... 38
9.2.1 Lake IJsselmeer/Markermeer (active gear) ..... 38
9.2.2 Main rivers (active gear) ..... 38
9.2.3 Main rivers (passive gear) ..... 38
9.2.4 Coastal waters (active gear) ..... 38
9.3 NL.G.3 Silver eel ..... 39

10. Data collected for the DCF ..... 40

11. Life history and other biological information ..... 41
11.1 Growth, silvering and mortality ..... 41
11.2 Parasites and pathogens ..... 41
11.3 Contaminants ..... 41
11.4 Predators ..... 43

12. Other sampling ..... 44

13. Stock assessment ..... 45
13.1 Method summary ..... 45
13.1.1 Estimate of $B_0$ ..... 45
13.2 Summary data ..... 45
13.2.1 Stock indicators and Targets ..... 45
13.2.2 Habitat coverage ..... 45
13.2.3 Impact ..... 46

13.2.4 Precautionary Diagram ..... 46
13.2.5 Management Measures ..... 47
13.3 Summary data on glass eel ..... 47

14. Sampling intensity and precision ..... 48

15. Standardisation and harmonisation of methodology ..... 49
15.1 Survey techniques ..... 49
15.2 Sampling commercial catches ..... 50
15.3 Sampling ..... 50
15.4 Age analysis ..... 50
15.5 Life stages ..... 50
15.6 Sex determinations ..... 50
15.7 Data quality issues ..... 50

16. Overview, conclusions and recommendations ..... 51

17. Quality Assurance ..... 53

References ..... 54

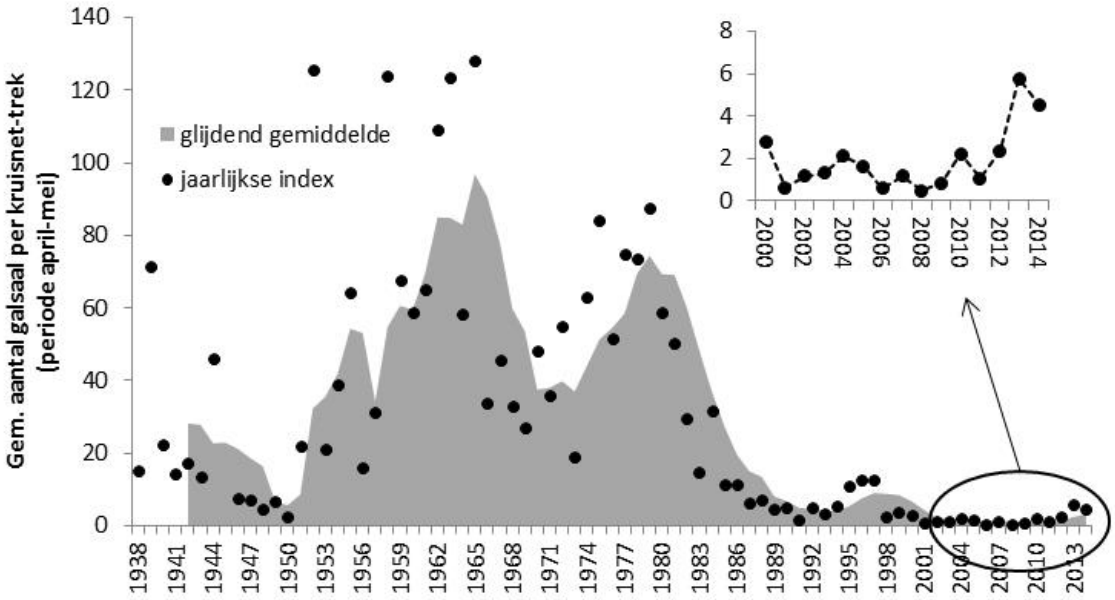
Justification ..... 55

# 1. Nederlandse samenvatting

In de Nederlands samenvatting wordt een overzicht gepresenteerd van de belangrijkste trends in aal en de aalvisserij in 2013 zoals deze zijn gerapporteerd in het Country Report aan de International Council of Exploration of the Sea Working Group on Eel (EIFAAC/GFCM/ICES WGEEL) in november 2014. In deze Nederlandse samenvatting wordt een verkorte presentatie van de inhoud gegeven, met de nadruk op de meest recente gegevens.

## 1.1 Trend glasaal

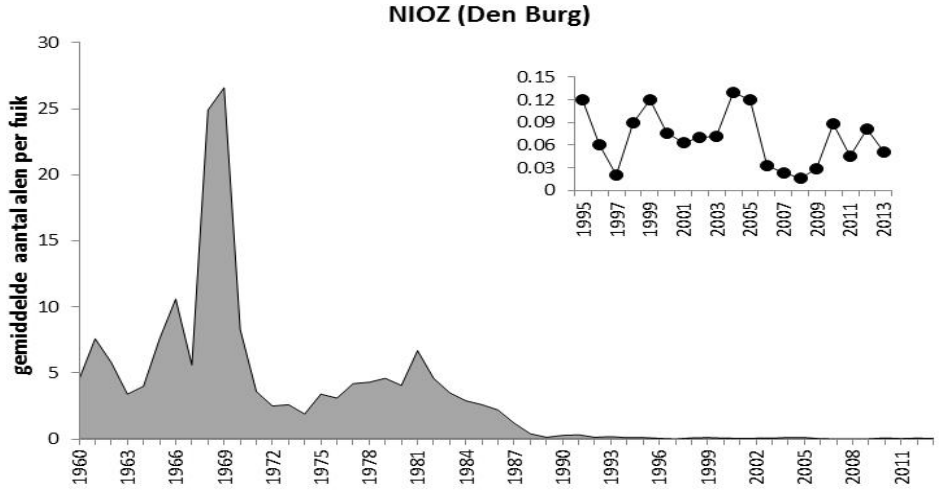
De intrek van jonge aal (glasaal) uit zee naar onze binnenwateren wordt bemonsterd op 12 plaatsen langs de kust. Bij Den Oever wordt sinds 1938 een intensieve bemonstering uitgevoerd. De resultaten van de intrekbemonstering tonen een sterke afname sinds 1980 en de glasaalvangst was in de periode 1998-2012 minder dan 5 % van het vroegere niveau. De resultaten van de zeer langjarige intrekbemonstering bij Den Oever tonen een sterk verlaagde intrek na 1985 (Figuur 3). De laatste 2 jaar is de index duidelijk toegenomen maar nog steeds laag ten opzichte van het vroegere niveau (voor 1980). Een vergelijkbare toename in de intrek aan glasaal is de laatste jaren ook internationaal waargenomen.




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

## 1.2 Trend (rode) aal Waddenzee

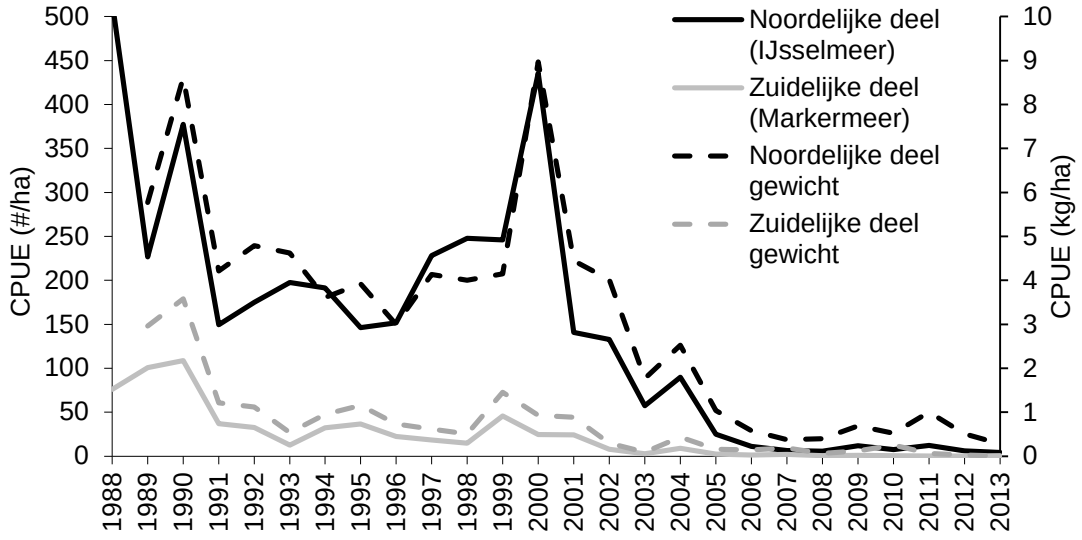
Sinds 1960 worden met een fuikbemonstering de vangsten rode aal in de haven bij het Horntje door medewerkers van het NIOZ nauwkeurig bijgehouden. Deze unieke tijdsserie (Figuur 2) is in 2010 toegevoegd aan het jaarlijkse aalrapport. Deze nieuwe dataset toont ook een duidelijk afname van de rode aal populatie sinds de jaren tachtig, vergelijkbaar met de drastische afname aan glasaal bij Den Oever. In tegenstelling tot de intrek van glasaal is bij deze index nog geen stijging zichtbaar.




***Figuur 2.*** *Trend in de hoeveelheden rode aal in de NIOZ fuik (Bron: NIOZ en van de Meer et al., 2011).*

## 1.3 Trend (rode) aal IJsselmeer/Markermeer

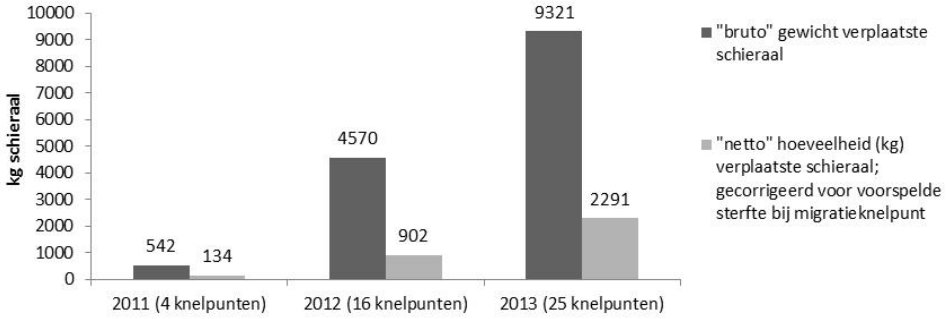
De bestandsopname met de electrostramienkor toont zowel in het IJsselmeer sinds 2000 als het Markermeer sinds 1990 een scherpe afname aan (rode) aal (Figuur 3).




***Figuur 3.*** *Trend in de hoeveelheid (aantallen en gewicht per ha) (rode) aal in het IJsselmeer en Markermeer op basis van de vangst met de electrostramienkor.*

## 1.4 Trend schieraal

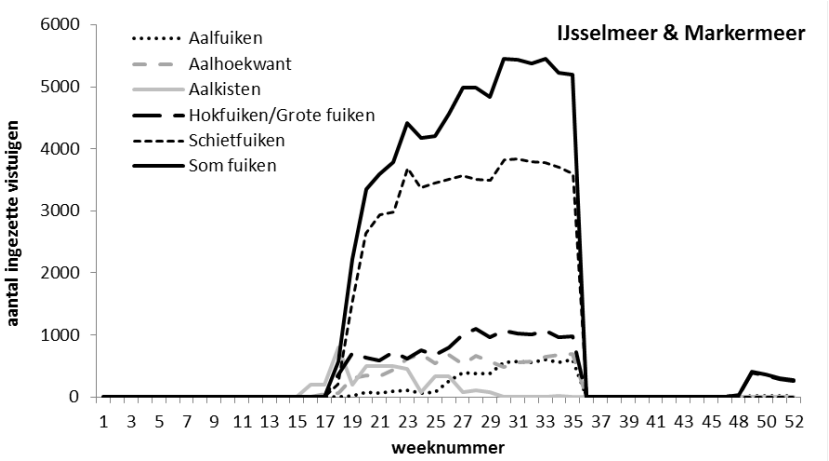
*Schieraal over de dijk*
Sinds 2011 worden bij een aantal gemalen in Zeeland, Noord-Holland en Friesland schieralen geassisteerd bij het passeren van de migratieknelpunten (DUPAN “schieraal over de dijk” initiatieven). In 2011, 2012 en 2013 werd respectievelijk “bruto” 0.5, 4.6 en 9.3 ton schieraal over de geselecteerde knelpunten gezet (Figuur 4). Echter een deel van de schieraal had volgens Winter *et al.* (2013) mogelijk ook zonder assistentie het migratieknelpunt kunnen passeren. Gebruikmakend van de verwachte sterfte (Bierman *et al.* 2012; Winter *et al.* 2013) tijdens het passeren van de geselecteerde migratieknelpunten kan een “netto” hoeveelheid aal worden berekend. De hoeveelheid extra schieraal die met succes heeft kunnen uittrekken als gevolg van de geleverde inspanning binnen “Schieraal over de dijk” initiatieven wordt geschat op 0.1 ton in 2011, 0.9 ton in 2012 en 2.3 ton in 2013.




***Figuur 4.*** *Overzicht van de “bruto” en “netto” hoeveelheden aal die in 2011-2013 bij diverse knelpunten “over de dijk” zijn gezet (geassisteerde migratie).*

## 1.5 Trend aalvangsten beroepsvisserij

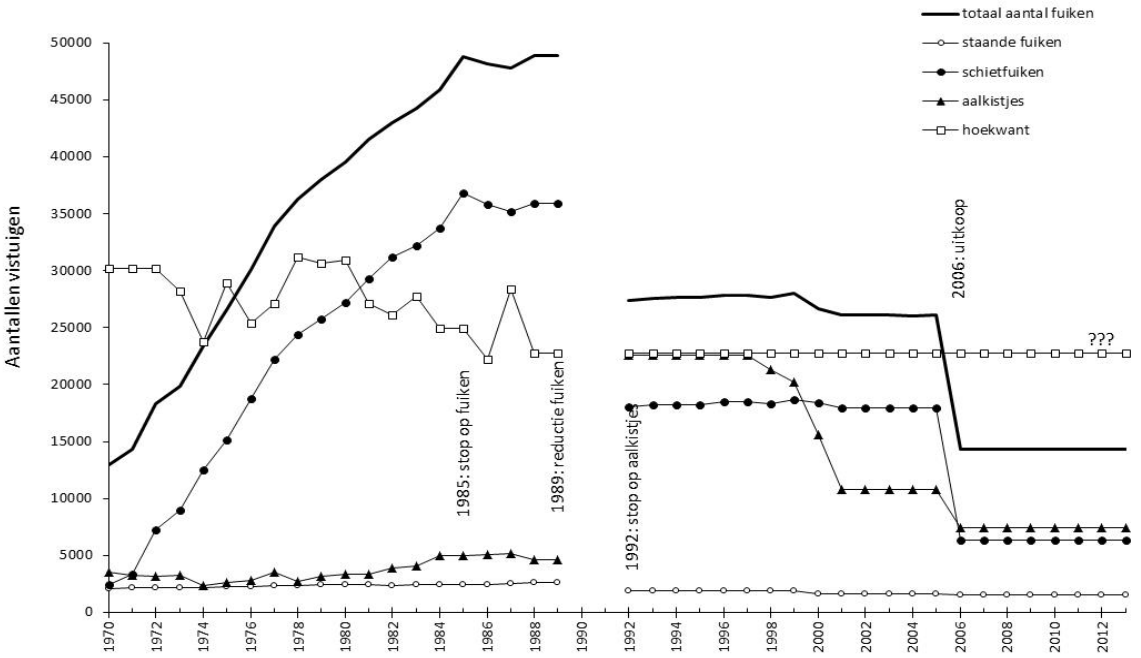
De visserij op aal in Nederland was tot voor kort nauwelijks gedocumenteerd. Invoering van de Europese Aalverordening en het Nederlandse Aal Beheersplan heeft de situatie echter snel verbeterd. De eerste stap is gezet met de invoering van de verplichte vangstregistratie voor aalvissers per 1/1/2010. Een nadeel van deze registratie was dat rode aal en schieraal vangsten gecombineerd werden geregistreerd en dat vistuig en visserijinspanning niet werden gedocumenteerd. Het Ministerie van EZ heeft per 1/1/2012 de visserijinspanning opgenomen in de verplichte digitale vangstregistratie. Een overzicht van de wekelijkse inspanning die wordt geleverd door beroepsvissers is te zien in Figuur 5.




***Figuur 5.*** *Overzicht van de wekelijkse inzet van verschillende vistuigen door beroepsvissers in 2013 (Bron: EZ).*

Op het IJsselmeer is het aantal te gebruiken vistuigen gelimiteerd door merkjes (Figuur 6), 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 staande fuiken heeft in de jaren 1970-1980 vrijwel geen groei plaatsgevonden, terwijl later wel reducties zijn doorgevoerd. Daarmee lag het aantal grote fuiken in 2009 een kwart lager dan in 1970. Voor de visserij met hoekwant ligt alleen het maximum aantal hoekwantvissers vast, maar omdat iedere visser zelf mag bepalen met hoeveel "spleten" (een hoekwant met 250 haken) wordt gevist is de daadwerkelijke inspanning niet duidelijk.

Voor alle tuigen geldt dat het tot 2012 onduidelijk was welk deel van de "merkjes" ook daadwerkelijk wekelijks werd ingezet door de beroepsvissers in het IJsselmeer en Markermeer. Tabel 1 laat zien dat in 2013 slechts een beperkt aantal van toegestane grote fuiken (max. ~18%) en aalkisten (max ~11% in) daadwerkelijk werden ingezet in de visserij. Voor schietfuiken was de maximale inzet in een week 60%.

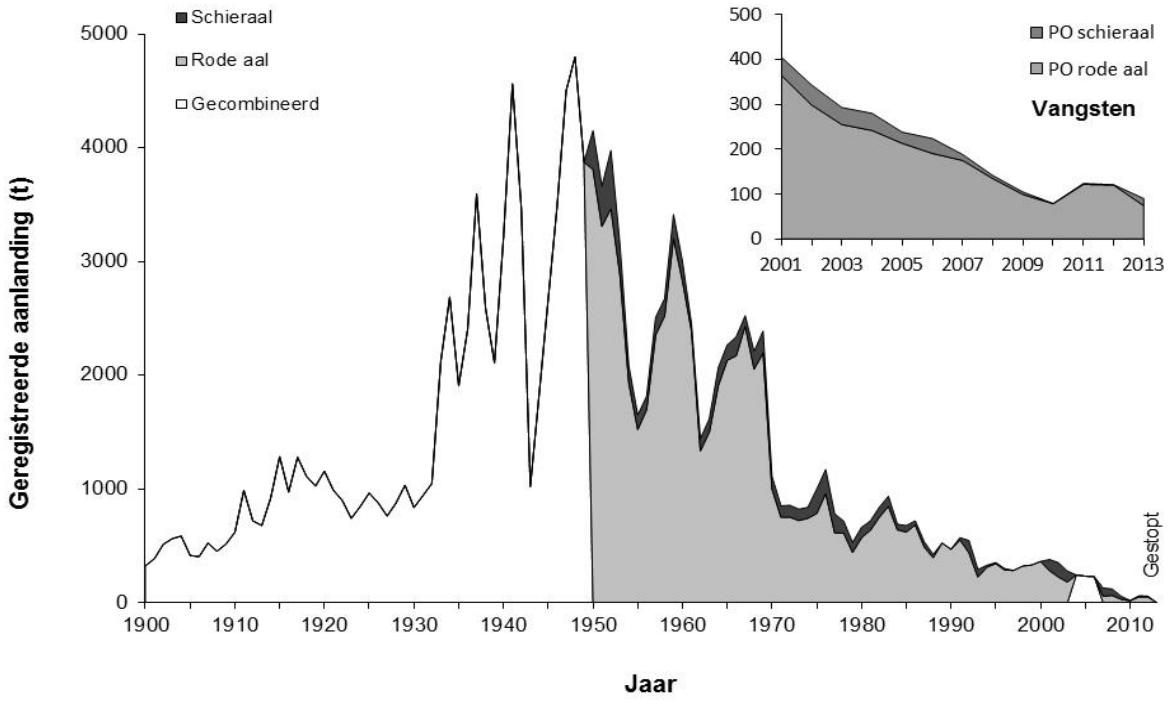



***Figuur 6.*** *Trend in de nominale hoeveelheden vistuig binnen de aalvisserij op het IJsselmeer/Markermeer (Bron: de Leeuw et al., 2006 en PO IJsselmeer)*.

***Tabel 1.*** *Overzicht van de maximale wekelijkse inzet van de verschillende vistuigen in het IJsselmeer/Markermeer en overige locaties. Voor het IJsselmeer/Markermeer wordt ook het percentage gebruikte vistuigen ten opzichte van het totaal aantal te gebruiken vistuigen getoond ("merkjes" per tuig) (Bron: EZ).*

| | IJSSELMEER/MARKERMEER | | | | | OVERIGE LOCATIES | |
|---|---|---|---|---|---|---|---|
| VISTUIG | 2012 | | 2013 | | BESCHIKBAAR | 2012 | 2013 |
| | NO. | % | NO. | % | | NO. | NO. |
| Hoekwant[1] | 755 | -- | 695 | -- | Geen limiet | 1330 | 1040 |
| Aalkistje | 1300 | 18 | 800 | 11 | 7400 | 125 | 300 |
| Staande fuiken[2] | 1795 | 19 | 1706 | 18 | 9400 | 4953 | 4523 |
| Schietfuiken | 4311 | 68 | 3842 | 60 | 6380 | 2955 | 2861 |
| Elektrovisserij | -- | | -- | | | 6 | 57 |

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 stijging van 300 naar 1000 ton. Bij de afsluiting van het IJsselmeer namen de aanlandingen toe tot ca. 2500 ton, om daarna verder te stijgen tot rond 3500 ton in de jaren 1940-1955. Sinds 1950 heeft de aanvoer sterk gefluctueerd, maar is wel een gestage daling opgetreden tot minder dan 400 ton sinds 2000 en nog maar 144 ton in 2013 (Figuur 7). Voor het IJsselmeer/Markermeer valt het verder op dat er aanzienlijke verschillen zitten tussen PVIS, PO en EZ zitten in de hoeveelheden aal die worden aangeland (Figuur 7 en Tabel 2).




***Figuur 7.*** *Trend in de geregistreerde aanlanding van aal op alle IJsselmeerafslagen (Bron PVIS) en trend in geregistreerde aanlandingen voor het IJsselmeer en Markermeer door de PO IJsselmeer. In 2009 was de aalvisserij gedurende oktober en november gesloten en vanaf 2010 is de visserij gesloten gedurende september, oktober en november*.

Tot voor kort waren er geen aanlandingsgegevens van de wateren buiten het IJsselmeer. Op 1 januari 2010 heeft EZ een verplichte vangstregistratie ingevoerd voor alle aalvissers op de binnenwateren. De wekelijkse aalvangsten (rode aal en schieraal gecombineerd) worden per VBC-gebied opgenomen in de database van EZ (Tabel 2).

***Tabel 2.*** *Aanlanding (ton) beroepsvisserij in Nederland (Bron: PO en EZ).*

| | **IJsselmeer/Markermeer** | | **Andere gebieden** | **Totaal NL** |
|---|---|---|---|---|
| | PO | EZ | EZ | EZ |
| 2010 | 79 | 128 | 324 | 452 |
| 2011 | 124 | 179 | 188 | 367 |
| 2012 | 121 | 168 | 182 | 350 |
| 2013 | 90 | 144 | 171 | 315 |

## 1.6 Trend aalvangsten recreatieve visserij

In 2009 is het Recreatieve Visserij onderzoeksproject van start gegaan. In december 2009, 2011 en 2013 zijn 50.000 huishoudens benaderd tijdens de Screening Survey om vast te stellen hoeveel recreatieve vissers er zijn in Nederland (1.7 in 2009, 1.4 in 2011 en 1.3 miljoen in 2013). In 2010 zijn 2000 recreatieve vissers geselecteerd om deel te nemen aan een logboekprogramma voor een periode van 12 maanden (maart 2010 – februari 2011) om inzicht te krijgen in hoeveelheden gevangen vis. De resultaten van de eerste survey laten zien dat in Nederland ongeveer 1.5 miljoen alen gevangen worden door recreatieve vissers waarvan er ongeveer 500.000 mee naar huis worden genomen (Tabel 3). Gezien het ontbreken van betrouwbare gegevens over de lengteverdeling van meegenomen alen, blijft het lastig om een schatting te maken van het gewicht aan meegenomen. Voor de evaluatie van het aalbeheerplan in juli 2012 is uitgegaan van 100 ton onttrokken aal door recreatieve vissers. De resultaten van het tweede logboekprogramma worden begin 2015 gerapporteerd.

***Tabel 3**. Overzicht van de aalvangsten door recreatieve vissers in de Nederlandse binnenwateren en kustwateren (van der Hammen & de Graaf 2012).*

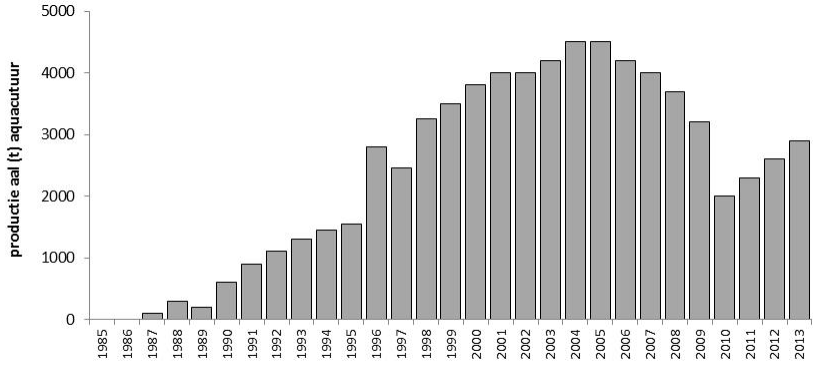
| | Aantallen | | | Ongecorrigeerde gewicht (kg) | | | Gecorrigeerde gewicht (kg) | | |
|---|---|---|---|---|---|---|---|---|---|
| | zeewater | binnenwater | som | zeewater | binnenwater | som | zeewater | binnenwater | som |
| onttrokken | 174.215 | 340.536 | 514.751 | 36.287 | 78.259 | 114.546 | 17.161 | 37.374 | 54.535 |
| teruggezet | 108.462 | 872.570 | 981.032 | 23.834 | 137.186 | 161.020 | 26.253 | 149.917 | 176.170 |
| som | 282.677 | 1.213.106 | 1.495.783 | 60.121 | 215.445 | 275.566 | 43.414 | 187.291 | 230.705 |
| % onttrokken | 62% | 28% | 34% | 60% | 36% | 42% | 40% | 20% | 24% |

## 1.7 Trend aquacultuur

De grootste hoeveelheid aal (~90%) in Nederland voor consumptie wordt geproduceerd in intensieve kwekerijen. Hierin wordt in het wild gevangen, geïmporteerde glasaal uit voornamelijk Frankrijk en Spanje (Tabel 4), opgekweekt onder gecontroleerde omstandigheden. De totale productie sinds de start in 1985 is gestegen tot meer dan 4000 ton in 2005. Tussen 2005 en 2010 is de productie gedaald tot 2000 ton maar de laatste jaren neemt de productie weer toe. In 2013 is ongeveer 2900 ton aal geproduceerd (Figuur 8). Kunstmatige voortplanting van de aal voor commerciële doeleinden is tot op heden niet mogelijk.

***Tabel 4.** Herkomst van de geïmporteerde, wild gevangen glasaal in de Nederlandse aquacultuur sector (Bron: DUPAN).*

| SEIZOEN | FRANKRIJK | SPANJE | ENGELAND | TOTAL (KG) |
|---|---|---|---|---|
| 2010/2011 | 4725 | 1890 | 135 | 6750 |
| 2011/2012 | 5325 | 1350 | 100 | 6775 |
| 2012/2013 | 5500 | 650 | 550 | 6700 |
| 2013/2014 | 3400 | 250 | 1250 | 4900 |




***Figuur 8.** Trend in de hoeveelheden aal die worden geproduceerd door de aquacultuur sector.*

## 1.8 Trend uitzet glasaal en pootaal

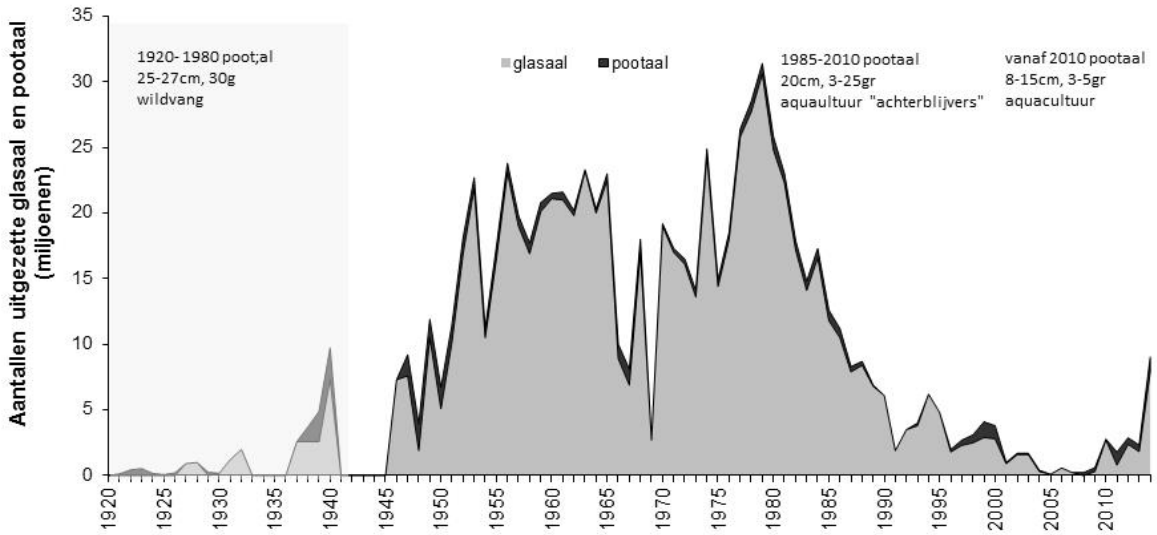
Sinds de jaren '20 is glasaal uit de omgeving van de Golf van Biskaje aangekocht en uitgezet in de Nederlandse binnenwateren (Figuur 9). De uitzet van glasaal heeft waarschijnlijk min of meer gelijke tred gehouden met de natuurlijke intrek, zoals te zien is aan de scherpe daling in de jaren '80. In 2009 werd nog maar ca. 0.3 miljoen glasalen uitgezet. Daarnaast is jonge rode aal (pootaal) uitgezet. Deze pootaal werd tot begin jaren '80 voornamelijk gevangen in de Nederlandse kustzone en/of de benedenloop van de rivieren. In recente jaren heeft de uitzet van gekweekte aal (opgekweekt uit glasaal van Frankrijk en Engeland) de overhand. 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 2014 is naar schatting 33% van alle door Nederland geïmporteerde glasaal uitgezet in binnenwateren (Tabel 5 en 6). Tussen 2010 en 2014 heeft de Combinatie van Beroepsvissers de uitzet van de door EZ aangekochte glasaal gecoördineerd ter bevordering van het herstel van de aalstand. Net als in voorgaande jaren is de door EZ aangekochte glasaal in 2014 vooral uitgezet in gebieden waar weliswaar vrije uittrek mogelijkheden zijn voor schieraal maar waar ook de beroepsvisserij actief is. Er is (internationaal) verdeeldheid over het nut van de uitzet van geïmporteerde, in het wild gevangen glasaal als maatregel voor het herstel van de aalstand. In het advies van ICES uit 2010 ten aanzien van het beheer van aal staat: *"Given the current record-low abundance of glass eels, ICES reiterates its concern that glass eel stocking programs are unlikely to contribute to the recovery of the European eel stock. This is because (a) there is no surplus anywhere of glass eel to be redistributed to other areas and (b) there is evidence that stocked/translocated eels experience impairment of their navigational abilities."* In het 2013 advies van ICES staat ten aanzien van het uitzetten van glasaal: "*Internationally coordinated research is required to judge the net benefit of restocking for the overall population, including carrying capacity estimates of glass eel source estuaries as well as detailed mortality estimates at each step of the stocking process."* Met andere woorden; het uitzetten van glasaal ten behoeve van het herstel van de aalstand heeft alleen nut als de productie schieraal per glasaal hoger is in het gebied van uitzet dan in het gebied van herkomst. Het is op dit moment onduidelijk of het uitzetten van glasaal in Nederland een netto positief effect heeft op de aalstand.

Het merken van alle uitgezette glasaal, zoals in sommige andere landen gebruikelijk is, is een goede manier om beter inzicht te krijgen in het lot van de uitgezette glasaal en om mogelijk beter inzicht te krijgen in de vraag of de huidige uitzet van glasaal een netto positieve of negatieve bijdrage levert aan het herstel van de Europese aalstand. Daarnaast geeft het mogelijk een indruk van de natuurlijke intrek van glasaal.

***Tabel 5.*** *Overzicht van het gebruik van geïmporteerde, in het wild gevangen glasaal (in kg) in Nederland.*

| GLASAAL | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| Gevangen in commerciele visserij | 0 | 0 | 0 | 0 | 0 | 0 |
| Gebruikt voor uitzet | 100 | 904 | 244 | 766 | 630 | 2.460 |
| Gebruikt voor aquacultuur | ? | ? | 6.750 | 6.775 | 6.700 | 4.900 |
| Directe consumptie | 0 | 0 | 0 | 0 | 0 | 0 |
| Mortaliteit | ? | ? | ? | ? | ? | ? |



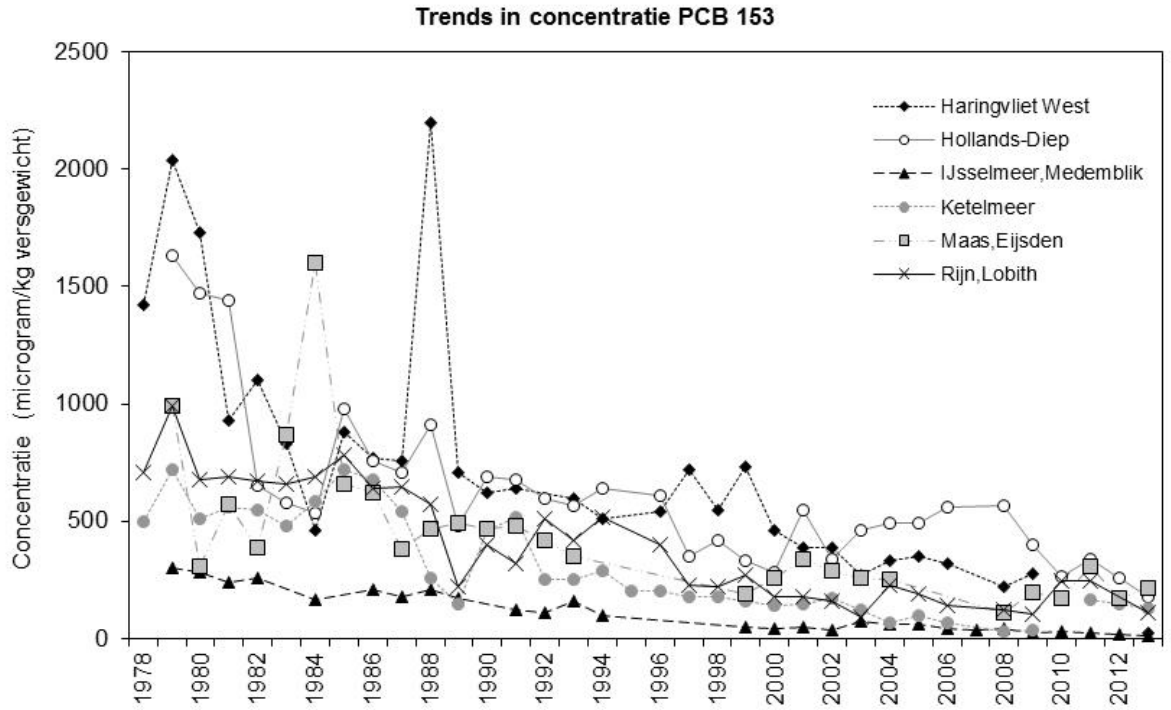

***Figuur 9.*** *Overzicht van de Nederlandse uitzet van glasaal en pootaal in miljoenen stuks. De gegevens van voor 1940 zijn slechts een indicatie. Het gewicht van de gemiddelde uitgezette pootaal is afgenomen van 30 gram (1920), 15 gram (1985) tot 5 gram (2010).*

***Tabel 6.*** *Overzicht van de in 2011 in Nederland uitgezette glasaal en pootaal (Bron CvB en DUPAN).*

| DATUM | UITZETLOCATIE | HERKOMST | QUARANTAINE | KG | # | #/KG |
|---|---|---|---|---|---|---|
| **GLASAAL** | | | | | | |
| 01/04/2014 | Wieringermeer | UK Severn | N | 26 | 84,500 | 3250 |
| 01/04/2014 | Zeeland (semi-closed areas) | UK Severn | N | 60 | 195,000 | 3250 |
| 02/04/2014 | Veersemeer | South France | N | 175 | 560,000 | 3200 |
| 02/04/2014 | Grevelingenmeer | South France | N | 900 | 2,940,000 | 3267 |
| 03/04/2014 | Noord-Holland | UK Severn | N | 377 | 1,225,000 | 3249 |
| 07/04/2014 | Friese Boezem | South France | N | 592 | 1,900,000 | 3209 |
| 09/04/2014 | Noord-West Overijssel | UK Severn | N | 80 | 260,000 | 3250 |
| 09/04/2014 | Zuid-Holland (semi-closed areas) | UK Severn | N | 91 | 295,750 | 3250 |
| 09/04/2014 | Groningen | UK Severn | N | 40 | 130,000 | 3250 |
| April-May | Den Oever | Local | N | 119 | 357,000 | 3000 |
| | | | Totaal | 2,460 | 7,947,250 | |
| **JONGE POOTAAL** | | | | | | |
| 21/05/2014 | Tjeukemeer/ Sneekermeer | South France (Nijmegen) | Y | 1,855 | 530,000 | 286 |
| 21/05/2014 | Kampen | South France (Nijmegen) | Y | 159 | 45,500 | 286 |
| 21/05/2014 | Elburg | South France (Nijmegen) | Y | 18 | 5,000 | 286 |
| 21/05/2014 | Harderwijk | South France (Nijmegen) | Y | 298 | 85,000 | 286 |
| 05/09/2014 | Markermeer Lelystad | UK Severn (Denmark) | Y | 600 | 208,000 | 347 |
| 05/09/2014 | Markermeer Hoorn | UK Severn (Denmark) | Y | 612 | 212,000 | 346 |
| | | | Totaal | 3,541 | 1,085,500 | |

## 1.9 Trend vervuiling

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 PCB's en dioxines in aal waargenomen. In Figuur 10 wordt een enkel voorbeeld (PCB 153) getoond; PCB 153 is een goede indicator voor de andere PCB's.




***Figuur 10.*** *Trend in PCB 153 in rode aal (elk punt is het gemiddelde van 25 alen van 20 tot 30 cm [of minder alen dan 25 als er minder aal beschikbaar was op die locatie]*).

## 1.10 Trend zwemblaasparasiet

De zwemblaasparasiet *Anguillicoloides crassus* is afkomstig uit Zuidoost Azië en sinds begin jaren '80 komt de parasiet voor in Nederlandse wilde aal. Bemonstering van aal laat zien dat het percentage geïnfecteerde aal in 2013 tussen circa 33%-55% lag (Tabel 7). Het percentage geïnfecteerde aal lijkt stabiel te blijven sinds de jaren '80 in alle onderzochte gebieden.

***Tabel 7.*** *Overzicht van de aanwezigheid van zwemblaasparasiet Anguillicoloides crassus in aal.*

| | IJSSELMEER | | MARKERMEER | | | FRYSLAN | | | OTHER LOCATIONS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N aal | % geïnfecteerd | N aal | % geïnfecteerd | N gebieden | N aal | % geïnfecteerd | N gebieden | N aal | % geïnfecteerd |
| 1986 | 699 | 31 | - | - | - | 421 | 44 | - | 30 | 70 |
| 2009 | - | - | - | - | - | 991 | 44 | - | 262 | 55 |
| 2010 | 390 | 49 | 225 | 48 | 11 | 534 | 46 | 10 | 1660 | 48 |
| 2011 | 293 | 43 | 104 | 34 | 5 | 107 | 37 | 17 | 1087 | 33 |
| 2012 | 320 | 53 | 253 | 38 | 5 | 133 | 33 | 17 | 1235 | 34 |
| 2013 | 159 | 55 | 93 | 43 | 2 | 17 | 47 | 9 | 531 | 38 |

# 2. Introduction

Dr. Martin de Graaf, IMARES (Institute for Marine Resources & Ecosystem Studies), IJmuiden, The Netherlands.
Tel: 00-31-317-486826. martin.degraaf@wur.nl
Dr. Charlotte Deerenberg, IMARES (Institute for Marine Resources & Ecosystem Studies), Den Helder, The Netherlands.
Tel: 00-31-317-487080. charlotte.deerenberg@wur.nl

**Reporting Period:** This report was completed in October 2014, and contains data up to 2013 and some provisional data for 2014.

**Contributors to the report:** Ingeborg de Boois (IMARES: survey data coastal areas), Mennobart van Eerden (Rijkswaterstaat – Waterdienst; cormorant breedings pairs IJsselmeer area), Ben Griffioen (IMARES; glass eel index); Arjan Heinen (Combinatie van Beroepsvissers; stocking data; silver eel fisheries data), Twan Leijzer (IMARES; parasite infections); Jaap van der Meer (NIOZ; yellow eel data NIOZ fyke), Michiel Kotterman (IMARES; data on contaminants), William Swinkels (DUPAN, glass eel data and eel aquaculture production).

## STANDARD GUIDANCE FOR THE COMPLETION OF THIS REPORT

### Codes to be used for circumstances of Nil Return in tables:

- 0: Reserve this designation for a measured data point with an actual zero value (for example when the catch is zero but the effort is >zero).
- NP: "Not Pertinent", where the question asked does not apply to the individual case (for example where catch data are absent as there is no fishery or where a habitat type does not exist in an EMU).
- NR: "Not Reported", data or activity exist but numbers are not reported to authorities (for example for commercial confidentiality reasons).
- NC: "Not Collected", activity / habitat exists but are not collected by authorities (for example where a fishery exists but the catch data are not collected at the relevant level or at all).
- ND: "No Data", where there are insufficient data to estimate a derived parameter (for example where there are insufficient data to estimate the stock indicators (biomass and/or mortality)).

NOTE: Where no data exists for a section, do not delete the section but use one of these codes instead.

### Units and number of decimal places:

| PARAMETER | UNIT | DECIMAL PLACES (MINIMUM) |
|---|---|---|
| Length of glass eel | mm | 0 |
| Length of yellow/silver eel | mm | 0 |
| Age yellow or silver eel | year | 0 |
| Age glass eel/on grown | days | 0 |
| Area (EMU scale) | ha | 0 |
| Area (Sub EMU scale) | ha | 0 |
| Weight (individual Glass eel) | g | 2 |
| Weight (Yellow or silver eel) | g | 0 |
| Weight (Catch level) GE | kg | 0 |
| Weight (Catch level) Other | kg | 0 |
| Site/position | Lat Long units (WGS84) | Deg + decimal Min (2) |
| Biomass ($B_0$ $B_{best}$ $B_{current}$ ,etc) | kg | 0 |
| Mortality rate | ΣF, ΣH, ΣA per year | 2 |
| Effort | Gear days, gear hours | 0 |
| Language | English | |
| Price | Euros | 0 |
| Distance | Km | 0 |
| Season | Clearly define season | |

## 2.1 General overview fisheries

Eel fisheries in the Netherlands occur in coastal waters, estuaries, larger and smaller lakes, rivers, polders, etc. 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. Since 1/1/2010 there is a general registration of landings, whereas a general registration of fishing efforts has not yet been implemented. In recent years, licensees in state-owned waters are obliged to participate in so-called Fish Stock Management Committees ['Visstand Beheer Commissies' VBC], in which commercial fisheries, sports fisheries and water managers are represented. The VBC is responsible for the development of a regional Fish Stock Management Plan. The Management Plans are currently not subject to general objectives or quality criteria. The future of VBC and their role in fish stock management is under debate.
Until April 2011 the total fishery involved approx. 200 companies, with an estimated total catch of nearly 442 tonnes in 2010. However, on 1 April 2011 a large part of the fishery was closed due to high PCB-levels in the eel (Fig. 1). This closure has affected about 50 fishing companies catching 170 tonnes of eel in 2010, roughly a third of the annual landings of inland waters in the Netherlands.



***Figure NL. 1*** *Overview of the areas closed for eel and Chinese mitten crab fishery as of 1 April 2011 (Source Ministry of Economic Affairs).*

## 2.2 Spatial subdivision of the territory

The fishing areas can be categorised into five groups:

1. The Wadden Sea; 53ºN 5ºE; 2,591 km$^2$. This is an estuarine-like area, shielded from the North Sea by a series of islands. The inflow of sea water at the western side mainly consists of the outflow of the river Rhine, which explains the estuarine character of the Wadden Sea. The fishery in the Wadden Sea 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 Wadden Sea is obliged to apply standard EU fishing logbooks. Landings statistics are therefore available from 1995 onwards; <50 tons per year. In 2009 there were 21 companies having a commercial license for fishing eel, and the total number of fyke nets was 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 Wadden Sea in 1932 by a dike (Afsluitdijk), substituting the estuarine area known before as the Zuiderzee. The surface of the lake was reduced stepwise 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 1,200 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 Wadden Sea at low tide, by passive fall. Fishing gears include standard and summer fyke nets, eel boxes and long lines; trawling was banned in 1970. Licensed fishermen are not spatially restricted within the lake, but the number of gears is controlled by a gear-tagging system. The registered landings at the auctions are assumed to cover some the actual total. There are, however, differences in estimated landings reported by PO IJsselmeer, PVIS and catch registration system of the Ministry of Economic Affairs. In 2009 there were 70 fishing licenses, owned by about 30 companies. The total number of gears allowed in 2013 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 in the Netherlands constitute a network of dividing and joining river branches. 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 effort is required. In 2009 there were 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). Since 1 April 2011 the eel fishery on the main rivers has been closed due to high levels of pollutants in eel.

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 bodies. 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. In 2009 there are 27 companies, using an estimated number of 174 fixed fykes, 233 train fykes, and unknown numbers of eel pots. This area has also been affected by the ban on eel and Chinese mitten crab fishery due to high pollution levels.

5. Remaining waters; inland 1,340 $km^2$. 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. In 2009 there are about 100 companies, using unknown quantities of gears of all types.

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

1. 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 Drenthe. Drainage area: 18,000 $km^2$, of which 2,400 $km^2$ in the Netherlands.
2. 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.
3. 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.
4. 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, whereas 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.

# 3. Time-series data

## 3.1 Recruitment

### *3.1.1 Glass eel recruitment*

### *3.1.2 Commercial*

Glass eel fisheries is forbidden, NO AVAILABLE DATA

### *3.1.3 Recreational*

Glass eel fisheries is forbidden, NO AVAILABLE DATA

### *3.1.4 Fishery independent*

Recruitment of glass eel in Dutch waters is monitored at Den Oever and 11 other sites along the coast (Figure NL. 2; see Dekker 2002 for a full description). In Den Oever (Figure NL.3), recruitment has significantly increase in the last two years and was at the highest level since the mid-'90s. However, overall the recruitment levels are still low compared to the reference period (1960-1979). The data from the other sites (Figure NL.2) confirmed the overall trend, though individual series may deviate. Note that in contrast to previous years the glass eel data are presented simply as the average number of glass eels per haul in the months April and May, between 18:00-8:00 and only years with >5 hauls are included.




***Figure NL. 2*** *Locations of glass eel monitoring in the Netherlands.*

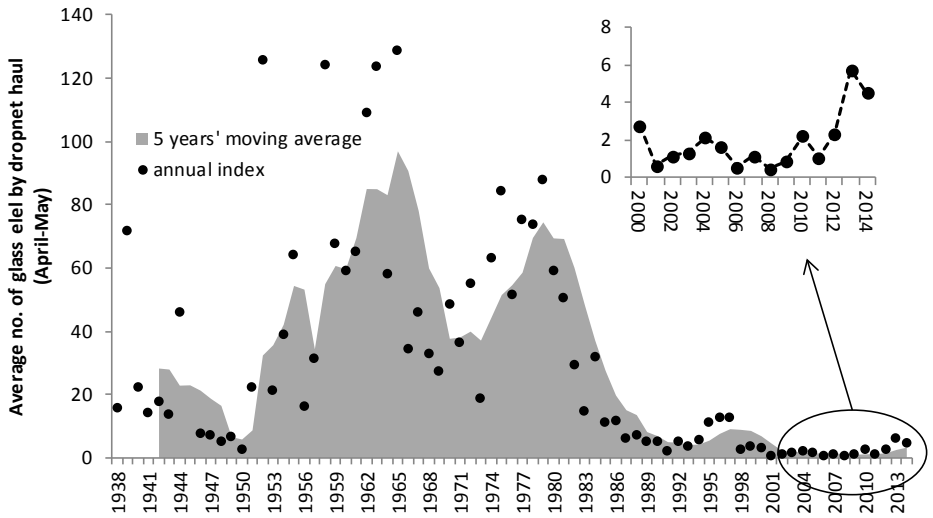



***Figure NL. 3*** *Trend indices (mean number per haul in April and May) of glass eel recruitment at Den Oever.*

***Table NL. A*** *Average number of glass eel caught per lift net haul at the sluices in Den Oever in de period April-May.*

| DECADE | 1930 | 1940 | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| YEAR | | | | | | | | | |
| 0 | | 22.4 | 2.7 | 58.9 | 48.1 | 59.0 | 4.9 | 2.8 | 2.2 |
| 1 | | 14.3 | 21.9 | 65.2 | 36.1 | 50.4 | 1.8 | 0.6 | 1.1 |
| 2 | | 17.5 | 125.6 | 108.9 | 55.0 | 29.4 | 5.2 | 1.2 | 2.4 |
| 3 | | 13.7 | 21.1 | 123.7 | 18.8 | 14.7 | 3.5 | 1.3 | 5.8 |
| 4 | | 46.1 | 38.8 | 58.1 | 63.0 | 31.6 | 5.4 | 2.1 | 4.5 |
| 5 | | NA | 64.1 | 128.3 | 84.3 | 11.2 | 11.1 | 1.6 | |
| 6 | | 7.5 | 16.1 | 34.0 | 51.4 | 11.4 | 12.5 | 0.6 | |
| 7 | | 7.2 | 31.3 | 45.8 | 75.0 | 6.2 | 12.6 | 1.2 | |
| 8 | 15.3 | 4.8 | 124.0 | 32.9 | 73.6 | 7.0 | 2.5 | 0.5 | |
| 9 | 71.5 | 6.6 | 67.6 | 27.1 | 87.7 | 4.8 | 3.7 | 0.9 | |

***Table NL. B*** *Average number of glass eel caught by dropnet haul between 18:00 and 8:00 hrs in the period April-May at 12 sites in the Netherlands. If five or less hauls were carried out, this was recorded as NA. 1 = very early season (warm spring), sampling stopped early (early May), low number of empty samples. 2 = sampling took place in part of the season.*

| | OTHEENSE KREEK | BATH | KRAMMERSLUIS | BERGSCHE DIEP | STELLENDAM | KATWIJK | IJMUIDEN | DEN OEVER (SCHIPLOCK) | HARLINGEN | LAUWERSMEER | NIEUWSTATEN–ZIJL | TERMUNTEN–ZIJL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RBD | SCHELDT | | MEUSE | | | RHINE | | | | | EMS | |
| 1979 | | | | | | | | | | 100.4 | | |
| 1980 | | | | | | | | | | | | |
| 1981 | | | | | | | | | | 75.9 | | |
| 1982 | | | | | | | | | | 21.6 | | |
| 1983 | | | | | | | | | | 15.8 | | |

| | Otheense Kreek | Bath | Krammersluis | Bergsche Diep | Stellendam | Katwijk | Ijmuiden | Den Oever (schiplock) | Harlingen | Lauwersmeer | Nieuwstaten-zijl | Termunten-zijl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **RBD** | **Scheldt** | | **Meuse** | | | **Rhine** | | | | | **Ems** | |
| 1984 | | | | | | | | | | 9.6 | | |
| 1985 | | | | | | | 0.6 | | | 25.2 | | |
| 1986 | | | | | | | 3.3 | | | 1.3 | | |
| 1987 | | | | | | | 7.7 | | | | | |
| 1988 | | | | | 13.8 | | | | | 1.0 | | |
| 1989 | | | | | 4.4 | | | | | 14.3 | | |
| 1990 | 0.3 | | 0.3 | | 10.9 | | | | | 6.0 | | |
| 1991 | 0.0 | | 0.2 | 1.3 | 3.1 | 5.1 | | | | 6.6 | | 0.5 |
| 1992 | 0.0 | 6.6 | 0.4 | | 16.9 | 9.1 | | | 16.7 | 12.1 | | 0.6 |
| 1993 | 0.0 | 22.7 | 0.4 | | 10.1 | 13.5 | | | | 33.2 | | 1.2 |
| 1994 | 0.0 | 14.2 | 0.5 | | 4.0 | | | | 16.0 | 31.0 | | 2.8 |
| 1995 | 0.5 | | 0.4 | | 3.3 | 29.7 | 2.0 | 34.7 | 6.6 | 16.9 | | 3.7 |
| 1996 | 1.3 | 22 | 0.7 | | 0.5 | 25.3 | | 11.0 | 34.2 | 49.4 | 27.5 | 7.7 |
| 1997 | | | 0.6 | | 2.8 | 12.9 | | 11.4 | 11.2 | 27.8 | 30.0 | 15.6 |
| 1998 | 0.7 | | 0.6 | | 1.0 | 38.8 | 2.0 | 6.5 | 18.3 | 14.4 | 21.8 | 1.4 |
| 1999 | 1.4 | | 0.5 | | 1.2 | 140.1 | | 7.2 | | 31.7 | 12 | 10.2 |
| 2000 | 0.9 | 10.2 | 1.0 | 3.8 | 7.1 | 11.6 | | 5.0 | | 7.2 | 38.8 | 8.7 |
| 2001 | 0.4 | | 0.1 | | 1.0 | | | 1.7 | | 2.4 | 39.7 | 1.1 |
| 2002 | | 1.9 | 0.2 | | 4.2 | 13.2 | 0.1 | 1.4 | 3.2 | 5.5 | 36.4 | 1.6 |
| 2003 | | 7.5 | 0.1 | | 0.3 | 12.7 | | 4.8 | | 1.7 | 23.6 | 0.8 |
| 2004 | 0.0 | 16.4[2] | 0.1 | | 0.3 | 4.5 | | | 14.3[2] | 2.3 | 28.1 | 1.9 |
| 2005 | 0.0 | 15.3 | 0.6 | | 0.2 | 5.6 | | | | 1.4 | 21.1 | 1.8 |
| 2006 | 0.0 | 12.4 | 0.2 | | 0.0 | 1.4 | | 0.3 | 0.6 | 1.7 | 8.3 | 1.3 |
| 2007[1] | 0.0 | 43.9 | 0.1 | 0.4 | 0.1 | 27.9 | 0.1 | | 1.7 | 1.0 | 21.7 | 4.0 |
| 2008 | 0.0 | 13.2 | 0.0 | 2.5 | 0.0 | 4.5 | 0.1 | 0.8 | 1.1 | 2.8 | 15.6 | 1.3 |
| 2009 | 0.0 | 9.1 | 0.0 | 1.3 | 0.5 | 3.5 | 0.1 | | 0.7 | 0.6 | 13.6 | 1.2 |
| 2010 | | 28.4 | 0.0 | 1.7 | 0.2 | | 0.0 | 1.2 | 1.0 | 1.1 | 13.0 | 1.2 |
| 2011 | | 39.2 | 0.1 | 1.3 | 0.3 | | 0.0 | | 3.1 | 1.4 | 11.6 | 1.4 |
| 2012 | | 25.8 | 0.2 | 0.8 | 0.1 | 1.6 | 0.2 | | 1.1 | 2.9 | 27.6 | 1.3 |
| 2013 | | 73.8 | 0.0 | 16.7 | 0.2 | 1.6 | 0.0 | | 5.2 | 9.1 | 60.5 | 1.9 |
| **2014** | | **96.3** | **0.0** | **6.3** | **0.6** | **0.4** | **0.0** | | **5.8** | **18.0** | **72.0** | **2.1** |

### *3.1.5 Yellow eel recruitment*

### *3.1.6 Commercial*

NO AVAILABLE DATA.

### *3.1.7 Recreational*

NO AVAILABLE DATA.

### *3.1.8 Fishery independent*

One of the few long time series for eel is the fyke monitoring at NIOZ (Den Burg, Texel; van der Meer *et al.* 2011). This data set shows a familiar pattern of a steep decline in abundance since the 1980s.

In the past almost all catches were yellow eel, based on their length. More recently , the catches also comprise silver eel.

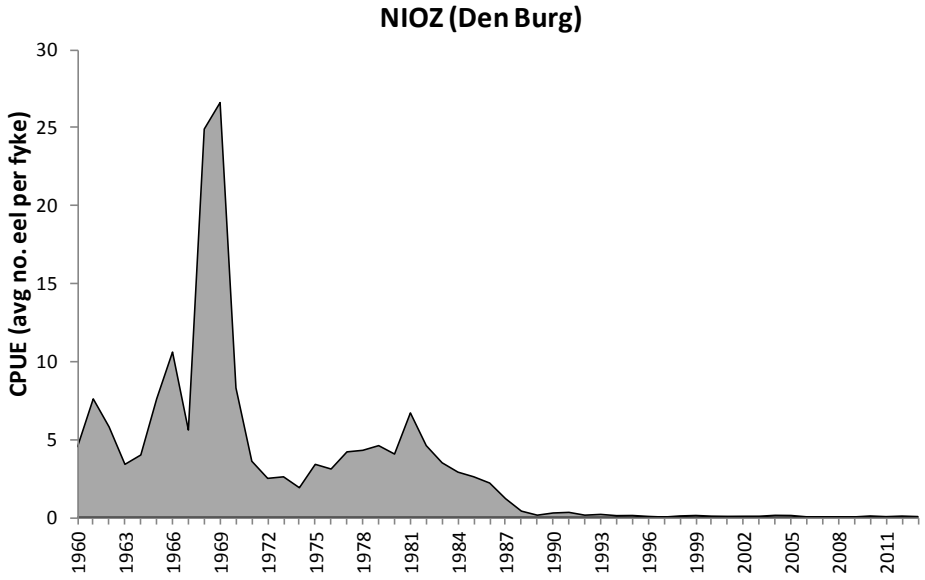



***Figure NL. 4*** *Time series of the mean catch per fyke (numbers) of yellow eel at NIOZ (data NIOZ and van der Meer et al., 2011.).*

## 3.2 Yellow eel landings

### *3.2.1 Commercial*

No reliable long term time series of yellow eel landing exist; total landings of yellow and silver eel combined have been reported.

Statistics from the auctions around Lake IJsselmeer were kept by the government (EZ, previously LNV) until 1994; since then and until 2012 statistics were kept by the Fish Board (PVis; Table NL.E; Figure NL. 5, main graph). These statistics are broken down by species, month, harbour and main fishing gear. The quality of this information has deteriorated considerably over the past decades, due to misclassification of gears, and the trading of eel from other areas at IJsselmeer auctions. In the data from auctions around Lake IJsselmeer yellow and silver eel were reported separately, but information in recent decades (from 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 further details).

In addition, the fishers organisation (PO IJsselmeer) has kept records of the catches of their associated fishers (>90% of the fishers active in the IJsselmeer area) from 2001 onwards (Figure NL. 5, insert graph).

An obligatory catch registration system was introduced in the Netherlands in January 2010 by the Ministry of Economic Affairs (EZ). 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. Information from this registration system is reported in section NL.6.2.1.

***Table NL. C*** *Landings in tons by 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 (since 1995) are suspect, due to misclassification of catches and trade from areas outside Lake IJsselmeer at the IJsselmeer auctions. Source Ministry of Economic Affairs (EZ; 1900-1994), Productschap Vis (PVIS; 1995-2012); PO IJsselmeer (in brackets; 2001-current).*

| DECADE | 1900 | 1910 | 1920 | 1930 | 1940 | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | | | | | | | | | | | | |
| 0 | 324 | 620 | 1157 | 838 | 3205 | 4152 | 2999 | 1112 | 641 | 472 | *368* | *21*(79) |
| 1 | 387 | 988 | 989 | 941 | 4563 | 3661 | 2460 | 853 | 701 | 573 | *381* (405) | *62*(124) |
| 2 | 514 | 720 | 900 | 1048 | 3464 | 3979 | 1443 | 857 | 820 | 548 | *353* (343) | *59*(121) |
| 3 | 564 | 679 | 742 | 2125 | 1021 | 3107 | 1618 | 823 | 914 | 293 | *279* (293) | **NC(90)** |
| 4 | 586 | 921 | 846 | 2688 | 1845 | 2085 | 2068 | 841 | 681 | 330 | *245* (280) | |
| 5 | 415 | 1285 | 965 | 1907 | 2668 | 1651 | 2309 | 1000 | 666 | *354* | *234* (238) | |
| 6 | 406 | 973 | 879 | 2405 | 3492 | 1817 | 2339 | 1172 | 729 | *301* | *230* (224) | |
| 7 | 526 | 1280 | 763 | 3595 | 4502 | 2510 | 2484 | 783 | 512 | *285* | *130* (188) | |
| 8 | 453 | 1111 | 877 | 2588 | 4750 | 2677 | 2222 | 719 | 437 | *323* | *122* (141) | |
| 9 | 516 | 1026 | 1033 | 2108 | 3873 | 3412 | 2241 | 510 | 525 | *332* | *58* (105) | |

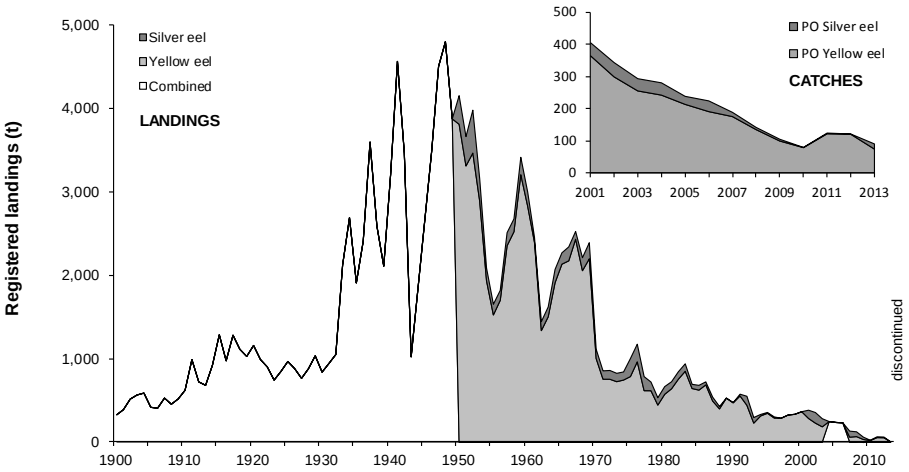



***Figure NL. 5*** *Main graph: Time series of landings of yellow eel and silver eel from Lake IJsselmeer/Markermeer at auctions. Source data main graph EZ and Productschap Vis. Insert graph: catches of yellow eel and silver eel recorded by PO IJsselmeer.*

### *3.2.2 Recreational*

NO AVAILABLE DATA.

## 3.3 Silver eel landings

### *3.3.1 Commercial*

No reliable long term time series of yellow eel landing exist. Data on total landings of yellow and silver eel combined have been reported for Lake IJsselmeer/Markermeer. 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 and labelled 'silver eel' (see section NL. 6.2. for details). In addition, catches registered by the PO IJsselmeer from 2001 onwards do distinguish silver eel from other eel catches. However, some silver eel may still be reported amongst the catches of 'other eel'. Still, landings and catches of silver eel are included "as is" in the figure of yellow eel landings and catches (Figure NL. 5). An obligatory catch registration system has been introduced in the Netherlands in January 2010 by the Ministry of Economic Affairs (EZ). However, weekly catches of eel are reported, but they consist of combined data for yellow eel and silver eel and no information on effort or gears is reported.

In 2012, a fisheries time series of silver eel catch data from three closely related sites in **Friesland** were made available. Two series covered the years 1933-1968 (Figure NL. 6), the other series covered the years 1974-1978 and 1990-2012 (Figure NL. 7; Figure NL. 8).

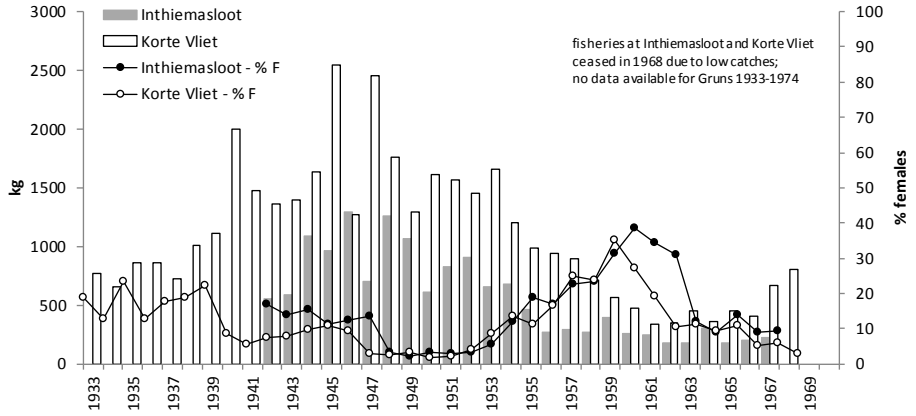



***Figure NL. 6*** *Silver eel catches in kg at two sites in Friesland between 1933 and 1968. The catch composition is represented by the percentage of females in the catch.*

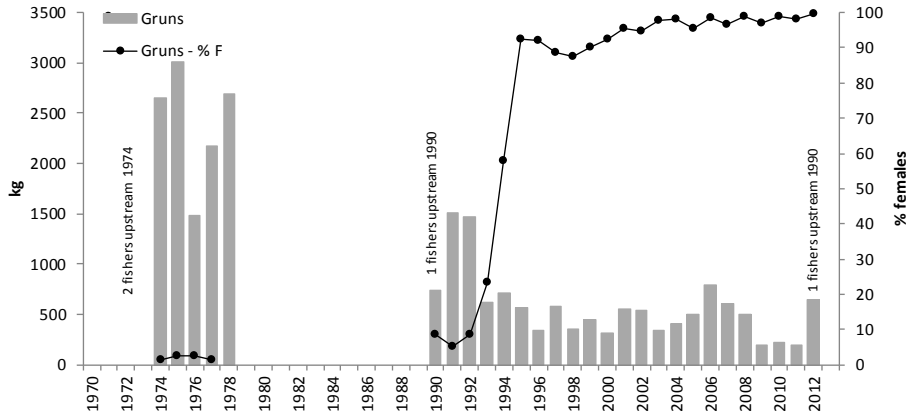



***Figure NL. 7*** *Silver eel catches in kg at a site in Friesland between 1974 and 1978 and between 1990 and 2012. The catch composition is represented by the percentage of the catch that consists of females.*

Silver eel catches at two sites (Inthiemasloot and Korte Vliet) in Friesland declined already in the late 1950 and fishing for silver eel at those two locations ceased in 1968 due to reduced catches. This decline coincided with a temporary change in the sex ratio of the catch from predominantly males to a higher fraction (>25%) of females. After less than 10 years, however, the catch composition was again dominated by male silver eel. The third site (Gruns), with silver eel catch data from 1974-1978 and from 1990 onwards, shows declined catches in the early 1990s compared to the 1974-1978 data. In addition to the decline in the total volume of the annual catch, the sex ratio reversed from a male dominated catch to a female dominated catch. This reversal in sex ratio means that the decline in *numbers* of silver eel caught is more pronounced than the decline in catch weight, as the average female silver eel (*c*. 700 gr) weighs significantly more than the average male (*c*. 100 gr). This is illustrated in Figure NL. 8.

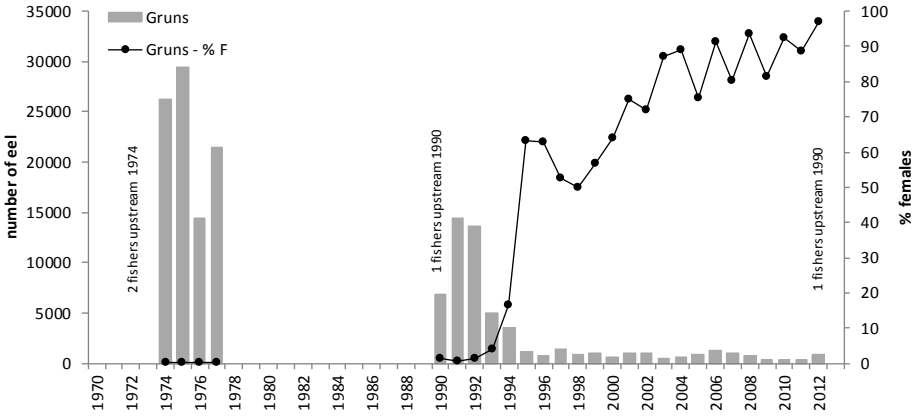



***Figure NL. 8*** *Silver eel catches in numbers at a site in Friesland between 1974 and 1978 and between 1990 and 2012. The catch composition is represented by the percentage of females in the catch.*

### *3.3.2 Recreational*

NO AVAILABLE DATA.

## 3.4 Aquaculture production

### *3.4.1 Seed supply*

***Table NL. D*** *Origin of glass eel used for aquaculture in the Netherlands since 2010 (Source DUPAN).*

| SEASON | FRANCE | SPAIN | ENGLAND | TOTAL (KG) |
|---|---|---|---|---|
| 2010/2011 | 4725 | 1890 | 135 | 6750 |
| 2011/2012 | 5325 | 1350 | 100 | 6775 |
| 2012/2013 | 5500 | 650 | 550 | 6700 |
| 2013/2014 | 3400 | 250 | 1250 | 4900 |

### 3.4.2 Production

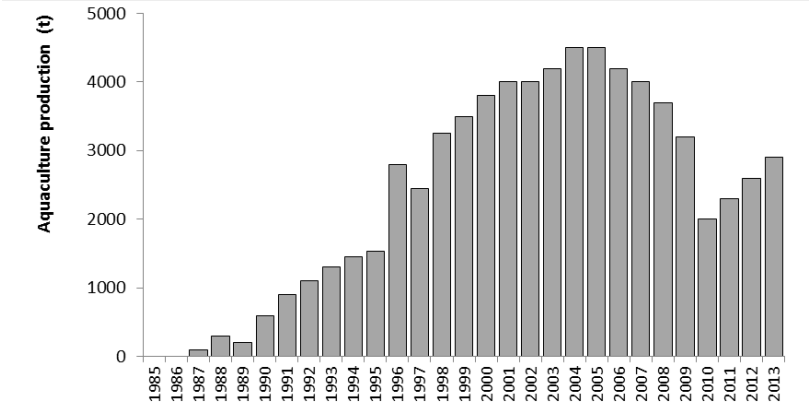



***Figure NL. 9*** *Trend in aquaculture production of yellow eel for consumption in the Netherlands (Source DUPAN).*

## 3.5 Stocking

### 3.5.1 Amount stocked

***Table NL. E*** *Overview of glass eel and young yellow eel stocked in the Netherlands in 2014 (Source DUPAN and CvB). For yellow eel, the location where they have been raised is set between brackets in the column 'Origin'.*

| DATE | STOCKING LOCATION | ORIGIN | QUARAN-TINED | KG | # | #/KG |
|---|---|---|---|---|---|---|
| **GLASSEEL** | | | | | | |
| 01/04/2014 | Wieringermeer | UK Severn | N | 26 | 84,500 | 3250 |
| 01/04/2014 | Zeeland (semi-closed areas) | UK Severn | N | 60 | 195,000 | 3250 |
| 02/04/2014 | Veersemeer | South France | N | 175 | 560,000 | 3200 |
| 02/04/2014 | Grevelingenmeer | South France | N | 900 | 2,940,000 | 3267 |
| 03/04/2014 | Noord-Holland | UK Severn | N | 377 | 1,225,000 | 3249 |
| 07/04/2014 | Friese Boezem | South France | N | 592 | 1,900,000 | 3209 |
| 09/04/2014 | Noord-West Overijssel | UK Severn | N | 80 | 260,000 | 3250 |
| 09/04/2014 | Zuid-Holland (semi-closed areas) | UK Severn | N | 91 | 295,750 | 3250 |
| 09/04/2014 | Groningen | UK Severn | N | 40 | 130,000 | 3250 |
| April-May | Den Oever | Local | N | 119 | 357,000 | 3000 |
| | | | Total | 2,460 | 7,947,250 | |
| **YOUNG YELLOW EEL** | | | | | | |
| 21/05/2014 | Tjeukemeer/ Sneekermeer | South France (Nijmegen) | Y | 1,855 | 530,000 | 286 |
| 21/05/2014 | Kampen | South France (Nijmegen) | Y | 159 | 45,500 | 286 |
| 21/05/2014 | Elburg | South France (Nijmegen) | Y | 18 | 5,000 | 286 |
| 21/05/2014 | Harderwijk | South France (Nijmegen) | Y | 298 | 85,000 | 286 |
| 05/09/2014 | Markermeer Lelystad | UK Severn (Denmark) | Y | 600 | 208,000 | 347 |
| 05/09/2014 | Markermeer Hoorn | UK Severn (Denmark) | Y | 612 | 212,000 | 346 |
| | | | Total | 3,541 | 1,085,500 | |

### *3.5.2 Catch of eel <12 cm and proportion retained for restocking*

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

### *3.5.3 Reconstructed Time Series on Stocking*

No (historical) data available with regards to origin and whether or not stocked eels were quarantined, overall all stocked of glass eel (see Figure .NL.6) is sourced outside the Netherlands.

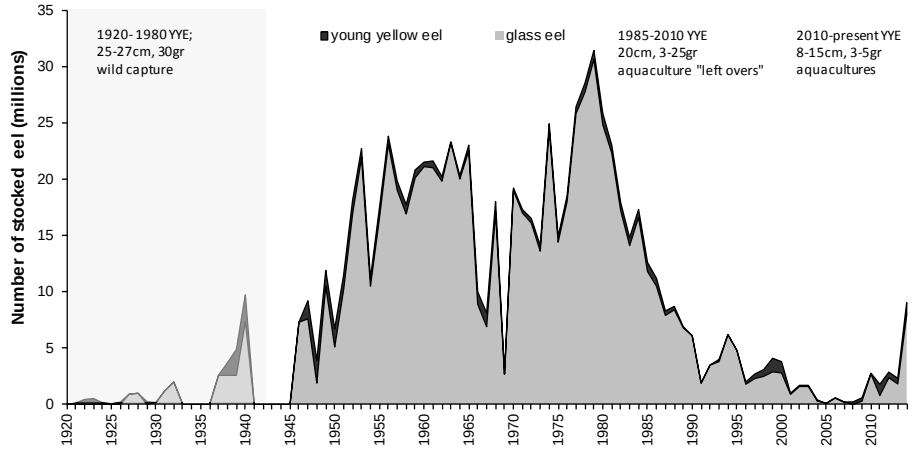



***Figure NL. 10*** *Overview of stocking of glass eel and young yellow eel in the Netherlands. Note that the average weight of stocked young yellow eel decreased from ~30g to ~3 g between 1920 and 2010.*

## 3.6 Trade in eel

| SOURCE | DESTINATION | STAGE | KG | MARKET VALUE (€/KG) |
|---|---|---|---|---|
| South France | Netherlands | glass eel | 2,329 | ? |
| UK Severn | Netherlands | galss eel | 1,212 | ? |
| | | TOTAL | 3,541 | |

## 4. Fishing capacity

For marine waters and Lake IJsselmeer a register of ships is kept, but for the other waters no central registration of the ships being used is available. Registration of the number of gears owned or employed was lacking until recently.

For Lake IJsselmeer/Markermeer (Figure NL. 11), 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.

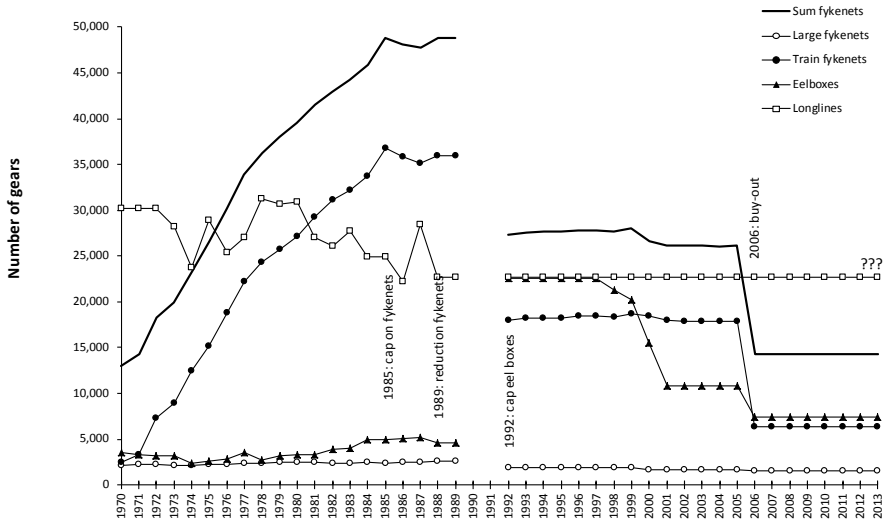



***Figure NL. 11*** *Trends in the nominal number of fishing gear employed in the eel fishery on Lake IJsselmeer/Markermeer. Information before 1989 is based on a voluntary inquiry in 1989 (Dekker 1991); after 1992, the licensed number of gear is shown. Note that long line fishery is only restricted by the number of licences, the number of long lines per licence is not regulated. The number of long lines since 1992 is unknown.*

# 5. Fishing effort

## 5.1 Glass eel

No fishing on glass eel.

## 5.2 Yellow eel

No distinction between fishing effort on yellow eel and silver eel. Data are combined.
For most of the country, fishing effort was unknown until 2012. In areas where fishing capacity was known (IJsselmeer/Markermeer), no record had been kept of the actual usage of fishing gears. For Lake IJsselmeer, a maximum number of gears by company is enforced (authenticated tags are attached to individual gears; see Chapter 4), but the actual usage is often much lower, amongst others since restrictions apply on the combinations of types of fishing gears (e.g. fyke nets and gill nets should not be operated concurrently, since perch and pikeperch are the target species of the gill netting, whereas landing perch and pikeperch from fyke nets is prohibited).
A national catch registration system was introduced by Ministry of Economic Affairs on 1/1/2010. Since 2012, eel fishers are obliged for the first time to weekly record their effort in addition to their catches; all eel fishers have to record the type of gear and number of gear used. Overviews of the number and type of gear deployed weekly throughout 2013 is presented in Figure NL. 12 for Lake IJsselmeer/Markermeer (combined) and in Figure NL. 13 for the other locations in The Netherlands (combined). In general, effort was fairly constant throughout the season, with at most a slight increase during the season. Only eelboxes were deployed mainly in the first half of the season.

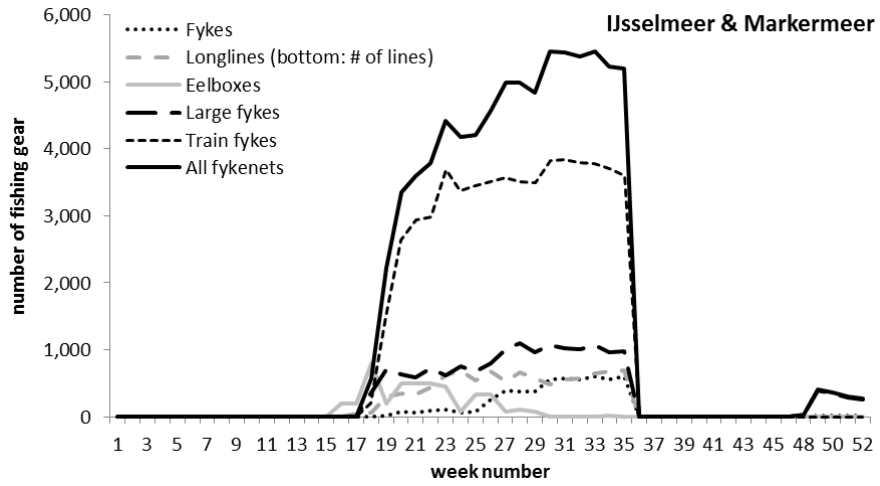



***Figure NL. 12*** *The number of fishing gear employed weekly in the eel fishery on Lake IJsselmeer and Markermeer (Source Ministry of Economic Affairs).*

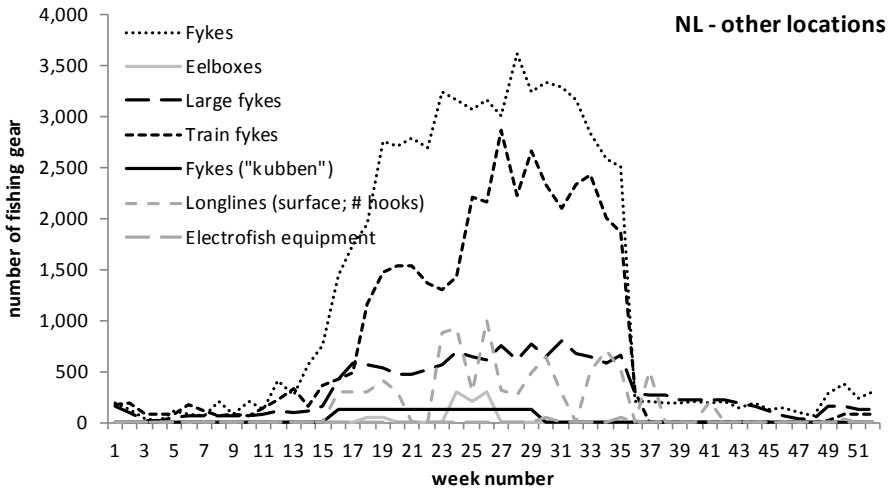



***Figure NL. 13*** *Number of fishing gear employed weekly in the Dutch eel fishery in 2013 on other locations throughout the Netherlands (source Ministry of Economic Affairs).*

The comparison of the maximum number of each eel fishing gear type deployed in Lake IJsselmeer/Markermeer in 2012 and 2013 with the maximum number of markers allowed (Table NL. F) demonstrates that for most gears there was an 'overcapacity' of fishing gears; the number of actually used fishing gears was considerably lower that the number of legally allowed gears.

***Table NL. F*** *Maximum number of eel fishing gear deployed weekly by the eel fishery in 2012 and 2013, on Lake IJsselmeer and Markermeer and on other locations. The number of fishing gear ("markers") allowed on Lake IJsselmeer/Markermeer is also given (6th column). [1] Longlines employed in Lake IJsselmeer/Markermeer are bottom lines, longlines employed elsewhere are surface lines; [2]The gear type listed as "Fykes" has been included in the gear type Large fykes.*

| | IJSSELMEER/MARKERMEER | | | | | OTHER LOCATIONS | |
|---|---|---|---|---|---|---|---|
| GEAR TYPE | 2012 | | 2013 | | AVAILABLE | 2012 | 2013 |
| | NO. | % | NO. | % | | NO. | NO. |
| Longlines[1] | 755 | -- | 695 | -- | no limit | 1330 | 1040 |
| Eelboxes | 1300 | 18 | 800 | 11 | 7400 | 125 | 300 |
| Large fykes[2] | 1795 | 19 | 1706 | 18 | 9400 | 4953 | 4523 |
| Train fykes | 4311 | 68 | 3842 | 60 | 6380 | 2955 | 2861 |
| Electrofish equipment | -- | | -- | | | 6 | 57 |

## 5.3 Silver eel

No distinction between fishing effort on yellow eel and silver eel. Data are combined and reported under yellow eel (Paragraph 5.2).

## 5.4 Marine fishery

Only the number of vessels reporting eel catches are known. These are reported in paragraph 6.4, Figure NL. 14.

# 6. Catches and landings

## 6.1 Glass eel

Glass eel fishing is forbidden; no data available.

## 6.2 Yellow eel

### *6.2.1 Catches and/or landings from Lake IJsselmeer/Markermeer*

The fishers organisation (PO IJsselmeer) has kept records of the catches of their associated fishers (>90% of the fishers active in the IJsselmeer area) from 2001 onwards (see section NL 3.2.1). Yellow eel catches and silver eel catches are reported separately (Table NL. G). In addition, in January 2010 an obligatory catch registration system was introduced in the Netherlands by the Ministry of Economic Affairs. In this program weekly catches of eel are reported, but yellow eel and silver eel catches are combined (Table NL. H). No information on effort and gears is reported.
Catches from Lake IJsselmeer have declined following the partial ban on eel fishery (September-November annually) as a result of the Council regulation for European Eel (2008) and the ensuing Dutch Eel management plan.

***Table NL. G*** *Left table: Catches of yellow eel in tonnes by year for the IJsselmeer area. Right table: Catches of silver eel in tonnes by year for the IJsselmeer area. (Source: PO IJsselmeer).*

| YELLOW EEL | | |
|---|---|---|
| DECADE | 2000 | 2010 |
| YEAR | | |
| 0 | | 78 |
| 1 | 364 | 122 |
| 2 | 299 | 120 |
| 3 | 255 | **74** |
| 4 | 242 | |
| 5 | 213 | |
| 6 | 191 | |
| 7 | 175 | |
| 8 | 135 | |
| 9 | 99 | |

| SILVER EEL | | |
|---|---|---|
| DECADE | 2000 | 2010 |
| YEAR | | |
| 0 | | 1 |
| 1 | 41 | 2 |
| 2 | 44 | 1 |
| 3 | 38 | **16** |
| 4 | 38 | |
| 5 | 25 | |
| 6 | 33 | |
| 7 | 13 | |
| 8 | 7 | |
| 9 | 5 | |

### *6.2.2 Catches and/or landings from other areas*

In January 2010, an obligatory catch registration system was introduced in the Netherlands by the Ministry of Economic Affairs. In this program weekly catches of eel are reported, but yellow eel and silver eel catches are combined (Table NL. H). No information on effort and gears is reported.
The reduction in catches following the closure of a most river systems due to high contaminant levels in eel is apparent (Table NL. H).

***Table NL. H*** *Comparison of combined yellow eel and silver eel catches in 2013 from different sources for IJsselmeer area and other areas in The Netherlands.*

| SOURCE | IJSSELMEER | | OTHER AREAS | TOTAL |
|---|---|---|---|---|
| | PO | EZ | EZ | EZ |
| 2010 | 79 | 128 | 324 | 452 |
| 2011 | 124 | 179 | 188 | 367 |
| 2012 | 121 | 168 | 182 | 350 |
| 2013 | 90 | 144 | 171 | 315 |

## 6.3 Silver eel

The fishers organisation (PO IJsselmeer) has kept records of the catches of their associated fishers (>90% of the fishers active in the IJsselmeer area) from 2001 onwards (see section NL 3.2.1). Yellow eel catches and silver eel catches are reported separately (Table NL. G).
Catches from the IJsselmeer area have declined following the partial ban on eel fishery (September-November annually) as a result of the Council regulation for European Eel (2008) and the ensuing Dutch Eel management plan. Catches in 2013 were high compared to the previous years.

## 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 river basin district (RBD). Annual registrations are available 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 obligation did not apply to smaller vessels. From 2001 onwards, vessels with a total length ≥ 10 m are obliged to report their eel catches, but only if their landings per day exceeded 50 kg. Thus, in 2001 the number of ships potentially reporting eel catches rose, but the actual reporting per ship potentially declined. This change the regulation was partly driven by changing practices, and vice versa.

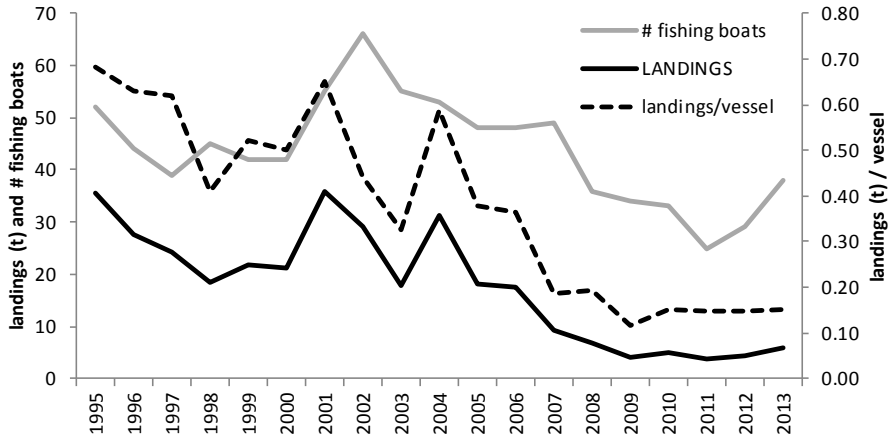



***Figure NL. 14*** *Registered landings of eel (no distinction available between yellow eel and silver eel) from marine waters in Dutch harbours since 1995.*

The number of vessels reporting eel catches, total landings and the landings per vessel have declined from 2001 until 2009. Since 2009, landings and landings by vessel have remained more or less constant, whereas the number of vessels reporting catches varied, with lower numbers in 2011 and 2012.

## 6.5 Recreational Fishery

In 2009 an extensive Recreation Fisheries Program was started in the Netherland. In December 2009, 50.000 households were approached during the screening survey to determine the number of recreational fishermen in the Netherlands (result 1.69 million recreational fishermen). In 2010, 2000 recreational fishermen were selected for a 12-month logbook programme (March 2010 – February 2011). In the Netherlands about 1.500.000 eels are caught by recreational fishermen, while about 500.000 eels are retained. Due to the lack of reliable length frequency data of the eel caught, raising the number of eel caught to a biomass estimate of eel caught remains difficult (van der Hammen & de Graaf, 2012). The program was repeated in 2012/2013 and the data have been analysed, but not yet been reported.

***Table NL. I*** *Recreational Fisheries: Retained and Released Catches of eel (in numbers) in the Netherlands in inland and marine areas. [1]Only combined numbers from both angling and passive gears were available.*

| | Retained | | | | Released | | | |
|---|---|---|---|---|---|---|---|---|
| | Inland | | Marine | | Inland | | Marine | |
| Year | Angling | Passive Gears | Angling | Passive gears | Angling | Passive gears | Angling | Passive gears |
| 2010 | 340536[1] | ibid. | 174215[1] | ibid. | 872570[1] | ibid. | 108462[1] | ibid. |

***Table NL. J*** *Recreational Fisheries: Catch and Release Mortality for eel in the Netherlands.*

| | Released | | | |
|---|---|---|---|---|
| | Inland | | Marine | |
| Year | Angling | Passive gears | Angling | Passive gears |
| 2012 | 0% | 0% | 0% | 0% |

## 6.6 Bycatch, underreporting, illegal activities

### *6.6.1 Bycatch*

No available data.

### *6.6.2 Underreporting and illegal catches*

The task of adherence to rules and regulations pertaining to eel fishery in carried out by Netherlands Food and Consumer Product Safety Authority (NVWA). Following indication of illegal eel fishing in 2012, they intensified their monitoring in 2013. The overall result (no. of fishers involved and total illegal catch) of the illegal fishing activities are reported in the annual report of the NVWA over 2013: http://www.nvwa.nl/onderwerpen/meest-bezocht-a-z/dossier/ jaarverslag-2013/palingstroperij (Table NL. L).

***Table NL. K*** *Estimation of underreported catches in 2013 by stage.*

| | Glass eel | | | | Yellow eel | | | | Silver Eel | | | | Combined (Y + S) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EMU | Reported catches (kg) | Underrept. % | Underrept. (kg) | Total catches (kg) | Reported catches (kg) | Underrept. % | Underrept. (kg) | Total catches (kg) | Reported catches (kg) | Underrept. % | Underrept. (kg) | Total catches (kg) | Reported catches (kg) | Underrept. % | Underrept. (kg) | Total catches (kg) |
| NL | | | | | | | | | | | | | | | | |
| Total/mean (%) | | | | | | | | | | | | | | | NC | |

***Table NL. L*** *Existence of illegal activities, its causes and the seizures quantity they have caused. For indications used in the column 'Cause' see Table NL. M.*

| | Glass eel | | | Yellow eel | | | Silver Eel | | | Combined (Y +S) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EMU | Y/N/? | Cause | Seizures (kg) | Y/N/? | Seizures (kg) | Cause | Y/N/? | Seizures (kg) | Cause | Y/N/? | Seizures (kg) | Cause |
| NL | NP | | | ND | | | ND | | | Y | 4.402 | 1. |

***Table NL. M*** *Overview of suspected causes of illegal fishing activities in the Netherlands.*

| Cause | | IJsselmeer | other areas |
|---|---|---|---|
| 1. | Fishing out of the season | Y | Y |
| 2. | Fishing without licence | Y | Y |
| 3. | Fishing using illegal gears | Y | Y |
| 4. | Retention of eel below size limit | ? | ? |
| 5. | Illegal selling of catches | Y | Y |

## 7. Catch per unit of effort

No data available.

# 8. Other anthropogenic and environmental impacts

## 8.1 Assisted migration of silver eel

Since 2011 several (pilot)projects have started at migration barriers (pumping stations) to assist the migration of silver eel. In 2011 0,54 t of silver eel was caught and released again past barriers at four sites ('assisted migration'). In 2012 this amount increased almost tenfold to 4,80 t (15 sites), and in 2013 to 9,32 t (25 sites; Figure NL. 15).
However, the mortality rates of silver eel passing the selected barriers has been assessed at moderate to low (Bierman *et al.* 2012; Winter *et al.* 2013). Thus, the net amount of eels saved by the assisted migration is much lower than the amount caught and released. In 2013 the barriers for silver eel were prioritised (Winter *et al.* 2013) to improve the selection and efficiency of assisted migration initiatives. Applying location-specific mortality rates, the net amount of 'saved' eels was 0,14 t in 2011, 0,72 t in 2012 and 0,86 t in 2013, a five-fold (2012) to six-fold increase (2013) compared to 2011 (Figure NL. 15).

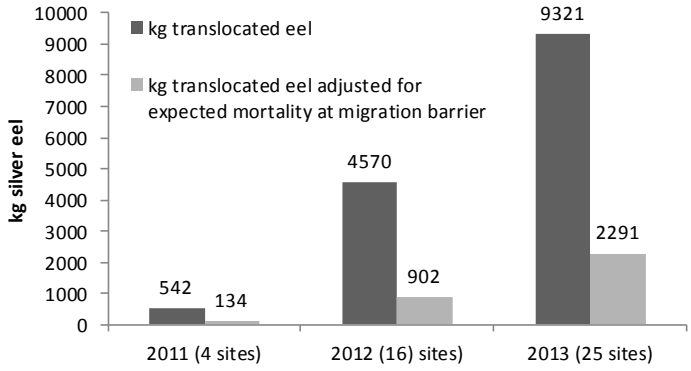



***Figure NL. 15*** *Overview of the "gross" and "net" amount of silver eel assisted over migration barriers in the Netherlands.*

# 9. Scientific surveys of the stock

## 9.1 NL.G.1 Recruitment surveys, glass eel

See paragraph 3.1.1.3.

## 9.2 NL.G.2 Stock surveys, yellow eel

### *9.2.1 Lake IJsselmeer/Markermeer (active gear)*

Figure NL.16 presents the trends in CPUE for the annual (yellow) eel surveys in Lake IJsselmeer (25 sites) and Lake Markermeer (15 sites), using the electrified trawl.

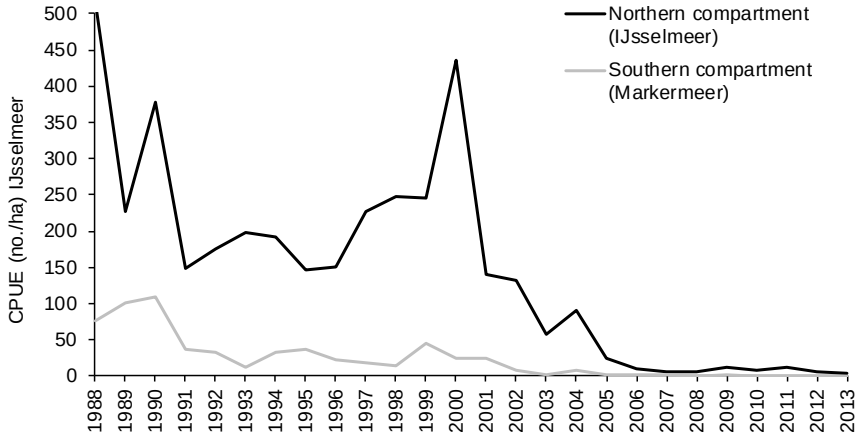



***Figure NL. 16*** *CPUE trends in Lake IJsselmeer stock surveys, in number per hectare swept area, using the electrified trawl. Note: The northern and southern compartments have been separated by a dyke since 1976.*

### *9.2.2 Main rivers (active gear)*

Data collected for the main rivers, but not (yet) available.

### *9.2.3 Main rivers (passive gear)*

No new data.

### *9.2.4 Coastal waters (active gear)*

The number of eels caught in a coastal survey (Demersal young Fish Survey) is presented in Figure NL.15. Until the mid-1980s, considerable catches of eel were observed, after which a gradual decrease was observed. A more elaborate statistical analysis of the abundance and length composition of the eel stock in coastal waters is presented in Dekker (2009).

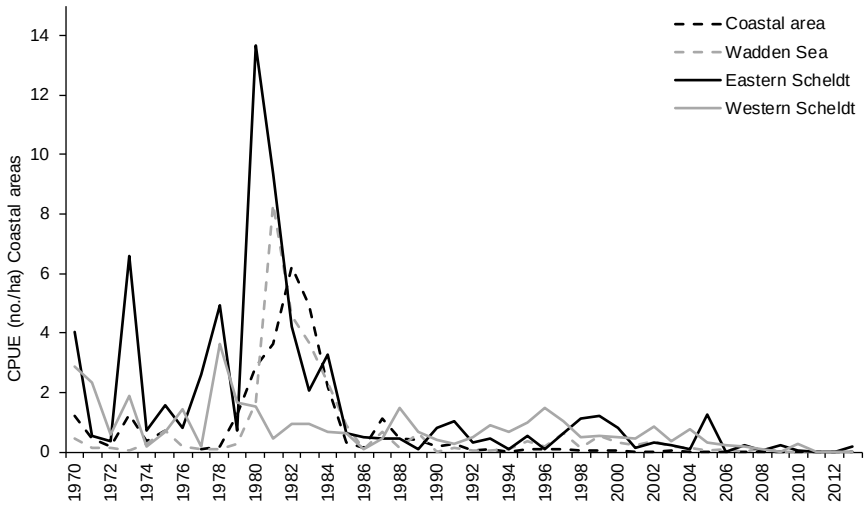



***Figure NL. 17*** *Trends in coastal survey CPUE. Most of the Wadden Sea belongs to RBD Rhine; Eastern Scheldt is mixed RBD Scheldt and Meuse; Western Scheldt belongs to RBD Scheldt (with an extra inflow from Meuse), the coastal area belongs to RBD Rhine.*

## 9.3 NL.G.3 Silver eel

The Silver Eel Index has been implemented in the Netherlands since 2012. In co-operation with commercial fishermen the abundance of migrating silver eel is monitored on seven locations (main entry and exit points for migratory fish) during the months September-November. The programme and the results will be presented and discussed when sufficient data have become available, after at least five years.

## 10. Data collected for the DCF

***Table NL. N*** *Summary of the DCF monitoring implementation for The Netherlands*

| Data | River | Lakes | Estuaries | Lagoons | Coastal & Marine |
|---|---|---|---|---|---|
| Production / escapement surveys[1] | Y (WFD) | Y (WFD) | NP | NP | NP |
| No. of recruitment time-series surveys[2] | 10 | 1 | NP | NP | NP |
| No. fished aged | 100 | | 0 | 0 | 0 |
| No. of fished sexed | 531 | | 0 | 0 | 0 |
| No. of fish examined for parasites | 531 | | 0 | 0 | 0 |
| No. of fish examined for contaminants | ca. 475 | | 0 | 0 | 0 |
| No. of non-fishery mortality studies[3] | 1 | 0 | 0 | 0 | 0 |
| Socio-economic survey | 0 | 0 | 0 | 0 | 0 |

[1] Surveys to estimate $B_{best}$ and/or $B_{current}$, including WFD surveys of which the data are being used to estimate production and/or escapement of eel

[2] Fishery-independent surveys

[3] Studies to determine $\sum H$ for non-fisheries anthropogenic impacts (hydropower, barriers, predation, etc.)

# 11. Life history and other biological information

## 11.1 Growth, silvering and mortality

*See Bierman et al. 2012.*

## 11.2 Parasites and pathogens

The swim bladder nematode *Anguillicoloides crassus* was introduced from South-East Asia in wild stocks of European eel in The Netherlands in the early 1980s. The market sampling for Lake IJsselmeer collects information on eels showing *Anguillicoloides crassus* infection based on inspection of the swim bladder by the naked eye. We scored an infection as 'present' when either we observed one or more *Anguillicoloides crassus* or a thickened swim bladder. As part of the extended market sampling program in 2009, data on *Anguillicoloides* infection rates have since also been collected in two other areas (Friesland and Rivers), and since 2011 the market sampling was conducted in most of the country.
Following the initial break-out in the late 1980s, infection rates in Lake IJsselmeer have been stable around 50 %. Over the past years, infection rates appear slightly lower both in the southern compartment of Lake IJsselmeer (i.e. Markermeer) and on average in the rest of the Netherlands (Table NL. L).

***Table NL. O*** *Infection rates of eels with A. crassus in the Netherlands. [1]Median infection rates of all sampled locations.*

| | IJSSELMEER | | MARKERMEER | | FRYSLAN | | | OTHER LOCATIONS | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N eels | % infected | N eels | % infected | N locations | N eels | % infected | N locations | N eels | % infected[1] |
| 2010 | 390 | 49 | 225 | 48 | 11 | 534 | 46 | 10 | 1660 | 48 |
| 2011 | 293 | 43 | 104 | 34 | 5 | 107 | 37 | 17 | 1087 | 33 |
| 2012 | 320 | 53 | 253 | 38 | 5 | 133 | 33 | 17 | 1235 | 34 |
| 2013 | 159 | 55 | 93 | 43 | 2 | 17 | 47 | 9 | 531 | 38 |

## 11.3 Contaminants

In 2013, 19 locations have been sampled to assess contaminant levels (dioxins and dioxin-like PCBs) in eel. Samples consisted of about 25 individuals, 30-40 cm or >45 cm length, and were pooled prior to analysis. (Table NL. M).

***Table NL. P*** *Monitoring data of PCBs and dioxin-like PCBs in eel in The Netherlands. Grey-shaded results are above limits.*

| AREA, LOCATION | SIZE CLASS (CM) | NO. EELS | MEAN LENGTH (CM) | MEAN WEIGHT (G) | SUM TEQ (UB,PG/G) | PCB 153 (NG/G) | SUM DIOXIN-LIKE PCBS (UB, NG/G) |
|---|---|---|---|---|---|---|---|
| Amsterdam-Rijnkanaal | 30-40 | 25 | 36 | 84 | 10.5 | 138 | 330 |
| Amsterdam-Rijnkanaal | >45 | 8 | 50 | 239 | 14.9 | 256 | |
| Haringvliet, seaside | 30-40 | 5 | 38 | 73 | 1.7 | 26 | 42 |
| Haringvliet, seaside | 40-45 | 11 | 44 | 112 | 2.6 | 25 | 38 |
| Haringvliet, seaside | >45 | 23 | 56 | 259 | 5.5 | 47 | 77 |
| Hollands Diep | 30-40 | 25 | 36 | 89 | 6.3 | 179 | 390 |
| Hollands Diep | >45 | 15 | 61 | 493 | 21.4 | 471 | 970 |

| AREA, LOCATION | SIZE CLASS (CM) | NO. EELS | MEAN LENGTH (CM) | MEAN WEIGHT (G) | SUM TEQ (UB,PG/G) | PCB 153 (NG/G) | SUM DIOXIN-LIKE PCBS (UB, NG/G) |
|---|---|---|---|---|---|---|---|
| IJssel, Deventer | 30-40 | 17 | 36 | 69 | 4.0 | 90 | 200 |
| IJsselmeer, Lelystad | 30-40 | 25 | 36 | 85 | 3.1 | 31 | 64 |
| IJsselmeer, Lelystad | >45 | 14 | 51 | 251 | 7.6 | 75 | 150 |
| IJsselmeer, Urk | 30-40 | 25 | 35 | 74 | 4.0 | 44 | 92 |
| IJsselmeer, Urk | >45 | 12 | 53 | 326 | 6.6 | 76 | 170 |
| IJsselmeer, Medemblik | 30-40 | 25 | 35 | 80 | 1.5 | 13 | 25 |
| IJsselmeer, Medemblik | >45 | 12 | 54 | 334 | 3.9 | 26 | 52 |
| Kan Gent-Terneuzen | 30-40 | 2 | 39 | 104 | 7.8 | 154 | 370 |
| Kan Gent-Terneuzen | >45 | 5 | 53 | 277 | 9.7 | 189 | 460 |
| Kan Wessem-Nederweert | >45 | 17 | 61 | 415 | 11.2 | 228 | 510 |
| Ketelbrug, north side | 30-40 | 17 | 36 | 84 | 7.1 | 118 | 250 |
| Ketelbrug, south side | 30-40 | 21 | 34 | 70 | 5.9 | 151 | 300 |
| Ketelbrug, south side | >45 | 13 | 53 | 313 | 12.0 | 216 | 460 |
| Ketelbrug, north side | >45 | 15 | 55 | 341 | 14.0 | 173 | 380 |
| Ketelmeer, north | 30-40 | 11 | 36 | 87 | 7.1 | 128 | 270 |
| Ketelmeer, north | >45 | 14 | 56 | 388 | 23.2 | 246 | 550 |
| Lek, Culemborg | 30-40 | 21 | 35 | 74 | 4.7 | 124 | 280 |
| Maas, Eijsden | 30-40 | 8 | 35 | 79 | 6.8 | 216 | 500 |
| Maas, Eijsden | >45 | 5 | 50 | 253 | 13.0 | 355 | 830 |
| Rijn, Lobith | 30-40 | 4 | 36 | 77 | 5.3 | 110 | 250 |
| Rijn, Lobith | >45 | 9 | 53 | 302 | 8.3 | 153 | 350 |
| Volkerak shiplock | 30-40 | 25 | 36 | 83 | 3.7 | 83 | 180 |
| Volkerak shiplock | 40-45 | 10 | 43 | 155 | 7.3 | 117 | 260 |
| Volkerak shiplock | >45 | 15 | 50 | 238 | 10.6 | 151 | 350 |
| Volkerak south-west | 30-40 | 25 | 37 | 88 | 4.5 | 53 | 110 |
| Volkerak south-west | >45 | 18 | 54 | 399 | 8.2 | 98 | 210 |
| Vossemeer | 30-40 | 25 | 34 | 75 | 7.4 | 111 | 240 |
| Vossemeer | >45 | 5 | 55 | 345 | 12.5 | 151 | 340 |
| Waal, Tiel | 30-40 | 9 | 37 | 87 | 6.9 | 125 | 300 |
| Waal, Tiel | >45 | 22 | 60 | 443 | 14.7 | 215 | 530 |

Contaminant concentrations are higher in larger eel than in smaller eel from the same locations. In 2013, several samples have contaminant levels above the revised regulatory limits of 2012 (10 pg/g Sum TEQ and 350 ng/g PCB-153, 10% uncertainty included). All locations that did have eels with a concentration of Sum TEQ or Sum dioxins and dioxin-like PCBs above the regulatory levels were fed by the rivers Rhine (IJssel), Meuse or Scheldt. Following the closure of these areas to eel fishery, samples are no longer available from these Rhine- or Meuse-fed locations.

Since 1978/1979 several locations have been monitored annually for PCB-153. Concentrations in 2013 were about similar to those in previous years.

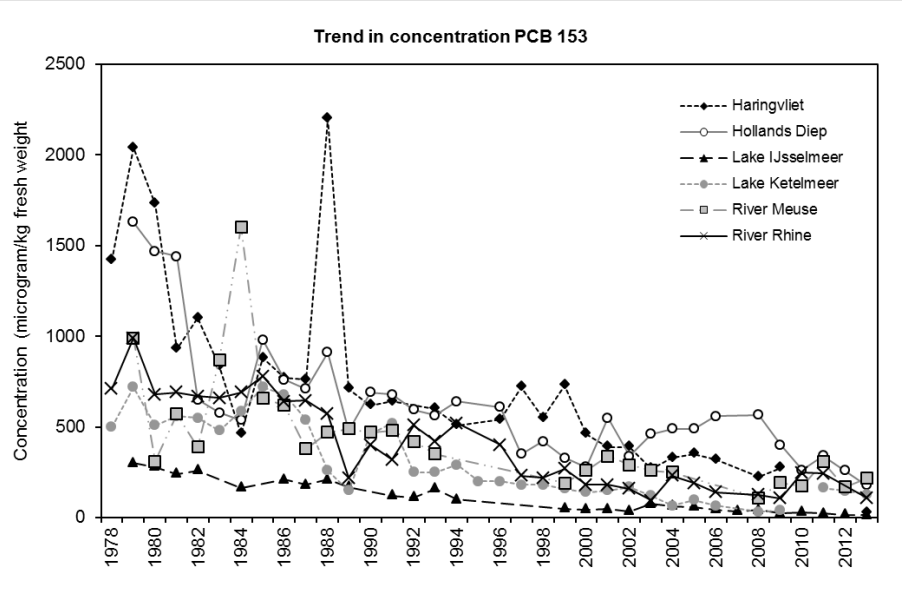



***Figure NL. 18*** *Trend in PBC-153 in 30-40 cm eel (data: IMARES and RIKILT).*

## 11.4 Predators

Predation of eel by cormorants (*Phalacrocorax carbo*) is much disputed amongst eel fishermen and bird protectors. The number of cormorant breeding pairs increased rapidly until the early 1990s, then stabilised and even decreased in recent years (Figure NL. 18). For Lake IJsselmeer, food consumption has been well quantified (van Rijn & van Eerden 2001; van Rijn 2004); eel constitutes a minor fraction of the diet of cormorants. In other waters, neither the abundance, nor the food consumption is accurately known.

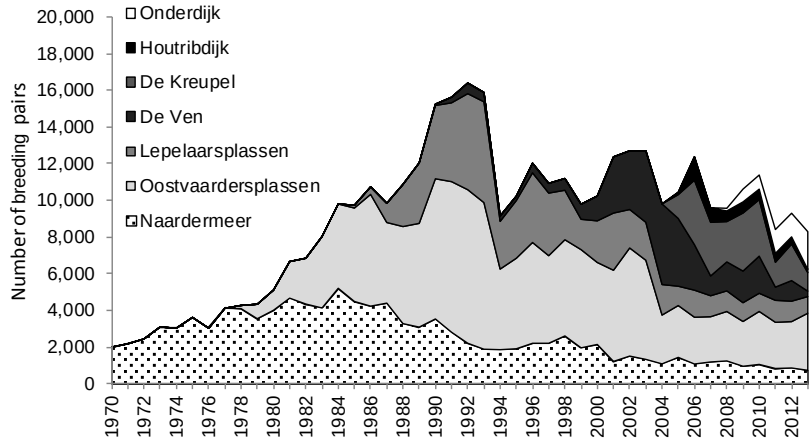



***Figure NL. 19*** *Trends in the number of breeding pairs of cormorants (Phalacrocorax carbo) in and around Lake IJsselmeer/Markermeer (Source: Waterdienst RWS).*

## 12. Other sampling

Nothing to report.

# 13. Stock assessment

## 13.1 Method summary

Bierman SM, Tien N, van de Wolfshaar KE, , Winter HV, de Graaf M (2012) Evaluation of the Dutch Eel Management Plan 2009-2011. IMARES C067/12, pp. 132.

### *13.1.1 Estimate of $B_0$*

***Table NL. Q*** *Reference period for $B_0$.*

| EMU_code | $B_0$ (kg/ha) | Reference time period | Whether or not changed from value reported last year (Y/N) |
|---|---|---|---|
| NL_Neth | 10.400 | 2011 | N |

## 13.2 Summary data

The summary data in the tables below are from "2011" as presented in Bierman et al. (2012).

### *13.2.1 Stock indicators and Targets*

***Table NL. R*** *Stock indicators and Target derived from: Bierman et al. 2012.*

| EMUCODE | INDICATOR | BIOMASS (T) | | MORTALITY (RATE) | | | TARGET | | |
|---|---|---|---|---|---|---|---|---|---|
| | $B_0$ | $B_{best}$ | $B_{curr}$ | ∑A | ∑F | ∑H | Source | Biomass (t) | ∑A (rate) |
| NL_Neth | 10.400 | 1.443 | 482 | 1.1 | 1.16 | 0.04 | EMP | | |
| | | | | | | | EU Reg | 4160 | |
| | | | | | | | WGEEL | | 0.106 |

### *13.2.2 Habitat coverage*

***Table NL. S*** *Habitat coverage derived from Bierman et al. 2012*

| EMU CODE | RIVER | | LAKE | | ESTUARY | | LAGOON | | COASTAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Area (ha) | A'd (Y/N) | Area (ha) | A'd (Y/N) | Area (ha) | A'd (Y/N) | Area (ha) | A'd (Y/N) | Area (ha) | A'd (Y/N) |
| NL_Neth | 88391 | Y | 232.758 | Y | NP | NP | NP | NP | 358.802 | N |

### 13.2.3 Impact

**Table NL. T** *Overview of the assessed impacts per habitat type or for 'All' habitats where the assessment is applied across all relevant habitats. Barriers include habitat loss; indirect impacts are anthropogenic impacts on the ecosystem, but only indirectly on eel (e.g. eutrophication). A = assessed, MI = not assessed, minor, MA = not assessed major, AB = impact absent.*

| EMU CODE | HABITAT | FISH COM | FISH REC | HYDRO & PUMPS | BARRIERS | RESTOCKING | PREDATORS | INDIRECT IMPACTS |
|---|---|---|---|---|---|---|---|---|
| NL_Neth | Riv | A | A | A | A | MI/MA | MI/MA | MI/MA |
| | Lak | A | A | A | A | MI/MA | MI/MA | MI/MA |
| | Est | NP | NP | NP | NP | NP | NP | NP |
| | Lag | NP | NP | NP | NP | NP | NP | NP |
| | Coa | MI | A | AB | AB | AB | AB | MI |
| | All | | | | | | | |

**Table NL. U** *Loss of eel (kg) for each impact per developmental stage. MI = not assessed, minor; MA = not assessed major; AB = impact absent. [1]All eel caught recreationally were assumed to be yellow eel. [2]Including 6 t mortality of GER/BE silver eel.*

| EMU CODE | STAGE | FISH COM | FISH REC | HYDRO & PUMPS | BARRIERS | RESTOCKING | PREDATORS | INDIRECT IMPACTS |
|---|---|---|---|---|---|---|---|---|
| NL_Neth | Glass | AB | AB | MI/MA | MI/MA | MI | MI/MA | MI/MA |
| NL_Neth | Yellow | 290 | 100 | MI/MA | MI/MA | AB | MI/MA | MI/MA |
| NL_Neth | Silver | 77 | AB[1] | 76[2] | MI/MA | AB | MI/MA | MI/MA |
| NL_Neth | Silver EQ | | | | | | | |

### 13.2.4 Precautionary Diagram

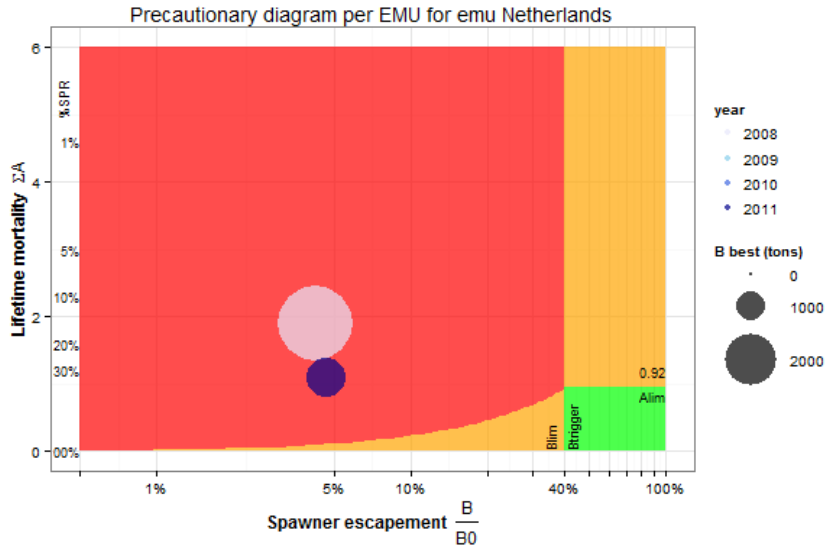



**Figure NL. 20** *Modified precautionary diagram for the Netherlands EMU (after WGEEL 2012), see section 1.3.2 of ICES (2013) for more information.*

### 13.2.5 Management Measures

***Table NL. V*** *Proposed and implemented management measures. 'Com fish': commercial fisheries; 'Rec fish': recreational fisheries; 'Hydropower & Pumps' includes obstacles; 'Other' refers to indirect measures (e.g. implementing data collection and conducting studies).*

| EMU CODE | ACTION TYPE | ACTION | LIFE STAGE | PLANNED | OUTCOME |
|---|---|---|---|---|---|
| NL_Neth | Com Fish | Closing fishing season | M | EMP | Fulfilled |
| NL_Neth | Com Fish | Introducing fishery-free zones | M | EMP | Fulfilled |
| NL_Neth | Com Fish | Closure of fishery in contaminated areas | M | After EMP | Fulfilled |
| NL_Neth | Com Fish | Sniggling Ban | M | EMP | Fulfilled |
| NL_Neth | Rec Fish | Eel releasing by anglers | M | EMP | Fulfilled |
| NL_Neth | Rec Fish | Ban on recreational fishery using professional gears | M | EMP | Fulfilled |
| NL_Neth | Rec Fish | Closing fishing season | M | EMP | Fulfilled |
| NL_Neth | Rec Fish | Sniggling ban | M | EMP | Fulfilled |
| NL_Neth | Hydropower & Pumps | Barriers reduction from 2015 | M | EMP | Partially |
| NL_Neth | Hydropower & Pumps | Hydroelectric stations barriers reduction | M | EMP | Partially |
| NL_Neth | Restocking | Stocking with glass eels | M | EMP | Fulfilled |

## 13.3 Summary data on glass eel

***Table NL. W*** *Overview of use of glass eel. [1]Not all translocated glass eel is stocked for recovery purposes.*

| USE OF GLASS EEL | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| Caught in commercial fishery | 0 | 0 | 0 | 0 | 0 | 0 |
| Used in stocking[1] | 100 | 904 | 244 | 766 | 630 | 2.460 |
| Used in aquaculture for consumption | ? | ? | 6.750 | 6.775 | 6.700 | 4.900 |
| Consumed directly | 0 | 0 | 0 | 0 | 0 | 0 |
| Mortalities | ? | ? | ? | ? | ? | ? |

## 14. Sampling intensity and precision

No new information.

# 15. Standardisation and harmonisation of methodology

## 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 |
| liftnet (1x1m; mesh 1x1mm) | 10 other locations along the coast | weekly | 2 hauls at night time | ~Mar-May |

SILVER EEL MONITORING

| GEAR | LOCATION | FREQUENCY | TIME | PERIOD |
|---|---|---|---|---|
| Fykes (6 sites) | Den Oever, Kornwerderzand, Noordzeekanaal, Nieuwe waterweg, Haringvliet, upper reaches river Meuse | continuous | weekly | Sep-Nov |
| Eel shocker | upper reaches river Rhine | continuous | once a week | Sep-Nov |

PASSIVE MONITORING PROGRAM: MAIN RIVERS AND LAKE IJSSELMEER

| GEAR | LOCATION | FREQUENCY | PERIOD |
|---|---|---|---|
| Fykes (4) (stretched mesh 18-20mm) | Veerse Meer, Haringvliet (North Sea) | continuous | ~May-Sep |
| Fykes (10) or summer fykes (20-40) (stretched mesh 18-20mm) | 7 locations in main rivers, estuaries and lakes | continuous | Sep-Nov |
| Fykes (10) or summer fykes (20-40) (stretched mesh 18-20mm) | 6 locations in main rivers, estuaries and lakes | continuous | Mar-May |

Due to closure of the eel fishery in polluted areas, this program – which started in the 1990s – has been interrupted. Almost two thirds of the sampling locations were located in the polluted areas and sampling ceased on 1 April 2011. A alternative program to study diadromous fish started in 2012..

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) | ~50 locations in main rivers | 20 min, 600m transect | ~May-Sep |

## 15.2 Sampling commercial catches

| AREA | SAMPLING FREQUENCY | NO. OF FISHERS SAMPLED | GEAR |
|---|---|---|---|
| Grevelingen | once | 1 | large fyke |
| Friesland | once | 2 | large fyke |
| Hollands Noorderkwartier | twice | 2 | large fyke |
| IJssel Plus | twice | 1 | large fyke |
| Lauwersmeer | once | 1 | large fyke |
| Noorderzijlvest | once | 1 | large fyke |
| Veluwe Randmeren | twice | 1 | large fyke |
| Rijnland | twice | 1 | large fyke |
| Volkerak-Zoommeer | twice | 1 | large fyke |
| Lake IJsselmeer | once | 1 | train fyke |
| Lake IJsselmeer | once/twice | 2 | large fyke |
| Lake IJsselmeer | twice | 1 | eel boxes |
| Lake IJsselmeer | once | 1 | longlines |
| Lake Markermeer | once/twice | 2 | large fyke |
| Lake Markermeer | twice | 1 | longlines |

| PARAMETER | SAMPLE DETAILS |
|---|---|
| No. eels for length-frequency | max. 150 eels per sample |
| No. eels for biology (sex, life stage, parasites) | < 50 cm: 4 eels per 10 cm size class |
| | ≥ 50 cm: 2 eels per 10 cm size class |
| Period | June – August (Fryslan: February – April) |

## 15.3 Sampling

Nothing to report.

## 15.4 Age analysis

Since 2010, age readings have been obtained annually of ~150 otoliths, which were collected from eels in different areas of the Netherlands. The number of annuli were counted to determine the age of individuals ("crack and burn" method). Furthermore, distances between consecutive annuli were measured using image analysis software to determine individual growth curves.

## 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.

## 15.6 Sex determinations

Sex is determined by macroscopic examination of the gonads.

## 15.7 Data quality issues

Nothing to report.

# 16. Overview, conclusions and recommendations

During the development of the current models for the evaluation of the eel management plan in the Netherlands, the main weaknesses of the current methodology surfaced quickly. Here we list the main recommendations to improve the quality of the assessment before the next evaluation in 2015.

***Dynamic Population Model***

**Key biological parameters**: improve the quality of the following key biological parameters

*Sex-ratio of cohorts*: estimates could be improved by using eels smaller than 30 cm. These eels could be obtained during the water framework directive (WFD) fish sampling.

*Growth rate*: estimates could be improved by including eels smaller than 30 cm. These eels could be obtained during WFD fish sampling. Population models could be improved by including variation in growth curves between individuals and locations.

*Maturation-at-age*: estimates of the silvering ogive for a given area could be improved by using data collected year round. Furthermore, it is recommended to record the stage of the eel (yellow/silver) during research surveys (e.g. IJsselmeer electro-trawl survey). Quantitative data on maturity stage should be collected such as eye diameter, rather than a purely visual (informal) assessment.

**Anthropogenic mortalities**: quantify sources of anthropogenic mortalities that are excluded from the current assessments; 1) catch-&-release mortality of recreational fisheries, 2) yellow eel mortality pumping stations and hydropower plants.

***Static Spatial Model***

**WFD survey data**: improve the accessibility of WFD fish survey data of regionally managed waters by establishing a central data base for The Netherlands, and ensure that the data is properly checked to ensure the quality of data.

**Catch efficiency**: conduct experiments to determine efficiencies of electrofishing for eel in different WFD water types in both nationally and regionally managed waters.

**Spatial distribution**: conduct experiments to determine the spatial distribution of eel in wide rivers and lakes in both nationally and regionally managed waters.

**Ditches**: conduct electrofishing surveys for eel in ditches to supplement the existing WFD eel survey data in regionally managed waters

**Habitat**: correct eel densities for habitat in nationally and regionally managed waters

**Electro-beam trawl**: develop an electro-beam trawl to provide reliable estimates of eel (>30 cm) densities in large lakes and wide rivers.

***Silver Eel Migration Model***

**Migration routes**: finalise the GIS model (Appendix A in Bierman et. al. 2012) to improve the estimate of silver eel mortality during migration. When this proves difficult or too expensive, an alternative is to further refine the simpler model based on hierarchies of water bodies (Chapter 6 in Bierman et. al. 2012) by creating such a model for various spatially separate parts. For example, such a simple model could be constructed for various water boards. The proportions of silver eels choosing different routes could be set equal to water discharge levels. It is not clear which of the two methods (GIS model, or further refinement of the 'simple' model) would lead to the best results or would be most cost-effective to get up and running. The GIS method would certainly need a lot more investment, but would be generic and work for the whole of The Netherlands and could be adapted for other species too. For the 'simple' model based on hierarchies of water bodies, information will have to be collected from water boards which will also take a lot of time and the results will apply only to that particular water board.

**Silver eels migrating downstream from Belgium and Germany**: The mortality caused by hydropower stations on silver eels migrating downstream on the river Meuse from Belgium and the river Rhine from Germany ('foreign' silver eels) have not been taken into account in the estimation of LAM in this report. It is unclear at the time of the writing of this report whether these mortalities have been included in the LAM of silver eels that were produced in German and/or Belgian waters. It is recommended that come to an agreement on how these mortalities should be accounted for.

Furthermore, as many other European countries (France, UK, Ireland) are using similar spatial models to estimate yellow eel standing stock and silver eel production, close international co-operation and collaboration will enhance the quality and uniformity of these models in the years to come.

## 17. Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 124296-2012-AQ-NLD-RvA). This certificate is valid until 15 December 2015. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

## References


Bierman, S.M., N. Tien , K.E. van de Wolfshaar., H.V. Winter and M. de Graaf. 2012. Evaluation of the Dutch Eel Management Plan 2009 – 2011. Imares rapport C067/12.

Dekker, W. 1991. Assessment of the historical downfall of the IJsselmeer fisheries using anonymous inquiries for effort data. — In: I.G. Cowx (ed.): Catch Effort Sampling Strategies, their Application in Freshwater Management, pp. 233-240. Fishing News Books, Oxford. 420 pp.

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

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 Ecosystems: Learning from the Past, Finding Solutions for the Future. American Fisheries Society, Symposium 58, Bethesda, Maryland.

Dekker, W. 2009. 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.

Tien, N. and W. Dekker. 2004. Trends in eel habitat abundance in the Netherlands during the 20th century. ICES C.M. 2004/S:12 (mimeo).

van der Hammen, T. and M. de Graaf. 2012. Recreational fishery in the Netherlands: catch estimates of cod (*Gadus morhua*) and eel (*Anguilla anguilla*) in 2010. IMARES C014/12, pp. 61.

van der Meer, J., H.W. van der Veer. And J.IJ. Witte. 2011.The disappearance of the European eel from the western Wadden Sea Journal of Sea Research 66; 434–439.

Van Rijn S. and 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.

Winter, H.V,. A.B. Griffioen and K.E. van de Wolfshaar. 2013. Knelpunten inventarisatie voor de uittrek van schieraal t.b.v. 'Paling Over De Dijk' Rapport C134/13, pp. 20.

## Justification

Report number : C003/15
Project number : 4301218529, 4301218530, 4301218531, 4301218532, 4301218533, 4301218534, 4301218535, 4301218536, 4301218537

The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

Approved: O.A. van Keeken
Researcher

Signature: 

Date: 23 January 2015

Approved: Drs. J.H.M. Schobben
Head of Fish department

Signature: 

Date: 23 January 2015