Report on the eel stock, fishery and other impacts, in:

Belgium

2016

Note to the reader - this document accompanies a series of spreadsheet tables that provide the bulk of the data in a format most suitable for the working practices of the WGEEL. Summaries of these data are provided in this document.

Authors

Claude Belpaire, Research Institute for Nature and Forest (INBO), Kliniekstraat 25, 1070 Brussels, Belgium. Claude.Belpaire@inbo.be

Gerlinde Van Thuyne, Research Institute for Nature and Forest (INBO), Dwersbos 28, 1630 Linkebeek, Belgium

Jan Breine, Research Institute for Nature and Forest (INBO), Dwersbos 28, 1630 Linkebeek, Belgium

David Buysse, Research Institute for Nature and Forest (INBO), Kliniekstraat 25, 1070 Brussels, Belgium

Jeroen Van Wichelen, Research Institute for Nature and Forest (INBO), Kliniekstraat 25, 1070 Brussels, Belgium

Johan Coeck, Research Institute for Nature and Forest (INBO), Kliniekstraat 25, 1070 Brussels, Belgium

Michael Ovidio, Laboratoire de Démographie des Poissons et Hydroécologie, Unité de Biologie du Comportement, Institut de Zoologie, Département des Sciences et Gestion de l'Environnement, Université de Liège, Quai van Beneden 22, 4020 Liège, Belgium

Billy Nzau Matondo, Laboratoire de Démographie des Poissons et Hydroécologie, Unité de Biologie du Comportement, Institut de Zoologie, Département des Sciences et Gestion de l'Environnement, Université de Liège, Quai van Beneden 22, 4020 Liège, Belgium

Jens De Meyer, Ghent University, Evolutionary Morphology of Vertebrates & Zoology Museum, K.L. Ledeganckstraat 35, 9000 Gent (Belgium)

Mathias Bouilliart, Ghent University, Evolutionary Morphology of Vertebrates & Zoology Museum, K.L. Ledeganckstraat 35, 9000 Gent (Belgium)

Dominique Adriaens, Ghent University, Evolutionary Morphology of Vertebrates & Zoology Museum, K.L. Ledeganckstraat 35, 9000 Gent (Belgium)

Pieterjan Verhelst, Ghent University, Marine Biology, Krijgslaan 281, 9000 Ghent (Belgium)

Jean-François Rees, Laboratory of Cellular, Nutritional and Toxicological Biochemistry , University of Louvain, Croix du Sud, 2, B-1348 Louvain-la-Neuve, Belgium

Xavier Rollin, Service de la Pêche, Département de la Nature et des Forêts (DNF), Direction générale opérationnelle de l'Agriculture, des Ressources Naturelles et de l'Environnement (DGARNE), Service Public de Wallonie (SPW), avenue Prince de Liège 7, 5100 Jambes (Namur), Belgium.

Kristof Vlietinck, Agency for Nature and Forests, Koning Albert II-laan 20/bus 8, 1000 Brussels, Belgium.

Met opmaak: Nederlands (België)

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This report is written in preparation of the Joint EIFAAC/ICES/GFCM Working Group on Eels (WGEEL), meeting in Cordoba, Spain, from 14 September to 23 September 2016. Extensive information on the eel stock and fishery in Belgium has been presented in the previous Belgian country reports (i.e. Belpaire *et al*., 2006; 2007; 2008; 2009; 2010, 2011, 2012, 2013, 2014, 2015 and 2016), in the Belgian Eel Management Plan (EMP), and in the first and second report submitted in line with Article 9 of the eel Regulation 1100/2007 (Vlietinck *et al*., 2012; Vlietinck and Rollin, 2015). This report should thus be read in conjunction with those documents.

1 Overview of the stock and its management

1.1 Describe the eel stock and its management

1.1.1 EMUs, EMPs,

Four international RBDs are partly lying on Belgian territory: the Scheldt (Schelde/Escaut), the Meuse (Maas/Meuse), the Rhine (Rijn/Rhin) and the Seine. For description of the river basins in Belgium see the 2006 Country Report (Belpaire *et al*., 2006). All RBDs are part of the NORTH SEA Ices ecoregion.

1.1.2 Management authorities

In response to the Council Regulation CE 1100/2007, Belgium has provided a single Eel Management Plan (EMP), encompassing the two major river basin districts (RBD) present on its territory: the Scheldt and the Meuse RBD.

Given the fact that the Belgian territory is mostly covered by two internationals RBDs, namely the Scheldt and Meuse, the Belgian Eel Management Plan was prepared jointly by the three Regional entities, each respectively providing the overview, data and measures focusing on its larger RBDs. The Belgian EMP thus focuses on the Flemish, Brussels and Walloon portions of the Schelde/Escaut RBD, and the Walloon and Flemish portions of the Meuse/Maas RBD.

The three Belgian authorities (Flanders, Wallonia or Brussels Regions) are responsible for the implementation and evaluation of the proposed EMP measures on their respective territory.

In the next years, all eel-related measures proposed in the Belgian EMP will be fine-tuned according to the existing WFD management plans and implemented in such manner by the responsible regional authorities.

1.1.3 Regulations

The Belgian EMP has been approved by the European Commission on January 5th, 2010, in line with the Eel Regulation.

In June 2012 Belgium submitted the first report in line with Article 9 of the eel Regulation 1100/2007 (Vlietinck et al., 2012). This report outline focuses on the monitoring, effectiveness and outcome of the Belgian Eel Management Plan.

The second Belgian Progress Report in line with Article 9 of the eel Regulation 1100/2007, was submitted in June 2015 (Vlietinck and Rollin, 2015).

1.1.4 Management actions

This section briefly lists actions related to management but also states some scientific or monitoring activities.

The Belgian EMP focuses on:

For the Flemish region

- the ban of fyke fishing on the lower Scheldt in 2009;
- making up an inventory of the bottle necks for upstream eel migration (priority and timing for solving migration barriers).

Specific action in 2014–2016:

In Flanders, the network of watercourses allocated to first priority for the sanitation of fish migration barriers is about 800 km long, and includes 51 fish migration barriers, of which 90% (or 46 barriers) should be sanitized by December 31, 2015. These 46 barriers include 35 priority migratory barriers defined in the eel management plan. On December 31, 2014, a total of 18 of the 46 (39%) barriers of phase 1 were remediated. Of the 35 high priority barriers of the eel management plan, however, only 11 (31%) were sanitized (https://www.inbo.be/nl/natuurindicator/).

- for downward migration:

Specific action in 2014–2016:

A study is being conducted on the Albert Canal to estimate the damage and mortality causes by the combined pump/hydropower installations. Also downstreaming silvers eels will be equipped with transmitters in order to study their behaviour at the pump/hydropower installations and in order to determine to which amount they use the Albert Canal as downstream migration route.

Moreover tagged silver eels in the Scheldt estuary will give further insight in the migration route of silvers leaving the Scheldt basin. A scientific survey of the silver eel migration on the River Scheldt is ongoing. For this, acoustic telemetry is used in combination with a permanent acoustic network in the Scheldt estuary and Belgian Part of the North Sea, funded by the LifeWatch ESRI observatory (Verhelst, work in progress).

In 2016 agreements were made with water managers of 3 pumping stations (Stenensluisvaart, Slopgatvaart and Berlarebroek) to replace screw pumps (which cause nearly 100% mortality to downstream migration silver eels) with fish friendly pumps. Installation of these pumps is planned the coming years. After the installation a field survey will be conducted to test their effectiveness.

- controlling poaching.

Specific action in 2014–2016:

Actions to control illegal fishing activities on eels were continued, focusing mainly on the province of West-Vlaanderen. Illegal fishing equipment was seized.

- Assessing the impact of the recreational fisheries in Flanders.

Specific action in 2016

An inquiry was organized in 2016 to assess the profile of recreational fishermen in Flanders including the assessment of their catch and yield (Agentschap voor Natuur en Bos, 2016).

- Glass eel restocking programme.

Specific action in 2014–2016:

In Flanders 500 kg was stocked in 2014. In 2015, 335 kg was ordered but due to failure of the supplier in France, no glass eel could be stocked in Flanders in 2015. In 2016 385 kg of glass eel was stocked in Flanders.

- Achieving WFD goals for water quality.

Specific action in 2010–2016: Flanders continues to work to the development of water treatment infrastructure to achieve the good ecological status and ecological potential for the WFD. A pilot program to monitor eel and perch quality with respect to their levels of contaminants for reporting to the WFD has been finalised (De Jonghe et al., 2014), and is now being implemented with new assessments (work in progress). A report has been issued with data on contaminants in perch and eel in Flanders (Teunen et al., 2016). This work is to be continued in next years.

- Eel stock monitoring.

Specific action in 2014–2016:

Glass eel: the monitoring of the glass eel recruitment at Nieuwpoort (River IJzer) has been continued in 2015, and will be continued in upcoming years. However, due to technical problems at the sluices, regular monitoring was not possible in 2016.

Yellow eel/silver eel: In 2015, Belpaire et al. (2015) calculated the escapement of silver eel for Flanders for the period 2011-2014, on the basis of data collected through fish stock assessments within the Flemish Monitoring Network Freshwater Fish. The method for calculating the level of escapement was modified in comparison to the method used in a previous report (Stevens and Coeck, 2013), taking into account previous recommendations (Stevens et al., 2013).

INBO analysed recent data of eel catches of the Flemish Fish Monitoring Network (Van Thuyne, unpublished).

- Eel quality monitoring.

  Specific action in 2016:

New information has been published about the presence of contaminants in eel brain. Organic and inorganic contaminants are detectable in European eel brain and brain levels of neurotoxic organochlorines are higher than in muscles and liver. Moreover brain contamination pattern strongly differs from those of muscle and liver (Bonnineau et al., 2016).

Belgium participated in an international workshop (WKBECEEL) of the Working Group on Eel (WGEEL) and the Working Group on Biological Effects of Contaminants (WGBEC) under the subject "Are contaminants in eels contributing to their decline?" (ICES, 2016). The objective of WKBECEEL was to develop ways to integrate quality parameters related to the impact of contaminants into quantitative stock assessment for the European eel. In particular the workshop aimed to progress in following issues: 1) assessment of the trends in contaminants in eel, 2) better understanding of the potential impact of contaminants on lipid metabolism and migration in eel and other species, 3) achieve better understanding of the impact of contaminants on reproduction in eel and other species, 4) assessment of the impact of contaminants on the genetics of the European eel, and 5) elaborating on methods to quantify eel quality with regards to contaminants and what could be learned from other species.

A report, within the requirements of the Water Framework Directive, has been issued with data on contaminants in perch and eel in Flanders in 2015 (Teunen et al., 2016).

- Eel mortality at pumping stations.

Eel mortality was studied in a Belgian lowland canal after downstream passage through a large and small de Wit-adapted Archimedes screw pump over a 12-month period (2012 – 2013) (Buysse et al., 2015a).

- General status

The European eel is categorized as 'Critical Endangered' on the Red List of Fishes in Flanders.

For the Walloon region

- avoiding mortality at hydropower stations;

For a complete report of the situation, see Vlietinck & Rollin (2015).

- sanitation of migration barriers on main waterways (especially in the Meuse catchment);

For a complete report of the situation, see Vlietinck & Rollin (2015).

- Eel stock monitoring.

  Specific action in 2014–2016:

Yellow eel: the monitoring of the eel recruitment at Lixhe (River Meuse) has been continued in 2016, and will be continued in upcoming years. See under the specific heading for results.

- Eel quality monitoring.

New information has been published about the presence of contaminants in eel brain. Organic and inorganic contaminants are detectable in European eel brain and brain levels of neurotoxic organochlorines are higher than in muscles and liver. Moreover brain contamination pattern strongly differs from those of muscle and liver (Bonnineau et al., 2016).

A new study has been set up to study the impact of aluminum on eel (Grisart M., Belpaire C, Bervoets, de Graaf M, Durif C, Lemaire B, Pecheyran C, Tabouret H, Thorstad E, Rees, J.F,.,The Eeluminium Project).

- Glass eel restocking programme.

Specific action in 2016:

In Wallonia 501 kg glass eel was ordered in 2014 with a 50% European Fishery Fund cofunding, but due to failure of the supplier in France, only 40 kg glass eel could be stocked and the delivery was reported in 2015. Due to a new failure of the same supplier in France, no glass eel could be stocked in Wallonia in 2015 and the contract had to be cancelled.

No glass eel were restocked in 2016 due to lack of funds.

- controlling poaching.

Specific action in 2014-2016:

Control actions have been focused specifically on the river Meuse, the river Sambre and in the canals during day and night. In the Plan Police Pêche control programme in 2015, the number of control actions was doubled (106 operations, 64 during the day and 42 during the night) compared to 2014 for a total of 2771 controlled fishermen. Numerous illegal fishing equipments were seized. Regarding Fisheries Act Violation, the rate was of 5.8% during the day in 2015, but of 20.1% during the night of the same year. Since 2010, the annual offence rate during the night decreased by about 5% per year and was highly correlated to control intensity (Rollin & Graeven, 2016). Only a small minority of violations concerned eel poaching, mostly illegal eel detention and utilisation for silurid fishing.

In the coming years, Belgium will pursue with its neighbouring countries the development and implementation of cross boundary eel management plans. These coordination activities will take place within the International Scheldt Commission (ISC) and the International Meuse Commission (IMC).

1.2 Stock status

No changes compared to last year's report

1.2.1 EMP Progress Report summary table

No changes compared to last year's report

EMUcode	Indicator	biomass (t)	Mortality (rate)				Target		
	B0	Bbest	Bcurr	∑A	∑F	∑H	Source	Biomass (t)	∑A (rate)
BE_Scheldt	169	45	33	0.3101	0.2879	0.02218	EMP		
	187	41	34	0,1872	0.1788	0.00841	EU Reg (Progress report 2012)		
	207	31	23	8	6	1	EU Reg (Progress report 2015)		11
BE_Meuse	53	41	16	0.9409	0.1520	0.78896	EMP		
	54	39	14	1.0245	0.11242	0.91209	EU Reg (progress Rep 2012)		
	32	16	1	16	0	15	EU Reg (Progress report 2015)		3

Key:
EMU_code = Eel Management Unit code (see sheet 'EMU names and codes' for list of codes)
B_0 = the amount of silver eel biomass that would have existed if no anthropogenic influences had impacted the stock (kg).
B_{curr} = The amount of silver eel biomass that currently escapes to the sea to spawn (in the assessment year) (kg).
B_{best} = The amount of silver eel biomass that would have existed if no anthropogenic influences had impacted the current stock (kg).
∑F=mortality due to fishing, summed over the age groups in the stock (rate)
∑H=anthropogenic mortality excluding the fishery, summed over the age groups in the stock (rate)
∑A=all anthropogenic mortality summed over the age groups in the stock (rate)

1.3 Precautionary diagram

No changes compared to last year’s report

1.4 Significant changes since last report

There are no significant changes with regard to the knowledge of the status of the stock, compared to last year's report (Belpaire et al., 2015).

In comparison to the first Belgian Progress Report (Vlietinck et al., 2012), the second Belgian Progress Report previous report submitted in June 2015 (Vlietinck and Rollin, 2015) showed that the escape rate of silver eel dropped significantly (from 18% to 11% for Scheldt river basin district, and from 25% to 3% for the Meuse river basin district). As was discussed in last year's report and in the Progress Report, one should be careful to draw firm conclusions from here considering the lack of eel density data in certain parts of the Meuse basin as well as the modified way of calculating the figures compared to 2012 (hypotheses) and the limitations inherent in the methods used (Vlietinck and Rollin, 2015).

2 Impacts on the stock

2.1 Fisheries

2.1.1 Glass eel

2.1.1.1 Commercial

There are no commercial glass eel fisheries. A recent feasibility study to assess the possibilities for commercial glass eel fisheries on the River Yser, did not indicate significant potential (Pauwels et al. 2016).

2.1.1.2 Proportion retained for restocking

Not relevant. No glass eel fisheries. In the pre-1980s the governmental glass eel fisheries/monitoring used their catches for restocking water bodies over Belgium. Nowadays, with the current very low recruitment, the glass eel caught during monitoring surveys by the Flemish fisheries managers are released in the same river catchment.

In 2016 a study was set up to assess adjusted sea sluice management for improving glass eels upstream migration capacity in the Veurne-Ambacht Canal, a small (830x26 m) artificial waterway that drains 20.000 hectares of polder area that spills excess water in the Yser estuary at low tide via the Ganzepoot sluice complex (Nieuwpoort). Glass eel migration in this canal was weekly monitored at 6 locations by means of fykes on the bottom, artificial substrates floating at the surface, 2 eel ladders installed on both riversides in front of a pumping station at the end of the canal and night time dipnet fishery in front of the pumping stations' outlets. Eel ladders, and to a lesser extent also artificial substrates, were shown to catch substantial amounts of glass eels and fingerlings (24.200 resp. 684 in total, the artificial substrates accounted for 2 resp. 25%). All eels caught during the experiments were released upstream the sluices (Pauwels et al. 2016).

2.1.1.3 Recreational

There are no recreational glass eel fisheries.

2.1.2 Yellow eel

2.1.2.1 Commercial

There is no commercial fishery for yellow eel in inland waters in Belgium. Commercial fisheries for yellow eel in coastal waters or the sea are negligibly small.

2.1.2.2 Recreational

Flemish region

Only eels above the size limit of 30 cm are allowed to be taken home. In 2013 a new legislation on river fisheries went into force (Agentschap Natuur en Bos, 2013). The total number of fish (all species, including eel) which an angler is allowed to take with him on a fishing occasion is now limited to 5. There is no indication to what extent this will have an impact on the total recreational biomass of eel retrieved by recreational fisheries.

A recent inquiry among Flemish fishermen was organized in 2016 (Agentschap Natuur en Bos, 2016). 10000 fishermen were contacted, and the inquiry got a response of 28.8%. Data refer to the year 2015. The results indicated that 7% of the Flemish recreational fishermen prefer eel fishing. This is identical as in previous inquiry.

73% of the recreational fishermen fishing with a rod on eel, indicated that they take home their catch for consumption (despite advice not to do this due to contamination and associated human health risks). Eels are the second highest ranked species (after pikeperch) with respect of amounts taken home for consumption. It was estimated that over Flanders 29523 kg of eels are retrieved annually from Flemish public water bodies to take home for consumption (as assessed for the year 2015, for a total of 66105 recreational fishermen). This estimation is 12.1% lower than in 2008, when the retrieved yield was estimated at 33600 kg of eels (Agentschap Natuur en Bos, 2016).

Professional coastal and sea fisheries

Marine eel catches through professional and coastal fisheries are negligible.

Estuarine fisheries on the Scheldt

The trawl fisheries on the Scheldt was focused on eel, but since 2006 boat fishing has been prohibited, and only fyke fishing was permitted until 2009. Since 2009 no more licences are issued, which is as a measure of the Eel Management Plan of Flanders to reduce catches. In 2010 a Decree (Besluit van de Vlaamse Regering van 5 maart 2010) was issued to regulate the prohibition of fyke fishing in the lower Seascheldt.

For a figure of the time-series of the number of licensed semi-professional fishermen on the Scheldt from 1992 to 2009 (Data Agency for Nature and Forests) we refer to Belpaire *et al.*, 2011 (Belgian Eel Country Report 2011).

Recreational fisheries in the Flemish region

The number of licensed anglers was 60520 in 2004, 58347 in 2005, 56789 in 2006, 61043 in 2007, 58788 in 2008, 60956 in 2009, 58338 in 2010, 61519 in 2011, 62574 in 2012, 64643 in 2013, 67554 in 2014 and 66105 in 2015. The time-series shows a general decreasing trend from 1983 (Fig. 1). However in 2007 there was again an increase in the number of Flemish anglers (+7.5% compared to the minimum in 2006). In 2014 the number of anglers was 19% higher than in 2006.

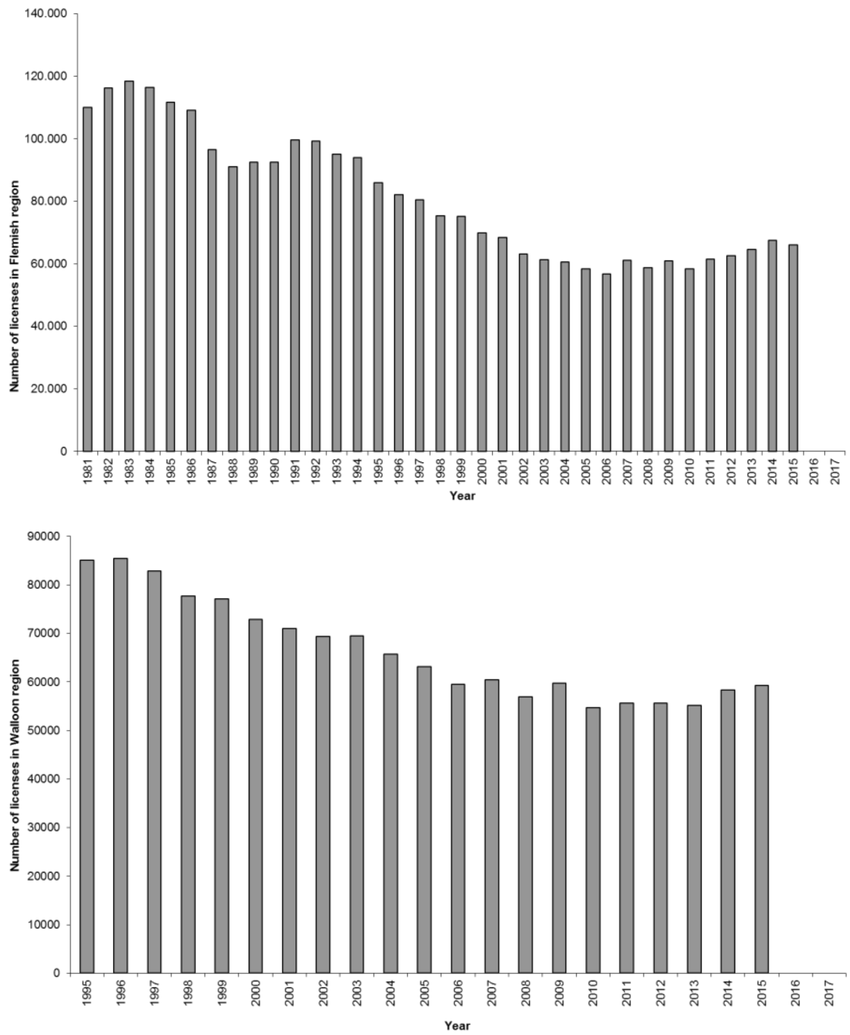

Figure 1. Time-series of the number of licensed anglers in Flanders (above) and Wallonia (below) since 1981 (Data Agency for Nature and Forests for Flanders and Nature and Fish Service of the Nature and Forests Department (DNF – DGARNE - SPW) for Wallonia.

Walloon region

Since 2006, captured eels may not be taken at home and have to return immediately into the river of origin. Therefore, yellow eel landing in Wallonia is estimated as zero.

Recreational fisheries in the Walloon Region

In Wallonia, the number of licensed anglers was 65687 in 2004, 63145 in 2005, 59490 in 2006, 60404 in 2007, 56864 in 2008, 59714 in 2009, 54636 in 2010, 55592 in 2011, 55632 in 2012, 55171 in 2013, 58379 in 2014 and 59294 in 2015 (Figure 1). The time-series shows a general decreasing trend from 1986. However in 2014 there was again an increase in the number of anglers in Wallonia (+6.9 % compared to the minimum in 2010). The result of 2015 confirms this slight increase(+8.5 % compared to the minimum in 2010). The proportion of eel fishermen in Wallonia is not documented, but is probably very small since it is forbidden to keep the catched eels.

Brussels capital

Recreational fisheries in the Brussels capital

The number of licensed anglers is approximately 1400 (Data Brussels Institute for Management of the Environment).

2.1.3 Silver eel

2.1.3.1 Commercial

There is no commercial fishery for silver eel in inland waters in Belgium. Commercial fisheries for silver eel in coastal waters or the sea are negligibly small.

2.1.3.2 Recreational

No time-series available. Due to the specific behaviour of silver eel catches of silver eel by recreational anglers are considered low.

2.2 Restocking & Aquaculture

2.2.1.1 Amount stocked

Stocking in Flanders

Glass eel and young yellow eels were used for restocking inland waters by governmental fish stock managers. The origin of the glass eel used for restocking from 1964 onwards was the glass eel catching station at Nieuwpoort on river Yser. However, due to the low catches after 1980 and the shortage of glass eel from local origin, foreign glass eel was imported mostly from UK or France.

Also young yellow eels were restocked; the origin was mainly the Netherlands. Restocking with yellow eels was stopped after 2000 when it became evident that also yellow eels used for restocking contained high levels of contaminants (Belpaire and Coussement, 2000). So only glass eel is stocked from 2000 on (Figure 2). Glass eel restocking is proposed as a management measure in the EMP for Flanders.

In some years the glass eel restocking could not be done each year due to the high market prices. Only in 2003 and 2006 respectively 108 and 110 kg of glass eel was stocked in Flanders (Figure 2 and Table 1). In 2008 117 kg of glass eel from U.K. origin (rivers Parrett, Taw and Severn) was stocked in Flemish water bodies. In 2009 152 kg of glass eel originating from France (Gironde) was stocked in Flanders. In 2010 (April 20th, 2010) 143 kg has been stocked in Flanders. The glass eel was originating from France (area 20–50 km south of Saint-Nazaire, small rivers nearby the villages of Pornic, Le Collet and Bouin). A certificate of veterinary control and a CITES certificate were delivered.

In 2011 (21 April 2011) 120 kg has been stocked in Flemish waters. The glass eel was originating from France (Bretagne and Honfleur). A certificate of veterinary control and a CITES certificate were delivered.

In 2012 156 kg has been stocked in Flemish waters. The glass eel was supplied from the Netherlands but was originating from France.

In 2013 140 kg has been stocked in Flemish waters. The glass eel was supplied via a French compagny (SAS Anguilla, Charron, France).

In 2014 the lower market price allowed a higher quantity of glass eel to be stocked. 500 kg has been stocked in Flemish waters. The glass eel was supplied via a French company (Aguirrebarrena, France).

In 2015, Flanders ordered 335 kg glass eel for stocking in Flemish waters (price 190 €/kg). However, the supplier was not able to supply the glass eel. Apparently, due to shortness of glass eel, suppliers prioritize fulfillment of their orders towards the more lucrative orders (e.g. by the aquaculture sector). As a result, no glass eel could be stocked in Flanders in 2015.

In 2016, Flanders purchased 385 kg glass eel for stocking in Flemish waters (price 180 €/kg). These glass eel were stocked on March 18th, 2016. Origin of the glas eel was France (sarl Foucher-Maury).

The cost of the glass eel per kg (including transport but without taxes) is presented in Table 2.

Glass eel restocking activities in Flanders are not taking account of the variation in eel quality of the restocking sites.

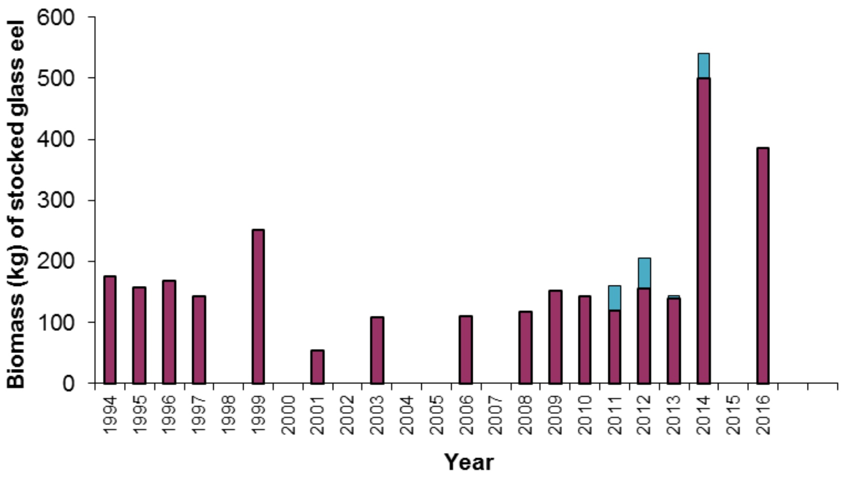

Figure 2 and Table 1. Restocking of glass eel in Belgium (Flanders and Wallonia) since 1994, in kg of glass eel. Flanders is represented in red and Wallonia in blue in the figure. * left Flanders/right Wallonia.

Decade				
Year	1980	1990	2000	2010
0			0	143
1			54	120/40*
2			0	156/50*
3			108	140/4*
4		175	0	500/40*
5		157,5	0	0/0*
6		169	110	385/0*
7		144	0	
8		0	117	
9		251,5	152	

Table 2. Prices of restocked glass eel in Belgium (2008–2015).

Year	Cost (€/kg)
2008	510
2009	425
2010	453
2011	470 (Flanders) 520 (Wallonia)
2012	416 (Flanders) 399 (Wallonia)
2013	460 (Flanders) 400 (Wallonia)

2014	128 (Flanders) 128 (Wallonia)
2015	190 (Flanders)(not supplied) 128 (Wallonia) (not suplied)
2016	180 (Flanders)

Stocking in Wallonia

In Wallonia, glass eel restocking was initiated in 2011, in the framework of the Belgian EMP. In March 2011 40 kg of glass eel was restocked in Walloon rivers, in 2012 the amount stocked was 50 kg.

In 2013, for financial reasons no stocking was carried out in Wallonia, except for some restocking in 3 small rivers in the context of a research program led by the University of Liège. This research program is financed by EFF (project code 32-1102-002) to test the efficiency of glass eel restocking in water bodies of diverse typology. In May 2013 in total 4 kg of glass eel was stocked (1,5 kg in La Burdinale, 1,5 kg in d'Oxhe and 1 kg in Mosbeux). (price per kg was 400 Euros). The origin of these glass eels was UK glass eels Ldt, UK Survival, dispersion, habitat and growth were followed from September on, to assess to what extent glasseel stocking is a valuable management measure to restore Walloon eel stocks. One year after stocking, elvers were found up and downstream the unique point of the glass eels release and in the complete transversal section of these streams, with preference for the sheltered microhabitats located near the banks where water velocity and depth are low (Ovidio et al. 2015). Higher recruitment success of glass eels was observed in the Mosbeux because of its high carrying capacity. Recently, the mark-recapture method using the Jolly-Seber model estimated the recruitment success at 658 young eels (density 11.1 eels/m², minimal survival 15.8%) two after stocking in Mosbeux. The young eels are monitoring two times a month in Mosbeux and Vesdre using a mobile detection RFID station to study their space use and seasonal movement.

In 2014, 501 kg glass eel were ordered from a French company (Aguirrebarrena, France) with EFF 50% cofunding. Unhappily, the French supplier was unable to supply the ordered quantity and only 40 kg were restocked in 2014. Therefore, the Walloon region accepted to delay the delivery of the remaining 461 kg glass eel in 2015. However, the French supplier was again "unable" to supply the ordered glass eel. The higher prices for glass eel in 2015 probably explain this situation. The French supplier was excluded from the Walloon market for three years (between 2016 and 2018).

In 2016, no glass eels stocking was carried out in Wallonia for financial reasons.

More information on stocking details for Wallonia is presented in Tables 2-4 (Cost of the glass eel, origin).

2.2.2 Reconstructed Time Series on Stocking

Stocking in Flanders

Table 3A. Source and size of eel restocked in Flanders between 1994 and 2015.

	Local Source	Foreign Source

Year	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured
1994					175		5394	
1995					157,5		4880	
1996					169		4168	
1997					144		5517	
1998					0		5953	
1999					251,5		5208	
2000					0		4283	
2001					54			
2002					0			
2003					108			
2004					0			
2005					0			
2006					110			
2007					0			
2008					117			
20090					152			
2010					143			
2011					120			
2012					156			
2013					140			
2014					500			
2015					0			
2016					385			

Stocking in Wallonia

Table 3B. Source and size of eel restocked in Wallonia between 1994 and 2015.

	Local Source				Foreign Source			
Year	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured	Glass Eel	Quarantined Glass Eel	Wild Bootlace	On-grown cultured
1994								
1995								
1996								
1997								
1998								
1999								
2000								
2001								
2002								
2003								
2004								

2005	
2006	
2007	
2008	
2009	
2010	
2011	40
2012	50
2013	4
2014*	40
2015*	0
2016	0

* Despite an order of 501 kg, only 40 kg glass eel was supplied in 2014 and no supplies in 2015.

All glass eel used for the Flemish and Walloon restocking programs are purchased from foreign sources (usually UK or France). There are no quarantine procedures. Nowadays, no bootlace eels, nor ongrown cultured eels are restocked.

Table 4. Origin and amounts of glass eel restocked in Belgium (Flanders and Wallonia) between 2008 and 2015.

Year	Region	Origin	Amount (kg)
2008	Flanders	UK	125
2009	Flanders	France	152
2010	Flanders	France	143
2011	Wallonia	UK	40
2011	Flanders	France	120
2012	Flanders	France	156
2012	Wallonia	France	50
2013	Flanders	France	140
2013	Wallonia	UK	4
2014	Flanders	France	500
2014	Wallonia*	France	40
2015	Flanders**	-	0
2015	Wallonia*	-	0
2016	Flanders	France	385
2016	Wallonia	-	0

* Despite an order of 501 kg, only 40 kg glass eel was supplied in 2014 and no supplies in 2015.

** Despite an order of 335 kg, no glass eel was supplied.

2.2.2.1 Aquaculture Seed supply

There is no aquaculture production of eel in Belgium.

2.2.2.2 Glass eel use

There are no glass eel fisheries in Belgium. As the glass eel caught for monitoring purposes by the Flemish authorities at the sluices at the mouth of River Yzer is so low, these glass eel are released directly above the sluices. Also glass eel caught during scientific surveys are all released within the catchment of catch.

Additionally glass eel are purchased mostly from France or UK to restock.

2.3 Entrainment

In Belgium, the eel stock is considerably impacted by a multitude of migration barriers, some of which may cause direct or indirect mortality, especially through passage through draining pumps and impingment by power stations and hydropower units.

Although numerous pumping stations have been used by water managers for a diversity of applications on rivers, canals and other water bodies, their impact on fish populations is poorly understood. Buysse *et al*. (2014) investigated European eel mortality after natural downstream passage through a propeller pump and two Archimedes screw pumps at two pumping stations on two lowland canals in Belgium. Fyke nets were mounted permanently on the outflow of the pumps during the silver eel migration periods. Based on the condition and injuries, maximum eel mortality rates were assessed. Mortality rates ranged from 97 ± 5% for the propeller pump to 17 ± 7% for the large Archimedes screw pump and 19 ± 11% for the small Archimedes screw pump. Most injuries were caused by striking or grinding. The results demonstrate that pumping stations may significantly impact the achievement of escapement targets set in eel management plans (Buysse et al., 2014).

In another study, eel mortality was assessed in a Belgian lowland canal after downstream passage through a large and small de Wit-adapted Archimedes screw pump over a 12-month period (2012 – 2013) (Buysse et al., 2015a). The hypothesis tested was the minimisation of fish injuries with the de Wit adaptation. Simultaneously, downstream migration through a Dutch pool and orifice fishway alongside the pumping station was monitored. Nets were mounted on the outflow of the pumps, and a cage was placed in the fishway. Based on the condition of the fish and injuries sustained, the assessed maximum mortality rates ranged from 19 ± 4% for the large de Wit Archimedes screw pump to 14 ± 8% for the small de Wit Archimedes screw pump. The screw adaptations did not substantially minimise grinding injuries and overall mortality, and the fishway did not mitigate downstream eel migration. To achieve escapement targets set in the eel management plans, fish-friendly pump designs and effective pumping stations bypass solutions are needed.

The effect of a pumping station on eel behaviour in a wetland area in Boekhoute, Belgium was studied between July 2012 and December 2015. The study was conducted by means of acoustic telemetry: 88 eel were tagged and followed throughout the study area by acoustic listening stations. Buysse et al. (2015a) investigated the direct physical impact of the pumping station on passing eels. However, also behaviour might be impacted by the pumping station, due to disrupted flow conditions. In this study, various types of individual behaviour as a reaction on the altered flow conditions were observed and the relation between eel behaviour and environmental conditions like flow, precipitation, water temperature and light intensity were analysed.

2.4 Habitat Quantity and Quality

No changes compared to last year's report. We refer to this report for details.

2.5 Others

No changes compared to last year's report. We refer to this report for details.

3 National stock assessment

The latest data regarding national stock assessment refer to the last country report (Belpaire et al., 2015) and the 2015 Belgian Eel Progress Report. We refer to these documents for detailed information.

No new quantitative assessments have not been made for the national stock assessment, but see also relevant issues under Chapter 4.4 and 4.5, and Chapter 5.

3.1 Description of Method

3.1.1 Data collection

3.1.2 Analysis

3.1.3 Reporting

3.1.4 Data quality issues and how they are being addressed

3.2 Assessment results

3.2.1 Habitat quantities

3.2.2 Silver Eel biomass indicators

3.2.3 Anthropogenic mortality rates

See 2.1.2.2 for new information about the eel yield of the recreational fisheries in Flanders.

4 Other data collection

4.1 International recruitment time series

Glass eel recruitment at Nieuwpoort at the mouth of River Yser (Yser basin)

In Belgium, both commercial and recreational glass eel fisheries are forbidden by law. Fisheries on glass eel are carried out by the Flemish government. Former years, when recruitment was high, glass eels were used exclusively for restocking in inland waters in Flanders. Nowadays, the glass eel caught during this monitoring are returned to the river.

Long-term time-series on glass eel recruitment are available for the Nieuwpoort station at the mouth of the river Yser. Recently new initiatives have been started to monitor glass eel recruitment in the Scheldt basin (see below).

For extensive description of the glass eel fisheries on the river Yser see Belpaire (2002, 2006).

Figure 3 and Table 5 give the time series of the total annual catches of the dipnet fisheries in the Nieuwpoort ship lock and give the maximum day catch per season. Since the last report the figure has been updated with data for 2016.

Fishing effort in **2006** was half of normal, with 130 dipnet hauls during only 13 fishing nights between March 3rd, and June 6th. Catches of the year 2006 were extremely low and close to zero. In fact only 65 g (or 265 individuals) were caught. Maximum day catch was 14 g. These catches are the lowest record since the start of the monitoring (1964).

In **2007** fishing effort was again normal, with 262 dipnet hauls during 18 fishing nights between February 22nd, and May 28th. Catches were relatively good (compared to former years 2001–2006) and amounted 2214 g (or 6466 individuals). Maximum day catch was 485 g. However this 2007 catch represents only 0.4% of the mean catch in the period 1966–1979 (mean = 511 kg per annum, min. 252–max. 946 kg).

In **2008** fishing effort was normal with 240 dipnet hauls over 17 fishing nights. Fishing was carried out between February 16th and May 2nd. Total captured biomass of glass eel amounted 964.5 g (or 3129 individuals), which represents 50% of the catches of 2007. Maximum day catch was 262 g.

In **2009** fishing effort was normal with 260 dipnet hauls over 20 fishing nights. The fishing was carried out between and February 20th and May 6th. Total captured biomass of glass eel amounted 969 g (or 2534 individuals), which is similar to the catches of 2008). Maximum day catch was 274 g.

In **2010** fishing effort was normal with 265 dipnet hauls over 19 fishing nights. The fishing was carried out between and February 26th and May 26th. Total captured biomass of glass eel amounted 318 g (or 840 individuals). Maximum day catch was 100 g. Both total captured biomass, and maximal day catch is about at one third of the quantities recorded in 2008 and 2009. Hence, glass eel recruitment at the Yser in 2010 was at very low level. The 2010 catch represents only 0.06% of the mean catch in the period 1966–1979 (mean = 511 kg per annum, min. 252–max. 946 kg).

In **2011** fishing effort was normal with 300 dipnet hauls over 20 fishing nights. The fishing was carried out between and February 16th and April 30th. Compared to 2010, the number of hauls was ca. 15% higher, but the fishing period stopped earlier, due to extremely low catches during April. Total captured biomass of glass eel amounted 412.7 g (or 1067 individuals). Maximum day catch was 67 g. Total captured biomass is similar as the very low catches in 2010. Maximal day catch is even lower than data for the four previous years (2007–2010). Overall, the quantity reported for the Yser station should be regarded as very low, comparable to the 2010 record. The 2011 catch represents only 0.08% of the mean catch in the period 1966–1979 (mean = 511 kg per annum, min. 252–max. 946 kg).

In **2012** fishing effort was higher than previous years with 425 dipnet hauls over 23 fishing nights. The fishing was carried out between and March 2nd and May 1st. Compared to 2010, the number of hauls was 42% higher. Total captured biomass of glass eel amounted 2407.7 g (or 7189 individuals). Maximum day catch was 350 g. Both, the total captured biomass and the maximum day catch are ca. six times higher than in 2010. Overall, the quantity reported in 2012 for the Yser station increased significantly compared to previous years and is similar to the 2007 catches. Still, the 2012 catch represents only 0.47% of the mean catch in the period 1966–1979 (mean = 511 kg per annum, min. 252–max. 946 kg).

In **2013** fishing effort included 410 dipnet hauls over 23 fishing nights. The fishing was carried out between 20 February and 6 May. Total captured biomass of glass eel amounted 2578.7 g (or 7368 individuals). Maximum day catch was 686 g. So compared to 2012, similar fishing effort (number of hauls), and similar year catches, but higher maximum day catch.

In **2014** fishing effort included 460 dipnet hauls over 23 fishing nights. The fishing was carried out between 24 February and 25 April. Total captured biomass of glass eel amounted 6717 g (or 17815 individuals). Maximum day catch was 770 g. So compared to 2013, same number of fishing nights, but 12% more hauls (increased fishing effort in number of hauls), and a 2.6 fold increase of the total year catches. Maximum day catch increased with 12% compared to the 2013 value.

In **2015** fishing effort was somewhat reduced compared to previous years, with 355 dipnet hauls over 19 fishing nights. The fishing was carried out between 16 February and 29 April. Total captured biomass of glass eel amounted 2489 g (or 6753 individuals). Maximum day catch was 487 g. So compared to 2014, 17% less fishing nights and 23% less hauls, and a decrease in total year catch of 63%. Compared to 2012 and 2013 total catch was similar in 2015, but considering the reduced fishing effort, the CPUE (catch per haul) was between 11 and 23% higher. Maximum day catch was between the levels of 2012 and 2013 (Figs 3A-D, and Table 5).

In **2016** fishing effort included 195 dipnet hauls over 11 fishing nights. The fishing was carried out between 2 February and 6 March. Total captured biomass of glass eel amounted 1023 g (or 2301 individuals). Maximum day catch was 208g. However, after 6 March, glass eel sampling had to be cancelled due to technical problems at the sluices. As such, only 11 fishing days took place, resulting in a low total catch (Table 5). The catch per unit effort (CPUE) was lower in 2016 compared to the two previous years (Table 6). However, since sampling was cancelled early in the glass eel season, the peak had probably yet to come. Therefore, the CPUE values might be underestimations. For purposes of international stock assessment, considering the technical problems and absence of catch data during the main migration period**, the 2016 data of the Yser glass eel recruitment series should be considered as not representative and are reported as “non-available”.**

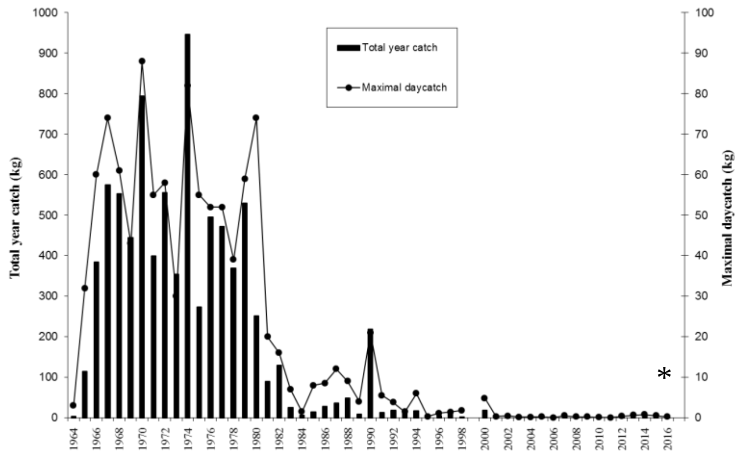

Figure 3A. Annual variation in glass eel catches at river Yser using the dipnet catches in the ship lock at Nieuwpoort (total year catches and maximum day catch per season), data for the period 1964–2016. * The data for 2016 are incomplete and not representative, due to technical problems at the sluices, and should not be used for statistical purposes, nor for international stock assessment.

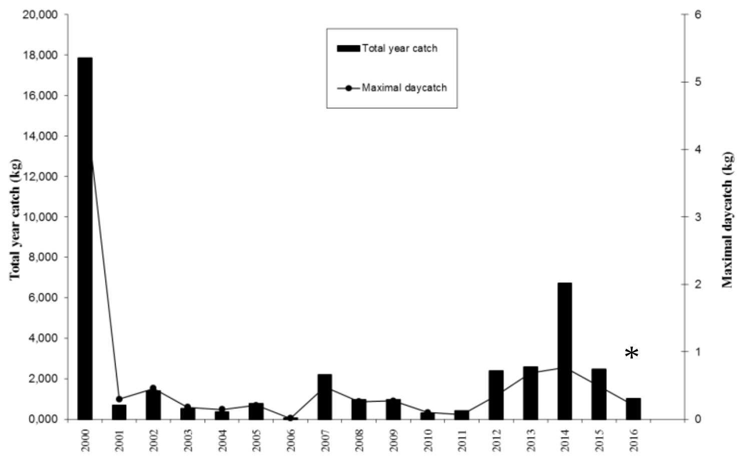

Figure 3B. Annual variation in glass eel catches at river Yser using the dipnet catches in the ship lock at Nieuwpoort (total year catches and maximum day catch per season), data for the period 2000–2016. * The data for 2016 are incomplete and not representative, due to technical problems at the sluices, and should not be used for statistical purposes, nor for international stock assessment.

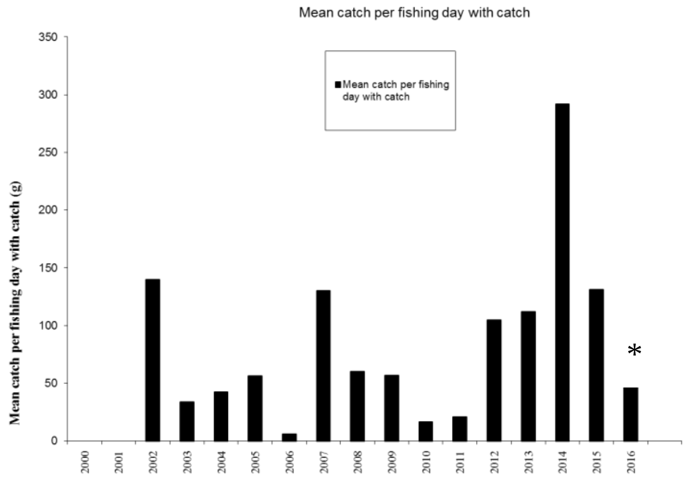

Figure 3C. Annual variation in glass eel catches at river Yser using the dipnet catches in the ship lock at Nieuwpoort) expressed as mean catches per fishing day with catch in g. * The data for 2016 are incomplete and not representative, due to technical problems, and should not be used for statistical purposes, nor for international stock assessment.

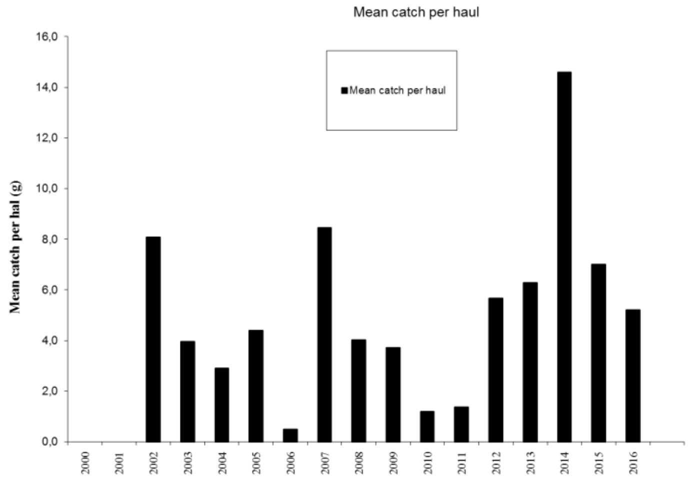

Figure 3D. Annual variation in glass eel catches at river Yser using the dipnet catches in the ship lock at Nieuwpoort), expressed as the mean catches per haul in g. * The data for 2016 are incomplete and not representative, due to technical problems, and should not be used for statistical purposes, nor for international stock assessment.

Table 5. Total year catches (kg) between 1964 and 2016. Data Provincial Fisheries Commission West-Vlaanderen. * The data for 2016 are incomplete and not representative, due to technical problems, and should not be used for statistical purposes, nor for international stock assessment.

DECADE						
Year	1960	1970	1980	1990	2000	2010
0		795	252	218.2	17.85	0.318
1		399	90	13	0.7	0.413
2		556.5	129	18.9	1.4	2.408
3		354	25	11.8	0.539	2.579
4	3.7	946	6	17.5	0.381	6.717
5	115	274	15	1.5	0.787	2.489
6	385	496	27.5	4.5	0.065	1.023*
7	575	472	36.5	9.8	2.214	
8	553.5	370	48.2	2.255	0.964	
9	445	530	9.1		0.969	

Table 6. Temporal trend in catch per unit of effort for the governmental glass eel monitoring by dipnet hauls at the sluices in Nieuwpoort (River Yzer, 2002–2015). Cpue values are expressed as Kg glass eel caught per fishing day with catch and as Kg glass eel per haul. * The data for 2016 are incomplete and not representative, due to technical problems, and should not be used for statistical purposes, nor for international stock assessment.

YEAR	TOTAL YEAR CATCH	MAX DAYCATCH	TOTAL YEAR CATCH/NUMBER OF FISHING DAYS WITH CATCH (KG/DAY)	TOTAL YEAR CATCH/NUMBER OF HAULS PER SEASON (KG/HAUL)
2002	1.4	0.46	0.140	0.0081
2003	0.539	0.179	0.034	0.004
2004	0.381	0.144	0.042	0.0029
2005	0.787	0.209	0.056	0.0044
2006	0.065	0.014	0.006	0.0005
2007	2.214	0.485	0.130	0.0085
2008	0.964	0.262	0.060	0.004
2009	0.969	0.274	0.057	0.0037
2010	0.318	0.1	0.017	0.0012
2011	0.412	0.067	0.021	0.0014
2012	2.407	0.35	0.105	0.0057
2013	2.578	0.686	0.112	0.0063
2014	6.717	0.77	0.292	0.0146
2015	2.489	0.487	0.131	0.0070
2016*	1.023*	208*	0.093*	0.0064*

Ascending young yellow recruitment series at Lixhe (Meuse basin)

On the Meuse, the University of Liège is monitoring the amount of ascending young eels in a fish-pass. From 1992 to 2016 upstream migrating eels were collected in a trap (0.5 cm mesh size) installed at the top of a small pool-type fish-pass at the Visé-Lixhe dam (built in 1980 for navigation purposes and hydropower generation; height: 8.2 m; not equipped with a ship-lock) on the international River Meuse near the Dutch–Belgium border (323 km from the North Sea; width: 200 m; mean annual discharge: 238 m 3 s -1 ; summer water temperature 21–26°C). The trap in the fish-pass is checked continuously (three times a week) over the migration period from March to September each year, except in 1994. A total number of 37415 eels was caught (biomass 2461 kg) with a size from 14 cm (1992 and 2001) to 88 cm (2012) and an increasing median value of 28.5 cm (1992) to 41 cm (2015) corresponding to yellow eels. The study based on a constant year-to-year sampling effort revealed a regular decrease of the annual catch from a maximum of 5613 fish in 1992 to minimum values of 21–324 in 2010–2016) (Figure 4, Table 7). In 2 008 2625 eels were caught. This sudden increase might be explained by the fact that a new fish pass was opened (20/12/2007) at the weir of Borgharen-Maastricht, which enabled passage of eels situated downward the weir in the uncanalized Grensmaas. Nevertheless the number of eels were very low again in 2009 (n=584), 2015 (n = 92) and 2016 (n=21). The figure for 2012 (n= 324) is a bit more than the two previous years. In 2013, 265 eels were caught (size range 19.6-76.5 cm, median 39.1 cm), the data for 2014 are similar with 255 individuals (size range 23.4-69.8 cm, median 40.1 cm). In 2015 92 eels were caught (size range 23.1-85 cm, median 41 cm). **In 2016 21 eels were caugh**t (size range 21.1-64.2 cm, median 35.2 cm) which is the lowest number of eels ever recorded since the start of the monitoring (1992, n = 5613). The decreasing trend in the recruitment of young eels in this part of the Meuse was particularly marked from 2004 onwards. The University of Liège (Nzau Matondo et al., 2015a, 2016 ; Nzau Matondo and Ovidio 2016) is continuing a research program financed by EFF-EU to monitor the status of ascending yellow eel stocks at Lixhe since 1992 and to follow the dynamic of their upstream movements in upper parts of the Belgian Meuse River basin. Since 2010, every individual yellow eel caught is pit-tagged and its upstream migration has been followed along detection stations placed at fish-passes located upstream in the Meuse and in the lower course of the river Ourthe (main tributary of River Meuse). A preliminary report has been published (Nzau Matondo et al, 2014). From 1273 eels (size range 21-88 cm) released 0.3 km upstream the Visé-Lixhe dam in 2010-2014, only 7.9% of these eels were detected beyond 31 km upstream the Visé-Lixhe dam moving upstream at night during spring and summer, which were deemed too insufficient to populate tributaries and sub-tributaries of the River Meuse basin. Note that some small changes have been made to the figure as presented in last years' reports.

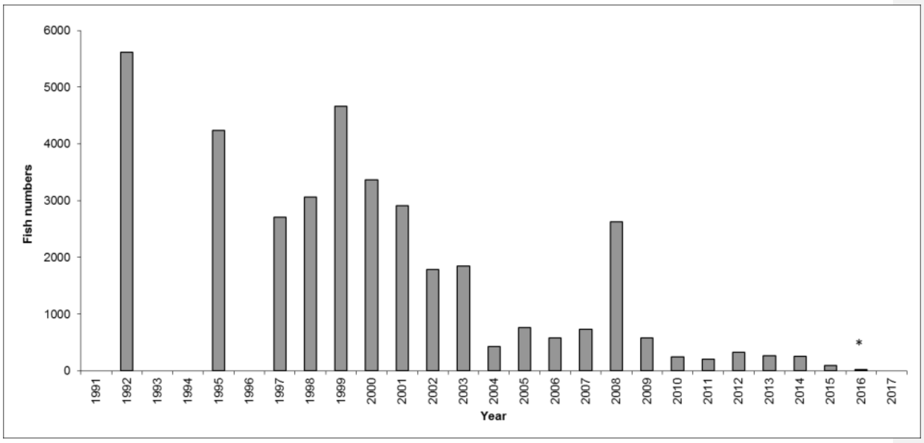

Figure 4. Variation in the number of ascending young yellow eels trapped at the fish trap of the Visé-Lixhe dam between 1992 and 2016. Data from University of Liège (Nzau Matondo et al., 2015 ; Nzau Matondo and Ovidio, 2016). * Data for 2016 may be incomplete.

Table 7. Variation in the number of ascending young yellow eels trapped at the fish trap of the Visé-Lixhe dam between 1992 and 2013. Data from University of Liège (in Philippart and Rimbaud (2005), Philippart et al. 2006, Nzau Matondo et al., 2015 ; Nzau Matondo and Ovidio, 2016). * Data for 2016 may be incomplete.

DECADE			
Year	1990	2000	2010
0		3365	249
1		2915	208
2	5613	1790	324
3		1842	265
4		423	255
5	4240	758	92
6		575	21*
7	2709	731	
8	3061	2625	
9	4664	584	

4.2 Other recruitment time series

Other glass eel recruitment studies

The glass eel recruitment-series for the Schelde estuary which was reported in the 2011 Country Report (See Belpaire *et al*., 2011) for the period 2004–2011 has been stopped.

4.3 National programme for EU Data Collection Framework or other

Not applicable for Belgium as there are no commercial catches in inland waters. Commercial catches of eel in coastal waters or marine fisheries are not reported to DCF.

There are no routine surveys on age of eels. Some silver eels from Flanders have been aged in the framework of the Eeliad program.

4.4 Yellow eel abundance surveys

Trend analysis of eel catches in the Flemish Fish Monitoring Network (INBO, G. Van Thuyne, unpublished).

In a preliminary assessment electrofishing and fykefishing data from the Flemish Fish Monitoring Network were analysed for temporal trends in eel presence and abundance (INBO data). Only data were used from locations assessed in each of the periods 1994-2000, 2001-2005, 2006-2009 en 2010-2012. 303 locations on running waters were assessed in each of the four periods.

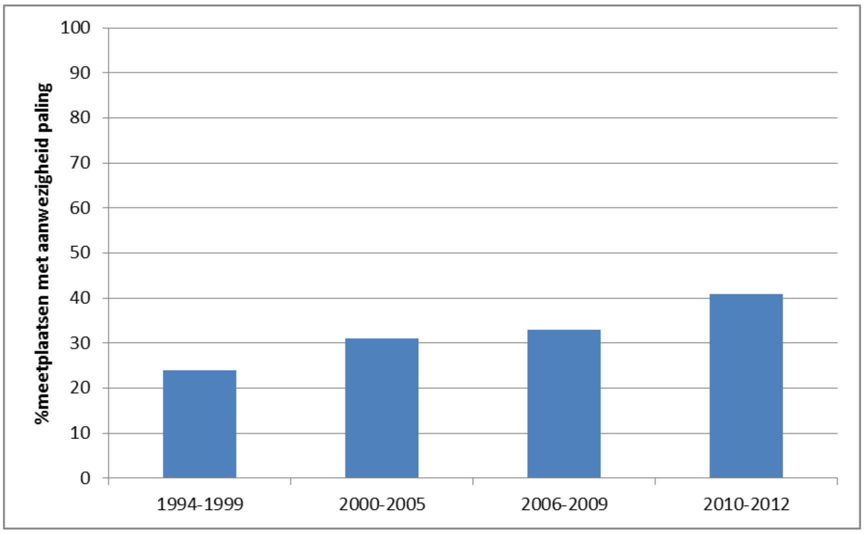

Figure 5: Presence of eel (% of sites assessed) in running waters during period 1: 1994-1999, period 2: 2000-2005, period 3: 2006-2009 and period 4: 2010-2012 (identical sites were fished in each of the periods).

During period 1 eel is caught in 24% of the sites on streams and rivers. During the period of assessment the presence of eel (in % of occurrence in the sites assessed) gradually increased (period 2: 31%, period 3: 33% and in the period 2010-2012: 41%). This temporal trend for eel is similar as the one found for fish overall, and is probably indicative of the general improvement of water quality in Flemish rivers. The significant increase in the last period might reflect the increase in the level of restocking.

The trend in abundance is reflected in Fig. 6. While the abundance decreased during the first 3 periods, there was a slight increase again during the last period.

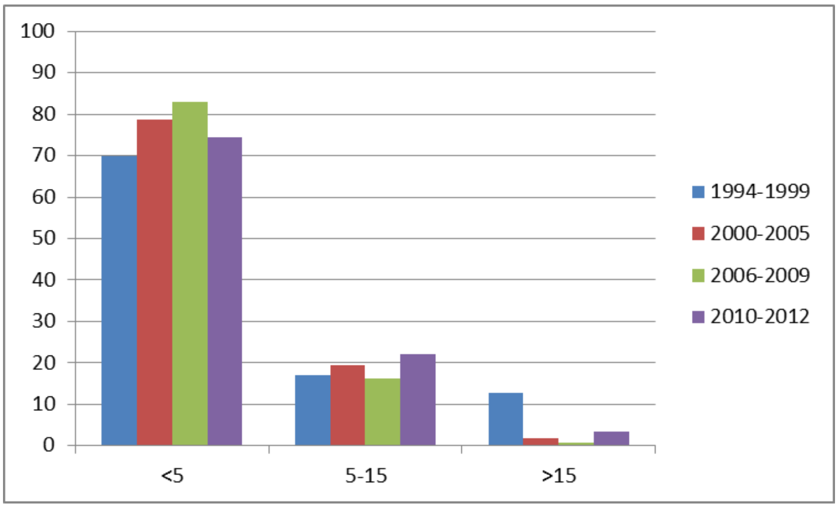

Figure 6: Relative frequency distribution in abundance of eel (numbers/100m electrofishing and numbers/fyke/day) on the locations where eel was present in running waters during period 1: 1994-1999, period 2: 2000-2005, period 3: 2006-2009 and period 4: 2010-2012 (identical sites were fished in each of the periods).

Estuarine fish monitoring by fykes

A fish monitoring network by INBO has been put in place to monitor fish stock in the Scheldt estuary using paired fyke nets (Fig. 7). Campaigns take place in spring and autumn, and also in summer from 2009 onwards. At each site, two paired fykes were positioned at low tide and emptied daily; they were placed for two successive days. Data from each survey per site were standardized as number of fish per fyke per day. Figures below show the time trend of eel catches in six locations along the Scheldt (Zandvliet, Antwerpen, Steendorp, Kastel, Appels and Overbeke) (Data Jan Breine, INBO; Breine & Van Thuyne, 2015).

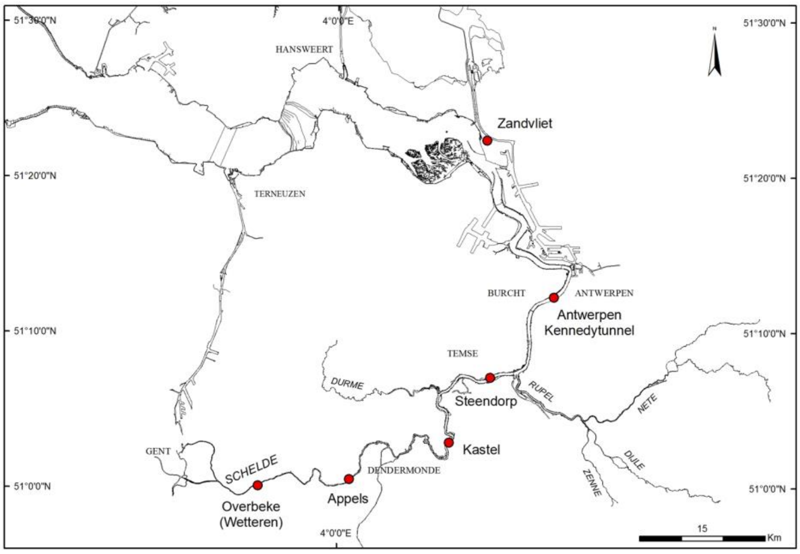

Figure 7. Locations sampled in the Zeeschelde estuary.

In the mesohaline zone (Zandvliet) catches are generally low. This could be due to the fact that eel moved since 2007 further upstream as since then the water quality improved in the oligohaline and freshwater parts of the estuary.

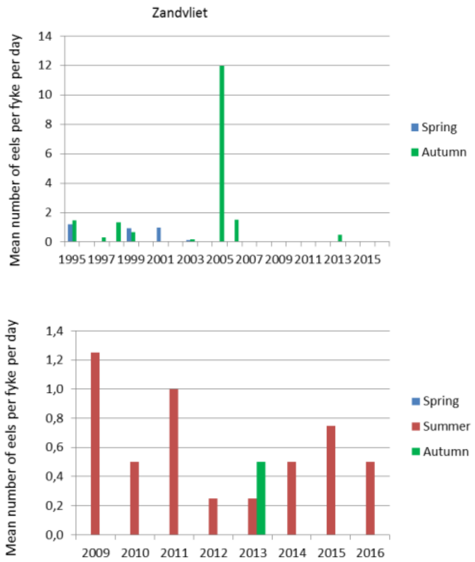

Figure 8. Time trend of fyke catches of eel in Zandvliet. Numbers are expressed as mean number of eels per fyke per day. Above, data are split up in spring catches and fall catches (1995-2016) while below, summer catches are added (2009-2015). Years without monitoring data are excluded from the X-axis.

Eel is rarely caught in spring (last catch in 2003). Since 2009 eel is caught in low numbers during summer and once in autumn. In 2015 more eel was caught in Zandvliet compared to previous campaign in 2014 (all data). Over the years a decline in numbers caught is observed.

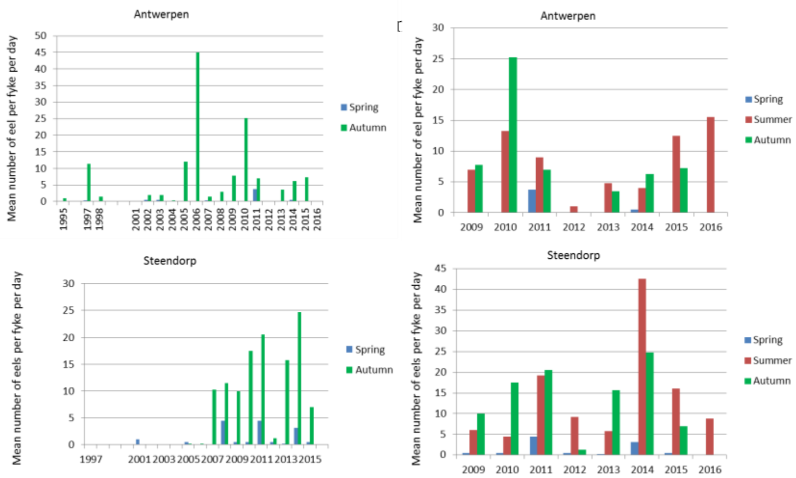

Figure 9. Time trend of fyke catches of eel in Antwerpen and Steendorp. Numbers are expressed as mean number of eels per fyke per day. On the left, data are split up in spring catches and fall catches (1995-2016) while on the right, summer catches are added (2009-2016). Years without monitoring data are excluded from the X-axis.

Eel is rarely caught in spring in the oligohaline zone. In autumn peaks were observed in Antwerpen: 2006 and 2010. After a decline in 2011 an increase in autumn catches is observed.

In Antwerpen a small increase in abundance is observed over the years but only for the campaigns in autumn (1995-2015). If however data for the period 2009-2015 are taken then in all seasons a decline is observed. Further upstream in Steendorp the positive effect of the water purification station in Brussel Noord (active since March 2007) is clear. In 2014 more eel was caught in Steendorp compared to the other campaigns. In summer eel is caught regularly in the two locations. In Steendorp an increase in eel abundance is noted when considering the summer campaigns (2009-2015) while for the autumn campaigns a status quo is recorded.

In the freshwater part of the estuary one location (Kastel) was sampled yearly since 2002. The two other sites (Appels and Overbeke) were sampled from 2008 onwards.

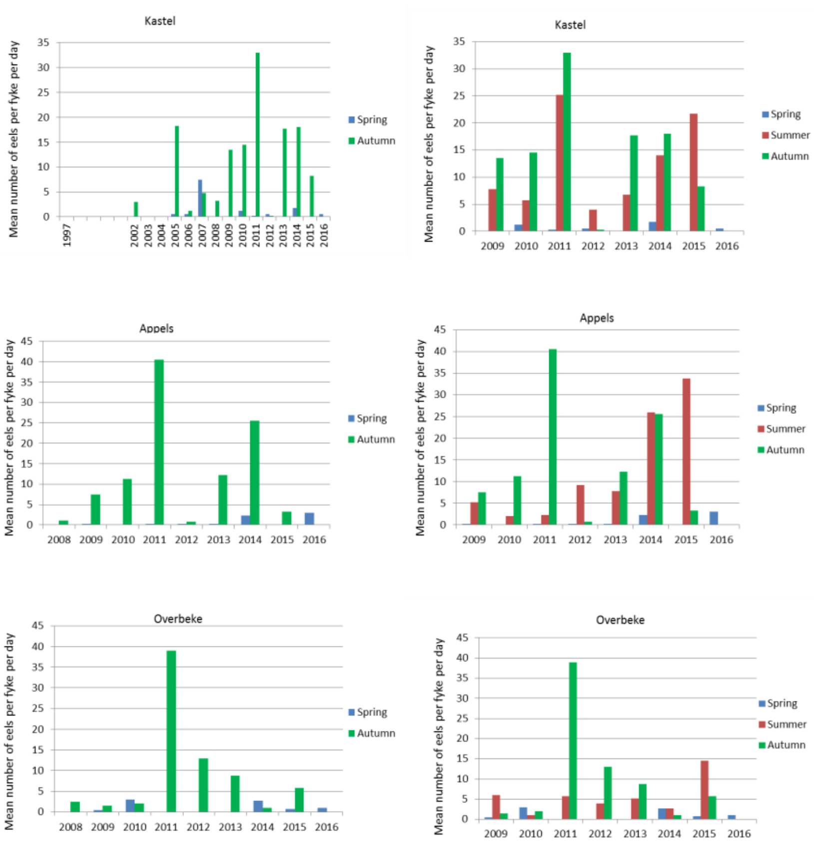

Figure 10. Time trend of fyke catches of eel in Kastel, Appels and Overbeke. Numbers are expressed as mean number of eels per fyke per day. On the left, data are split up in spring catches and fall catches (1997 or 2008-2016) while on the right, summer catches are added (2009-2016). Years without monitoring data are excluded from the X-axis.

In all locations eel is rarely caught in spring. In autumn a peak is observed in all locations in 2011. In all locations an increase in eel caught during summer is noted. In later autumn campaigns catches in Kastel were extremely low in 2012 while in 2013-2014 more eel was caught. This is also the case in Appels while further upstream in Overbeke a decline in eel catches continued until 2014.

Conclusion

In summer eel was caught in all locations in all campaigns. In the mesohaline and oligohaline zone the average abundance of eel is highest in summer (2009-2015). In the freshwater zone however, eel is more abundant in autumn. The lowest catch abundance is in Zandvliet.

Surveys in salt marshes of River Scheldt

European eel abundance has been monitored intensely in freshwater systems. Moreover, the dramatic decline on eel abundance is based on glass eels penetrating these systems from the marine and estuarine environment. However, eel abundance and behaviour in estuarine habitats is still unknown and the population decline might be less severe in estuarine habitats. Namely, due to the absence of tidal barriers, these areas might be colonised more easily. In addition, estuarine habitats tend to be very productive. The Drowned Land of Saeftinghe (The Netherlands) is the largest salt marsh of Europe. In this nature reserve, there will be fished for eels during two consecutive years (2016 and 2017). Not only will the eel biomass be estimated, but at least 15 eels will be tagged with acoustic transmitters and tracked through the system by 15 acoustic listening stations. The results of this study will provide new insights into the importance of salt marshes for European eel and their behaviour in these habitats.

4.5 Silver eel escapement surveys

Silver eel tagging experiments in the River Scheldt estuary

The European eel is a critically endangered fish species which migrates from coastal and freshwater habitats to the Sargasso Sea to spawn. However, exact migration routes and destination of European eel are still unknown.

To investigate the behaviour of silver eels in tidal rivers and estuaries, 30 eels were tagged in the River Scheldt estuary with acoustic transmitters in 2015 and in the three consecutive years, 30 eels will be tagged each year. The tagged fish can be detected by the permanent acoustic network in the Scheldt estuary and Belgian Part of the North Sea, funded by the LifeWatch ESRI observatory. Recently, acoustic tagged eels from Belgium, Germany and The Netherlands were detected in the Belgian part of the North Sea (Huisman et al., 2016, see also Chapter 5). As such, this is the first time to observe southward migrating silver eels in the North Sea. Therefore, at least part of the Western European eels migrate towards the English Channel, in contrast with the Nordic migration route hypothesis. This different migratory route may affect the energy reserve available for spawning and therefore the contribution of these eels to the population.

Results from this study might allow a better estimation of the quantification of the 40% silver eel escapement. Also, the results of this study will be useful for management measures for the conservation and restoration of the eel stocks.

4.6 Biological parameters

We refer to last year's country report for the latest information. No new information available.

4.7 Parasites & Pathogens

We refer to last year's country report for the latest information. No new information available.

4.8 Contaminants

See some relevant issues below, under Chapter 5.

We refer to last year’s country report for more information.

4.9 Predators

We refer to last year’s country report for the latest information. No new information available.

5 New and emerging threats and opportunities:

This section briefly lists a number of recent papers or reports on eel research carried out in Belgium.

Glass eel behaviour at an unnaturally sharp salt/freshwater interface. Preliminary results reported in Pauwels I., Van Wichelen J., Vandamme L., Vught I., Van Thuyne, G., Auwerx J., Baeyens R., De Marteleire N., Gelaude E., Picavet B., Pieters S., Robberechts K., Belpaire C. & Coeck J. (2016). Wetenschappelijke onderbouwing en ondersteuning van het visserijbeleid en het visstandbeheer - onderzoeksprogramma visserij 2015: eindrapport. Rapporten van het Instituut voor Natuur- en Bosonderzoek 2016. Instituut voor Natuur- en Bosonderzoek, Brussel.

Adjusted (reverse drainage) barrier management is currently applied as a measure to improve the passage of glass eels around sluice complexes at the salt/freshwater interface. The fate of these migrants, that suddenly enter a freshwater environment without tidal activity, is however rarely evaluated. These glass eels not only face possible physiological adaptations but should also be able to switch immediately to a more active state in order to sustain their upstream migration. Such abrupt habitat shifts might lead to significant energy losses and behavioural changes that can hamper or even halt further migration. The success of adjusted barrier management (ABM) in glass eels upstream migration capacity is currently investigated in the Veurne-Ambacht Canal, a small (830x26 m) artificial waterway that drains 20.000 hectares of polder area that spills excess water in the Yser estuary at low tide via the Ganzepoot sluice complex (Nieuwpoort). Glass eel migration in this canal is weekly monitored at 6 locations by means of fykes on the bottom, artificial substrates floating at the surface, 2 eel ladders installed on both sides of a pumping station at the end of the canal and night time dipnet fishery in front of the pumping stations’ outlets. Biometric analyses (length, weight, pigmentation) are carried out weekly on a representative subsample of the catch on each locality. A control situation (T0: without applying ABM) was first surveyed in spring (March-May) 2016, the effects of ABM (minimal opening of sluice gates at high tide) will be evaluated in spring 2017.

Glass eel fykes were not able to catch a single specimen (apart of some bycatch) even when placed side by side on a central location thus fencing off the whole width of the canal. Eel ladders, and to a lesser extent also artificial substrates, were shown to catch substantial amounts of glass eels and fingerlings (24.200 resp. 684 in total, the artificial substrates accounted for 2 resp. 25%). The amount of weekly ascending glass eels in each ladder rapidly increased from a few in the beginning of March to maximally about 6.000 one month later and eventually decreased again to values < 100 at the end of May. The presence of these numbers in the absence of ABM suggests that glass eels apparently enter the canal already by means of substantial seawater seepage during high tide through cracks and openings in the locked sluice doors (estimated at about 100 ind./door/tide during the migration peak). Moreover, once they entered the canal, glass eels (also un- to low pigmented) were able to migrate upstream actively and to ascend the eel ladders at the end of the canal, apparently not hampered by physiological constraints, even in the beginning of the migration period when discharges were high and water temperatures low (< 7°C). The results obtained so far underline the staggering robustness of migrating glass eels against some abrupt environmental changes they may encounter during the transition from salt to freshwater habitats.

Bonnineau, C., Scaion, D., Lemaire, B., Belpaire, C., Thomé, J-P., Thonon, M., Leermaker, M., Gao, Y., Debier, C., Silvestre, F., Kestemont, P., Rees, J-F., 2016. Accumulation of neurotoxic organochlorines and trace elements in brain of female European eel (Anguilla anguilla). Environmental Toxicology and Pharmacology http://dx.doi.org/10.1016/j.etap.2016.06.009

Xenobiotics such as organochlorine compounds (OCs) and metals have been suggested to play a significant role in the collapse of European eel stocks in the last decades. Several of these pollutants could affect functioning of the nervous system. Still, no information is so far available on levels of potentially neurotoxic pollutants in eel brain. In present study, carried out on female eels caught in Belgian rivers and canals, we analyzed brain levels of potentially-neurotoxic trace elements (Ag, Al, As, Cd, Co, Cr, Cu, Fe, Hg, MeHg, Mn, Ni, Pb, Sn, Sb, Zn) and OCs (Polychlorinated biphenyls, PCBs; Hexachlorocyclohexanes, HCHs; Dichlorodiphenyltrichloroethane and its metabolites, DDTs). Data were compared to levels in liver and muscle tissues. Eel brain contained very high amounts of OCs, superior to those found in the two other tissues. Interestingly, the relative abundance of PCB congeners markedly differed between tissues. In brain, a predominance of low chlorinated PCBs was noted, whereas highly chlorinated congeners prevailed in muscle and liver. HCHs were particularly abundant in brain, which contains the highest amounts of β-HCH and ϒ-HCH. p,p’-DDTs concentration was similar between brain and muscle (i.e., about twice that of liver). A higher proportion of p,p’-DDT was noticed in brain. Except for Cr and inorganic Hg, all potentially neurotoxic metals accumulated in brain to levels equal to or lower than hepatic levels. Altogether, results indicate that eel brain is an important target for organic and, to a lesser extent, for inorganic neurotoxic pollutants.

Ovidio M., Tarrago-Bès F., Nzau Matondo B. 2015. Short-term responses of glass eels transported from UK to small Belgian streams. Ann. Limnol. - Int. J. Lim. 51:219-226. DOI : 10.1051/limn/2015016

Restocking of inland waters with glass eels is one of the recovery options to prevent the decline of European eel *Anguilla anguilla* (L.) populations. We studied the growth, dispersion, density and habitat preferences in the imported glass eels from UK and stocked in three typologically different small Belgian streams, using electrofishing surveys around the single release point, 1 year following stocking. Our results clearly support that the recaptured individuals stocked in our streams farther from the sea, survived, grew, dispersed upstream and downstream. Elvers exploited the complete transversal section of stream, with preference for the sheltered microhabitats near the banks with slower water velocity and low depth. Length–weight relationship was different between streams in terms of allometric coefficient (b). We assume that microhabitats and food availabilities lead to contrasted results in terms of growth and absolute occurrence. Restocking of glass eels in small middle-land streams was found to be an interesting and unconventional option that requires adequate stream and habitat selection.

Nzau Matondo, B., J. P. Benitez, A. Dierckx, J. C. Philippart and M. Ovidio, 2016. Assessment of the entering stock, migration dynamics and fish pass fidelity of European eel in the Belgian Meuse River. River Res. Applic. (2016) DOI: 10.1002/rra

Migration dynamics of incoming eels in Belgium via Lixhe in the Meuse River were investigated using two fish passes with different configurations—net traps and automatic detection stations—as tools to distinguish resident and migrating eels. From April to September 2013, 435 eels (P50 length, 403 mm; range, 196–836 mm) were caught (daily maxima catch, 90 eels per day), 90% between 13 June and 1 August (50 days) and P50 on 19 July. Eels migrated mostly at 19–26 °C (P50, 24.4 °C), river discharge 65–314 m3 s 1 (P50, 84 m3 s 1), during the dark at 00:00–05:00 h and during both the waxing and waning phases of moonlight. From 396 eels tagged and released 0.3 km downstream of the Lixhe dam, 6.8% of them were recaptured, and 37.4% were detected. Migration flux was estimated at 7184 eels (0.863 t) using the mark-recapture method and decreased to 1156 eels (0.139 t) using automatic transponder detection. Most eels probably migrated through a sluice located downstream of Lixhe to reach the upper Meuse via the Albert Canal. Eels moved almost independently to the configuration of the fish passes and their location, but most eels displayed fidelity to the fish pass where they were captured. Migrant eels showed a wide range of size and life stages, with a higher proportion of eels (80%) belonging to the yellow eel stage. A lower proportion of eels (6%) had a larger size and presented an advanced continental silvering process corresponding to the migrating stage before their transatlantic migration.

Nzau Matondo, B. and Ovidio, M., 2016. Dynamics of upstream movements of the European eel *Anguilla anguilla* in an inland area of the River Meuse over the last 20 years Environ Biol Fish (2016) 99:223–235 DOI 10.1007/s10641-016-0469-x

The dynamics of upstream movements of the yellow eel *Anguilla anguilla* were investigated at Lixhe on the Belgian River Meuse in an inland fish pass regularly monitored from 1992 to 2014. Based on a constant year-to-year sampling effort, we examined the abundance of ascending yellow eels and their body size, seasonal movement, and the associated water temperature and flow. Over the last 23 years, the number of ascending yellow eels has declined at an average 4.2 % per year since 1992. The abundance of eels in 2014 is estimated at 4.5 % of the ascending stock in 1992. We observed that some annual variations in eel abundance at Lixhe might be related to opening fish passes downstream of the study site. The results clearly demonstrated that long-term declining abundance of eels has resulted in increased sizes (mean increase, 4.1 mm per year since 1992) and temperatures triggering the upstream movement process (1.03 °C per decade), with earlier dates for the last eel passages reducing the difference between temperature extremes of eel passages through the fish pass during the migration season. Eel movements occurred in spring and summer at low river discharge and were mainly triggered by high-temperature events. Eels have become larger with time because of improved feeding opportunities and more growth habitats available resulting from the long-term reduction in recruitment. This study highlights the importance of investigating long time spans for a better comprehension of the changes observed in yellow eels and for the optimization of management measures and future research.

De Meyer, J., Christiaens, J. & Adriaens, D. 2016. Diet-induced phenotypic plasticity in European eel (*Anguilla anguilla*). Journal of Experimental Biology, 219, 354-363.

Two phenotypes are present within the European eel population: broad-heads and narrow-heads. The expression of these phenotypes has been linked to several factors, such as diet and differential growth. The exact factors causing this dimorphism, however, are still unknown. In this study, we performed a feeding experiment on glass eels from the moment they start to feed. Eels were either fed a hard diet, which required biting and spinning behavior, or a soft diet, which required suction feeding. We found that the hard feeders develop a broader head and a larger adductor mandibulae region than eels that were fed a soft diet, implying that the hard feeders are capable of larger bite forces. Next to this, soft feeders develop a sharper and narrower head, which could reduce hydrodynamic drag, allowing more rapid strikes towards their prey. Both phenotypes were found in a control group, which were given a combination of both diets. These phenotypes were, however, not as extreme as the hard or the soft feeding group, indicating that some specimens are more likely to consume hard prey and others soft prey, but that they do not selectively eat one of both diets. In conclusion, we found that diet is a major factor influencing head shape in European eel and this ability to specialize in feeding on hard or soft prey could decrease intra-specific competition in European eel populations.

Teunen L., Belpaire C., Dardenne F., Blust R., Bervoets L., 2016. Veldstudie naar de monitoring van biota in het kader van de rapportage van de chemische toestand voor de Kaderrichtlijn Water. Universiteit Antwerpen en INBO, 2015-2016

This report presents the results of the analysis of contaminants in the muscle from eel (and perch) from 11 locations in Flanders (sampled in 2015). This work was done following the requirements of the Water Framework Directive to monitor specific substances in aquatic biota.

Huisman, J., Verhelst, P., Deneudt, K., Goethals, P., Moens, T., Nagelkerke, L.A.J., Nolting, C., Reubens, J., Schollema, P.P., Winter, H.V., Mouton, A. (2016). Heading south or north: novel insights on European silver eel *Anguilla anguilla* migration in the North Sea. Marine Ecology Progress Series. Mar Ecol Prog Ser 554:257-262.

The European eel *Anguilla anguilla* L. is a critically endangered fish species that migrates from coastal and freshwater habitats to the Sargasso Sea to spawn. However, the exact migration routes and destination of European eel are still unknown. We are the first to observe southward migrating silver eels in the North Sea. Eels were tagged with acoustic transmitters in 3 different river catchments in Western Europe and swam to the Dutch-Belgian coastal zone during their spawning migration. Therefore, at least part of the Western European population of eels migrates towards the English Channel, in contrast with the Nordic migration route hypothesis. This different migratory route may affect the energy reserve available for spawning and therefore the contribution of these eels to the population. As such, increasing our knowledge of marine eel migrations contributes to the goal of achieving sustainable eel stock management.

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