Report on the eel stock and fishery in:

Belgium

2014/'15

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Reporting Period: This report was completed in November 2015, and contains data up to 2015.

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	

Table of Contents

2 Introduction:

This report is written in preparation of the Joint EIFAAC/ICES/GFCM Working Group on Eels (WGEEL), meeting in Antalya, Turkey, from 24 November to 2 December 2015. 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 and 2014), 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.

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.

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 Belgian EMP has been approved by the European Commission on January 5th, 2010.

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.

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 2014–2015: 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/).

In 2013, a study was started at the sea sluices of Leopold Canal and Schipdonk Canal to optimize management of the sluices in order to allow glass eel migration.

- for downward migration:

Specific action in 2014–2015: 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 r

- controlling poaching.

Specific action in 2014–2015: Actions to control illegal fishing activities on eels were continued in 2014 and 2015, focusing mainly on the province of West-Vlaanderen. Illegal fishing equipment was seized.

- Glass eel restocking programme.

Specific action in 2014–2015: 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.

- Achieving WFD goals for water quality.

Specific action in 2010–2015: 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).

- Eel stock monitoring.

Specific action in 2014–2015:

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.

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).

- Eel quality monitoring.

Specific action in 2015: New information has been published about the presence of dyes (Belpaire et al., 2015) and specific contaminants such as organophosphorus flame retardants and plasticizers (Malarvannan et al., 2015), which contributes to the scientific work about the status and effects of hazardous substances on the eel (see abstracts under subchapter 11.3). An international workshop has been organized to progress with the development of internationally harmonized methods for the evaluation of eel quality with respect to measuring and reporting on contaminants and diseases (ICES, 2015).

- Eel migration in river Scheldt.

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).

- 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 new Red List of Fishes in Flanders.

For the Walloon region

- avoiding mortality at hydropower stations;

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

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

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

- Eel stock monitoring.

Specific action in 2014–2015:

Yellow eel: the monitoring of the eel recruitment at Lixhe (River Meuse) has been continued in 2015, and will be continued in upcoming years.

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).

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- Glass eel restocking programme.

Specific action in 2014–2015: 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. A new public market will be done in 2016 but without EFP cofunding.

- controlling poaching.

Specific action in 2014-2015: Control actions have been focused specifically on the river Meuse, the river Sambre and in the canals during day and night. In 2015, the number of control actions was doubled (101 operations, 59 during the day and 42 during the night) compared to 2014 for a total of 2690 controlled fishermen. Numerous illegal fishing equipments were seized. Regarding Fisheries Act Violation, the rate was of 5.4% 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. 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).

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).

In comparison to the previous report (2012), 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). However, 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).

3 Time-series data

3.1 Recruitment

3.1.1 Glass eel recruitment

3.1.1.1 Commercial

There are no commercial glass eel fisheries.

3.1.1.2 Recreational

There are no recreational glass eel fisheries.

3.1.1.3 Fishery independent

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 1 and Table 1 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 2015.

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 1A-D, and Table 1).

See below under 7.1 for CPUE data for the period 2002–2015.

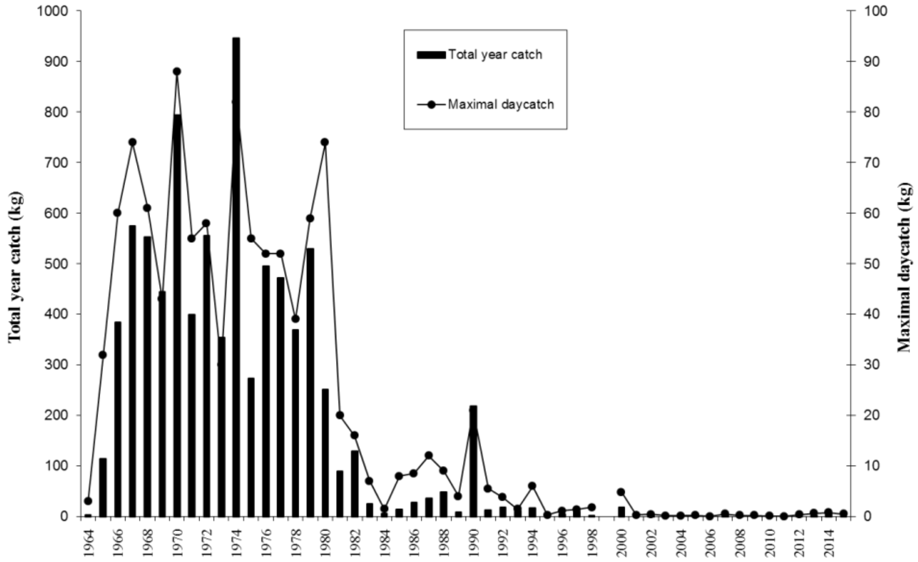


Figure 1A. Annual variation in glass eel catches at river Yser using the dipnet catches in the ship lock at Nieuwpoort (total year catches and maximum day catch per season), data for the period 1964–2015.

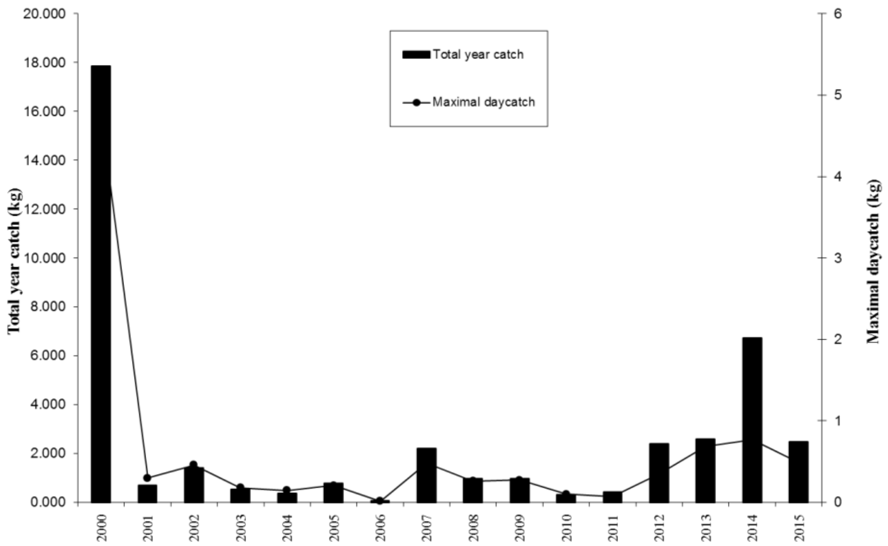


Figure 1B. Annual variation in glass eel catches at river Yser using the dipnet catches in the ship lock at Nieuwpoort (total year catches and maximum day catch per season), data for the period 2000–2015.

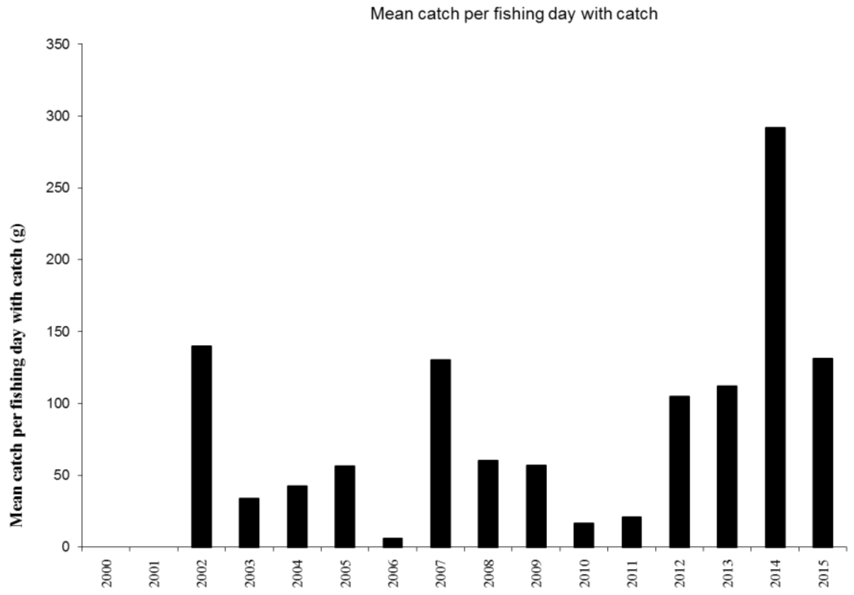


Figure 1C. Annual variation in glass eel catches at river Yser using the dipnet catches in the ship lock at Nieuwpoort) expressed as mean catches per fishing day with catch in g.

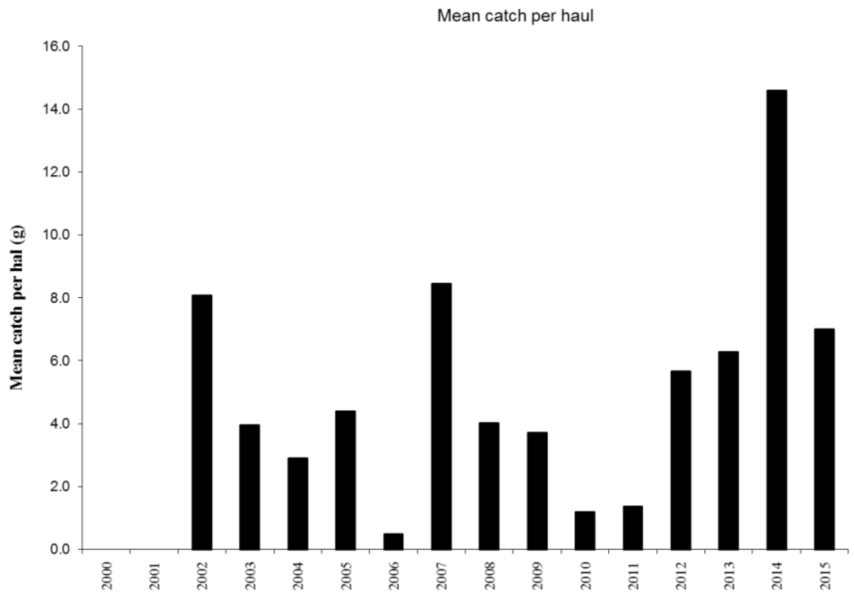


Figure 1D. Annual variation in glass eel catches at river Yser using the dipnet catches in the ship lock at Nieuwpoort), expressed as the mean catches per haul in g.

Table 1. Total year catches (kg) between 1964 and 2015. Data Provincial Fisheries Commission West-Vlaanderen.

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	
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	

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.

3.1.2 Yellow eel recruitment

3.1.2.1 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.

3.1.2.2 Recreational

No data available.

3.1.2.3 Fishery independent

On the Meuse, the University of Liège is monitoring the amount of ascending young eels in a fish-pass. From 1992 to 2015 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 (290 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 37394 eels was caught (biomass 2459 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 423–758 in 2004–2007) (Figure 2, Table 2). In 2008 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), 2010 (n =

249) and 2011 (n=208). The figure for 2012 (n= 317) 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) that is the lowest number of eels ever recorded since the start of the controls (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) is continuing a research program financed by EFF-EU to follow the upstream migration of yellow eels at Lixhe and to analyse the historical trends. Since 2010, every individual yellow eel 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.

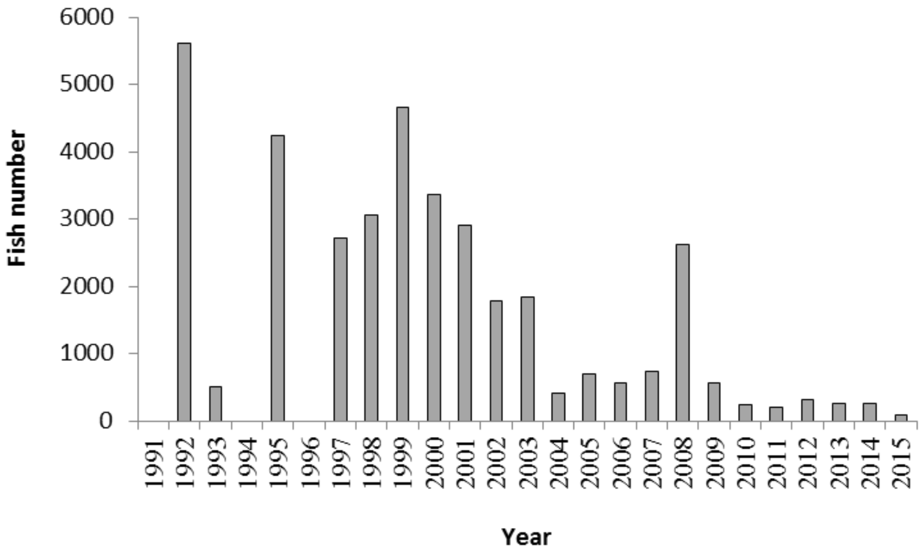


Figure 2. Variation in the number of ascending young yellow eels trapped at the fish trap of the Visé-Lixhe dam between 1992 and 2015. Data from University of Liège (Nzau Matondo et al., 2015).

Table 2 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

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
7	2709	731
8	3061	2625
9	4664	584

3.2 Yellow eel landings

3.2.1 Commercial

No time-series available. Currently there is no commercial yellow eel fisheries.

3.2.2 Recreational

No time-series available.

Flemish region

Based on an inquiry by the Agency for Nature and Forest in public waters in Flanders in 2008, recreational anglers harvest on a yearly basis 33,6 tons of eel (Vlietinck, 2010). In 2010 a small restriction of eel fishing was aimed by a new regulation (Besluit van de Vlaamse Regering 5/3/2010). Between April 16th and May 31th, and during the night, eels may not be taken home. This results in a roughly estimate of 10% reduction of eel harvest. Hence estimates for 2010 and later are an annual eel harvest of 30 tons (Vlietinck, pers. comm.). There is no distinction between the catch of yellow eel and silver eel, but due to the specific behaviour of silver eel, it is considered that these catches are mainly composed of yellow eel.

Soon, a new inquiry to anglers will be organized, to assess the eel yields by recreational fishermen in Flanders.

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 voor 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.

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 zero.

3.3 Silver eel landings

3.3.1 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.

3.3.2 Recreational

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

3.4 Aquaculture production

There is no aquaculture production of eel in Belgium.

3.4.1 Seed supply

3.4.2 Production

3.5 Stocking

3.5.1 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 3). 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 3 and Table 3). 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.

The cost of the glass eel per kg (including transport but without taxes) is presented in Table 4.

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

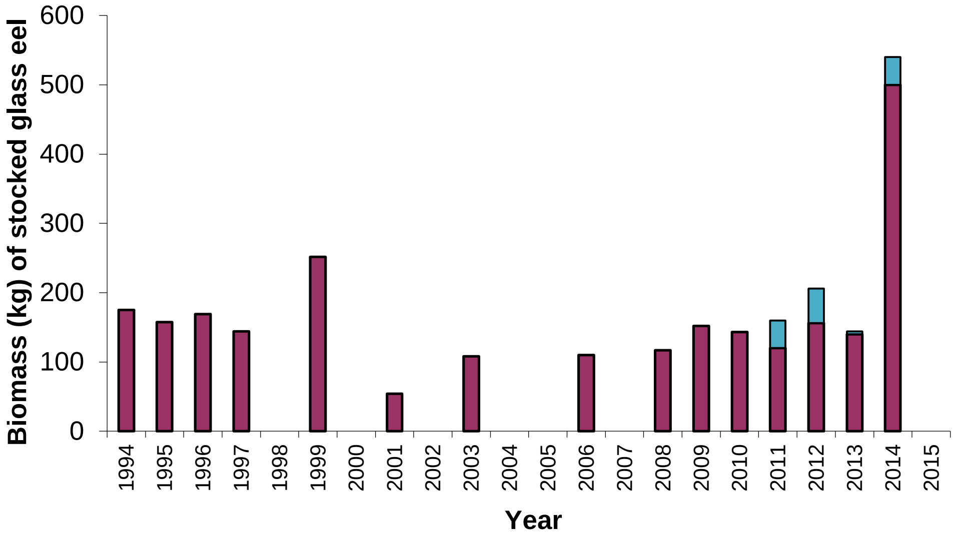


Figure 3 and Table 3. Restocking of glass eel in Belgium (Flanders and Wallonia) since 1994, in kg of glass eel. Flanders is represented in red and Wallonia in blue in the figure. * left Flanders/right Wallonia.

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	
7		144	0	
8		0	117	
9		251,5	152	

Table 4. 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)

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 to a French company (Aguirrebarrena, France) with EFF 50% cofounding. 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 of the Walloon market for three years (between 2016 and 2018).

More information on stocking details for Wallonia is presented in Tables 4-6 (Cost of the glass eel, origin).

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

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.

3.5.3 Reconstructed Time Series on Stocking

Stocking in Flanders

Table 5A. 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			

Stocking in Wallonia

Table 5B. 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

* 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 6. 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

* 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.

3.6 Trade in eel

Information on the trade of the eel in Belgium is currently not available, but will be integrated in next year's report.

4 Fishing capacity:

4.1 Glass eel

Commercial nor recreational fishery for glass eels is allowed in Belgium.

4.2 Yellow eel

Professional coastal and sea fisheries

Marine eel catches through professional and coastal fisheries are negligible.

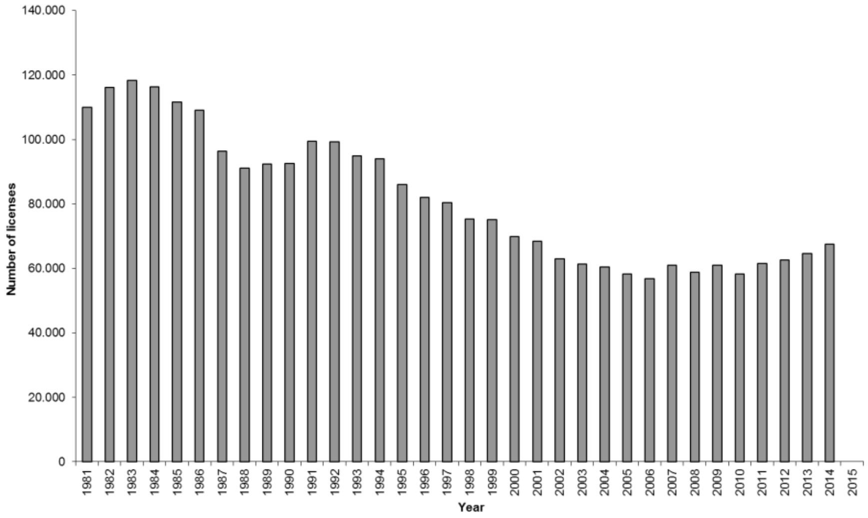
Estuarine fisheries on the Scheldt

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 and 67554 in 2014. The time-series shows a general decreasing trend from 1983 (Figure 4). 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. From an inquiry of the Agency for Nature and Forests in 2008 among 10000 recreational anglers (36% feedback) it appeared that ca. 7% fishes for eel.



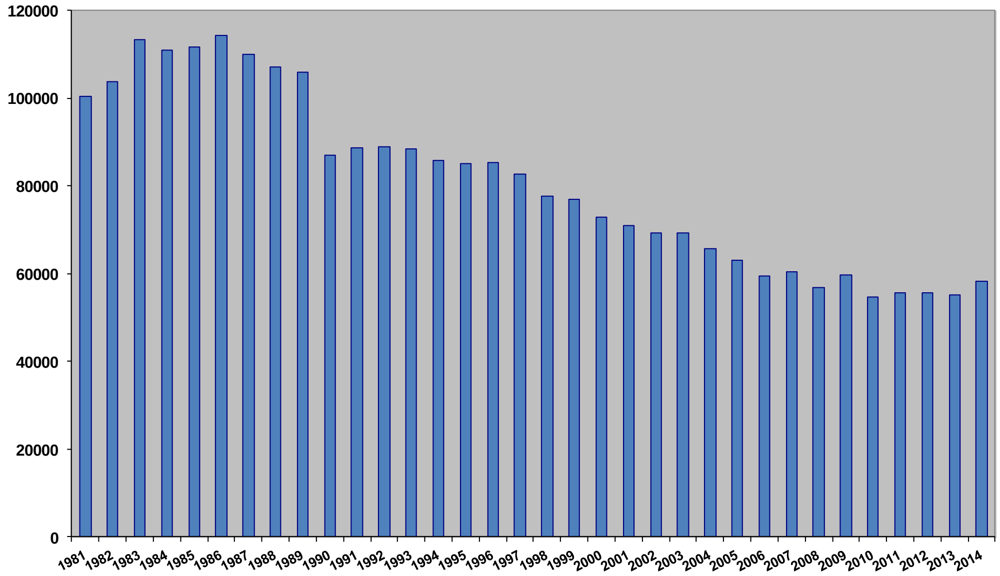


Figure 4. Time-series of the number of licensed anglers in Flanders (above) and Wallonia (below) since 1981 (Data Agency for Nature and Forests for Flanders and Nature and Fish Service of the Nature and Forests Department (DNF – DGARNE - SPW) for Wallonia.

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 and 58379 in 2014 (Figure 4). 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. The proportion of eel fishermen in Wallonia is not documented, but is probably very small since it is forbidden to keep the catched eels.

Recreational fisheries in the Brussels capital

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

4.3 Silver eel

See Sections 3.3.1 and 3.3.2.

4.4 Marine fishery

Marine eel catches through professional and coastal fisheries are negligible.

5 Fishing effort:

5.1 Glass eel

There is no professional or recreational fisheries on glass eel.

5.2 Yellow eel

See Section 4.2 for the number of recreational fishermen and the proportion of eel fishermen.

5.3 Silver eel

There are no professional or recreational fisheries on silver eel.

5.4 Marine fishery

Marine fisheries on eel are not documented and are assumed to be negligible.

6 Catches and landings

6.1 Glass eel

Commercial nor recreational fishery for glass eels is allowed in Belgium.

6.2 Yellow eel

Catches and landings-estuarine fyke fisheries on river Scheldt

Fyke fishing for eel on the lower Scheldt estuary is prohibited now. Since 2009 no more licences for fyke fisheries on the river Scheldt are issued, which is as a measure of the Eel Management Plan of Flanders to reduce fishing capacity. Before 2009 annual catches of eel by semi-professional fyke fishermen was estimated between 2.8 and 12.4 tons. This is thus reduced to zero in 2009 and later.

Catches and landings–recreational fisheries in Flanders

Based on an inquiry by the Agency for Nature and Forest in public waters in Flanders in 2008, recreational anglers harvest on a yearly basis 33,6 tons of eel (Vlietinck, 2010). This figure holds for 2009 too (Vlietinck, pers. comm.). In 2010 a small restriction of eel fishing was aimed by a new regulation (Besluit van de Vlaamse Regering 5/3/2010). Between April 16th and May 31th, and during the night, eels may not be taken home. This results in a roughly estimate of 10% reduction of eel harvest. Hence estimate for 2010, 2011 and 2012 is an annual eel harvest of 30 tons (Vlietinck, pers. comm.). There is no distinction between the catch of yellow eel and silver eel, but due to the specific behaviour of silver eel, it is considered that these catches are mainly composed of yellow eel.

Other earlier estimates were 121 tonnes per annum and 43 tonnes per annum (Belpaire *et al*., 2008).

In 2000 a catch and release obligation for the recreational fishing of eel was issued due to high contaminant concentrations, however this law was abolished in 2006. This resulted in an increase in yield of yellow eel by recreational fisheries from nihil to the actual 30 tons.

It is worth mentioning that based on the 2008 inquiry in a population of recreational anglers (Vlietinck, 2010), the majority (77%) of anglers are in favour of a restriction in the fishing or the harvest of eel (in the framework of the protection of the eel). 27% of the respondents are in favour of (among other options) the obligatory release of caught eel as management option (Figure 5).

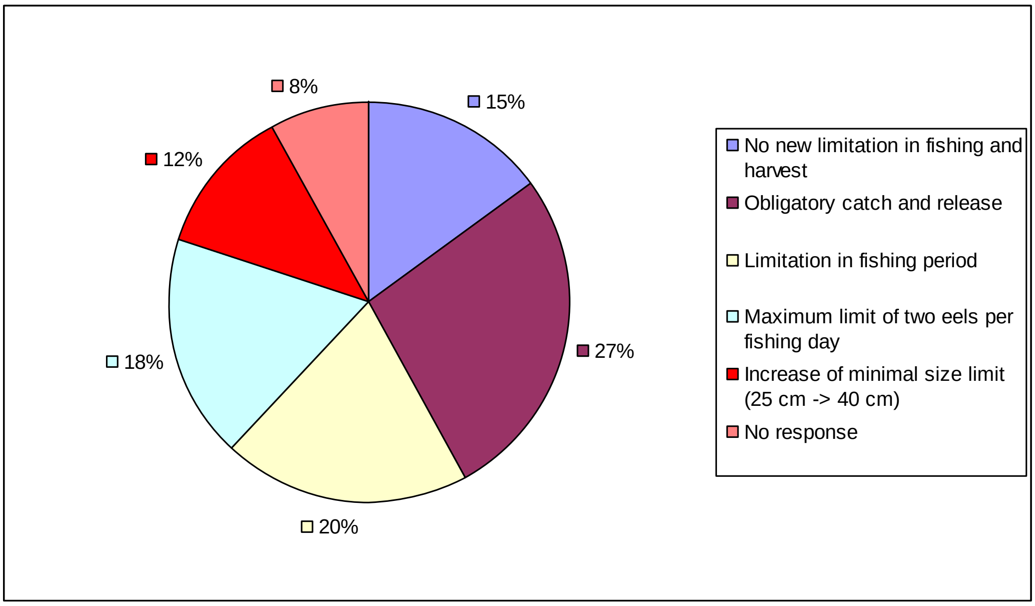


Figure 5. Results of a 2008 inquiry among 10 000 Flemish recreational anglers for their preference in management options for restoring the eel stock. 36% (N = 3627 anglers) responded (Vlietinck, 2010).

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 voor 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.

Currently (2014), in Flanders the eel is classified as “Critically Endangered” in the new Flemish Red List of Freshwater Fishes and Lampreys (Verreycken et al., 2014). It is not known if in the future this will have some implications on further restrictions on fishing and taking home eel by recreational fishermen.

Catches and landings by poaching

In the province of West-Vlaanderen, in the period 2012 to 2014 at least 14 actions were taken to search for illegal fishing equipment for eel. During these actions a total number of 41 illegal fykes were reported, indicating that some semi-professional poachers may cause very localized damage to the eel population (Vlietinck and Rollin, 2015). Van Thuyne and Belpaire (2015) estimated that in these water bodies of West-Vlaanderen poaching with a fyke may result in a mean catch of 0.850 to 1.265 kg/fyke/24h (dependent of the season).

Catches and landings–recreational fisheries in Wallonia

In the Walloon region, fishing of eels is prohibited since 2006 (Walloon Government, 2006). By modification of the 1954 law on fishing activities, there is an obligation to release captured eels whatever their length. So from 2006 on, recreational catches of eel in Wallonia should be zero, except poaching of yellow and silver eels.

In Wallonia, fishery control actions have been focused specifically on the river Meuse, the river Sambre and in the canals during day and night. In 2014, 49 control operations were undertaken (20 during the day, 29 during the night) for a total of 1370 controlled recreational fishermen. In 2015, the number of control actions was doubled (101 operations, 59 during the day and 42 during the night) for a total of 2690 controlled fishermen. Numerous illegal fishing equipments were seized. Regarding Fisheries Act Violation, the rate was of 4.7% and 5.4% during the day in 2014 and 2015, respectively, but of 25.3% and 20.1% during the night of the same years. Since 2010, the annual offence rate during the night decreased by about 5% per year and was highly correlated to control intensity. Only a small minority of violations concerned eel poaching, mostly illegal eel detention and utilisation for *Silurus glanis* fishing.

Recreational fisheries in Brussels capital

No information on eel catches.

6.3 Silver eel

There are no professional or recreational fisheries on silver eel.

6.4 Marine fishery

Marine fisheries on eel are negligible and not documented.

6.5 Recreational Fishery

See under 6.2 and 7.2 for the information available on recreational fisheries.

No further data available.

Recreational Fisheries: Retained and Released Catches

	Retained				Released			
	Inland		Marine		Inland		Marine	
Year	Angling	Passive Gears	Angling	Passive gears	Angling	Passive gears	Angling	Passive gears
2015 Flanders	30t							
2015 Wallonia	0							

Provide the catch and release mortality (%) used in your country for angling in marine and inland waters.

Recreational Fisheries: Catch and Release Mortality

	Released			
	Inland		Marine	
	Angling	Passive	Angling	Passive

	gears	gears
Year		

6.6 Bycatch, underreporting, illegal activities

Bycatch through exploitation of marine fish stocks is not reported and is considered low.

From time to time illegal activities have been observed. Fishing using illegal gears, and illegal selling of catches might be the illegal activities with most impact on the eel stock. Quantitative information is not available.

7 Catch per unit of effort

7.1 Glass eel

Commercial nor recreational fishery for glass eels is allowed in Belgium.

There is some information available on the cpue trend in the governmental glass eel monitoring at Nieuwpoort (River Yzer) (Table 7).

Table 7. 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.

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	0,0040
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	0,0040
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	0.770	0.292	0.0146
2015	2489	0.487	0.131	0.0070

7.2 Yellow eel

There are only rough estimates about the catches of eel by recreational fishing. These data are based on an inquiry (N=3627 responses) by the Agency for Nature and Forest in public waters in Flanders in 2008 (Vlietinck, 2010). At that time recreational anglers harvest on a yearly basis 33,6 tons of eel. 6.6% of the recreational fishermen (N=58 788) are eel fishermen. So

3880 eel fishermen are catching 33.6 tons, or an average eel fishermen is fishing 8.7 kg eel per year.

7.3 Silver eel

There are no professional or recreational fisheries on silver eel.

7.4 Marine fishery

Marine fisheries on eel are negligible and not documented.

8 Other anthropogenic and environmental impacts

In Belgium, the eel stock is considerably impacted by an overall poor water quality (especially for Flanders), and by a multitude of migration barriers (draining pumps, sea sluices, dams, weirs, impingment by power stations and hydropower units).

Water quality

Improvement of water quality by installing purification units is an on-going process (within the objectives of the Water Framework Directive). As an example the installation of an important purification unit in 2007 on the River Senne (north of Brussels) purifying the waste waters of the capital, has led to an impressive increase in the eel population in river Senne and Rupel during 2008 and 2009. Due to a temporary closure of the water treatment plant (for technical reasons) at the end of 2009 all eels disappeared, subsequent monitoring showed that the eel population restored approximately six months after restart of the plant.

Wallonia

The implementation of the European Water Framework Directive (WFD), which was adopted in 2000, included the development of ecological and chemical monitoring programs and the drafting and implementation of River Basin Management Plans (RBMP). In 2013, 145 out of the 354 inland surface water bodies (41 %) encountered in Wallonia reached a good or very good ecological status (Table X1). The chemical status except ubiquitous Persistent Bioaccumulative Toxic (PBT) chemicals and based on EQS from Directive 2008/105/EC is good in 280 out of 354 surface water bodies (79 %) in Wallonia (Table X2).

Water quality has improved during the last decade, due to investment in sewage systems to reduce pollution from urban wastewater treatment. Nevertheless, challenges remain. Many rivers are affected by diffuse pollution from agriculture, while some stay subject to point source pollution, for example from industrial facilities, sewage systems and wastewater treatment plants. The second RBMP (2016-2021), for which the public consultation process is ongoing, addresses these issues.

Table 8.1: Ecological status in 2013 of inland surface water bodies for Wallonia by sub-basins

Subbasin	Number of water bodies	Ecological status: Bad	Poor	Moderate	Good	High	Un-determined
Amblève	**20**	0	3	3	11	0	3

Lesse	**30**	1	0	7	21	1	0
Meuse amont	**39**	3	5	8	21	1	1
Meuse aval	**35**	8	7	14	3	3	0
Ourthe	**35**	2	0	5	24	2	2
Sambre	**32**	6	12	7	2	0	5
Semois-Chiers	**42**	0	5	5	27	4	1
Vesdre	**24**	3	3	6	7	3	2
Dendre	**12**	5	1	4	2	0	0
Dyle-Gette	**13**	7	4	2	0	0	0
Escaut-Lys	**25**	14	9	1	1	0	0
Haine	**17**	5	4	6	2	0	0
Senne	**12**	5	5	1	1	0	0
Moselle	**16**	0	0	9	7	0	0
Oise	**2**	0	0	0	2	0	0
Wallonia	**354**	**59**	**58**	**78**	**131**	**14**	**14**

Table 8.2: Chemical status except PBT in 2013 of inland surface water bodies for Wallonia by subbasins (EQS from Directive 2008/105/EC)

Subbasin	Number of water bodies	Chemical status except for ubiquitous PBT		
		Poor	Good	Un-determined
Amblève	**20**	1	14	5
Lesse	**30**	2	28	0
Meuse amont	**39**	4	35	0
Meuse aval	**35**	9	26	0
Ourthe	**35**	0	24	11
Sambre	**32**	3	22	7
Semois-Chiers	**42**	0	42	0
Vesdre	**24**	1	23	0
Dendre	**12**	6	6	0
Dyle-Gette	**13**	2	11	0
Escaut-Lys	**25**	10	15	0
Haine	**17**	5	6	6
Senne	**12**	2	10	0
Moselle	**16**	0	16	0
Oise	**2**	0	2	0
Wallonia	**354**	**45**	**280**	**29**

Restoring migration possibilities

On April 26, 1996, the Benelux Decision about free fish migration was adopted. The Decision sets that the Member States should guarantee free fish migration in all hydrographic basins before January 1, 2010. Recently, the 1996 Benelux decision has been evaluated. The general conclusion is that a lot of barriers have been removed, but also that the timing is not achievable and that the focus should be on the most important watercourses. On June 16, 2009 a new Benelux Decision (Benelux, 2009) was approved. According to this new Decision, Member States commit themselves to draw up a map indicating the most important watercourses for fish migration. Hereto, the Research Institute for Nature and Forest (INBO) drew up a proposal for this prioritization map based on ecological criteria (Figure 6).

The proposal for the new prioritization map accounts for both the distribution of EU Habitat Directive species and the recommendations of the eel management plan. In addition, the Benelux Decision allows accounting for regionally important fishes (i.e. rheophilic species for which Flanders has developed a restoration program such as dace, chub and burbot).

The total length of the prioritization network of Flemish water courses is 3237 km (almost 15% of the total length of the watercourses in Flanders). Besides the barriers on the selected watercourses, also pumping stations and hydro turbines on unselected water courses should be taken into account. Depending on their location and functioning, pumping stations and hydro turbines may have a significant impact on the survival of downstream migrating fish and eel in particular. The results of a survey of pumping stations in Flanders will be used to draw up a list of the most harmful pumping stations. This list will then be added to the prioritization map.

The prioritization map gives an overview of the water courses that should be barrier-free in order to preserve the populations of the target species. Hereto a distinction is made between obstacles of first and second priority. Obstacles of first priority are those located on the main rivers of the major river basins (Scheldt and Meuse). 90% of these barriers should be eliminated by 2015, the remaining 10% by 2021. In Flanders, the highest priority is given to the obstacles on the River Scheldt and to the obstacles that should be removed first according to the eel management plan. The remaining obstacles on the water courses of the prioritization map are assigned to the second priority. These obstacles will be divided into three groups. 50% of these should be removed before December 31, 2015. 75% should be removed before December 31, 2021 and 100% by December 31, 2027.

Additionally, water courses of special attention were selected. These are water courses that have important fish habitat, but where the removal of migration barriers is not a priority. These water courses are important for the restoration of the eel stock, have an ecologically valuable structure or are located in a sub-basin where Habitat Directive species occur. They are not part of the prioritization map and have no timing for the removal of existing migration barriers. However, downstream migration should be guaranteed in these water courses and if an opportunity arises, the existing fish migration barriers should be removed.

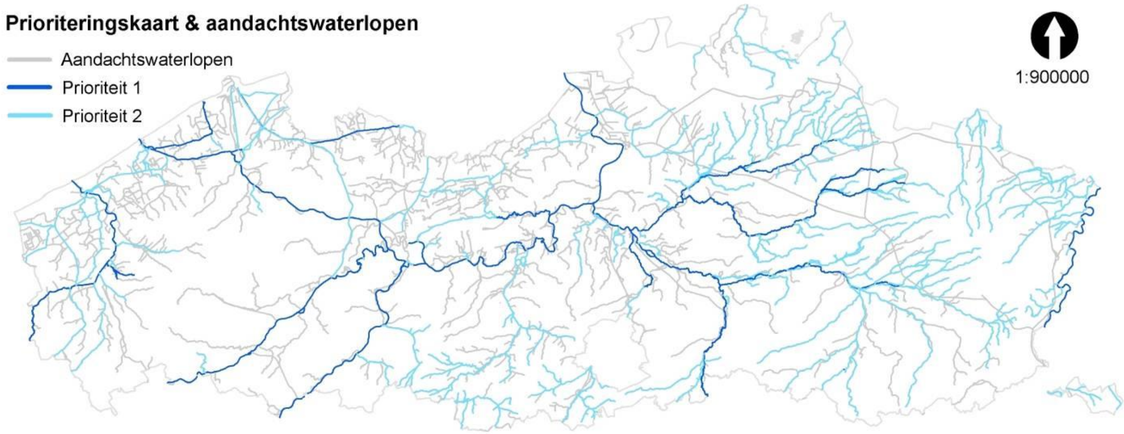


Figure 6. Fish migration prioritization network of Flemish water courses (blue) and water courses of special attention (grey) following the Benelux Decision "Free migration of fish" M(2009)1.

The indicator presented under Fig. 7 shows the number of sanitized migration barriers on the watercourses of the strategic prioritization map for fish migration. The BENELUX decision on fish migration states that 90% of the fish migration barriers categorized as first priority on the strategic priority map must be eliminated before December 31, 2015 (phase 1 - MINA plan 4 indicator 1) and the obstacles of second priority before December 31, 2021 (phase 2 - MINA plan 4 Indicator 2).

On a significant part of the watercourses of second priority, fish migration barriers have not yet been fully inventoried. Therefore it is currently not possible to assess the second indicator (phase 2).

The network of watercourses allocated to first priority 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. Hence, by the end of 2015 still 24 barriers included in the eel management plan and four other bottlenecks in waterways of first priority need to be sanitized. The total number of bottlenecks may change as they sometimes naturally disappear or may turn out to be less problematic after in depth assessment.

Considering the current efforts in sanitizing barriers, phase 1 of the Benelux decision probably will not be achieved. Besides, the inventoried fish migration barriers of phase 2 will probably be sanitized only after 2021. The main bottlenecks remain available budgets, staff capacity and societal considerations.

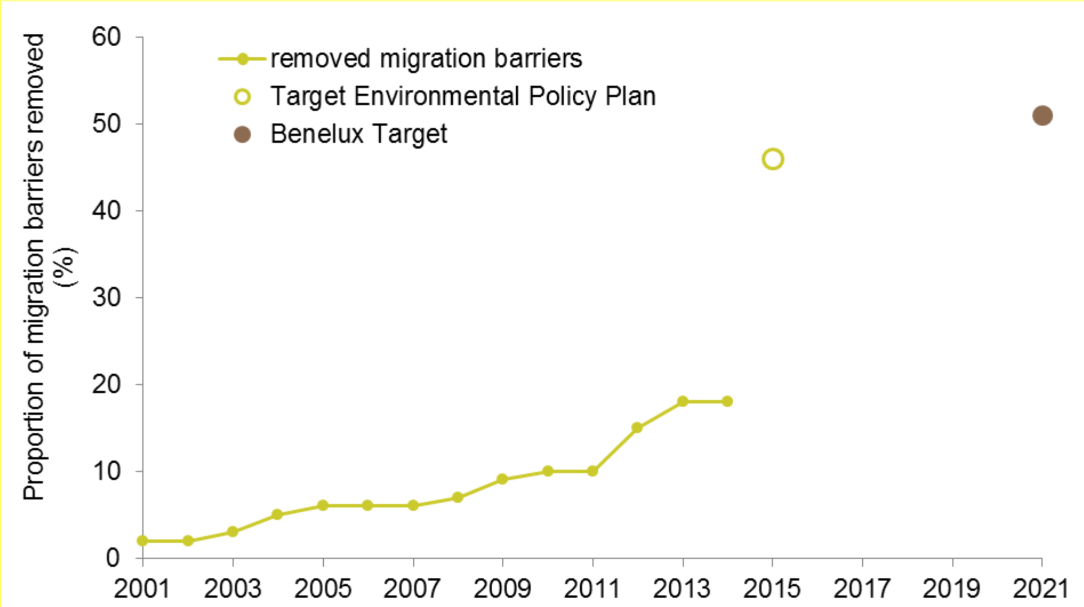


Figure 7: Number of sanitized fish migration barriers in Flanders (https://www.inbo.be/nl/natuurindicator/gesaneerde-vismigratieknelpunten-prioriteitsklasse-1?utm_source=INBO+Nieuwsbrief&utm_campaign=c30ade603d-Natuurindicatoren_201511_10_2015&utm_medium=email&utm_term=0_402da5b35e-c30ade603d-205261121).

To enhance eel migration possibilities, a reverse drainage sluice management was conducted at two major salt-freshwater transition sites (sluices at river IJzer and the canal Ghent-Ostend). This was estimated to increase the glass eel passage at the sluices by about 200 fold. Research for the establishment of a similar reverse sluice management at two other major salt-freshwater transition sites at Zeebrugge is ongoing and will be implemented next year. For eel, the main migration bottleneck in Flanders is the access from the Lower Sea Scheldt to the Upper Scheldt. The Scheldt is the largest Flemish waterway and resolving this migration barrier can give access to a large eel habitat. Currently, some scenarios examine the feasibility to provide fish passage possibilities at the Merelbeke bottleneck to allow migration towards Upper Scheldt and river Leie. Further upstream on the Upper Scheldt 2 fish passages already exist (at Oudenaarde and Asper) but these need to be optimized. The third and most upstream fish migration bottleneck (Kerkhove) will be addressed in 2016-2017 (Vlietinck and Rollin, 2015).

An update of the anthropogenic impacts has recently been made in the framework of the report of the evaluation of the Belgian EMP (Vlietinck *et al.*, 2012). We refer to this document for a more complete description of the anthropogenic impacts on the stock.

In summary following management measures are foreseen:

Table 9. Status of measures of habitat restoration as reported in the evaluation of the Belgian EMP (Vlietinck *et al.*, 2012).

MEASURES	REGION	STATUS	TIMING
Resolving migration barriers for upstream migration	Flanders	In progress	2027
Resolving migration barriers for upstream migration	Wallonia	In progress	2027
Measures to protect eels from impingment (by industries using cooling water) during their downward migration.	Wallonia	In progress	To be defined
Measures to protect eels from hydropower installations during their downward migration.	Wallonia	In progress	To be defined
Measures to protect eels from hydroturbines and pumping stations during their downward migration.	Flanders	In progress	To be defined
Measures to attain good ecological status or good ecological potential of water bodies.	Belgium	In progress	2027
Measures for sanitation of polluted sediments	Flanders	To be started	To be defined
	Wallonia	In progress	To be defined

Although numerous pumping stations have been used by water managers for numerous 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 threaten escapement targets set in eel management plans (Buysse et al., 2014).

In another study, 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). 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.

Evaluation of reverse drain management to improve glass eel migration into the Diversion Canal of the Leie (DCL) and the Leopold Canal (LC) in Zeebrugge

During the last decades, European eel populations have declined dramatically. The limitation of upstream migration of glass eel is considered to be one of the critical factors endangering eel populations.

Previous research conducted by INBO (commissioned by W&Z and ANB) near the Ganzepoot in Nieuwpoort (Mouton et al., 2011 & 2014) and the Sas Slijkens in Ostend (Buysse et al., 2015b) showed that reverse drain management significantly increases the upstream migration of glass eels from the sea to fresh water. Hence this study investigated the applicability of this reverse drain management on another fresh water/sea transition of the Diversion Canal of the Leieand that of the Leopold Canal in Zeebrugge. These two canals with a sharp salt/fresh water transition are two potentially important land inwards routes for glass eels in Flanders.

We looked at how many glass eels migrated upstream in the DCL by applying the reverse lock management. In this study the arriving glass eels were quantified when a door was 'slightly opened'. Quantification was done by sampling at one of the DCL sluice gates . Three large glass eel fyke nets where used to evaluate the impact of limited sluice opening on glass eel migration.

Limited opening of a sluice gate (hinged at the top) during tidal rise appeared to be a cost-efficient and effective mitigation option to improve upstream glass eel migration, without significant inflow of sea water. Since the adjusted sluice gate management is easily implementable and could be applied on numerous tidal barriers, the presented results may contribute to restoration of eel populations worldwide and be of interest to a wide range of river managers and stakeholders.

The goal of this research was also to assess whether the measures taken are efficient, i.e. do the glass eels that enter via reversed drain management grow and spread in the LC?

During this study only very few glass eels (and eels in general) were caught so it has to be investigated in a later stage whether an efficient migration with low mortalities may or may not take place there. It will also be necessary to assess whether the current eel densities, which were calculated in four different sectors of the LC now, will increase by the adjusted management strategy.

9 Scientific surveys of the stock

9.1 Glass eel

See Section 3.1.1.3 Glass eel recruitment at Nieuwpoort at the mouth of River Yser (Yser basin).

<u>Evaluation of the efficiency of the glass eel restocking and dispersal and habitat use of glass eel</u>

The University of Liege has carried out a EFF cofounded research project on the efficiency of restocking glass eel in 3 small rivers of Wallonia, affluents of rivers Méhaigne, Meuse and

Vesdre, in order to increase our knowledge about the potential of restocking programs in the framework of the international eel management. Results are in the final report (Matondo et al. 2015). Shortly, the results indicated a good survival, growth and upstream as well as downstream dispersion of glass eel after restocking in the three tested small brooks of different typology. The authors concluded that this technique of direct restocking with glass eels seems appropriate to increase eel populations in continental hydrosystems. However, brooks containing suitable habitats have to be selected. Priority should be given to rivers with a high carrying-capacity containing diversified habitats, low bioenergetic losses for eels, rich in feeding resources and protections against predators. Most favourable habitats were sediments, tree roots and crevices between rocks and stones. The relative abundance of these habitats in these rivers would explain the differences of observed eel density and production between these brooks.

9.2 Yellow eel

Fish stock monitoring network in Flanders

Since 1994, INBO runs a freshwater fish monitoring network consisting of ca. 1500 stations in Flanders. These stations are subject to fish assemblage surveys on regular basis (on average every two to four years depending of the typology of the station). This network includes all water types, head streams as well as tributaries (stream width ranging from 0.5 m to 40 m), canals, disconnected river meanders, water retaining basins, ponds and lakes, in all of the three major basins in Flanders (Yser, Scheldt and Meuse). Techniques used for analysing fish stocks are standardized as much as possible, but can vary with water types. In general electrofishing was used, sometimes completed with additional techniques, mostly fyke fishing. All fish are identified, counted and at each station 200 specimens of each species were individually weighed and total length was measured. As much as possible biomass (kg/ha) and density (individuals/ha) is calculated. Other data available are number (and weight) of eels per 100 m electrofished river bank length or number (and weight) of eels per fyke per day. The data for this fish monitoring network are available via the website http://vis.milieuinfo.be/.

This fish monitoring network is now been further developed to cope with the guidelines of the Water Framework Directive.

A temporal trend analysis has been performed based on a dataset including fish stock assessments on locations assessed during the periods 1994–2000, 2001–2005 and 2006–2009. 334 locations were assessed in those three periods (30 on canals and 304 on rivers). These results have been reported in the 2011 Country Report; see Belpaire *et al*. (2011) for further details.

In 2012-2013 a new data-analysis has been carried out for the most recent period, in the framework of updating the Red List status of Flanders' fresh water fishes. In the new Flemish Red List of Freshwater Fishes and Lampreys (Verreycken et al., 2014), eel was placed in the Critically Endangered category. The number of eel individuals, steeply decreased with 75% between the periods 1996–2003 and 2004-2011 and this despite the yearly restocking with glass eel.

Reporting for the Eel Regulation and the Fish stock monitoring network in Flanders

According to the EU Eel Regulation, each Member State has to report every three years on the progress of the implementation of the eel management plans. One of the things that need to be reported is the effective escapement of silver eels to sea. Both the calculations for the eel management plan and the first interim report are based on data on yellow eel abundances collected by the Flemish Fish Monitoring Network Freshwater. However, the current Monitoring Network for Freshwater Fish was evaluated and merged into a new monitoring network for the Water Framework Directive (Stevens et al., 2013). This report discusses the methodology for calculating the escapement of silver eel in Flanders. The suitability of the new Monitoring Network Freshwater Fish for the European Eel Regulation reporting is discussed and recommendations are made to improve the methodology and validate the model results.

It was concluded that the new Monitoring Network Freshwater Fish covers satisfactorily the watercourses of the eel management plan and is suitable for reporting on the distribution of eel in Flanders. However, the number of sampling points in the new monitoring network is strongly reduced. As a result, the estimators for the calculation of the density of yellow eel will be based on a limited number of measurements, resulting in a lower reliability of these estimators. The new monitoring network can be used to calculate estimators per basin and per stratum (instead of current classification per basin and typology). This limits the number of combinations and avoids the double spatial component for the small streams in the ecological typology. Possibly a number of combinations can be grouped to increase the number of points per estimator. An analysis of the data from the Monitoring Network Freshwater Fish is necessary to determine which classification of watercourses is best suited to determine these estimators.

Large rivers, canals and estuaries represent a significant portion of the surface area of watercourses in the eel management plan. However, electric fishing is less efficient or impossible (brackish waters) in these watercourses, as a result of which the density estimators are less reliable. Therefore a method should be developed to improve the density estimators for these watercourses and for the Scheldt estuary in particular.

The methodology for calculating the escapement of silver eel is sufficiently suitable for reporting to Europe (see Stevens et al., 2009). However, the method and model parameters need to be refined to reduce the uncertainty in the model output and the results of the model should be validated with real data on the escapement of silver eels.

The report suggests two approaches:

- First, desk studies can be used (1) to improve the calculations of eel mortality and (2) to refine the classification of the freshwater eel habitat (analysis of the habitat and fish data from the Monitoring Network Freshwater Fish). In addition, the habitat analysis is also important to underpin the conversion of eel CPUE to eel density.

- On the other hand, field studies are necessary to calibrate the conversion of eel CPUE to eel density, to improve the model parameters and to validate the model results.

Finally, supporting research can be used to evaluate the effectiveness of measures in the management plan and to improve the model (e.g. research on the impact of eel quality and on the contribution of the Scheldt estuary in the production and migration of silver eels in Flanders) (Stevens et al., 2013).

See 13.1 under “Stock assessment” for a description of the elaboration of the figures for Flanders in the framework of the second progress report 2015 (report by Belpaire et al., 2015).

River Scheldt fish monitoring at the power station of Doel

Between 1991 and 2012, INBO has been following the numbers of impinged fish at the nuclear power station of Doel on the Lower Scheldt. We refer to the 2012 Country Report (Belpaire et al 2012) for a presentation of results and trends. Unfortunately, due to a shortness of means this monitoring series has been stopped in 2012.

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. XX). 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).

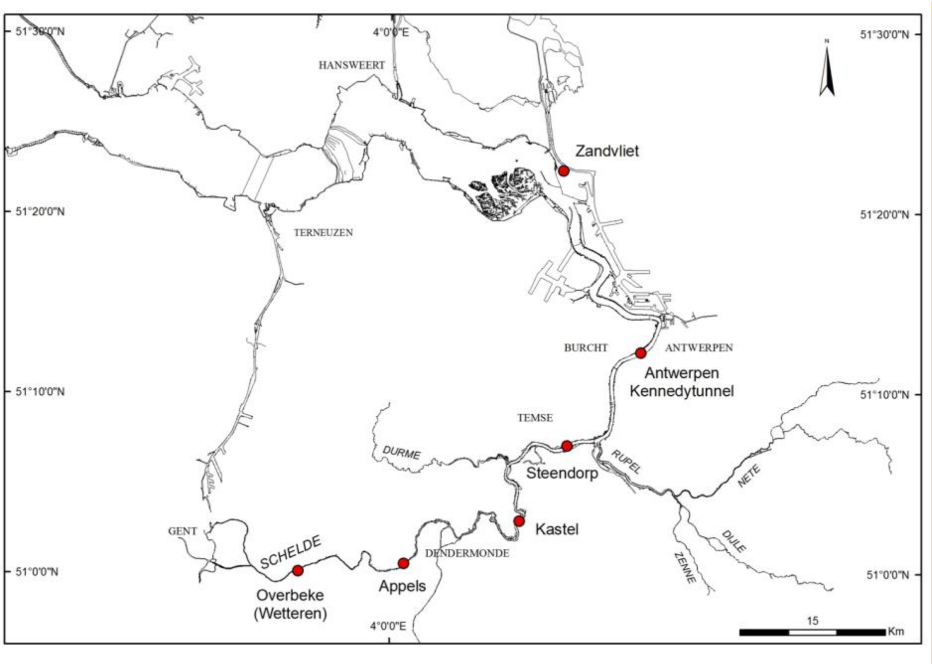


Figure 8. Locations sampled in the Zeeschelde estuary.

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.

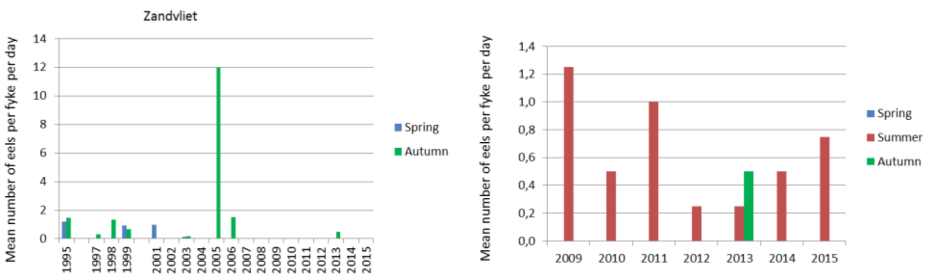


Figure 9. Time trend of fyke catches of eel in Zandvliet. Numbers are expressed as mean number of eels per fyke per day. On the left, data are split up in spring catches and fall catches (1995-2015) while on the right, summer catches are added (2009-2015). Years without monitoring data are excluded from 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.

In the oligohaline zone two locations are sampled (Antwerpen and Steendorp).

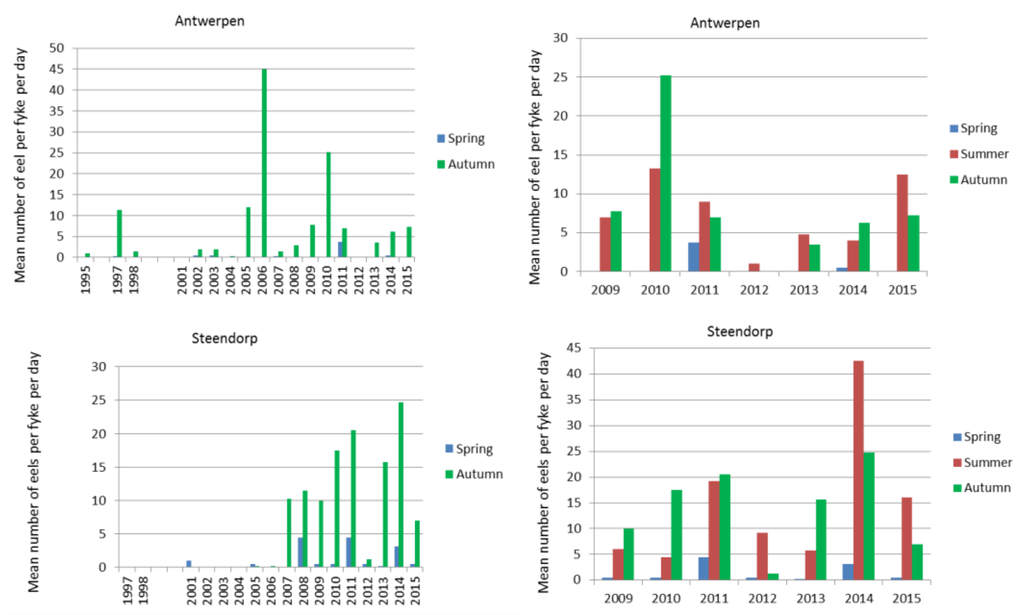


Figure 10. Time trend of fyke catches of eel in Antwerpen and Steendorp. Numbers are expressed as mean number of eels per fyke per day. On the left, data are split up in spring catches and fall catches (1995-2015) while on the right, summer catches are added (2009-2015). Years without monitoring data 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.

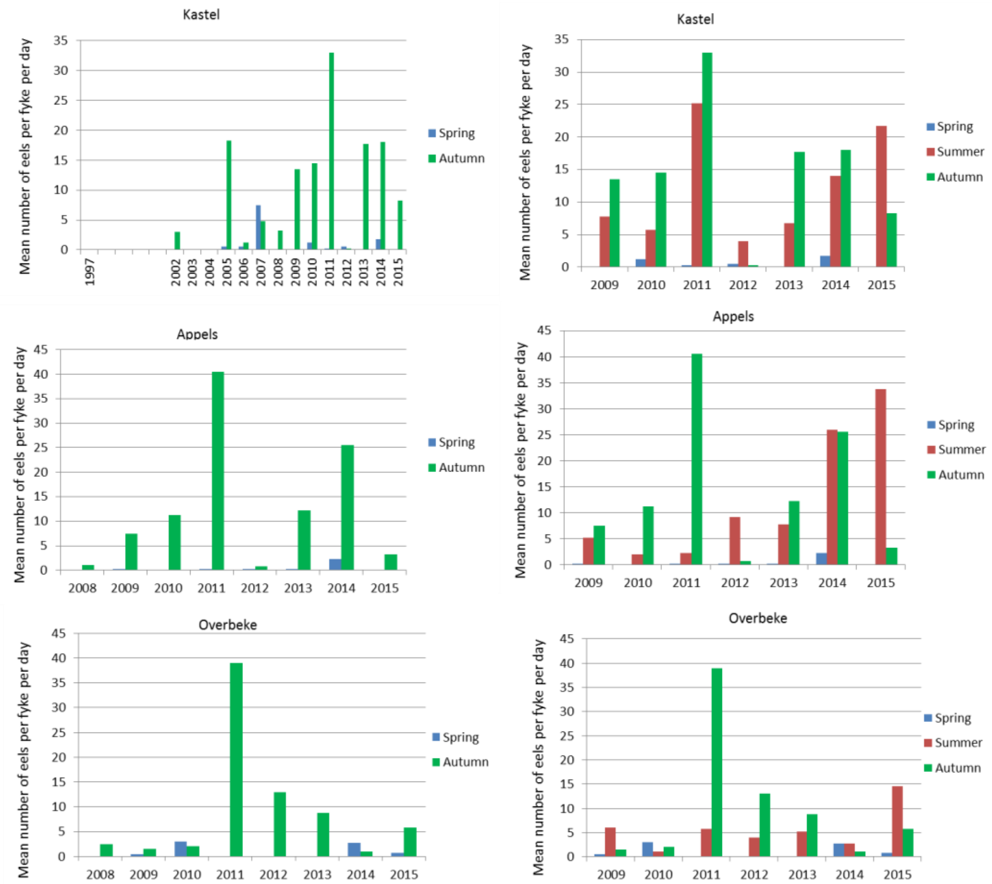


Figure 11. Time trend of fyke catches of eel in Kastel, Appels and Overbeke. Numbers are expressed as mean number of eels per fyke per day. On the left, data are split up in spring catches and fall catches (1997 or 2008-2015) while on the right, summer catches are added (2009-2015). Years without monitoring 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.

Yellow eel telemetry study in the river Méhaigne (Meuse RBD)

In 2009, University of Liège started up a telemetry study on 50–80 cm yellow eels in the Méhaigne, tributary of the river Meuse. The objectives are the evaluation of home range, mobility, habitat choice, impact of alterations of water regime by hydropower stations and the assessment of up and downstream migration. This study aims to study habitat choice of eels in support of the management of river habitat in Walloon rivers.

The movements and habitat use of resident yellow eels were studied in a stream stretch having both natural and minimum flow zones. N = 12 individuals (total length 505–802 mm) were surgically tagged with radio transmitters and released at their capture sites. They were located using manual radio receivers during the daytime from 2 to 5 days/week over periods ranging from 200 to 329 days, for a total of 1,098 positions. Eels showed home ranges ranging from 33 to 341 m (median value, 62 m), displayed strong fidelity to sites and demonstrated a great degree of plasticity in habitat use. Eels were slightly mobile throughout the year, but their movements were season and temperature dependent, with a maximum during the spring (mean water temperature, 12°C) and a minimum in winter (3°C). Stones and roots (utilization rate greater than 50 % of eels for more than 30 % of location days) were significantly the most frequently used habitats. Between the two flow zones, the natural flow was the most occupied, with a significantly higher proportion of resident eels (66.7 % of radio-tagged yellow eels) and longer occupation (81 % of location days) than the minimum flow zone with less suitable habitats (Ovidio et al., 2013).

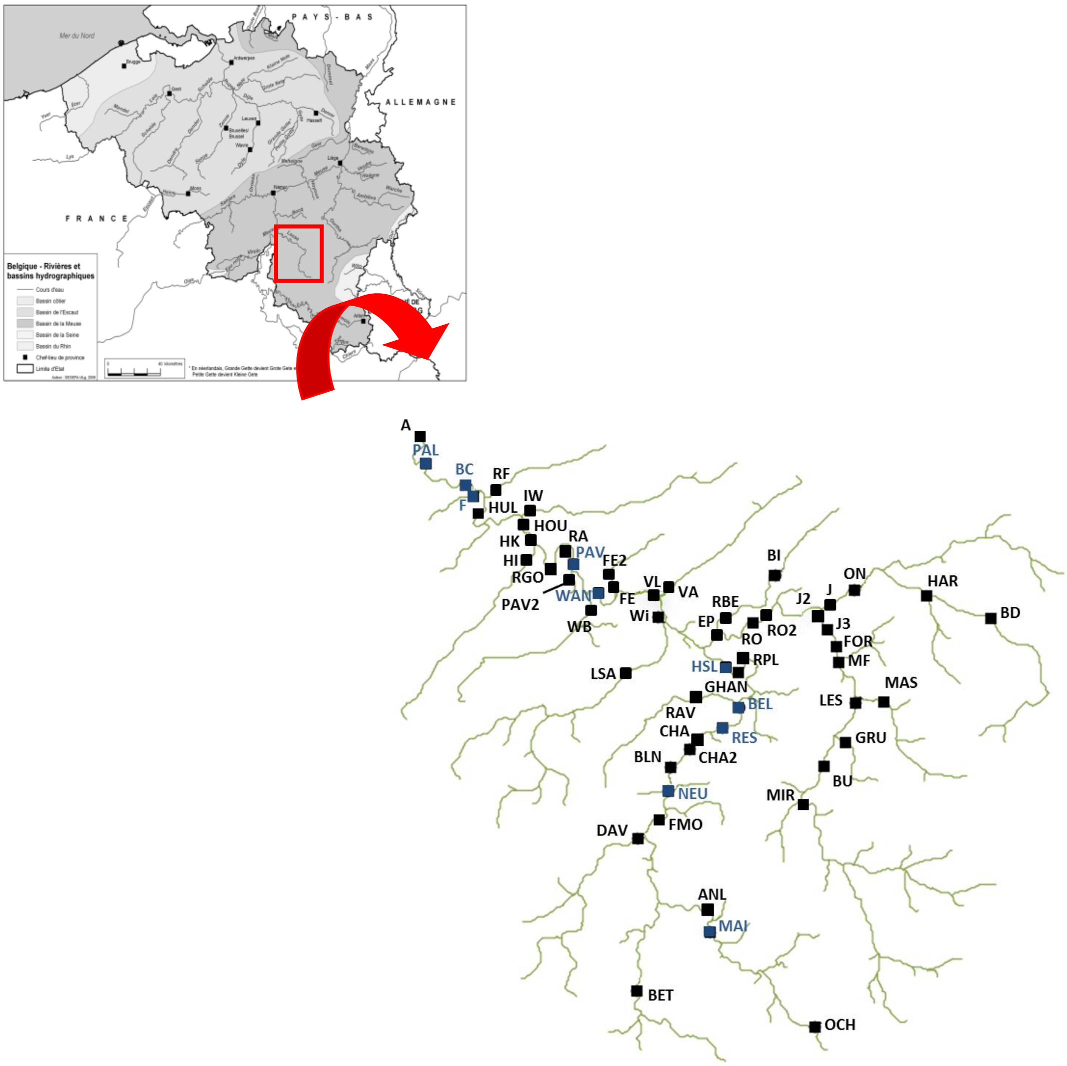
Upstream migration of yellow eel in the River Meuse bassin

Migration flux at the Visé-Lixhe dam was estimated at 6152 eels (0.738 t, density: 1187 eels/ha, biomass 142 kg/ha) using the mark-recapture method (Nzau Matondo et al. 2015a). This estimated value is much lower than the 445 000 eels (16.5 t) estimated by Baras *et al.* (1996) at Ampsin in the upper Meuse. At the Visé-Lixhe dam, eels moved upstream through the two fish passes but the old fish pass monitored since 1992 is their preferred migration route (Nzau Matondo et al. 2015b).

Eel population study in the Lesse (Meuse RBD)

An ongoing research program financed by the European Fishery Fund (FEP) and the Service Public de Wallonie (SPW), aims to estimate the resident stock of eels in the Lesse river, sub-basin of the River Meuse. The stock is estimated by the method of capture-recapture sampling and densities are calculated according to the Petersen method. On each sampling site, electrofishing is performed and fyke nets are placed. The eels captured are individually tagged with passive integrated transponders. Morphometric measurements such as total length, weight, length of pectoral fins and eye diameters allowed to determine the stages of eels. As their migration can be compromised by their health state, eel blood samplings are also made on each fish in order to evaluate the physiological and immunological state of the stock. The results of thyroïd hormones (T3 and T4), growth hormone (GH) and Insulin Like Growth Factor 1 (IGF1) measurements will be compared with the stages previously defined. Lysozyme and complement activities measurements will give us some indications on the health state of fish individuals. The detection of herpesvirus (HVA) is also done in each fish (Roland and Kestemont, 2014).

Eel samplings have been done in 56 stations distributed along the Lesse sub-basin (Figure 12). Among these sites, 22 are located on the Lesse River itself; the other 34 sites are located on Lesse tributaries. In total, 14 Lesse tributaries were used for eel sampling (Ri des Forges, Iwène, Hileau, Rau d'Avène, Rau du Godelet, Biran, Wimbe, Rau de Fenffe, Vachau, Ri d'Ave, Ry de la Planche, Almache, Our and Lhomme) as well as 5 tributaries of the Lomme River (Rau de Behotte, Biran, Wamme, Masblette, and Linçon).



<u>Figure 12.</u> Map of the Lesse sub-basin with the different sampling stations. The blue squares indicate the stations that have been sampled twice.

A : Anseremme ; ANL : Anloy ; BC : Aiguilles de Chaleux ; BD : Bande ; BEL : Belvaux ; BET : Beth ; BI : Rochefort (Biran) ; BLN : Neupont (Bras de Lesse) ; BU : Bure ; CHA : Chanly ; CHA2 : Chanly (station n°2) ; DAV : Daverdisse ; EP : Eprave ; F : Furfooz ; FE : Finffe ; FE2 : Finffe (station n°2) ; FMO : Ferme de Mohimont ; FOR : Forrières ; GHAN : Han-sur-Lesse (Grottes) ; GRU : Grupont ; HAR : Harsin ; HI : Houyet (Hileau) ; HOU : Houyet ; HK : Houyet (parking kayak) ; HSL : Han-sur-Lesse ; HUL : Hulsonniaux ; IW : Houyet (Iwène) ; J : Jemelle ; J2 : Jemelle (station n°2) ; J3 : Jemelle (station n°3) ; LES : Lesterny ; LSA : Lavaux Sainte-Anne ; MAI : Maissin ; MAS : Masbourg ; MF : Masbourg-Forrières ; MIR : Mirwart ; MO : Ferme de Mohimont ; NEU : Neupont ; OCH : Ochamps ; ON : On ; PAL : Pont-à-Lesse ; PAV : Pont d'Havène ; PAV2 : Pont d'Havène (station n°2) ; RA : Rau d'Avène ; RAV : Ri d'Ave ; RBE : Rau de Behotte ; RES : Resteigne ; RF : Ri des Forges ; RGO : Ruisseau du Godelet ; RO : Rochefort ; RO2 : Rochefort (station n°2) ; RPL : Rau de la Planche ; VA : Villers-sur-Lesse (Vachau) ; VIL : Villance ; VL : Villers-sur-Lesse ; Wi : Villers-sur-Lesse (Wimbe) ; WAN : Wanlin ; WB : Wanlin (Biran).

Among these 56 stations, 10 contained a large number of eels and have been sampled twice, in order to study the growth of eels sampled at two occasions as well as the possible changes in developmental stage and physio-immunological status: Pont-à-Lesse, Aiguilles de Chaleux, Furfooz, Pont d'Avène, Wanlin, Han-sur-Lesse, Belvaux, Resteigne, Neupont et Maissin.

In total, 213 eels were captured and tagged during the sampling campaign (from Autumn 2013 to Autumn 2015), distributed on 21 stations only Except 2 eels, all fish were sampled in stations located on the Lesse River itself. Twelve eels were also sampled in Anseremme, close to the River Meuse, during the samplings aiming to investigate the downstream migration pattern of eels in the Lesse River. Thus, the grand total of captured and tagged eels is 225. The most abundant captures were done in the lower part of the Lesse, with 23 eels at the Aiguilles de Chaleux et 30 eels at Furfooz, in 2013. In 2014, 24 eels were also sampled at Belvaux (Higher section of the Lesse River). No eels were caught in the Lhomme River, the main tributary of the Lesse River, as well as in the tributaries of the Lhomme River,

The density, estimated by the Petersen method, varied between 28 and 800 eels/ha and the biomass ranged from 29.5 à 720.3 kg/ha (Table X). However, in most cases, the Petersen method was not applicable, due to the lack of recapture.

As mentioned above, 10 stations were sampled twice, with the same sampling methodology. For each station, the Schnabel method, adjusted by Chapman (1952), was used, as follows.

$$Nt = \sum (Ci * mi) / (R + 1)$$

where Nt is the number of fish in the population ; Ci, the number of fish of the i sampling; mi, the number of fish tagged just before the i sampling et R, the total number of tagged fish recaptured in the station after n successive samplings.

Based on this method, a density ranging from 31 to 298 eels/ha was calculated (Table 10).

Table 10. Number of eels captured and re-captured in each station and by each sampling method, estimated densities and estimated biomass per station.

Code station	River	Year	Capture D0	Capture D2		Recapture	Total number of fish	Estimated number of fish	Density (n/ha)	Biomass (kg/ha)
			Electrofishing	**Electrofishing**	**Fyke nets**					
PAL	Lesse	2013	0	0	3	0	3	N.A.	N.A.	N.A.
		2015	0	0	2	0	2	N.A.	N.A.	N.A.
BC	**Lesse**	**2013**	**8**	**6**	**11**	**2**	**23**	**92**	**409**	**348,4**
		2015	**3**	**2**	**3**	**1**	**8**	**24**	**107**	**100,7**
F	**Lesse**	**2013**	**8**	**1**	**22**	**1**	**30**	**240**	**800**	**720,3**
		2015	4	1	12	0	17	N.A.	N.A.	N.A.
HUL	Lesse	2015	0	0	11	0	11	N.A.	N.A.	N.A.
HOU	Lesse	2014	0	0	3	0	3	N.A.	N.A.	N.A.
HK	Lesse	2014	0	0	5	0	5	N.A.	N.A.	N.A.
HI	Hileau	2014	1	0	0	0	1	N.A.	N.A.	N.A.
VL	Lesse	2013	1	1	0	0	2	N.A.	N.A.	N.A.
PAV	Lesse	2014	0	0	5	0	5	N.A.	N.A.	N.A.

		2015	0	0	2	0	2	N.A.	N.A.	N.A.
WA	Lesse	2014	0	0	6	0	6	N.A.	N.A.	N.A.
		2015	0	0	2	0	2	N.A.	N.A.	N.A.
Wi	Wimbe	2013	0	0	1	0	1	N.A.	N.A.	N.A.
HSL	Lesse	2014	0	0	8	0	8	N.A.	N.A.	N.A.
		2013	0	0	6	0	6	N.A.	N.A.	N.A.
GHAN	Lesse	2014	0	0	2	0	2	N.A.	N.A.	N.A.
BEL	**Lesse**	**2014**	**4**	**1**	**21**	**2**	**24**	**48**	**96**	**93,6**
		2015	1	2	11	0	14	N.A.	N.A.	N.A.
RES	Lesse	2014	0	1	4	0	5	N.A.	N.A.	n.a.
		2015	0	0	6	0	6	N.A.	N.A.	n.a.
CHA	**Lesse**	**2014**	**2**	**0**	**4**	**2**	**4**	**4**	**200**	**171,3**
CHA (2)	**Lesse**	**2015**	**7**	**0**	**5**	**5**	**7**	**10**	**98**	**90,3**
NEU	**Lesse**	**2014**	**5**	**0**	**4**	**3**	**6**	**10**	**28**	**29,5**
		2015	0	0	8	0	8	N.A.	N.A.	N.A.

MO	Lesse	2015	0	0	2	0	2	N.A.	N.A.	N.A.
BLN	Lesse	2014	1	0	0	0	1	N.A.	N.A.	N.A.
MAI	Lesse	2014	2	1	0	0	3	N.A.	N.A.	N.A.
		2015	**2**	**0**	**6**	**1**	**7**	**14**	**400**	**346,7**

Table 11. Number of eels captured and re-captured in the 10 stations sampled twice and by each sampling method, estimated densities and estimated biomass per station.

Code station	Capture year 1		Capture year 2		Total number of recapture	Total number of fish	Estimated number	Density (n/ha)
	Electrofishing	Fyke nets	Electrofishing	Fyke nets				
PAL	0	3	0	2	0	5	N.A.	N.A.
BC	**12**	**11**	**4**	**3**	**4**	**29**	**67**	**298**
F	**9**	**21**	**5**	**12**	**8**	**40**	**83**	**277**
PAV	0	5	0	2	0	7	N.A.	N.A.
WA	0	6	0	2	0	8	N.A.	N.A.
HSL	0	8	0	6	0	8	N.A.	N.A.
BEL	**5**	**19**	**3**	**11**	**5**	**35**	**73**	**146**
RES	**1**	**4**	**0**	**6**	**4**	**7**	**6**	**31**
NEU	**5**	**1**	**0**	**8**	**4**	**13**	**14**	**39**
MAI	**3**	**0**	**2**	**5**	**3**	**8**	**10**	**286**

9.3 Silver eel

Information on the migratory behaviour of silver eel in estuaries is scarce. Therefore, more insight is needed to efficiently restore and conserve the species. We tracked 47 eel with acoustic telemetry between July 2012 and December 2015 and analysed their behaviour from the Braakman creek into the Scheldt Estuary, separated by a tidal barrier. Eels arrived in the Braakman between mid-summer and early winter and showed searching behaviour, resulting in significant delays before entering the Scheldt estuary. The long residence time in the Braakman was probably due to the discontinuous operation of the tidal barrier, resulting in a irregular flow condition, to control the water level in the upstream located wetland area. Eventually the majority of the eel did pass the sluice and reached the Scheldt Estuary. In the Scheldt Estuary, eels migrated towards the sea, however, a minority took the opposite direction. These eels might show estuarine retention behaviour. Moreover, the relation between the migratory behaviour of the tracked eels and environmental conditions like tidal currents, flow, water temperature, light intensity and precipitation were analyzed. Preliminary results indicate that eel migration is obstructed by a tidal barrier and resulted in delayed eel migration. The information obtained by this study can be implemented in management plans such as environmental windows to open the sluice during eel migration if circumstances allow such measurements (Verhelst, work in progress).

The exact migration routes of European eel in estuaries and the marine environment are still unknown. To unravel these mysterious routes, 30 eels were tagged in 2015 with acoustic transmitters 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. By unravelling the migration routes and accompanied behaviour, a better estimation about the fate of the marine migrating silver eels from the Scheldt River can be made. The results of this study will be useful for management measures for the conservation and restoration of the eel stocks (Verhelst, work in progress).

See under 9.2 for information on a EFF research project assessing downstream migration of silver eel at the confluence of the Lesse and the Meuse.

de Canet et al. (2014) estimated the actual and historical eel stock and escapement to the sea estimated for French and Belgium Meuse by applying the EDA.2.0 model (Jouanin et al., 2012, Eel Density Analysis). A total of 19 980 yellow eels and 1000 silver eels was estimated in 2013 in the Belgian part of the Meuse. This number is 5.8 times lower than the estimated number in 1980. Eel presence and abundance are decreasing linearly with the distance to the sea and the cumulative height of dams. As part of this work, a first attempt to estimate the anthropogenic mortality and biomass according to a pristine state has provided some results. However the lack of data and proper biological parameters limited the results to plots used to illustrate the possible outputs. The numbers estimated by the model are fairly lower than previous estimates for this area, and the reasons for this result are discussed.

10 Data collected for the DCF

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.

See Section 11.1 for data on length and weight gained from research sampling.

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

11 Life history and other biological information

11.1 Growth, silvering and mortality

Von Bertalanffy parameters: Linf, K, t0

L50 = the length at which 50% of the population has silvered (my interpretation of 50% maturity)

Length and age at silvering

Fecundity

Weight at age

Length/weight relationship

Length and weight and growth (DCF)

Flemish Region

Length and weight data of individual eel collected through the freshwater fish monitoring network are available via the website http://vis.milieuinfo.be/.

An analysis of the length of yellow eels per catchment has been made for the EMP and is presented there.

A length–weight relationship (W = aL^b) in eel from 17 586 individual eels recorded has been published by Verreycken *et al.* (2011). See also the 2014 Belgian Eel Country Report (Belpaire et al. 2014) for more details.

Results from a study on head dimorphism (Ide *et al.*, 2011) are presented in the 2011 Belgian Eel Country Report (See Belpaire *et al.*, 2011) for details).

Walloon Region

An analysis of the length of yellow eels in some rivers of the Meuse catchment has been made for the EMP and is presented there.

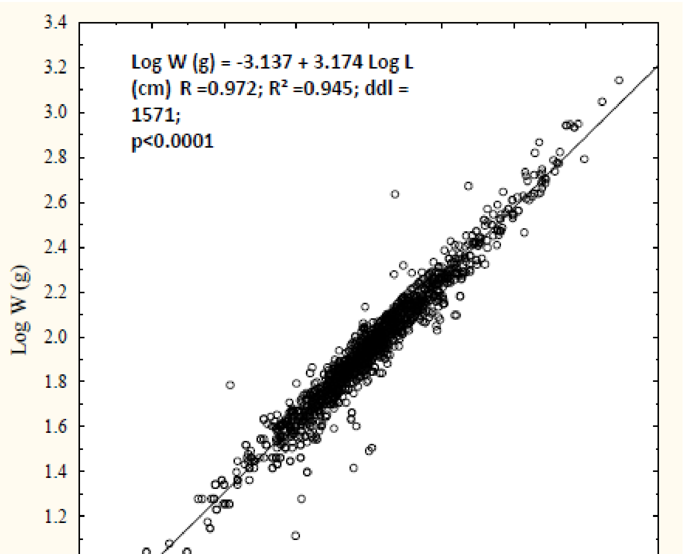


Figure 13. Length–weight relation of yellow eels (n = 1572, size range 19.6-88.5 cm) sampled at the Visé-Lixhe dam in the period 1992–2014.

Nzau Matondo *et al*. (2015a) describe the length–weight relationship of ascending yellow eels using the equation $W = aL^b$ and logarithmically transformed into $\log_{10}$ (W) = $\log_{10}$ (a) + b $\log_{10}$ (L) at the Visé-Lixhe in Wallonia. The equation was based on 1572 individual eels recorded for total length and weight is shown in Figure 10.

Lesse River sub-basin

Below are presented the main characteristics of the eels sampled from 2013 to 2015 in the Lesse River sub-basin.

Silvering stages

Among the 225 eels sampled in the Lesse River sub-basin, 44 (19.6 %) were classified at the silvering stage FII, 159 (70.7 %) at the stage FIII and 10 (4.4 %) at the stage FV, while 10 eels could not be classified due to the abundance of damages. One eel was caught at the stage F1 in Chanly (CHA2) (Figure 14).

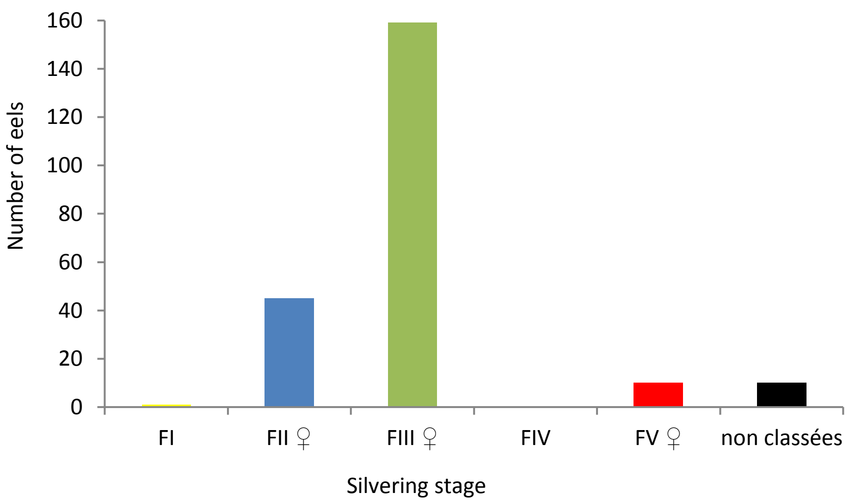


Figure 14. Number of eels at the different silvering stages (FI, FII, FIII, FV et "non classes" (unbclassified)), all stations combined (n = 226).

In the lower Lesse (i.e. between Belvaux and Han-sur-Lesse), 24.6 % of the eels (35 fish) were at the stage FII ; 67.6 % (96 fishs) at the stage FIII and 5 eels (3.5 %) at the stage FV. In the Upper Lesse, most eels were at the stage FIII (75.9 %) or 63 fish) ; 12.0 % at the stage FII (10 fish) ; 6.0 % (5 fish) at the stage FV and one fish (1.2 %) at the stage FI (Figure 15).

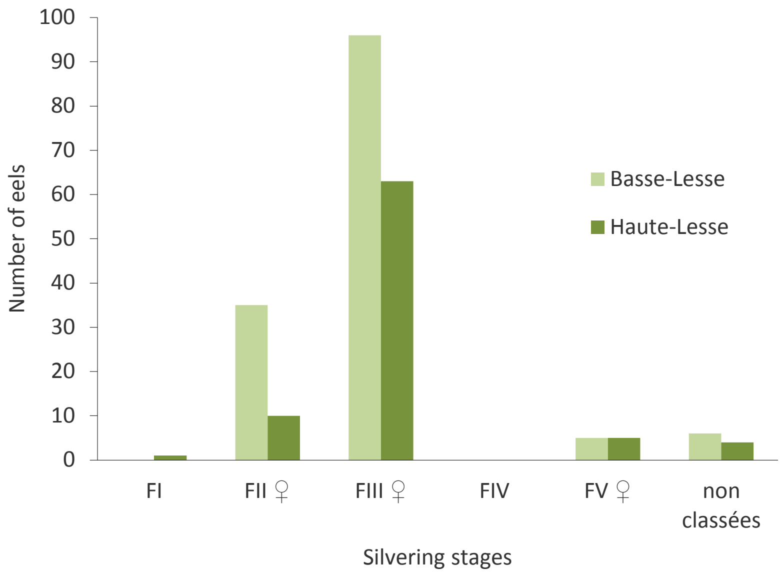


Figure 15. Number of eels of the different silvering stages (FI, FII, FIII and FV), in Lower Lesse (n = 142) and Upper Lesse (n = 83).

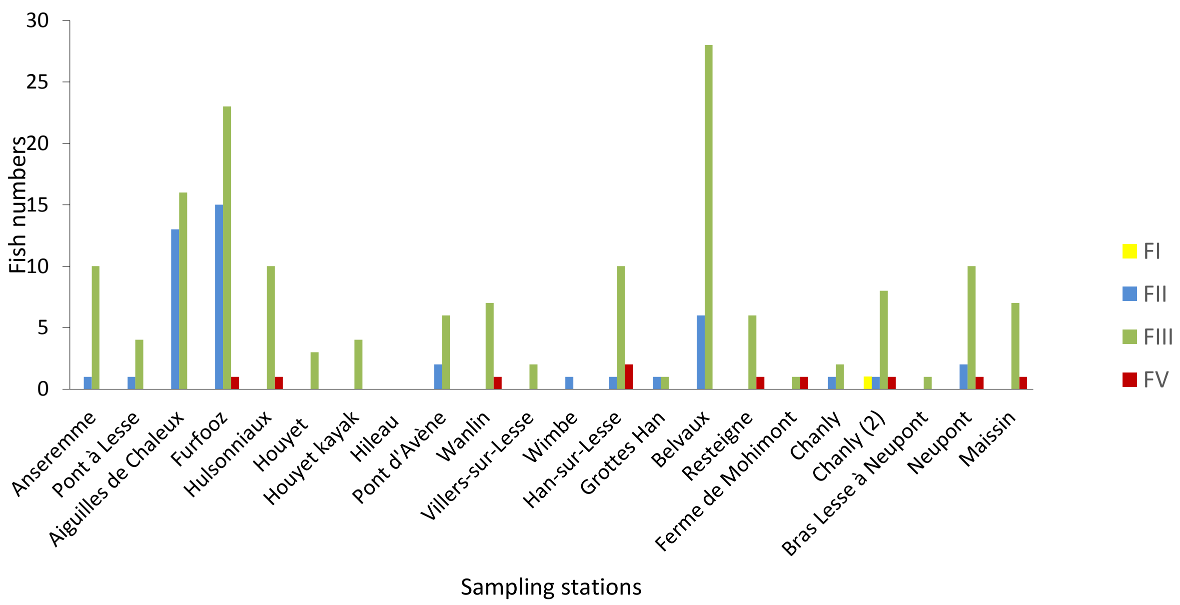


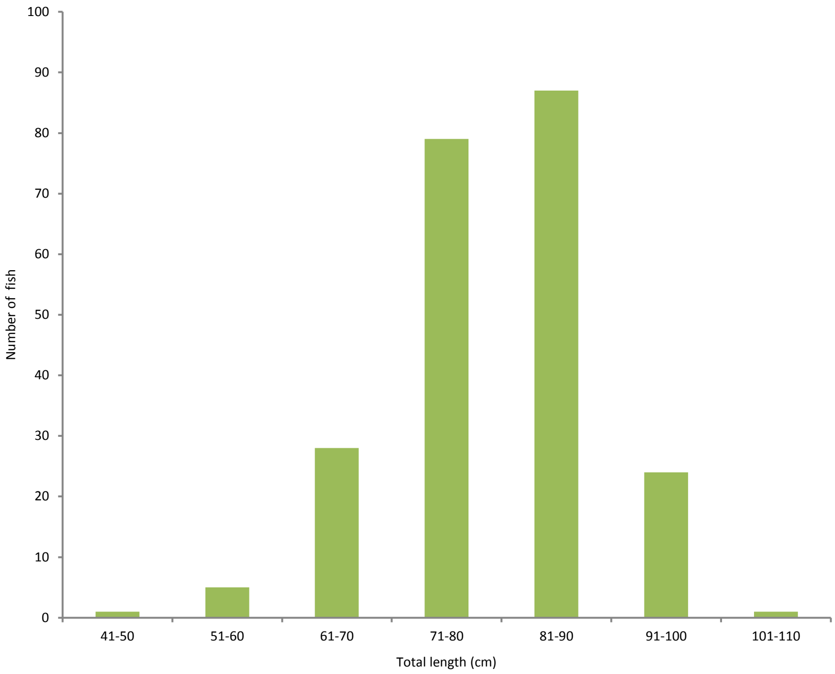
Figure 16.

Sex-ratio

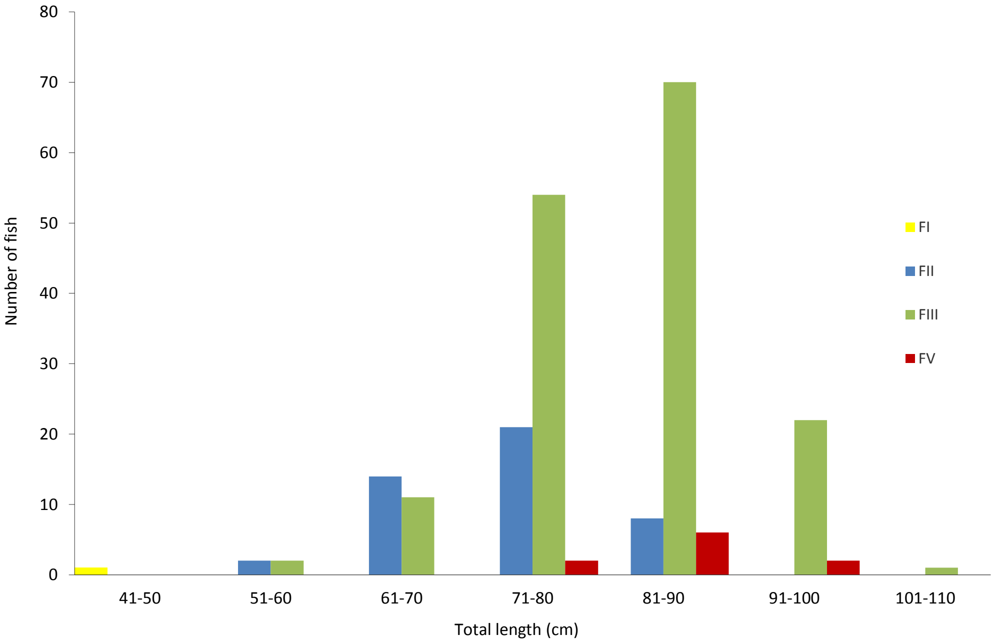
Sexual dimorphism is strongly marked in eel, and it is generally established that a body length of 46 cm is a female. The mean length of the captured eels was 79.8 ± 9.0 cm, with a minimum length of 44.5 cm (Chanly 2) and a maximum length of 105 cm (Han-sur-Lesse). At the exception of one eel with a body length below 46 cm, all sampled eels could be considered as females.

Length-Frequency Distribution

Among the 225 eels sampled in the Lesse River sub-basin, the dominant size class was the length interval 71-80 and 81-90, with 35.1 % (79 fish) and 38.7 % (87 fish) respectively. About 85 % of the eels were considered as large fish, ranging from 71 to 110 cm. The length-frequency distribution was related to the silvering stage. About 50% of eels of stage FII belong to the size class 71-80 cm while fish of stage FIII were mainly present in the size class 81-90 cm, as well as the eels of stage FV.



nt size classes



Growth

Among the 21 stations of the River Lesse sub-basin that were sampled from 2013 to 2015 and which contained eels, 10 were ampled two times. This second sampling campaign allowed recapturing 18 eels previously tagged. The table 12 shows the length, weight and silvering stage of the recaptured fish. Most fish grew of 144 to 170 g between 2014 and 2015, with a maximum of 230.3 ± 83.9 g in the Resteigne station. In 2015, most eels (13) at the same silvering stage as in 2014, while the silvering stage increased in 3 eels and decreased in 2 eels.

Table 12: Weight (g), length (cm) and silvering stage (FII, FIII, or FV) of eels recaptured in the River Lesse stations that were sampled twice between 2014 and 2015.

			2013			2014			2015		
Station	**Code individu**	**Code PitTag**	**Poids**	**Taille**	**Stade**	**Poids**	**Taille**	**Stade**	**Poids**	**Taille**	**Stade**
Furfooz	F2 = F31	00074EFB31	1192	87	FIII				1419	87	FV
	F13 = F32	00074EF78C	467	65	FII				634	69	FIII
	F26 = F35	00074DA74B	1182	87	FIII				1397	92	FIII
	F28 = F37	00074EEFBC	1207	87,1	FIII				1385	89,9	FIII
	F29 = F39	00074DB58F	677	73,7	FII				750	77,6	FII
	F30 = F40	00074D8801	666	71	FIII				850	73,9	FIII
	F20 = F44	00074F1B1E	797	76	FIII				927	79,5	FII
Aiguilles de Chaleux	BC20 = BC28	00074EFED3	921	79,4	FIII				824	81,5	FIII
Maissin	MA1 = MA6	00074F26E8				762	75	FIII	740	75	FIII
	MA2 = MA8	00074FB98D				816	75	FIII	892	77	FIII
Belvaux	BEL 15 = BEL 25	00075010FC	675	69	FIII				751	72	FIII
	BEL 21 = BEL 29	00074DE4EC	1535	87	FIII				1850	93,1	FIII
	BEL19 = BEL 31	00074D8A42	858	78	FIII				977	83,3	FIII
Resteigne	RES 2 = RES 7	00074F113E				1406	91	FIII	1608	97,5	FIII
	RES 1 = RES 8	00074F0969				1370	88	FIII	1725	93	FIII
	RES 4 = RES 9	00074F2D4D				910	76	FIII	1099	79	FV
	RES 5 = RES 10	00074ED7B0				663	72	FV	838	77	FIII
Neupont	NEU 1 = NEU 8	00074FCE31				1073	80	FIII	1285	83,5	FIII

Trophic plasticity in European eel

A recent study on the head shape of glass eels (*A. anguilla*) showed that there were already broad-headed and narrow-headed phenotypes present in this stage. However, there was still no unambiguous support for dimorphism, implying that head shape in glass eels is changing from a unimodal to a bimodal distribution (De Meyer et al., 2015). Since glass eels are non-feeding, the presence of both phenotypes should be related to other trophic segregation.

However, to assess the importance of trophic segregation, De Meyer et al. (under review) divided glass eels in three groups that were fed different diets: one got hard prey, one got soft prey and one group got both. This allowed studying diet-induced morphological plasticity of the head in European eel. We found that glass eels feeding on hard prey develop a broader general head width and specifically, a broader postorbital region than soft feeders. The postorbital region is the region where the jaw-closing adductor mandibulae can be found. A broadening of this region is therefore most likely related to a larger volume of the adductor mandibulae muscles, increasing the bite force of these eels, which could allow them to cope with the harder prey. Specimens of the group with mixed diet developed a wide variation of head shapes, from broad-heads to narrow-heads. This implies that some eels prefer the hard prey, whereas other ones prefer the soft prey when the choice is given. This study thus indicates that, while head shape is not completely determined by it, trophic segregation still plays an important role. Next to this, trophic segregation was commonly studied in yellow eels larger than 30 cm. This study showed, however, that differences in head shape through differences in diet can already be induced shortly after eels start to feed in the rivers, with the eels still being smaller than 10 cm.

Musculoskeletal anatomy and feeding performance of pre-feeding larvae

Bouillart et al. (2015) studied the anatomy of the skull in leptocephali. Being part of the elopomorph group of fishes, Anguillidae species show a leptocephalus larval stage. However, due to largely unknown spawning locations and habitats of their earliest life stages, as well as their transparency, these *Anguilla* larvae are rarely encountered in nature. Therefore, information regarding the early life history of these larvae, including their exogenous feeding strategy and feeding performance, is rather scarce. To better understand the structural basis and functional performance of larval feeding in captivity, the functional morphology of the cranial musculoskeletal system in pre- and first-feeding engyodontic leptocephali of the European eel (*Anguilla anguilla*) was studied. A 3D reconstruction of the feeding apparatus (head of the leptocephali < 1 mm) was used to visualize and describe the musculoskeletal changes throughout these stages. To analyze the ontogenetic changes in the functionality of the feeding apparatus towards the active feeding phase, 3D data of joints, levers and muscles derived from the reconstructions were used to estimate bite and joint reaction forces (JRFs). Observing a maximum estimated bite force of about 65 µN (and corresponding JRFs of 260 µN), it can be hypothesized that leptocephalus larvae are functionally constrained to feed only on soft food particles. Additionally, potential prey items are size delimited, based on the theoretically estimated average gape of these larvae of about 100 lm. This hypothesis appears to be in line with recent observations of a diet consisting of small and/or gelatinous prey items (Hydrozoa, Thaliacea, Ctenophora, Polycystenia) found in the guts of euryodontic leptocephalus larvae.

11.2 Parasites and pathogens

Flemish Region

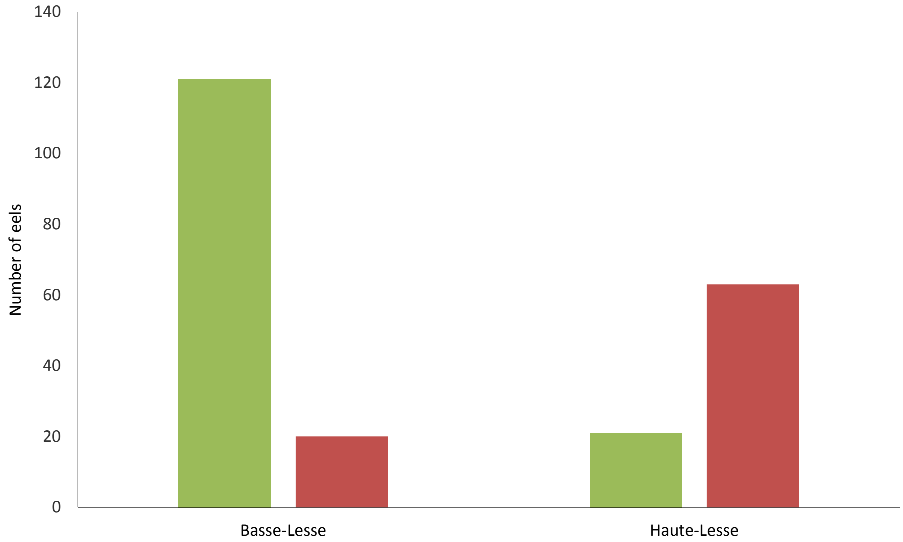
See for results on a pan European survey on the actual status of *Anguillicola* in silver eels (Faliex *et al*., 2012), 2012 Country Report (Belpaire et al., 2012).

Walloon Region

Pathological code

Within the framework of the European Decision n°1100/2007, ONEMA has set up a standardised protocol based on the sanitary guide proposed by Girard and Elie (2007). This protocol has been used to evaluate the health status of the eels sampled in the Lesse River sub-basin between 2013 and 2015. The macroscopic observations done in eels allowed one or several pathological codes to be given for each fish. All types of lesions and parasites are listed. The pathological code is attributed on the basis of the code grid, as described by Beaulaton and Penil (2009). The pathological code is composed of 4 characters: 2 characters for the lesion and parasitism, one character for the localisation and one numeric character indicating the importance of the lesion or parasitosis.

Among the 225 eels caught in the Lesse River sub-basin from 2013 to 2015, 184 (81.8%) displayed no lesions or parasites, and the code OOC0 was given. The remaining 41 eels dispayed diverse lesions. No external parasites were found. Most eels sampled in the Lower Lesse were healthy, without any lesion, while a majority of fish sampled in the Upper Lesse displayed some lesions (Figure 19).



] and
Upper (Haute) Lesse (n total = 225).

Immune markers

In order to obtain some complementary information on the health status of eels, some nonspecific immune markers (lysozyme, complement activity) as well as the presence of the eel herpes virus *Herpesvirus anguillidae* have been analysed in the plasma of eels sampled in different stations of the Lesse River sub-basin. Biomarker assays in plasma were chosen as a non invasive method to follow the health status without killing eels.

The lysozyme activity was measured in 222 eels, including 18 fish captured a second time during the second sampling campaign The mean (± S.E.M.) lysozyme activity reached 11.19 ± 0.92 U/min for the eels of silevring stage FII (n = 44), 9.97 ± 0.43 U/min for those of stage FIII (n = 158) and 12.95 ± 2.62 U/min for stage FV (n = 10) without any statistical differences between silvering stages.

The lyzozyme activity in eel plasma varied according to the station (figure X), with a statistical difference ($p < 0.05$) between the stations « Belvaux » and « Pont d'Avène ». The mean activity in fish without any damage was 10,1 ± 0.4 U/min (n = 178) while the activity reached 10.8 ± 1.1 U/min for eels with lesions (n = 26), with any difference between healthy and affected eels. Same statement has been observed between eels with and without herpes virus.

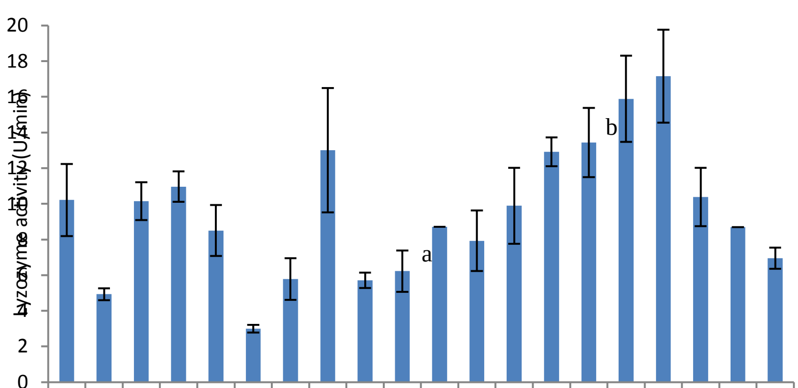


Figure 20: Mean lyzozyme activity assayed in eel plasma sampled in different stations of the Lesse River sub-basin: A (n = 12), PAL (n = 5), BC (n = 27), F (n = 37), HUL (n = 11), HOU (n = 3), HK (n = 5), VL (n = 2), PAV (n = 8), WAN (n = 8), Wi (n = 1), HSL (n = 13), GHAN (n = 2), BEL (n = 33), RES (n = 11), CHA (n = 7), CHA 2 (n = 6), NEU (n = 12), BLN (n = 1) and MAI (n = 8). (see table X for station names and locations)

The complement activity (ACH50) was assayed in 95 eels. The mean activity (± S.E.M.) reached 4429.7 ± 273.37 in eels of silvering stage FII (n = 31), 3784.5 ± 237.33 for those of stage FIII (n = 62) and 3788.1 ± 668.09 in fish of stade FV (n = 2), without significant differences between silvering stages. Based on the available data so far, ACH50 varied according to sampling stations, with a highly significant difference between the station «Belvaux » and those of « Anseremme » and « Aiguilles de Chaleux » (Figure XX). The mean complement activity did not differ between eels without and with lesions, nor between eels with and without the contamination by the herpesvirus.

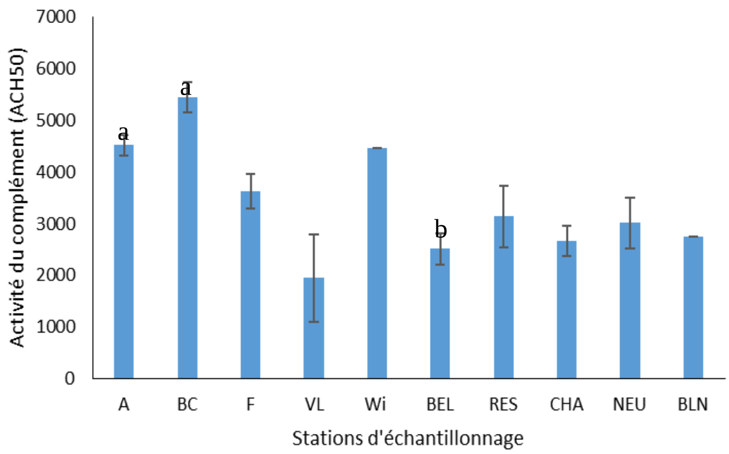


Figure 21: Mean complement activity (ACH50) assayed in eel plasma of eels sampled in 10 stations of the Lesse River sub-basin : A (n = 5), BC (n = 25), F (n = 29), VL (n = 2), Wi (n = 1), BEL (n = 18), RES (n = 4), CHA (n = 3), NEU (n = 6) and BLN (n = 1). (see table X for station names and locations)

Presence of the herpesvirus (HVA)

Based on a PCR method (table X), the detection of the eel herpesvirus (HVA) was performed in 225 eels sampled in the Lesse River sub-basin. Almost all eels (97%) are contaminated by the herpesvirus (Figure 22 A) while only 6 eels were considered as virus free, without any link a specific station. Among the 219 contaminated eels, 193 (86%) did not exhibit any specific lesion or clinical symptom of virus contamination, suggesting that the virus is present at a latent stage, without exhibiting its virulence (Figure 22 B).

Table 13: Sequences of the external probes used for the DNA amplification of *Herpesvirus anguillae* by PCR (according to Rijsewijk et al., 2005).

External probe	Sequence	Length of the amplified segment
ANGHV-1POLVPSD (forward)	5'-GTGTCGGGCCTTTGTGGTGA-3'	394 base pairs
ANGHV-1POLOOSN (reverse)	5'-CATGCCGGGAGTCTTTTTGAT-3'	

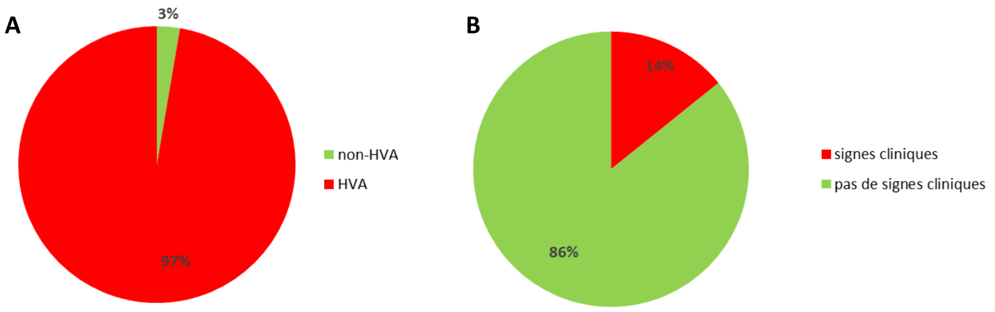


Figure 22: A) Proportion of eels contaminated by the herpes virus (HVA). In red: the percentage of contaminated eels. In green the percentage of eels free of herpes virus. B) In red, percentage of contaminated eels displaying some clinical signs. In green, absence of clinical symptoms in herpes virus contaminated eels.

All in one, it appears that most eels are contaminated by the eel herpesvirus. At this stage, this contamination does not seem to affect the health status as evaluated by nonspecific immune markers or clinical observation of HVA symptoms. Either the eels can cope in nature with the presence of such virus (reported to induce large mortalities in fishfarms) or the virus is in a latent stage without expressing its virulence. In this latter case, the situation can be considered as of real concern because the herpesvirus are well known to stay in a latent stage during a relatively long period, and then become virulent (inducing diseases and mortalities) once the fish are under a stressful condition or physiologically weak. A more in-depth study of this situation, as well as a more complete database of eel status, including more biomarkers, are needed.

11.3 Contaminants

Some recent work (recently published papers and contributions to international meetings) is summarized below.

In order to meet the requirements of Water Framework Directive, De Jonghe et al . (2014) measured bioaccumulation of hydrophobic micropollutants in muscle tissue of eel (*Anguilla anguilla*) and perch (*Perca fluviatilis*) from Flemish waterbodies. Quantified pollutants included mercury (Hg), hexachlorobenzene (HCB), hexachlorobutadiene (HCBd), Polybrominated diphenyl ethers (PBDE), Hexabromocyclododecane (HBCDD), perfluorooctane sulfonate (PFOS) and its derivates, dicofol, heptachlor and heptachlorepoxide. Measured Hg and HCB concentrations were compared between species and in time, based on historical data of eel pollutant monitoring in Flanders. In addition two polycyclic aromatic hydrocarbons (PAH), fluoranthene and benzo(a)pyrene, were measured in zebra mussels (*Dreissena polymorpha*), which were caged for six weeks. At all sample sites eel could be captured, however this was not possible for perch. For perch only (too) small individuals could be captured. An exceeding of the biota environmental quality standard (EQS) was observed for HCB, HBCDD and PFOS at some sample sites. For Hg and PBDE, biota-EQS were exceeded at all sample sites. EQS evaluation for HCB depended on fish species, since more elevated HCB concentrations were measured in eel compared to roach. Measured Hg concentrations were dependent on fish size, and strong relations were observed between Hg accumulation in eel and perch. HCB concentrations in eel were found to decrease in time. In contrast, Hg concentrations seem to increase, although measured Hg bioaccumulation was comparable with levels found in other European studies. Based on results from the present study and data from literature, biota EQS for both Hg and PBDE seem unrealistically low for Flemish and European watercourses. This study recommends eel as the most suitable species to monitor bioaccumulation of hydrophobic micropollutants in Flanders. The latter is based on both practical aspects (spatial distribution and amount of biomass) and species-specific aspects of the immature eel related to biomonitoring (sedentary, no gender issues, no reproduction). Furthermore, this study also highlights the need for intercalibration studies relating pollutant concentraties between different species (De Jonghe et al. 2014).

This assessment was continued in 2015, with the aim to report on the status of contaminants in eel and perch at 11 sites in Flanders (work in progress, collaboration University Antwerp, INBO, VMM).

Malarvannan et al (2015) investigated the levels, profiles and human health risk of organophosphorus flame retardants and plasticizers (PFRs) in wild European eels (*Anguilla anguilla*) from freshwater bodies in the highly populated and industrial Flanders region (Belgium).Yellow eels (n=170) were collected at 26 locations between 2000 and 2009 and for each site, muscle samples of 3–10 eels were pooled and analyzed (n=26). Muscle lipid percentages varied widely between 2.4% and 21%,with a median value of 10%. PFRs were detected in all pooled samples in the order of tris-2-chloroisopropylphosphate (TCIPP) > triphenylphosphate (TPHP) > 2-ethylhexyldiphenylphosphate (EHDPHP) > tris-2-butoxyethyl phosphate (TBOEP) > tris-2-chloroethylphosphate(TCEP) > tris-1,3-dichloro-2-propylphosphate (TDCIPP). The median sum PFR concentration for all 26 sites was 44 ng/g lw (8.4 ng/g ww), and levels ranged between 7.0 and 330 ng/g lw(3.5 and 45ng/g ww). Levels and profiles of PFRs in eels showed that sampling locations and river basin catchments are possible drivers of spatial variation in the aquatic environment. Median PFR concentrations were lower than those of polybrominated diphenylethers (PBDEs) and hexabromocyclododecanes(HBCDs). No correlation was observed between the PFR concentrations and lipid contents, suggesting that the accumulation of PFRs is not primarily associated with lipids. Human exposure to PFRs, due to consumption of wild eels, seems to be of minor importance compared to other potential sources, such as inhalation and ingestion of indoor dust. Nevertheless, considering the very limited data available on PFRs in human dietary items and their expected increasing use after the phase out of PBDEs and HBCDs, further investigations on PFRs in biota and human food items are warranted.

Belpaire et al. (2015) published the results of a comprehensive survey of the presence of dyes in the muscle tissue of wild yellow eel over Flanders. Dyes are used to stain inks, paints, textile, paper, leather and household products. They are omnipresent, some are toxic and may threaten our environment, especially aquatic ecosystems. The presence of residues of sixteen dyes (triarylmethanes, xanthenes, phenothiazines and phenoxazines) and their metabolites was analysed in muscle tissue samples of individual yellow-phased European eels (*Anguilla anguilla*) from 91 locations in Belgian rivers, canals and lakes sampled between 2000 and 2009 using ultra performance liquid chromatography-tandem mass spectrometry. Eel was contaminated by dyes in 77% of the sites. Malachite Green, Crystal Violet and Brilliant Green were present in 25-58% of the samples. Dye occurrence was related to the distribution of textile and dye production industries. This field study is the first large-scale survey to document the occurrence of artificial dyes in wildlife. Considering the annual amounts of dyes produced worldwide and the unintentional spillage during their use, our observations warrant additional research in other parts of the world. The presence of these highly toxic dyes in the European eel may form an additional threat to this critically endangered species. The contaminated eels should be considered as not suitable for consumption.

A workshop was organized by Belpaire (INBO, Belgium) and Haenen (CDI, The Netherlands) aiming to progress in the development of standardised and harmonised protocols for the estimation of eel quality. There were 31 participants (21 attendees and 10 remote participants) representing 13 countries. The objective of WKPGMEQ (Workshop of a Planning Group on the Monitoring of Eel Quality) was to document standardised and harmonised protocols for the estimation of the quality of the European eel *Anguilla anguilla*, with regard to the bioaccumulation of contaminants and the presence of diseases, including parasites. The report (ICES, 2015) is available at http://www.ices.dk/community/groups/Pages/WKPGMEQ.aspx. The report starts with an overview of the current eel quality assessments in the Member States, and further discusses general issues on sampling of eel quality assessments. It includes a chapter on the assessment of eel condition in terms of fitness and lipid levels. In further chapters best practices to (sub)sample, analyse, report and visualize contaminants in the eel are described. The disease sections focus on parasitic diseases (including the swimbladder parasite *Anguillicoloides*), and on viral and bacterial diseases. Possible ways to integrate data and to implement them into eel quality indices have been suggested. The workshop also discussed the future perspectives of using biomarkers of effects to assess eel health. Finally the report concludes describing the international context and future perspectives in eel health assessments. Several recommendations were made to facilitate the further development of a framework to integrate eel quality assessments into the quantitative management of the eel stock.

11.4 Predators

Flemish Region

Information on the occurrence and distribution of the cormorant has been provided for Flanders in the Belgian EMP.

It was estimated that the yearly consumption of eels by cormorants amounts 5.6–5.8 tonnes for Flanders.

Walloon Region

For the Walloon region, no new data were available. See 2008 report and the Belgian Eel Management Plan.

12 Other sampling

Information on habitat, water quality, migration barriers, turbines is available in the Belgian Eel Management Plan, and has been updated by the second EMP Progress Report (Vlietinck and Rollin, 2015).

13 Stock assessment

This section does not contain new information compared to the 2013 Country Report. Information from last year is copied here.

13.1 Method summary

Flemish Region

The EU Eel Regulation demands to report every three years on the effective migration of silver eels from the eel management units of the Meuse and the Scheldt. In a report by Belpaire et al (2015) the scientific underpinning of Flanders' figures required for the second progress report 2015 was described.

Monitoring the actual numbers of emigrating silver eel leaving river catchments is technically complex and challenging. Instead, Flanders opted to determine the migration of silver eel based on model calculations. Within each stratum *River Basin * River Type*, the total number of yellow eels was estimated based on the recorded density of yellow eel, and adjusted for various factors of natural and anthropogenic mortality. The data are supplied by Flanders' Freshwater Fish Monitoring Network.

More recent and more complete GIS layers allowed us to make an accurate calculation of the surface of the waters of the eel management plan.

The modified calculation is based on data collected between 2011 and 2014. The Fish Monitoring Network was reorganized in 2013 in the context of the Water Framework Directive and the Habitats Directive. This resulted in a more limited set of available data compared to the previous report with smaller sample size and larger variability, with for certain strata less representative results. Moreover, for the estimates of tidal waters, no suitable methodology is available. Also ponds and lakes remain undersampled.

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). The current model uses a more realistic estimate of the sex ratio. The model takes into account mortalities cormorant predation, fishing and effects of pumping stations and turbines. The impact of predation and sport fisheries was incorporated in the calculation model in a slightly different way compared to previous report.

The influence of different eel distribution patterns depending on river width was assessed through an exploratory analysis. The choice of the scenario for the correction of the river width in the calculation model seems to be of great influence on the end result, advocating the need for an empirical study.

A modeling study was performed to assess which habitat and water quality variables have the most impact on recorded yellow eel densities. Besides river type, oxygen and bank structure were found to be the most explanatory variables. If sufficient data became available this would allow more adequate estimations of eel densities in non-sampled waters.

The new figures clearly point to a reduction in stocks and silver eel escapement compared to the previous reporting period. With a $B_{current}$ / B_0 of 11%, Flanders is further away from the targets than during the previous reporting period. The current low figures may have been the result of low recruitment about 5-10 years ago.

On the other hand, it may not be excluded that the results also were influenced by differences in measurement strategy, data quality and calculation method. The necessary field research recommended by Stevens *et al.* (2013) was not carried out, jeopardizing sound estimates also for the current figures. Moreover, due to the reorientation of the fish monitoring efforts in the context of the WFD, significantly less data were available than for previous reporting, undermining the quality of the estimates. Additionally, the report formulates a number of recommendations.

Finally, during this project significant advancements were made to optimize future reports through the development of a custom module of database querying, and the programming of an R script to run the calculation model.

Walloon Region

See the EMP Progress Report 2015

13.2 Summary data

13.2.1 Stock indicators and Targets

*Note that not all targets may be available, for example the Reg does not set a mortality rate target. The mortality rate target from WGEEL 2012 corresponds to (0.92 if '$B_{current}/B_0$' >40%, or 0.92 * $B_{current}/(40\%*B_0)$ if '$B_{current}/B_0$'<40%)*

EMUcode	Indicator	biomass (t)	Mortality (rate)				Target		
	B0	Bbest	Bcurr	$\sum A$	$\sum F$	$\sum H$	Source	Biomass (t)	$\sum A$ (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

13.2.2 Habitat coverage

Area corresponds to the wetted area of eel-producing habitat. “A’d” asks whether or not eel are assessed in that habitat type.

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)
BE_Scheldt	8978	Y	3505*	Y	4130**	Y	/	N	/	N
BE_Meuse	987	Y	452*	Y	0	/	/	N	/	N

* Lake = WFD waterbodies type ‘lake’, including the docks of the ports of Antwerp and Zeebrugge

** Estuary = Scheldt estuary + IJzer estuary

13.2.3 Impact

For each EMU, provide an overview of the assessed impacts per habitat type or for ‘All’ habitats where the assessment is applied across all relevant habitats. Barriers includes 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*
BE-Scheldt	Riv	AB	A	A	A	A	A	Nr/MA
	Lak	AB	A	Nr	Nr	A	A	Nr/MA
	Est	AB	A	Nr	A	A/Nr	A	Nr/MA

	Lag	Nr	Nr	Nr	Nr	Nr	Nr	Nr
	Coa	Nr	Nr	Nr	Nr	Nr	Nr	Nr
	All							
BE-Meuse	Riv	AB	A	A	A	A	A	Nr/MA
	Lak	AB	A	Nr	Nr	A	A	Nr/MA
	Est	Nr	Nr	Nr	Nr	Nr	Nr	Nr
	Lag	Nr	Nr	Nr	Nr	Nr	Nr	Nr
	Coa	Nr	Nr	Nr	Nr	Nr	Nr	Nr
	All							

* indirect impacts were not assessed as such, but the calculated eel densities implicitely account for the current habitat conditions. i.e. the eel density in rivers is the result of water quality and habitat structures.

Express the loss in tonnes (t) for each impact per developmental stage or MI = not assessed, minor, MA = not assessed major, AB = impact absent. Where available, also report the total loss as silver eel equivalents, and explain the method used to calculate equivalents in section 13.1.

EMU code	Stage	Fish com	Fish rec	Hydro & pumps	Barriers	Restocking	Predators**	Indirect impacts*
BE_Scheldt	Glass	AB	MI	AB	MA	MA ?	MI ?	
	Yellow	AB	27	MI ?	MA	MI	5.2	
	Silver	AB	6	1.27	MI	MI	1.51	
	Silver EQ	AB						
BE_Meuse	Glass	AB	MI	AB	MA	MA ?	MI ?	
	Yellow	AB	3	MI ?	MA	MI	0.58	
	Silver	AB	0.7	0.24	MI	MI	0.18	
	Silver EQ	AB						

* See previous table

** Predation by cormorants. Scheldt = 90% of total silver eel biomass in Flanders → impact of predation calculated for Meuse & Scheldt together and then divided over both basins according to their contribution to overall biomass.

13.2.4 Precautionary Diagram

13.2.5 Management Measures

No new information compared to last year's report.

13.3 Summary data on glass eel

See chapters 3.1.1 and 3.5.1.

14 Sampling intensity and precision

No new data available.

15 Standardisation and harmonisation of methodology

No new data available.

15.1 Survey techniques

15.2 Sampling commercial catches

15.3 Sampling

15.4 Age analysis

15.5 Life stages

Wallonia

Nzau Matondo *et al*. (2015a) report the absence of young eel stage in upstream migrant eels during the season 2013. From a sample of 50 ascending yellow eels (range size 31.6-77.5 cm, median 42.1 cm) at the Visé-Lixhe dam, eels showed a wide range of life stages, with a higher proportion of eels (80%, range size 31.6-74.6 cm) belonging to the yellow eel stage. A lower proportion of eels (6%) had a larger size (range size 72.4-77.5 cm) and presented an advanced continental silvering process corresponding to the migrating stage before their transatlantic migration. Between these two ecophases, there are eels (14%, range size 37-69 cm) that were neither yellow, nor quite silvery, but probably in transition phase between yellow eels and silver eels.

15.6 Sex determinations

15.7 Data quality issues

16 Overview, conclusions and recommendations

Recent (2011–2015) data from recruitment-series or other scientific stock indicators in Belgium indicate a further decrease of the stock, although the glass eel recruitment at Nieuwpoort (River Yzer) showed an increase within recent years (especially in 2012-2014). After significant higher glasseel recruitment in 2014, this year's (2015) data dropped back to similar values as 2012-2013. The monitoring series of ascending young yellow eels trapped at the fish trap of the Visé-Lixhe dam between 1992 and 2015, showed the lowest catches for 2015 since the start of the series.

Special fisheries management actions to restore the stocks in Flanders are confined to the prohibition of the semi-professional fyke fisheries in the Lower Scheldt. In the Walloon region eel fishing is prohibited to avoid human consumption of contaminated eels. In Flanders the eel has been listed as *Critically Endangered* on the Red List of Fishes.

In Flanders, restocking practises with glass eel are going as in former years. Glass eel restocking activities are not taking account of the variation in eel quality (diseases/contamination) of the restocking sites. Due to failure of the supplier, no glass eel could be stocked in Flanders in 2015. In the Walloon Region restocking with glass eel has been initiated in 2011 and in 2012, but was temporarily stopped in 2013 for financial reasons. As in Flanders, the Walloon region was faced with failure of the supplier. As a result no glass eel was stocked in Belgium in 2015.

In Belgium, habitat and water quality restoration is a (slow) ongoing process within the framework of other regulations, especially the Water Framework Directive and the Benelux Decision for the Free Migration of Fish (which has been reformulated in 2009). Numerous migration barriers, pumps and hydropower stations still affect the free movement of eels and many rivers and brooks still have an insufficient water quality to allow normal fish life. Measures have been taken to enhance the migration of glass eel at the seas sluices, by adapted sluice management.

Specific programs for eel sampling and other biological sampling for stock assessment purposes of eel as required in the context of the Belgian EMP have been initiated and are ongoing in Wallonia under cofunding of EFF.

Some research programs focusing on habitat, migration and eel quality are being initiated or ongoing. Several scientific results have been published. A pilot project to monitor contamination in eel and perch for reporting about the chemical status of water bodies within the WFD has been reported in Flanders in 2014, and is currently implemented.

Recommendations

It is recommended that the sampling programmes as required in the Belgian EMP and the European restoration plan is initiated as soon as possible.

Considering further downward trend of most stock indicators, additional protection of the local stock is required. In the Walloon Region the harvest of eels by recreational fishermen is prohibited for human health considerations (as the eels are contaminated). Similarly Flanders could envisage the same management option. Eels from many places in Flanders are considerably contaminated and their consumption presents risks for human health. Furthermore apparently recreational fishermen are not reluctant for a limitation in eel fishing.

Putting in place a catch and release obligation in Flanders would save 30 tons of eel on annual basis.

Issues regarding the difficulties to purchase glass eel for restocking should be considered on international scale.

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