Report on the eel stock and fishery in

Belgium

2006

BE.A Authors:

Claude Belpaire

Research Institute for Nature and Forest (INBO)

Duboislaan 14, 1560 Groenendaal-Hoeilaart, Belgium

Tel. +32 +32 2 658 04 11. Fax : +32 2 657 96 82

Claude.Belpaire@inbo.be

Serge Gomes da Silva, Groupe d'Intérêt pour les Poissons, la Pêche et l'Aquaculture (GIPPA), Av. Maréchal Juin 23, B-5030 Gembloux

Thierry Demol, Groupe d'Intérêt pour les Poissons, la Pêche et l'Aquaculture (GIPPA), Av. Maréchal Juin 23, B-5030 Gembloux

Kristof Vlietinck, Agency for Nature and Forest, Brussels

Gerlinde Van Thuyne, Research Institute for Nature and Forest (INBO), Duboislaan 14, 1560 Groenendaal-Hoeilaart, Belgium

Geert Goemans, Research Institute for Nature and Forest (INBO), Duboislaan 14, 1560 Groenendaal-Hoeilaart, Belgium

Caroline Geeraerts, Research Institute for Nature and Forest (INBO), Duboislaan 14, 1560 Groenendaal-Hoeilaart, Belgium

Els Cuveliers, Katholieke Universiteit Leuven, Laboratory of Aquatic Ecology, Ch. De Beriotstraat 32, 3000 Leuven

Jean-Claude Philippart, Laboratoire de Démographie des Poissons et Hydroécologie, Unité de Biologie du Comportement, Institut de Zoologie, Département des Sciences et Gestion de l'Environnement, Université de Liège, Quai van Beneden 22, 4020 Liège, Belgique

Reporting Period: This report was completed in August 2007, and contains data up to 2007.

BE.B Introduction

This report is written in preparation of the EIFAC/ICES Working Group on Eel meeting at Bordeaux (3 - 7 september 2007).

BE.C Fishing capacity

Professional coastal and sea fisheries.

Following a global European downward tendency, the Belgian fishing fleet consisted in 2005 of a total of 121 motorized vessels, with a total power of 65643 kW and a gross registered tonnage of 22 694. The national fishing fleet represents 0.1 % of the European fleet, 1.1% of the European tonnage and 0.9% of total engine power (2005 data)(EC, 2006). The fleet consists mostly of beam trawlers, the remainder being otter trawlers. There are data available on fishing effort.

Estuarine fisheries on the Scheldt.

Fishing capacity has decreased last 5 five years. The estuarine Scheldt fisheries around 2000 was performed by 2 boat trawlers (one beam trawler and one otter trawler) and by ca 30 semi professional fishermen fishing with fykes (estimated at 150 fykes). The trawl fisheries was focused on eel, but recently boat fishing has been prohibited, and only fyke fishing is permitted. The number of licensed fyke fishermen has decreased to seven (in 2005 and 2006)(Fig. BE.1). Including possible poaching we may estimate the number of eel fishermen with fykes on the Scheldt on ten, which means that maximum ca 50 fykes are used along the estuarine river.

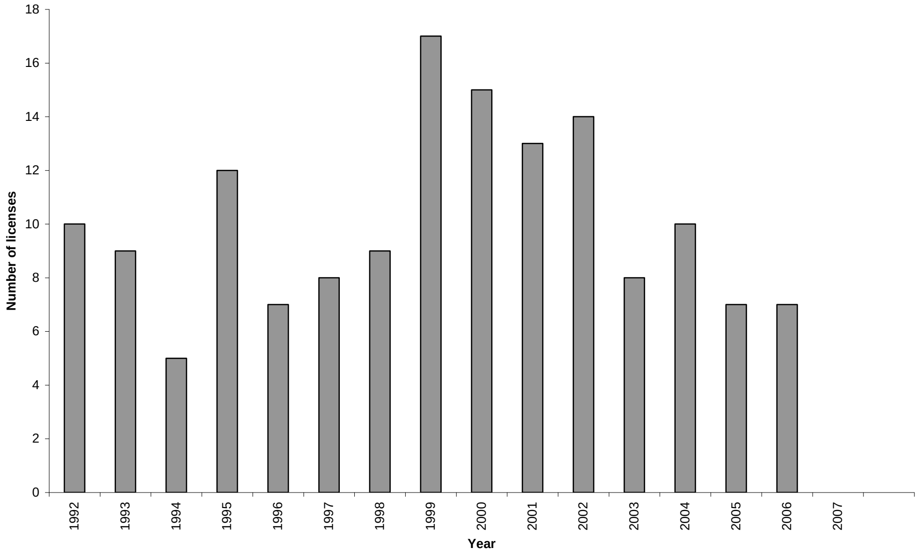


Fig. BE.1 Time series of the number of licensed semi professional fishermen on the Scheldt from 1992 to 2004 (Data Section Forest and Green, AMINAL).

Recreational fisheries in the Flemish Region.

The number of licensed anglers was 60 520 in 2004, 58 347 in 2005 and 56 789 in 2006. The time series shows a general decreasing trend from 1983 (Fig BE.2). From an inquiry among anglers it was estimated that ca 8% were eel fishermen (Vandecruys, 2004).

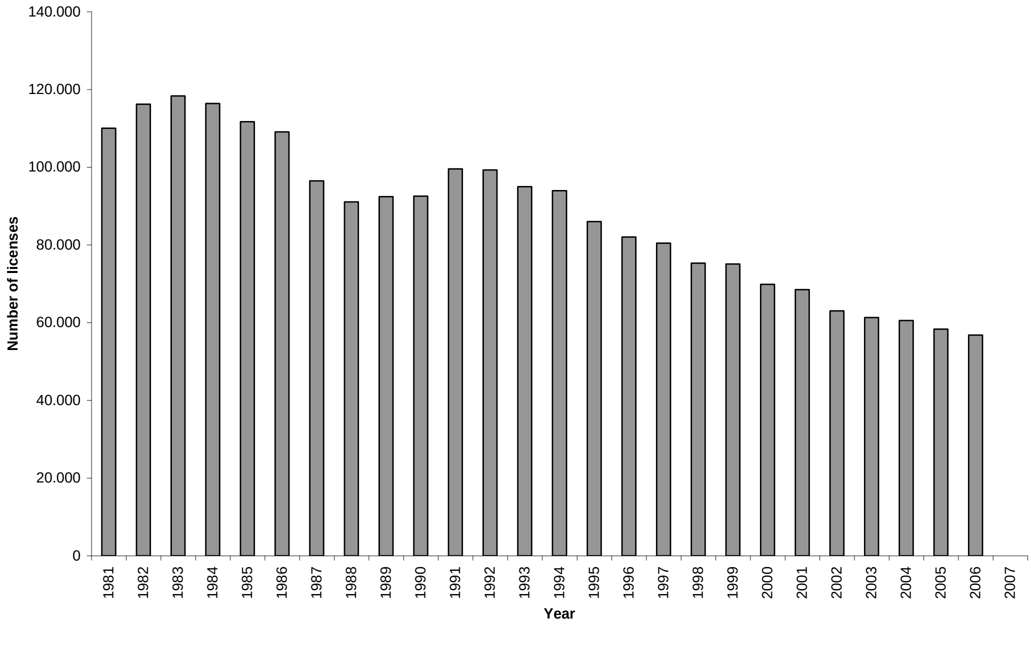


Fig. BE.2 Time series of the number of licensed anglers in Flanders from 1980 to 2006 (Data Data Agency for Nature and Forests).

Recreational fisheries in the Walloon Region.

Although in constant decline since the nineties, fishermen are still a well represented community in the Walloon region. The number of licensed anglers was 65 687 in 2004. For the year 2006, 59489 fishing licenses were attributed for fishing activity in rivers, ponds and lakes. In addition, according to estimations given by the Nature and Forestry Division (DNF) of the Walloon Environment and Natural Resources DG (DGRNE), approximately 50000 persons exercise fishing activity in private waters and closed ponds dedicated to recreational angling (Fig.BE.3).

Fig. BE.3 . Number of fishing licences issued in the Walloon region since 1995 (Source MRW-DGRNE-DNF)

Recreational fisheries in the Brussels-Capital.

The number of licensed anglers is approximately 1 400 (Data Brussels Institute for Management of the Environment).

In total, there are approximately 118 000 licensed recreational fishermen in Belgium for 2006. It was not possible to split out this information per RBD, however this is feasable as databases exist concerning the localities where licenses were emitted.

BE.D Fishing effort:

No specific data. See also under BE.E

BE.E Catches and Landings:

Professional coastal and sea fisheries

Professional coastal and sea fisheries are of minor relevance as this fisheries is targeted on sole, plaice, turbot and cod, and by-catch of eels is of minor importance. Eel catches are small and unpredictable. Usually these eels are sold directly on the quay. Only exceptionally, eels are presented for selling in the fish market and reported in these statistics.

Estuarine fisheries on river Scheldt

No official landing statistics for the fyke fisheries are available. On the basis of some fishermen's logbooks and on the basis of CPUE data on scientific monitoring (see BE.F) the total landings of eels by fyke fishermen were roughly estimated at 5 tonnes per year around 2000. Considering the decrease in fishing capacity it may be roughly estimated that the catch now is between 1 and 2 tonnes per annum.

Recreational fisheries

Recreational catches of eels are not recorded, data exist on number of licenses per region, and results of inquiries.

As will be clear from the information below there is a big gap in knowledge concerning the recording of eel landings from recreational fisheries in Belgium. Data available are only rough estimates.

Recreational fisheries in the Flemish Region.

There are no official data about the catches of eels. A recent estimate of the total amount of fish (all species) taken from Flemish waters by recreational anglers was 431 tonnes. 28% or 121 tonnes of the total number of extracted fish are eels (De Vocht and De Pauw, 2005). However, the catches and the number of extracted eels have been considerably influenced by a catch and release obligation for eels. This law was brought out as a result of the high PCB levels measured in most Flemish eels.

Another estimate can be deduced from data from Bilau et al, (2007). In 2003, 61,245 individuals in Flanders had a fishing license for public waters. A survey on specific aspects of recreational fisheries, including the issue of taking home a catch, was carried out (Vandecruys, 2004). The survey included questions on the fish species caught and taken home as well as the number and the weight of the fish caught and taken home. A total number of 3,001 of the licensed anglers (out of 9,492 contacted) completed a questionnaire about recreational fishing. Respectively 1.9% and 5.3% of these anglers indicated that they "always" (group A) or "sometimes" (on average: 1 out of 5 eels caught)(group B) take home the eel they have caught. Based on extrapolation to all licensed fishermen, the number of people taking home the eel, caught in Flemish public waters is estimated to be 4,429 (7.2% of licensed anglers). Considering the catch and release obligation for eels in all public waters in Flanders, this is a high proportion, and an underestimate of the situation where all eels may legally taken home.

Based on the number of fishing occasions (average of 41.67 and 42.03 trips/y, respectively for group A and B), the number of eels caught per occasion (average of 4.14 and 3.12, respectively for group A and B) and a mean weight of edible portion per eel (150 g), it has been calculated that individuals in group A take home on average 25.9 kg of edible eel per year or a mean of 498 g/week. For group B it was calculated to be 3.9 kg per year or 76 g/week (Bilau et al, 2007). The total estimate for Flanders is thus 43 tonnes of eels per annum, which is approximately one third of the estimate by De Vocht and De Bruyn (2005)(Tab. BE.1).

Table BE.1 Rough estimate of the catch of recreational fisheries in Belgium

Country		drainage area km2		Estimate for the 1.9% or 1164 anglers each taking 25.9 kg eel per annum	Estimate for the 5.3 % or 3246 anglers each taking 3.9 kg per annum	Total estimate	
BE	Flanders	13.521		30148	12659	42807	
	Wallonia	16.845		no data	no data	no data	
	Brussels	162		no data	no data	no data	
BE	sum	30.528					

Recreational fisheries in the Walloon Region.

There are no official estimates about the catches of eels in the Walloon region. Precise quantitative figures of fishing catches in the Walloon region are thus lacking, however, species submitted to heavier fishing are identified. These are: the brook trout (*Salvelinus fontinalis*), the roach (*Rutilus rutilus*), the pike (*Esox lucius),* the perch (*Perca fluviatilis*) and the common carp (*Cyprinus carpio*). A 2002 survey estimated that 8% of the anglers never catch any eels and 33% sometimes catch them. More then half the anglers catch them and the others rarely. In 61% of the fishing occasions one eel is caught, in 26% of the cases two are caught, in 11% of the cases 3 eels are caught. In 1% of the fishing occasions more then 3 eels are caught. 63% of the eels are eaten. (Data from an inquiry from the Federation of Anglers in Wallonia).

In the Walloon region, fishing of eels is prohibited since 2006 (Walloon Governement, 2006). By modification of the 1954 law on fishing activities, there is now an obligation to release captured eels whatever their length. So from 2006 recreational catches of eel in Wallonia should be nihil.

Recreational fisheries in Brussels-Capital.

No information on eel catches.

BE.F Catch per Unit of Effort:

There are some data about the catch per unit of effort for the estuarine fyke fisheries on the Scheldt. These CPUE data were collected from scientific monitoring. The CPUE is strongly influenced by temporal and regional variation. Fig. BE.4 gives the trend in CPUE of estuarine fyke fishing from 1995 to 2003 in the Scheldt estuary. Additional data of other sampling stations along the estuary are available.

See also some data under BE.E.

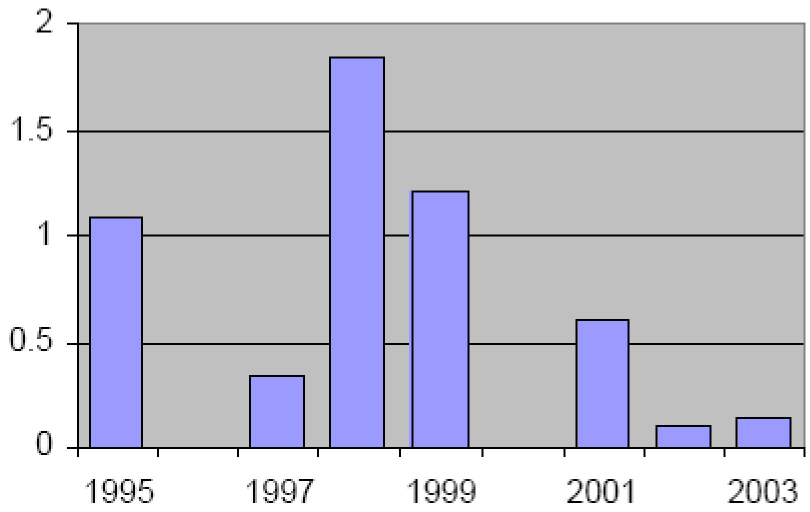


Fig. BE.4 Mean number of eel per day per fyke from 1995 to 2003 in the Scheldt estuary at Zandvliet (Maes et al., 2003)

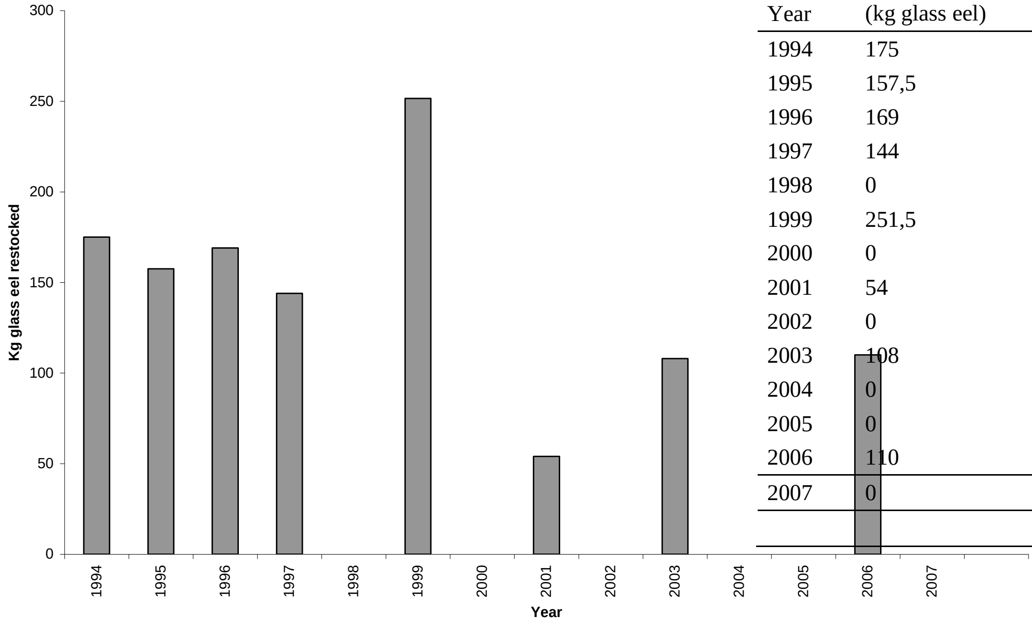
BE.G Restocking

Restocking 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).

In recent 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 (Fig BE.5 and Tab BE.2).



Year	Quantity (kg glass eel)
1994	175
1995	157,5
1996	169
1997	144
1998	0
1999	251,5
2000	0
2001	54
2002	0
2003	108
2004	0
2005	0
2006	110
2007	0

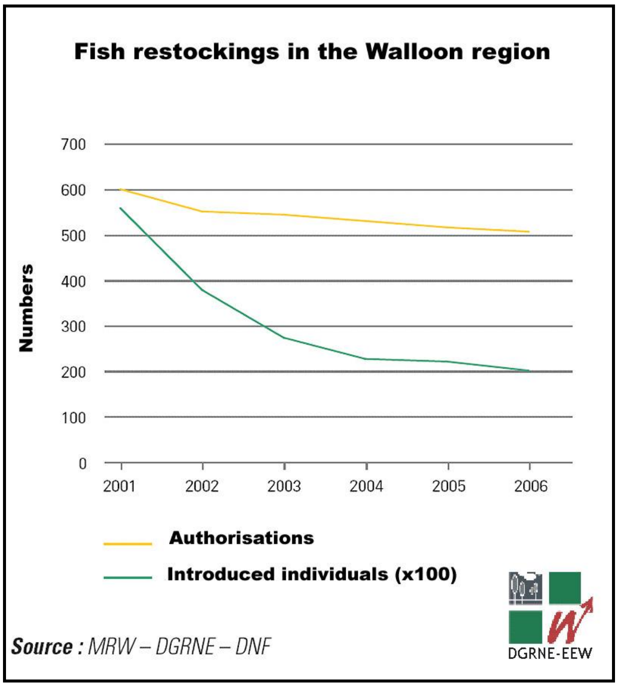
Fig BE.5 and Table BE.2 Re-stocking of glass eel in Belgium (Flanders) over the period 1994 to 2007, in kg of glasseel.

Restocking in Wallonia

Restockings of fish species in a given location are usually performed in order to enhance the biomass of the naturally occurring species, mainly for the purpose of recreational fishing. Those above-densitary restockings represent, in weight, the main part of restocking measures in the Walloon region, the concerned species for these restocking procedures are the brook trout, the roach, the rudd (*Scardinius erythrophthalmus*) and the common carp.

In 2006, 503 restocking authorisations were issued by the DNF. They concerned approximately 200000 fishes for a total weight of 150 tons. Since 2001, both authorisations and quantity of introduced fishes are in decline (Fig. BE.6) (Philippart, 2006).

No eel restocking was performed in 2006 in the Walloon region.



Figs. BE.6. Number of authorisations and quantity of fishes introduced in waterways for restocking

BE.H Aquaculture

Flanders

Allthough in recent years, two farm for intensive production of eels in recirculation systems were operating for a total production of 125 tonnes per annum (Belpaire and Gerard, 1994), nowadays eel culture has stopped completely.

Wallonia

The only eel farming society (Pi.B.A. S.A.) in the Walloon region started its activities in 2000 and ceased in 2005. No feedback was obtained from the owner or controlling authorities as to the activities and results of this society

BE.I Scientific surveys of the stock:

BE.I.1 Glass eel recruitment at Nieuwpoort at the mouth of River Yser (Yser basin).

Fisheries on glass eel is carried out by the Flemish government. The glass eels are used exclusively for restocking in inland waters. In Belgium, commercial glass eel fisheries is forbidden by law.

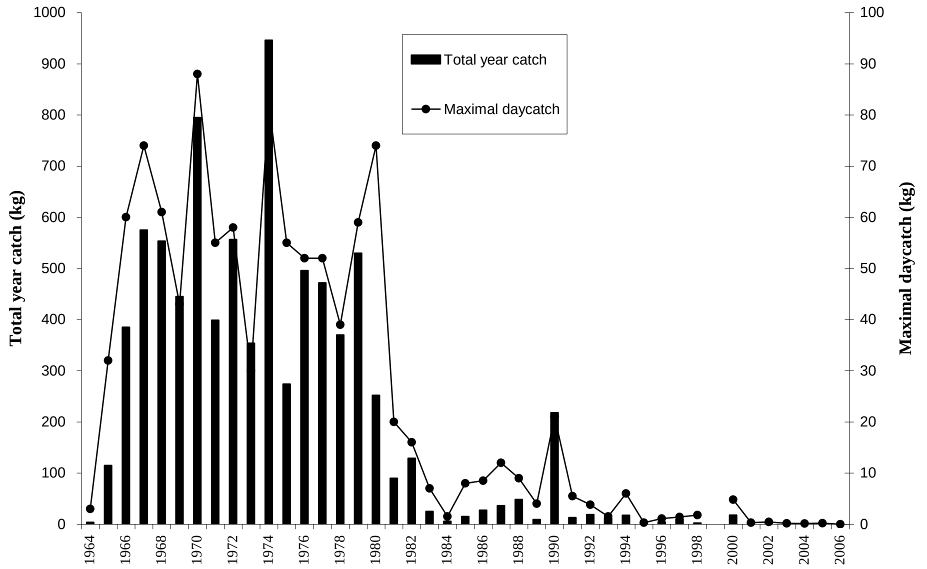
Long term time series on glass eel recruitment are available for the Nieuwpoort station at the mouth of the river Yser. Recently new initiatives have been started to monitor glass eel recruitment in the Scheldt basin.

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

Fig BE.7 and Tab BE.3 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 (Belpaire, 2006) the figure has been updated with data for 2006 and 2007.

Fishing effort in 2006 was half of normal, with 130 dipnet hauls during only 13 fishing night 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 daycatch 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 daycatch 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).



Decade Year	1960	1970	1980	1990	2000
0		795	252	218,2	17,85
1		399	90	13	0,7
2		556,5	129	18,9	1,4
3		354	25	11,8	0,539
4	3,7	946	6	17,5	0,381
5	115	274	15	1,5	0,787
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	
9	445	530	9,1		

Fig. BE.7 and Table BE.3 Annual variation in glass eel catches at river IJzer using the dipnet catches in the ship lock at Nieuwpoort (Total year catches and maximum day catch per season). In Table BE.3 the presented data are the total year catches. Data Provincial Fisheries Commission West-Vlaanderen.

BE.1.2 Eel impingement at the power station at Doel on the Lower Scheldt (Scheldt basin).

The Catholic University of Leuven is following the numbers of impinged fish at the nuclear power station of Doel on the Lower Scheldt. The numbers of impinged eels are given in Fig BE.8.

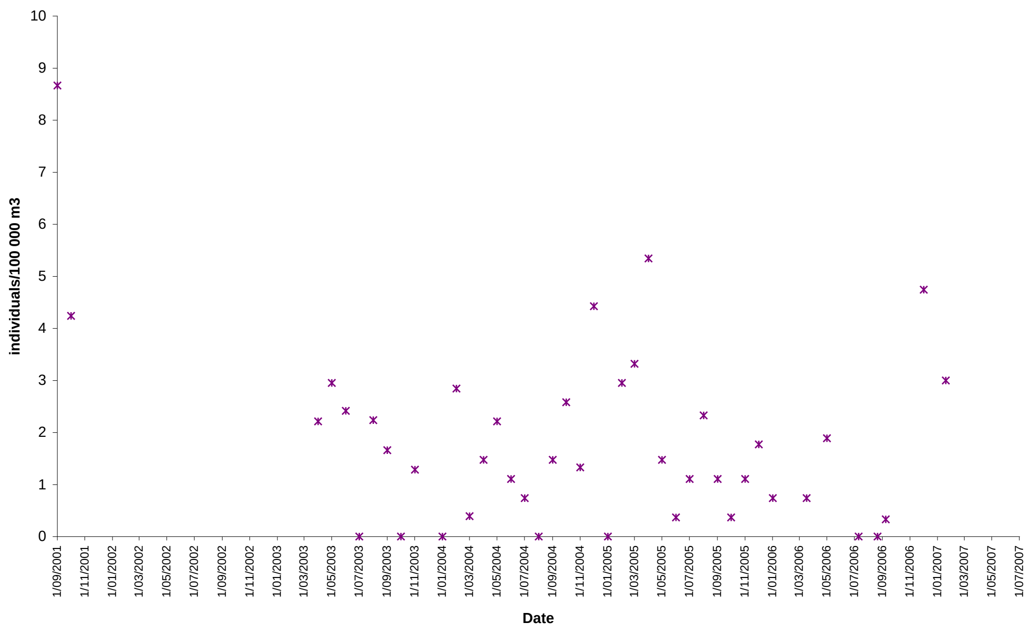


Fig. BE.8 Annual and seasonal variation in the number of impinged eels at the power station of Doel (Lower Scheldt, nearby Antwerp). Numbers are expressed as individuals impinged per 100 000 m3 water. Data Catholic University of Leuven, Laboratory of Aquatic Ecology.

BE.1.3 Eel surveys in Flanders (Yser, Scheldt and Meuse basin).

To examine temporal trends in eel stocks in Flanders an INBO dataset with eel densities from 487 sites in Flanders was used. Each site was fished with electrofishing or fykefishing during period 1 (1995-2000) and period 2 (2001-2005). Fishing procedures were standardised. From the 487 sites 124 were situated on canals and 363 on running waters.

In general, it could be concluded that the number of sites where fish was present increased from 74,7% to 82,5%, given an indication of the general increase in water quality in Flanders.

The same was found for the presence of eel. The number of sites where eel was present increased from 34% in 1995-2000 to 42.5% in 2001-2005. This increase is statistically significant. The increase is mainly due to an increase in water quality, but also the buiding of fish ladders had a positive effect on eel colonization. A striking example of the positive evolution in water quality has been the recent report by INBO of eel and other fish on the River Zenne, a river flowing through Brussels, and considered as dead since beginning of 1900.

However the densities of the eel collected both by electrofishing and by fykefishing are low. Density data even tend to decrease between period 1 and 2. The decrease is significant for the electrofishing data.

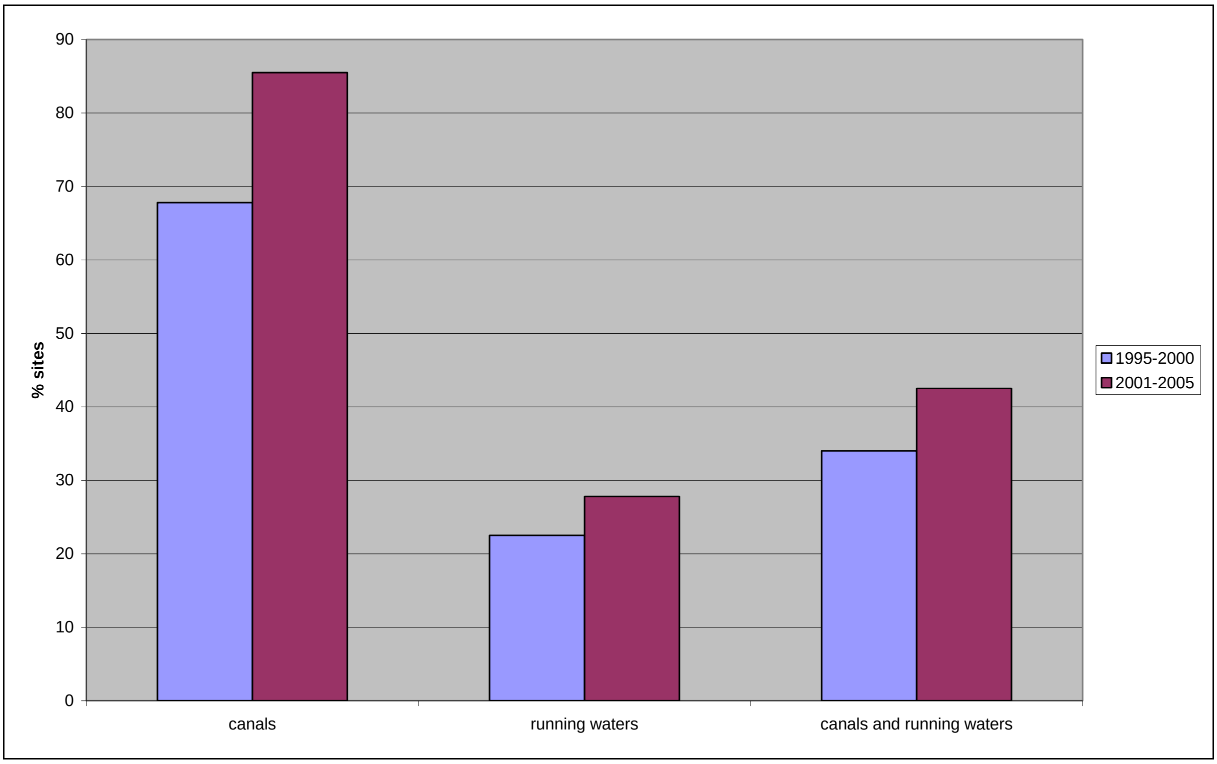


Fig. BE.9 Presence of eels from 487 surveys in canals and running water in period 1: 1995-2000 and 2: 2001-2005 (the same locations were fished in period 1versus period 2).

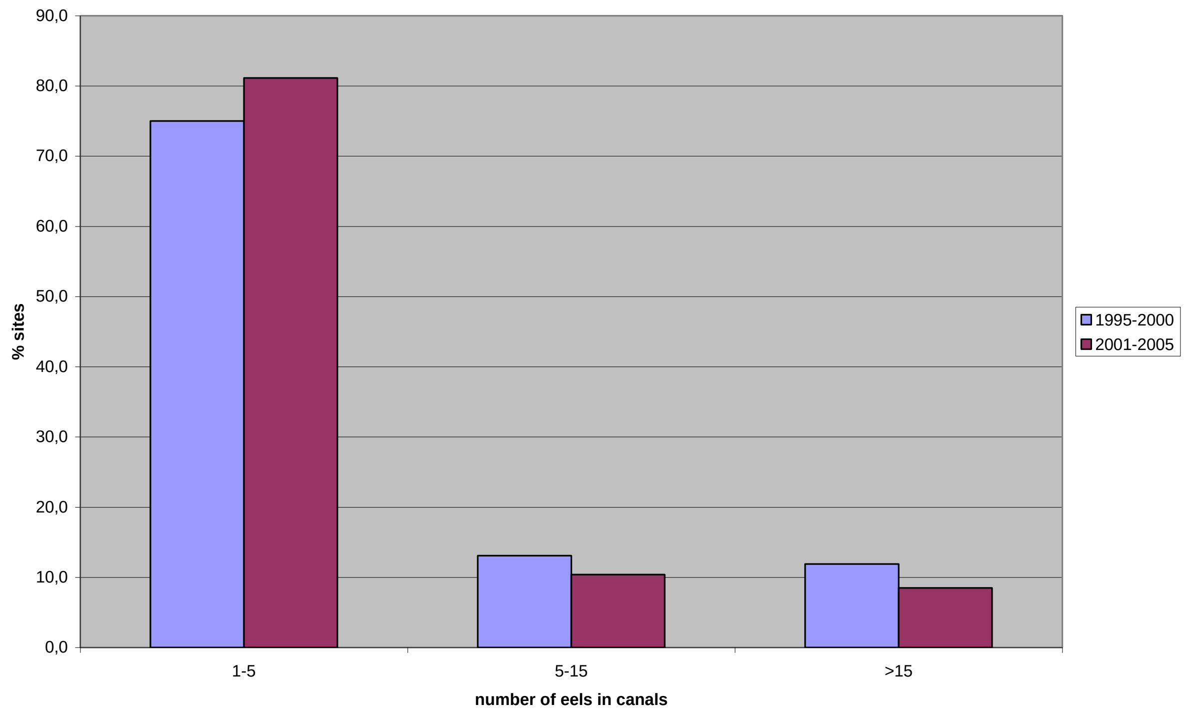


Fig. BE.10 Abundance of eels (number of eels/100m EF and number of eels/fyke/24 u) on sites where eels are present in canals in period 1: 1995-2000 and 2: 2001-2005 (the same locations were fished in period 1 versus period 2).

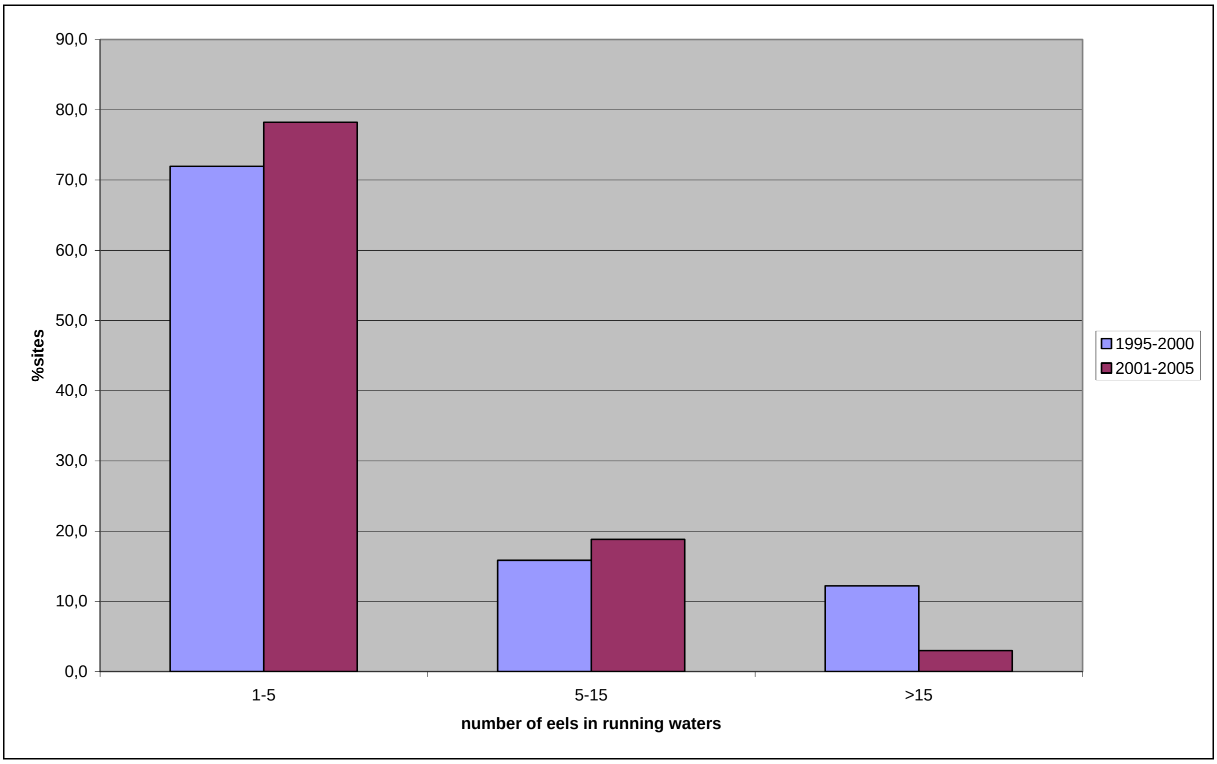


Fig. BE.11 Abundance of eels (number of eels/100m EF and number of eels/fyke/24 u) on sites where eels are present in running water in period 1: 1995-2000 and 2: 2001-2005 (the same locations were fished in period 1 versus period 2).

BE.I.4 Eel surveys in the Walloon region (Meuse basin).

Decline of the European eel in Belgium – Walloon region (adapted from Philippart, pers. comm..)

At the Walloon region scale, the European eel shows recent demographic degradation in the last river basin (Meuse) where the species could still be encountered with fair abundance (Fig. BE.13 and Tab BE.4). Other basins have faced eel stock depletion for a long time because of multiple factors including (**1**) pollution (Scheldt, Sambre), (**2**) obstacles caused by dams (basins of the Chiers, the Semois and the Viroin, upstream Nisramont dam oriental and occidental Ourthe, and the Amblève upstream Coo) and (**3**) the suspension since 1980 of restocking with wild glass eels (from the Yser), yellow, or silver eels obtained from the wild and farmed before release (Fig. BE.12).

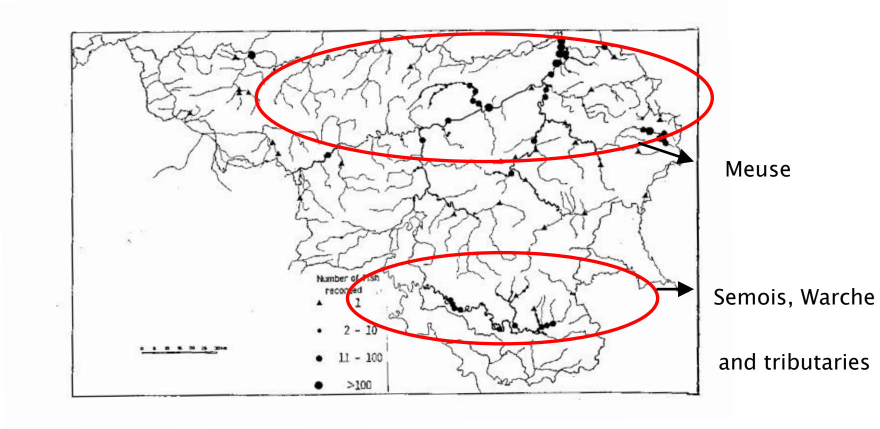


Fig. BE. 12 Distribution of the European eel in Wallonia between 1970 and 1982 showing catches i) in the lower Meuse and its tributaries (typically colonised by young eels originating from the sea, and ii) in the Semois and the Warche, (typically fed by young eels from the Yser estuary, captured and farmed for restocking)

On the Meuse, the University of Liège is monitoring the amount of ascending young eels in a fish-pass. From 1992 to 2004 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; 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 32157 eels was caught (biomass 1,955 kg) with a size from 14 cm to 85 cm and a mean value of 31,6 cm corresponding to yellow eels (data up to 2004). 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 a minimum of 423 in 2004 (Baras et al, 1994, Philippart et al., 2004, Philippart and Rimbaud, 2005) (Fig. BE.13).

The data for 2005 and 2006 stay low : respectively 758 and 559 (Philippart, 2006).

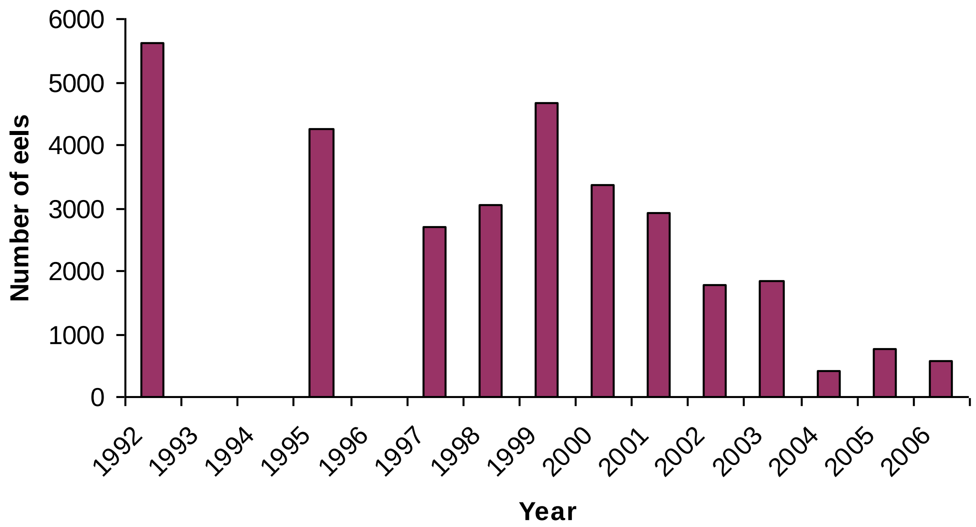


Fig. BE.13 Variation in the number of ascending young yellow eels trapped at the fish trap of the Visé-Lixhe dam Data from University of Liège (J.C. Philippart) in Philippart and Rimbaud, 2005 and Philippart (2006)

Scientific samplings of resident eels (counts from the Méhaigne, in Hosdent, from 1985 to 2005) and migrating eels (upstream migrating in the Meuse at the Lixhe dam, from 1992 to 2006) show a clear and critical demographic collapse (Fig.BE.14). This could lead before 2010 to the disruption of recruitment of young individuals at the gates of the mosan basin in Wallonia, straightly leading for decades to a drastic reduction in continental populations, and eventually, to their extinction within twenty years.

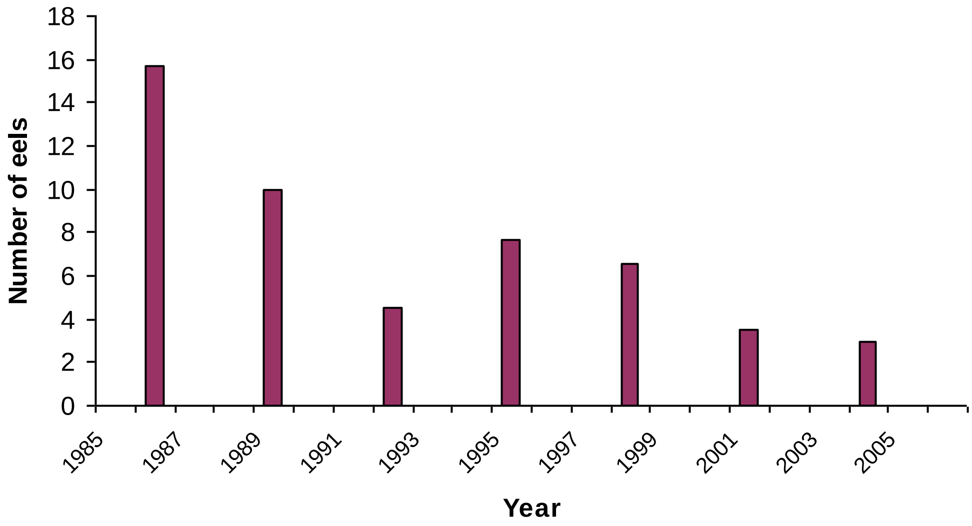


Fig. BE.14 Number (x 100) of resident eels sampled by electric fishing in the Méhaigne in Hosdent-Latinne between 1985 and 2005 (Phillipart 2006).

Table BE.4 Number of yellow eels captured swimming upstream in the fish ladder unit of the Lixhe dam between 1992 and 2006, and number (x 100) of resident eels sampled by electric fishing in the Méhaigne in Hosdent-Latinne between 1985 and 2005 (Phillipart 2006)

	Meuse	**Mehaigne (x 100)**
1985		
1986		1570
1987		
1988		
1989		1000
1990		
1991		
1992	5613	450
1993		
1994		
1995	4240	770
1996		
1997	2706	
1998	3061	660
1999	4664	
2000	3365	
2001	2915	350
2002	1790	
2003	1842	
2004	423	300
2005	758	
2006	559	

BE.J Restoring fish migration

For an overview of the actions of restoration of fish migration in Flanders, see www.vismigratie.be

Fish ladders (adapted from the 2006-2007 report on Walloon environment)

In the perspective of the program "Saumon Meuse" (Malbrouck *et al.*, 2007), modern fish ladders have been, or are in the process of being, built on five major dams and smaller obstacles distributed along the Meuse river and its tributaries (Fig. BE.15). Efficiency of these ladders is under scientific monitoring. This monitoring shows positive and encouraging results, it has appeared that all mosan species, including the European eel, have been seen "using" the ladder devices. Between 1999 and 2005, 71000 individuals belonging to 35 fish species were intercepted, then freed, in the mosan fish ladder of the Visé-Lixhe dam. Such migratory passes are useful tools for fish biodiversity monitoring. The process of fish ladder installation follows a systematic obstacle listing for the navigable and un-navigable waterways of the Walloon region. This inventory should be finalized by the end of 2007 for the southern basins of Wallonia, which are the most important regarding migrating amphihaline species (Fig. BE.16). Those measures fit perfectly in the perspective of the Water Framework Directive which aims to restore good ecological state or potential for 2015, notably trough restoring a longitudinal ecological continuity along European rivers.

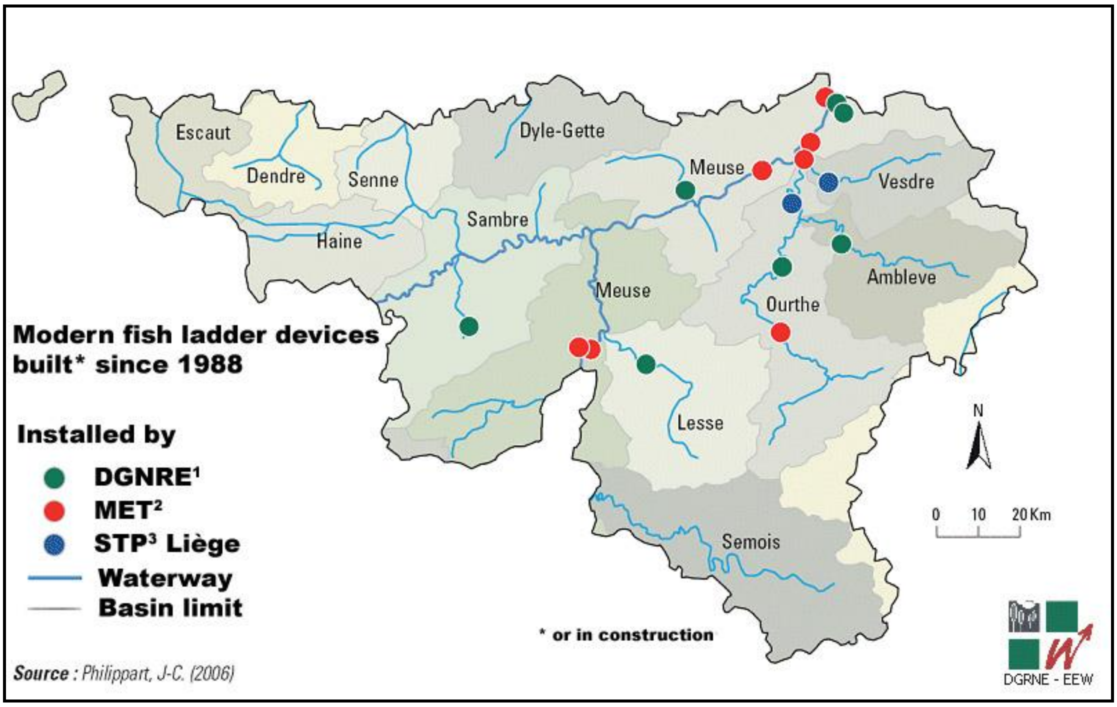


Fig. BE.15 Fish ladders in the Walloon region [1]Direction Générale des Ressources Naturelles et de l'Environnement, [2] Ministère de l'Equipement et des Transports, [3] Service Technique Provincial

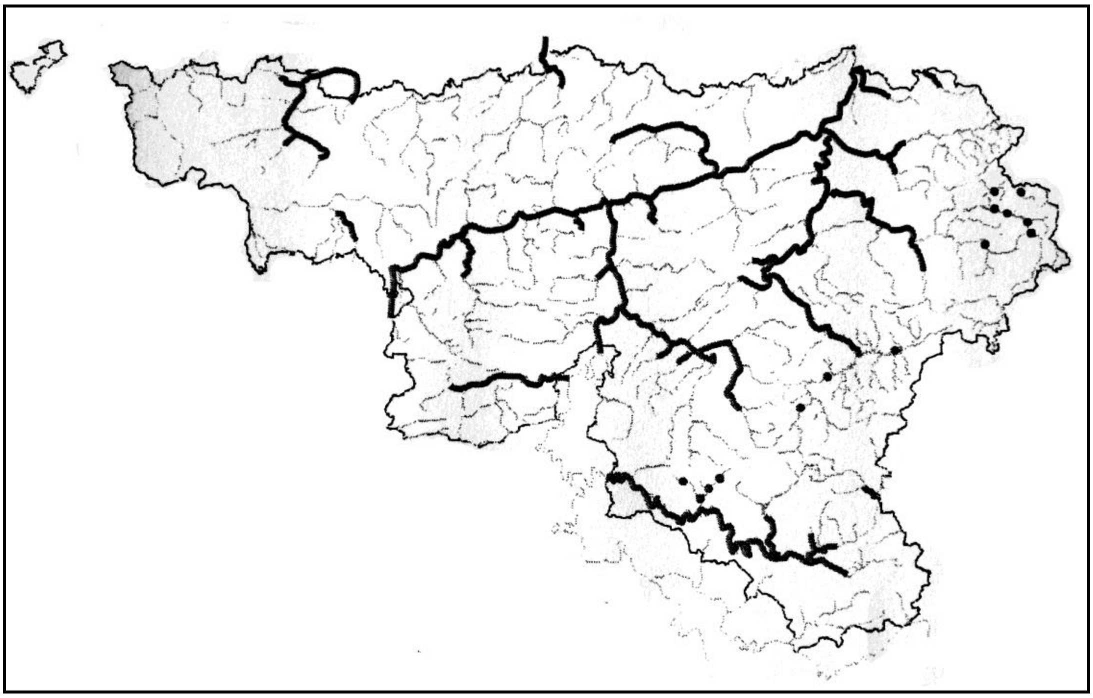


Fig. BE.16 Hydrographical domain where planning is needed in order to restore open circulation of the European eel

Priorities in obstacle planning in the Walloon region – The case for European eel (adapted from Philippart and Ovidio - Laboratoire de Démographie des Poissons et Hydroécologie de l'Unité de Biologie du comportement, Université de Liège) (adapted from Philippart and Ovidio, 2007)

The geographical distribution area of the European eel encompasses the whole hydrographical network (figure), even if several sub-basins experience a critical decline in eel numbers due to the presence of major dams. In the future, all waterways from the mosan basin in the Walloon region should be accessible and provide settlement for yellow eels originating from the Atlantic Ocean. This is also the case for the Scheldt basin.

Effective management of migrating eel populations faces two main threats:

1- Wild stocks of young eels migrating upstream in the Meuse river experience a critical decline (clearly shown by the continuous samplings since 1990 in the small fish ladder of the Visé-Lixhe dam), ultimately leading to a definitive halt in natural recruitment trough that migration course around 2008 (Philippart *et al*. 2005).

2- Restockings with young eels from the wild (notably with glass eels from the Yser estuary) in waterways (Meuse, Sambre, Semois, Shelt and tributaries), channels and dam lakes (Bütgenbach, Robertville, Nisramont) situated upstream from physical barriers thus impassable for migrating eels.

For a migrating catadromous species such as the European eel, experiencing critical demographic decline in Europe and Belgium (Belpaire, 2005), it is necessary (a) to provide an adequate migration route along the Meuse migrating axis, especially in the segment between Lixhe and Monsin/Liège where dams are not equipped with navigation locks, (b) to list and provide solutions to provide eels with means to bypass obstacles blocking or slowing down upstream migration. Management actions should primarily focus on obstacles located in basins closer to the sea (Berwinne, the great-basin of Ourthe-Vesdre-Amblève) then spread to the basins located upstream from Liège (Méhaigne, Samson, Lesse…).

In the sub-basin of the Sambre, and in all waterways of the Schelt basin, the European eel is the only amphihaline migrating species justifying recovery actions in order to restore their upstream migration pattern. However, given the present status of the stocks actually reaching those waterways, some of those still showing significant levels of pollution, those actions taken isolatedly, will not curb down the pressures experienced by eel populations, and must be integrated to broader actions promoted by international initiatives such as the International Schelt Commission (Scaldit Project (http://www.scaldit.org/)) and cooperation programs, *i.a*. with France regarding the Sambre and trans-boundary waterways.

BE.K Catch composition by age and length:

Flanders

An extensive database on length and weight is available at INBO, based on surveys with electrofishing and fykenetting. Many data are also available on the internet at http://vis.milieuinfo.be/.

Wallonia

An extensive database on length and weight is available at GIPPA, based on fish stock surveys in Wallonia.

BE.L Other biological sampling:

BE.L.1 Length & Weight & Growth (DCR)

An extensive database on length and weight is available at INBO, based on surveys with electrofishing and fykenetting. Many data are also available on the internet at http://vis.milieuinfo.be/. Growrth is studied in a population of eels at lake Weerde, a man made lake, but is not reported yet. In Wallonia length and weight data from scientific surveys is available at GIPPA.

BE.L.2 Parasites

Since last report (Belpaire, 2006) no new information is available on *Anguillicola* in Belgium. *Anguillicola* infection rates were monitored in 1987, 1997 and 2000. The presence of *A. crassus* in Flanders was first discovered in 1985; 2 year later a survey revealed a prevalence of 34.1% and a mean infection intensity of 5.5, based on adult nematodes only, and 10 year later the parasite was present at all 11 sites sampled. Prevalence had increased to 62.5% but the mean infection intensity had decreased to 3.9 adults per infected eel. In the year 2000, a third study revealed that *A. crassus* was present in 139 of 140 investigated sites; a further increase in prevalence to 68.7% and a decrease in mean infection intensity to 3.4 adults per infected eel was observed. When all larval stages were taken into account, mean prevalence amounted to 88.1% and mean intensity to 5.5 adults. The high infection level in Flanders is thought to be the result of restocking with glass eel and yellow eel, both of which are susceptible to *A. crassus*. For distribution maps of the parasite, see Belpaire (2006) or Audenaert et al. (2003).

In an older study (Schabuss et al., 1997) endoparasitic helminth communities of eel were investigated in for cut off meanders of Rivers Leie and Scheldt. Two cestodes (*Proteocephalus* *macrocephalus* and *Bothriocephalus claviceps*), two nematodes (*Anguillicola crassus* and *Camallanus lacustris*) and two acanthocephales (*Acanthocephalus lucii* and *Acanthocephalus anguillae*) were studied. Parasite communities were quite different between sites, but it was the nematode *Anguillicola* which was dominant at all sites.

BE.L.3 Contaminants

Flanders

Extensive information has already been provided in the WG Eel 2006 report (Belpaire, 2006).

Maes et al (2007) described the results of a spatial and temporal analysis of the data from the Flemish eel pollution network. This network is running since 1994 and aims to use to yellow eel muscle tissue as an indicator of environmental and potential human dietary exposure by hazardous chemicals of surface waters and sediments. It also gives direct indications of the health of the eel, with respect to the presence of these chemicals. Between 1994 and 2005, over 2800 eel captured at 365 stations were analysed for PCBs, pesticides and heavy metals. A spatial analysis of the data demonstrated that the variation in pollutant concentration tended towards higher values (Figs BE.17, 18 and 19). This was especially evident for PCBs, lindane, endrin, dieldrin and DDE. The concentration of almost all banned substances decreased significantly during the study period, however some heavy metals like mercury and cadmium did not decrease.

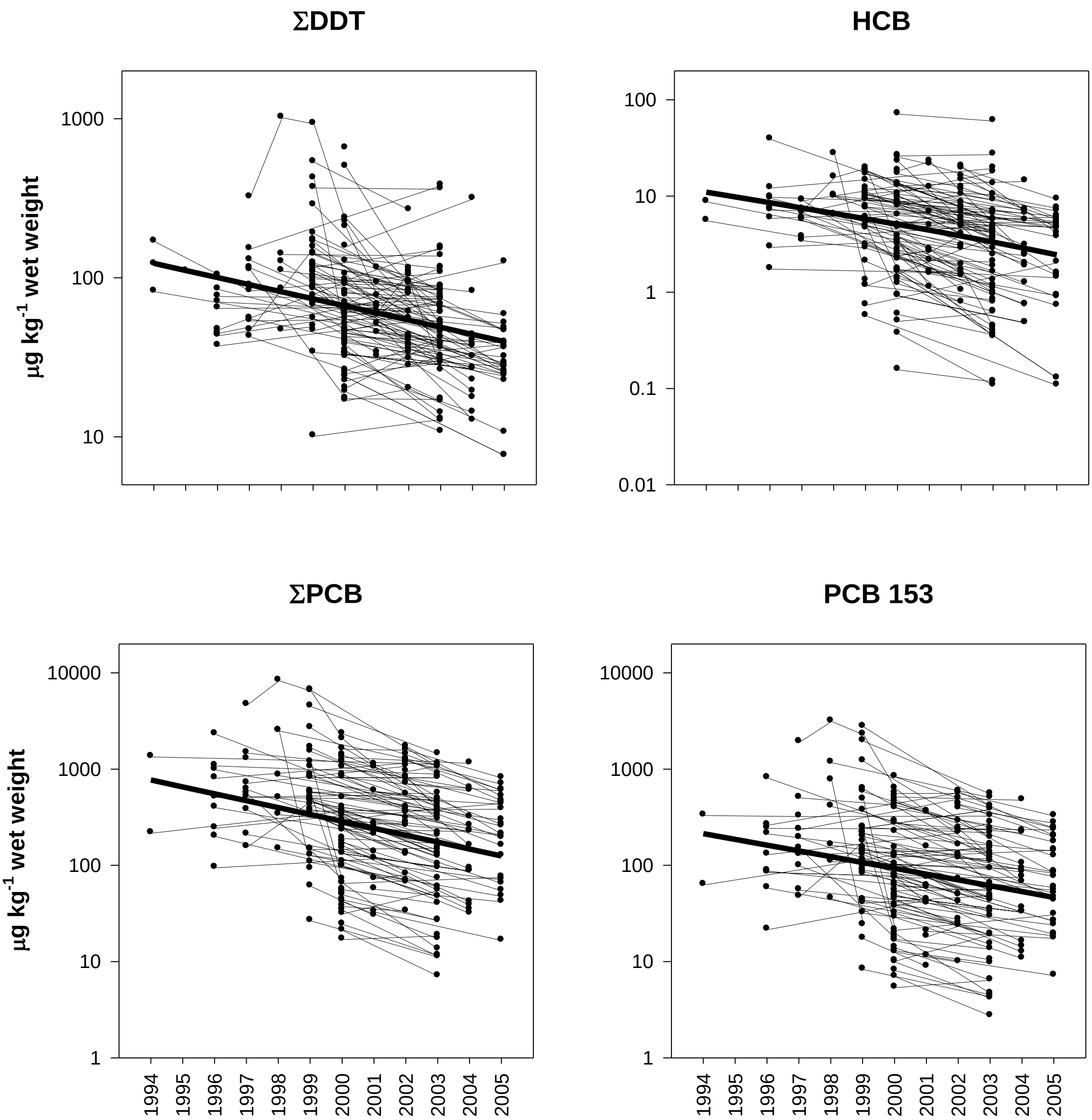


Fig BE.17. Temporal trends in average eel muscle tissue concentration of ∑DDT, ∑PCB, HCB and PCB 153 at sampling stations that were sampled more than once between 1994 and 2005. The bold line represents the average time trend which was modelled using a linear mixed model. Data from Maes et al., 2007.

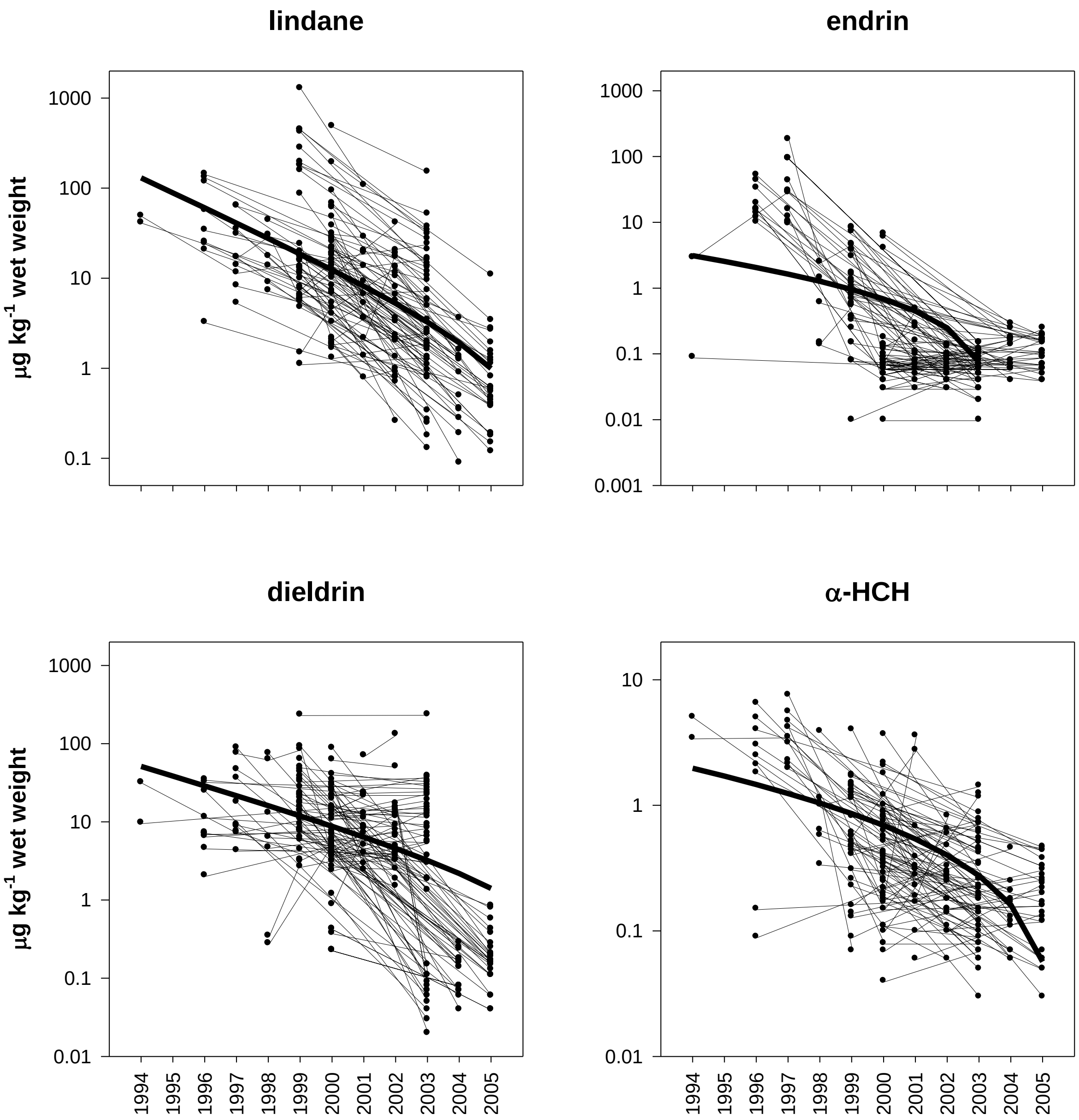


Fig. BE. 18 Temporal trends in average eel muscle tissue concentration of lindane, dieldrin, endrin and alpha-HCH at sampling stations that were sampled more than once between 1994 and 2005. The bold line represents the average time trend which was modelled using a linear mixed model. Data from Maes et al., 2007.

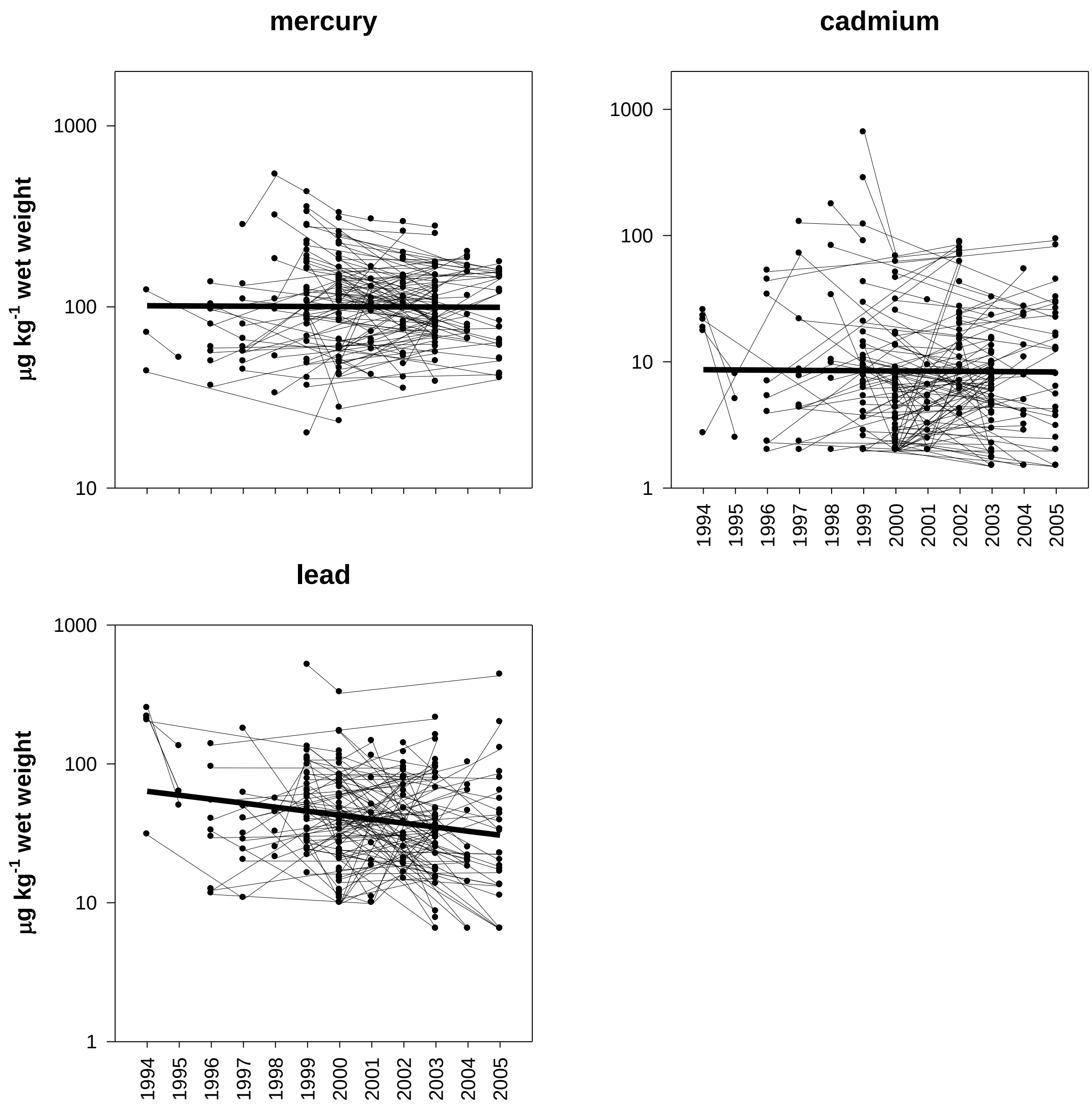


Fig. BE.19 Temporal trends in average eel muscle tissue concentration of three heavy metals at sampling stations that were sampled more than once between 1994 and 2005. The bold line represents the average time trend which was modelled using a linear mixed model. Data from Maes et al., 2007.

Recent results of analyses of dioxins, furanes and dioxin like PCBs on eels from 8 sites in Flanders indicate that on 50% of the sites the levels were higher than the maximum allowed levels (Goemans, pers. comm.). Maximum allowed levels of the sum of dioxins, furans and dioxin-like PCBs (WHO-PCDD/ F-PCB-TEQ) is for eel 12,0 pg/g fresh weight (EC, 2006). Comparing with the Palstra *et al*. (2006) benchmark of 4 pg TEQ (PCDDs/PCDFs + PCBs) /g ww where malformation of larvae appear, 5 on 8 sites (62%) are above this level.

There is an increasing awareness that spawner quality might be an essential element in the decline of the European eel. Recent studies have shown that pollution with dioxin like substances, including PCBs may have a large impact on the reproduction success of the eel. We did a study (Geeraerts et al., 2007) around the ecotoxicological effects of pollutants in European eel which contains a literature overview about the (harmful) consequences of these contaminants on eel. For various compounds the relation between the concentration in the water and the contamination and

subsequent health of eels is described. A general survey is given about the analysed pollutants in Flanders (Belgium) and their properties. The relevance of eel as a bio-indicator species is explained and the results of the Flemish eel pollution network presented.
During their transoceanic migration to the spawning grounds eels consume about 60% of their fat supplies (van Ginneken & van den Thillart, 2000) meaning that a part of the accumulated pollutants becomes available. A continuously fat burning means a continuous availability of pollutants and a large extent of toxicity in the eel, despite the fact that a part of those contaminants again is stored in the fat tissue. Such a poisoning leads to disruptions in the immune, reproduction, nervous and endocrine system. The toxification that way causes physiological disruptions, reduced endocrine stress response and reduced resistance against infections of viruses and parasites, which for his part leads to a disturbed reproduction and even dead of the eel. So pollutants can play an important role in the decline of the species.
A study done by De Boer *et al.* (1993) brought to light that 85-90% of the toxic effects of PCBs is caused by PCBs 126, 156 and 118 which have many industrial purposes. De Boer *et al.* (1994) also showed that once PCBs are accumulated in eel tissue, the biological half-life in eels can be years (1-4 years). It is reasonable to assume that persistent contaminant levels reported in eel tissues remain very close to the initial values after the migration, when spawning takes place. Other results show that hosts (eels) exposed to pollution easily are infected by parasites opposite to non-contaminated eels. The sensitivity to contaminants and the consequences are species- and dose dependent. Much is known about the influence of pollutants on eels and its predators but there still are many uncertainties. Less information is available on the exact concentration at which a compound becomes toxic. Further research is necessary.

A review of latest data and reports on contaminants in eel has been given, and Flemish eel data are compared to toxic benchmarks from literature. An extensive dataset of contaminants has been analysed by statistical modelling, to show relationships between fitness (lipid content and eel condition) and various environmental variables. We saw that mean fat percentage of Flemish eel (1994-2005) is 15.1% of the body weight meaning that eels will not be able to finish their transoceanic migration with sufficient reserves. The analysis shows that the fat percentage is influenced by typology and year. Eels from standing waters and polder waters have lowest fat percentage while eels from rivers and canals have striking higher fat percentages. It was also concluded that PCBs (especially the higher chlorinated ones) and DDTs have a negative impact on the lipid content of the eel. (Geeraerts et al., 2007).

Belpaire et al. (2003) reported on the extreme high levels of Brominated Flame Retardants (BFRs) in eels (collected in 2000) from one particular site on the Scheldt river (near Oudenaarde) (which were the highest concentrations worldwide in eel measured). New samples were taken in 2006 and analysed. Even though the BFR concentrations dropped significantly compared to the concentrations found in 2000, they remain among the highest in the world. Atmospheric deposition can be considered as a minor pollution pathway since the two closed water bodies in the close vicinity of these highly contaminated sites on the River Scheldt, used as reference waters, showed no abnormally high BFR contamination (Goemans et al., 2007).

Starting from the same dataset of the eel pollution network and additional analyses of brominated flame retardants, volatile organic pollutants (VOCs), endocrine disruptors, dioxins, perfluorooctane sulphonic acids (PFOSs), metallothioneins, and polycyclic aromatic compounds, Belpaire and Goemans (2007a) have illustrated how eel can pinpoint environmental contamination of the environment. The biomonitoring value of eels as a tool for monitoring environmental contamination has been discussed. It was concluded that (1) eel is a highly suitable biomonitor for environmental contaminants, for both local and international purposes, e.g. to evaluate the chemical status for the Water Framework Directive, and (2) dependent on the degree of pollution in their habitat, the levels of certain contaminants reported in yellow eels can be high, and might affect their potential for reproduction.

The usefulness of monitoring contaminants in eel for the WFD was further discussed in Belpaire and Goemans (2007b). The Water Framework Directive recently (2006) proposed to monitor a selection of priority substances and to report on the chemical status of our water bodies. The final objective is the protection of aquatic life and human health. The majority of these substances are lipophilic, nevertheless it is proposed to monitor them in the water-phase. As there is serious concern about whether measurements of these lipophilic compounds in water will give satisfying results to guarantee the protection of aquatic life, monitoring in biota seems to be more appropriate.

The advantages of using the European eel (*Anguilla anguilla*) as a model for evaluating the chemical status within the WFD is discussed. A wide range of studies over Europe exist and have pinpointed various types of environmental contamination. Eel contaminant profiles seem to be a fingerprint of the contamination pressure of a specific site. From the Flemish eel pollution database, reference values and quality classes for PCBs, OCPs and heavy metals in eel were deduced and are presented.

The set up of a harmonised, Europe-wide chemical monitoring programme of eels could stand for a triple application: (1) the evaluation of environmental health and chemical status, (2) the sanitary control of fisheries products within human food safety regulations, and (3) the monitoring of eel quality within the requirements of the international eel restoration plan (Fig. BE.20). Taking into account the actual high concentration of some contaminants in certain eel subpopulations and the ecotoxicological effects of these substances, achieving good chemical status of EU waters will directly be beneficial for the eel restoration. By measuring in eel itself we could better direct protect the eel.

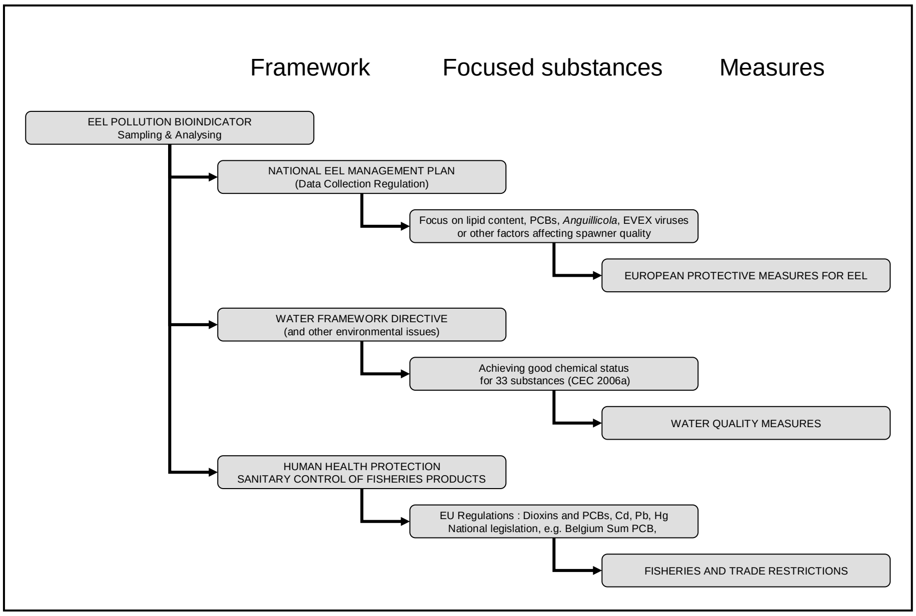


Fig. BE.20 Possibilities of combined use of monitoring contaminants in the eel (Belpaire and Goemans, 2007b).

Another recent study (Bilau et al., 2007) assessed the intake PCBs through consumption of eel by recreational fishermen and compared it with the intake of a background population. Concentrations of the sum of the seven indicator PCBs (Sum PCBs) measured in non commercial European eel (*Anguilla anguilla* L.*)* in Flanders are high: in 80 % of all sampled localities, the Belgian PCB standard for fish was exceeded. The median estimated intake for recreational fishermen varies between 18.4 and 237.6 ng Sum PCBs/kg bw/day, depending on the consumption scenario, while the estimated intake of the background population (consumers only) is 4.3 ng Sum PCBs/kg bw/day. Since the levels of intake via eel for two intake scenarios were respectively 50 and 25 times higher than the intake of the background population, the body burden might be proportionately higher and reach levels of toxicological relevance**.** The intake of PCBs via consumption of self-caught eel in Flanders seems to be at a level of high concern. It was advised to maintain the Flemish catch-and-release obligation for eel, established in 2002, but withdrawn in 2006.

Considering (1) that the effects of contaminants on biota in general and on eel specifically are better known and seem to be of utmost importance for the reproduction success of the species, (2) that the pollution in eels is impressively varying between sites within and between member countries, (3) that the level of pollution in eel in many cases surpasses binding human consumption maximum allowed levels or advisory consumption limits and thus has an effect on fisheries management and regulation, we strongly recommend that at community level initiatives are taken to collate information, to set up comparative monitoring actions, to set up a pan-european database, to set up studies on effects , …

Wallonia (adapted from the 2006-2007 report on Walloon environment)

In order to assess the health risk associated to the consumption of fishes originating from Walloon rivers (fishes sampled in 61 stations situated on 30 different waterways between 2001 and 2004), the amounts of PCB dioxins and furans encountered in eel tissues were compared with the standard values applied to human health (Thomé et al., 2004)(Fig. BE.21). These are set to 75 ng/g of fresh weight for PCBs (Royal Order from 6th March 2002 modifying the previous Royal Order (19th may 2000) establishing maximal dioxin and PCB levels in several food stuffs. Levels concern PCB congeners 28, 52, 101, 118, 138, 153 and 180) and 12 pg TEQ-WHO/g (TEQ-WHO or Toxic Equivalents – World Health Organization) of fresh weight for dioxins and furans (European Council regulation of the 29th November 2001).

Eel contamination by dioxins and furans stays in safe levels, encountered values never exceed the 12 pg TEQ-WHO/g of fresh weight.

However, the situation of PCB contamination is far more alarming. Eels reveal PCB concentrations between 40 and 1761 ng/g of freshweight (Fig. BE.22 and Tab. BE.5). Such results are particularly disturbing because they nearly systematically exceed the defined value for human consumption. The highest contamination levels are encountered in the lower Meuse, the Albert channel and the Vesdre. It is to be feared that a regular consumption of eel meat should reveal a threat to human health. Facing this situation, a Walloon jurisdiction aiming to prohibit consumption of eels fished from Walloon rivers was published in june 2006 (Walloon Governement, 2006).

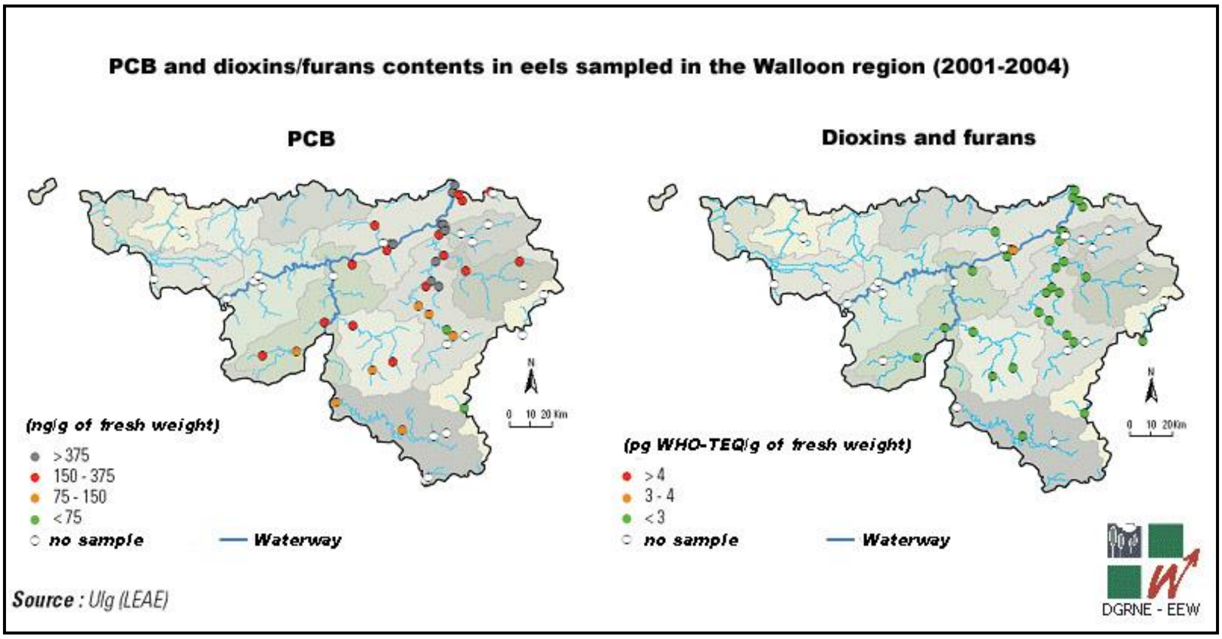


Fig. BE.21 Eel contamination by PCB, dioxins and furans in Wallonia (Chalon et al., 2006, Thomé et al., 2004)

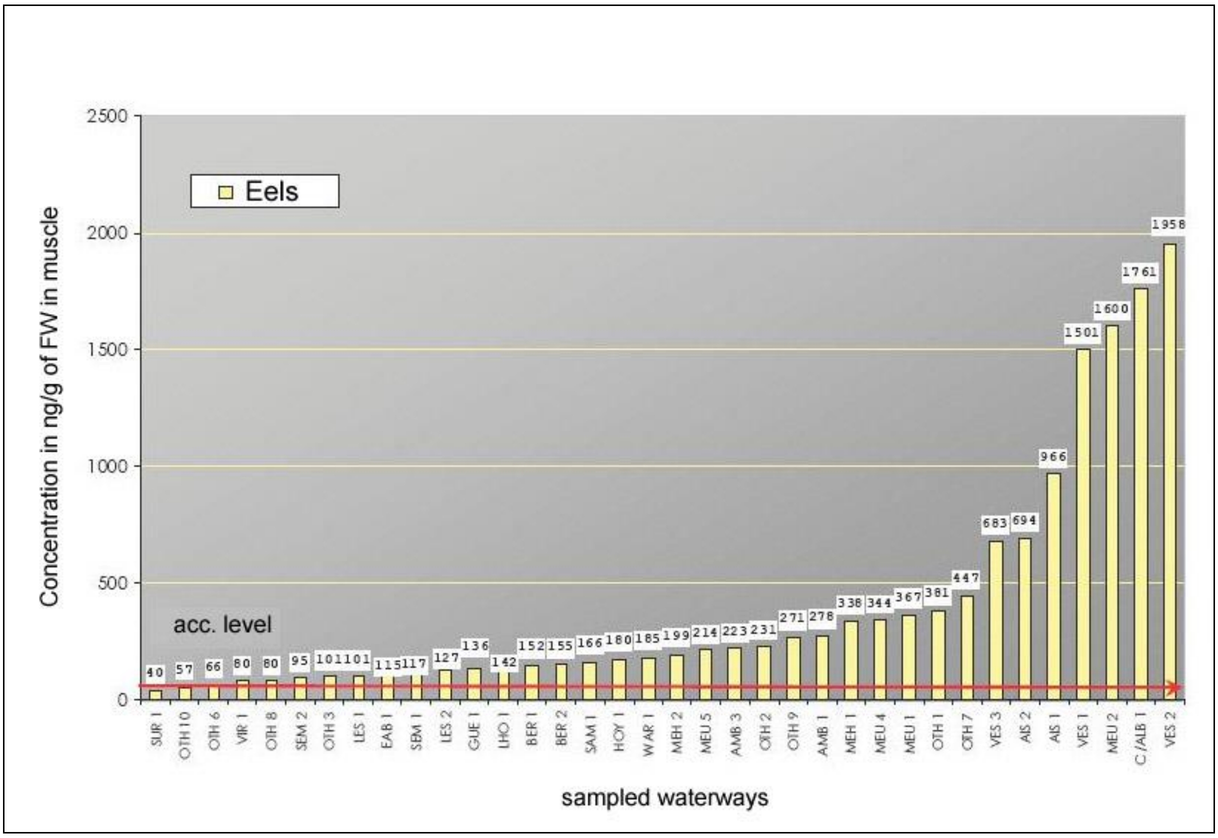


Fig. BE.22 Comparison between the accepted PCB level of 75ng/g FW (red line) and leves in eels reported by waterway and basin – acronyms explained in annexed table (adapted from Chalon *et al.* 2006)

Tab. BE.5 Acronyms for the sites in Fig. BE.22 (PCB contamination samples)

Basin	sub-basin	waterway	code	Location
Meuse	Amblève	Amblève	AMB 1	Comblain-la-tour/Halleux
		Amblève	AMB 2	Deidenberg
		Amblève	AMB 3	Lorcé-Mabompré
		Warche	WAR 1	Robertville
	Lesse	Lesse	LES 1	Redu
		Lesse	LES 2	Eprave
		L'homme	LHO 1	Poix-st-Hubert
	Meuse-amont	Eau- Blanche	EAB 1	Aublain
		Meuse	MEU 5	Waulsort
		Meuse	MEU 3	Tailfer
		Samson	SAM 1	Goyet
		Viroin	VIR 1	Vierves/Dourbes Olloy
	Meuse-aval	Berwinne	BER 1	Mortroux
		Berwinne	BER 2	Berneau
		Canal Albert	C/ALB 1	Lanaye
		Gueule	GUE 1	Sippenaeken
		Gueule	GUE 2	Plombières
		Hoyoux	HOY 1	Huy
		Mehaigne	MEH 1	Goyet

		Mehaigne	MEH 2	Latinnes-Hosdent
		Mehaigne	MEH 3	Wanze
		Meuse	MEU 1	Tihange
		Meuse	MEU 2	Lixhe/Visé
		Meuse	MEU 4	Ben Hahin/Ampsin
	Ourthe	Aisne	AIS 1	Bomal
		Aisne	AIS 2	Haut-Roche
		Ourthe	OTH 1	Comblain-la-tour
		Ourthe	OTH 2	Tilff-Colonster
		Ourthe	OTH 3	Hotton
		Ourthe	OTH 4	Houffalize
		Ourthe	OTH 5	Ortho
		Ourthe	OTH 6	Maboge
		Ourthe	OTH 7	Angleur
		Ourthe	OTH 8	Nisramont
		Ourthe	OTH 9	Barvaux
		Ourthe	OTH 10	Bardonwez
	Sambre	Eau d'Heure	EDH 1	Jamioulx
		Hantes	HAN 1	Wiheries
		Sambre	SAB 1	Landelies
		Sambre	SAB 2	Marchienne-au-pont
	Semois-Chiers	Rulles	RUL 1	Marbehan
		Rulles	RUL 2	Habay-la-vieille
		Semois	SEM 1	Bohan
		Semois	SEM 2	Chiny
		Ton	TON 1	Lamorteau
		Ton	TON 2	Harnoncourt
	Vesdre	Hoegne	HOE 1	Theux
		Vesdre	VES 1	Vaux -s/Chevremont
		Vesdre	VES 2	Chênée
		Vesdre	VES 3 et 4	Chaudfontaine
		Vesdre	VES 5	Nessonvaux
		Vesdre	H VES	Aval Dohain
Escaut	Dendre	Dendre	DEN 0	Lessines
		Oriental Dendre	DEN 1	Ath
	Dyle-Gette	Dyle Bassin	/	/
	Escaut-Lys	Escaut	ESC 1	Kain
	Haine	Grande-Honnelle	GHO 1	Baisieux
		Trouille	TRO 1	Givry
Rhine	Moselle	Our	OUR 1	Ouren
		Our	OUR 2	Andler
		Sûre	SUR 1	Martelange

BE.L.4 Predators

We hereby give some information about the great cormorant in Flanders and Wallonia.

Flanders (after Devos et al., 2005)

The great cormorant disappeared as a nesting bird in Flanders in 1965 and only returned in 1993. Since then the breeding population has increased from 8 pairs in 1993 to 443 in 1999 with a wintering group of between 2,000 and 2,500 birds. The total (ecological and economical) impact of this large number of fish-eating birds on a small area like Flanders (with only 257 km^2 water surface) needs urgent investigation. The diet of the great cormorant mainly consists of roach and other cyprinids, perch and ruffe with only a few eel. However, the impact of great cormorant predation on fish stocks is difficult to assess because of lack of data on fish populations. Moreover, economic losses can only be deduced roughly from numbers of birds and their daily food requirement.

In Flanders there are very few commercial fisheries and no specific studies on great cormorants. Nevertheless the population has increased considerably during the last decade and damage to fish farms and ponds was considered to be a major problem. For the extensive aquaculture facilities in Flanders, losses in yields are estimated to be almost 50% and economical losses are even higher as investments have to be made to prevent further damage. Thus, the impact of the great cormorant on fish stocks and fisheries in Flanders can be highlighted as follows:

(i) Ecological problems: preference for roach rather than bream which resulted in depleted roach stocks; habitat alteration and predation on rare species.

(ii) Pathologic problems: wounding of fish and causing stress as well as the spread of diseases.

(iii) Social problems: decrease in the number of fishermen/anglers.

(iv) Economic problems: loss of income because of lower fish yields; fewer fishing/angling permits sold.

Consideration of cormorant management in Flanders laid emphasis on financial support and/or compensation for fish culturists rather than the reduction of the cormorant population.

In conclusion : (i) Further investigation is necessary to assess possible ecological damage.(ii) Damage to fish farms and ponds is a major local problem highlighting the necessity for government intervention in the form of financial compensation and/or subsiding of scaring technology. Passive deterrents are not possible for very large ponds and are not allowed in nature reserves.

Wallonia (after Paquet, 2005)

Almost no scientific studies on Cormorant impacts are available in Wallonia as conflicts have only surfaced as recently as 1994. Data presented here were mostly collected in 2001-02. Since then, an interdisciplinary research team has conducted an in-depth study of the conflicts involving cormorants in Wallonia. A technical report (web site: http://environnement.wallonie.be/crnfb/), which updates the data presented here, has been published by the Centre de Recherche Nature, Forêt, Bois.

The great cormorant first appeared as a regular wintering bird in Wallonia during 1991-1992. The wintering population subsequently developed rapidly, first along the main valley of the Meuse River and then along the tributaries and other water systems. The total mid-winter count in January 2002 was 3,900 individuals, with 2,600 birds in the Meuse valley. The wintering population is still increasing slowly in the smaller river systems, primarily due to colonization of new fishing grounds. Since 1992 a still growing small breeding population of 250 pairs has been established in two colonies within Wallonia but they have not shown any sign of expanding yet.

The cormorant is still strictly protected (regional law on wild indigenous birds from 14/07/1994). The regional law from 8/10/1998 allows financial compensation for damage caused by protected birds to professional fisheries but these compensations are considered too low or too difficult to obtain by fish farmers, for whom the fish farming activity is mostly a supplementary job.

String devices have been used at some fish farms as well as across some stretches of river important for fly-fishing. Illegal culling of great cormorants is probably limited, although difficult to assess. The use of a fishing hook fixed into small live or dead fish and used as bait for the birds has been known to occur. Disturbance of night roosts rarely happens although it has along some small rivers. Breeding colonies are located in protected/private sites.

(i) More studies are needed of the impact of wintering Great Cormorants, particularly on smaller rivers (e.g. Semois, Lesse, Amblève).

(ii) Wallonia is a good area to assess conflicts with cormorant in the context of a 'no killing' policy.

(iii) Good communication with fish farmers and anglers about the problems they face and possible solutions is urgently needed.

BE.M Other sampling:

BE.N Stock assessment:

BE.O Sampling intensity and precision:

BE.P Standardisation and harmonisation of methodology:

BE.P.1 Survey Techniques

Flanders

The survey techniques are following the standardised procedures used for the INBO Fish Assessment Network and described in Belpaire et al. (2000). For particular projects more appropriate methods can be used (see under Wallonia)

Table BE.6. Description of the techniques used for fish stock analysis in Flandrian waterbodies by INBO.

Watertype	Techniques used
Running waters < 1.5 m	100 m electrofishing with 1 anode
Running waters 1.5-4 m	100 m electrofishing with 2 anodes
Running waters 4-6 m	100 m electrofishing with 3 anodes
Running waters 6-8 m	100 m electrofishing with 4 anodes

Running waters > 8 m	Combination of: 500 m boat electrofishing (2 x 250 mon both river banks) fykes and/or gill nets
Closed river arms and ponds Polder drainage systems	Combination of : seine netting boat electrofishing (both river banks) fykes and/or gill nets

Wallonia

Two main techniques are employed in order to assess eel numbers in standard sampling points: electrical fishing and direct counts of eels passing fish ladders. Other techniques in use are the metallic grid keepnet, net, seine, direct obstacle counts, bait fishing (using crayfish), observations from tanks emptying, and from biotic index.

BE.P.2 Sampling Commercial Catches

No data.

BE.P.3 Sampling

BE.P.4 Age analysis

There is currently no general monitoring program for growth rates of eel. In the past studies haven been undertaken to follow growth of elvers stocked in ponds (Belpaire et al., 1992). In 2001, a study has been set up to study and monitor growth of tagged eel in a Flandrian lake (Lake Weerde) over 6 years. Results are in process.

BE.P.5 Life Stages

BE.P.6 Sex Determinations

No data.

BE.Q Overview, conclusions and recommendations:

The development of eel management plans are still to be worked out in Belgium. There are major critical points where considerable efforts still have to be made, essentially on water quality and pollution, and on habitat restoration and restoration of the migration possibilities.

Considering (1) that the effects of contaminants on biota in general and on eel specifically are better known and seem to be of utmost importance for the reproduction success of the species, (2) that the pollution in eels is impressively varying between sites within and between member countries, (3) that the level of pollution in eel in many cases surpasses binding human consumption maximum allowed levels or advisory consumption limits and thus has an effect on fisheries management and regulation, we strongly recommend that at community level initiatives are taken to collate information, to set up comparative monitoring actions, to set up a pan-european database, to set up studies on effects , …

BE.R Literature references:

Audenaert V., Huyse T., Goemans G, Belpaire C. and Volckaert F. 2003 Spatio-temporal dynamics of the parasitic nematode *Anguillicola crassus* in Flanders, Belgium. Diseases of Aquatic Organisms 56: 223–233

Baras E., Salmon B. and Philippart J.C. 1994 Evaluation of a eel-trap sampling method for the assessment of migrant yellow eels *Anguilla anguilla* (L.) in the river Meuse. Bull. Fr. Pêche Piscic. 335: 7-16 (in French)

Belpaire C., Goemans G., de Boer J. and Van Hooste H. 2003 Verspreiding van gebromeerde vlamvertragers. [Distribution of Brominated Flame Retardants.] In: MIRA-T 2003: Report of the Environment and Nature in Flanders, Flemish Environmental Agency and Lannoo publishing, Heverlee, Belgium, pp 387-395. (in Dutch)

Belpaire C., Goemans G., Van Thuyne G., Verreycken H. and Maes, J., 2003 Eel Fisheries and Management in Flanders, Belgium: Status and Trends. International Eel symposium, Quebec 10-15 august, 2003. .

Belpaire C., Van Driessche H., Gao F.Y. and Ollevier, F. 1992 Food and feeding activity of glasseel *Anguilla anguilla* (L.) stocked in earthen ponds. Irish Fisheries Investigations, series A (Freshwater) 36: 43-54

Belpaire, C. (2002) Monitoring of glass eel recruitment in Belgium. In: Dekker W. (Ed.) Monitoring of glass eel recruitment. Netherlands Institute of Fisheries research, report C007/02-WD, Volume 2B, pp. 169-180

Belpaire, C. (2006) Report on the eel stock and fishery in Belgium 2005. In FAO European Inland Fisheries Advisory Commission; International Council for the Exploration of the Sea. Report of the 2006 session of the Joint EIFAC/ICES Working Group on Eels. Rome, 23–27 January 2006. EIFAC Occasional Paper. No. 38, ICES CM 2006/ACFM:16. Rome, FAO/Copenhagen, ICES. 2006. 352p., 217-241.

Belpaire, C. and Coussement, M. 2000 Nota omtrent het uitzetten van paling in de Vlaamse openbare waters. [Note on the restocking of glasseel in Flandrian public waters]. Advice for the High Fisheries Council (March 20, 2000). Institute for Forestry and Game Management, Vlaamse Vereniging van Hengelsport Verbonden, IBW.Wb.V.ADV.2000.070 (in Dutch)

Belpaire, C. and Gerard, P., 1994 Rapport sur la situation de l'aquaculture en Belgique. EIFAC, Consultation sur les stratégies d'aménagement des pêches et de l'aquaculture, Rome (Italie), May 1994, p. 7

Belpaire, C., Goemans, G. (2007a). Eels: contaminant cocktails pinpointing environmental pollution. *Journal of Marine Science*, in press.

Belpaire, C., Goemans, G. (2007b) submitted. The European eel *Anguilla anguilla*, a rapporteur of the chemical status for the Water Framework Directive? 12 years of monitoring in Flanders. *Life and Environment*, subm.

Belpaire, C.; Smolders, R.; Vanden Auweele, I.; Ercken, D.; Breine, J.; Van Thuyne, G.; Ollevier, F. (2000). An index of biotic integrity characterizing fish populations and the ecological quality of Flandrian water bodies. Hydrobiologia 434: 17-33.

Bilau, M., I. Sioen, C. Matthys, A. De Vocht, G. Goemans, C. Belpaire, J.L. Willems, S. De Henauw, 2007 in press. Polychlorinated biphenyl (PCB) exposure through eel consumption in recreational fishermen as compared to the general population, using a probabilistic approach. Food Additives and Contaminants,

Cellule Etat de l'Environnement Wallon (2007). *Rapport Analytique sur l'état de l'environnement Wallon 2006-2007* (2006-2007 report on Walloon environment) – MRW – DGRNE, Namur ; 736 p. Direct link : http://environnement.wallonie.be/eew/tablematiere.aspx

Chalon, C., Leroy, D., Thome, J.P., Goffart, A. (2006) Les micropolluants dans les eaux de surface en Région wallonne. Dossier scientifique réalisé dans le cadre de l'élaboration du Rapport Analytique 2006-2007 sur l'état de l'environnement wallon.

de Boer, J., C.J.N. Traag, W.A. Stronck & J. van der Meer, 1993. Non-ortho and mono-ortho substituted chlorobiphenyls and chlorinated dibenzo-p-dioxins and dibenzofurans in marine and freshwater fish and shellfish from the Netherlands. Chemosphere 26(10): 1823-1842.

de Boer, J., F. van de Valk, M.A.T. Kerkhoff, P. Hagel & U.A.Th. Brinkman, 1994. 8-Year study on the elimination of PCBs and other organochlorine compounds from eel (*Anguilla anguilla*) under natural conditions. Environmental Science and Technology 28(13): 2242-2248.

Devos, K., H. Verreycken, D. de Charleroy, C. Belpaire, 2005. Flanders. In : Reducing the conflict between cormorants and fisheries on a pan-European scale. Summary & National Overviews. Edited by: D N Carss & M Marzano (2005)

EC (2006a). Facts and figures on the CFP - publication of the European Commission Basic data on the Common Fisheries Policy Luxembourg: Office for Official Publications of the European Communities ISBN 92-79-00898-6

EC (2006b) COMMISSION REGULATION (EC) No 199/2006 of 3 February 2006 amending Regulation (EC) No 466/2001 setting maximum levels for certain contaminants in foodstuffs as regards dioxins and dioxin-like PCBs L 32/34 EN Official Journal of the European Union 4.2.2006

Geeraerts, C., G. Goemans, P. Quataert & C. Belpaire (2007) Ecologische en ecotoxicologische betekenis van verontreinigende stoffen in paling. Studie uitgevoerd in opdracht van de Vlaamse Milieumaatschappij, MIRA, MIRA/2006X/XX, INBO/R/2007/40. Instituut voor Natuur- en Bosonderzoek. p. 207, in press.

Goemans, G., Roosens, L., Dirtu A.C., Belpaire, C., Neels, H., Covaci, A. (2007). Brominated flame retardants in fish from the Scheldt river (Belgium). Proceedings Dioxin2007, Tokyo, Japan.

Groupe d'intérêt pour les poissons, la pêche et l'aquaculture (GIPPA asbl) 2006. *Vers une nouvelle politique des rempoissonnements.* Ebauche de document de synthèse, fruit des travaux du Groupe de Travail "Rempoissonnements". 179p.

Maes J., Geysen B., Ercken D. and Ollevier F. 2003 Opvolging van het visbestand van de Zeeschelde. Resultaten voor 2002. KU Leuven, Laboratorium voor Aquatische Ecologie, Report for Institute for Forestry and Game Management, 29p. (in Dutch)

Maes, J., Goemans, G. and Belpaire, C., 2007. Spatial variations and temporal trends between 1994 and 2005 in polychlorinated biphenyls, organochlorine pesticides and heavy metals in European eel (*Anguilla anguilla* L.) in Flanders, Belgium. *Environmental Pollution* doi:10.1016/j.envpol.2007.07.021

Malbrouck, C, Micha., J.-C., Philippart J.-C.(2007) Projet « Meuse Saumon 2000 » Project associating the Walloon Cabinet for Agriculture, Rural affairs, Environment and Tourism, the Facultés Universitaires Notre-Dame de la Paix de Namur (FUNDP) and the Université de Liège (ULg). Direct link: http://environnement.wallonie.be/publi/education/saumon2000.pdf

Palstra AP, van Ginneken VJT, Murk AJ, van den Thillart GEEJM 2006. Are dioxin-like contaminants responsible for the eel (*Anguilla anguilla*) drama? *Naturwissenschaften* 93: 145-148.

Paquet, J.Y., 2005. Wallonia. In : Reducing the conflict between cormorants and fisheries on a pan-European scale. Summary & National Overviews. Edited by: D N Carss & M Marzano (2005)

Philippart J.C and Rimbaud G. 2005 L'efficacité de la nouvelle grande échelle à poissons du barrage de Visé-Lixhe sur la Meuse. Eléments du suivi scientifique 1999-2004. [Efficiency of the new large fish pass at the Visé-Lixhe dam on the river Meuse. Follow-up 1999-2004]. Draft report – 50 years of Fonds Piscicole

Philippart J.C, Sonny D. and Ovidio M. 2005 A 12-year study of the upstream migration of *Anguilla anguilla* in a fish-pass in the River Meuse reveals a dramatic decrease of the stock in Belgium. Bordeaux, Fish and diadromy in Europe; Ecology, Management, Conservation Bordeaux Conference 2005, poster.

Philippart, J.C and Ovidio, M. (2007) Définition des bases biologiques et éco-hydrauliques pour la libre circulation des poissons dans les cours d'eau non naviguables de Wallonie. Identification des priorités d'action d'après les critères biologiques et piscicoles. Vol.3. LDPH. Rapport final de synthèse pour la période 2005-2007, convention Ulg n°05/43388

Philippart,J-C. (2006) *L'érosion de la biodiversité : les poissons*. Dossier Scientifique réalisé dans le cadre de l'élaboration du rapport analytique 2006-2007 sur l'état de l'environnement Wallon. Université de Liège. 306 pp.

Schabuss, M., Konecny, R., Belpaire, C., Schiemer, F., 1997. Endoparasitic helminths of the European eel, *Anguilla anguilla*, from our disconnected meanders from the rivers Leie and Scheldt in western Flanders, Belgium. *Folia Parasitologica* 44 : 12-18

Thomé JP, Bertrand A, Brose F, Carabin O, De Pauw E, Dukmans C, Eppe G, Gaspar P, Leroy A, Louvet M, Maghuin-Rogister G, Marneffe Y, Massart AC, Philippart, JC, Rimbaut G, Scippo ML 2004. Evaluation du niveau de contamination des rivières par les PCBs et les dioxines. Report Université de Liège. Convention avec la Région Wallonne, Ministère de l'Aménagement du Territoire, de l'Urbanisme et de l'Environnement, Engagement n° 01/4143, 167 p.

van Ginneken, V.J.T. & G.E.E.J.M. Van den Thillart, 2000. Eel fat stores enough to reach the Sargasso. Nature 403: 156-157.

Vandecruys, W., 2004. Economische en sociale aspecten van de hengelsport op openbaar water in Vlaanderen. Limburgs Universitair Centrum.

Vocht, de A. and Bruyn, de L., 2005 Binnenvisserij. In Natuurrapport 2005, Institute of Nature Conservation, Brussels.

Walloon Government (2006) Walloon Government Order of 15th june 2006 modifying the Walloon Regional Executive Order of 11th March 1993 concerning angling, in order to impose no-kill practices for the European eel.