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BOTTLE-NECKS FOR RESTORATION OF THE EEL POPULATION, *Anguilla anguilla* (L.) OF THE RIVER YSER BASIN (FLANDERS)

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A B S T R A C T. This paper describes some preliminary results on the status of eel populations in the River Yser and its tributaries. Data on glass eel migration at the river mouth during recent years are presented and compared with earlier observations. Populations of yellow eel were studied at several localities during three successive periods. Attention was given to all factors limiting development of normal eel stocks, especially migration obstructions to all stages. Suggestions for improving the aquatic habitat in order to ensure normal migration and restore the Yser eel population are proposed.

Key words: EEL, RESTORATION, RIVER YSER BASIN.

INTRODUCTION

European eel stocks are believed to be diminishing because of declining glass eel recruitment, migration barriers and loss of habitats.

A research programme was started in Flanders aiming not only at data collection on the status of *Anguilla* but to suggest management programmes for the amelioration of conditions for fish in general, with special attention to eel. The River Yser was of particular interest, and its catchment was selected as a model. The programme, started up in 1991, aims to study eel populations in the Yser catchment, and more specifically: 1) glass eel migration in Nieuwpoort, 2) yellow eel populations in the Yser and its tributaries, 3) silver eel runs, 4) inventory of bottle-necks or obstacles for development of normal eel populations, 5) feeding regimes in relation to food availability, 6) eel diseases, 7) measuring bioaccumulating contaminants in eel.

This paper gives some preliminary results of the study.

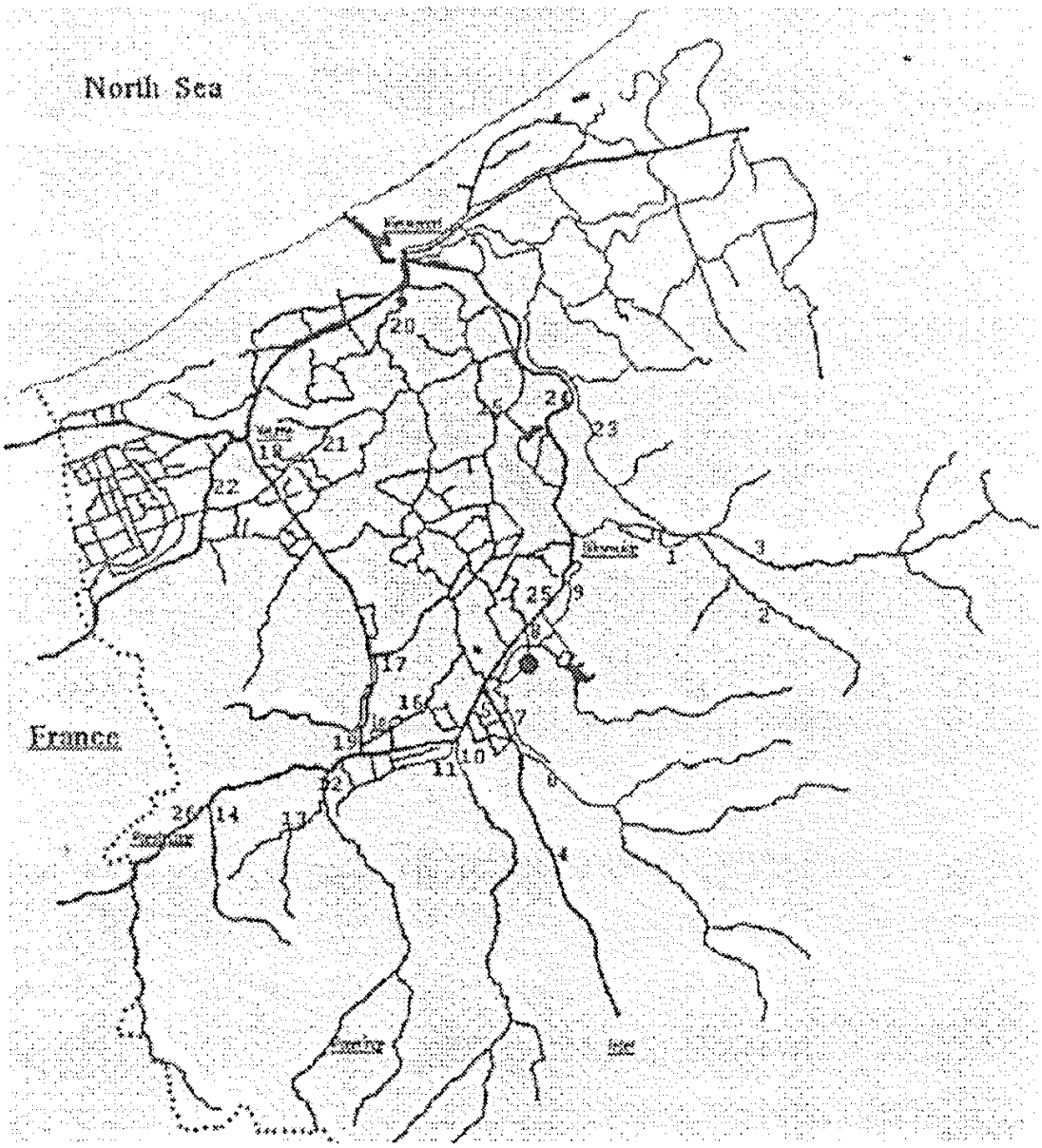

Figure 1. Sampling localities for yellow eel in the Yser valley during 1991 and 1992. Numbers in the figure refer to locality names in Table 2 and 3.

MATERIALS AND METHODS

THE RIVER YSER BASIN AND ITS IMPORTANCE FOR EEL POPULATIONS

The River Yser is 76 km long and the upstream part (43 km) runs through France (Fig. 1). Only the Flandrian part of the river was studied. With the exception of a limited hilly part in the South („Vlaams Heuvelland"), the Yser area is a flat polder landscape containing numerous ditches, brooks and canals. This hydrographic maze represents an important part of the Flandrian aquatic environment.

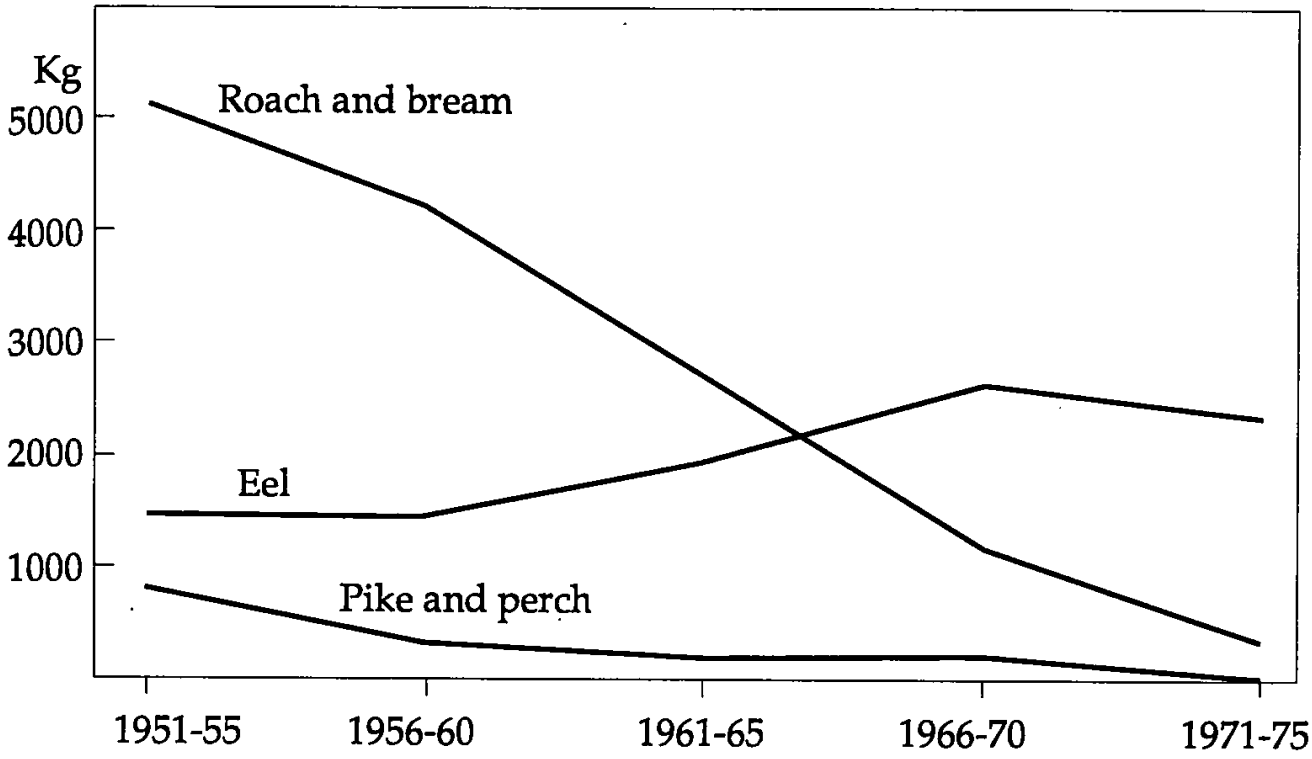

Figure 2. Evolution of the anglers' catch on the Yser from 1951 to 1975 (after Timmermans 1976).

The Yser runs through an area with intensive agrarian activities (pork production) which are responsible for 65% of the total pollution load of the river. Also industrial activities pollute the river. Consequently, water quality of the Yser gradually decreases downstream. Incoming water of ditches and canals may locally influence the quality of water.

Regulation of the river system has long been based on a quantitative management, the river being seen as a cheap discharge channel. Draining the surrounding wetlands and polders to win land for agriculture is still the rule. However, recently several regional, national and international environmental programmes were set up in order to increase quality of the Yser valley.

The Yser system has long been known as an important area for eels because of easy access to the sea to glass eels and wide extent and diversity of the aquatic habitat. During 1950-1970 eutrophication resulted in a decrease of fish species such as roach and rudd and piscivorous fish (pike and perch), and a simultaneous increase of the eel population (according to the angling data from Timmermans, 1976, see Fig. 2). With increasing eutrophication during 1970s, eel population appeared to decline drastically (Fig. 4).

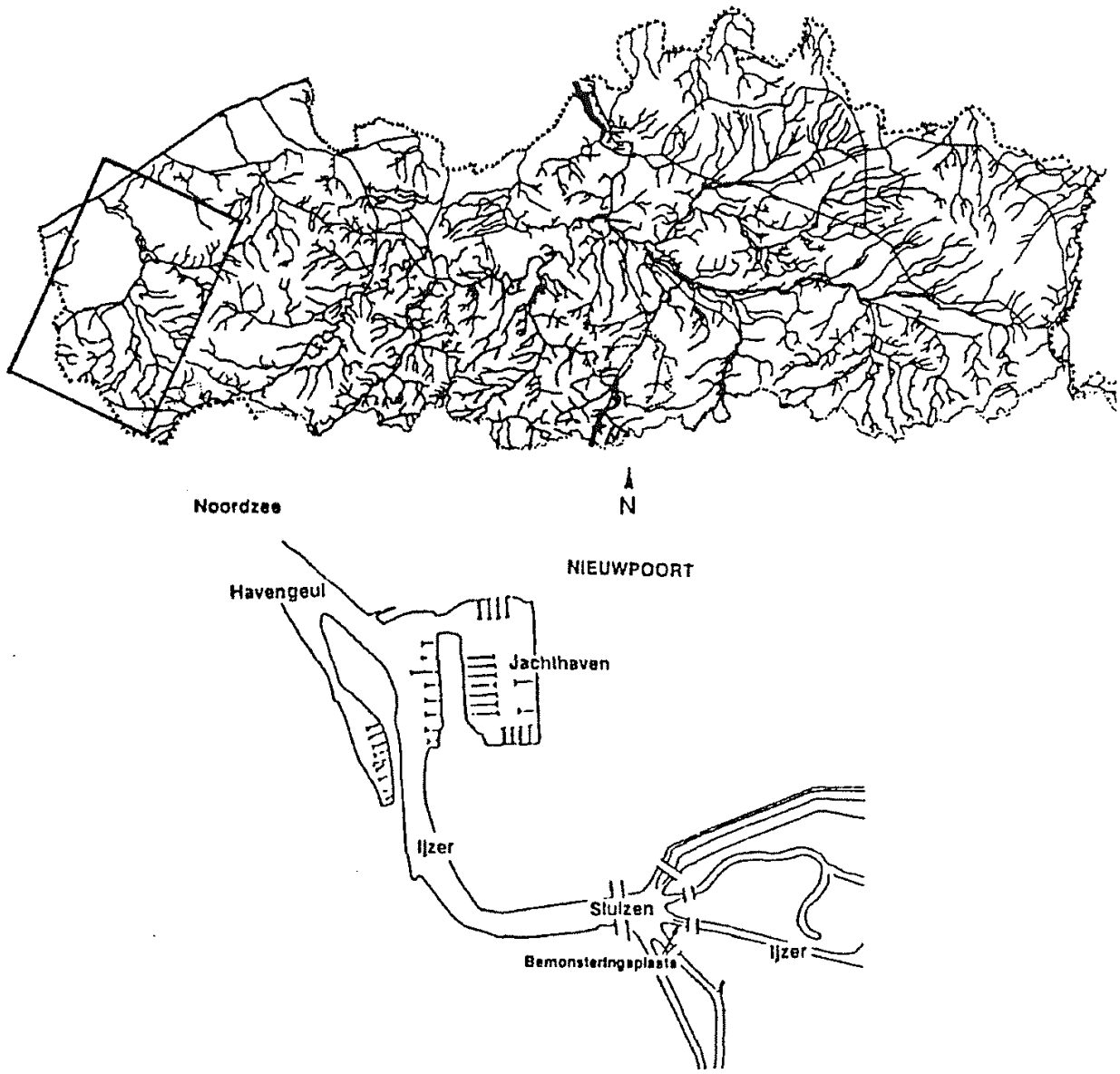

Figure 3. Location of the Yser catchment in Flanders and sampling locality for glass eel at the sluices of the Yser River mouth at Nieuwpoort (from Belpaire et al. 1991).

MONITORING OF GLASS EEL MIGRATION AT NIEUWPOORT

Each year since 1964, glass eel have been caught at the „Iepersas" sluices at the mouth of the Yser (Fig. 3). The sluice is quite small (50 m long) and the old lock-gates are closed at night. There is no commercial fishing for glass eel. The site allows simple and standardized sampling. This is achieved by three people sampling over approximately 30 nights in the period March - April for 2-3 hours, by pulling a dipnet along the south quay wall.

To evaluate passage of glass eel with time and tidal height through leaks in the sluices, all glass eel on the inland side were caught by means of cutting off the sluice

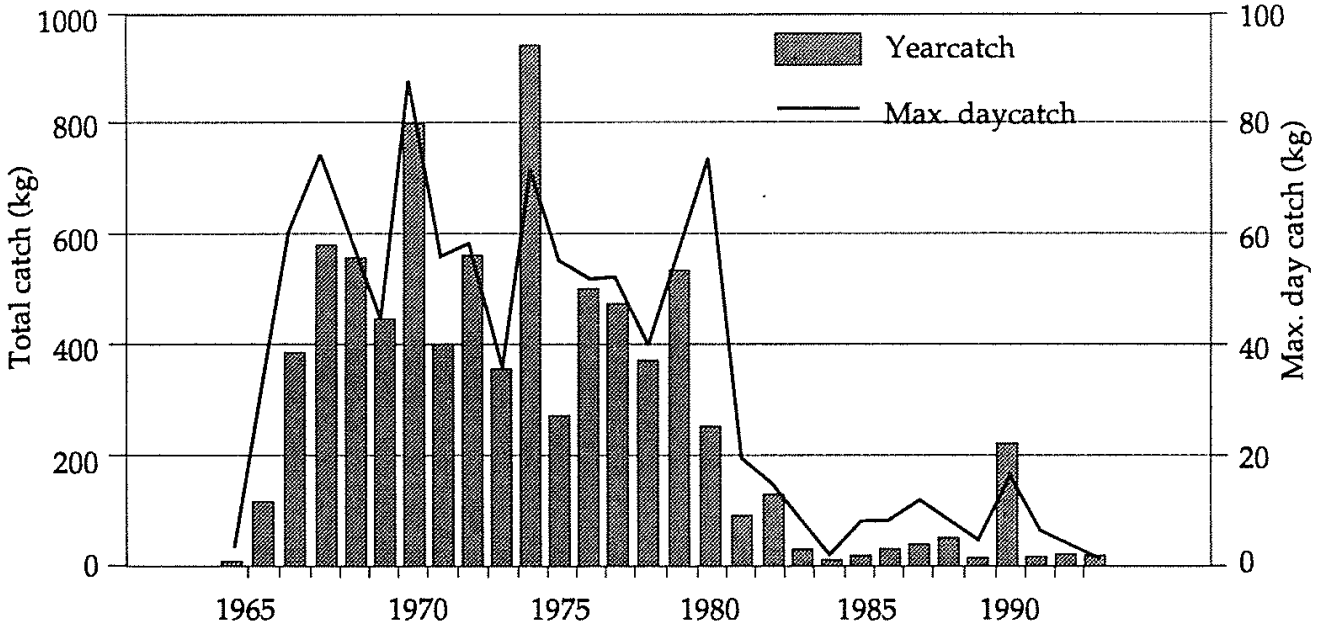

Figure 4. Glass eel catches (total annual catch and maximum daily catch in kg) on the River Yser at Nieuwpoort in the period 1964-1993.

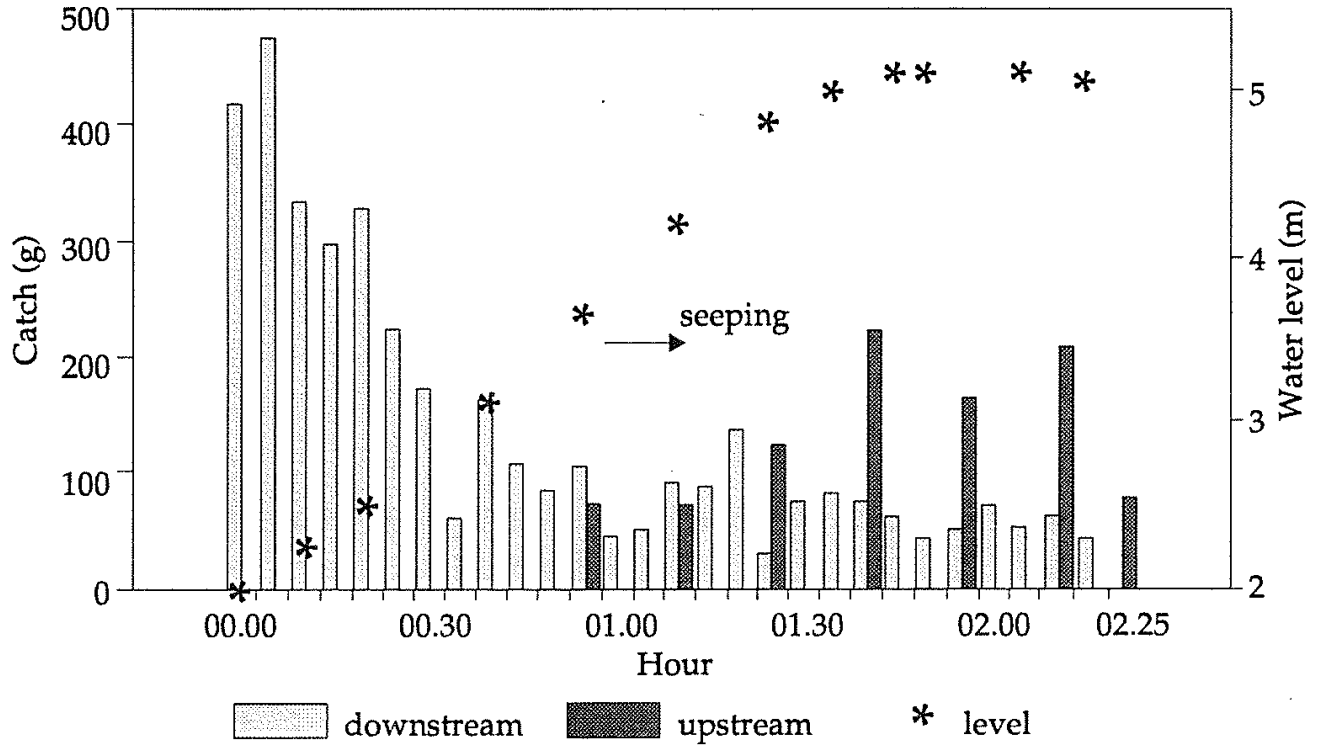

Figure 5. Catches of glass eel by means of the dip net along the quay wall downstream and catches of glass eel by means of a Hamen net upstream of the sluice in function of water level (Nieuwpoort, 20 March 1992). The tidal level at which water seeped through the sluice is show by an arrow.

with a net as used in Portugal (Minho) (Weber 1986). Glass eel caught at Nieuwpoort are distributed throughout Flandrian waters for restocking.

MONITORING YELLOW EEL POPULATIONS IN THE YSER CATCHMENT

Sampling localities (Fig. 1) were distributed throughout the Yser basin; for some localities regular water quality measurements were available (IHE 1990, VMM 1990). Yellow eels were sampled by fyke netting over three periods: autumn 1991 (23 September - 12 November, 14 localities), spring 1992 (7 April - 12 May, 13 localities) and autumn 1992 (22 September - 20 October, 23 localities). Fyke nets were set at right angles to the river bank. The fyke nets were all identical, with 3 chambers (2 m) and a 1.7 m long wing. The opening hoop diameter was 40 cm, mesh size 10 mm. Fyke nets were emptied once a week. All fish were weighed, measured and released in the water, any dead or diseased fish being noted.

BOTTLE-NECKS FOR NATURAL EEL POPULATIONS IN THE RIVER YSER AREA

An inventory was made of all possible obstructions to glass eel migration and silver eel migration in the Yser system.

RESULTS AND DISCUSSION

GLASS EEL CATCHES AND PENETRATION THROUGH THE SLUICES

Fig. 4 shows catch data for 1964-1993 (results from Belpaire and Ollevier 1987, Belpaire et al. 1991, Denayer and Belpaire 1992c). Other than in 1990, catches have fallen considerably since the 1970s.

As the glass eel recruitment is very poor, it is extremely important to develop a management programme to enable a maximum number of glass eel to reach their inland growing habitat. Beside the restocking programmes for inland waters, lock keepers should allow glass eel to pass successfully through the gates. The results in Fig. 5 show that glass eel could only be found upstream of lock gates after seepage of water through them occurred. This took place a few minutes after the sea water level reached the normal Yser level (3.14 m). This one-day experiment demonstrated that

TABLE 1

Catches of yellow eel in CPUE biomass (g)/fyke/day at different localities for the monitoring of eel stocks during the autumn of 1991 and during the spring and the autumn of 1992

	Locality number	Autumn'91	Spring'92	Autumn'92
Polder Bethoosterse Broeken				
Oude Gracht	1	-	-	-
Oude Zarrebeek	2	-	223	32
Handzamevaart	3	0	0	0
Zuid-IJzer Polder				
Ieperkanaal (middle reach)	4	-	-	203
Ieperkanaal (lower reach)	5	24	59	35
Martjevaart	6	44	223	9
Engelendelft	7	-	32	0
Stenensluisvaart	8	38	14	65
Walevaart	9	9	-	-
Kemmelbeek (mouth)	10	8	18	4
Boezingegracht	11	35	-	18
Poperingse Vaart	12	142	-	59
Heidebeek	13	72	-	-
Haringse Beek (mouth)	14	56	-	40
Polder Noordwatering of Veurne				
Grote Beverdijk at Pervijze	15	-	13	99
Grote Beverdijk at Lo.	16	187	55	52
Slopgatvaart	17	22	-	-
Lovaart at Veurne	18	-	-	129
Lovaart at Fintele	19	44	48	22
Koolhofvaart	20	-	-	23
Steengracht	21	-	-	11
Bergenvaart	22	-	-	172
Polder of Vladslo-Ambacht				
Vladslovaart	23	-	2	35
The river IJzer				
at the bridge of Tervate	24	0	28	49
at Woumen	25	-	10	0
at Roesbrugge	26	-	-	26

- = *no sampling*

for one kg of glass eel fished at the sea side of the lock gates, only 0.247 kg succeeded in passing the gates into fresh water. These results show that where gates are not opened for shipping at high tide, lock keepers should allow seepage or open the gates at the right moment. Alternatively, appropriate elver passes should be fitted.

TABLE 2

Percentages survival of captured eels at different localities for the monitoring of eel stocks during the autumn of 1991 and during the spring and the autumn of 1992

	Locality number	Autumn'91	Spring'92	Autumn'92
Polder Bethoosterse Broeken				
Oude Gracht	1	ns	ns	ns
Oude Zarrebeek	2	ns	100	100
Handzamevaart	3	-	-	-
Zuid-IJzer Polder				
Ieperkanaal (middle reach)	4	ns	ns	100
Ieperkanaal (lower reach)	5	97.4	97.9	100
Martjevaart	6	54.5	100	0
Engelendelft	7	ns	100	-
Stenensluisvaart	8	100	100	100
Walevaart	9	33.3	ns	ns
Kemmelbeek (mouth)	10	71.4	100	100
Boezingegracht	11	68.4	ns	100
Poperingse Vaart	12	61.5	ns	93.8
Heidebeek	13	100	ns	ns
Haringse Beek (mouth)	14	53.8	ns	100
Polder Noordwatering of Veurne				
Grote Beverdijk at Pervijze	15	ns	100	100
Grote Beverdijk at Lo.	16	100	100	100
Slopgatvaart	17	100	ns	ns
Lovaart at Veurne	18	ns	100	0
Lovaart at Fintele	19	8.7	100	0
Koolhofvaart	20	ns	ns	100
Steengracht	21	ns	ns	100
Bergenvaart	22	ns	ns	75.4
Polder Watering of Vladslo-Ambacht				
Vladslovaart	23	ns	100	17.6
The river IJzer				
at the bridge of Tervate	24	-	100	100
at Woumen	25	ns	100	-
at Roesbrugge	26	ns	ns	100

ns = no sampling; - = no catch

YELLOW EEL POPULATIONS

Table 1 shows that CPUE (catch per unit of effort expressed as the biomass of eel caught per fyke-day) differs considerably between the various localities, showing that eel biomass varies over the whole area. Many ecological or other factors may be responsible for this. However, it is assumed that in many localities eel populations are below their potential densities. Only at one locality water quality did not permit any fish life. Length frequency distributions of several sites (Fig. 6) indicate that population structure differs considerably from one site to another. When looking at the eel mortalities caught in fyke nets (Tab. 2) and at other data of Denayer and Belpaire (1992a), it may be concluded that, at some sites, water quality fluctuates so much that mortalities occur.

BOTTLE-NECKS FOR THE EEL STOCKS IN THE YSER CATCHMENT

The first difficulty glass eels encounter is during the penetration in fresh waters at the **sea sluices**. Mechanical arrangements and/or appropriate management can facilitate migration. Elvers trying to migrate upstream encounter many **weirs or dams**. **Lock gates** and **sluice flap valves** at the connection points between canals or ditches and the river are often closed and do not permit eels to reach these waters.

Water quality is a major problem limiting development of normal fish populations in the Yser river system. Zones of bad water quality quite often function as mechanical barriers which are impossible to pass. Large fluctuations in quality occur and temporal passage of poor water force the eels to search for other routes.

Eutrophication has led to not only **improverishment** of the fish population density and species diversity, but also of the **habitat quality** in general, eg. to the decrease of the reed fringes (*Phragmites*) which are especially important for foraging eels. Only large scale water purification programmes could solve this problem.

An important part of the aquatic environment of the Yser valley comprises interconnecting ditches, many of which are weed-chocked or dry. As a result, a large water area particularly suited as spawning places for fish and foraging places for eel is being lost. For the Yser area with its critical fluctuations in water quality, these ditches play an essential role as **escape routes** and **refuges** for fish faced with a temporal pollution. Bank owners which are responsible for managing these ditches should be called upon.

Underground water uptakes may be a barrier for migrating fish. At water intake points, screens to prevent intake and injuries to eels should be provided.

When setting up a restoration programme for a particular species, special attention should be given to the production of individuals able to reproduce. Fisheries biologists concerend with the status of eel stocks should emphasized that a protection programme for the silver eel and its migration is of major importance for the restoration of the eel stocks. Two major problems occur for the silver eel in the Yser valley.

As the Yser valley is essentially a polder landscape, with extensive and flat areas below the Yser level, draining of the land during heavy rain season (autumn) is performed by pumping water up into the Yser. Denayer and Belpaire (1992a) and Jansen (1992) showed that the silver eel run in the polders of the „Blankaart Nature Reserve" (water surface 48 ha) was initiated by **activity of the pumps** which cause a stream current in polder waters. For this area, a silver eel production of 2.5 kg/ha was calculated during a 3-day survey. As the pump which drains this area is of a centrifugal type ($2 \times 60\ m^3/min$), the authors assumed no eels could reach the Yser alive. Only fragments of eels could be found in nets placed after the pumps. Pumps causing high mortality of migrating fish should be banned. They should be replaced by a more friendly pumping system, screened by the by-passes to prevent eel passing through. A priority list for the most damaging pumps in Flanders (based on strategic location of the pumps on major migration routes) has been composed (Germonpre, in press). Experiments on pumps showed that eel mortality was zero with an Archimedean screw pump (although 23% of the eels did show some injuries (Denayer and Belpaire 1992b).

No professional eel fisheries exist on the Yser. However, poachers use prohibited fishing gear to catch eels. In some parts, fishing with square fishing nets is allowed which catch migrating silver eels. Denayer and Belpaire (1992a) estimate that considerable part of the silver eel run of the „Blankaart" polders is caught by these fishermen. Therefore, it is important that **fisheries regulations** should also focus on the protection of emigrating potential eel spawners.

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STRESZCZENIE

WĄSKIE GARDŁA PROGRAMU RESTYTUCJI POPULACJI WĘGORZA, *ANGUILLA ANGUILLA* (L.), W ZLEWNI RZEKI YSER (FLANDRIA)

Przedstawiono wstępne wyniki badań oraz aktualny stan populacji węgorza w rzece Yser i jej dopływach. Przedstawiono dane dotyczące wchodzenia do rzek węgorzyka szklistego w ostatnich latach oraz w okresach wcześniejszych. Na kilkunastu stanowiskach położonych w zlewni badanej rzeki przeprowadzono obserwacje węgorza żerującego uwzględniając czynniki hamujace rozwój normalnych stad, szczególnie przeszkód uniemożliwiających migracje różnych stadiów rozwojowych węgorza. Przedstawiono propozycje co do metod poprawy stanu środowiska wodnego, które pozwoliłyby węgorzom na odbywanie normalnych wędrówek oraz działań niezbędnych do restytucji węgorza w zlewni rzeki Yser.