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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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ABSTRACT

This paper describes some preliminary results on the status of eel populations in the river Yser and its affluences. Data on glass eel migration at the river mouth during recent years are presented and compared with earlier observations. On several localities during three successive periods populations of yellow eel were studied. Attention is given to all factors limiting development of a normal eel population, 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.

INTRODUCTION

During the last EIFAC Working Party on Eel sessions it became evident that serious concern should be given to the status of European *Anguilla* stocks especially because glass eel recruitment seriously declined and the habitat of inland population is getting lost (EIFAC, 1989 and 1991).

In order to know and describe the situation in Flanders a research program was started aiming not only to collect data on the status of *Anguilla* in Flanders but to suggest a concrete action and management program for the aquatic habitat with as central view the amelioration of the condition for fish life in general, but with special attention to eel. As for various reasons the river Yser was of particular interest for eel, this river catchment was selected as model. The program started up in 1991, aims to study eel population in the Yser catchment and more specifically (1) glass eel migration in Nieuwpoort, (2) yellow eel population in the Yser and its affluences, (3) silver eel runs, (4) draw up an 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 contaminates in eel.

This paper gives some preliminary results of some aspects of this study.

MATERIALS AND METHODS

The river Yser basin and its importance for eel populations

The hydrographical status of the river Yser is limited: the stream is 76 km long and the upstream part (43 km) is running through France. Only the Flandrian part of the river was studied and is described here. With the exception of a quite limited hilly part in the South ("Vlaams Heuvelland"), the Yser area is characterised as a flat polder landscape containing numerous ditches, brooks and canals. This hydrographic maze represents an important part of the Flandrian aquatic natural environment.

The stream is running through an area with intensive agrarian activities (pork production), which is responsible for 65 % of total pollution load of the river (72 000 i.e.). Also industrial activities are known to pollute the river (50 000 i.e.). Consequently, water quality of the Yser is gradually decreasing downstream. Incoming water of affluences and canals may locally influence the quality of the water considerably. Smuggle draining is an acute problem, especially in the most upper parts which have the best water quality.

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

The Yser is since long known as an eminent eel area. The neighbourhood of the sea, a brackish water transition zone, the numerous ditches and brooks with well developed reed fringes were predilection biotopes for foraging eels. Anglers came from far to catch eels by 'peuring'.

However with decreasing quality of the water eels seemed to disappear.

While initially (period 1950-1970), eutrophication resulted in a decrease of fish species such as roach and rudd and piscivorous species (pike and perch) and simultaneously an increase of the eel population (according to data of angling activity analyses from Timmermans, 1976, see Figure 1), with increasing eutrophication during the seventies eel populations seem to decline drastically.

Monitoring of Glass eel migration at Nieuwpoort

Each year since 1964 glass eel are caught at the sluices "Iepersas" at the mouth of the Yser (Figure 2). The river mouth at Nieuwpoort is the best place in Flanders to collect data on glass eel migration as the other localities (a.o. Scheldt, Blankenbergse Vaart) where glass eel are known to migrate upstream are very difficult to sample. The sluice is quite small (50 m long) and the old lock-gates are to be controlled manually. There is no commercial fishing for glass eel. This small scale station allows simple and standardized sampling.
Three persons are sampling during approximately 30 nights in the period March - April. Each fishing session takes 2-3 hours. Fishing is performed by pulling a dipnet with a long handle along the south quay wall.
At night no navigation through the sluices takes place. The lock-gates are of an old type with turning gates and allow seeping of water. To evaluate passage of glass eel succeeding in coming through this sluices all glass eel at the inland side was caught by means of cutting off the sluice with a Hamen net as used in Portugal (Minho) and described by Weber (1986).
Glass eel caught at Nieuwpoort are distributed over Flandrian waters for restocking.

Monitoring yellow eel populations in the Yser catchment

In order to try to monitor eel populations in the Yser area a sampling strategy was worked out consisting in sampling eels by means of fyke nets. For several reasons sampling was restricted a spring and an autumn period. Sampling localities (Figure 5) were chosen all over the Yser basin, for some localities regular water quality measurements were available (IHE, 1990 and VMM, 1990). Sampling was achieved over three periods: autumn 1991 (25 September - 12 November 1991, 14 localities), spring 1992 (7 April - 12 May 1992, 13 localities) and autumn 1992 (22 September - 20 October 1992, 23 localities).
Each locality was sampled by means of a fyke which was set perpendicular to the river bank. The fyke nets were all identical, with 3 inks (2 m) and a 1.7 m long wing. The opening hoop has a diameter of 40 cm, mesh size is 10 mm. Fyke nets were controlled once a week. All fish species were weighed, measured and released in the water. The occurrence of dead or diseased fish was noticed.

Bottle-necks for the natural eel populations in the river Yser area.

By a number of field visits in the Yser valley it was possible to make an inventory of all possible obstructions for the development of a normal eel population which should succeed in reaching its spawning grounds.

RESULTS AND DISCUSSION

Glass eel catches and penetration through the sluices

Various studies reported the glass eel influx at Nieuwpoort on the river Yser. Belpaire and Ollevier (1987) gave figures for total catches during the period 1973-1986, whereas Belpaire et al (1991) gave an overview for the years from 1964 up to 1991. Denayer and Belpaire (1992c) gave figures of the glass eel catches in 1992 and described the morfometric characteristics of incoming glass eel. By marking glass eel (Bismarck coloration techniques) the authors obtained data about fishing efficiency in the sluices, accumulation of glass eel in front of the lock gates and passage of glass eel through those gates.

The figures of yearly catches were completed with the 1993 catch in Figure 3. In 1991, 1992 and 1993 catches were respectively 13.0 kg, 18.8 kg and 11.8 kg: extremely low figures compared to the mean of the total yearly catches of the period 1970-1979 (Table 1). When considering the fluctuation of the maximum day catch the same phenomenon is evident.

As the glass eel recruitment is very poor it is extremely important to elaborate an adequate management program in order to enable a maximum number of glass eel to reach their inland growing habitat. Beside restocking programs for inland waters, sluice managers should be aware of this and should allow glass eel to pass successfully through the sluices. In order to evaluate this passage through the seasluices of the Yser an experiment was set up using a Hamen net at the inland side of the sluice. The results are represented in Figure 4 and show that glass eel could only be found after the lock-gates after seeping of water was observed. Seeping by upcoming tide took place a few minutes after the sea water level reached the normal Yser level (3.14m). This one-day experiment demonstrated that for one kg of glass eel fished at the sea side of the lock-gates only 0.247 kg is succeeding in passing the gates and is able to reach fresh water.

Sea sluices where no regular ship transfer takes place should apply in the migration season a special adapted management to help glass eel penetrate through inland waters, either by allowing seeping or sluicing a certain quantity of sea water at upcoming tide (with accumulating glass eels), or - if technically feasible - by opening sluice doors for a short moment at equivalent water levels. If, for security reasons no such managements of sea sluices is possible, technical arrangements have to be installed to siphon migrating glass eels over the barrier.

Yellow eel populations

Table 2 shows that CPUE (expressed as biomass of eel caught per fyke per day) may differ considerably between the various localities giving evidence eel biomass is quite different over the whole area. Many ecological or other factors may be responsible for this. However it is assumed that on many localities eel populations are beneath their potential densities. At one locality water quality did not permit any fish life (Handzamevaart). Also when considering the length frequency distributions of several sites as illustrated in Figure 6 it is evident that population structure differs considerably from one site to another and mostly do not represent distribution of individuals of a normal population. When looking to the eel mortalities caught in the fyke (Table 3) and to other data of Denayer and Belpaire (1992a) it may be concluded that for some waters water quality is fluctuating so much that mortality regularly occurs.

Bottle necks for the eel population in the Yser catchment

As already stated, the first difficulty glass eel encounters is during the penetration in fresh water at the sea sluices. Mechanical arrangements and/or an appropriate management can facilitate migration.

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

Eutrophication has led to not only apoverishing of the fish population and species diversity, but also to the habitat quality in general, a.o. to the decrease of the reed fringes of *Phragmites* which are especially important for foraging eels. Only large scale water purification programs are able to solve this problem.

An important part of the aquatic surface of the Yser valley is taken in by ditches which are connected to the Yser or one of its affluences. At this moment many of these ditches are getting landed: they are colonised by bank vegetation and get dry. As a result, a large water area particularly suited as spawning places for fish and foraging places for eel is getting lost. For the Yser area with its critical fluctuations in water quality these ditches play an essential role as escape routes for all fish faced with a temporal pollution. Bank owners which are responsible for managing these ditches should be called upon.

Elvers trying to migrate upstream encounter many mechanical obstructions: on many places weirs or dams cut off their route. Lock-gates and one way draining valves at the connection point between canlas or ditches and the river are often closed and do not permit eels to reach these waters. In some cases affluences are simply cut off from the main river by means of an earthen dam.

Underground siphons may be a barrier for migrating fish.

In some cases human activities necessitate water intake. In these water intake points intake and injuries of eel should be prevented.

When setting up a restoration program for a particular species special attention should be given to the protection of individuals able to reproduce. Fisheries biologists concerned with the status of eel stocks should emphasize that a protection program for the silver eel and its migration is of major importance for the restoration of the eel population. For the silver eel in the Yser valley two major problems occur.

As the Yser valley is essentially a polder landscape with extensive and flat land areas lower than the Yser level, draining of the land during the heavy rain season (autumn) is performed by pumping water up into the Yser. Denayer and Belpaire (1992a) and Jansen (1992) showed that silver eel run in the polders of the "Blankaart Natural Reserve" (a total water surface of 48 ha) was initiated by activity of the pumps which cause a stream current in these polder waters. For this area a silver eel production of 2.5 kg/ha was calculated during a 3 days survey. As the pump which is draining this area is of the centrifugal type (2 x 60 m^3/min) the authors assumed no eels could reach the Yser alive. Only phragments of eels could be found in the nets placed after the pumps. These pumps which cause a high (total?) mortality for migrating fish should be banned in future. Existing pumps should be replaced as much as possible by more fish friendly pumping systems or a bypass way should be build to prevent eels passing through these pumps. A priority list for the most damaging pumps in Flandres (based on strategic location of the pumps on major migration routes or nearby important eel population) is set up (Germonpre, in press). Experiments with more fish friendly pumps showed that eels which were brought into an Archimedean screw pump did not present any mortality (although 23 % of the eels did show some injuries)(Denayer and Belpaire, 1992b). As an example an overview of bottle necks for eel migration in the Zuid IJzer Polder is given in Figure 7.

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

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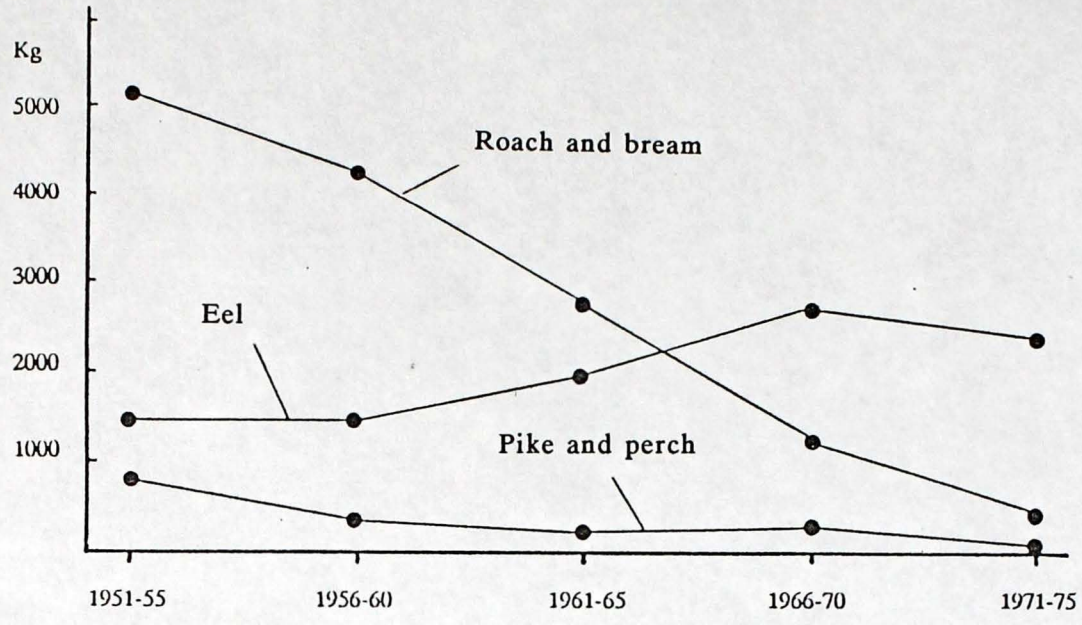

Figure 1 : Evolution of the anglers catch on the Yser from 1951 to 1975 (after Timmermans, 1976).

Table 1 : Yearly glass eel catches in kg (total year catch and maximum day catch) on the river Yser at Nieuwpoort: comparison between the period 1970-1979 and 1980-1989.

	Total year catch		Maximum day catch	
Period	1970-79	1980-89	1970-79	1980-89
Mean ± S.D.	519 ± 196	64 ± 72	57 ± 16	16 ± 20
Min - Max	(274 - 946)	(6 - 252)	(30 - 88)	(1-74)

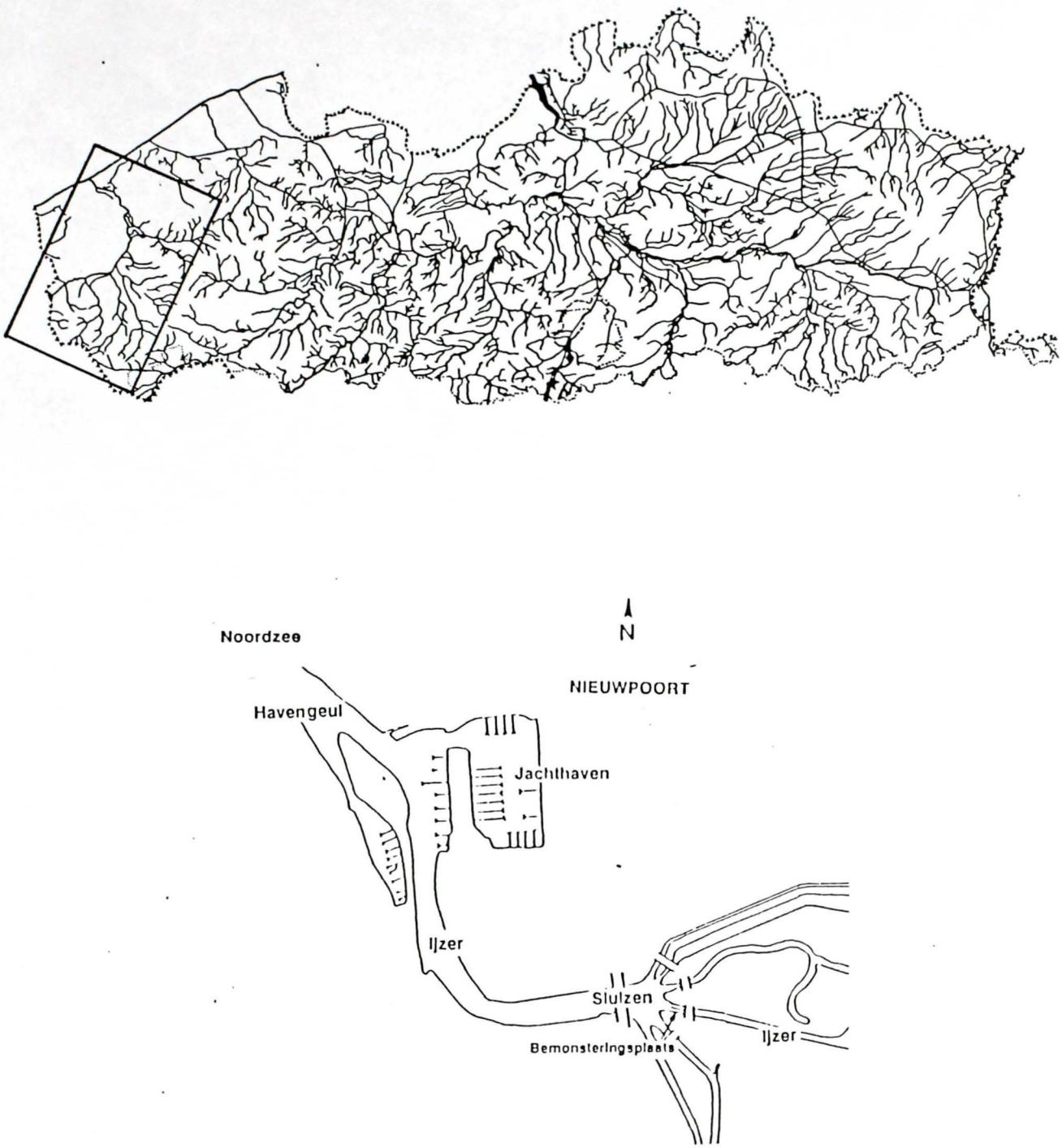

Figure 2 : Location of the Yser catchment in Flanders and sampling locality for glass eel at the sluices of the Yser river mouth at Nieuwpoort (from Belpaire et al, 1991).

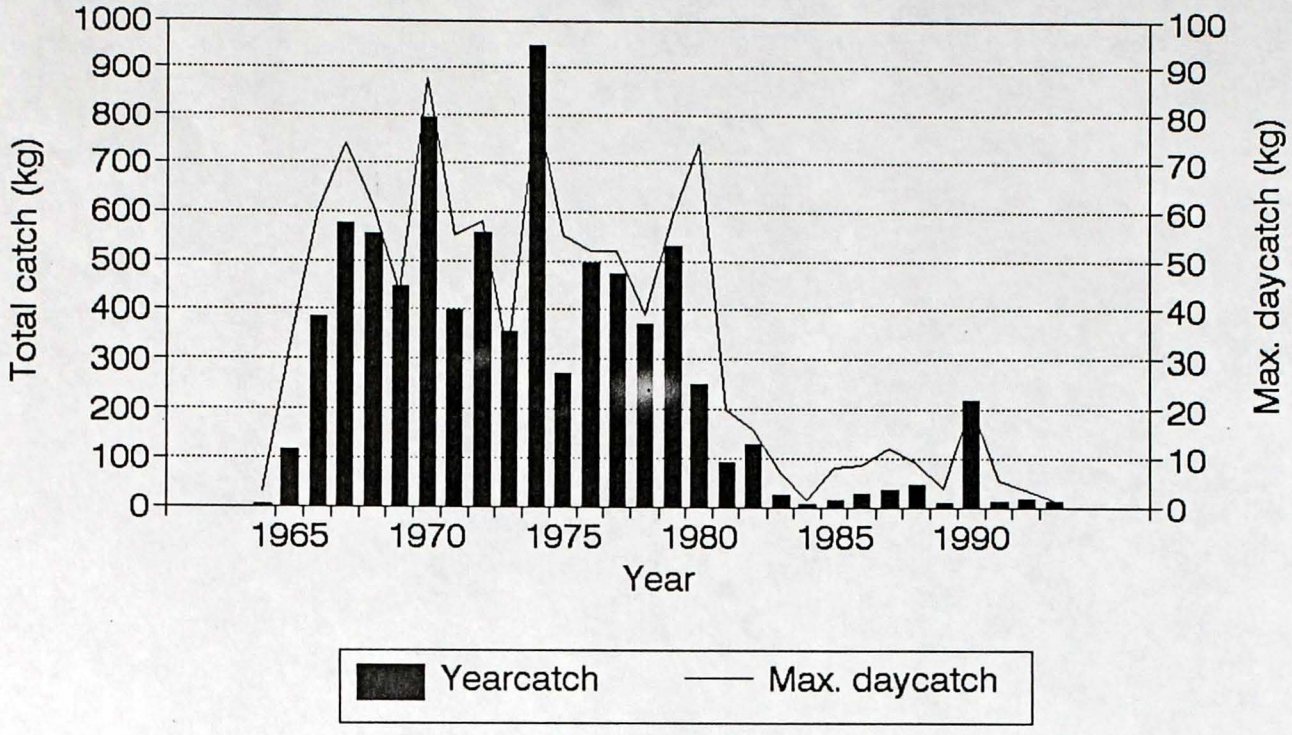

Figure 3 : Yearly glass eel catches (total year catch and maximum day catch) on the river Yser at Nieuwpoort in the period 1964-1993

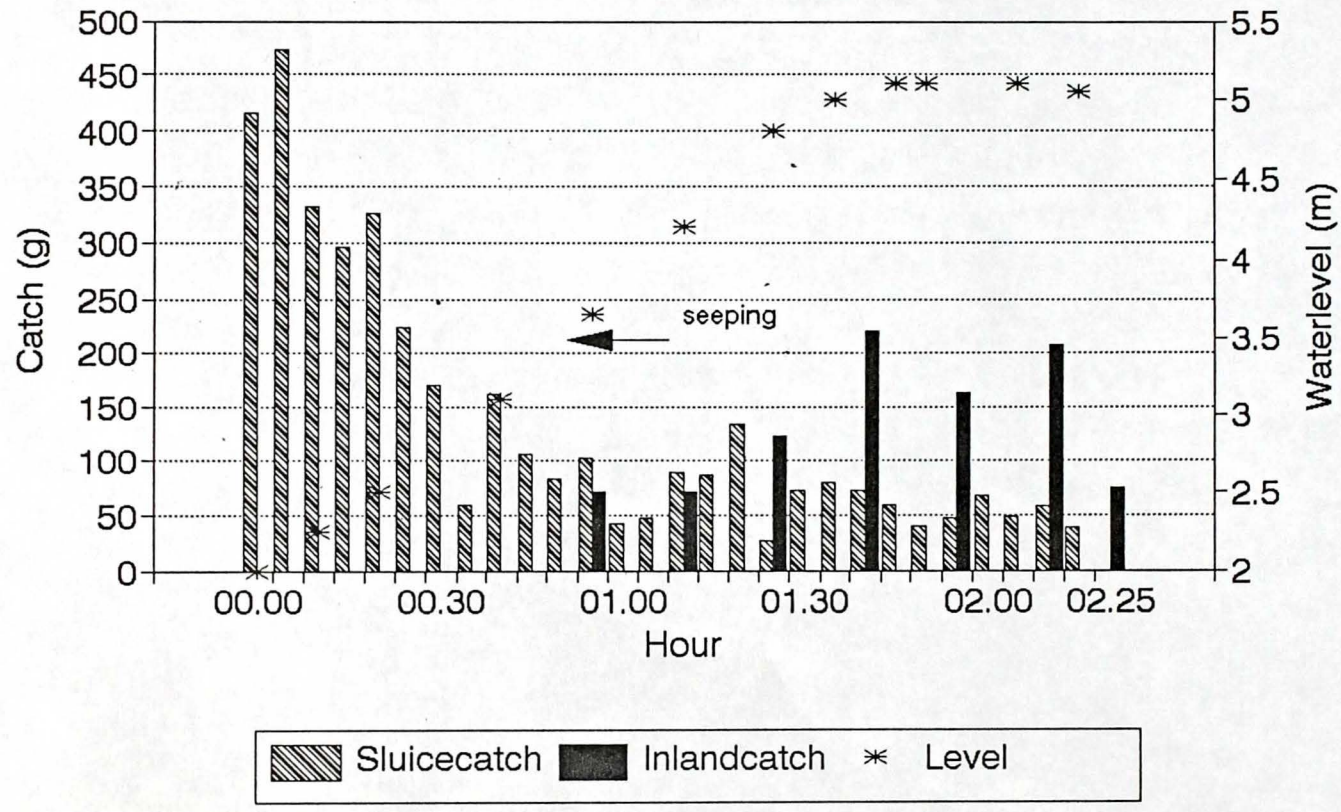

Figure 4 : Catches of glass eel by means of the dip net along the quay wall and catches of succesfull glass eel by means of a Hamen net after the sluice in function of water level (Nieuwpoort, 20 March 1992).

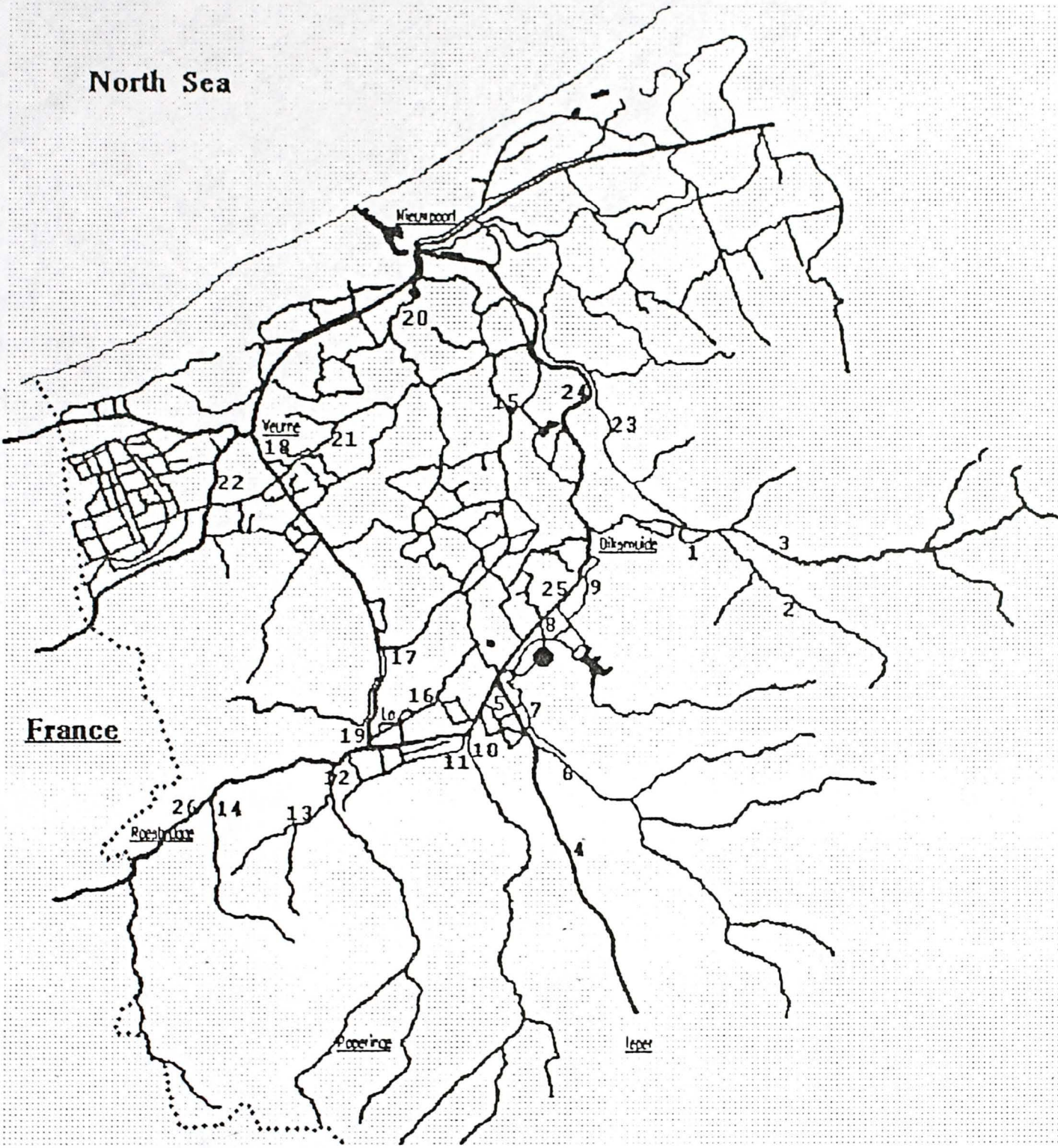

Figure 5 : Sampling localities for yellow eel in the Yser valley during 1991 and 1992. Numbers in the figure refer to locality names in Table 2 and 3.

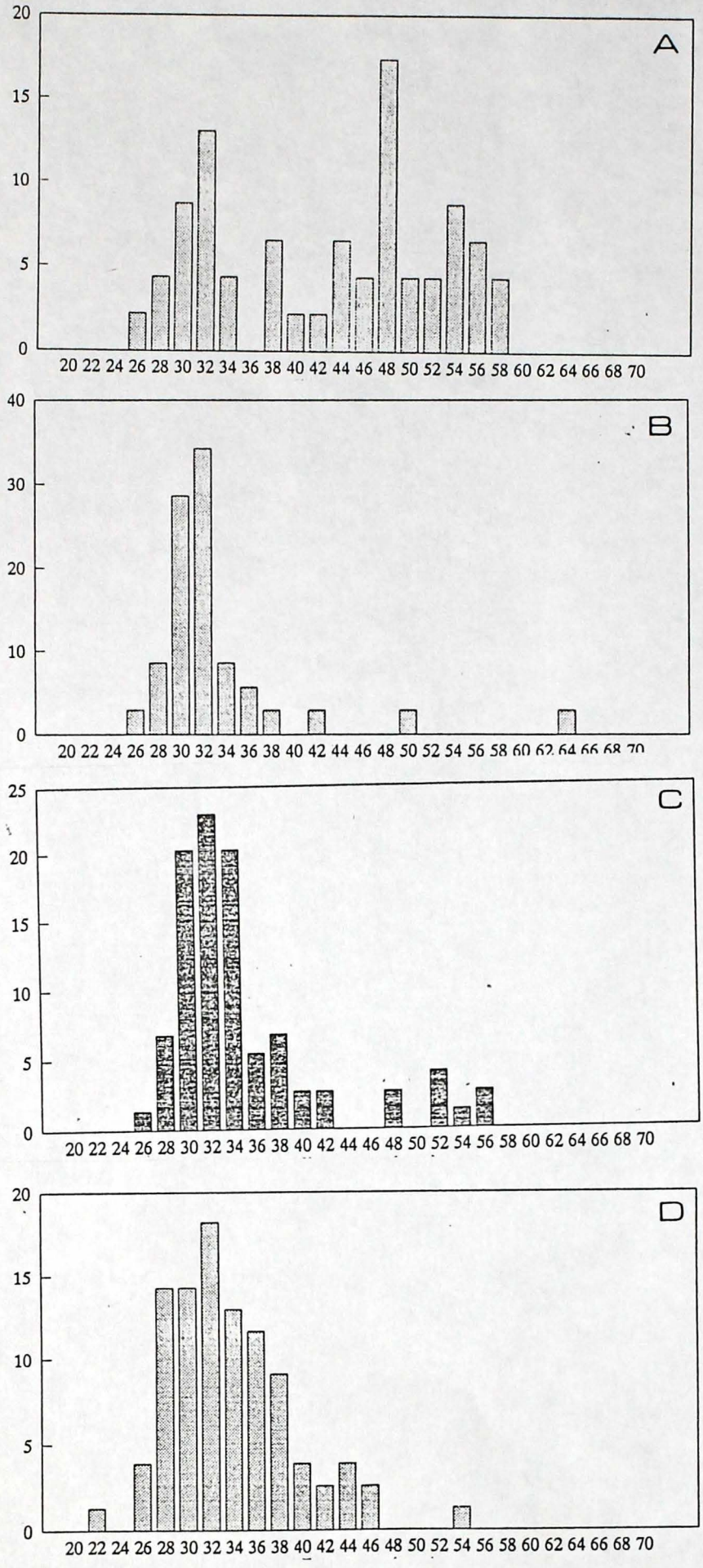

Figure 6 : Length frequency distribution (Relative frequency in % vs length in cm) for yellow eel populations from 4 different localities in the Yser basin: A = Grote Beverdijk (16), B = Heidebeek 13), C = Poperingevaart (12), D = Ieperkanaal (5) (from Denayer and Belpaire, 1992a).

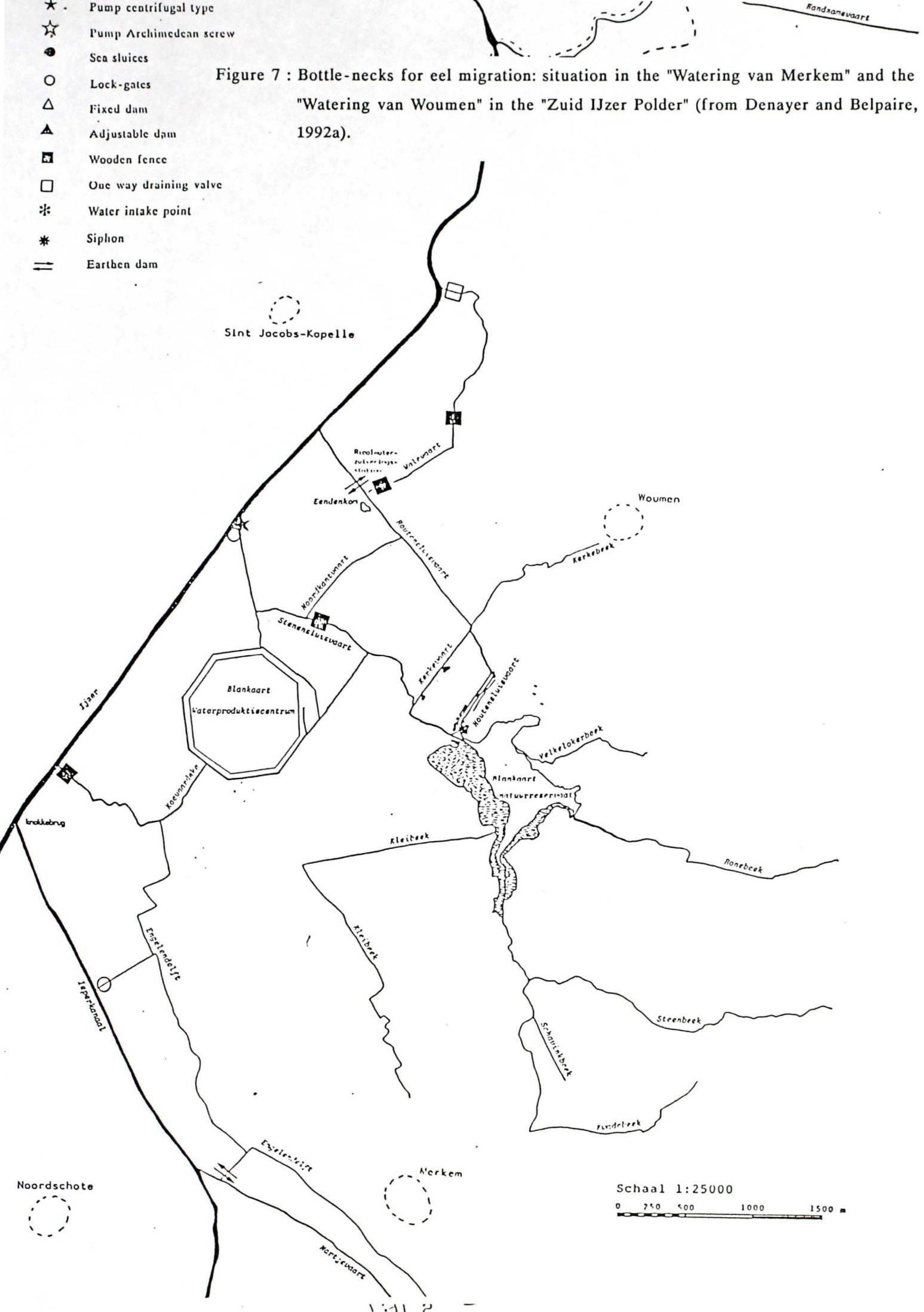

Figure 7 : Bottle-necks for eel migration: situation in the "Watering van Merkem" and the "Watering van Woumen" in the "Zuid IJzer Polder" (from Denayer and Belpaire, 1992a).

	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

Table 2 : 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	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

Table 3 : 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.