Case Study Description

Garonne, France

Gerard Castelnaud
Inland Living Aquatic Resources Research Unit, Cemagref, Agricultural and Environmental Engineering Research Institute
50, av. de Verdun, Gazinet, 33612 Cestas cedex, France
Tel. + 33 5 57 890 803, Fax. + 33 5 57 890 801
gerard.castelnaud@bordeaux.cemagref.fr

1 General presentation

The Garonne basin, situated in the South-West of France has a total surface of 81000 km^2 with a total cumulated length of the main rivers of 3414 Km. It comprises (**Figure 1**):

- the Brackish Estuary : 70 km long, 635 km^2 surface;
- the Fresh Garonne river: 478 km long, 57 000 km^2 surface, mean flow : 647 m^3/s (65%);
- the Fresh Dordogne river: 484 km long, 24 000 km^2 surface, mean flow : 342 m^3/s (35%).

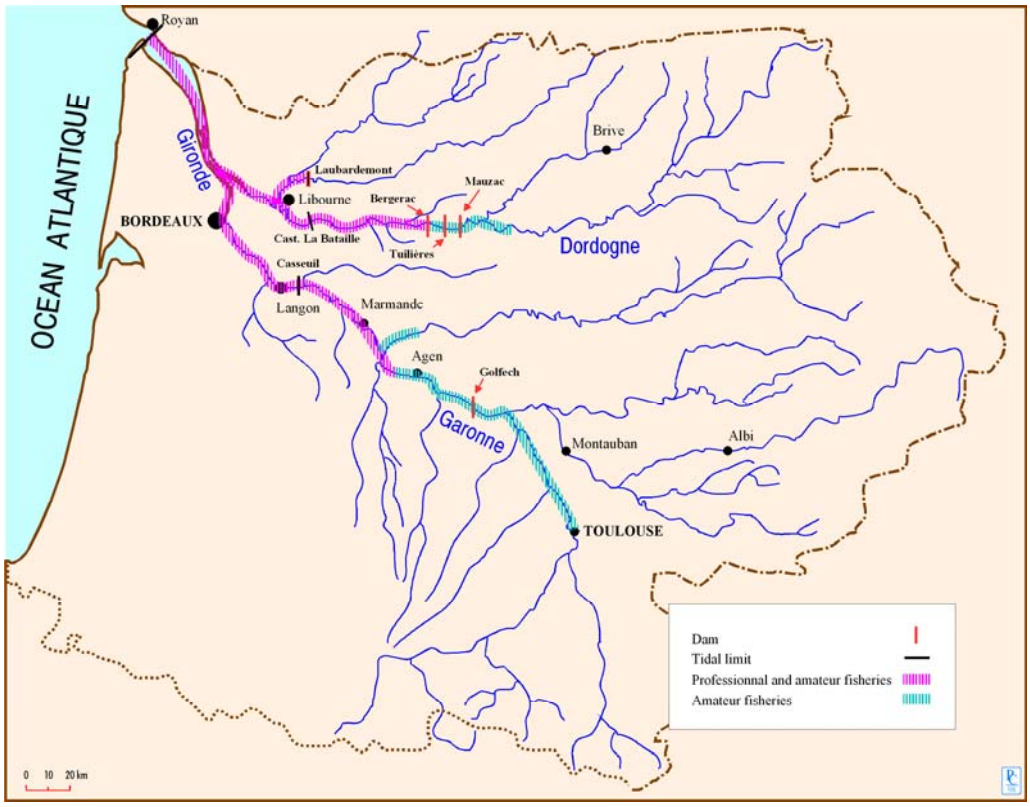


Figure 1: the Garonne basin with the tidal limits (Gironde sub-basin), the first dams on the main rivers and the eel fishing areas

The eel fishery occur at present downstream the main dams (**Figure 1** , pink section) of Garonne river (Golfech), of Dordogne river (Bergerac) and of the Isle tributary (Laubardemont). In the past there were some professional and amateur fishermen seeking for yellow eel above these dams (**Figure 1** , blue section).

In fact, the Eel fishery which concerns the glass eel and yellow eel stage is concentrated in the Gironde sub-basin (**Figures 1 and 2**) which is the tidal part of the Garonne basin comprising the brackish estuary and the tidal freshwater reach of the Garonne river, Dordogne river and of its tributary, the Isle river.

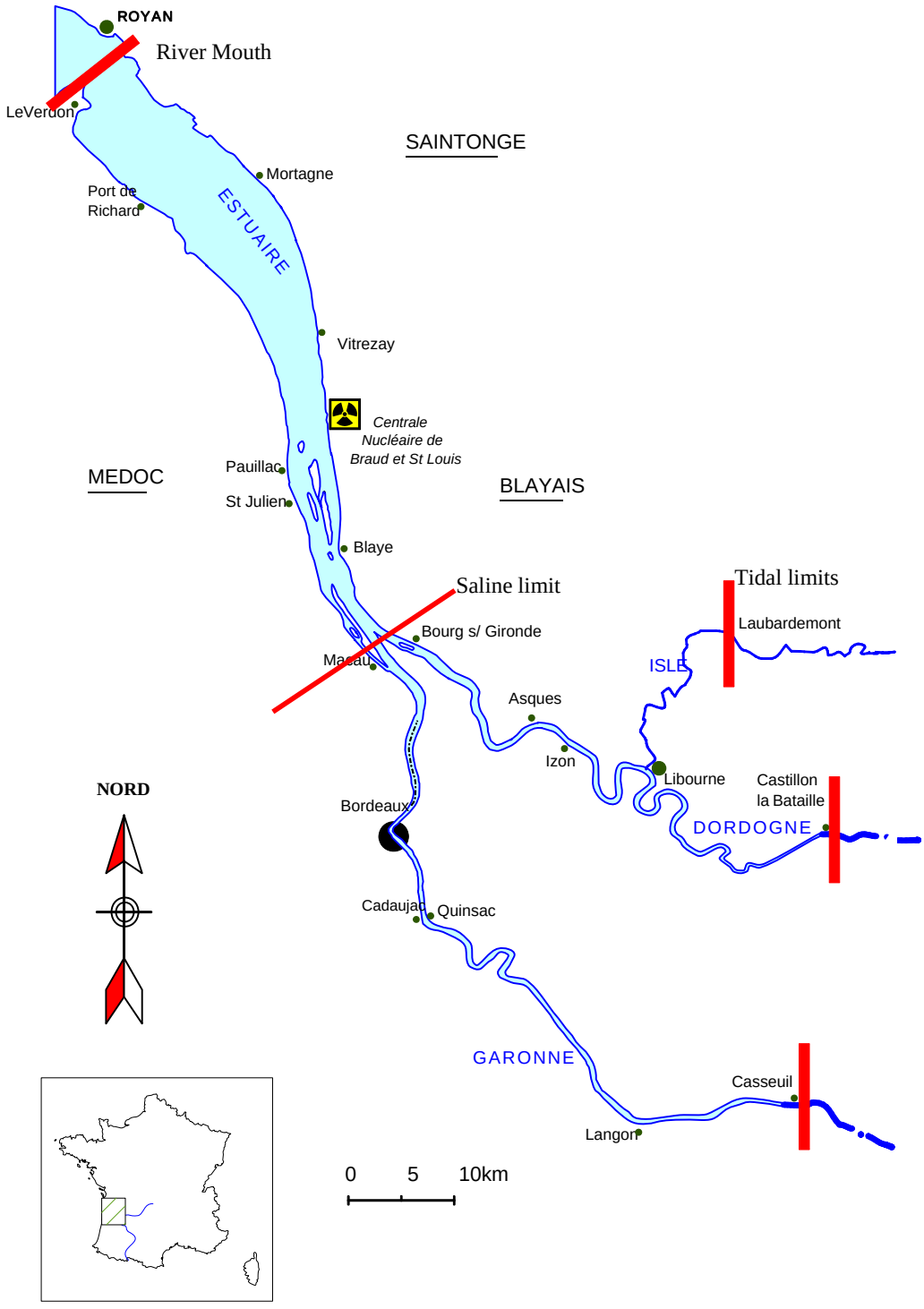


Figure 2: The Gironde sub-basin with the administrative limits

2 Administratives limits, fishing regulations and main management tool

The administrative saline limit separate the brackish estuary under marine regulation and the freshwater rivers under fluvial regulation (**Figure 2**). In the rivers upstream from the saline limit, the fluvial professionals and the fluvial amateurs fishermen are authorized to fish. They are not allowed to go downstream the saline limit. In the "tidal freshwater reach", comprised between the saline limit and the tidal limit, some marine professional fishermen can fish along with river fishermen while the most part of them are located in the brackish estuary.

A system of licenses and glass eel stamps with quotas is set up for marine fishermen and river fishermen in these inland waters.

In the rivers under fluvial regulation, the licenses are delivered to fishermen by the local Fluvial Fisheries administrations. In the estuary under marine regulation, the authorization to fish depends on the local Marine Fisheries Administrations.and the licenses are delivered by the fishermen organization "Commission des poissons Migrateurs et des Estuaires".

To manage the migratory species and their fisheries all along the watershed (under marine and fluvial regulation), a special organization, called "Comité de Gestion des Poissons Migrateurs" (COGEPOMI) of the Garonne basin, has been created in 1994. It gather representatives of fishermen organizations, administrations and research centers. The COGEPOMI propose a management plan and funding every five years and has to monitor them. The plan determines conservation and management actions, restocking operations, propose fishing regulations, etc for both recreational and professional fisheries (see **table attached to France Management Questionnaire** for more complete presentation).

Until now, these management plans did not aim at achieving a particular escapement rate for eel, and the results of management actions have not really been evaluated. While this system allows a global approach, and tries to solve environmental problems such as dam or turbine mortality, it does not give for the moment, a consistent management basis for eel at the national and local level by lack of central regulation and designing of practical management rules (see **France Management Questionnaire** for more complete information).

3 Fisheries monitoring

3.1 The different systems

The marine professional fishermen in the brackish estuary and the tidal part of the rivers have been monitored since 1993 by the Centre Régional de Traitement Statistiques CRTS depending from the Direction des Pêches Maritimes et de l'Aquaculture (DPMA) of the Ministry of Fishery and Agriculture. There is a lack of reliability of the data available.

The river professional fishermen in freshwater rivers have been monitored since 1999 by the Conseil Supérieur de la Pêche (CSP) in the frame of the « Suivi National de la Pêche aux Engins et aux filets » (SNPE) in connection with the local professional association (AADPPED de Gironde). The amateur fishermen have been monitored more recently.

These two monitoring system are based on compulsory declarations of captures and effort using fishing forms collected monthly. They are supposed to permit completion of CEMAGREF monitoring which has been developed in the Gironde basin.

3.2 The Cemagref system

Two stages are monitored: glass eel (from Va to Va 4, mainly Vb) and yellow eel. This monitoring approach is only concerned with the glass eel stage .

The data are obtained from a sample of cooperative professional fishermen. This cooperation is the result of a diplomatic approach to create a confidential and personal contact. Catch and effort data are registered generally per day or per fishing operation from the personal fishing book of the fisherman with comments. All the information about the fishery is registered, particularly environmental information and fishing effort information, about the individual fisherman and other fishermen in his fishing area.

The data are stored in a database “GIRPECH” and are used to estimate three fishing indicators for each fishing method : total fishing effort, total captures (by extrapolation of the data of the sample to the total population of fishermen) and CPUE by month and season.

3.2.1 Data quality

These data can be considered of high reliability because of the common way of collecting data from fishermen with an official statistical system. An important part of this investigation concerns contacts with fishermen in the field and cross-checking information as an assurance of confidence and accuracy of the data collected.

The sample of professional fishermen represents presently 25%-30% of the total population which is the maximum percentage which can be expected to give reliable data.

3.2.2 Spatial and temporal consistency

The CEMAGREF system used to collect data and to ensure the quality of the data, has been in place since the beginning of the study in 1976 (first data collected for season 1976-1977). This system has improved in the last 10 years (1991-2000) because of the evolution of the status of the commercial fishery and because of better relations between fishermen and scientists.

Better relations with the older and more recent fishermen has permitted the collection of verifiable data from the period 1977-1990. The total number of fishermen has decreased and the magnitude of the sample has increased, leading to a better representativity in the data.

3.2.3 Framework

The eel monitoring conducted by CEMAGREF is included in a more general monitoring of commercial target species in the Gironde. The monitoring of the glass eel is the best among all species, along with the monitoring of the marine lamprey, due to sample size and data accuracy. This monitoring is carried out by CEMAGREF because of the obligation for Electricité de France (EDF), to evaluate and monitor the impact on the aquatic environment of the nuclear power plant on the left side of the estuary.

EDF is supposed to continue to finance this operation of monitoring the commercial fishery. but the administrations involved in fishery management are required to participate in it.

Total costs: 50 000€ including collect of data, storage, exploitation and reporting.

4 4- Eel fisheries in the Gironde sub- basin

The data and results are available for the glass eel and yellow eel fisheries only in the Gironde sub- basin for the period 1978-2003.

4.1 Gears and Fishing effort

4.1.1 For glass eel

In the estuary the professional fishermen use a “pibalour” which is a push net. The gear is composed of 2 rectangular frames of 5-7*1m dimension each. The maximum surface area authorised is 14 m2 and the most part of fishermen use it. The net is pushed at the front of a boat which varies in size from 9 to 12 m ; the power should not exceed 100CV (in theory).

Since 1996 in the Garonne, Dordogne and Isle fresh river, a push net has been authorised for the professional fishermen ; this push net is composed of 2 circular frames of 1.20 m diameter, fixed on each side of a boat of 6-7 m long powered by an engine of 40-60 CV. In this fishing area, some professional fishermen continue to catch glass eel with the traditional gear which is a scoop net of 1, 2 m diameter manipulated by hand from a boat anchored to the bank. It was the only gear used by professional fishermen before 1996. The non-professional fishermen use the same scoop net manipulated by hand from the bank or from a boat anchored to the bank. The scoop amateurs net is 0.5 m diameter corresponding to 0.19 m^2. Illegal fishermen use scoop net of 1, 2 m diameter and different type of nets like big fike nets and fixed trawls.

The mesh size of all these gears is 1.5-2 mm square.

The fishing operation occurs only by night in the rivers, mainly by night in the estuary according to the tide. It generally lasts 3 hours in the rivers, 3-5 hours in the estuary.

4.1.2 For yellow eel

All the categories of fishermen in the Gironde sub-basin use plastic pipe traps of 1 m long, 0.2 m diameter; the mesh size is 1 mm square. The traps are attached by 10 to 20, each 5m, on a cable which is fixed on the bottom. They are baited with molluscs, worms, shrimps, lifted and reset each day or two days by the fishermen.

4.2 Fisheries data

4.2.1 Recent global results

• Glass eel fishery 2003: estuary, pushed net (pibalour): 69 professional fishermen, landings 9.5t; tidal part of the rivers: scoop net and small push net: 76 professional fishermen, landings 0.9t; 44 amateur fishermen+ poachers, landings :0.2t; total landings: 10.6t, 2144 000€.

• Yellow eel fishery 2003: Gironde, 68 professional fishermen, 74 amateurs fishermen, total landings 11t, 104 000 €.

4.2.2 Glass eel fishery

One of the notable features of the glass eel fishery in the Gironde during the 1978-2003 period is the major shift from scoop net catches in favor of large push net catches. The fishery is presently very largely a large push net fishery in the estuary, whereas formerly it was a mixed-gear fishery in both the brackish and fresh estuary (GIRARDIN *et al.*, 2005).

After a strong decrease of the glass eel abundance in the Gironde basin between 1981 and 1985, the situation at present seems stationary, at a very low level (**Figure 3**). The 2003 season is close to the worst historical level (2001).

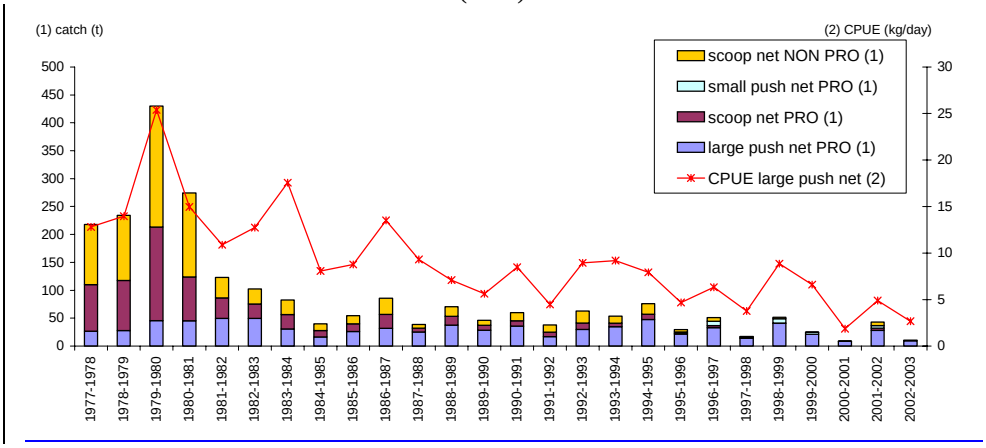


Figure 3: Cumulated capture of glass eel for professional and non professional fishermen, CPUE on the Gironde basin for 1978-2003 (Source: Cemagref)

The use of GLM model with these fishery data has permitted to correct the variation of catches and effort between fishermen. The glass eel CPUE in the Gironde is a valid abundance index, the same trend is obtained for two metiers (large push net and scoopnet) and two zones (brackish and fresh estuary) (BEAULATON and CASTELNAUD, in press). This result confirm the decreasing trend of glass eel in the Gironde basin (**Figure 4**).

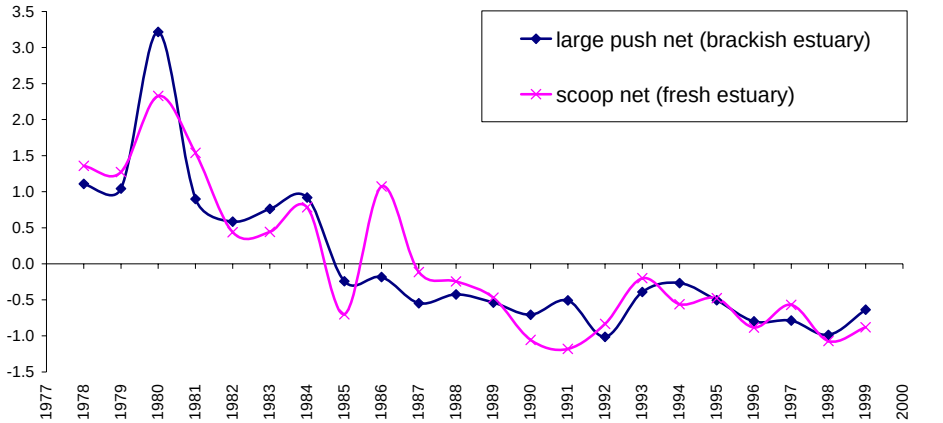


Figure 4: Standardized CPUE (from GLM) for the large push net (*Pibalour*) and the scoop net (*Tamis*) metiers for the period 1978-1999 (BEAULATON and CASTELNAUD, in press)

4.2.3 Yellow eel fishery

The eel pot CPUE for yellow eel has falled down between 1988 and 1989, slightly increased until 1998 before decreasing again until 2003 (**Figure 5**). The total catches have decreased while the number of fishermen has also decreased. But changes in the fishing power and in the tactics have increased the real effort and our effort unit does not reflect these changes. Consequently, this CPUE is not fully representative of the real current tendency of the abundance which presents certainly a more marked decrease(GIRARDIN *et al.*, 2005).

To analyse this situation, we set up a biological sampling through the professional fishery (2004 and 2005). This sampling permitted to precise the effort parameters, the stock structure and the fishing impact on the stock.

GLM methods will also be applied on eel pot CPUE, to precise and verify the tendency of yellow eel abundance.

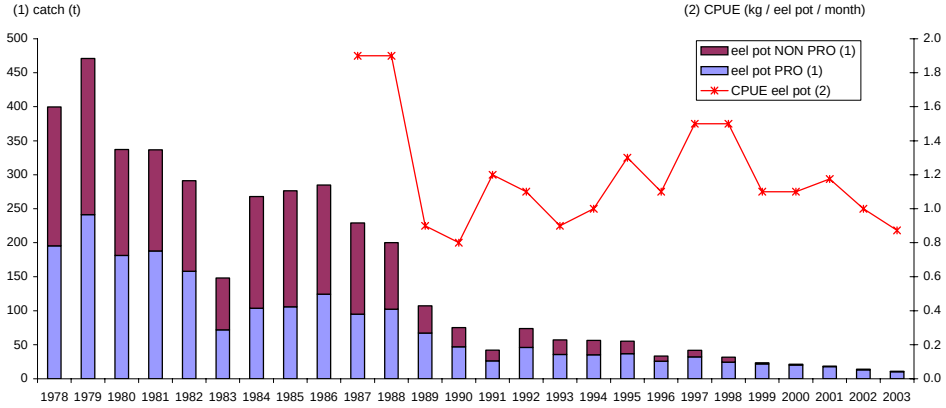


Figure 5: Cumulated catch of yellow eel for professional and non professional fishermen, CPUE on the Gironde basin for 1978-2003 (Source: Cemagref).

A study (LAMAISON, 2005) on age and growth of the eel has been carried out with different samples gathered in 2004 in the Garonne basin with (**Figure 1**):

- scientific fisheries with trawl in the brackish estuary, professional fisheries with pots in the brackish estuary and in the fresh river under the first dams (respectively Bergerac on the Dordogne and Golfech on the Garonne);
- electrofishing in several small tributaries;
- capture in the eel passes of the Tuilières and Golfech dam.

The results concerning 6393 eels collected show (**Figure 6**): that the growth rate decrease from downstream to upstream. It is better in brackish water (mean growth rate: 67 mm /an),

than in the tidal part of the fresh rivers with a difference between Dordogne (mean growth rate: 50 mm/an) and Garonne (mean growth rate: 53 mm/an), than in the eel passes with a difference between Dordogne (mean growth rate: 42 mm/an) and Garonne (mean growth rate: 44 mm/an).

The condition index confirm these results.

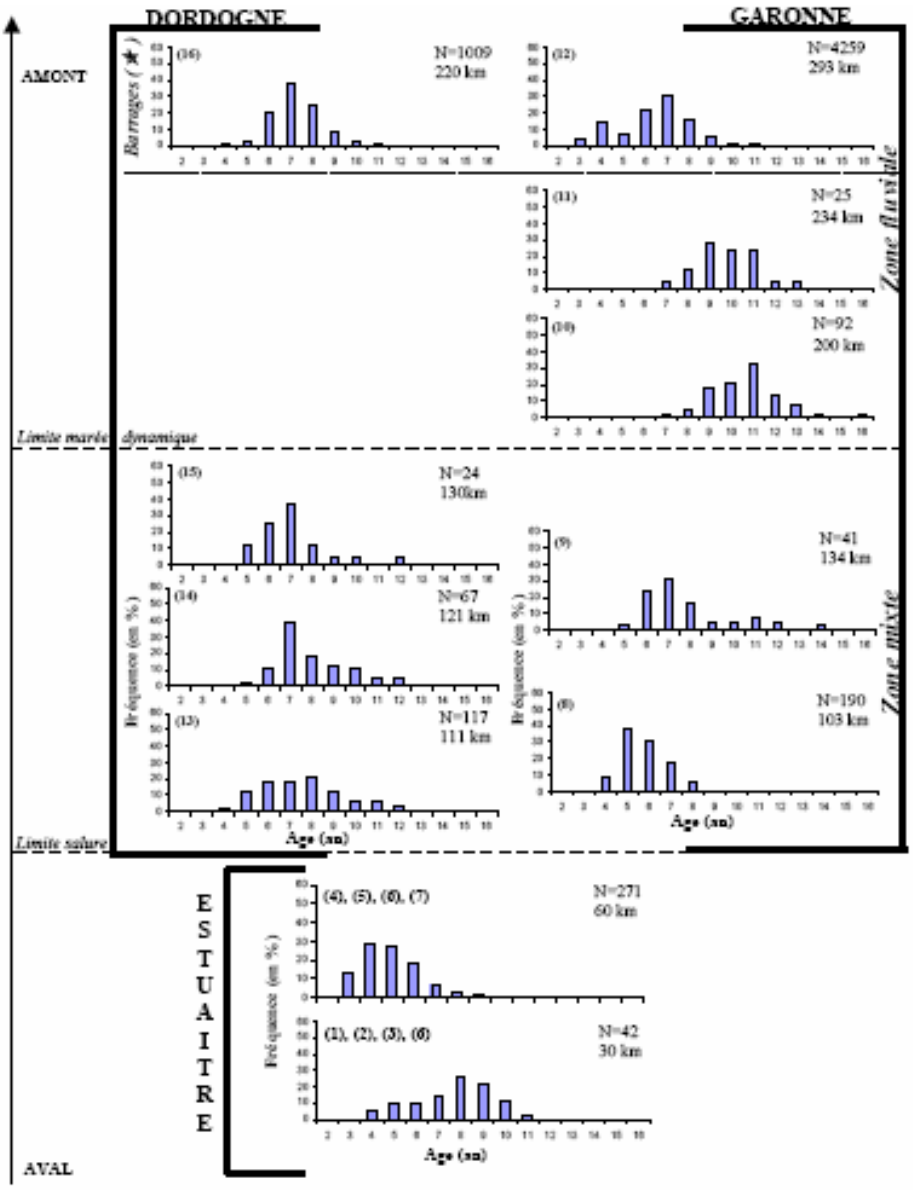


Figure 6: Age distribution of the eel sample from the Garonne basin from downstream to upstream; (location of the sample); on the right corner: Number of eels and distance to the sea.

5 Scientific surveys

5.1 Cemagref Experimental fishery

*The general Gironde survey consists in a monthly sampling of 24 stations (surface + deep) distributed along 4 transects. This monitoring uses a research vessel (**Figure 8**) and aims at evaluating the abundance variations of the juveniles of fish and crustacean and the adults of small species (FEUNTEUN* et al.*, 2002).*

5.1.1 Life stage

Two stages are captured: glass eel (from Va to Va4, mainly Vb) and elver. This monitoring approach is only concerned with the glass eel stage .

Site, location of the fishery experiments

The Gironde estuary, 70 km long, 3-13 km wide, 3-25 m deep, with a gradient of salinity from 0 to 18 %, is composed of two channels, the channel situated on the right side is regularly dredged for navigation. A nuclear power plant on the right side takes 168m3/s for cooling water.

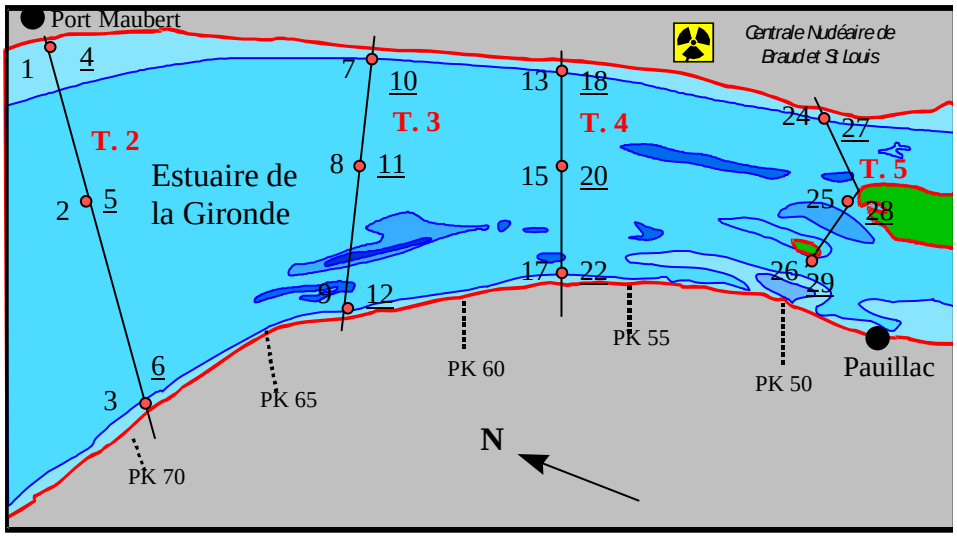


Figure 7: The area of fishing experiments with transects and stations

Since 1979, different stations have been fished during 5 min, regularly once per month , while physical an chemical parameters are collected (**Figure 7**).

Between 1979 and 1988, only one transect (T 4) was sampled in the middle of the estuary at 5 points, with one station on the surface and 1 station on the bottom.

In 1989 and 1990 the transects 3 and 5 were added.

Since 1991, 4 transects covering 20 km, numbered 2, 3, 4, 5 and containing 12 points with 1 station on the surface and 1 station on the bottom (one point close to each bank and one in the middle) have been investigated, once time a month, each month.

Gears

For the surface stations, 2 push nets of “pibalour” type fixed on each side of the research vessel are used (**Figure 8**) ; dimensions: 4*1 m.. For the bottom stations a net of trawl type maintained open by a rectangular frame and maintained above the substratum (0,2 m) by a pair of large skies is used ; dimensions: 2*1.2 m.

The mesh size for each gear is 18 mm (stretch mesh).

Figure 8: L'ESTURIAL, the research vessel of Cemagref with the gears

5.1.2 Data type

For each fishing operation we register exact time of fishing (normal duration 5 mn), volume of water filtred ; the glass eel are counted and stored in formalin or alcohol, for biometrics, pigmentation level.

During each fishing operation the weather parameters are registered: wind, sun, air Temp. ; The physical and chemical parameters are also registered: water Temp., salinity, conductivity, turbidity, oxygen saturation.

All methods are standardised, quality assured and covered by standard operating procédures.

The data are stored in a database"GIRPOIS".

5.1.3 Framework

The sampling of glass eel conducted by Cemagref is included in a general monitoring of juveniles of commercial target species and other small species of the Gironde estuary. This sampling is conducted because of the obligation for Electricité de France to evaluate and monitor the impact on the aquatic environment of the nuclear power plant on the left bank of the estuary.

EDF is required by law to continue to finance the scientific sampling of fish and crustacea until the nuclear power plant ceases to operate and possibly thereafter.

5.1.4 Costs

120 000 € including scientific fishing operations, storage of biological samples and data, exploitation and reporting.

5.2 Indicang Experimental fishery

A recruitment surveys as part of the Indicang program (European project) has been set up in the Isle (tributary of the Dordogne river) since 2004.

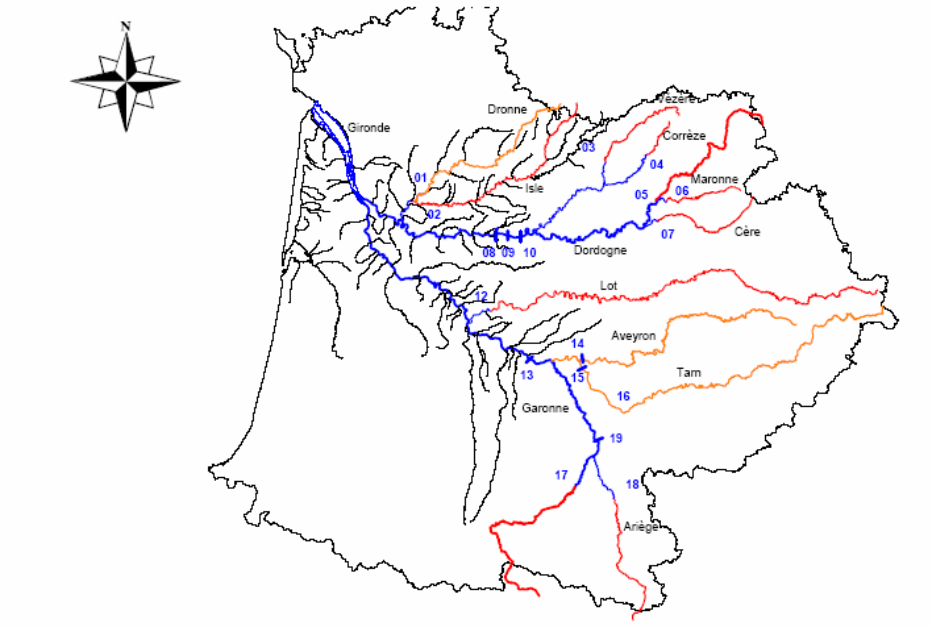
6 Dams and eel passes

The portion of the total cumulated length of the main rivers (3414 Km) which is currently accessible for eel colonization is around 40% (**Figure 9**).

Concerning the Dordogne river, its upper part and the upper part of the main tributaries (Isle, Maronne, Cère and Vézère) are considered as definitely non-accessible. On the middle part of the Dordogne river, 3 hydropower dams limit the upstream and downstream migration of eel but a specific eel pass has been settled at the Tuilières dam in 1997 which has strongly improved the migration possibilities. At present, the total cumulated length (573 Km) which is currently accessible for eel colonization is 38%.

Concerning the Garonne river, its upper part and the upper part of the Ariège tributary are considered as definitely non-accessible and the totality of the Lot and Tarn-Aveyron tributaries also. A specific eel pass has been settled at the Golfech dam in 2002 and at present, the total cumulated length (747 Km) which is currently accessible for eel colonization is 40%.

The fish passes monitoring (lifts and then specific eel passes of the Tuilières dam on the Dordogne river and the Golfech dam on the Garonne river) show that the number of eel controlled are very weak related to the situation of the dams and the magnitude of the river sub-basins (**Figure 10)**.



(Source : MIGADO, 2005)

Zone colonisable
Zone difficile d'accès
Zone inaccessible

Principaux obstacles à la libre circulation

Dordogne :
1 - Montfourrat (Dronne)
2 - Laubardemont (Isle)
3 – Le Saillant (Vézère)
4 – Bar (Corrèze)
5 – Sablier (Dordogne)
6 – Hautefage (Maronne)
7 – Brugale (Cère)
8 – Bergerac (Dordogne)
9 – Tuilières (Dordogne)
10 – Mauzac (Dordogne)

Garonne :
12 – Le Temple (Lot)
13 – Golfech- Malause (Garonne)
14 – Loubéjac (Aveyron)
15 – La Palisse (Tarn)
16 – Rabastens (Tarn)
17 – Carbonne (Garonne)
18 – Labarre (Ariège)
19 – Bazacle (Garonne)

Figure 9: Main barriers to free circulation for eel (bars in blue) and accessibility (blue: possible Colonization; orange: difficult C.; red: impossible C.)

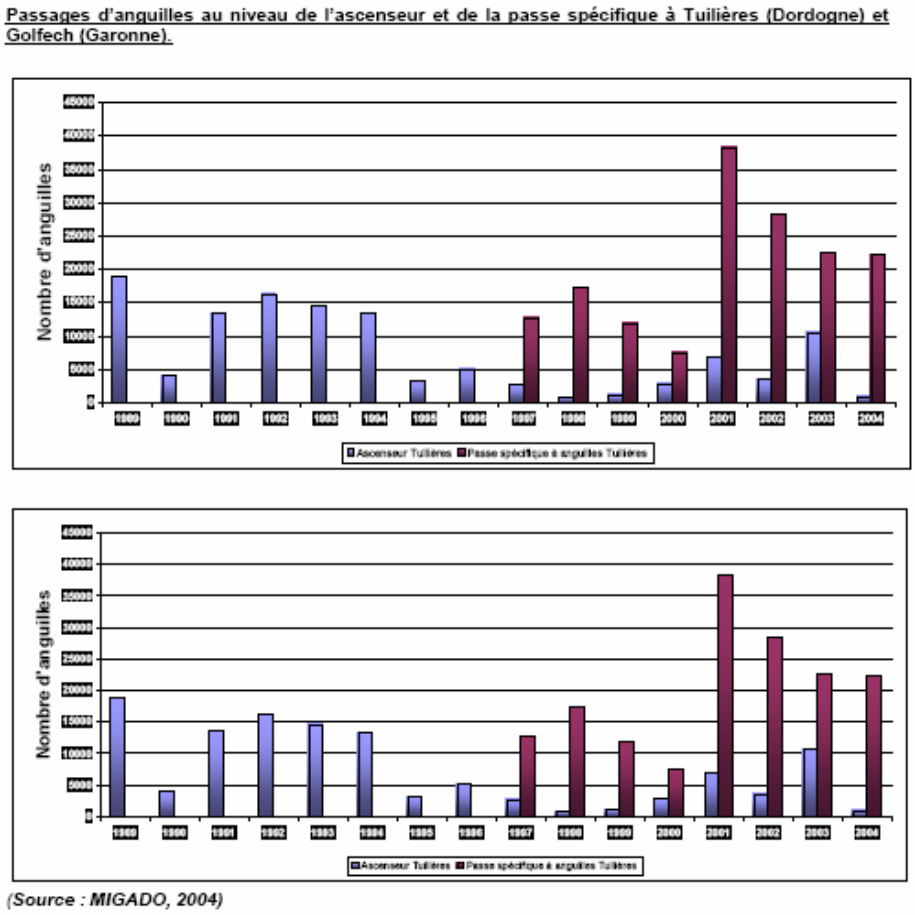


Figure 10: Eel passages on the lifts (blue) and specific eel passes (red) of the Tuilières dam (Dordogne) and the Golfech dam (Garonne) for the period 1989-2004.

7 Electrofishing

The electrofishing operations have been conducted by the Conseil Supérieur de la Pêche (CSP) on the Garonne basin since 1975 (**Table 1**) The total number of fishing operation is 2082, for 975 sites during this period. They are of two types:

- fishing operations on a lot of sites (853) with few repetition on the same site (operation rate per site: 1.4) since 1975 (General network);

- fishing operations on a limited number of sites (122) with systematic repetition on the same site (operation rate per site: 7) since 1994 (Réseau Hydrobiologique et Piscicole network).

Globally, no eel has never been captured on nearly 61% of the station; for the RHP network this percentage is a little bit less important: 52%.

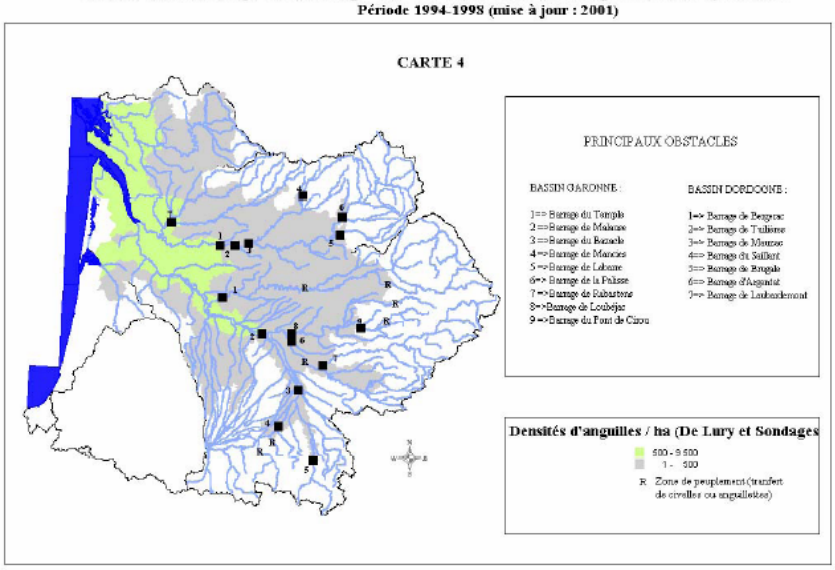
Table 1: Electrofishing operations and sites on the Garonne basin during the period 1975-2003

	Complete data base	data base fishing operations RHP (since 1994)	data base others fishing operations (since1975)
Number of fishing operations	2 082	890	1 192
Number of sites	975	122	853
Number of fishing operations (no eel capture)	56,50%	50%	61,20%
Number of sites (no eel capture)	60,90%	52,40%	62,10%

The two data base permit to determine the different colonization zones: active zone with eels of length < 30 cm, colonization zone and free zone to be colonized

The eels of length < 30 cm and particularly of length < 15 cm are very often under-captured. These eels of length < 15 cm are indicative of the fluvial recruitment above the tidal limit.

The electrofishing monitoring for the period 1994-1998 (updated in 2001) show that the most important colonization of eel (density > 500 individual per hectare) occur in the lower part of the basin, the coastal zone (**Figure 11).**



(Source : Gayou F., Gamendia L., 2000. Plan de gestion des poissons migrateurs amphihalins Garonne – Dordogne-Charente-Seudre-Leyre- Situation de l'anguille sur le bassin. Conseil supérieur de la Pêche. Délégation Régionale Aquitaine. Midi-Pyrénées)

Figure 11: Eel density from electrofishing monitoring 1994-1998 (green= density > 500 individual per hectare) main dams (black squares) and restocking sites (R).

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