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1 - Dredge design and fisheries

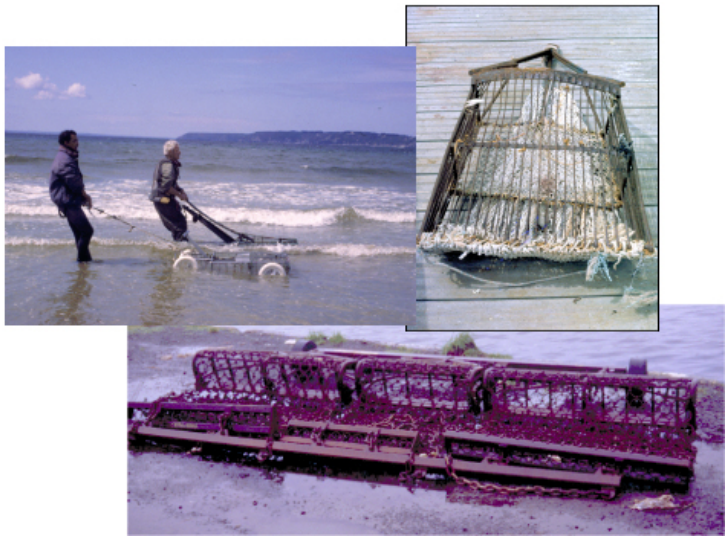
Les dragues françaises et la pêcherie

2 - Environnemental impact

Impact sur l'environnement

3 - Management

Gestion



Programme ECODREDGE 1999-2001

These 3 reports have been realised during Ecodredge Program (1999-2001) and contribute to a final ECODREDGE report on international dredges designs and fisheries, environnemetal impact and management.

REPORT 1

DREDGE DESIGNS AND FISHERIES

ECODREDGE

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1 DREDGE DESIGNS

Introduction

French dredge fisheries are numerous and diversified. The dredges are characteristic to the area and the target species. The main locations related to dredging are quoted on the following map :

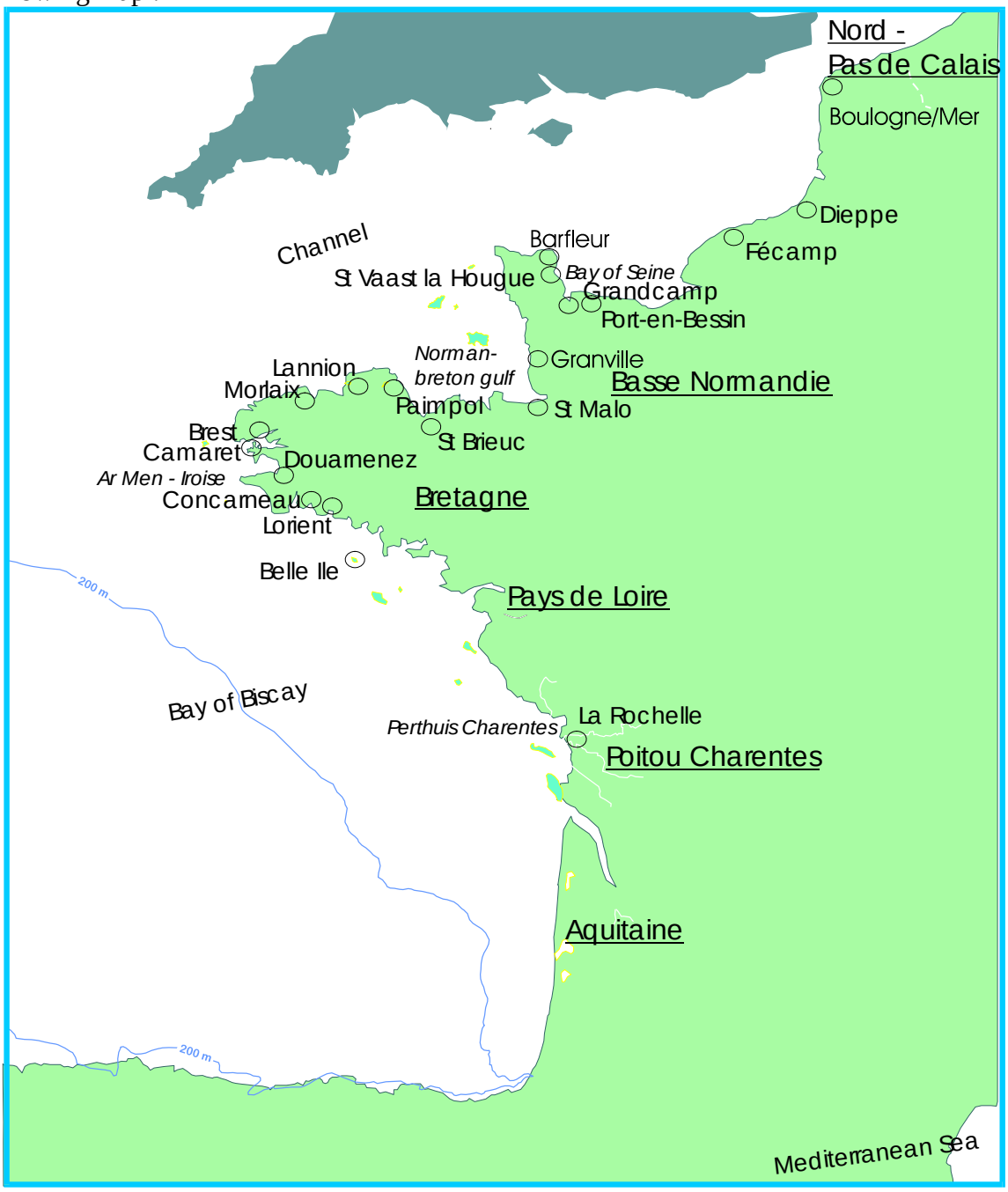


Figure 1 : Locations of areas related to dredging (from M. Pitel IFREMER).

Basically, a dredge is a bottom-towed gear and consists of a metal frame with a blade or teeth, to dig into the sediment and extract the shelled molluscs, and a mesh bag to collect the catch. Whereas hand dredging is observed on some intertidal beds (*Donax trunculus* in France), the use of dredge generally needs a fishing boat. There is a great diversity of dredge types, with specific designs used to target different species in particular beds:

- Manual dredges for Donax (*Donax trunculus*), Warty venus (*Venus verrucosa*) and clams (*Venerupis pulastra, Ruditapes sp*)
- Dredges for King scallops (*Pecten maximus*)
- Dredges for Warty venus (*Venus verrucosa*)
- Dredge for Queen scallops (black and white, *Chlamys varia* and *Chlamys opercularia*)
- Dredges for small bivalves : Thick trough shell (*Spisula ovalis*), palourid (*Venerupis rhomboïdes*), bittersweet (*Glycymeris glycymeris*)
- Dredge for Mussels (*Mytilus edulis*)

Except in the case of scalloping where the dredges designs are widely used, fishermen European used a variety of local designed dredges adapted at the target species. The inter-specific selectivity of these gears is generally very high and the by-catch rate is low : however, in the norman-breton gulf it is possible to catch bittersweet or whelks with a warty venus dredge and to catch a mixed of bittersweet palourdi and spisula with the small clam dredges.

1.1 Manual dredges for sea-shore fishing

1.1.1 Recreational fisheries

Gear

The dredge is 25-40 cm large, with diving teeth and it is mostly used by recreative fishermen for personal consumption.

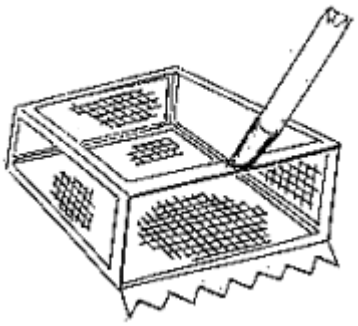


Figure 2 : Manual dredge towed with a stick (from IFREMER DRV/RH).

Gear operation

This hand dredge is towed with a stick.

1.1.2 Professional fisheries

Gear

This diving blade manual dredge is more sophisticated for professional purposes.

Figure 3 : Manual dredge for Donax (from G. Véron IFREMER).

Gear operation

This diving blade manual dredge is more sophisticated with wheels and attached point for harness.

Figure 3 bis: Gear operation for manual dredge for Donax (from G. Véron IFREMER).

1.2 Flexible Dredges for King scallops (*Pecten maximus*)

Gear

A scallop dredge is a bottom towed fishing gear and consists of a metal frame with a toothed bar at the aim of digging in the sea ground, extracting the scallops and catching them in the mesh bag. Its use needs generally a fishing vessel.

Three main types of dredges are used in the French scallop fisheries :

1-Classical dredge with toothed bar and without depressor plate ("heavy Breton dredge")

This fishing gear is frequently used in Atlantic waters (scallop beds of Belle-Ile, Lorient, Groix, Glénan, Concarneau, Douarnenez, Brest). This type of dredge has a usual width of 1.8 to 2 m and it is fitted out with toothed bar which has spaces between teeth of 9 cm. Diameter of metal or nylon rings is included between 72 mm (Lorient/Groix) and 92 mm (Bay of Brest) with a usual size of 85 mm (regulation for Atlantic and Western English Channel listed beds). The total weight and the teeth length are not regulated apart from scallop stock of Bay of Brest (the maximum allowed weight is equal to 170 kg and the total length of teeth is 10 cm).

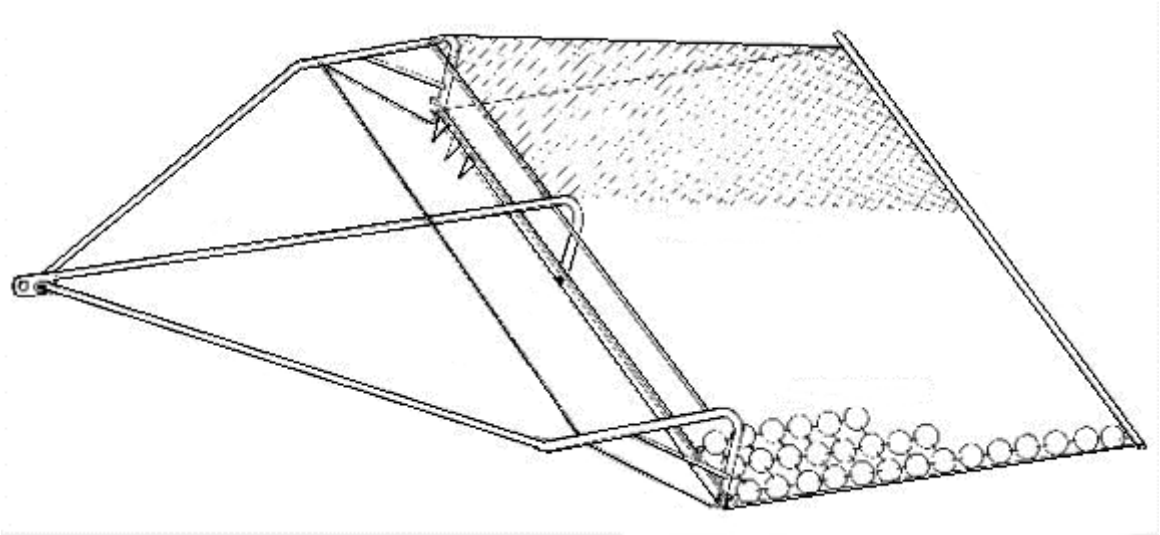


Figure 4 : Traditional King scallops dredge used in Bay of Brest (from IFREMER DRV/RH).
A : Frame, B : Blade with teeth (space between teeth 9 cm, length teeth 10 cm), C : Square for fixing the bag (chain belly and back netting, diameter of metal or nylon rings 72, 92 or 85 mm), D : Bar (widht 1.8 to 2 m).

Figure 5 : King scallop dredge without diving plate in Brest harbour (from IFREMER DRV/RH).

2-Dredge with toothed bar and with a depressor plate ("Saint-Brieuc dredge") :

This fishing gear has been initially used on Bay of Saint-Brieuc fishery since 1968. A depressor plate behind the tow frame has been introduced at the aim of growing the fishing yield per hour because of a dredge digging deeper than previously (the yield per hour has increased three times). This gear is exclusively tolerated in Bay of Saint-Brieuc, but, in fact, it is also used in other stocks of the Northern Brittany (Bay of Morlaix and Lannion, Minquiers, Bay of Saint-Malo) and in Atlantic waters (Lorient, Belle-Ile, Concarneau). The dredge net is fitted out with meshes of 85 mm excepted the scallop fishery of Bay of Saint-Brieuc (92 mm, previous regulations of 72 mm until 1985 and of 85 mm until 1996). Its usual width is equal to 2 m (dredges wider than 2 m are forbidden) and the space between teeth is regulated equal to 9 cm. No regulation exists for weight.

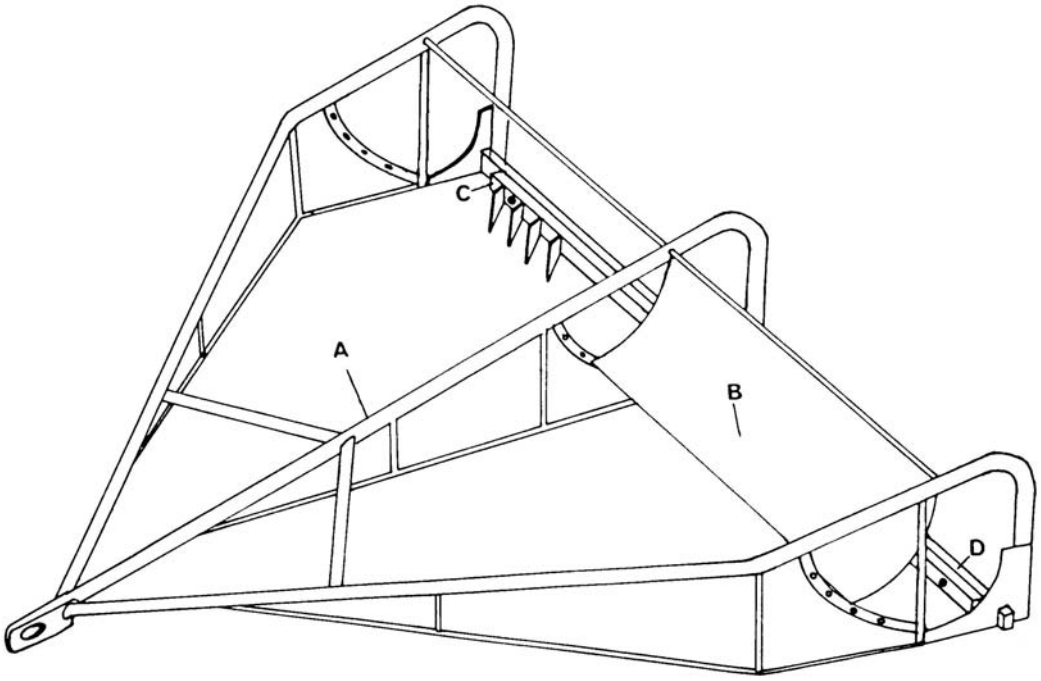


Figure 6 : Traditional King scallops dredge used in VIIe (West Channel) (from Dupouy, 1990).
This dredge is equipped or not with a diving plate.
A : Main frame, B : Diving plate, C : Tooth bar or rake (space between teeth 9 cm), D : Blade (maximum width 2 m). The bag is not represented (diameter of meshes 85 or 92 mm)

3-Spring-loaded dredge ("English dredge") : this fishing gear was initially towed in British waters, but at present it has been also used on several main French scallop stocks (ICES division 7E ; Bay of Seine and offshore waters of the Eastern English Channel). Its dimension can vary according to characteristics of fishing vessels. The width of a wheeled beam is often comprised between 4 and 6 m with a usual number of 4 to 6 fixed dredges which have a mean width of 80 cm. Metal net rings have been sized at 85 mm in the middle of 1990's (previous regulation allowed meshes of 72 mm).

4-Other scallops dredge types : the dredge used at Saint-Malo area is a medium type between the heavy Breton dredge described in the first paragraph (dredge 1)and the classical spring-loaded dredge (dredge 3): three dredges equipped with a ring mesh bag are fixed at a wheeled towing beam.

Figure 7 : King scallop dredge used is Saint-Malo Bay (from IFREMER DRV/RH).
3 dredges (width 2 m) equipped with a ring bag (diameter 85 mm) and fixed on a wheeled towing beam (total width 6 m).

Table 1 : Usual characteristics of scallop dredges used on Atlantic and English Channel beds (from S. Fifas IFREMER).

Type	ICES division	Main fisheries	Width (m)	Weight (kg)	Mesh (mm)
Classical dredge without depressor plate	8A, 7H, 7E	Belle-Ile, Iroise - Ar Men, Brest	1.8 to2 m (maximum of 1.8 m at Concarneau and Brest)	150 to 200(1)	85 apart from Lorient/Groix (72), Brest (92)
Dredge with depressor plate	7E	Saint-Brieuc	2	250 to 300	92
Spring-loaded Dredge	7D	Seine	3.5 to 5(2)	350	85

(1) In Bay of Brest, maximum allowed dredge weight exists (170 kg).
(2) Cumulated width of 4 to 6 dredges of 80 cm fixed at a wheeled towing beam.

Gear operation

Vessels works single dredges in the Bay of Brest and in the others listed beds mostly with two dredges.

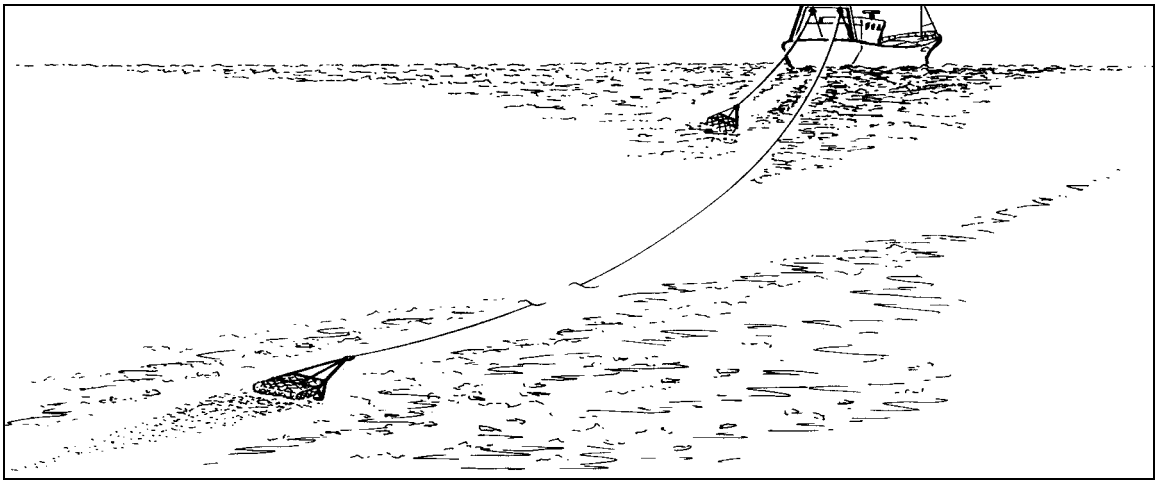


Figure 8 : Towing operation with 2 dredges (except Bay of Brest).

1.3 Flexible and rigid dredges for Warty venus (*Venus verrucosa*)

Warty venus dredging concerns only the French coast of VIIe from Bay of Granville to Paimpol and Bay of Brest.
The dredges for *Venus verrucosa* are lightly different from an area to an other. We distinguish then the dredge of Bay of Brest equipped or not with teeth from the dredge of Granville.

Flexible dredge description of Bay of Brest

This flexible dredge is equipped with teeth and ring bag.

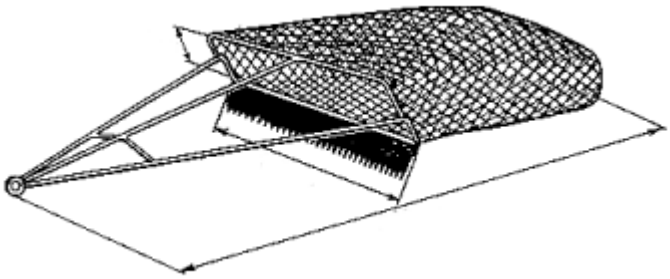


Figure 9: Warty venus flexible dredge used in the Bay of Brest (from IFREMER DRV/RH).

Figure 10: Frame of Warty venus dredge used in the Bay of Brest (from IFREMER DRV/RH)

Gear operation of the flexible dredge for Warty venus of Brest

Vessels work single dredge. The dredge is towed by fits and starts controlled before by hand and now with a winch, to evacuate mud and *Lithothamnion* from the dredge.

Rigid Dredge description of Granville

The cage is rigid with parallel bars surroundings. Space between 2 iron bars is smaller on both sides. A diving blade is at the entrance.
The bar space is 21 – 25 mm and the digging blade is 10 to 50 mm deep.

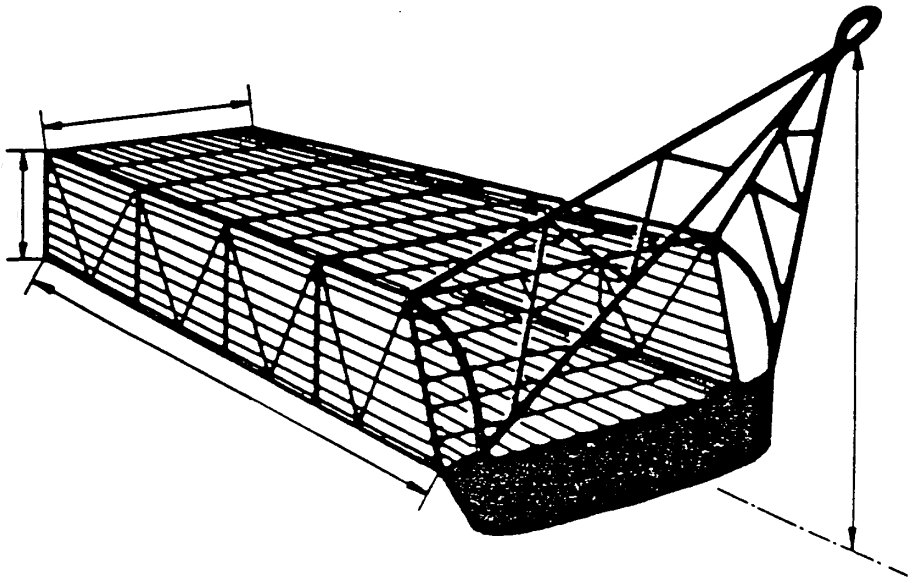


Figure 11 : Warty venus soft bottom dredge in the Norman-breton gulf (Granville) (from P. Berthou IFREMER).

On sandy and flat bottoms, dredges are equipped with short straight or curved blades and have a very heavy iron bars ballast at the mouth. On these grounds, the recent technological innovation, with the introduction of a diving plate on the back of the dredge (figure 12) appears in 1990's (Biseau A., Mahevas S., Perodou J.B., Berthou P.,1999). The diving plate helps the dredge to stay at the bottom, by hydraulic efforts, and not to lift up from the back when encountering an obstacle at the blade. The efficiency improved temporarily by increasing the towed speed. This system is only used by the most powerful fishing boats.

Figure 12 : Warty venus dredge with diving plate of Granville (from IFREMER DRV/RH).

The bar space is 21 – 25 mm and the digging blade is 10 to 50 mm deep.

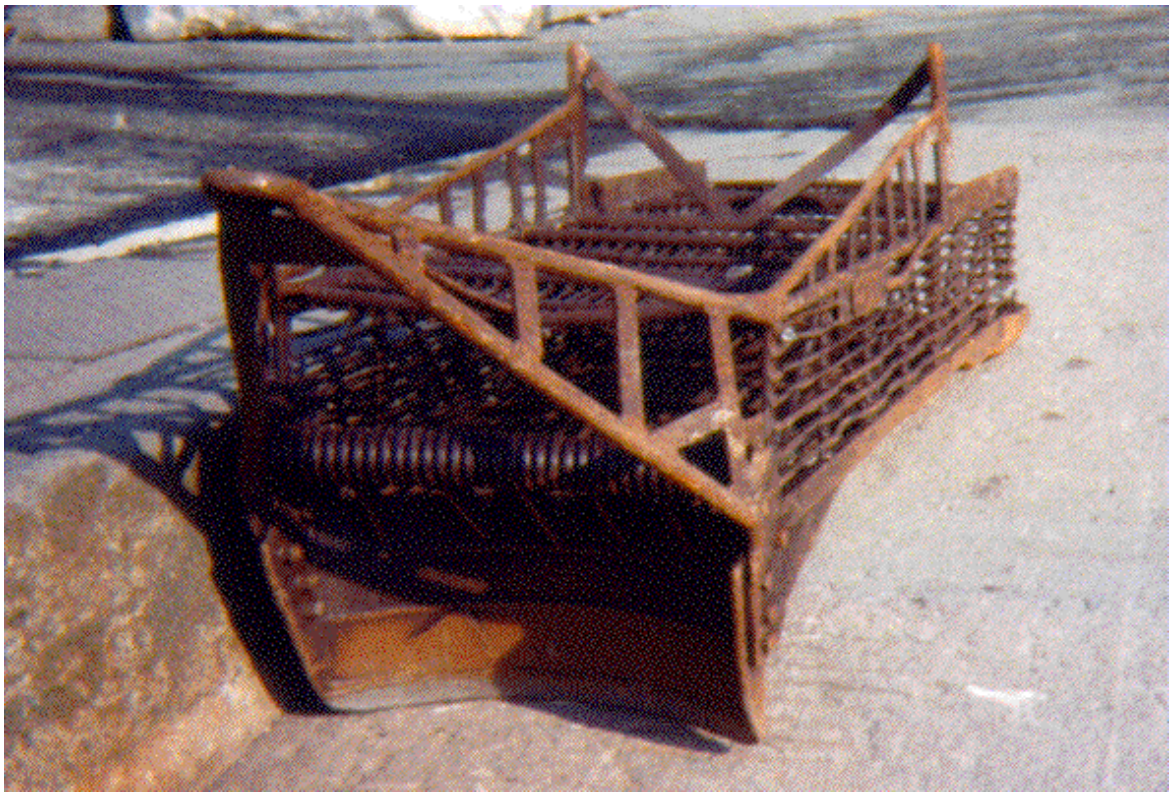


Figure 13 : Warty venus rocky bottom dredge of Erquy (from IFREMER DRV/RH).

The dredge is 60 cm large and 2 m long, the blade is 30 to 40 cm deep and the bar space is 25 mm.

On rocky bottoms, light dredges with high blade are used (figure 13).

Gear operation for rigid dredges of Norman breton gulf

Small boats work single dredges while bigger boats of Saint Brieuc work 2 dredges.

Boats are dredging all year with a light diminution the 4th quarter of year, for dredging King scallops.

1.4 Flexible Dredge for Queen scallops (*Chlamys varia, Chlamys opercularia*).

Gear

Here is described only the dredge used in the Bay of Brest.
The mouth of the dredge is composed of 2 wooden bars without teeth.

Figure 14 : Queen scallop dredge with ring bag used in the Bay of Brest and the Bay of Camaret (from IFREMER DRV/RH).
Maximum width 1.80 m, rings internal diameter 42 mm.

Gear operation

The boat tows one dredge, with constant speed of 4 knots.

1.5 Rigid Dredges for small bivalves

The dredges for small bivalves are technologically derived from dredges for Warty venus. The dredge varies according to the area (Granville, Saint Brieuc of Brest).
We distinguish different types of dredges for small bivalves for different areas : The dredge of Granville has a curved short blade, the dredge of Paimpol and Erquy has a deeper blade, and more in the South of Brittany, the dredge has a curved short blade with teeth.

Dredge description of Granville

The dredge is 90 cm large, 2.20 m long and the bar space is 18 mm.

Figure 15 : Small bivalves' dredges of Granville with curved short blade (from IFREMER DRV/RH).

Dredge description of Paimpol and Erquy

The blade is deeper for better sort of bivalves.
The dredge is 80 cm large, 2 m long, the blade is 40 cm deep and the bar spacing is 18 mm.

Figure 16 : Dredge with high blade of Bay of St Brieuc (from IFREMER DRV/RH).

Dredge description of South Brittany

The dredges described in figure 17 and figure 18 are used in France (south Brittany) to catch 'Bittersweet' (*Glycymeris glycymeris)*; 'Warty venus' (*Venus verrucosa)*, Spisula sp, and palourd (*Venerupis rhomboïdes)*. These dredges have a blade with or without teeth.

Figure 17 :Thick trough shells dredge with short blade (from IFREMER DRV/RH).

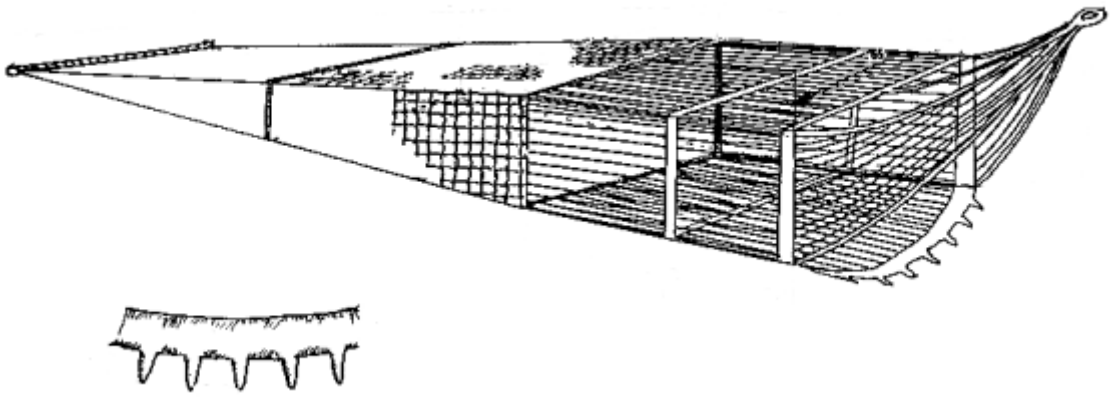


Figure 18 : Thick trough shells dredge with blade and teeth (from IFREMER DRV/RH).

Gear operation

The boats are specialised dredges for each target species.
Bittersweet (*Glycymeris glycymeris*), and also Warty venus in the normand-breton gulf: one, bot more usually, two box type constructions, 60 cm to 80 cm wide dredges fitted with a curved blade. The space between the screen bars is 21 to 25 mm.
Spisula sp, palourid (*Venerupis rhomboïdes*) : in the normand-breton gulf ,60 cm to 1 m wide box-type construction with an average weight of 300 kg. Spaces between bars are about 15 mm for Spisula and 18 mm for palourid. Two dredges are used.

In the bay of Douarnenez, Iroise and south Britanny, the dredges are fitted with a wire netting bag and the weight under 100 kg. One dredge is used.

1.6 Flexible Dredge for Mussels (*Mytilus edulis*)

Dredge description

The dredge, close to King scallop dredge, is an heavy metal frame with a netting bag, protected on one or both sides (up and bottom) by a black rubber cover.
A blade or knife (10 cm maximum height) is fixed on lower part. On muddy or friable substrata, the dredge is lighter and does not have any blade.

Smaller dredges are used for more inshore deposits, exploited by “doris” type gear : the mouth of the dredge is 0.75 m large and 0.40 m high. A blade is surrounding the mouth 45 degrees inclined. Mussels are collected into a bag 1.50meters deep, protected on top and bottom sides by a black rubber cover.

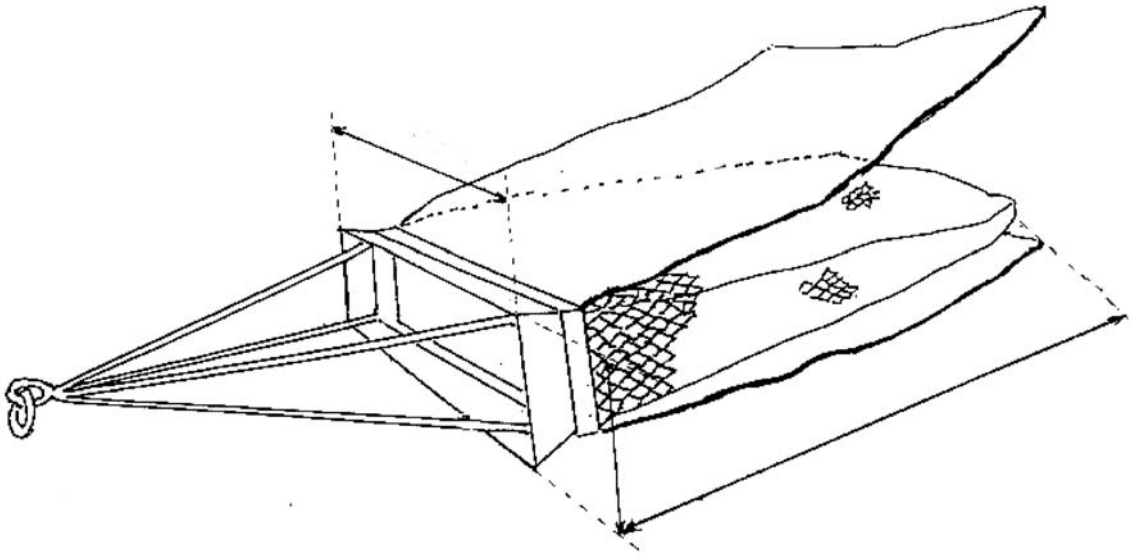


Figure 19 : Dredge for mussels (from IFREMER DRV/RH).
Tapis caoutchouc noir : protecting black rubber cover.
Alèze : drawsheet.

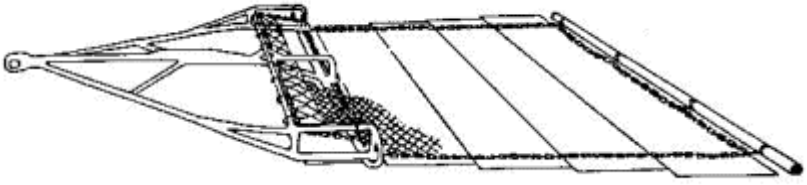


Figure 20 : Dredge for mussels, east Channel (from IFREMER DRV/RH).

Gear operation

The dredge is towed with a cable. The length of this cable is three times the water column height and varies according to currents and the bed type.

The dredge is composed of 1.60 m fixed bar, without teeth, to detach mussels from rocks or rough substrate, and a net bag to retain catches. A similar gear is used for smooth substrate.
Boats dredging in deep water tow only one dredge at 3 knots speed.

2 DREDGE FISHERIES

France

2.1 Manual dredges for sea-shore fishing

2.1.1 Recreational fisheries

Target species and by-catch

The target species is Warty venus (*Venus verrucosa*) and clams species (*Venerupis pullastra*, *Ruditapes decussatus*, *Ruditapes philippinarum*).

Fishing areas (and ports)

This dredge is used in beaches and estuaries of French Atlantic and English Channel coasts.

Resource characteristics

Animals recruit to the recreative fishery at about 30-35 mm shell length for Warty venus and 35 mm shell length for clams species.

Fishing strategy

Low tide.

Interactions

Other recreational fisheries.
Tangible ecosystem (*Zostera marina*).

Regulation measures

This fishery is not controlled (recreational fishery) but the fishermen must respect the minimum sizes of shells (40 mm for Warty venus, 35 mm for clams).

Markets

There is no market on this fishery.

Trends and comment

The conservation of shells is now possible with the deep freezer. This fishery is too much productive.

2.1.2 Professional fisheries

Target species and by-catch

The target species is Donax (*Donax trunculus*) buried in sand with by-catch of *Donax vitatus*.

Fishing areas (and ports)

In West and South Brittany : Bay of Douarnenez, Bay of Audierne, Morbihan coast.

Resource characteristics

Animals recruit to the fishery at about 25 mm shell length.

Fishing strategy

On beaches at low tide.

Interactions

Tourism : this fishery is not possible while tourists season.

Regulation measures (Préfecture de la Région Bretagne, Direction Régionale des Affaires Maritimes, 1997)

For Douarnenez-Camaret area :
For some beaches, it is only allowed from Sunday to Friday from 7 a.m to 9 p.m.
For others, fishing is allowed day and night.
For all, fishing is not allowed during July and August.
A number of licences is fixed every year.
Fishermen can not collect more than 2 kilograms of shell per day.
Professional sea-shore fishing is allowed only with an handed-gear whose characteristics are :

- maximal width : 70 cm
- maximal internal mouth : 50 cm
- bottom and back constitution : longitudinally or transversally bars
- minimal space between two bars : 8 mm.

Markets

Exportation to Spain and Italy.

Trends and comments

Fluctuating resource.
This fishery began at the end of 1980’s. The regulation is installed since 1995.

2.2 Flexible Dredges for King scallops (*Pecten maximus*)

Target species and by-catch

Pecten maximus with by-catch of flatfish in Bay of Seine (plaice, sole, brill).

Fishing areas (and ports)

King scallops' dredging is the main métier : 80 % of the dredge fleet are involved from Boulogne to La Rochelle. The main regions are :

REGION	ICES DIVISION
Saint-Brieuc	7E
Seine	7D
Saint-Malo/Granville	7E
Brest	7E
Morlaix – Lannion	7E
Ar Men – Iroise	8A, 7H, 7E
Belle-Ile	8A
Concarneau	8A

Resource characteristics

See Spyros Fifas, Ifremer Brest.

Fishing strategy

The deployment of the fishing effort and the different strategies chosen by skippers depend on management rules. Before founding of first management methods, variability of resource abundance were taken into account at the aim of modification of annual fishing effort only after several years : in Bay of Brest, skippers started reducing their effort after the severe winter of 1963, but less quickly than the scallop abundance fell (figure 23). The first management systems were carried on the main scallop fisheries in the middle of 1970's when the first signs of depletion were observed : in Bay of Saint-Brieuc, fishing effort decreased six times from 1974 to 1998 (Guyader and Fifas, 1999) ; the daily allowed fishing time per vessel was equal to six hours before 1973, three hours between 1973 and 1980, two hours between 1980 and 1986, and, at present, it is equal to one hour, sometimes three quarters (allowed dredging time of a half hour was also observed several years ago *i.e.* between 1992 and 1994).

Fishing strategies in Bay of Saint-Brieuc

The decrease of the allowed fishing effort incited fishermen to develop fishing capacities at the aim of reducing loss of profits by an increase of catch per unit of effort. In the particular case of Bay of Saint-Brieuc, increase of fishing capacities has been distinguished by different stages (Fifas, 1991, 1993) :

(1) Depressor plate.
Introduction of depressor plate on dredges in 1968 caused a high increase of fishing yield per hour (Piboubes, 1974) ; random components of the dredge efficiency reduced

significantly. Fishing activities targeting recently recruited year class (age group 2) on flat sea bottom became profitable.

(2) Limitation of fishing effort.
Founding of fishing licences in 1973 and establishment of a management system based on total allowed catches in 1974-1975 caused deployment of fishing effort during a minimised time interval. Strategy adopted by skippers has involved to concentrate dredging effort on the areas of the highest density of recruited year class ; at the opposite, the fishing fleet has to spread its activity to age groups already exploited whether a recruitment class was weak. At the aim of optimising their activities, skippers have taken into account information about distribution of year classes well known by yearly direct stock assessment led by scientists ; summer annex fishing activities (otter trawling) have made easier that information.

(3) Engine power and otter trawling.
Increase of engine power of fishing vessels has also made a contribution in fishing strategies ; it became easier because of :
(3.1) Efficient use of dredges with depressor plate requires powerful boats at the aim of moving quickly on the flat sea bottom and towing dredges at high speed. Foucher (1986) cited some examples of skippers who have adopted towing speed of 5 knots instead of previous speed of 3 knots (weight of dredges is not limited) ; at present, towing speed can be sometimes equal to 6 knots.
(3.2) Use of powerful engines allows diversification to annex fishing activities ; Foucher (1986) wrote that entries in scallop fishery of Bay of Saint-Brieuc in the middle of 1980's (period of high development of coastal otter trawling) affected only powerful ships.

Those three stages have defined a particular dredging strategy of targeting sedentary species. Fifas (1993) wrote that catchability coefficient on scallops (*i.e.* probability to catch an individual which includes components called accessibility and vulnerability) depends on mean engine power and abundance of mainly targeted age groups which are the age group 2 (the first recruited age group) and 3 (on a mean resource statement, this age group is the most abundant of the remainder ratio of population) (fig. 21). In the history trends of the scallop stock of Bay of Saint-Brieuc, two main events have increased the value of the age group 3 :
(i) The management system with total allowed catches : skippers have to increase their part in a global quantity fixed previously for the whole fishing fleet. In case of a weak abundance of recruited year class, it is possible to stabilise the weight yield per vessel by targeting the age group 3.
(ii) Introduction of steel reinforced teeth on dredge bars (in 1977) got possible towing activities on rough sea bottom which were preserve of reproducers in the past.

(4) Limitation of maximum allowed engine power.
Modification of access criteria related to characteristics of fishing vessels (in 1990, the maximum allowed engine power was limited at 185 kW instead of 294 kW and the maximum allowed length was fixed at 13 m instead of 16 m) affected fishing strategies. At present, it has not been useful to maximise engine power, at least above a level lower than previously. Bioeconomic simulations were realised by Guyader and Fifas (1999) who stratified the fishing fleet of Bay of Saint-Brieuc at four groups of vessels :

[1] engine power below 60 kW ; [2] between 60 and 120 kW ; [3] between 120 and 185 kW and [4] above 185 kW (this group consists of fishing boats which are still allowed to dredge scallops in spite of regulation of 1990 ; no entries can be set).

The number of fishing vessels of each stratum is variable from year to year and the main trend is increase of the number of the third group (120 to 185 kW) : an increase of the number of ships close to the present allowed limit leads to a more strong fishing capacity ; furthermore, it makes easier a diversification to otter trawling.

The figure 22 shows evolution of catchability (expressed by standardised fishing mortality for fishing effort equal to 10000 hours) per stratum of vessels against abundance of the age group 2. Similar evolution of all curves is obvious except for the stratum below 60 kW. Decrease of the maximum allowed limit in 1990 did not reduce significantly the fishing effect on the fishery (the curves corresponding to the strata 120 to 185 kW and above 185 kW are very close).

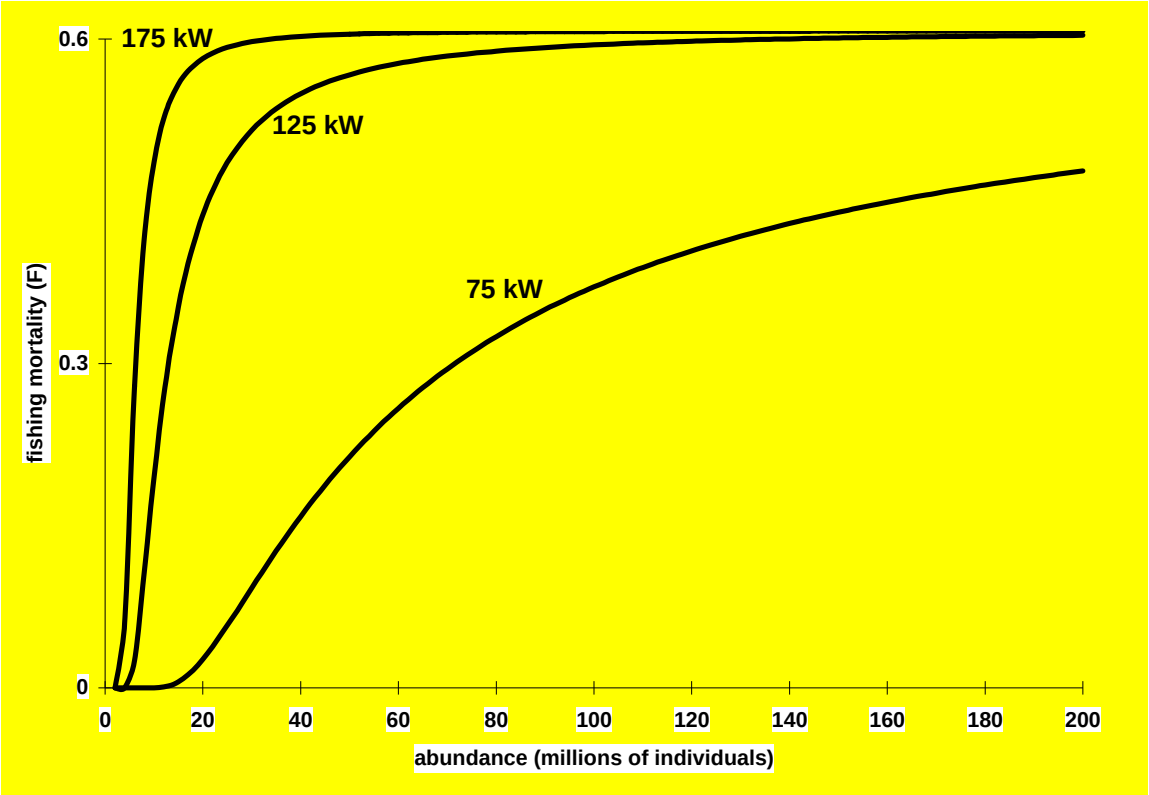


Figure 21 : Bay of Saint-Brieuc. Theoretical catchability coefficient (from S. Fifas IFREMER).
(expressed by fishing mortality for fishing effort of 10000 hours) versus abundance of year class (example of the age group 2) for different levels of mean engine power of the fishing fleet.

Table 2 : Bay of Saint-Brieuc. Patterns of fishing vessels according to stratification based on engine power. Years 1993 to 1997 (S. Fifas IFREMER).

stratum	Number					engine power (kW)					engine power (ch)					% trawling (1)
	1993	*1994*	*1995*	*1996*	*1997*	*1993*	*1994*	*1995*	*1996*	*1997*	*1993*	*1994*	*1995*	*1996*	*1997*	
0-60 kW	26	28	28	25	25	42	44	45	43	46	56	59	60	57	61	3.8
60-120 kW	102	103	100	100	101	92	92	91	91	92	124	123	122	122	123	44.3
120-185 kW	86	94	95	102	100	150	151	151	151	151	201	202	202	203	203	58.7
> 185 kW	34	32	31	26	23	242	244	244	241	242	324	327	327	323	324	76.0

(1) Percentage of trawling per stratum is expressed in number of vessels ; it is calculated on the mean statement of the years 1993 to 1997.

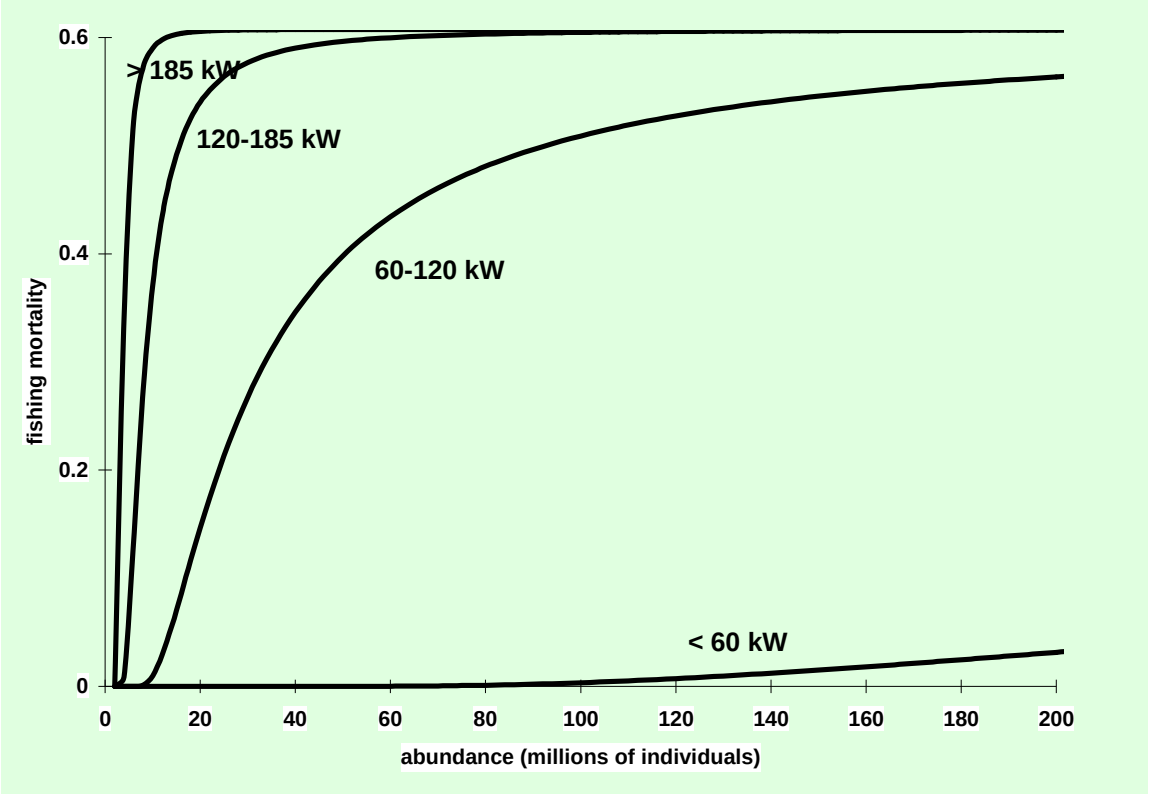


Figure 22 : Bay of Saint-Brieuc. Theoretical catchability coefficient (from S. Fifas IFREMER).
(expressed by fishing mortality for fishing effort of 10000 hours) versus abundance of year class (example of the age group 2) for the four strata of the fishing fleet of dredgers based on engine power. The mean engine power per stratum is calculated according to mean patterns of the fleet for the years 1993 to 1997.

(5) Technological acquired knowledge.

Trends of mean engine power of the fishing fleet of dredgers are not enough to explain the evolution of fishing capacities. At present, the mean engine power is not significantly upper than in the beginning of 1990's, but, for a given status of scallop resource, catches per unit effort are greater than ten years ago : the catch rate calculated for a given administrative fishing effort (expressed by fishing hours x engine power) has increased spectacularly for ten years. It is obvious that catchability coefficient per age group must be fitted versus supplementary components else than engine power and scallop abundance.

Learning fishing activity and optimising deployment of fishing effort is a continuous process because of rare replacement of crew and vessels on scallop fisheries. Technological progress are integrated in the fishing effort deployment by two ways :(i) for a standardised duration of daily dredging activities, it is possible to cover a more huge area than in the past : at present, it is better known where it is optimum to concentrate dredging effort with no lost time because of development of otter trawling and technological equipment of navigation and positioning (PC, GPS, plotter, etc.) ; (ii) after arrival on a fishing area with high potentiality, it is possible to dredge more and more quickly with fishing gears more and more heavy (no regulation of weight of dredges except Bay of Brest).

Catchability models describing dredging strategies can take into account those ways of optimisation of fishing strategies : the asymptotic levels of curves (fig. 21 and 22) may be upper because of covering more huge areas and the medium levels of catchability may be stronger (*i.e.* they may correspond to lower levels of abundance) as though mean engine power was higher.

Fishing strategy for other fisheries

The particular case of Bay of Saint-Brieuc can be extrapolated on other scallop fisheries with two main differences :
- Use of dredges with depressor plate gets more necessary to increase engine power because of a more efficient digging of fishing gears.
- Limitation of duration of daily dredging is more drastic in Bay of Saint-Brieuc than on other fisheries.
However, the main trends described above are valid.

Bay of Seine : The fishing power is based on deployment of effort on huge areas with scallop densities less strong than in Bay of Saint-Brieuc and longer duration of daily activities. These two patterns underline that the effect of engine power (combined with weight of dredges) and technological progress of navigation and positioning may be less obvious than on the Western fisheries. However, targeting always the firstly recruited year class may define fishing strategies close to Saint-Brieuc. It is necessary to well know physical patterns of spring-loaded dredges.

Bay of Brest : An analysis of data on statistical network for the period 1983 to 1995 showed that skippers concentrate their effort on the same areas with no modification depending on yearly level of resource (Boucher and Fifas, 1995) : the calculated index of concentration of Robson on this fishery was no significantly different to 1. However, opening of dredging activities on previously closed areas (extensive farming ratio of population) may affect fishing strategies.

Interactions

In the past, conflicts between fishing fleet of different regions were strong. The history of discovery and beginning of exploitation of the scallop bed in Bay of Saint-Brieuc (1960's) underline the important part of fishing vessels originated from Brest (they left the almost collapsed fishery of Bay of Brest and introduced the heavy Breton dredge on the Northern fisheries : Piboubes, 1974). This first contact created several conflict statuses. Several years later, during the top of increasing period of stock abundance in the English Channel, the conflict core moved : it was linked to relationships between Northern Brittany (mainly Saint-Brieuc) and Norman fishing fleets (Foucher, 1986 ; Fifas, 1991). This problem was resolved by two ways :

- Bay of Saint-Brieuc : a maximum allowed limit of engine power was introduced in 1974 : only vessels with less than 400 ch (294 kW) could obtain the fishing licence input in 1973 at the aim of access limitation of powerful fishing units of Fécamp and Dieppe.

- Eastern English Channel : in 1972, use of dredges with depressor plate was forbidden in Bay of Seine at the aim of limiting the access of fishing vessels originated from Saint-

Brieuc which were less powerful, but obtained higher catches per unit effort because of a positive effect of depressor plate on dredge efficiency.

At the present statement, the main types of conflicts are related to management options or to choice of supplementary fishing gears (mobile or fixed gears).

1-Conflict between fisheries linked to different management strategies. On the most abundant scallop beds (Bay of Saint-Brieuc, Bay of Seine), the strategies of management and exploitation are opposite : on the Saint-Brieuc fishery, a global allowed catch is proposed each year whereas this option is not retained on Norman fisheries. Quantities can be excessive in the second case and disadvantage the weak market statement of the Western English Channel fisheries.

2-Conflict between mobile and fixed fishing gears. The fishing gears used on each scallop bed are standardised, but several conflicts can be generated because of use of supplementary fishing gears : the mobile gears can catch scallops illicitly during all year (a otter trawl equipped with a chain for flatfish on the front of the gear can catch 10 % of scallops present on sea bottom : Hamon et al., 1991 ; Guyader and Fifas, 1999).

3-Conflict between divers and towing users. Some illicit catches of scallops are possible by scuba-diving ; no quantitative data exist, but the deployment of diving activities on the northern coast of Brittany targeting other species (ear shell, Haliotis rubens) can make easier this type of conflict.

Regulation measures

On the listed scallop beds, the main management regimes have several common patterns. They are related to : (1) limitation of a time fishing effort (number of allowed days per week and hours per day) ; (2) biological or market regulations (minimum commercial size, fishing season) ; (3) allowed characteristics of fishing vessels (number of licences, maximum allowed engine power or maximum length) ; (4) characteristics of dredges (type, number, allowed weight, width, space between teeth, mesh size) and (5) maximum allowed catches (cumulated or per vessel quotas).
These management choices are different according to administrative status of scallop beds (listed or not listed beds). On the not listed beds (Sea of Iroise and Ar Men in the Atlantic waters, Minquiers in the Western English Channel, offshore beds of the Eastern English Channel), only minimum size regulations (10 cm in 7E, 11 cm in 7D) exist ; we can add several regulations concerning characteristics of fishing vessels or towed gears (e.g. spring-loaded dredges are forbidden in the Sea of Iroise), size of net meshes (at least 72 mm) and maximum allowed fishing season (between 1st October and 15th May).
In the case of listed beds, management regimes differ from area to area.

(1) Fishing effort. The maximum allowed number of dredging days per week is included between two (Bay of Saint-Brieuc) and four (Bay of Seine). The number of fishing hours per day is also variable (usually three quarters or one hour in Bay of Saint-Brieuc ; two hours in Bay of Brest ; from four to six hours in the inshore Eastern English Channel). Duration of fishing season can also be regulated (usually from November to April in Bay of Saint-Brieuc, from November to March in Bay of Brest).

(2) Biological or market regulations. The minimum scallop size is usually equal to 102 mm on the listed Atlantic and Western English Channel scallop beds (105 mm in Bay of Brest) ; it is fixed at 110 mm in Bay of Seine. Duration of fishing seasons are variable (five months in Bay of Saint-Brieuc, two months in Bay of Morlaix and Lannion).

(3) Characteristics of fishing vessels. Usual limitations related to fishing boats take into account number of licences (90 for all shellfish activities in Bay of Brest, 259 in Bay of Saint-Brieuc, 268 in Bay of Seine), maximum allowed length (12 m in Bay of Brest, 13 m in Bay of Saint-Brieuc since 1990 instead of 16 m previously, 16 m in Bay of Seine since 1996 instead of 19 m previously) and maximum allowed engine power (150 kW in Bay of Brest, 185 kW in Bay of Saint-Brieuc since 1990 instead of 294 kW previously, 330 kW in Bay of Seine since 1996).

(4) Characteristics of dredges. (4.1) Different types of dredge (with depressor plate or not, spring-loaded dredge) are taken into account by local regulations : depressor plate is tolerated only in the Saint-Brieuc Bay (in fact, it is used everywhere apart from Brest, Iroise/Ar Men and Douarnenez), spring-loaded dredge is forbidden in the Atlantic listed fisheries. (4.2) The number of dredges is also regulated (maximum 1 in Bay of Brest and 2 in Bay of Saint-Brieuc, 16 in Bay of Seine). (4.3) The dredge weight is limited in the case of Bay of Brest (170 kg) ; in other fisheries no limitation exists (in fact, in Bay of Saint-Brieuc and Morlaix - Lannion the mean weight of dredges varies around 250 kg). (4.4) The allowed width of dredge is of 1.8 m (Brest), 2 m (Saint-Brieuc) ; it is not regulated explicitly in the inshore Norman fisheries (in fact, it does not exceed 80 cm per dredge). (4.5) Spaces between teeth can't be smaller than 9 cm. (4.6) Mesh sizes must be variable according to patterns of individual growth of scallops : they are fixed at 85 mm on the listed beds of ICES divisions 8A and 7E except for Lorient (72 mm), Bay of Brest (92 mm) and Bay of Saint-Brieuc (92 mm) ; the mesh are sized at 85 mm in the Eastern English Channel.

Market

Market – International scale

A first type of international market competition concerns relationship between scallops fished by French fishing fleet and those caught in United Kingdom and Ireland and specifically in England and Wales where a different fishing strategy is carried (fishing activities are allowed during all year). A second type of competition is related to import of other Pectinid species close to the European scallop such as Australian and New Zealand species. A third type of international market interaction is created by import of deep-frozen Pectinid species (*Chlamys sp*. of northern sea waters e.g. *Chlamys islandicus* or of subtropical areas e.g. *Chlamys purpuratus* of Chile ; *Patinopecten sp*. of Japanese and Chinese fisheries).

Market - Country scale.

Two different statuses can be cited :

1-Competition between catches obtained on scallop beds that are characterised by populations with different reproduction strategy. The scallop populations included in the Norman-Breton Gulf (from the Isle of Bréhat at the tip of the Northern Brittany to Cherbourg) are distinguished because of a sexual maturation and reproduction period only in summer in opposition to the Southern Brittany or Norman scallops ; on the other hand,

they have disadvantaged growth characteristics because of a slower growth than scallops of the Eastern English Channel. In the case of Bay of Saint-Brieuc, in spite of advantages due to selling scallops at auction (system established in 1978), market problems appear often according to Norman landings.

2-Competition between legal and illicit catches. Illicit catches can exceed 1000 tons per year in some coastal scallop fisheries such as in Bay of Saint-Brieuc (Guyader and Fifas, 1999) mainly during the closed fishing period ; in the Eastern English Channel, individual quotas by fishing boat can be overtaken easily and this fact prompts sometimes to illicit market activities. Even if illicit catches can't exceed those obtained legally, a competition is established because of advantages of illicit activities (they are deployed during all year, illicitly caught scallops are often less expensive, etc.).

Trends and comments

The main scallop fisheries are the following :

(1) Atlantic (divisions 8A, 7H and 7E) : we can cite here the listed scallop beds of Belle-Ile and Quiberon (8A ; 120 tons of mean annual production), Concarneau (8A ; 60 tons), Brest (7E ; more than 200 tons) ; we can add the not listed bed of Iroise (7E, 7H) and Ar Men (8A) with 150 tons. Those stocks were distinguished by a highly increasing period during the 1950's followed by a slump of productions in 1962-1963 because of a combination of overfishing (mainly in Bay of Brest where maximum productions around 2500 tons were recorded in 1953 and 1959 ; fig. 23 : Boucher and Fifas, 1995) and extreme climate conditions (severe winter). Those fisheries have entered in a new increasing phases at the beginning of 1990's because of several strong abundance of recruitment (year classes between 1989 and 1992) ; in the particular case of Bay of Brest, the increase of abundance has been reinforced by the additional production of extensive farming activities.

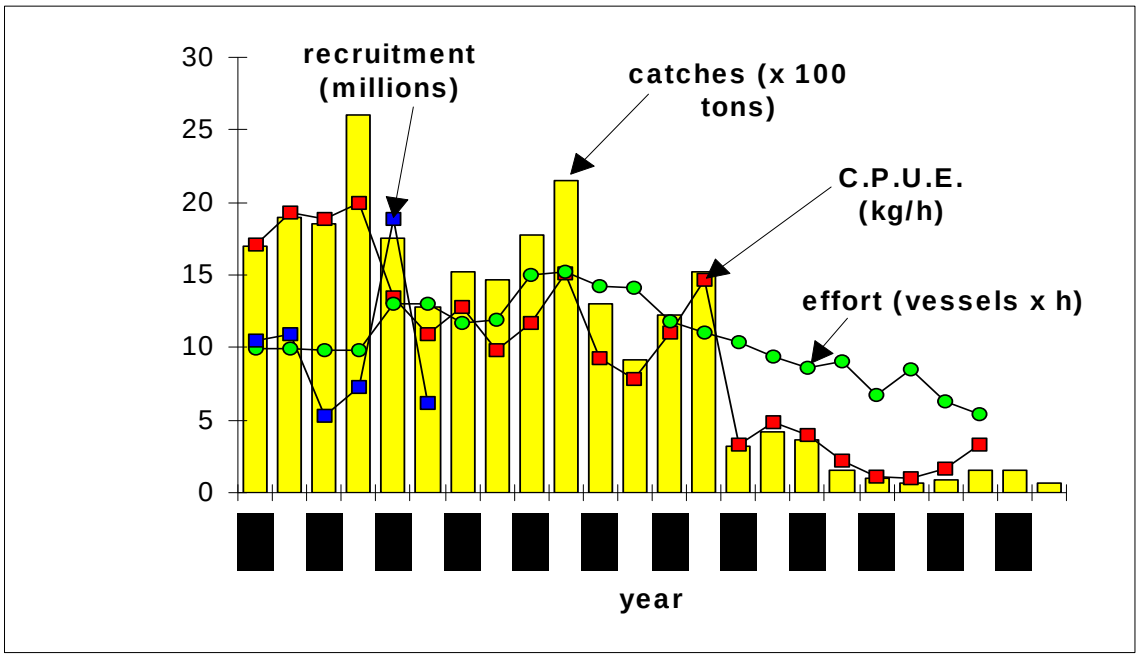


Figure 23 : Evolution of several parameters of the scallop stock in Bay of Brest. Years 1950 to 1973 (from S. Fifas IFREMER).

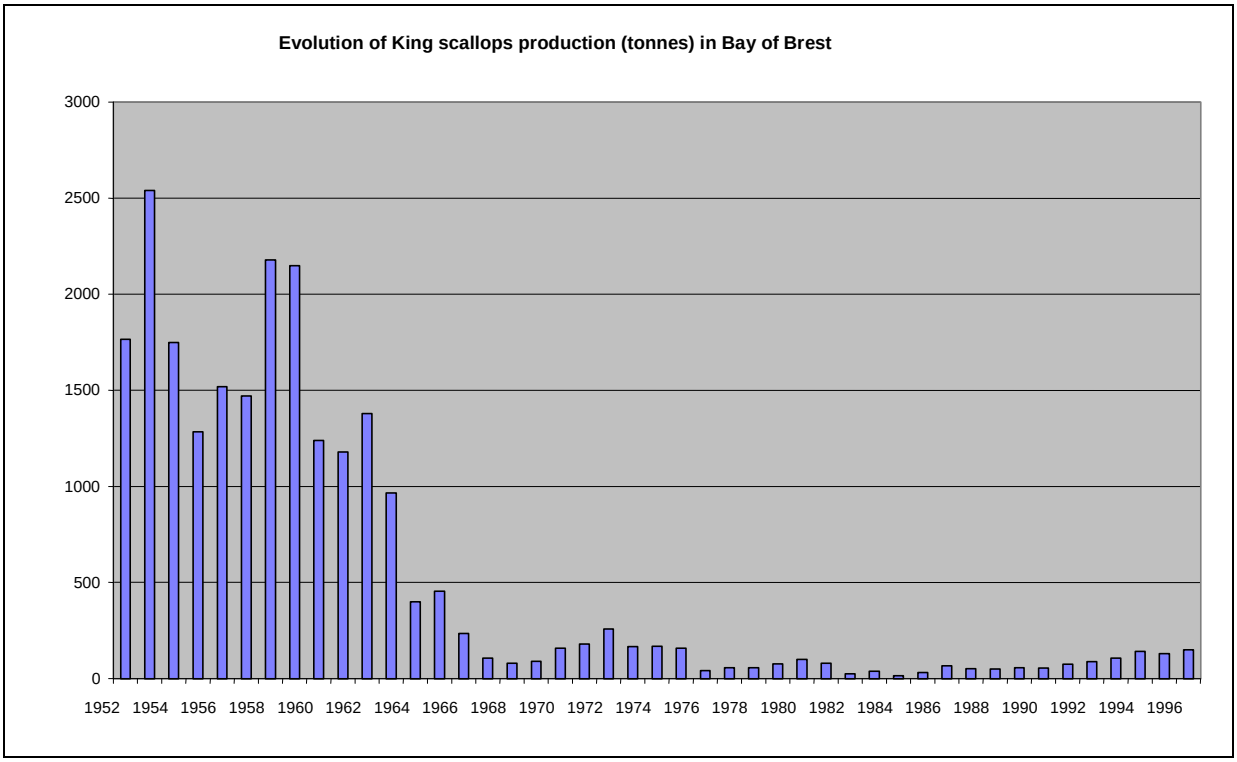


Figure 24 : Evolution of production of the scallop stock in Bay of Brest. Years 1952 to 1996 (from IFREMER DRV/RH).

(2) Western English Channel (division 7E) : the stock of Bay of Saint-Brieuc is the most productive (mean annual production of 1990's equal to 4000 tons) ; we can also cite the stock of Saint-Malo and Granville (cumulated production of 1500 tons) and the scallop beds of Bay of Morlaix and Lannion (150 tons). These stocks had a more recent history of exploitation than those of Atlantic waters (beginning of dredging activities in 1960's) because of less traditional coastal fishing activities in the Northern Brittany. The severe winter of 1962-1963 caused a collapse of Octopus sp. populations which were the main predators of scallops during 1950's (Piboubes, 1974). The stock of Bay of Saint-Brieuc was in the top of its productivity in the middle of 1970's (high abundance of year classes born between 1968 and 1973 ; 12500 tons were caught in the fishing season 1972-1973 and 10500 in 1975-1976) followed by a slow decreasing phases until a minimum level of 1300 tons in 1989-1990 ; favourable climate conditions caused an increase of production in 1990's (fig. 25). That characteristic generated self-evolving stocks in the Norman-Breton Gulf (Saint-Malo, Granville, Minquiers) even though their abundance were sporadic in the past. A decreasing phases has been rebooted recently because of dredge overfishing.

(3) Eastern English Channel (division 7D) : those stocks are spread on a huge area and we comment only patterns of the inshore scallop bed of Bay of Seine. Main trends of the Norman scallop beds coincided with Bay of Saint-Brieuc : significant abundance of those fisheries appeared in the middle of 1960's and the maximum production was reached in the middle of 1970's (more than 14000 tons). At present, the stock of the inshore Bay of Seine has got an increase trend because of favourable reproductions since the beginning of 1990's ; productions have varied highly from year to year (between 2000 and 6000 tons) because of dredging strategies targeting mainly the firstly recruited year class.

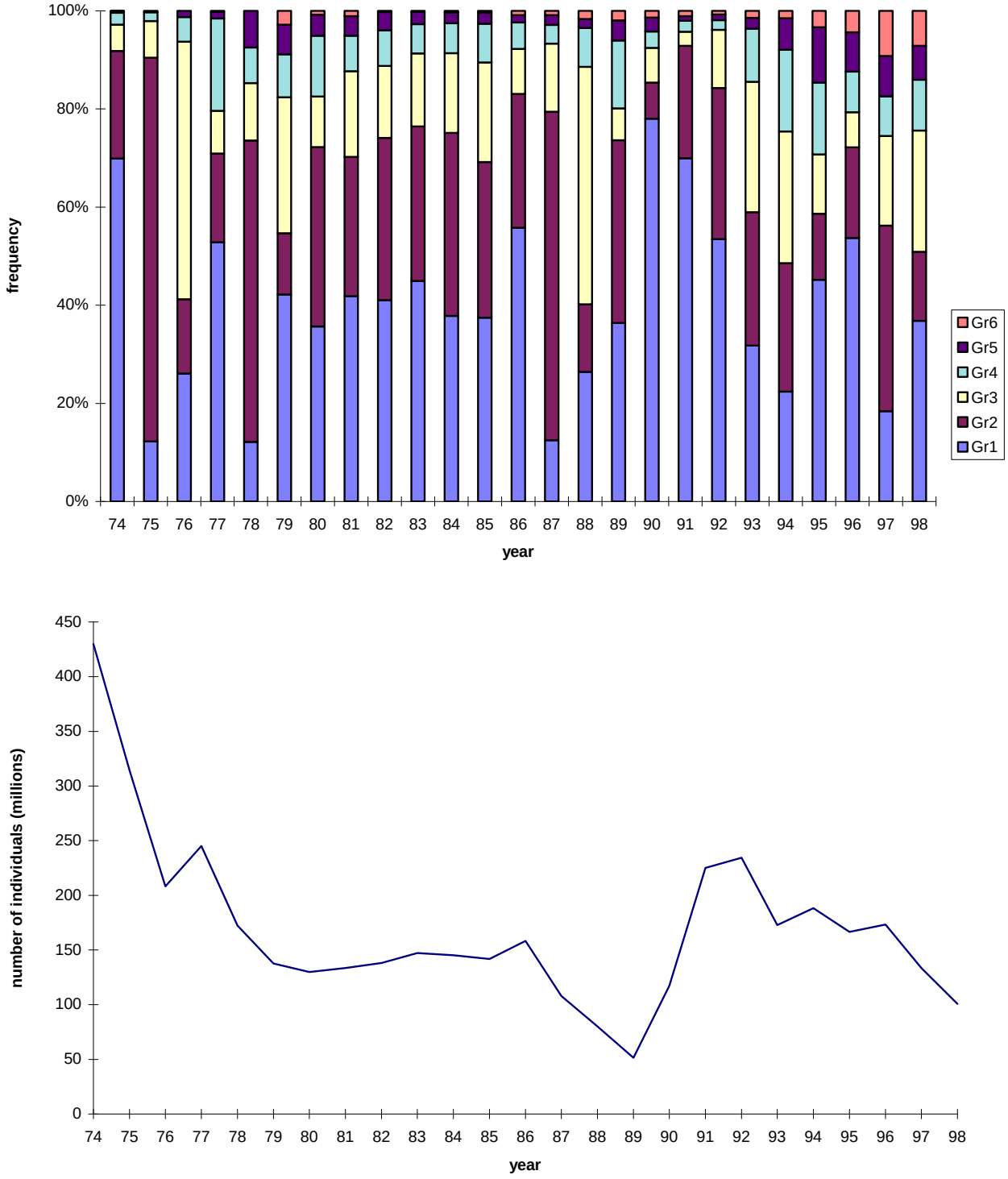


Figure 25 : Evolution of the scallop abundance and composition per age (age group 1 to 6 ; Gr1 to Gr6) in Bay of Saint-Brieuc. Years 1974 to 1998 (from S. Fifas IFREMER).

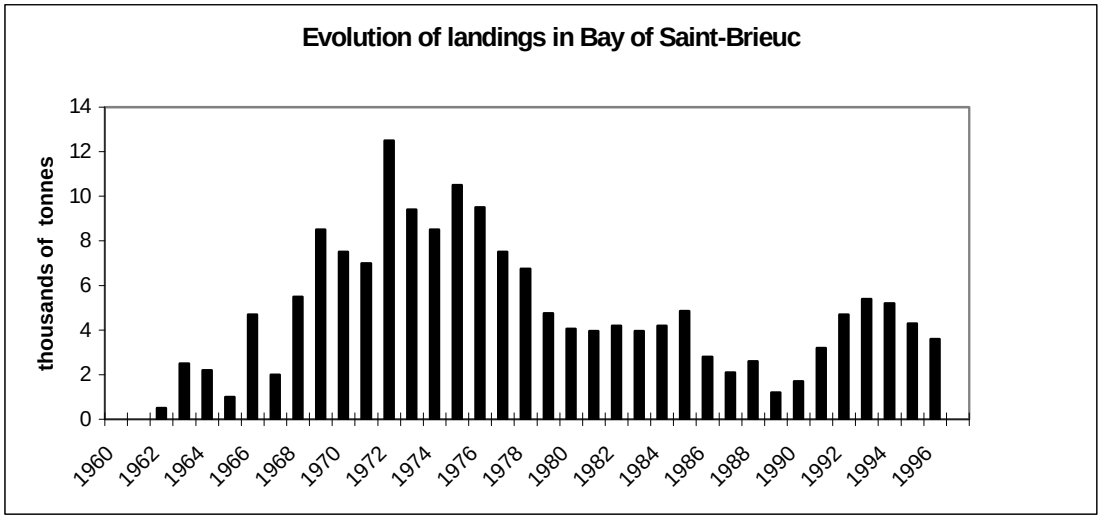


Figure 26 : Bay of Saint-Brieuc. Evolution of landings from 1962 to 1998 (from IFREMER DRV/RH).

Table 3 : Productions of several French scallop stocks in Atlantic and English Channel (from S. Fifas IFREMER).

Region	ICES division	Mean quantity in 1990's (tons)	Present trend
Belle-Ile	8A	120	Stable
Concarneau	8A	60	Stable
Ar Men – Iroise	8A, 7H, 7E	150	Decreasing
Brest	7E	more than 200	Increasing
Morlaix – Lannion	7E	150	Decreasing
Saint-Brieuc	7E	4000	Decreasing
Saint-Malo/Granville	7E	1500	
Seine	7D	2000 to 6000	Variable

2.3 Flexible and rigid Dredges for Warty venus (*Venus verrucosa*)

Warty venus dredging concerns only the French coast of VIIe from Bay of Granville to Paimpol and Bay of Brest.

Target species and by-catch

For the Bay of Brest, the target species is Warty venus (*Venus verrucosa*), with non-negligible by-catch of other bivalves (*Chlamys sp, Pecten maximus*).
For the Norman-breton gulf, the target species is Warty venus (*Venus verrucosa*), with non-negligible by-catch of other molluscs (*Glycymeris glycymeris, Buccinum undatum*).

Fishing areas (and ports)

128 boats in 1996 catch Warty venus, mainly in the Norman-breton gulf and in the Bay of Brest. The main concerned ports are : Saint Brieuc, Granville, Saint Malo, Paimpol and Brest.
Estimated total activity in ICES division VIIe : 704 boats in 1996.

Resource characteristics

Self-regenerating fishery based on wild spat settlement that fluctuates annually.
Animals recruit to the fishery when 7 - 8 years old at about 40 mm shell length.

Fishing strategy

The season is September to April.

Interactions

In resource terms, this métier has few interactions. In activity terms it is complementary to inshore trawl, scallop dredge, crustacean métiers and bass longline.

Regulation measures (Préfecture de la Région Bretagne, Direction Régionale des Affaires Maritimes, 1999)

The characteristics of the dredges for the bay of Brest are :
- maximal width : 1.50 meters
- dredge type : rake
- mesh ring inner diameter : 35 mm
- maximal dredge weight : 90 kilograms.

Each dredge used must be identified with the boat registration number soldering.

The caracteristics of the warty venus dredge in Norman breton Gulf are regulated, without any change since 1975 (Berthou, 1984). Most of the dredges exceed the regulation rules and the biggest ones reached a width of 80-90 cm and a weight of one ton.

Year	Length (m)	Width (m)	Height (m)	Weight (kg)
1954	1.50	0.60	0.25	-
1961	1.70	0.60	0.25	250

1969	2.00	0.60	0.25	300
1975	2.00	0.60	0.30	300

The « Comités régionaux des pêches » have decreed that every boat fishing bivalves on the designated beds must have an annual, specific and non transferable licence, which specifies the characteristics of the boat and the gear. The number of licences, the duration of the season and sometimes the total and individual annual quota are more or less closely assigned to each bed. Legal minimum shell length for Warty venus = 40 mm.

Markets

Mainly regional and national market.
More than 95% of French catches are from Norman-breton gulf, the rest is from South Brittany and the Bay of Brest.
Commercialised fresh.

Trends and comments

Bay of Brest :

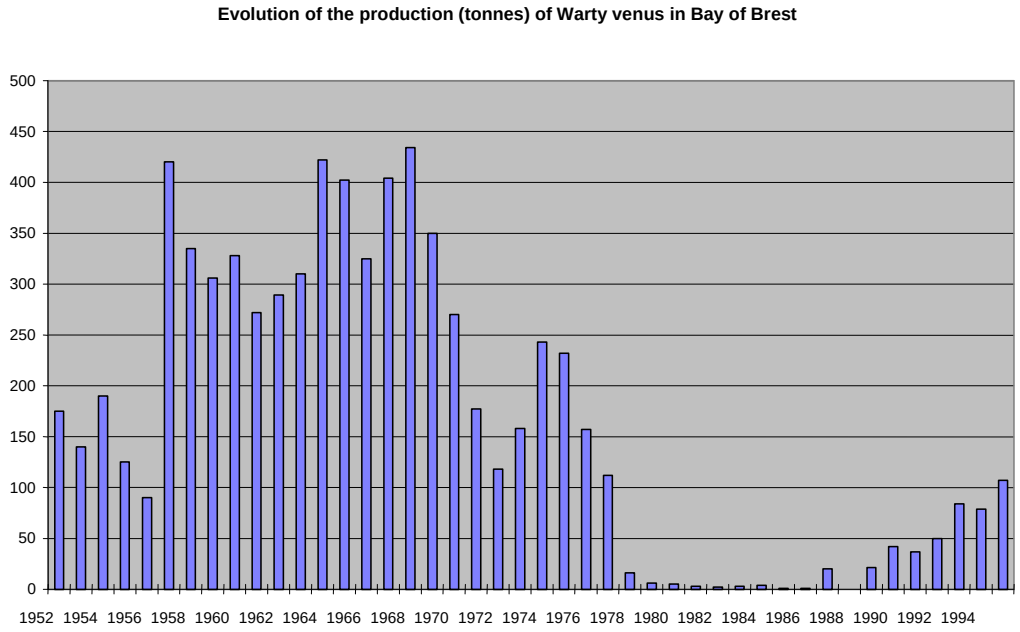
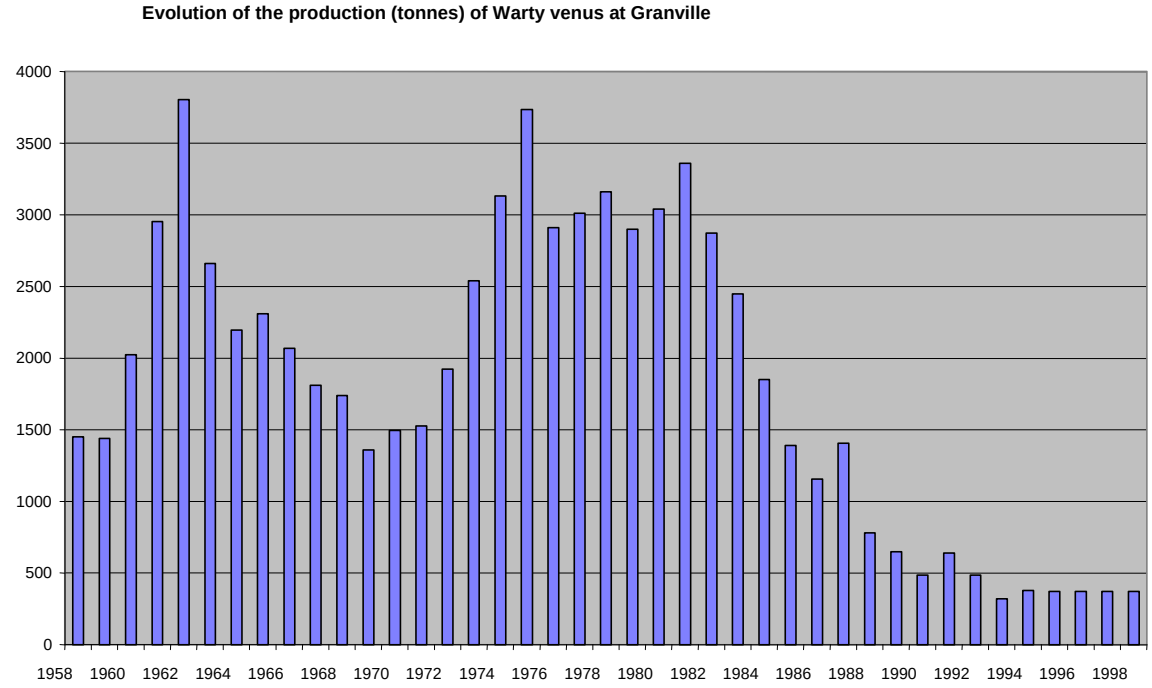


Figure 27 : Evolution of Warty venus production in the Bay of Brest (production (tons) / year) (from IFREMER DRV/RH).

This shellfish fishery is the oldest compared to Saint Brieuc and Granville. It is also the last more important in Europe with exploitation by sailing up to 1950. The introduction of engine increases catches and leads to new constructions. The fleets reached 280 units. After the hard winter of 1963, the shells annual production changed from 1500 tons on average to less than 100 tons on average.
Since 1973, the number of dredging boats has been divided by 2, the engine power has almost tripled and the inboard driving power has increased almost 30%.

Norman-breton gulf :

Graph 1 : Evolution of Warty venus production at Granville (production (tons) / year) (graph IFREMER DRV/RH).



The fishery of Warty venus of Granville has developed since 1958 and leads to the new harbour with a peak production of 3500 tons in 1962, 1975 and 1982. From 1982, the production had been in constant diminution and since 1993, it has been less than 400 tons. The shell deposit helped to the constitution of a specialised fleet in the harbour of Granville. In the beginning of the exploitation, 30 to 60 small dredgers from Côtes d'Armor (County of Brittany) are in the harbour up to 1963. These boats are half-decked boats of 7-8 meters, of more than 3 tons burden and of engine power of 18-30 kW. The Granville trawlers, lobster pot boats turn into dredgers. Much boats of 5 tons burden are built at Granville and others more robust (more than 10 tons burden) from 1964. The number of boats of less 5 tons burden decreases in 1969 and in 1974, one is left. The fleet is then composed of 10 to 12 boats of 5 to 25 tons of burden. In 1981, the fleet is about 74 units : since 1958, the number of boats has tripled and dredgers of Granville as doubled their tonnage and tripled their engine power.

Then, the fleet is decreasing because of a separation into two blocks with small boats (about 10 tons burden, 110 kW), and bigger boats (14-15 meters long, 30 tons burden). The number of bigger boats increases at the end of 1980's and small boats disappear from the fleet or change their fishery. Then, with innovation, the depressor plate installed on the dredge helps to increase the tow speed for most powerful boats.

2.4 Flexible Dredge for Queen scallops (*Chlamys varia, Chlamys opercularia*).

Target species and by-catch

Queen scallops (*Chlamys varia* and *Chlamys opercularis*) with by-catch of Sea urchins.

Fishing areas (and ports)

Bay of Brest and Camaret : 50 boats for the ports of Brest and Camaret.
East part of the Bay of Brest for *Chlamys varia* (black Queen scallop), West part of the Bay of Brest and Bay of Camaret for *Chlamys opercularis* (white Queen scallop).
Perthuis Charentais : *Chlamys varia*.
English Channel *: Chlamys opercularis*.

Estimated total activity in ICES division VIIe : 160 months in 1995 (Tétard A., 1995).

Resource characteristics

The common size of *Chlamys varia* is 4.5 - 5.5 cm. His maximum size is 8 cm. His colour varies and is not always black.
The common size of *Chlamys opercularis* is 4 - 6 cm. His maximum size is 11 cm. The animal does not resist long time to the air. Species longevity is about 4 to 5 years. Deposits are not stable, they appear suddenly and stay only few years.

Fishing strategy

For *Chlamys varia* , accessory fishing, season from November to February.
For *Chlamys opercularis*, the stock fluctuating, as soon as a deposit is detected, fishing starts.

Interactions

King scallops, Warty venus.

Regulation measures

Caracteristics of the dredge must be, for the Bay of Brest (Préfecture de la Région Bretagne, Direction Régionale des Affaires Maritimes, 1999) :
- maximum width : 1.80 m
- dredge type : blade
- rings internal diameter : 42 mm
- maximum weight : 120 kg.

As *Chlamys opercularis* does not resist long time to the air, commercial measures are taken for selling *Chlamys opercularis* in good sanitary conditions.

Market

For *Chlamys varia*, the consumption is traditional in Perthuis Charentes. Exportation to there from Bay of Brest.
Chlamys opercularis is delivered to firms of Saint Quay Portrieuc for shelling (« Noix de Saint Jacques »). This dredge fishing is interacting with other bivalves, the selling price being low and the conditions for keeping the animal fresh hard.

Trends and comments

For *Chlamys varia*, the production, in the Bay of Brest, fluctuated between 200 and 400 tons/year, the stock is at present decreasing.
In Perthuis Charentes, the production was 800 tons/years then was null from 1969 and 1991. Since 1992, the production has restarted and the production reached 200 tons in 1996-1997.
For *Chlamys opercularis*, fishing is active only when a deposit is detected.

2.5 Rigid Dredges for small bivalves

Target species and by-catch

Palourid (*Venerupis rhomboïdes*), bittersweet (*Glycymeris glycymeris*), thick trough shell (*Spisula sp*) and by-catch of Warty venus (*Venus verrucosa*).

Fishing areas (and ports)

50 boats dredge one or several species of small clam *Tapes* : Saint-Brieuc, Paimpol, Granville ; Bittersweet : Granville, Saint-Brieuc, Camaret ; *Spisula sp* : Granville, Camaret, Douarnenez, Le Guilvinec, Concarneau (a given boat can be involved in several métiers dedicated to clams).

Resource characteristics

Self-regenerating fishery based on wild spat settlement that fluctuates annually.

Fishing strategy

The boats work by day trips mainly within 6 miles. It is either a part-time or full-time métier. Most of the year for *Spisula sp*, palourid and bittersweet. When it is part-time activity, these boats switch to scallop or warty venus dredging in summertime.

Interactions

In resource terms, this métier has few interactions. In sea activity terms it is complementary to inshore trawl, scallop dredge, crustacean métiers and bass longline.

Regulation measures

The Fishermen organisations have decreed that every boat fishing bivalves on the designated beds must have an annual, specific and non-transferable licence, which specifies the characteristics of the boat and the gear. The number of licences, the duration of the season and sometimes the total and individual annual quota are more or less closely assigned to each bed. Legal minimum shell length are : Spisula sp = 28 mm, palourid = 38 mm and bittersweet = 40 mm.

Markets

Venerupis rhomboïdes is commercialised fresh in bays of Saint-Brieuc and Granville. A market for freezed palourid is being developped but is irregular.

Glycymeris glycymeris : 50 % of captures are from the Norman-breton gulf, the rest from South Brittany. *Glycymeris glycymeris* is commercialised fresh or freezed.

Spisula sp : Catches are from South brittany, Iroise, Vendée and Norman-breton gulf. *Spisula sp* was commercialised fresh but a market for freezed *Spisula sp* has been developppped to South Europe.

Trends and comments

Spisula sp, palourid and bittersweet are mainly under-exploited in the Channel according to the market's or recruitment's fluctuations.

Venerupis rhomboïdes : Before 1983, the catches were almost null but increased the last years from about ten to more than three thousand tons. They are still above the biological potential of the stock. In South Brittany the production is stable (300 tons).

Glycymeris glycymeris : The production is stable because of a poor market ; the production was between 2000 and 2500 tons in 1988, increasing during the 90's to 4000-5000 tonsand potentialities are still strong

Spisula sp : Stock fluctuates a lot. In 1987, production was about 5000 tons and did not exceed 1000 tons in 1995. At the end of 90's the french production is near zero according to strong recruiment fluctuations. As stocks are monocohort, fishermen have to wait for the next recruitment. Exploitations are successive along the coast.

2.6 Flexible Dredge for Mussels (*Mytilus edulis*)

Target species and by-catch

Mussels (*Mytilus edulis*).

Fishing areas (and ports)

Main ports : Barfleur, Saint Vaast La Hougue, Grandcamp (Cotentin, Normandie).
Characteristics of the boats (mean and range) :

- length	mean 12.5 t	range 5 –16 m
- gross tonnage	mean 20 t	range 2 – 47 t
- age	mean 18 years old	
- power	mean 132 kW	range 29 – 221 kW

Number of concerned boats : 19 units (this number varies between 10 and 40 according to mussel abundance and trade conditions).
Estimated total activity in ICES division VIId : 117 months (Tétard A., 1995).
Other area activity for the same boats and gears : none.

Resource characteristics

Animals recruit to the fishery at about 50 mm shell length, 60 – 70 mm in Mediterranena Sea.

Fishing strategy

Mussel dredging is carried out along the east coast of Cotentin, between 0.5 and 5 miles offshore, according to the location of the mussel beds. The working season generally begins in June and continues for about 6 months, according to the mussel abundance that depends on annual recruitment.

Interactions

Boats mainly alternate this métier with inshore bottom trawling for 12 units and 46 months, beam trawling for 8 units and 37 months, and scallop dredging for 16 units and 37 months.

Regulation measures

- MLS of mussels : 4 cm,
- Gears : only one dredge (120 kg maximum weight, and 2 knifes maximum (order number 33 of the 3rd of May 1977) per boat,
- Licences to fish mussels are issued each month. In recent years, licence numbers were limited, but in 1991 a limit of 40 was set, without restriction of maximum length or power of boats,
- Daily quota : 600kg/fisherman/day and limit of 3000 kg/boat/day,
- Mussel landings are allowed into only 3 ports : Barfleur, Saint-Vaast-La-Hougue and Grandcamp,
- Fishing is allowed only 5 days per week, during daylight.

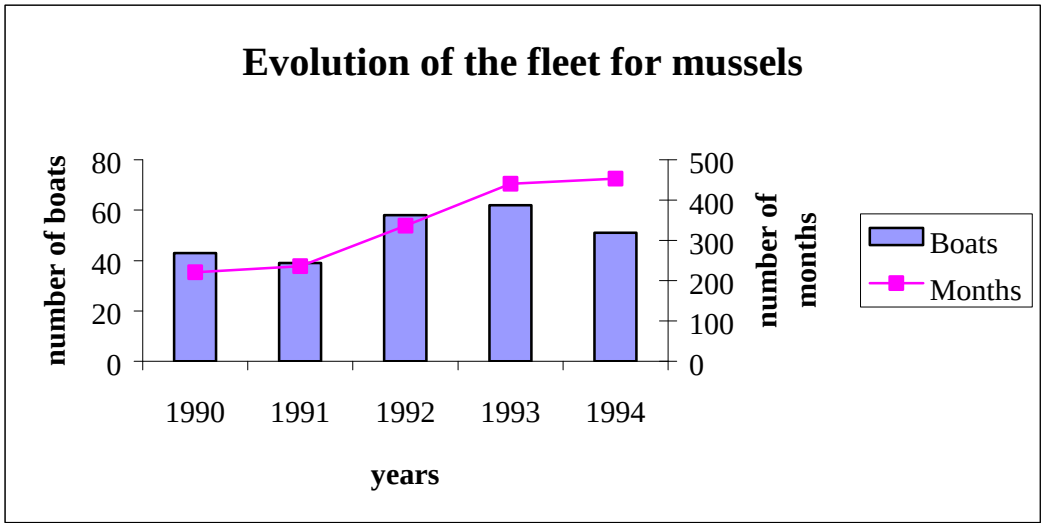
Markets

Most of animals are from culture but natural banks contribute to national production. National demand is below the production and 30 – 45 % is exported.

Trends and comments :

Table 4 : Evolution of the fleet (number of boats and months per year) (from IFREMER DRV/RH).

	1990	**1991**	**1992**	**1993**	**1994**
Boats	43	39	58	62	51
Months	221	236	336	440	453
% boats	3	2.7	4	4.3	3.5
% months	1.3	1.6	2.3	2.9	2.9



The deposit of mussels in East Cotentin is known from the XVIIIth century but the exploitation is real since 1962. The exploitation stopped in 1968 because of the decrease of the resource but has been reopened since 1976. A regulation has been installed in 1980 and an annual closing has been installed since in 1981 up to now.

Mussel dredging has been carried out for about 25 years in east Cotentin. The management of this resource, which depends on annual recruitment, is based on immediate recommendations given to the fishermen after a short assessment cruise. This resource is locally important because of its landings value and because it allows fishing effort to transfer from other métiers.

3 DREDGE FISHERIES ELSEWHERE

3.1 Flexible Dredge for scallop, Japan.

The whole dredge :

Description of the front of the dredge :

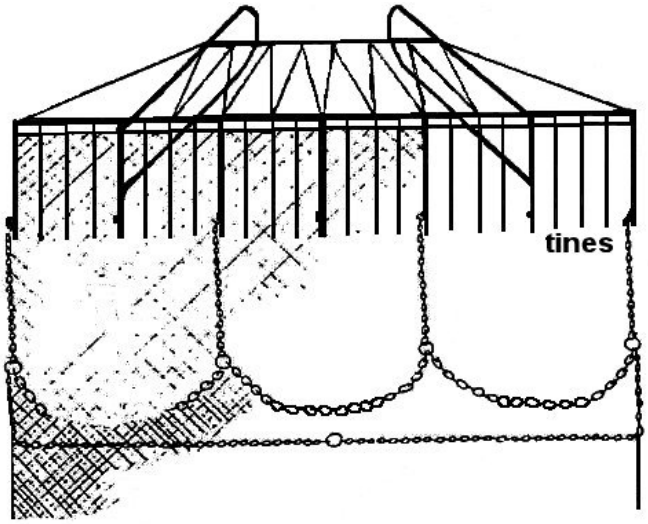


Figure 28: Japanese scallop dredge

Figure 29 : Japanese scallop dredge

3.2 Flexible Dredge for scallop, USA and Canada

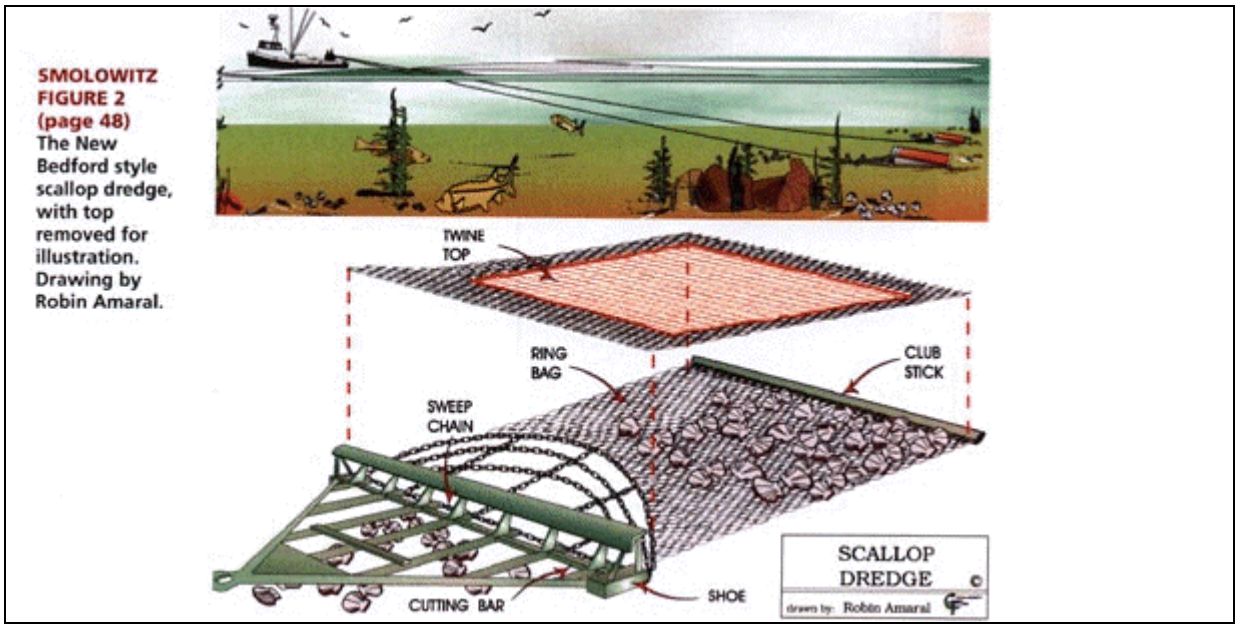


Figure 30 : Canadian and USA scallop dredge.

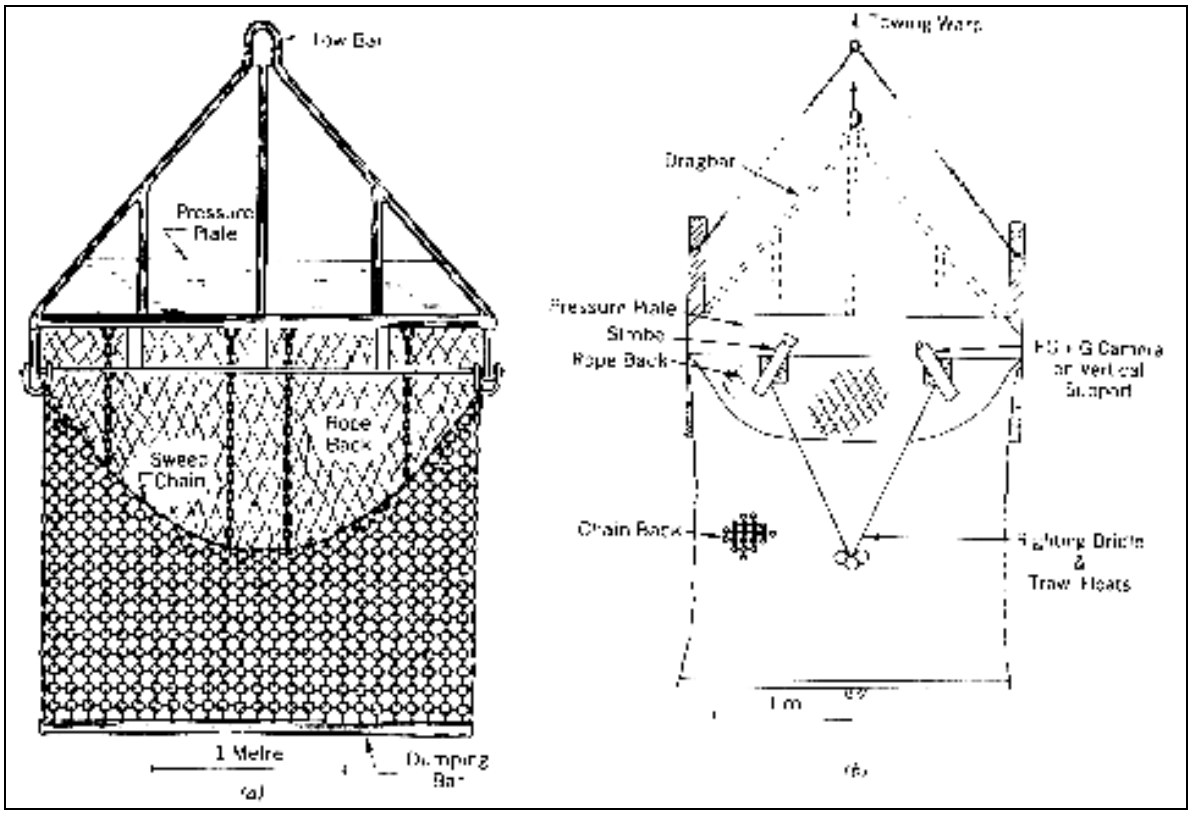


Figure 31 : Canadian and USA scallop dredge

3.3 Hydraulic dredge for clams, USA and Canada.

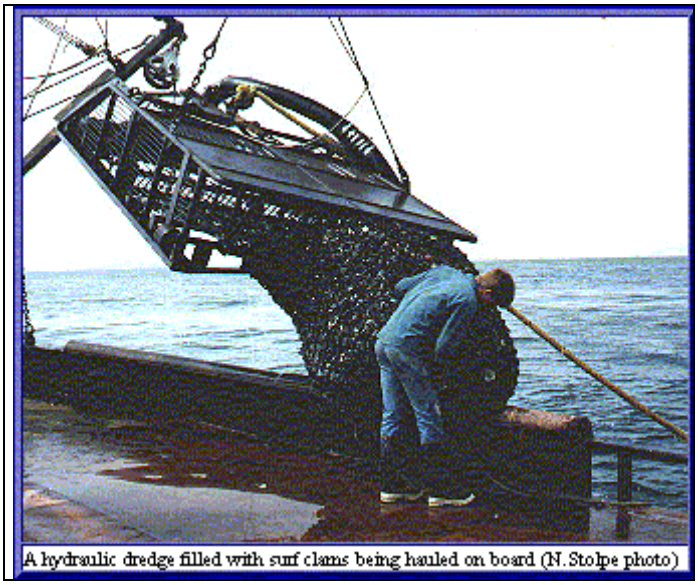


Figure 32 : Hydraulic dredge for clams of Canada and USA.

Figure 33 : Measures and storage on board.

Figure 34 : Dredging boat of Canada and USA.

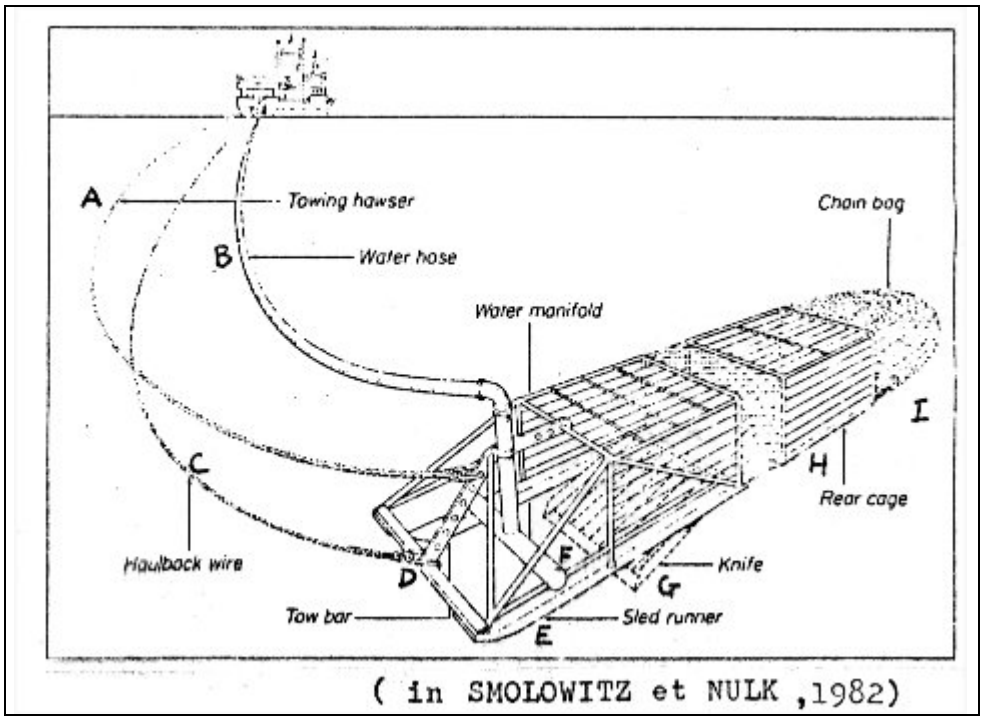


Figure 35 : Hydraulic dredge for clams of Canada and USA.

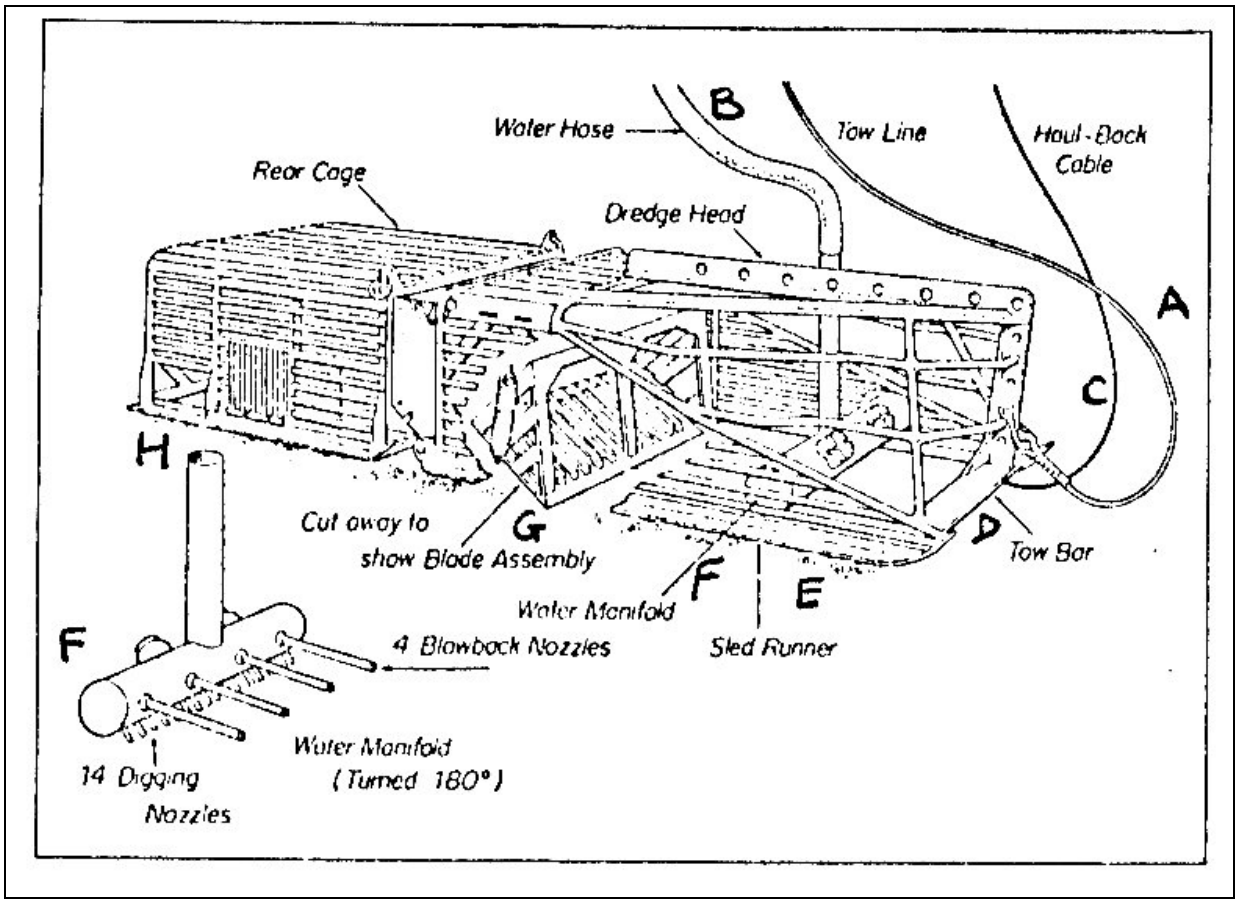


Figure 36 : Hydraulic dredge for clams of Canada and USA.

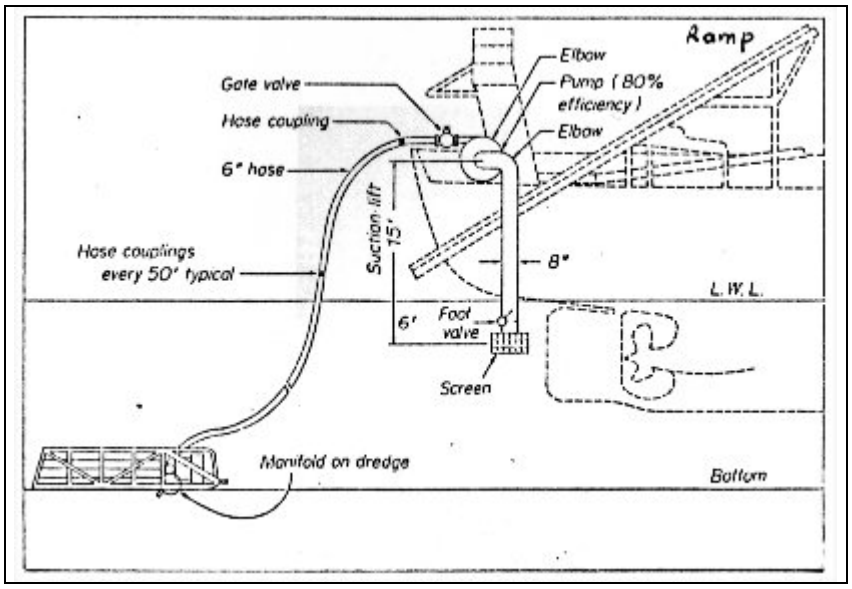


Figure 37 : Hydraulic dredge for clams of Canada and USA.

3.4 Hydraulic dredge, Netherlands.

Figure 38 : Hydraulic dredge of Netherlands.

Figure 39 : Hydraulic dredge of Netherlands.

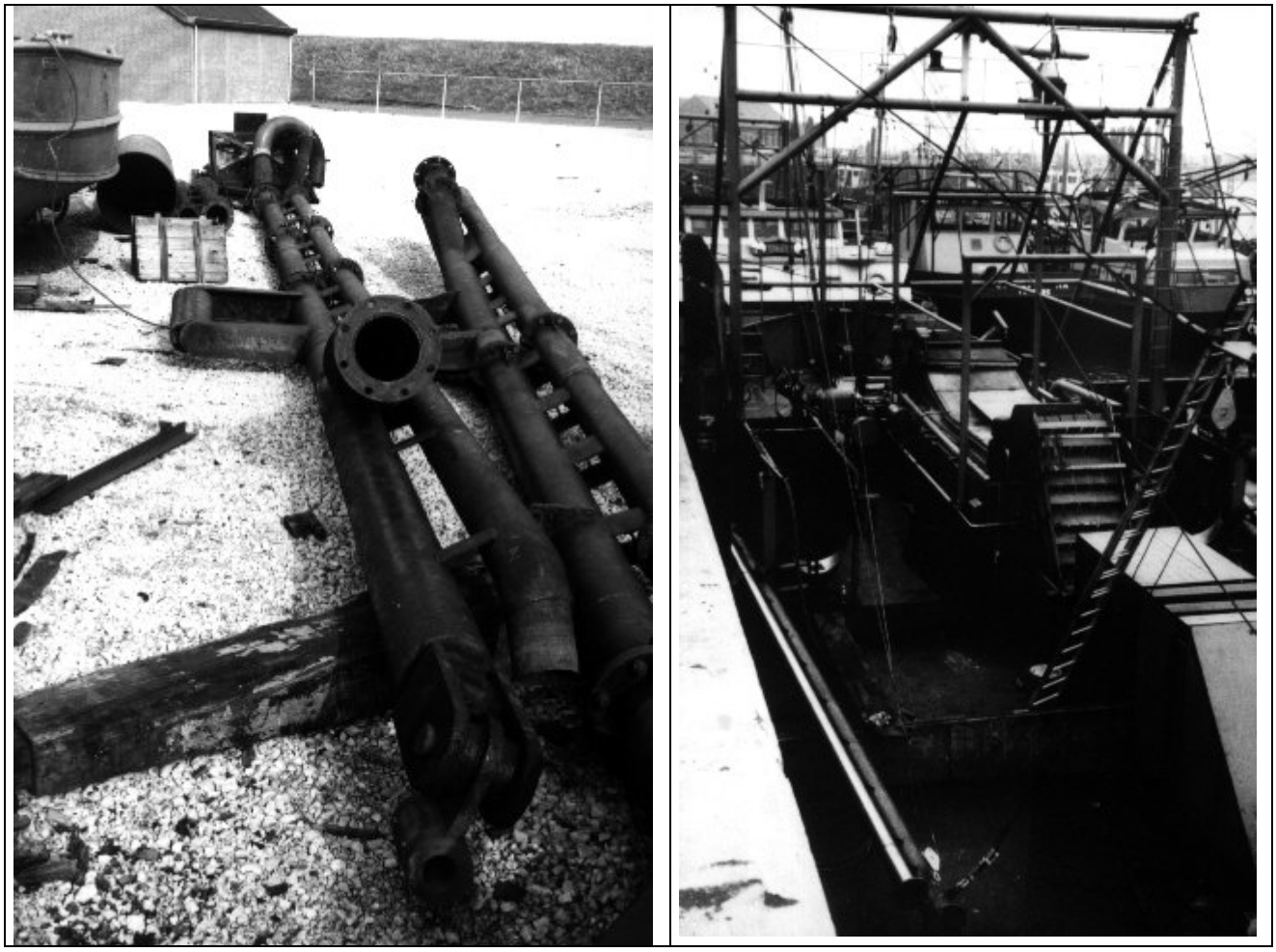


Figure 40 : Hydraulic dredge of Netherlands.

Figure 41 : Hydraulic dredging boat, Netherlands.

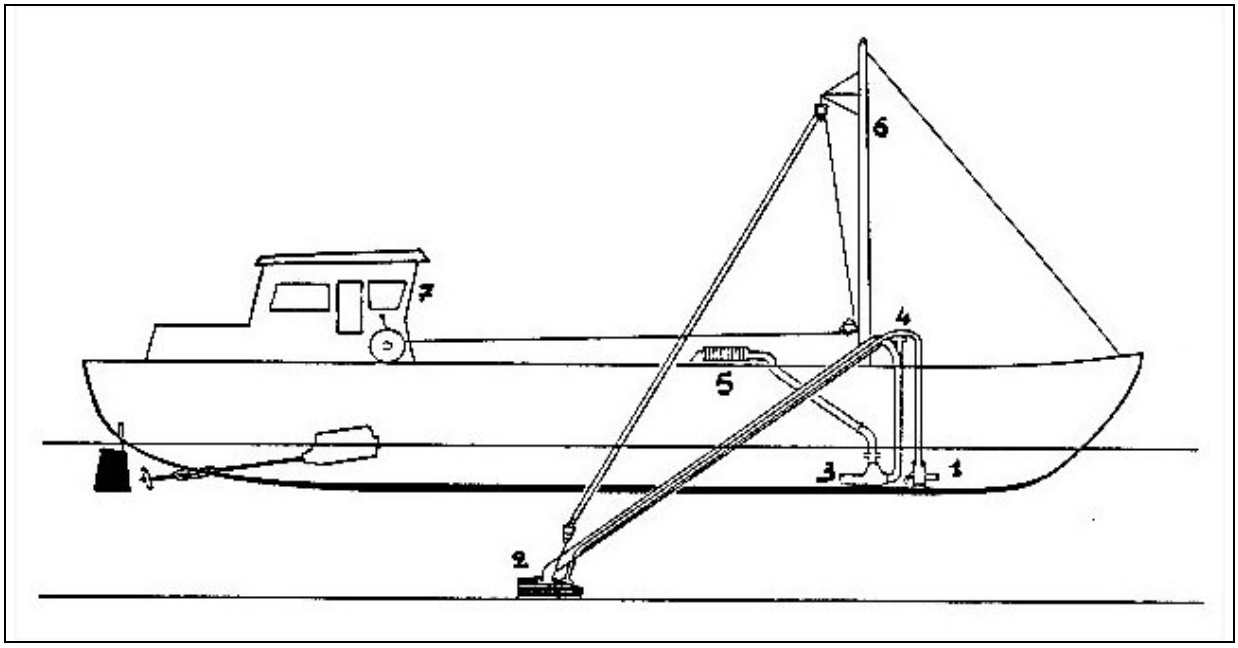


Figure 42 : Hydraulic dredging boat, Netherlands.

3.5 Flexible Dredge for mussels, Holland.

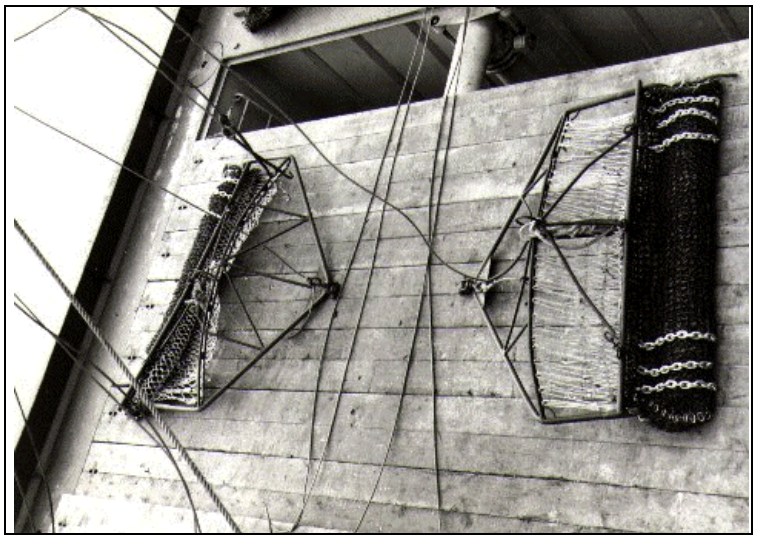


Figure 43 : Flexible dredge for mussels of Holland.

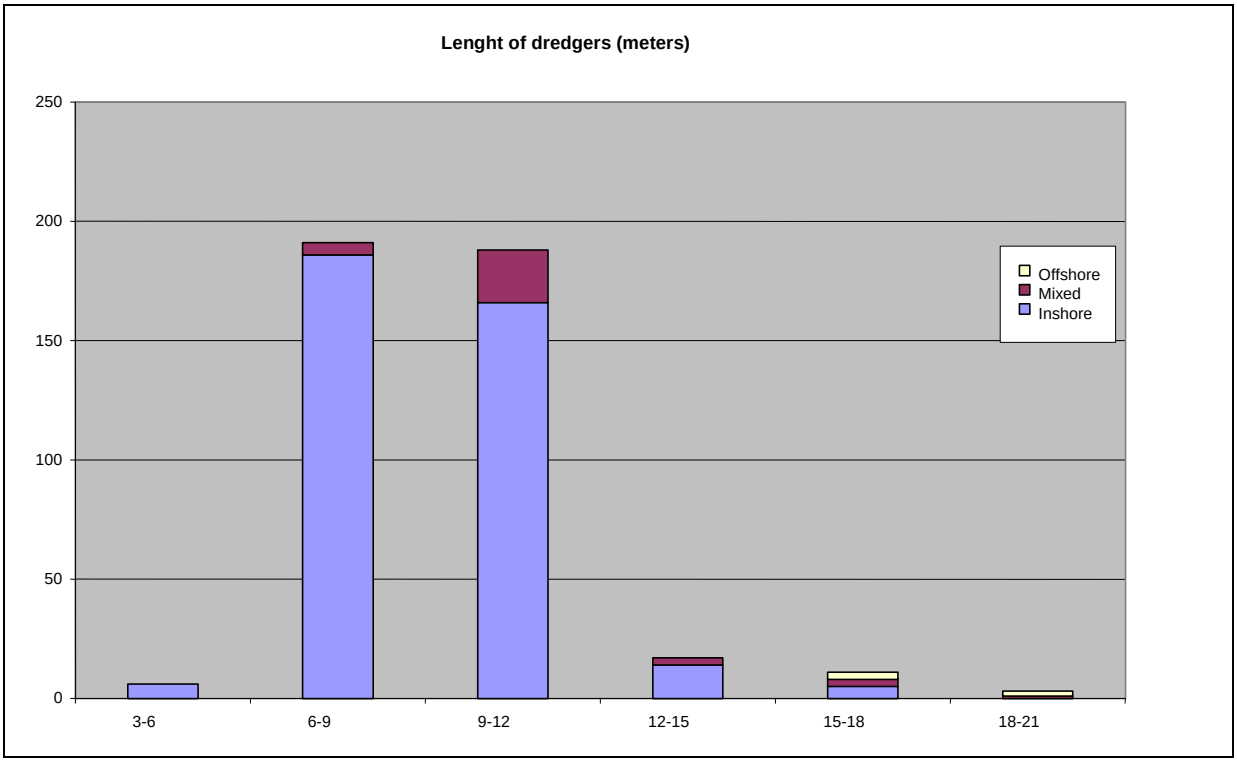
4 DREDGES FISHING EFFORTS

French dredge fisheries are numerous and diversified. Within the Channel and Atlantic French fleet, in 1996, 945 fishing vessels (21 % of the fleet) are involved in one or several dredging métiers, on average 6.4 months per year. Seventy per cent of the French dredgers are operating in the Channel (664 boats) ; they represent 37 % of the French Channel fleet, while only 10 % of the bay of Biscay French fleet are concerned.

Table 5 : Characteristics of the VII-VIII French dredgers by region (31.12.1996) (from IFREMER DRV/RH).

Région	Total number of boats	Number of dredgers	% dredgers	Mean length (m)	kW	Gauge
Nord Pas Calais	254	23	9	15	5796	80417
Haute Normandie	153	63	41	15	14606	207638
Basse Normandie	654	224	34	13	41065	502672
Nord Bretagne	734	354	48	10	39359	387779
Sud Bretagne	1159	168	14	10	17683	155482
Pays de Loire	741	58	8	9	4827	45339
Poitou Charentes	377	49	13	10	4563	43768
Aquitaine	440	6	1	11	693	8362
Total	4512	945	21	11	128592	1431457

According to the closed season adopted in the French dredge fisheries, most of the dredgers practise others métiers : some 416 of them (44 % of the dredgers) are also trawlers, others are involved on fixed gears métiers.



Graph 2 : Length of dredgers (from IFREMER DRV/RH).

The majority of the fleet is from 6 to12 meters long: the biggest dredgers (13 to 20 meter long) are located on VIId and in the Norman-breton gulf.

According to the extension of the resources (fig. 44 and 45 : location pectinids and others) the French dredging is mainly an inshore activity, except 90 scallopers of the east Channel who work also outside the 12 nautic milles (fig. 46: number of dredging boat months).

The importance of the main dredging métiers could be appreciated through the number of boats involved and the activity time is accounted in boat-months which correspond to the number of months during which the métier had been an activity.

Métiers	Number de boats	Number of months of fishing
DRB King scallop	755	3825
DRB Warty venus	128	704
DRB small clams	116	673
DRB Queen scallop	109	361
DRB Mussel	77	399

King scallops dredging is the main métier : 80 % of the dredger fleet are involved from Boulogne to La Rochelle. This métier represent 62 % of total number of months of activity.

Warty venus dredging concerns only the French coast of VIIe from Bay of Granville to Paimpol and the bay of Brest.

Dredging for small clams (*Glycymeris glycymeris*, *Venerupis rhomboïdes*, *Spisula* sp., *Ruditapes philippinarum*) is located mainly on VIIe and South Brittany.

Dredging for variegated scallop is concentrated in the Bay of Brest and the Pertuis Charentais.

Dredging for mussel concern mainly the East Cotentin from Barfleur to Saint Vaast la Hougue.

In South Brittany, some fishermen are dredging for sea urchins. Furthermore about forty boats are using dredges to catch flat fishes.

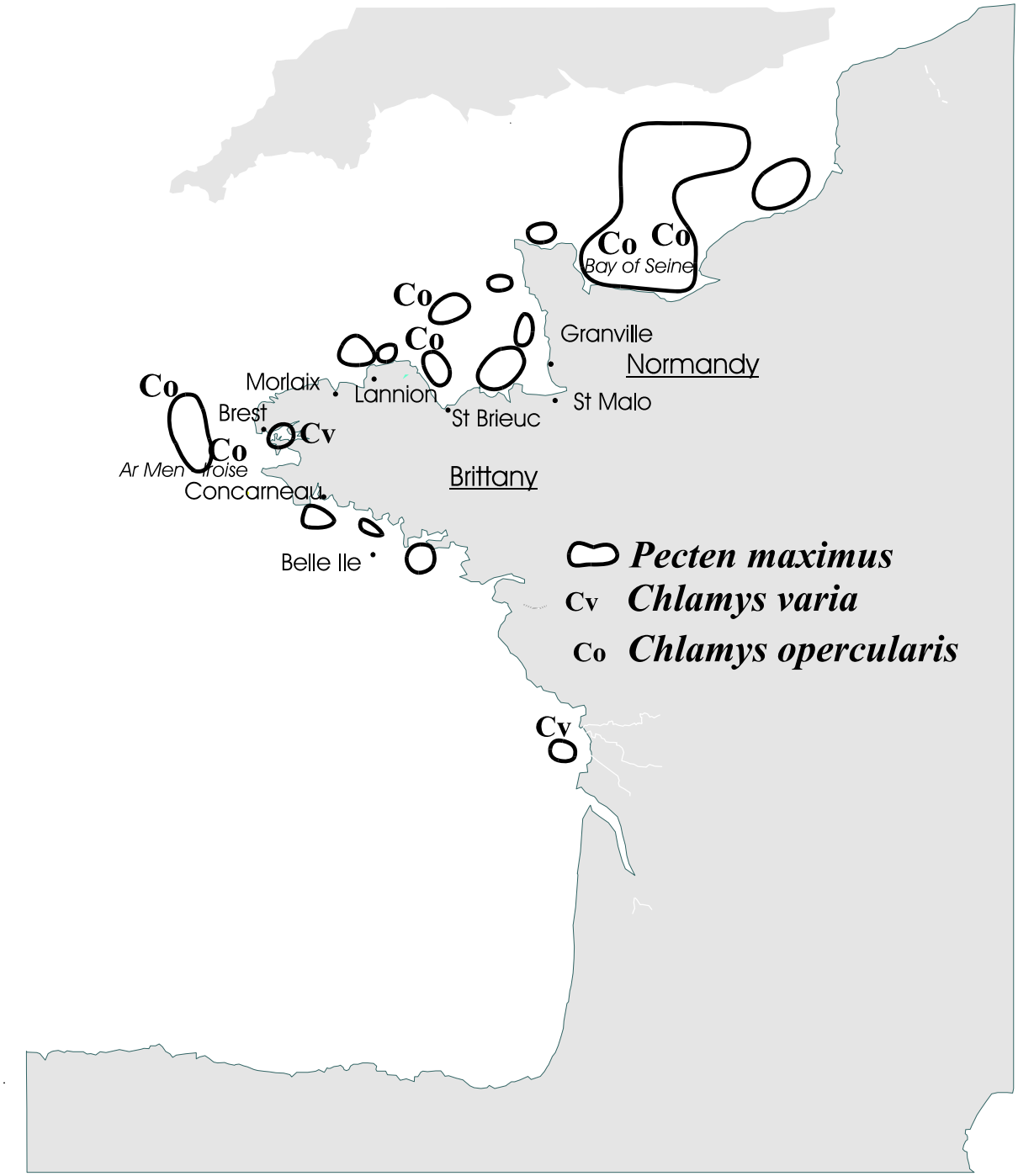


Figure 44 : Location of pectinids (from IFREMER DRV/RH).

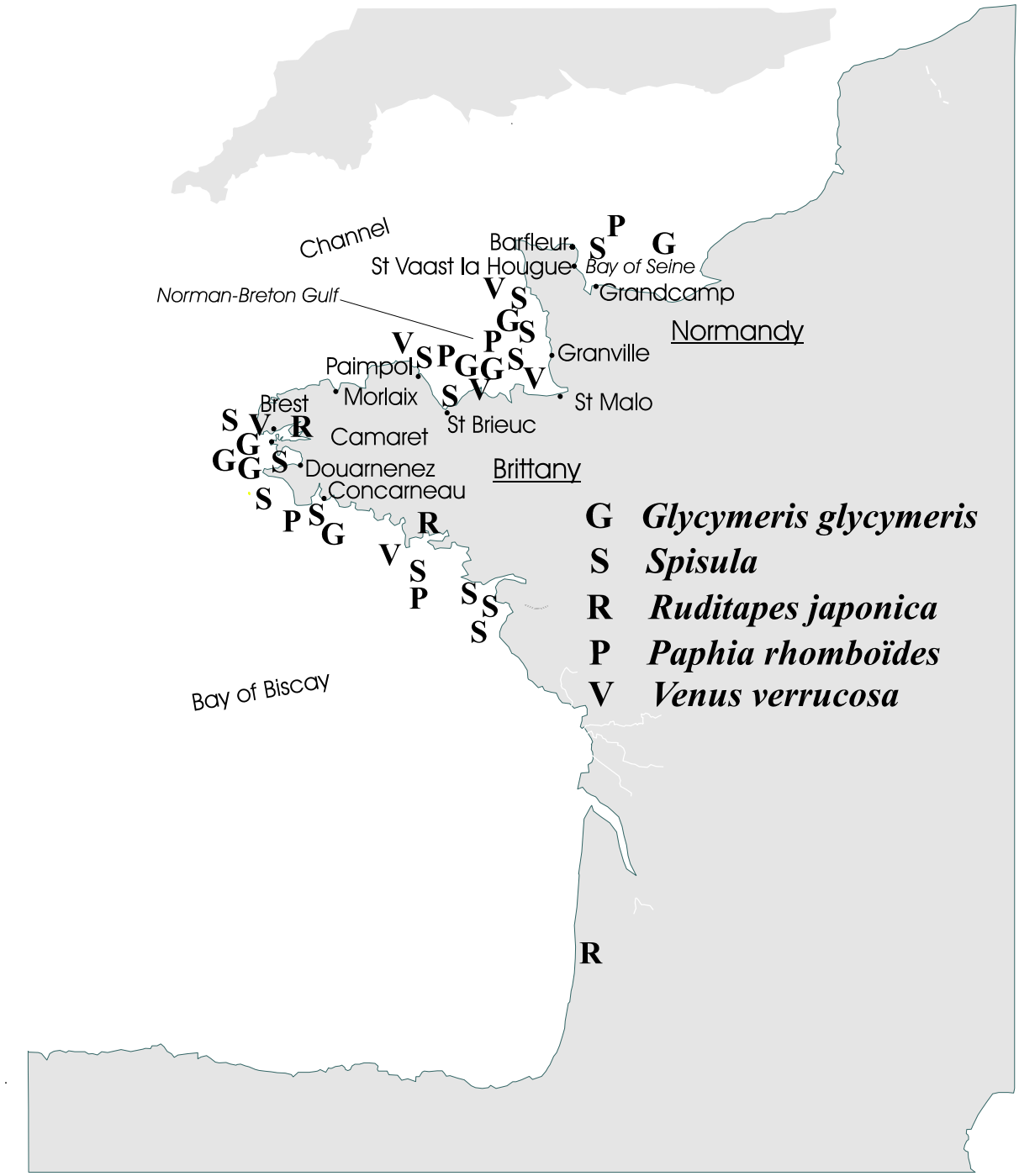


Figure 45 : Location of other bivalves (from IFREMER DRV/RH).

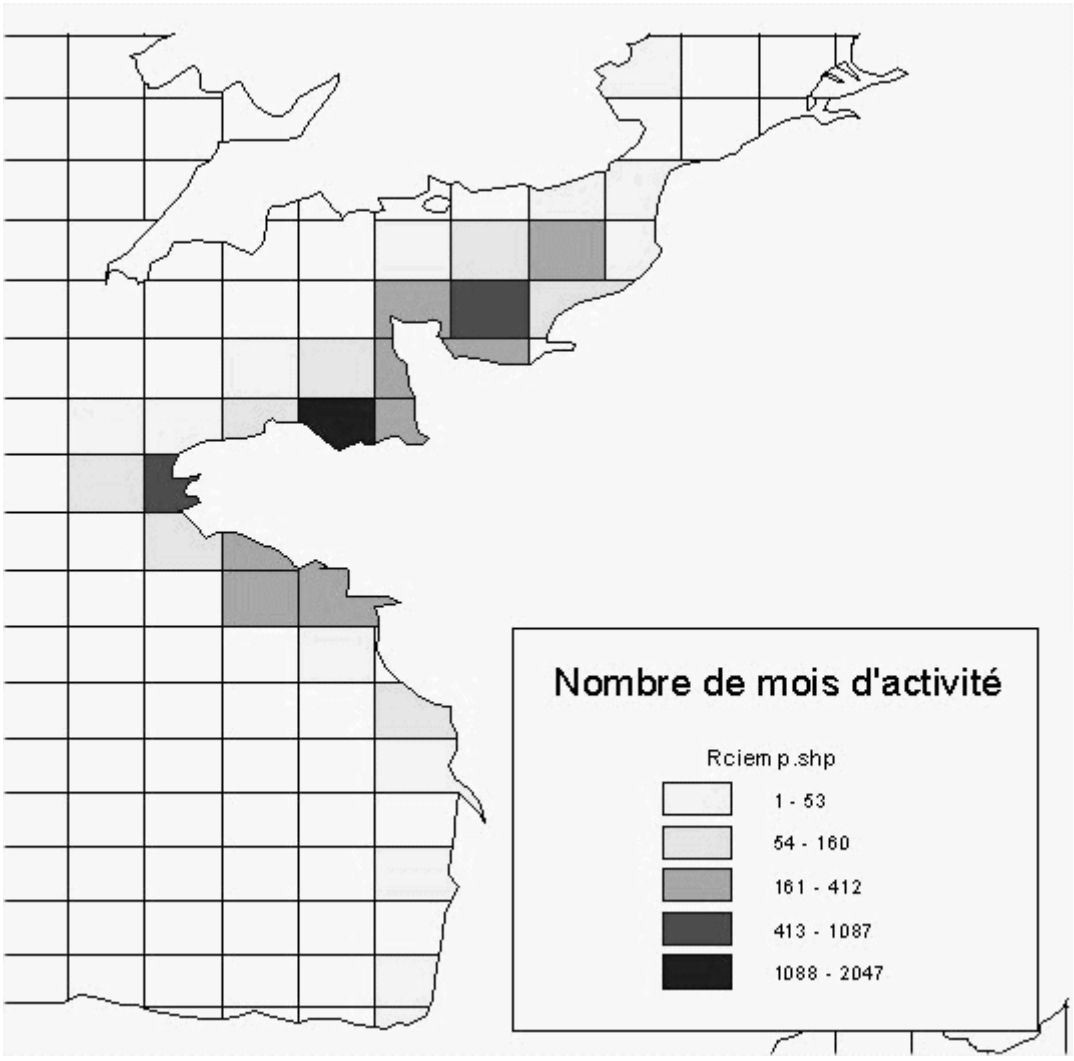


Figure 46 : Number of dredging boat-months for 1996 (from IFREMER DRV/RH).

REPORT 2

ENVIRONNEMENTAL IMPACT

ECODREDGE

Table of contents

Table of figures, tables, and graphs

1 SUB TASK 1.5 : ENVIRONNEMENTAL IMPACT

1.1 Mortality

Table 1: Percentage efficiency and mortality for shellfish dredges.

Dredge type, target species	**Species and location**	**Ground type**	**% Efficiency**	**% Mortality of target species**	**Comments**
Fixed tooth bar with diving plate. Dupouy, 1982	*P.maximus* Bay of Saint-Brieuc (period = 1970's and 1980's)	Sand-gravel-shell	34-40	Less than 15	
Fixed tooth bar with diving plate.	*P.maximus* Bay of Saint-Brieuc (1990's)	Sand-gravel-shell	60-80	1.2 low damage in dredge track, 1.2 low damage dredge caught	The damage increases on rough bottom and with bad weather conditions
Fixed tooth bar without diving plate. Dupouy, 1982	*P.maximus* Bay of Brest (period = 1970's)	Muddy sand-gravel-shell	15-20	More than 20	
Fixed tooth bar without diving plate.	*P.maximus* Bay of Brest	Muddy sand-gravel-shell	35 maximum	low damage in dredge track, low damage dredge caught	
Fixed blade without diving plate.	*T. Rhomboïdes* Bay of Saint-Brieuc	Sand-gravel-shell	15-20	10-20 severe damage in dredge track, 5-20 severe damage dredge caught	Related to blade designs and may be the width of the dredge
Flexible dredge Fixed tooth bar	*V.verrucosa* Bay of Brest	Muddy sand-gravel-shell		low damage in dredge track, 0-1 low damage dredge caught	
Box dredge Fixed blade	*V.verrucosa* Norman-breton gulf	Sand-gravel-shell-stone		severe damage in dredge track, 5-20 severe damage dredge caught	
Flexible dredge Fixed blade	Tapes, Spisula South Brittany	Sand-gravel-shell		Low damage	

2 SUB TASK 1.6 : EXPERIMENT OF SELECTIVITY

British references are numerous on this subject of selectivity and efficiency of scallop dredges (Scottish waters : Mason *et al*., 1979 ; Western English Channel : Dare and Palmer, 1994). In the case of spring-loaded dredges, Dare *et al*. (1993) described two-stage selection and retention process (by toothed bar and meshes) ; Fifas and Berthou (1999) presented a mathematical analysis and formulation of this aspect for scallop experiment dredges with depressor plate. In past references, we can cite Dupouy (1982) who compared selectivity and efficiency of dredges without and with depressor plate : this author found that adding a depressor plate modifies deviation of selection of dredges and a more strong ratio of small scallops can be caught for a given mesh size and teeth spacing. The same author cited a value of 35 % of catch rate for dredges equipped with depressor plate and 20 % without this equipment (at present, values of 80 % and 36 % are observed).

In general trends, selectivity and efficiency of French dredges can be described by logistical curves (fig. 1 and 2) expressing size-selectivity of fishing gears and fitted by different algorithms (maximum likelihood model : Millar, 1991 ; multinomial likelihood method : Perez-Comas and Skalski, 1996, etc.). It does not seem that efficiency decreases with scallop size (Buestel *et al.*, 1985 ; Fifas, 1991). Deviation of selection and half rate size (L_{50}) seem be linear functions of mesh size.

In the case of spring-loaded dredges, the problem may be more complexe. It is probable that a component of avoiding reaction must be added in function because of behaviour of fishing gears on a rough sea bottom : in fact, this avoiding reaction may be only passive and may be done by cracking of scallop valves caused by disturbance of sea bottom by dredging. The avoiding additive function seems decrease against scallop size (fig. 3 ; see Mason *et al*., 1979).

Table 2. Fitting of logistical curves for selectivity of dredges with depressor plate (from Labbé, 1983 ; Fifas, 1991).

$$y(l) = \frac{1}{1 + \exp(-\alpha.(l - L_{50}))}$$

mesh size (mm)	71	82	93	105
estimation of α	1.094	0.342	0.239	0.285
L_{50} : size (mm)	71.0	79.7	88.5	98.9
market size (mm)	81.5	91.7	102.1	114.5
factor of selection	1.00	1.03	1.05	1.06
deviation of selection (mm)	2.01	6.42	9.20	7.71

factor of selection : L_{mesh}/L_{50}

deviation of selection : $L_{75}-L_{25} = -2.\ln(3)/\alpha$

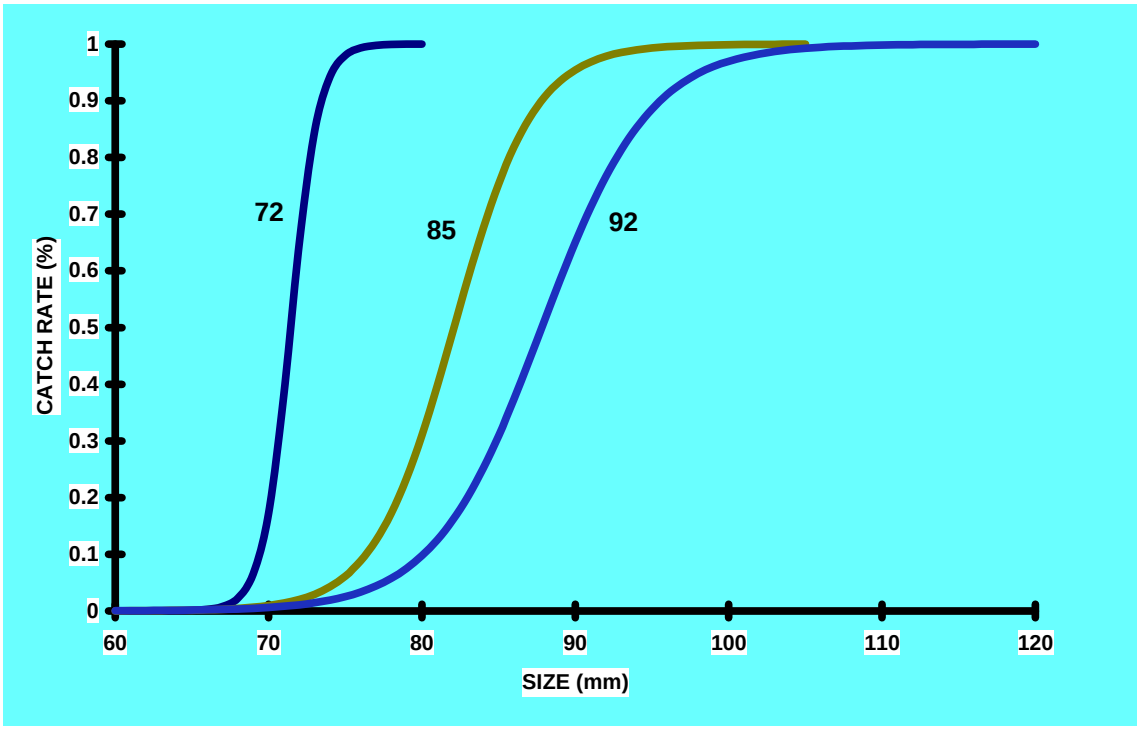


Figure 1 : Dredge with depressor plate. Selectivity curves for different mesh sizes (in mm) (from IFREMER DRV/RH).

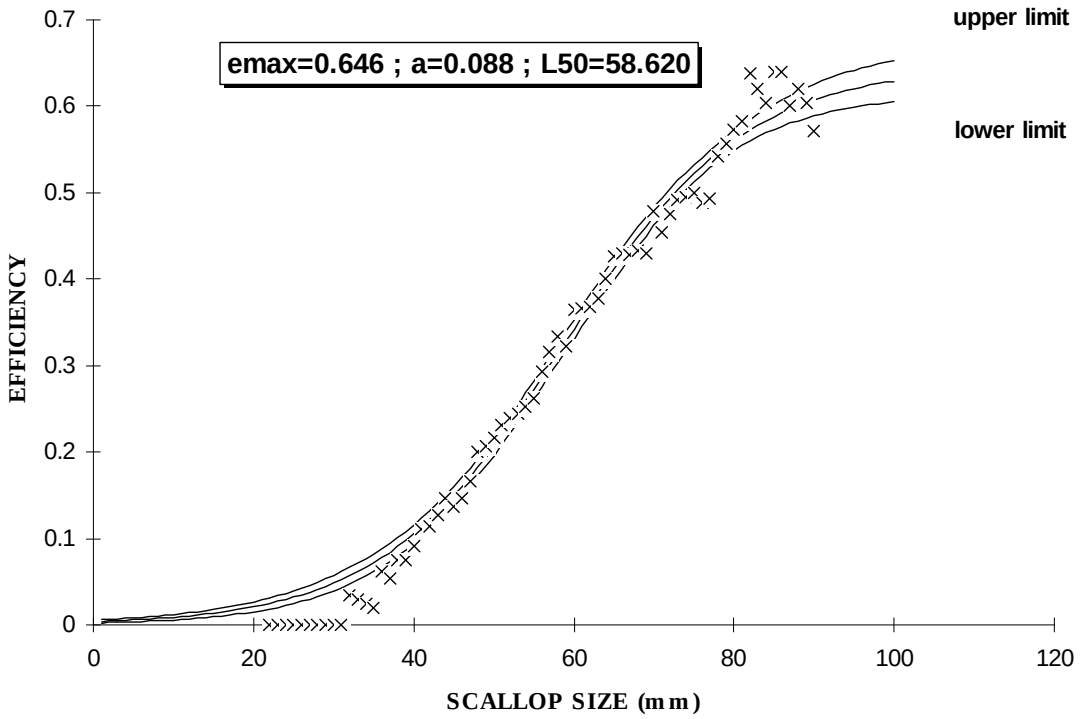


Figure 2. Fitted efficiency model of an experimental scallop dredge with depressor plate (*in* Fifas and Berthou, 1999) ; mean confidence intervals are plotted with confidence level of 0.95).

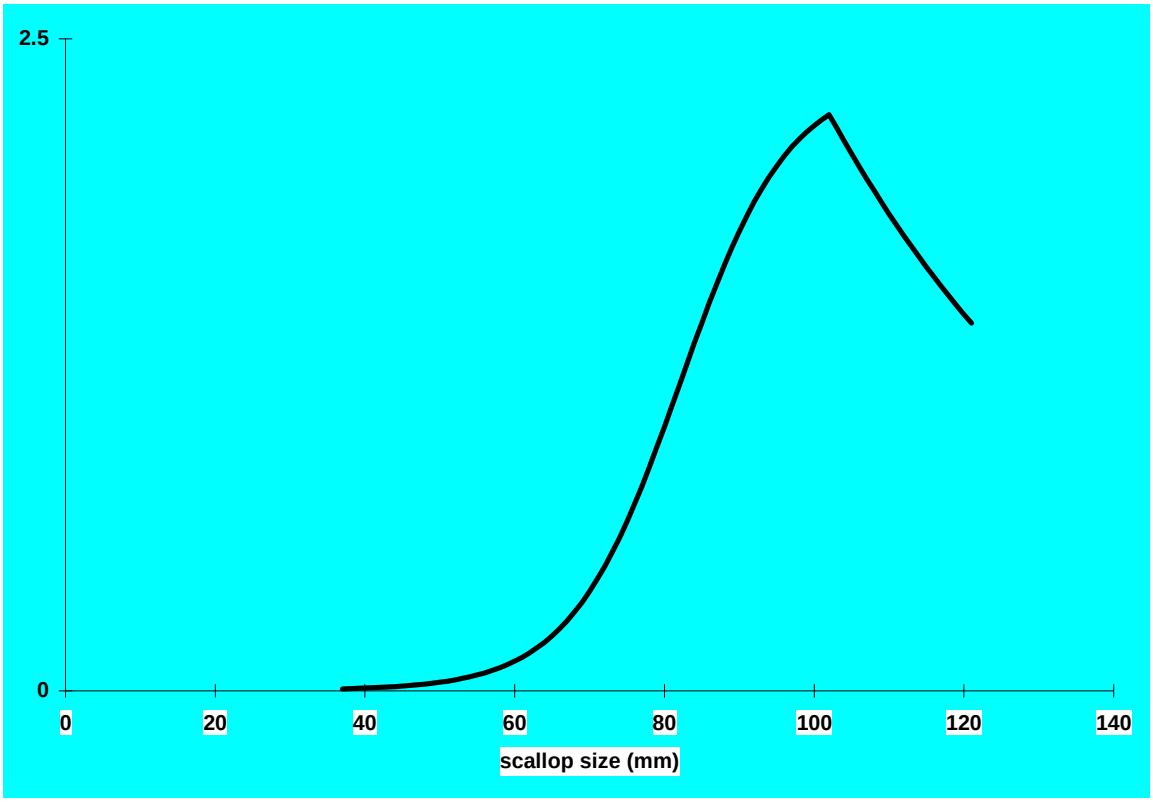


Figure 3 : Theorical efficiency curve of spring-loaded dredge (from S. Fifas IFREMER).

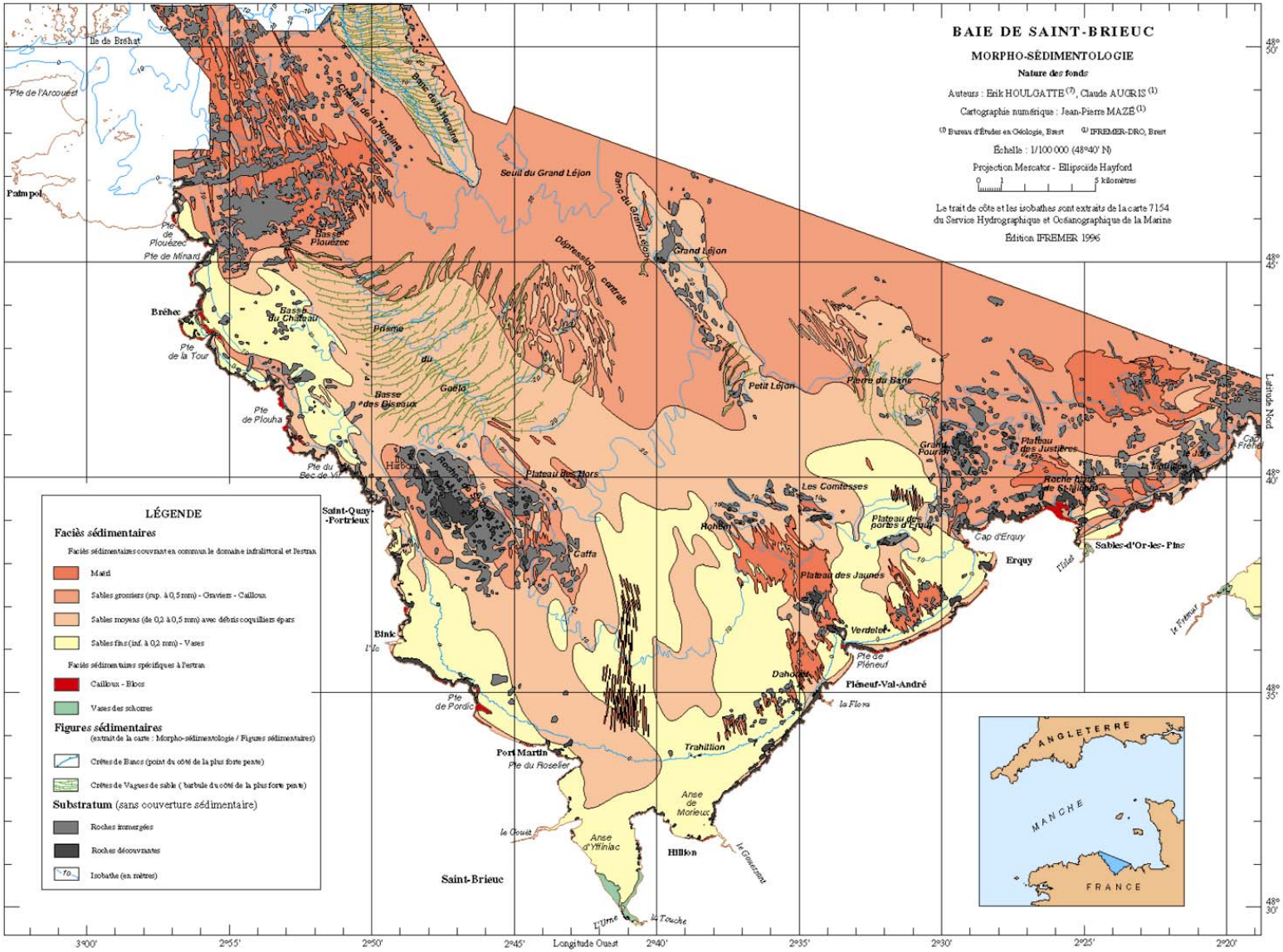
3 SUB TASK 1.7 : ECOLOGICAL CONDITIONS AND SEDIMENT TYPES

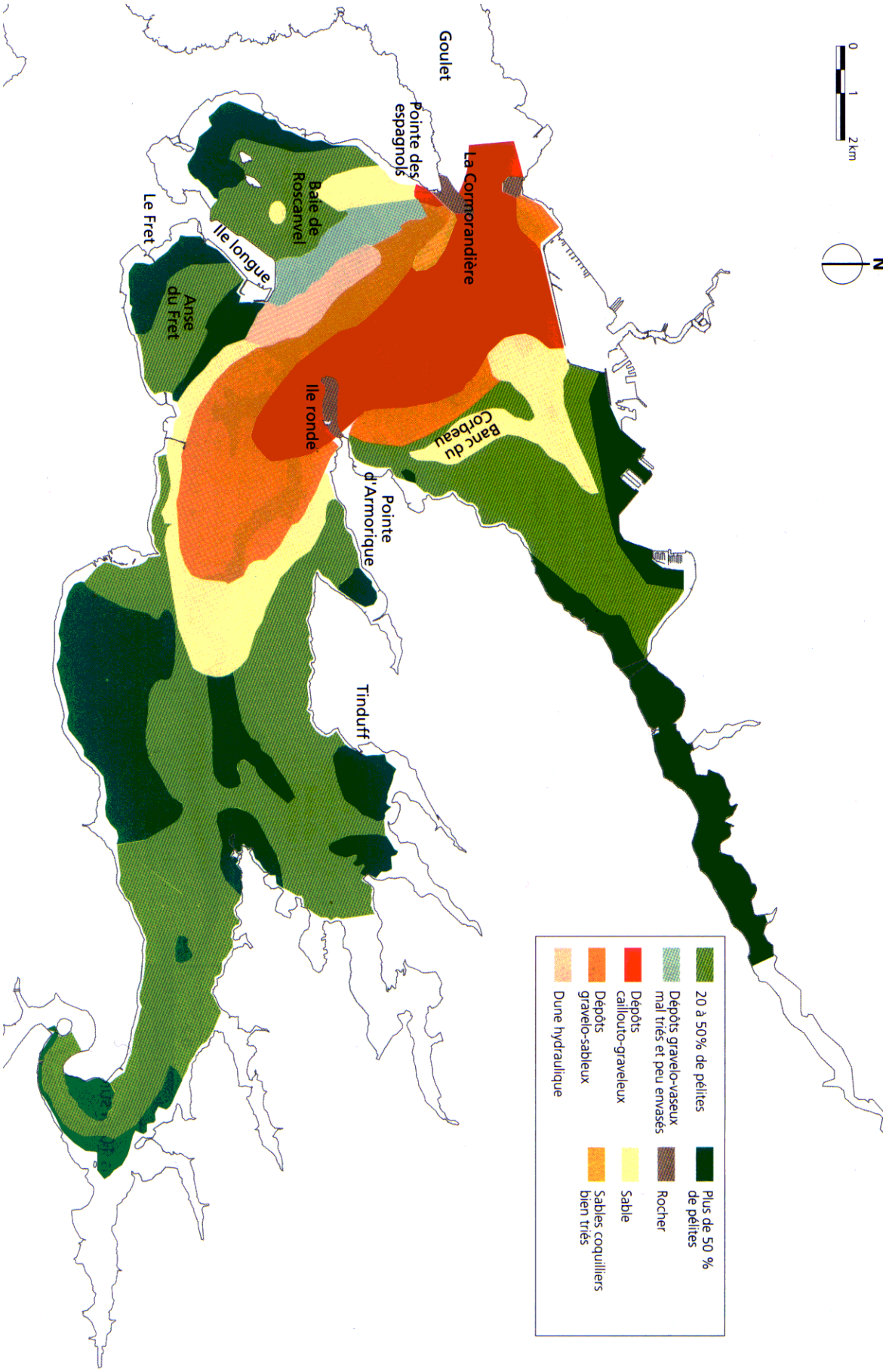
3.1 Sediment types

3.1.1 Saint Brieuc

Figure 4 : Sedimentary facies map of Bay of Saint-Brieuc (from Augris D., 1997)
See below.

Figure 5 : Sedimentary facies map of Bay of Brest (from Troadec P.1997) :
Fisheries for *Pecten maximus* and *Chlamys opercularis* are applied in the west part of the Bay, and fisheries for *Chlamys varia* and *Venus verrucosa* in the East part of the Bay.
See below.


BAIE DE SAINT-BRIEUC
MORPHO-SÉDIMENTOLOGIE
Nature des fonds
Auteurs : Erik HOULGATTE (7), Claude AUGRIS (1)
Cartographie numérique : Jean-Pierre MAZÉ (1)
(7) Bureau d'Études en Géologie, Brest (1) IFREMER-DRO, Brest
Échelle : 1/100 000 (48°40' N)
Projection Mercator - Ellipsoïde Hayford
0 1 5 kilomètres
Le trait de côte et les isobathes sont extraits de la carte 7154
du Service Hydrographique et Océanographique de la Marine
Édition IFREMER 1996
LÉGENDE
Faciès sédimentaires
Faciès sédimentaires couvrant en commun le domaine infralittoral et l'estran
Maërl
Sables grossiers (rup. à 0,5 mm) - Graviers - Cailloux
Sables moyens (de 0,2 à 0,5 mm) avec débris coquilliers épars
Sables fins (inf. à 0,2 mm) - Vases
Faciès sédimentaires spécifiques à l'estran
Cailloux - Blocs
Vases des schorres
Figures sédimentaires
(extrait de la carte : Morpho-sédimentologie / Figures sédimentaires)
Crêtes de Bancs (point du côté de la plus forte pente)
Crêtes de Vagues de sable (barbule du côté de la plus forte pente)
Substratum (sans couverture sédimentaire)
Roches immergées
Roches découvrantes
Isobathe (en mètres)
Ile de Bréhat
Pte de l'Arcouest
Paimpol
Pte de Plouézec
Pte de Minard
Basse Plouézec
Bréhec
Basse du Château
Pte de la Tour
Pte de Plouha
Pte du Bec de Vir
Saint-Quay-Portrieux
Binic
l'Ic
Pte de Pordic
Port Martin
Pte du Roselier
Saint-Brieuc
le Gouet
Anse d'Yffiniac
l'Urne
la Touche
Hillion
Anse de Morieux
le Gouessant
Trahillion
Dahouet
Pléneuf-Val-André
la Flora
Pte de Pléneuf
Verdelet
Erquy
Cap d'Erquy
Sables-d'Or-les-Pins
l'Islet
le Frémur
Plateau des Jaunes
Plateau des portes d'Erquy
Les Comtesses
Ronbon
Caffa
Plateau des Hors
Petit Léjon
Grand Léjon
Seuil du Grand Léjon
Banc du Grand Léjon
Dépression centrale
Chenal de la Horaine
Banc de la Horaine
Prisme du Gobla
Basse des Oiseaux
Pierre du Banc
Grand Pourrain
Plateau des Justières
Roche Noire de St-Julien
Cap Fréhel
ANGLETERRE
MANCHE
FRANCE
3°00'
2°55'
2°50'
2°45'
Longitude Ouest
2°40'
2°35'
2°30'
2°25'
2°20'
48° 30'
48° 35'
48° 40'
48° 45'
Latitude Nord


0
1
2 km
N
Goulet
Pointe des espagnols
La Cormorandière
Baie de Roscanvel
Le Fret
Ile longue
Anse du Fret
Ile ronde
Banc du Corbeau
Pointe d'Armorique
Tinduff
20 à 50% de pélites
Plus de 50 % de pélites
Dépôts gravelo-vaseux mal triés et peu envasés
Rocher
Dépôts caillouto-graveleux
Sable
Dépôts gravelo-sableux
Sables coquilliers bien triés
Dune hydraulique

3.2 Ecological conditions

Environmental impacts of dredge fishing concern at the same time target species, benthic communities and the substrate. The dominant types of incidental damage caused to shelled molluscs include chipped valve margins, the separation of hinges, but shelled molluscs may be buried or sand packed. Another cause of incidental mortality concerns the increase of predators on fished beds. Dredge's chains, blades, teeth or waterjets burrowing in the sand and the passing trough the bag of the gear affect all the benthic community : as not all organisms are equally vulnerable, modifications on benthic assemblages are observed on various fishing areas (Murawski and Serchuk, 1989). Mechanical impacts on the seabed induce changes in structure, nature and chemical composition of the substrate. The extent of these impacts depends on features of the bottom mobile gear (including trawls) and fishing intensity, on substrate type as well as the benthic ecosystem effected.

3.2.1 For Pecten maximus

3.2.1.1. Mortalities.

Only dredging effect on ecological characteristics of benthic communities will be commented in this session. The main problems of a reliable analysis of dredging environmental effects are :

(1) Experiments and available results were limited only on targetted species in the past.

(2) In the case of scallop populations, effects can be studied only on size classes that can be sampled reliably by divers (*i.e.* individuals greater than 3 or 4 cm).

(3) An environmental effect can be different to number of times that dredges pass on a given ground (additional effect after repeated dredging).

In spite of these inconvenients, several results are already available. Previous studies (Dupouy, 1982) showed that dredge equipped by depressor plate caused less damage mortality than the classical one : depressor plate produces more stability of dredge during towing. In past references (Dupouy, 1982 ; Fifas, 1991) a damage index of 0.15 (*i.e.* individuals damaged by dredge on sea bottom are equal to 15 % of total catches) was proposed in the case of dredge with depressor plate. More recent studies (Berthou, pers. comm.) suggested that damage index seems lower than in past (dredges more heavy than previously) : that suggestion is based on experiments led in Bay of Saint-Brieuc in the beginning of 1990's where a ratio of damaged scallops of 3% were observed : nevertheless, on the one hand, this experiment was carried by favourable meteorological conditions and, on the other hand, no reliable observation of mortalities caused on age group 0 (scallops smaller than 3 cm) was obtained. That experiment was also led by repeated towing on an area ; however, it was realised during a short time interval : only an experiment on a long time scale can be conclusive (it would be necessary to forbid mobile gears on an area during several years).

If dredging effects are examined on whole benthic community, it is necessary to take into account results about inexploited populations (*e.g. Crepidula fornicata*). Recent observations by sonar system in Bay of Saint-Brieuc and comparison with previous data (middle of 1980's) showed a spectacular evolution of crepidula populations due probably

to towing activities. However, at present, it has not been easy to dissociate effects obtained by dredging and by trawling : results cited by Grall *et al.* (1996) in Bay of Brest indicate some differences between dredged bottoms in Bay of Brest and Saint-Brieuc : on the first fishery, clusters of scallops and crepidulas seem not be covered even though the effect is opposite in Bay of Saint-Brieuc. Bay of Brest is closed for otter trawling activities and this event can explain observed differences.

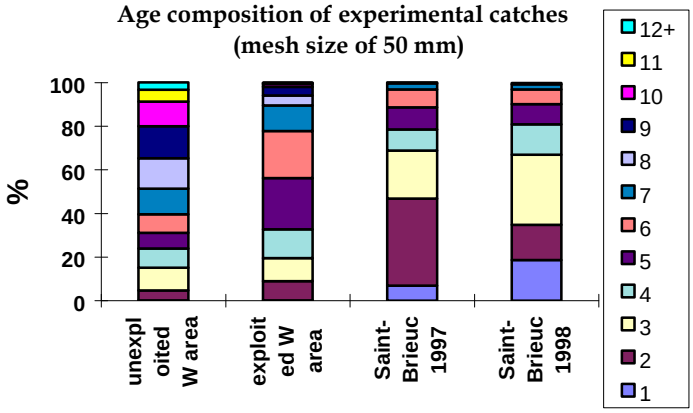
3.2.1.2. Size selection.

The main scallop populations in the French coastal waters have been overexploited for many years. In the case of the Saint-Brieuc bay (area 7E) analysis undertaken on patterns of individual growth since 1996 and comparisons with decades 70's and 80's have shown obvious phenotypic modifications related to dredging effect (significant decrease of values of growth parameters, strengthening of skewness of distribution of length frequencies). The absence of a «zero» statement in those analysis (comparisons with unexploited populations) got necessary to lead a research survey on scallop populations lain on the Western oceanic areas of the tip of Brittany. Study surface was subdivised in two areas, the first weakly exploited (Island of Ouessant - Sea of Iroise - Ar Men), the second unexploited (until continental slope *e.g.* 200 m of depth). Combination of acquired results with those of Saint-Brieuc Bay showed several trends :

Saint-Brieuc Bay : The long term trend, in a scale of twenty five years, is characterized by a strong decrease of the $L\infty$ parameter with no equivalent increase of value of the K parameter. This result was analysed by different ways (differences of fitting methods used for non linear growth models, hydroclimatic effect, increasing concentration of competitive species, spatial and bathymetric differences of yearly overspread recruitment, selective effect of dredging activities). The most probable effect is caused by exploitation. The short and mean term trends, for a given year class from year to year, is characterized by modifications of distribution patterns of back-calculated length frequencies according to three main processes ((1) effect on most probable sizes because of overfishing of areas with high densities of scallops, (2) effect on mean sizes because of selection of the greatest individuals, (3) effect on diversity and variance of sizes because of selection of scallops characterized by high growth rate) ; in all cases, distributions are skew with dominance of small sizes.

Western areas of the tip of Brittany : The age composition of the unexploited part of those areas is characterized by presence of old age groups (dominance of year classes born between the end of 80's and the beginning of 90's because of favourable hydroclimatic conditions) ; in the weakly exploited part of those areas the age composition is younger, but older than that of the Saint-Brieuc Bay. On the long term effects, a modification of values of growth parameters $L\infty$ and K is not obvious. In the case of distribution patterns of length frequencies, the modifications are less strong than those observed in the Saint-Brieuc Bay (see previous paragraph) : only an effect on mean sizes seems be significant and distributions are symmetrical.

long term effect on growth parameters L∞ et K.			
area	*decade*	*L∞*	*K*
Saint-Brieuc	1970's (Antoine, 1979) 1980's (Fifas, 1991) 1990's (Fifas and Boucher, 1997)	124.2 113.3 103.1	0.56 0.58 0.72
Western Brittany exploited	1970's (Antoine, 1979) 1990's (Hergas, 1999)	107.1 106.8	0.52 0.48
unexploited oceanic areas	1990's (Hergas, 1999)	105.7	0.39



4 SUB TASK 1.10 : TARGET SPECIES' LIFE CYCLES AND POPULATION DYNAMICS

4.1 Donax trunculus

Order Eulamellibranches, family Donacidae.

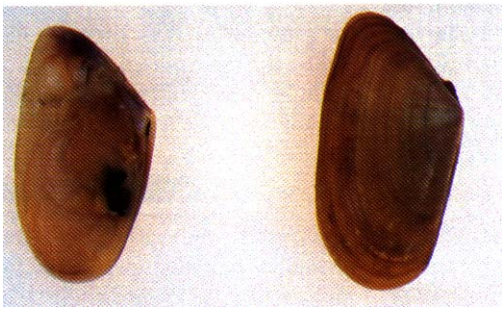


Figure 6 : *Donax trunculus* (from Quéro, 1998).

Location

Atlantic and Mediterranean coasts and Black Sea.

Description

Triangular solid shell with back part shorter. Maximum size : 5 cm, 2.5 – 3.5 cm on average.
Superficial sediment of 250 – 500 microns. Youngers animals are at high tide level and the oldest more at low tide level.

Reproduction

Summer

Growth

Composed of 5 age groups. Growth from Marsh to October. Maximum longevity 1 to 2 years.

4.2 Pecten maximus

Order Lamellibranches, family Pectinidae.

Location.

The main scallop stocks of the Atlantic and English Channel waters are overspread on sea bottoms of depth included between 10 and 60 m ; several unexploited populations were found until 200 m of depth.

Figure 7 : *Pecten maximus*.

Description.

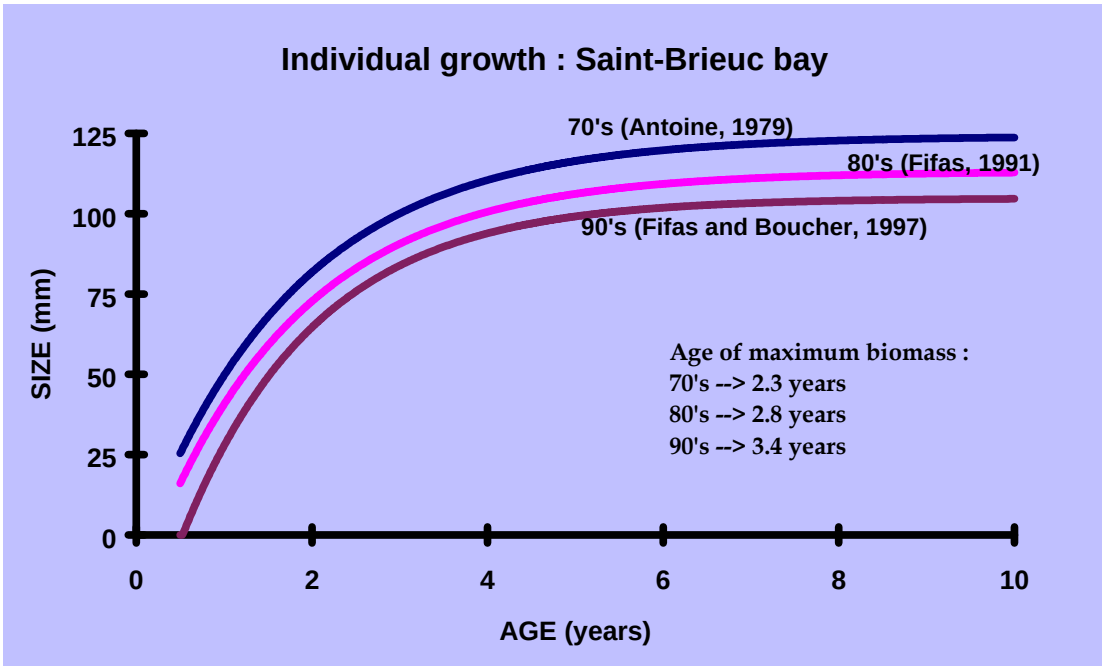
The King scallop is a sedentary bivalve filtering phytoplanktonic species which is its mainly targetted prey. It is often concentrated on thin sandy-muddy sea bottoms.

Reproduction.

Scallops are hermaphroditic ; they reach their first sexual maturity when two years old. Spawning is external. The first life cycle stage is planktonic and its duration is comprised between 18 and 25 days. After metamorphosis, scallops acquired their definitive form and are settled.

Growth.

The individual growth can be studied by back-calculation on winter rings formed on scallop shells. The growth rate is high during the first two years of the settled life ; individual sizes approach an asymptotic level of 110 to 120 mm in the Western Channel and Atlantic waters (130 to 140 mm in the Eastern Channel).



Population dynamics.

In terms of reproduction, spawning and demographic trends, scallop populations of the Normand-Breton Gulf (between Paimpol and Cherbourg) are characterized by several particularities.

Apart from few years, only one spawn of a significant level is observed between beginning of July and September with a more probable period from middle of July and August. The first spawn is stimulated by an external parameter (temperature of 16° C). Decreases of gonad-somatic index are very strong at the opposite of other scallop populations (Bay of Brest, Bay of Seine). Sexual maturity is observed only in spring and summer months. The recruitment rate can reach very high values.

Those singularities constitute an aspect of demographic strategy adapted on selective pressure of the environment. Research on relationship between those characteristics and nutritional parameters of the Normand-Breton Gulf have been led (i.e. low primary production of the Saint-Brieuc Bay).

	Saint-Brieuc	**Brest**
Spawning period	July - August	April to August
Number of spawns	1 - 2 (synchronization)	many
Stimulation factor	T° (16 ° C)	?
post-spawning (state of gonads)	empty	partially empty
Sexual maturity	summer	apart from winter

4.3 Venus verrucosa

Order Eulamellibranches, family Veneridae.

Figure 8 : *Venus verrucosa* (from Quéro, 1998).

Location

East atlantic, from West Scotland coast to Angola coast, in the Channel and in Mediterranean sea, up to 100 meters deeep, mostly between 0 and 50 meters on french coasts.

Description

« Fouisseur » bivalve not deep in coarse sand and gravel. « Filtreur suspensivore ».

Reproduction

Dioecious species. Ratio male female balanced. First maturity age is 3 years old. Gametes are released in very high number all year with maximum during summer into the water column where fertilisation and development occur (pelagic life 3 to 4 weeks), until the larvae are ready to settle and metamorphose into benthic juveniles. Fertilisation is then fully external and not under the control of the parents.

Growth

Growth is observed and characterised threw lecture of annual rings of reduce of growth. The growth of Warty venus is slow and is varies according to beds. Maximum longevity is 20 years.

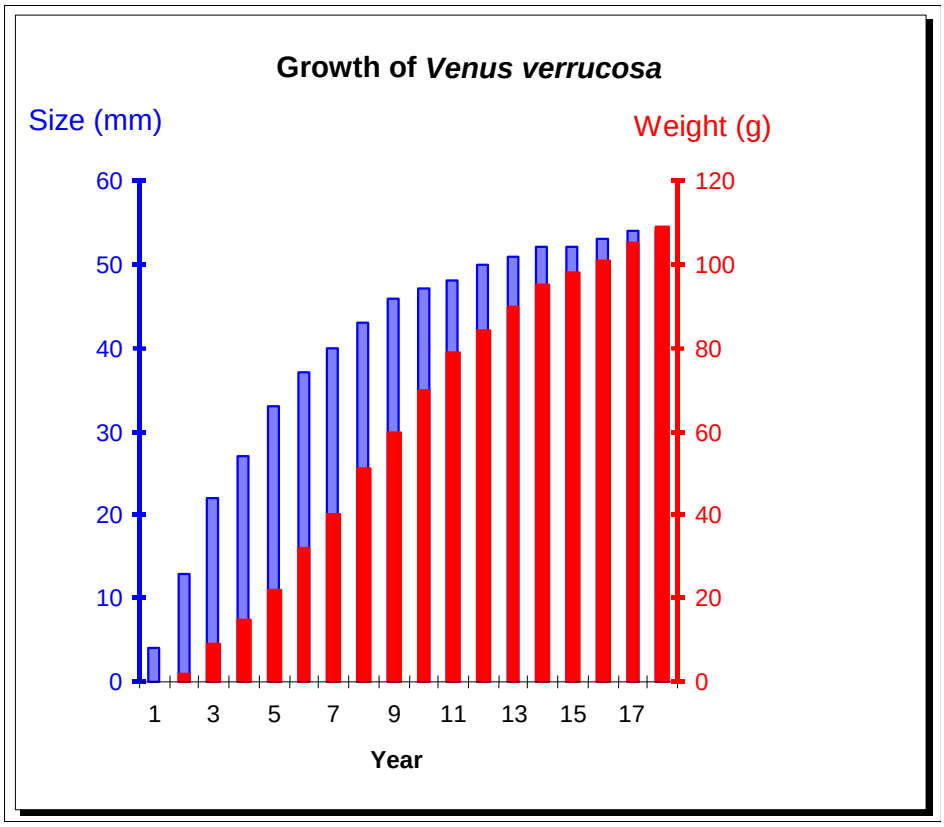


Figure 9 : Growth of *Venus verrucosa* (from IFREMER DRV/RH).

Dynamics population

For most shelled molluscs species, the larval stage is a pelagic dispersal stage depending on current distribution and migration behaviour (vertical distribution). The larval stages can last for weeks, depending on environmental constraints such as food, temperature and salinity and therefore affect spatial dispersion. However, thermal or hydrodynamic fronts in estuaries can limit larval dispersion. Survival rate is commonly a function of the temperature and salinity combination. However, many factors can effect recruitment including the availability of a suitable habitat. With a limited protection, this is a critical stage for shellfish larvae which show at that time the greatest susceptibility to environmental changes; although this susceptibility will decrease with age. Suitable environment is more critical than population size to obtain a successful recruitment and sustainable population as demonstrated by shellfish population rebounds, following overfishing, disease or introduction.

Global diminution of catches of *Venus verrucosa*.

4.4 Chlamys varia

Order Filibranches, family Pectinidae

Figure 10 : *Chlamys varia* (from Quéro, 1998).

Location

North Sea, English Channel, South Norway to Senegal, Mediterranean Sea, and a little in Black Sea. From the coast to 80 meters deep.

Description

Rounded valves higher than large, colour not always black. Maximum size 8 cm, 4.5 – 5.5 cm on average. Unequal auricles. The most coastal of Pectinidae bivalves. Fixed with solid byssus on movable beds, on varieted substrata.

Reproduction

« Protandrique »hermaphroditic species : male the first years (white gonad), then female (yellow gonad).
Gametes are released from the end of spring to the end of summer. Fertilisation is external in the water column.

Growth

During development, the byssus secreted helps the animal to be permanently fixed on a substrata. Maximum longevity is 4 to 5 years.

Dynamics population

For most shelled molluscs species, the larval stage is a pelagic dispersal stage depending on current distribution and migration behaviour (vertical distribution). The larval stages can last for weeks, depending on environmental constraints such as food, temperature and salinity and therefore affect spatial dispersion. However, thermal or hydrodynamic fronts in estuaries can limit larval dispersion. Survival rate is commonly a function of the temperature and salinity combination. However, many factors can effect recruitment including the availability of a suitable habitat. With a limited protection, this is a critical stage for shellfish larvae which show at that time the greatest susceptibility to

environmental changes; although this susceptibility will decrease with age. Suitable environment is more critical than population size to obtain a successful recruitment and sustainable population as demonstrated by shellfish population rebounds, following overfishing, disease or introduction.

Self-regenerating fishery based on wild spat settlement that fluctuates annually.
Catches decrease in Brest and fluctuate in Perthuis Charentes.

4.5 Chlamys opercularis

Already described in final report of Seafish by an other country.

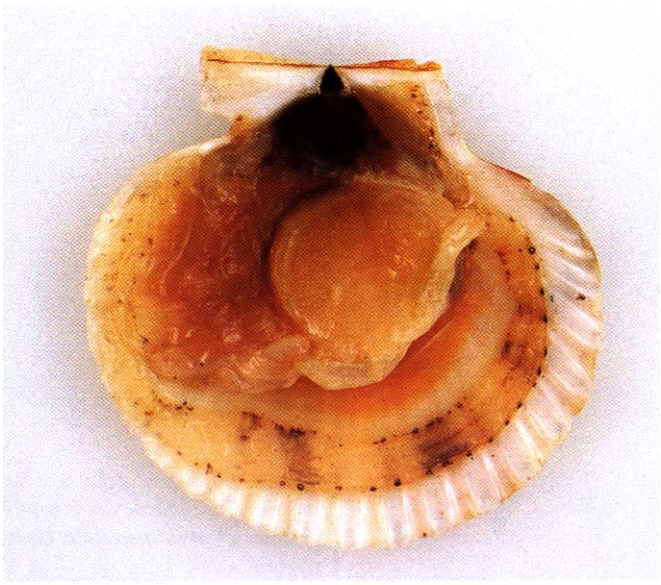


Figure 11 : *Chlamys opercularis* (from Quéro, 1998).

4.6 Venerupis rhomboïdes

Order Eulamellibranches, family Veneridae.

Figure 12 : *Venerupis rhomboïdes* (from Quéro, 1998).

Location

From Norway to Morroco and in Mediterranean sea, and most common in Channel. Up to 180 meters deep, maximum density from 0 to 50 meters and in coarse sand of *Lithothamnion.*

Description

Burrowing bivalve in coarse sand and gravel and also in mud sand. « Filtreur suspensivore ».

Reproduction

Dioecious species with little external dimorphism. Ratio male female balanced.
First maturity age is 2 years old. Gametes are released all year with maximum during summer into the water column where fertilisation and development occur (pelagic life 3 to 4 weeks), until the larvae are ready to settle and metamorphose into benthic juveniles. Fertilisation is then fully external.

Growth

The growth of palourid is quick. Maximum longevity is 12 years. Maximal size is 70 mm, and 45 mm on average.

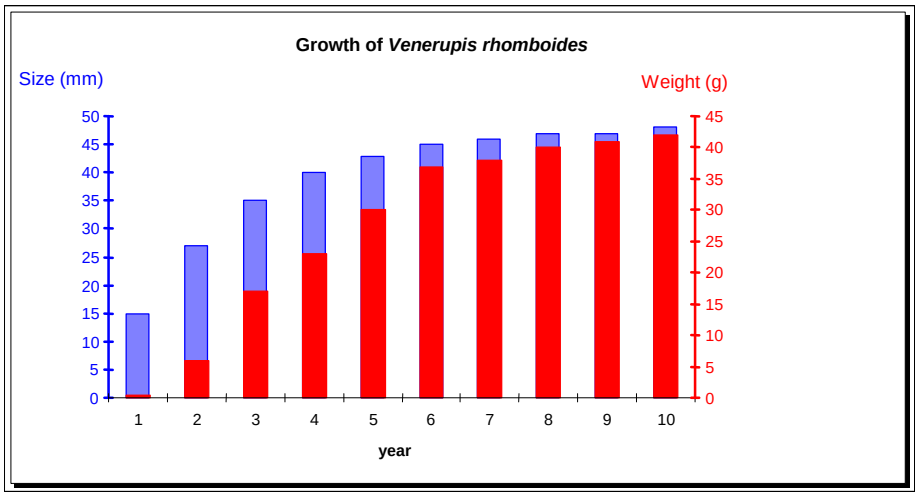


Figure 13 : Growth of *Venerupis rhomboïdes* (from IFREMER DRV/RH).

Dynamics population

For most shelled molluscs species, the larval stage is a pelagic dispersal stage depending on current distribution and migration behaviour (vertical distribution). The larval stages can last for weeks, depending on environmental constraints such as food, temperature and salinity and therefore affect spatial dispersion. However, thermal or hydrodynamic fronts in estuaries can limit larval dispersion. Survival rate is commonly a function of the temperature and salinity combination. However, many factors can effect recruitment including the availability of a suitable habitat. With a limited protection, this is a critical stage for shellfish larvae which show at that time the greatest susceptibility to environmental changes; although this susceptibility will decrease with age. Suitable environment is more critical than population size to obtain a successful recruitment and

sustainable population as demonstrated by shellfish population rebounds, following overfishing, disease or introduction.

Venerupis rhomboïdes is mainly under-exploited in the Channel according to the market's or recruitment's fluctuations.

4.7 Glycymeris glycymeris

Order Filibranches, family Glycymeridae.

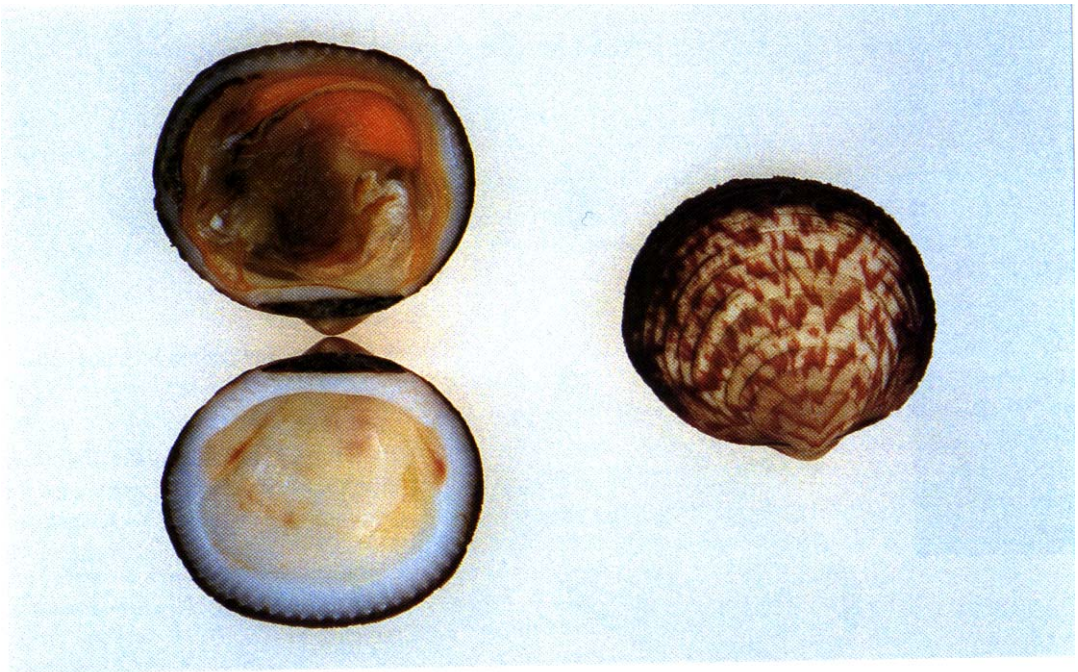


Figure 14 : *Glycymeris glycymeris* (from Quéro, 1998).

Location

Lives up to 80 meters deep, from « Cap Vert » Islands to Norway.

Description

Thick shell, with 2 valves identical, nearly round, colour dark brown (or ochre red) and white.
« Fouisseur » bivalve not deep in coarse sand and gravel, clean or muddy. « Filtreur suspensivore ».

Reproduction

Gametes are released from spring to autumn. Fertilisation is fully external. Pelagic life of the larva is 3 to 4 weeks.

Growth

The growth of Bittersweet is very slow. Maximum longevity is about 10 years. Maximal size is 80 mm, and 40 – 60 mm on average.

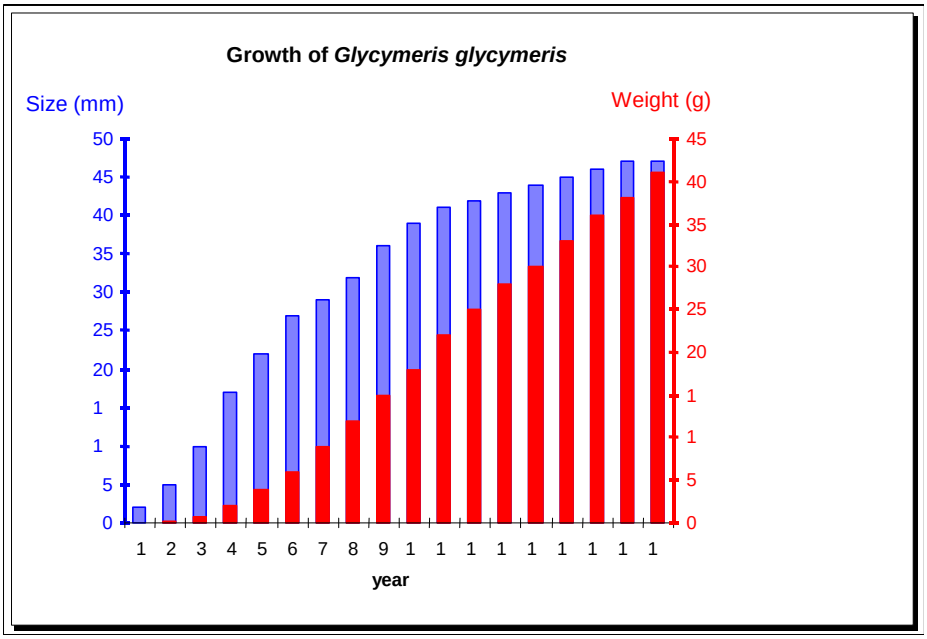


Figure 15 : Growth of *Glycymeris glycymeris*(from IFREMER DRV/RH).

Dynamics population

For most shelled molluscs species, the larval stage is a pelagic dispersal stage depending on current distribution and migration behaviour (vertical distribution). The larval stages can last for weeks, depending on environmental constraints such as food, temperature and salinity and therefore affect spatial dispersion. However, thermal or hydrodynamic fronts in estuaries can limit larval dispersion. Survival rate is commonly a function of the temperature and salinity combination. However, many factors can effect recruitment including the availability of a suitable habitat. With a limited protection, this is a critical stage for shellfish larvae which show at that time the greatest susceptibility to environmental changes; although this susceptibility will decrease with age. Suitable environment is more critical than population size to obtain a successful recruitment and sustainable population as demonstrated by shellfish population rebounds, following overfishing, disease or introduction.

Glycymeris glycymeris is mainly under-exploited in the Channel according to the market's or recruitment's fluctuations.

4.8 Spisula sp

Spisula ovalis and *spisula solida*.
Order Eulamellibranches, family Mactridae.

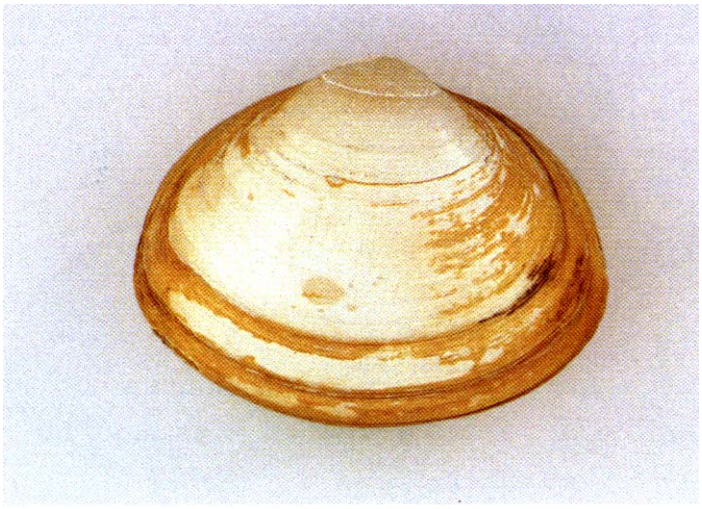


Figure 16 : *Spisula solida* (from Quéro, 1998).

Location

East Atlantic, from South Iceland to Morroco. From the coast (+ 2 m) and 50 meters deep.

Description

Thick shell with equal valves.Colour white-yellow, internal valve white.
« Fouisseur » bivalve. « Filtreur suspensivore ».

Reproduction

Dioecious species. Ratio male female balanced. First maturity age is 18 months to 2 years old. Gametes are released all year with maximum during summer into the water column where fertilisation and development occur (pelagic life 3 to 4 weeks), until the larvae are ready to settle and metamorphose into benthic juveniles. Fertilisation is then fully external.

Growth

Growth is observed and characterised threw lecture of annual rings of reduce of growth. The growth of *Spisula sp* is quick and from 5 years old, the shell grows mostly in thickness.

Dynamics population

For most shelled molluscs species, the larval stage is a pelagic dispersal stage depending on current distribution and migration behaviour (vertical distribution). The larval stages can last for weeks, depending on environmental constraints such as food, temperature and salinity and therefore affect spatial dispersion. However, thermal or hydrodynamic fronts in estuaries can limit larval dispersion. Survival rate is commonly a function of the temperature and salinity combination. However, many factors can effect recruitment including the availability of a suitable habitat. With a limited protection, this is a critical stage for shellfish larvae which show at that time the greatest susceptibility to environmental changes; although this susceptibility will decrease with age. Suitable

environment is more critical than population size to obtain a successful recruitment and sustainable population as demonstrated by shellfish population rebounds, following overfishing, disease or introduction.

Spisula form oftenly very local and very high density assemblages beds mainly on sandy banks. This specie is characterised in French beds by a very high level of fluctuations of the recruitment and the beds are commonly strictly monocohort.

4.9 Mytilus edulis

Order Filibranches, Family Mytilidae.

Figure 17 : *Mytilus edulis* (from Quéro, 1998).

Location

Widespread in the world ; inEurope, Baltic Sea, North Sea and Atlantic down to Portugal. From high tide level to 6 – 9 meters deep or 17 meter deep in North Sea and 30 – 40 meters deep in Baltic Sea.

Description

Equal blue - black valves, with byssus.

Reproduction

Dioecious species. Ratio male female balanced. First maturity age is 6 – 8 months old. Gametes are released all year with maximum during summer into the water column where fertilisation and development occur (pelagic life 18 to 80 days), until the larvae are ready to settle and metamorphose into benthic juveniles. Fertilisation is then fully external.

Growth

Depends on area conditions. Maximum logevity varies according to populations.

Dynamics population

Self-regenerating fishery based on wild spat settlement that fluctuates annually.

REPORT 3

MANAGEMENT

ECODREDGE

Table of contents

1 SUB TASK 1.3 : DISCUSSION FOR MANAGEMENT

1.1 For Pecten maximus

Main measures were cited in the chapter 1.2 (regulations measures : (i) limitation of a time fishing effort ; (ii) biological or market regulations *i.e.* minimum commercial size, fishing season ; (iii) allowed characteristics of fishing vessels *i.e.* number of licences, maximum allowed engine power or maximum length ; (iv) characteristics of dredges *i.e.* type, number, allowed weight, width, space between teeth, mesh size and (v) management of sustainable catches). This session comments the last management system that can be developed by three ways :

(1) *Total allowed catches (global quota)* : It is applied in Bay of Saint-Brieuc where a yearly direct stock assessment led by IFREMER gives necessary information on resource statement.

(2) *Individual quota* : It is applied in Bay of Seine and is referred to the number of sailors by vessel. It does not take into account a yearly stock statement because it is not integrated in a global allowed quantity.

(3) *Closed areas* : In the particular case of Bay of Brest distinguished by development of extensive farming activities, it is more and more frequent to open a previously closed area where high densities of additional ratio of population are exploited. Neither individual nor global quota exists, only a rotation of areas is operated.

In the past for a given scallop bed, interactions between three methods existed (*e.g.* in Bay of Saint-Brieuc, closed areas of high densities of recruited scallops were created in 1978 and 1987). In fact, each method is characteristic by fishery (*e.g.* Bay of Saint-Brieuc is one of the most trawled coastal areas in Europe and it is not conceivable to close an area for dredging, but not for trawling). By this way, interactions can be generated between fisheries (interactions between Saint-Brieuc and Brest concerning extensive farming activities in the beginning of 1990's) ; the usual state of those interactions is conflicting especially for the most productive fisheries. The problem can be resolved only by combination of different management methods of sustainable catches : combination of individual and global quotas can be applied on main scallop beds by taking into account information about yearly age and size composition of population (surveys in Saint-Brieuc and Seine) and dependent variables of fishing power of dredgers (characteristics of vessels, crew, type of dredge).

Table 1 : Management measures for French 'traditional mechanical' dredge fisheries (from IFREMER DRV/RH).

Fishery	Species	Location	Input Controls	Technical controls	Output controls: e.g. Quota
King scallop	*Pecten maximus*	East Channel (ICES AreaVIId)	No more than 10% of protected species may be landed and only whole scallops may be landed (EC). Close season 15 May to September inclusive (N), and restricted licence entry (L); Vessel length restriction and maximum beam length (L).	Carriage size and MLLS of 100mm (EC). MLLS of 110mm (EC). Dredge specification: metal belly ring size of 82 mm (L), diving plate prohibited on French dredges.	Daily quota of 200 kg per fisherman (L)

King scallop	*Pecten maximus*	Channel and Bay of Biscay (ICES Area VIIe and VIII)	No more than 10% of protected species may be landed (EC) and only whole scallops may be landed (EC and L). Close season 15 May to September inclusive (N) locally longer (L), and restricted licence entry (L); Vessel length restriction and maximum beam length depending on the beds (L).	Carriage size and MLLS of 100mm (EC), increased to 102 mm in Bay of Saint-Brieuc and 105 mm in the Bay of Brest. French dredge specification: maximum width of 2m, metal ring size of 85 mm every where and 92 mm in the Bay of Saint-Brieuc and Bay of Brest (L). diving plate locally prohibited on French dredges.	Seasonal quota only in the Bay of Saint-Brieuc (L)

MLLS - Minimum Legal Landing Size. (EC) - EC legislation. (N) – National UK legislation. . (L) - Local legislation

1.2 For others

Table 2 : Management measures for French 'traditional mechanical' dredge fisheries (from IFREMER DRV/RH).

Fishery	**Species**	**Location**	**Input Controls**	**Technical controls**	**Output controls: e.g. Quota**
Mussel	*Mytilus edulis*	East coast Cotentin (ICES Area IVd)	Regulated fishery; listed beds, close season October-May inclusive; gear restriction of 1 dredge per vessel; restricted licence entry (L).	Dredge weight restricted to 120 kg, only two blades allowed, and MLLS of 50mm (L).	Daily quota of 3 tons per vessel
Warty venus	*Venus verrucosa*	Norman-breton gulf (ICES Area VII e)	Regulated fishery; listed beds, close season May-August inclusive (N); gear restriction of 2 dredges per vessel; ; vessel length locally restricted to 13m, restricted licence entry (L). Days and hours at sea.	Dredge width and weight restricted (N), and MLLS of 40mm (N).	Daily quota per vessel (L)
Warty venus	*Venus verrucosa*	Bay of Brest (ICES Area VII e)	Regulated fishery; listed bed, close season April-October inclusive (L); gear restriction of 1 dredge per vessel; Days and hours at sea.; vessel length restricted to 12m restricted licence entry (L).	Dredge width and weight restricted (L), and MLLS of 42mm (L).	
"various Clams"	*Spisula sp Tapes rhomboïdes G. glycymeris*	Channel and Bay of Biscay (ICES Area VIIe and VIII)	Regulated fisheries; listed beds, close season; gear restriction of 1 or 2 dredges per vessel; Days at sea.; vessel length restricted; restricted licence entry (L).	Dredge width and weight restricted (L), and MLLS per specie (N)	Locally Daily quota
Queen Scallops	Aequipecten *Opercularis*	East coast Cotentin (ICES Area VIId)	None	None	None
Queen Scallops And	Aequipecten *Opercularis*, *Chlamys varia*	Bay de Brest, Bay of Camaret (ICES Area VIIe)	Regulated fishery; listed beds, close season October-May inclusive; gear restriction of 1 dredge per vessel; Days and hours at sea.; vessel length restricted to 12m; restricted licence entry (L).	Dredge width and weight restricted (L), and MLLS	None

MLLS - Minimum Legal Landing Size. (EC) - EC legislation. (N) – National UK legislation. . (L) - Local legislation

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