By-catch and Discarding in Pelagic Trawl Fisheries

-Final report -

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GENERAL INTRODUCTION

There has been little study of bycatch and discarding in mid-water trawl fisheries in Europe. These fisheries are of recent origin, beginning in France in the early 1980's. Corten (1991) investigated fish discards in Dutch pelagic fisheries (Eastern Channel herring fishery and English Channel-Celtic Sea horsemackerel fishery). A report of the European Commission (anon., 1992) on discard practises in European waters do not provide sufficient quantitative informations on discards in the other pelagic fisheries and nothing on discards in French pelagic fisheries. A more recent report of the FAO (Alverson et al., 1994) underlines the lack of information on discarding in pelagic fisheries in the North East Atlantic. The reasons for fish discarding need to be known in order to diminish discarding through better management of the fisheries.

The incidental catch of marine mammals is an important aspect of by-catch in marine ecosystems. Interactions between marine mammals and fisheries are complex and often become emotive issues. There is evidence that elsewhere pelagic trawlers incidentally capture large numbers of cetaceans (Waring et al., 1990). Anecdotal information suggests thet up to 50 dolphins may be taken in a single tow by Irish pelagic trawlers. High numbers of stranded cetaceans have also been reported as being possibly caused by pelagic trawling in several areas of the North East Atlantic. Kuiken et al. (1994) identified a mackerel pelagic fishery as the most likely cause of a mass mortality of common dolphins in the southwest of England in 1992/93. There is also some evidence of an interaction between harbour porpoises and herring fisheries off the Cork coast in southwest Ireland. Smiddy (1984; 1985) found a seasonal peak in harbour porpoise strandings which matched the distribution of fishing effort in that area.

The 4 countries (France, Ireland, UK and the Netherlands) participating in this study on by-catch and discarding cover a wide range of the North East Atlantic in several seasonal pelagic fisheries: herring, mackerel, horsemackerel, pilchard, anchovy, albacore, hake, black sea bream and bass.

By-catch and discarding in pelagic trawl fisheries

Abstract

Incidental mammal catch and the composition of the fish catch were studied in pelagic trawl fisheries in the North-East Atlantic. Several seasonal European fisheries were investigated with scientific observation on the fishing vessels. A total of 379 days at sea were observed . The sampled fisheries were horsemackerel (Dutch, French), herring (Irish), mackerel (UK), pilchard (UK , French) and other French fisheries (hake, tuna, bass, black bream, anchovy)..

Unintentional catches of dolphins were recorded in four of the investigated fisheries (Dutch horsemackerel, French tuna, French hake and French sea bass) at a rate of 1 dolphin per 100 tow hours; Grey seals were caught in the Irish herring fishery at a rate of 4 individuals per 100 tow hours.

The fish catches showed a high selectivity in several pelagic fisheries with a low discard rate (< 20 % by weight of the total catch) and a high percentage of the target species (> 50 % by weight) in the catch. However in some fisheries poor selectivity was observed particularly in the French hake fishery (with discards equal to 50 % of the total catch) and in the French black bream fisheries where legal targeted individuals amounted less than 30 % by weight in the total catch. This might be improved by appropriate technical measures such a minimum mesh size appriopriate according to the target species.

Length compositions of discarded and landed fish are provided for future utilisation in Working groups.

key-words:
pelagic trawl; by-catch; discards; reasons for discarding; incidental mammal catch; cetacean; seal; horsemackerel; mackerel; pilchard; anchovy; hake; whiting ; black bream; bass; albacore; bluefin tuna;

RESUME pour non-specialistes

La pêche au chalut pélagique est connue pour comporter parfois des captures accidentelles de mammifères marins, mais leur taux de capture n'a jamais été établi par des observations scientifiques dans l'Atlantique Nord-Est. De plus, les données existantes concernant les rejets et les prises accessoires en poisson de ce type de pêche en Europe sont fragmentaires. L'étude présentée a été menée par l'IFREMER, CTNC, RIVO/DLO et l'UCC pour collecter des informations sur les captures de poissons et de mammifères marins dans plusieurs pêcheries pratiquées au chalut pélagique tant en France, qu'en Grande-Bretagne, aux Pays-Bas ou en Irlande.

1 Les pêcheries étudiées

Les observateurs scientifiques ont observé 379 jours à bord des navires de pêche. Les pêcheries analysées sont classées dans le Tableau A ci-dessous avec l'indication du total des heures de traits correspondant échantillonnés pour chacune d'entre elles. Les zones de pêche étudiées figurent sur la carte (Figure A).

Tableau A : Nombre de navires, total des débarquements d'espèces cibles et durée des observations de chacune des pêcheries étudiées.

Pêcheries	Nombre de navires	Débarquements d'espèces cibles exprimés en tonnes	Lieu des observations	Nombre d'heures de traits observés
Chinchard (Pays-bas)	12(1995)	110 000(1994)	VII D, E, H, J.	486
Merlu (France)	120(1992)	3 310(1994)	VIII A, B.	314
Thon (France)	50(1992)	1 907(1994)	VIII A, B, C, D.	265
Hareng (Irlande)	49(1994)	50 000(1992)	VII G.	101
Bar (France)	70(1992)	217(1994)	VII E, VIII B.	73
Maquereau (Irlande)	12(1990)	4 800(1990)	VII E	72
Sardine (Angleterre)	12(1990)	1 330(1990)	VII E.	37
Chinchard à queue jaune (France)	130(1992)	3 235(1994)	VIII A.	19
Anchois (France)	130(1992)	14 500(1994)	VIII A, B.	15
Dorade grise (France)	15(1992)	691(1994)	VII E	9
Sardine (France)	90(1992)	3 700(1994)	VIII A.	3

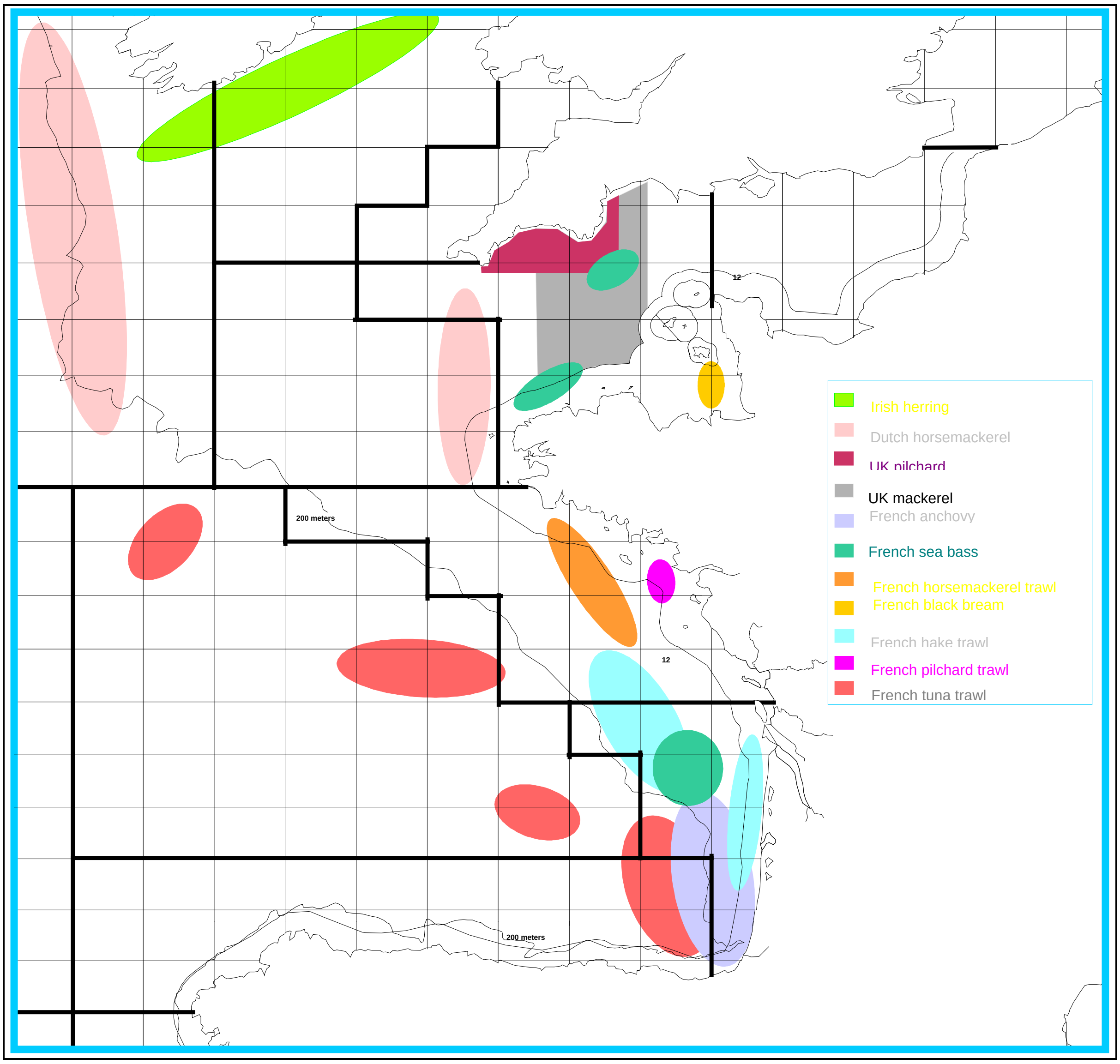

Figure A : Localisation des opérations de chalutage échantillonnées dans chaque pêcherie.

2 Résultats pour chaque pêcherie:

Les pêcheries sont classées en fonction de leur niveau de sélectivité, à savoir de la moins à la plus sélective.

2.1 Pêche du merlu par les chalutiers pélagiques français

Sept marées ont fait l'objet d'échantillonnages durant l'année. La sélection des espèces apparaît faible. Seulement 31% des captures totales étaient du merlu retenu et plus de 50% des captures totales étaient rejetées. La sélection des tailles au niveau du merlu n'est pas meilleure. Plus de la moitié du nombre des merlus capturés étaient inférieurs à la taille minimale imposée et ont ainsi dû être rejetés. La mauvaise sélectivité de l'engin au niveau de l'espèce cible est dûe en grande partie à la quantité élevée de captures accessoires obstruant les mailles (chinchards). Pour une tonne de merlus débarquée, les chalutiers pélagiques suivis ont rejeté plus d'une tonne de chinchards et environ 180 kilos de merlus sous-taille.

Une augmentation de la taille minimale du maillage jusqu'à 90mm voire 100mm permettrait vraisemblablement de réduire les captures de merlus sous-taille et les importantes captures de chinchards par ailleurs non commercialisés. La zone de pêche semble également jouer un rôle déterminant dans les captures accessoires et les rejets. Des rejets importants ont été observés dans les nourriceries à merlu et dans les zones littorales.

Les captures accessoires de mammifères marins observées lors de l'étude de cette pêcherie sont de l'ordre de 1,2 dauphins pour 100 heures de trait de chalut.

2.2 Pêche de l'anchois par les chalutiers pélagiques français

Pour cette pêcherie se déroulant toute l'année, 3 marées seulement ont été étudiées durant deux mois (mars et juin). La sélection par espèce apparait bonne puisque près de 70% des captures sont constituées d'anchois et la sélection des tailles pour cette même espèce semble bonne, mais, à l'inverse, elle est faible pour les espèces accessoires capturées (sardine, chinchard) lorsque les bancs sont mélangés. Ces captures accessoires ont été toutefois observées lors d'une seule marée (sur les trois étudiées) et qui, selon les pêcheurs, n'est pas révélatrice de la pêcherie.

Au regard du faible nombre d'observations réalisées lors de cette étude en comparaison de l'importance de cette pêcherie pélagique (plus de 14 000 tonnes débarquées en 1994), une étude complémentaire est nécessaire pour dégager des conclusions claires concernant les éventuelles quantités de poissons rejetés et leur raison.

2.3 Pêche de la dorade grise par les chalutiers pélagiques français

Cette pêcherie qui s'exerce toute l'année a été l'objet d'échantillonnages durant deux marées en mai-juin. Une faible sélectivité apparait dans cette pêcherie. Les débarquements de dorades grises ne représentent en effet que 55% en poids des captures totales (toutes espèces confondues) et contiennent un tiers d'individus sous-taille débarqués comme appât. Pour une tonne de dorades grises débarquée, les chalutiers pélagiques rejettent 110 kilos de sardines, 100 kilos de dorades grises et 100 kilos de maquereaux. Dans nos observations, 40% des dorades grises capturées étaient sous-tailles. Toutefois, une seule saison a pu être étudiée et ces résultats ne reflètent probablement pas les conditions de déroulement de la pêcherie tout au long de l'année. Quoiqu'il en soit, une augmentation du maillage minimum à au moins 100 mm devrait être appliquée pour améliorer à la fois la sélection des espèces et la sélection des tailles de l'espèce cible.

2.4 Pêche du chinchard à queue jaune par les chalutiers pélagiques français

Dans cette pêcherie dirigée sur *Trachurus mediterraneus*, nous avons suivi deux marées durant les mois de février et de mars, alors que les débarquements les plus importants ont lieu durant l"été. La sélectivité apparait élevée : les espèces cibles représentent 83% du poids total de poissons capturés. Les espèces accessoires sont constituées essentiellement de chinchard commun (*Trachurus trachurus*), espèce rejetée : pour une tonne de chinchards-à-queue-jaune débarquée, seulement 70 kilos de chinchards communs ont été rejetés.

2.5 Pêche de la sardine par les chalutiers pélagiques britanniques

C'est une pêcherie traditionnelle, autrefois très importante, laquelle durant l'hiver 1993/1994 était réduite à un seul navire. Durant les traits de chaluts observés, 117 tonnes de poissons ont été capturées, dont 47% de prises accessoires de maquereaux. Ce résultat provient du faible nombre de bancs constitués uniquement de sardines. Les rejets dans cette pêcherie sont dûs aux restrictions de captures concernant le maquereau du Cantonnement du Sud de la Cornouaille et à la faible valeur marchande des captures constituées d'un mélange d'espèces.

2.6 Pêche du chinchard par les chalutiers pélagiques néerlandais

La flotte de pêche des chalutiers congélateurs néerlandais a fait l'objet d'une étude durant quatre marées entre les mois de février et de mars en 1994 et en 1995 lorsque le chinchard est recherché dans la zone VII. Au total 216 traits ont été effectués durant ces marées. L’étude des captures accessoires de mammifères marins a porté sur l’ensemble de ces traits. Les débarquements et les rejets de poissons ont été examinés sur 119 traits. Le pourcentage de rejets par marée se situait entre 3% et 19% du poids total des captures et était constitué approximativement à part égale de maquereaux et de chinchards.

Neuf dauphins capturés ont été capturés accidentellement au cours de six traits.

2.7 Pêche du maquereau par les chalutiers pélagiques anglais

La pêcherie étudiée est une pêcherie d'hiver au maquereau effectuée à proximité du cantonnement de maquereau situé dans le sud-ouest de l'Angleterre. La plupart des navires chalutent en boeuf et le poisson est pompé à bord. Un navire a fait l'objet d'un suivi. Les rejets et/ou pertes de poissons s'élèvent à 11% du poids total des captures. La part des espèces cibles représente 88% du poids total des espèces conservées à bord. La plupart des prises accessoires sont de la sardine et du chinchard.

Les rejets sont effectués souvent avant le pompage des captures lorsqu'il y a de trop faibles captures ou lorsqu'il ya de trop fortes proportions de sardines ou de petits maquereaux. La sardine est aussi rejetée, lorsqu'elle est mélangée à d'autres captures, grâce à un pompage sélectif mettant à profit la plus grande flottabilité de cette espèce. Les rejets et/ou les pertes de maquereaux représentaient 9% du poids total des maquereaux capturés. Au cours de la marée, un trait était constitué d'un million de juvéniles de maquereaux et fut rejeté. La cause des rejets provenait généralement soit de la difficulté de détecter la taille des poissons dans les bancs (68% du poids total des rejets) soit des avaries de chalut lors des opérations de pêche (18% du poids total des rejets).

2.8 Pêche de la sardine par les chalutiers pélagiques français

Deux marées ont été échantillonnées au mois de mai, bien que l'essentiel des apports se fasse durant l'été. La sélection des espèces semble particulièrement forte : 93% des captures étaient des espèces cibles et le sprat constituait l'essentiel des captures accessoires. Pour une tonne de sardines débarquée, les chalutiers pélagiques ont rejeté 50 kilos de sprats et seulement 10 kilos de sardines abîmées. De plus amples observations seraient nécessaires pour confirmer cette estimation laquelle ne constitue qu'une étude partielle ne couvrant pas l'intégralité de la saison de pêche.

Une chaussette était utilisée pour réduire la taille des mailles afin que les sardines ne soient pas abîmées en se maillant au cul du chalut. La présence de cette chaussette a eu des incidences sur les captures de sprat. Mais, selon les pêcheurs, ce système est jugé indispensable pour l'exercice de cette pêche.

2.9 Pêche du hareng par les chalutiers pélagiques irlandais:

La pêche du hareng en Mer Celtique par les navires irlandais est une pêcherie hivernale. Elle a été étudiée du mois d'octobre 1994 au mois de janvier 1995. Sur la période étudiée, 78 traits ont été échantillonnés ce qui représente 7% de l'effort de pêche total de la pêcherie. Cette pêche est très sélective car la part d'espèces cibles représente en poids 99,5% du tonnage global capturé. Dans 84% des traits échantillonnés, le merlan représentait la majeure partie des prises accessoires. Les rejets constituent 4,7% du poids total des captures et ont surtout été observés dans la zone VIIg3. Les raisons des rejets étaient variables, mais la plupart d'entre eux étaient dûs à des impératifs de marché concernant le rejet de poissons de faibles qualités marchandes ou d'individus sous-tailles.

Dans les captures d'un trait sur quatre, il y avait un phoque gris. Les captures accidentelles représentaient un ratio de quatre phoques pour cent heures de traits. Il n'y a pas eu de capture accidentelle de cétacés.

2.10 Pêche du thon par les chalutiers pélagiques français

Cette pêcherie saisonnière (automne) a été suivie durant 4 marées accomplies entre les mois d'août et d'octobre. La sélection des espèces dans cette pêcherie apparait bonne : la proportion de rejets était seulement de 4%. Il n'y a pas de rejets dûs à des individus sous-taille (critère ICCAT). Pour une tonne de germons, les chalutiers pélagiques ont rejeté 33 kilos de poissons-lunes et 14 kilos de germons. Les rejets de poissons-lunes semblent être inévitables, mais ces poissons sont toujours en vie lorsqu'ils sont rejetés à la mer. Les rejets de germons ou de thons rouges abîmés interviennent seulement lorsque les prises sont particulièrement abondantes dans un même trait.

Des captures accessoires de dauphins ont été observées dans cette pêcherie à raison de 1,5 dauphins pour 100 heures de trait.

2.11 Pêche du bar par les chalutiers pélagiques français:

Cette pêcherie se pratique l'hiver à l'aide de chaluts pélagiques. Deux marées ont fait l'objet d'un échantillonnage, une dans la zone VII B et l'autre dans la zone VII E. Le bar, espèce cible durant la saison de ponte, représentait 90% du poids total des captures et les rejets étaient extrêmement faibles. La sélectivité au niveau de la taille des individus de l'espèce cible capturée est excellente, les captures étant toutes adultes. Pour une tonne de bars débarquée, les chalutiers pélagiques rejetaient moins de 6 kilos de chinchards et de sardines.

Les captures accessoires de dauphins observées dans cette pêcherie présentaient un ratio de 1,4 dauphins pour 100 heures de chalutage.

3 Conclusion et recommandations :

Certaines pêcheries n'ont pas été analysées au cours de cette étude et des observations à la mer supplémentaires sont nécessaires pour la pêcherie hollandaise de maquereaux, la pêcherie britannique de harengs, la pêcherie irlandaise de maquereaux en zone VII B, et française en zone VII D, la pêcherie danoise de harengs en zones III A et IV. Il en est de même des chalutiers congélateurs hollandais battant pavillon étranger (Royaume-Uni, France, Allemagne) n'ont jamais fait l'objet de suivis. Quelques études complémentaires devraient également être effectuées sur certaines pêcheries déjà étudiées :

- la pêcherie française de l'anchois en raison de son importance
- la pêcherie française de la dorade grise et la pêcherie hollandaise du chinchard aux différentes saisons
- la pêcherie française de la sardine afin d'augmenter le nombre d'échantillonnage
- la pêcherie française du merlu pour étudier l'aménagement des zones et périodes de pêche.

3.1 Captures de poissons

Le pourcentage du poids d'espèces cibles débarquées par rapport aux captures totales varie de 31 à 95 % en fonction des pêcheries. Le taux global des rejets varie entre 2 et 56 %. Les pêcheries peuvent être classées (Fig. B) de celles comportant le taux le plus bas de rejets à celles présentant le taux le plus fort de rejets comme suit : pêche française du bar, pêche française du thon, pêche irlandaise du hareng, pêche française de la sardine, pêche britannique du maquereau, pêche hollandaise du chinchard, pêche française du chinchard, pêche britannique de la sardine, pêche française de la dorade grise, pêche française de l'anchois et pêche française du merlu.

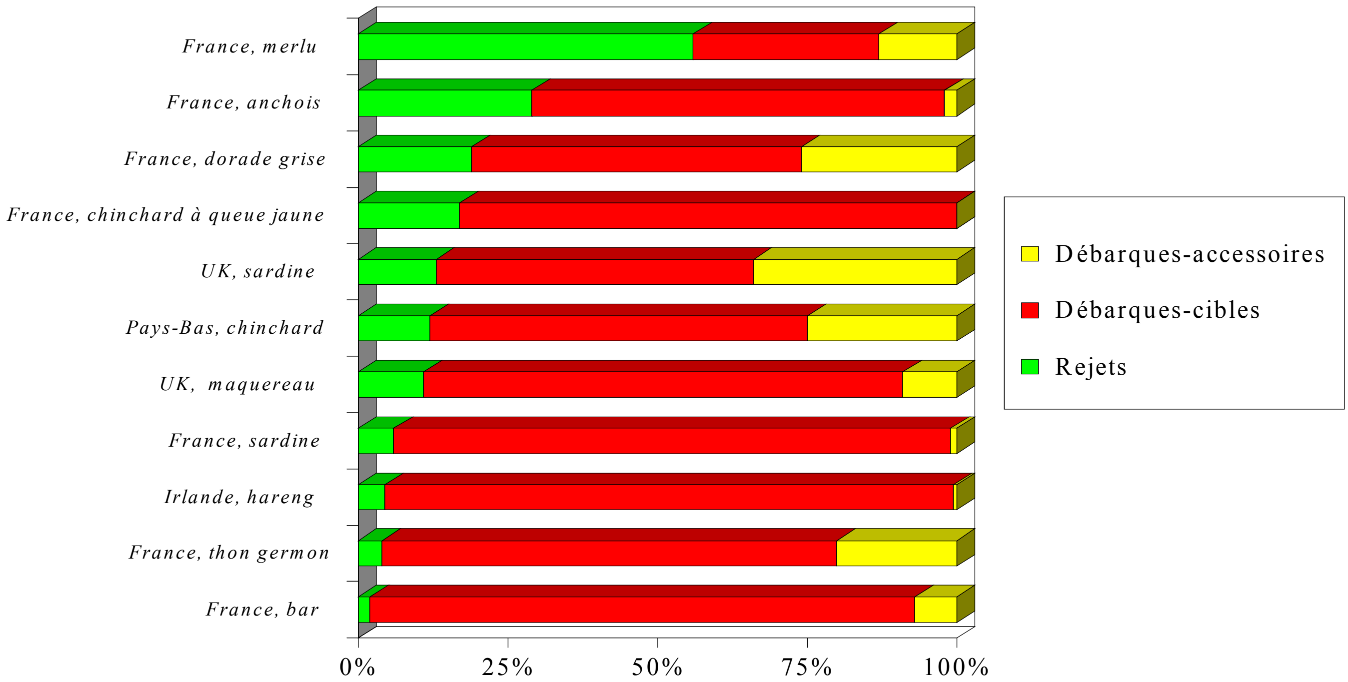

Figure B: Répartition des captures dans chacune des pêcheries en rejets totaux, débarquements (espèces cibles/ accessoires). Pourcentage en poids.

La mauvaise sélectivité observée dans certaines pêcheries (pêcherie française du merlu, pêcherie française de la dorade grise) pourrait être corrigée par une augmentation du maillage. Un maillage approprié en fonction de l'espèce cible n'existe dans la réglementation communautaire pour les espèces autres que les petits pélagiques. Des réglementations spécifiques pourraient être appliquées : lorsque le poids des espèces cibles suivantes (merlu, dorade grise, bar) dépasse 30% dans les débarquements, un maillage minimum de 100 mm pourrait être imposé.

3.2 Captures accidentelles de mammifères marins

Les captures accidentelles de cétacés (dauphins) sont apparues dans quatre pêcheries pélagiques (pêcherie hollandaise de chinchard, pêcherie française de thon, pêcherie française de merlu, pêcherie française de bar). Au cours de 11 captures accidentelles de mammifères marins, 18 dauphins furent pris. Ces captures ont été observées au cours de 1 300 heures de chalutage pélagique. Le nombre de ces captures accidentelles observées est, toutefois, trop faible pour présenter une estimation fiable des taux de capture.

Dans le cadre de la pêcherie irlandaise de hareng, 4 phoques gris ont été capturés séparément en un peu plus de 100 heures de chalutage.

SUMMARY FOR NON-SPECIALISTS

Pelagic trawls are known to have sometimes mammals caught unintentionally but the catch rate has never been assessed through scientific observations in the North-East Atlantic. Moreover, poor data exists on by-catches and fish discards in most of the European pelagic fisheries. The following study was initiated by IFREMER, CTNC, RIVO-DLO and UCC to collect information about the catches of fish and mammals of several pelagic fisheries from France, England, Netherlands and Ireland.

1. FISHERIES STUDIED

Scientific observers spent 379 fishing days on board vessels and a total of 379 fishing days were observed. The fisheries investigated are ranked in the table below according to the total duration of the sampled tows in each. The fishing areas of this study are shown in the map (Fig. A).

FISHERIES	Number of boats		Landings of the target species (tonnes)		Sampled locations	Number of hours of sampled tows
Dutch horsemackerel trawling	~ 12	(1995)	110000	(1994)	***(VII d, e, h, j)***	486
French hake trawling	~ 120	(1992)	3310	(1994)	***(VIII a, b)***	314
French tuna trawling	~ 50	(1992)	1907	(1994)	***(VIII a, b, c, d)***	265
Irish herring trawling	~ 49	(1994)	50000	(1992)	***(VII g)***	101
French sea bass trawling	~ 70	(1992)	217	(1994)	***(VII e, VIII b)***	73
UK mackerel trawling	~ 12	(1990)	4800	(1990)	***(VII e)***	72
UK pilchard trawling	~ 12	(1990)	1330	(1990)	***(VII e)***	37
French horsemackerel trawling	~ 130	(1992)	3235	(1994)	***(VIII a)***	19
French anchovy trawling	~ 130	(1992)	14500	(1994)	***(VIII a, b)***	15
French black bream trawling	~ 15	(1992)	691	(1994)	***(VII e)***	9
French pilchard trawling	~ 90	(1992)	3700	(1994)	***(VIII a)***	3

Table A: Number of boats, landings of target species and duration of the observations in each fishery investigated .

2. RESULTS IN EACH FISHERY

The fisheries are listed according to their level of catch selection starting with the lowest from the highest.

2.1. French hake trawl fishery

Seven trips were sampled along the year. The species selectivity was low -only 31 % of the catches was the landed target species hake, and more than 50 % of catch discarded. The size selection was no better : more than half of hake by numbers caught were below the minimum landing size and were discarded. The obseved bad selectivity for the target species is partly due to the high quantity of by-catches. For one landed ton of hake, the pelagic trawling was observed to have discards more than 1 ton of Atlantic horsemackerel, and nearly 180 kg of undersized hake.
An increase of the mesh size to a minimum of 90 mm or 100 mm might reduce discards of undersized hake, and the big catches of unmarketable horsemackerel. Fishing area seems also to be a factor determining by-catch and discards. High discards were observed in hake nursery and in inshore areas.
Dolphin by-catches were observed in this fishery at the rate of 1.2 dolphins per 100 towing hours.

2.2. French anchovy trawl fishery

In this whole year fishery, 3 trips were sampled covering only 2 months (March and June) in the year. The species selectivity appeared to be fair with nearly 70 % of anchovy in the catch, and the size selection seemed to be high for anchovy, low for the main by-catches (Pilchard, Atlantic Mackerel and Atlantic horsemackerel) when

catches were mixed. These by-catches were observed in only one trip -out of the three investigated trips- which was said to be non representative by the fishermen.
Considering the low quantity of observations in this study compared to the importance of this pelagic fishery (more than 14 000 tons landed in 1994), further study is needed to give a clearer perspective as to the real quantity of fish discarded and the reason.

2.3. French black bream trawl fishery

This fishery which is a whole year fishery was sampled during two trips in May and June. A lack of selection appears in the fishery. Landed black bream accounted for 55 % by weight of the catch in which one third were undersized individuals landed for bait. For one ton of landed black bream, pelagic trawlers discard 110 kg of pilchard, 100 kg of black bream, and 100 kg of Atl. mackerel. 40 % by number of black bream in the catch were undersized. Only one season was studied and the results are probably not the reflect of what occurs along the year.
However an increase of the minimum mesh size to at least 100 mm might be applied in order to improve the size and species selection.

2.4. French horsemackerel trawl fishery

In this fishery on *Trachurus mediterraneus* we sampled 2 trips during February and March, while the main landings occurred in the summer season. The selectivity appeared to be high : the target species accounted for 83 % of the weighted fish caught. The by-catch species was Atlantic horsemackerel, *Trachurus trachurus*, which was discarded : for one ton of landed Mediterranean horsemackerel,*Trachurus mediterraneus*, only 70 kg of the Atlantic species (*T. trachurus*) were discarded.

2.5. UK pilchard trawl fishery

This is a traditional fishery, formerly a large one, which by the winter of 93/94 was reduced to a single boat. Observed tows caught 117 tons of fish and had a mackerel bycatch of 47 %. This arose from the lack of shoals composed only of pilchard. Discarding in this fishery is partly due to the restriction of mackerel catches in the Mackerel Box and partly to the low value of mixed catches.

2.6. Dutch horsemackerel trawl fishery

The Dutch freezer trawler fleet was investigated during 4 trips between February and March 1994 and 1995 when horsemackerel was targeted in Area VII. A total of 216 hauls were made during these trips and were studied for mammal catch. Details of fish landings and discards were based on samples from 119 hauls. The discard percentage by trip ranged from 3 to 19 % in weight (on average 11.8 %) and consisted of approximately equal amounts of mackerel and horsemackerel. Nine dolphins were caught during 6 tows.

2.7. UK mackerel trawl fishery

The fishery studied is a winter fishery for mackerel in the vicinity of the Mackerel Box south-west of England. Most boats tow in pairs and the fish is pumped aboard. One boat was sampled. Discards or fish loss amounted to 11 % by weight of the total catch. The target species represented 88 % by weight of the retained species. The main retained by-catch species were pilchard and horsemackerel.
Discarding was mainly by rejecting, before pumping, any small catches or those containing large numbers of pilchard or small mackerel. Pilchard were also discarded from mixed catches by selective pumping utilising the greater buoyancy of pilchard. The discarded or lost mackerel was 9 % by weight of the mackerel catch. One mackerel catch was of 1 million small fish and was discarded. The causes of waste were mainly the inability to detect the small size of fish in shoals (68 % by weight of total discards) and gear failures (18 %).

2.8. French pilchard trawl fishery

Two trips were sampled in May while main landings occurred in summer. The success of species selection seems to be high : 93 % of the catch was the targeted species and sprat was the main by-catch of this fishery. For one landed ton of pilchard, pelagic trawlers discarded 50 kg of sprat and only 10 kg of damaged pilchard. Further observation would be necessary to confirm this estimate as this was a limited study which does not cover the main season.
An inner bag was used in this fishery to reduce the mesh size in order to avoid pilchards being enmeshed in the cod-end and being damaged. The presence of this inner bag may have some effect on the sprat catch. But according to fishermen, it is indispensable for this fishery.

2.9. Irish herring trawl fishery

The Celtic Sea herring fishery is a winter fishery. It was studied from October 1994 to January 1995. Over the study period 78 tows were monitored which was 7 % of the total fishing effort in this fishery. The Celtic Sea fishery is very selective with 99.5 % of the total catch by weight being the target species. Whiting was the most frequently recorded by-caught species occurring in 84 % of the monitored tows.

Discards amounted to 4.7 % by weight of the total catch and were mainly observed in area VII g03. Reasons for discarding varied but most were due to market requirements leading to rejection of undersized and poor quality fish.

One grey seal was caught in each of four tows. These unintentional catches occurred at the rate of 4 per 100 tow hours. There was no incidental cetacean by catch.

2.10. French tuna trawl fishery

This seasonal fishery (autumn) was sampled during 4 trips between August and October. Selection in this fishery appeared to be good : the discard rate was approximately 4 %. There was no discard due to small size.

For one landed ton of albacore, pelagic trawlers discarded 33 kg of sunfish and 14 kg of albacore. Discards of sunfish seemed to be unavoidable, but this species was often alive when it went back into the sea. Discards of damaged albacore or bluefin tuna only occurred when the catch in a tow is too great.

Marine mammals by-catches were observed in this fishery at the rate of 1.5 dolphins per 100 towing hours.

2.11. French sea bass trawl fishery

This fishery is a winter activity for pelagic gears. Two trips were sampled, one in VIIb and one in VIIe. Sea bass, the target species during its spawning season, accounted for 90 % by weight of the catch and discards were very low. The size selectivity for sea bass was also really good : the catch consisted entirely of adults. For one landed ton of sea-bass, pelagic trawlers discarded less than 6 kg of Atl. mackerel and pilchard.

Marine mammals by-catches were observed in this fishery at the rate of 1.4 dolphins per 100 towing hours.

3. Conclusion and Recommendations

Some fisheries were not investigated in this study and future observations at sea are needed as for Dutch mackerel, UK herring, Irish mackerel in VII b; French mackerel in VIId, Danish herring in IIIa and IV. Also Dutch owned freezer trawlers sailing under foreign flag (UK, France, Germany) have never been investigated.

Some studied fisheries require also further investigations :

French anchovy because of the size of the industry.
French black bream and Dutch horsemackerel in the different seasons.
French pilchard to increase sample size.
French hake to study the management of areas and seasons.

Fish

The percentage by weight of the target species landed from the catch varied from 31 % to 95 % according to the fisheries. The total discard rate varied between 2 % and 56 %. Fisheries can be ranked (Fig. B) from the lowest discard ratio to the highest discard ratio (total discards) as follows : French sea bass, French tuna, Irish herring, French pilchard, UK mackerel, Dutch horsemackerel, French horsemackerel, UK pilchard, French black bream, French anchovy, and French hake trawl fisheries.

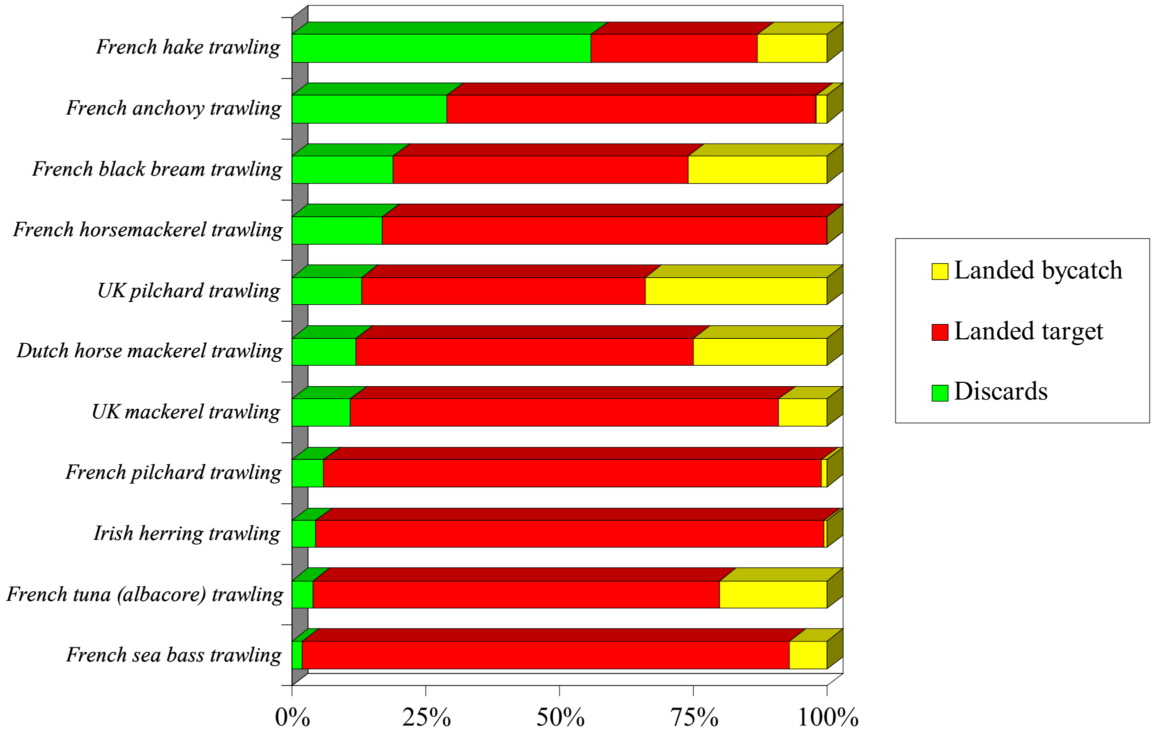

Figure B : Percentage by weight of landed target, landed by-catch, and discards in each fishery (Discards = discarded Target + discarded By-catch).

The lack of selection observed in some fisheries (e.g. French hake, French black bream fisheries) might be corrected by an increase of mesh size. Such an appropriate mesh size according to the target species does not exist in the present EC regulation for species other than small pelagic species. Specific regulations could be applied : if targeted hake, black bream or sea bass exceeds 30 % by weight of the retained species, a minimum mesh size of 100 mm could be used.

Mammal by-catches

Cetaceans (dolphins) were unintentionally caught in four pelagic fisheries (Dutch horsemackerel, French tuna, French hake, French sea bass fisheries). In 11 by-catch incidents 18 dolphins were caught. These incidents were observed during 1300 hours of pelagic trawling. The number of observed incidents is, however, too small to make a reliable assessment of by-catch rates.

In the Irish herring fishery, 4 grey seals were caught in 4 incidents during slightly more than 100 hours trawling.

Chapter I :

By-catch and discarding in the French small scale pelagic trawl fisheries

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The scientific names of species referenced in this chapter are listed in a table of Appendix V.

1. DESCRIPTION OF THE FRENCH PELAGIC TRAWL FISHERIES

1.1 THE FLEETS

1.1.1 Number of French pelagic trawlers

The French pelagic fleets consist mainly of small scale fishing boats operating mostly in the Bay of Biscay but also in the Western English Channel. Three large scale boats target mackerel in the Eastern English Channel and in the North Sea (only one boat existed, The« Scombrus » at the outset of this study). These large scale boats are not included in this French study on by-catch and discarding in pelagic fleets. The small scale boats are numerous : 120 boats were recorded fishing full time with pelagic gear in pairs and 150 other boats (in pairs or not) had a seasonal pelagic activity in 1992. The small scale fleets are based in ports along the Atlantic coast (Saint-Jean-de-Luz, Hendaye, Saint-Gilles-Croix-de-Vie, La Turballe, Lorient) and also in two ports of the Western English Channel (Granville and Cherbourg).

1.1.2 Fishing area and target species by quarter

A typology of pelagic fishing by these small scale fleets was made using their production by species, gear and fishing area (1992 reference year). The fishing areas were the South of the Bay of Biscay, the North part of the Bay of Biscay, the Celtic Sea, the Western English Channel, the offshore areas of the Bay of Biscay. A detailed analysis is reported in Appendix VII. Table 1 shows the results.
We must specify that pelagic fishing for anchovy was forbidden between 1st April and 1st June by a Spanish-French agreement. This was also the case in 1995.

YEAR 1992	*Quarter 1*			*Quarter 2*			*Quarter 3*			*Quarter 4*		
Total number of pelagic trawlers	250			258			268			127		
North part of the Bay of Biscay	**Hake** **Sea Bass** **Horsemackerel**	Pair fishing trawling	77 Boats	**Pilchard** Mackerel (Garfish)	Pair fishing trawling	42 Boats	**Anchovy** **Pilchard** **Horsemackerel**	Pair fishing trawling	90 Boats	**Anchovy** **Pilchard** (Herring)	Pair fishing trawling	51 Boats
	Horsemackerel Squids	Pair fishing trawling	62 Boats	Cuttlefish Pollack	Pair fishing trawling	33 Boats	**Anchovy** (Garfish)	Single boat trawling (with doors)	37 Boats	**Anchovy**	Single boat trawling (with doors)	32 Boats
North part of the Bay of the Biscay and the Celtic Sea				**Hake** **Horsemackerel**	Pair fishing trawling	78 Boats						
South part of the Bay of Biscay	**Anchovy**	Pair or single boat trawling (with doors)	67 Boats	**Anchovy**	Pair or single boat trawling (with doors)	17 Boats	**Hake** **Albacore** **Bluefin tuna** (Swordfish)	Pair fishing trawling	49 Boats			
	Whiting and other species	Single boat trawling (several gears)	44 Boats	**Horsemackerel** Red seabream	Pair fishing trawling	35 Boats	Misc.	Single boat trawling	60 Boats	Misc.	Single boat trawling (with doors)	13 Boats
South part of the Bay of Biscay and offshore areas				Whiting Other species	Single boat trawling	37 Boats	**Albacore** **Bluefin tuna** (Swordfish)	Pair fishing trawling	22 Boats	**Albacore** **Bluefin tuna** **Hake** **Horsemackerel**	Pair fishing trawling	16 Boats
Western English Channel				**Black bream** **Sea bass** Mackerel		16 Boats				**Black bream**		15 Boats

Table 1 : Target species of the pelagic fisheries by area and season (established according to the landings of the pelagic fleet in 1992).

1.2 PRODUCTION OF THE FRENCH PELAGIC TRAWL FISHERIES

All these data we used came from the national landing database. Gaps in time series data were observed for the year 1994 (ports Lorient, Concarneau, and Douarnenez) and were filled by using partial 1993 data.
We retained the 11 most important species.

1.2.1 Production in 1994

1.2.1.1 Landed tonnage

Landings in tons in 1994 are shown in Figure 1. The most often targeted pelagic fishery appeared to be anchovy (more than 14 000 tons). All the landings of this species came from division VIII and especially from the Bay of Biscay (Subdivisions VIIIa and VIIIb).
Mackerel and herring, which ranked second and third, were mainly fished in subdivision VII d and IV c. These areas were not sampled in our study. Moreover these two species were most of the time targeted by the « industrial » fleet.
Pilchard, hake and Med. horsemackerel were the three most fished species following herring. Their respective landings were near 3 500 tons. A great part of these landings came from subdivision VIIIa., pilchard and hake were the three most fished species following anchovy.
Albacore (and its main by-catch, bluefin tuna) ranked seventh in the French pelagic fishery. A great part of this landings was fished in offshore area of the Bay of Biscay (Subdivisions VIII c, d, e).

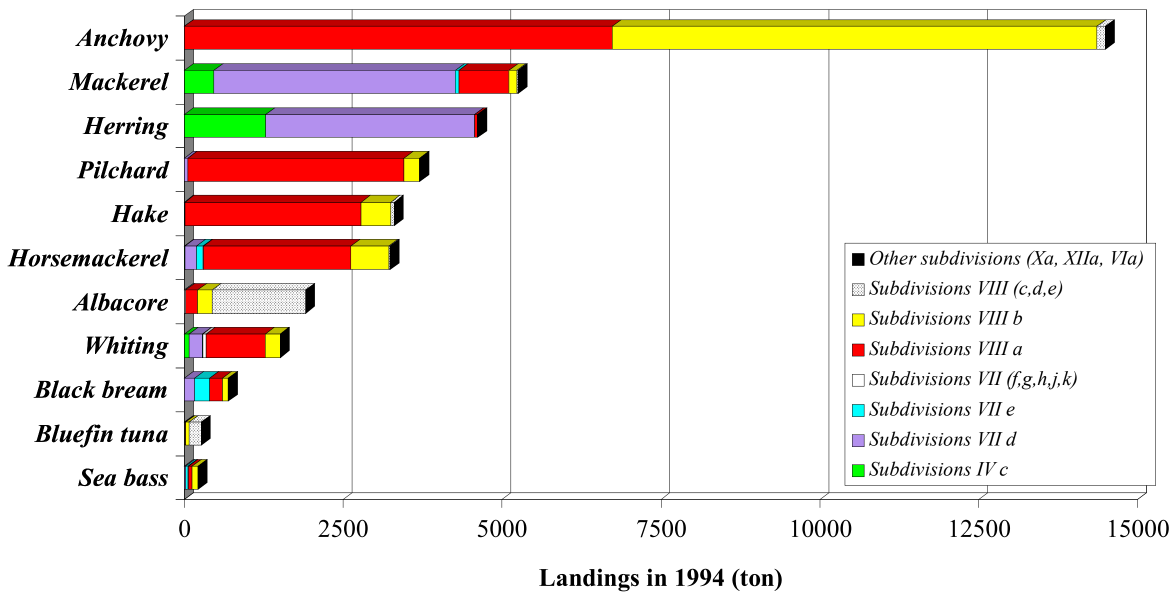


Figure 1 : Tonnage and fishing areas of the main species landed by the French pelagic trawling.

Whiting was often caught with hake : it was sometimes considered as a target species, and sometimes as a by-catch.
The last two species of this classification were black bream (700 tons) and sea bass (200 tons). Black bream appeared to be caught in several areas (Subdivisions VIId, VIIe, VIIIa and VIIIb).
To rank order the species fished by the pelagic fleets and concerned by our study, we took into account this production. This order is as follows :

- Anchovy
- Hake and whiting
- Pilchard

- Horsemackerel
- Albacore and bluefin tuna
- Black bream
- Sea bass

Albacore and bluefin tuna were fished together as well as hake and whiting. So seven fisheries were studied.

1.2.1.2 Landings in value

The order of the classification of the main species caught by the French pelagic trawling becomes different if we take into account the value of the landings. Figure 2 shows this new order.

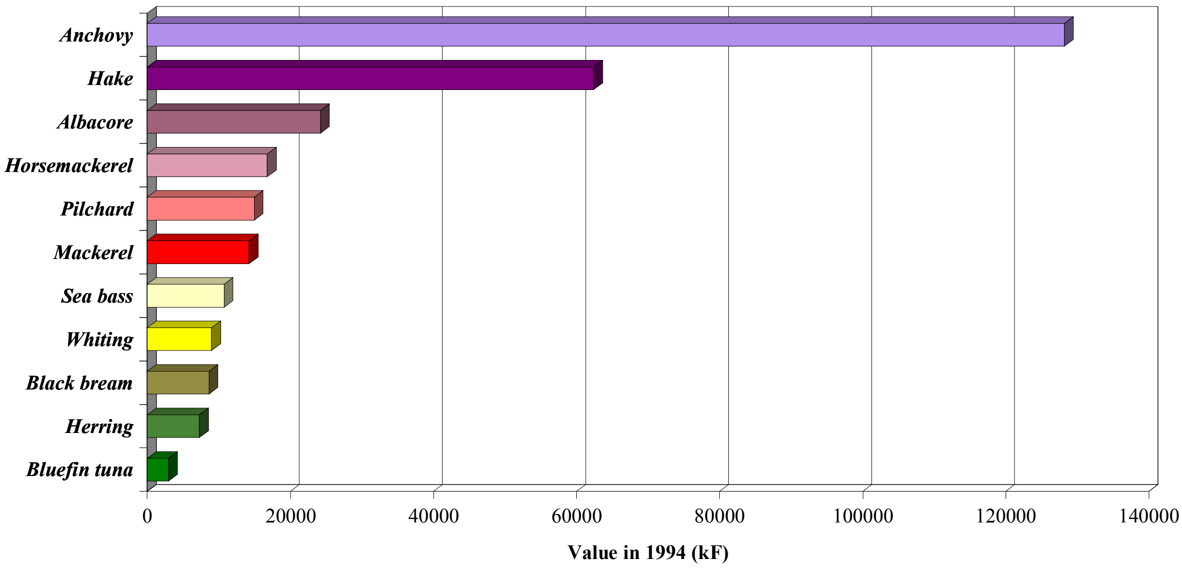


Figure 2 : Value of the main species landed by the French pelagic trawling

It appeared that the first species in value was also anchovy. But hake became the second species : hake had a high market value, and so it is a very important species for the French pelagic trawling. Albacore ranked third : it is also a high market value species. Sea bass which was the last species in the previous classification, ranked seventh in this one.

1.2.1.3 Seasonality of the landings

Seasonality of the landings in 1994 is shown in Figure 3 and in Figure 4.

Anchovy is landed nearly all the year except in April-May because of the French-Spanish agreement which forbade pelagic trawling for anchovy at this time.

Albacore and bluefin tuna are targeted from August to December.

Pilchard is fished from April to October.

Horsemackerel trawling seems to be mainly a spring activity.

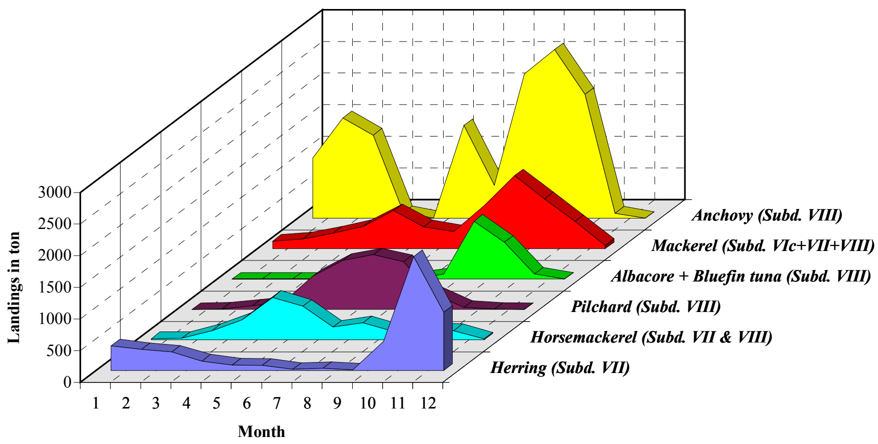
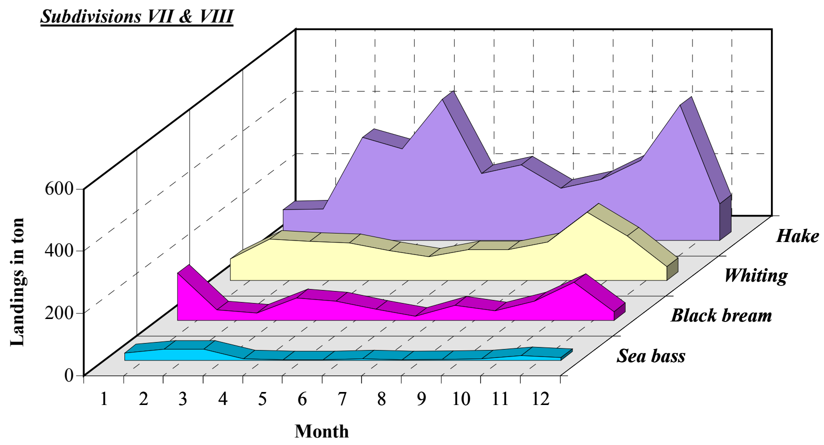


Figure 3 (part 1).: Seasonality of the landings in 1994.



No clear activity appears in the hake (and whiting) fishery. Hake trawling is considered as a secondary activity of the pelagic fleets. Landings of black bream and sea bass were higher in winter.

Figure 4 (part 2) : Seasonality of the landings in 1994

1.2.2 Evolution of the production since 1985

This evolution has been studied for the species previously quoted. Landings from 1985 to 1991 are given in Figure 5. A plateau near 37 000 tons seems to be reached in 1992. Landings were above this value in 1992, under in 1993 and equal in 1994.

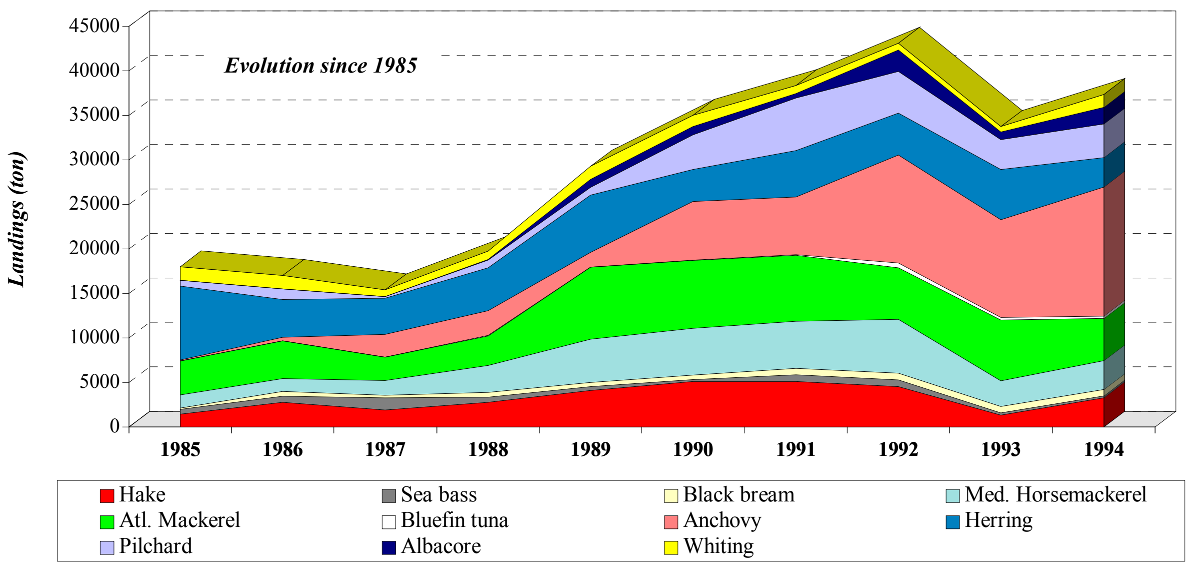


Figure 5 : Evolution of the landings of the French pelagic fisheries since 1985 (for the eleven most fished species).

From one species to another, this evolution was not the same.

- Some species had rather steady landings throughout these ten years : this is the case for whiting, herring, sea bass and black bream.
- Landings of some species (Atl. mackerel, pilchard, Med. horsemackrel and hake) increased slowly until 1991.
- Other species appeared during these ten years :

  Anchovy was rare in the landings in 1985, and became the first species since 1992.

  Albacore and bluefin tuna appeared in 1988, and increased slowly until 1992.

The decrease of hake landings since 1992 is worrying, all the more because this species plays a great economic part in pelagic trawling.

2. METHODOLOGY IN DATA COLLECTION

For the study at sea we used 2 observers , one was based at Biarritz for the ports in the South of the Bay of Biscay and one at Brest for ports in the North of the Biscay and the Western English Channel.

2.1 COLLABORATION WITH FISHERMEN

Difficulties arose at the beginning of the study with the pelagic committee of the French « Comité National des Pêches maritimes et des Cultures Marines » when we presented our study to obtain their collaboration. Their opposition was due to the political exploitation of a tuna drifnet study and the lack of consideration for the scientific results in that case. They revised their position after this study was given confidential status by the European Commission. We quickly obtained local agreement to start the sampling. During the study at sea our observers found access to the commercial boats easy enough in order to investigate each pelagic fishery.

2.2 CATCH ASSESSMENT

2.2.1 Sampling scheme

We tried to sample the French pelagic fisheries which worked in the Bay of Biscay or in Western English Channel. That is to say the following fisheries :

- Anchovy trawl fishery
- Hake (and whiting) trawl fishery
- Pilchard trawl fishery
- Horsemackerel (med. species) trawl fishery
- Albacore (and bluefin tuna) trawl fishery
- Black bream trawl fishery
- Sea bass trawl fishery

Mackerel and Herring trawl fisheries, which worked mainly in Subdivision VIId and IVc were not concerned by this study.

A stratified sampling plan was carried out. Seven strata were distinguished : one strata by fishery. In each stratum several trips were choosen (sampling rate in the fishery) and in each trip several tows were sampled at random.
The sampling unit was the tow, and observations were carried out in each tow in order to collect simultaneous informations on discards and landings. The investigation was done in order to cover all the fish species caught. So part of each sampled tow was taken (sampling rate in the tow) to obtain numbers of discarded and landed individuals per species. In this part, a sub sample was sometimes taken in order to collect fish measurements (measurement rate in the sample).
We have decided to exclude from this study the non-pelagic tows which can occur during a «pelagic» trip.

2.2.2 Allocation of each sample tow to a specific fishery

The same trip may sometimes target several species. So the allocation of each tow to a specific fishery was done after checking the observer's information with the specific composition found in the landings. Table 1 shows the specific composition in the landings according to the targets. The trips with successive targeted species (trips 4, 8, 12) are distributed to the fisheries according the target species.

The target species represented 58 to 100 % by weight in the landings. The highest percentage was found for small pelagic targets (anchovy, scad, pilchard).
However different pelagic gears can be used in each fishery. We have not separated the gears in the analysis of each fishery because the sampling effort was too small.

Trip	All the species / Target species	Anchovy	Sea bass	Med. horsemackerel	Black bream	Hake	Pilchard	Albacore	Gilthead seabream	Smoothhound	Swordfish	Squid	Atl. horsemackerel	Red gurnard	Pollack	Atl. mackerel	Whiting	European Mullet	Dogfish	Cuttlefish	Northern bluefin tuna
15	*Anchovy*	**94**				2	3														
17	*Anchovy*	**99**																			
18	*Anchovy*	**100**																			
4	*Sea bass*		**64**			35	1														
6	*Sea bass*		**88**	8														4			
4	*Med. horsemackerel*			**100**																	
5	*Med. horsemackerel*			**100**																	
7	*Black bream*				**77**								20			2					
10	*Black bream*				**58**					6			26	3					6		
3	*Hake*		5			**59**						20					14				
8	*Hake*					**92**											8				
9	*Hake*					**100**															
12	*Hake*				1	**82**			1								11	6			
13	*Hake*		4		1	**58**						18					6			2	
14	*Hake*		11			**82**									2					4	
16	*Hake*		2			**60**	5						14			11	7				
8	*Pilchard*			3			**97**														
9	*Pilchard*			1			**99**														
1	*Tuna*							**94**			2										4
2	*Tuna*							**70**													30
11	*Tuna*							**96**			1										3
12	*Tuna*							**67**			10										22

Table 2 : The composition (percentage in weight) in the landings from tows (sampled and unsampled tows combined) by trips and target species.

2.2.3 The sampling effort

The sampling effort was carried out in order to cover the best we can in the space and in the time each previously quoted fishery. On Table 3, each sampled box was darkened in order to show sampling allocation.

18 trips were sampled in this French study. The duration of the observed trips varied between 1 and 15 days. All the observed trips represent around 100 days at sea. But pelagic trawling did not take place during all this time (other fishing activities). Nevertheless, the sampled catches represented more than 700 sampled tow hours.

YEAR 1992	*Quarter 1*			*Quarter 2*			*Quarter 3*			*Quarter 4*		
Total number of pelagic trawlers	**250**			**258**			**268**			**127**		
North part of the Bay of Biscay	Hake Sea Bass Horsemackerel	Pair fishing trawling	7 **4**	**8** …hard …kerel (Garfish)	Pair fishing trawling	4 **9**	Anchovy Pilchard Horsemackerel	Pair fishing trawling	90 Boats	Anchovy Pilchard (Herring)	Pair fishing trawling	51 Boats
	Horsemackerel Squids	Pair fishing trawling	62 **5**	Cuttlefish Pollack	Pair fishing trawling	33 Boats	Anchovy (Garfish)	Single boat trawling (with doors)	37 Boats	Anchovy	Single boat trawling (with doors)	32 Boats
North part of the Bay of the Biscay and the Celtic Sea				**8** …ke Horsemackerel	Pair fishing trawling	**16** 7… Boats						
South part of the Bay of Biscay	Anchovy	Pair or single boat trawling (with doors)	6 **15**	**17** …hovy	Pair or single boat trawling (with doors)	1 **18**	Hake Albacore Bluefin tuna (Swordfish)	Pair fishing trawling	4 **1**			
	Whiting and other species	Single boat trawling (several gears)	4 **14**	Horsemackerel Red seabream	Pair fishing trawling	35 Boats	Misc.	Single boat trawling	60 Boats	Misc.	Single boat trawling (with doors)	1 **3**
South part of the Bay of Biscay and offshore areas				Whiting Other species	Single boat trawling	37 Boats	**11** …core …n tuna (Swordfish)	Pair fishing trawling	**2** 22…	**11** …core …tuna Hake Horsemackerel	Pair fishing trawling	**12** 1…
Western English Channel				**6** …bream …bass Mackerel	**7**	**10** 1… Boats				Black bream		15 Boats

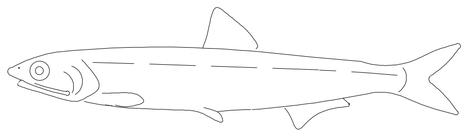
Table 3 : Allocation in time and in space of the sampling effort : sampled box are darkened (the number of the trip is indicated).

2.2.4 The raising method

The data of each sub sample are raised to the whole of the sampled tows in each fishery by using the measurement rate in the sample and the sampling rate in the tow. By using this method, we obtain raised data for all the sampled tows (but not for all the tows of a trip). The catch composition of unsampled tows is considered to be nearly the same as the composition of the sampled one.

Each rate (measurement and sampling rate) is calculated either by using a number of fish or by using a weight of fish. Computing by numbers was done for large size fish like tunas. When computing by weight, we used the landing estimate given by fishermen (which is used to fill in the log-book) and the sub sample weight computed from the length composition by a specific length-weight relationship.

3. BY-CATCH AND DISCARDING IN THE FRENCH ANCHOVY TRAWL FISHERY : RESULTS AND DISCUSSION



3.1 RESULTS

3.1.1 Sampling effort

One pair of boats was studied for this study and three trips were sampled. During these 3 trips only one pelagic gear was used to target anchovy. Table 4 showed the number of sampled and unsampled tows by trip. In all, **15 hours of towing** were sampled.

Trip	Gear	unsampled tows	sampled tows
15	Pelagic	4	3
17	Pelagic	5	6
18	Pelagic	1	2

Table 4 : Number of tows by trip

3.1.2 Characteristics of the sampled tows

The sampled vessel always worked as a pair. The trawl was generally towed just under the surface at a speed of 3.5 m/h. The stretched mesh size of the codend measured 20 mm, the headline of the trawl 102 m in length, and the vertical aperture 25-30 m.

3.1.2.1 Period of observation

Three trips were observed for this pair of boats with a total duration of 9 days. The first trip occurred in March, the others in June 1995 (Figure 6). There was no observation in April and May because of the French-Spanish agreement which forbade pelagic trawling for anchovy at this time. The anchovy trip was short to ensure the freshness of fish.
During this period, **11 out of 21 tows were sampled**.

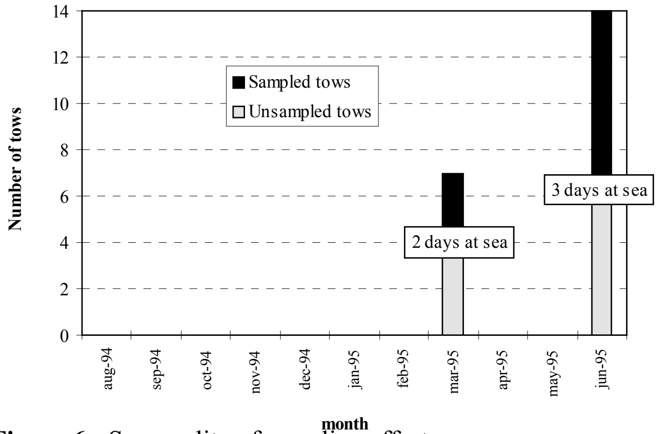


Figure 6 : Seasonality of sampling effort.

3.1.2.2 Location of the observed tows

Observed tows were located in the South of the Bay of Biscay (Subdivision VIII b). During the Spring, anchovy fishery was located in this area. Whereas the fishery moved to the North of the Bay during the Summer and the Autumn.

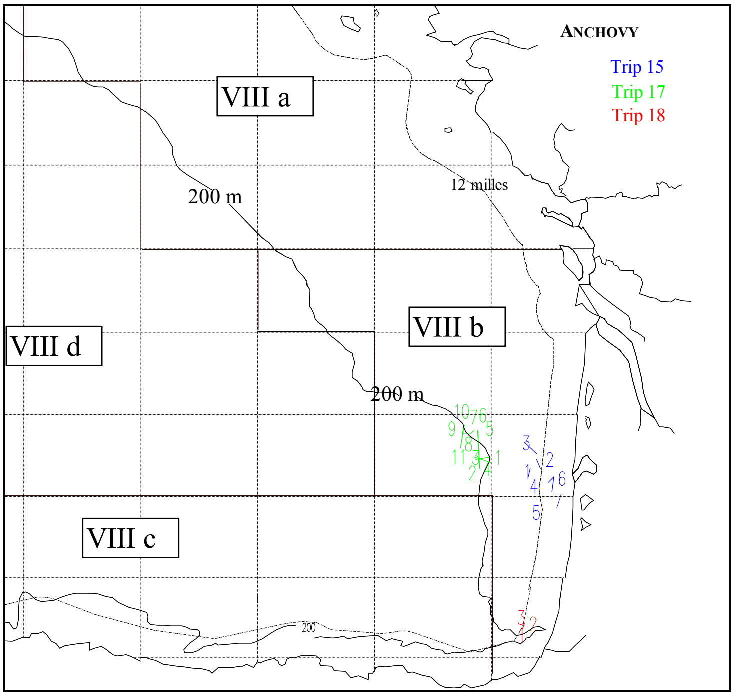


Figure 7 : Location of observed tows in the anchovy trawling. (One colour per trip / the number of the tow is indicated near the location).

3.1.2.3 Duration of the observed tows

Tows occurred during the day. Boats worked rarely during the night because of an increase in the diversity of the catch and tedious sorting. The mean duration of sampled tows was 1 h 25 mn, and it was found to vary from 0 h 30 mn to 2 h. The distribution of the durations is shown in Figure 8. The duration of tows was short because of the anchovy fragility.

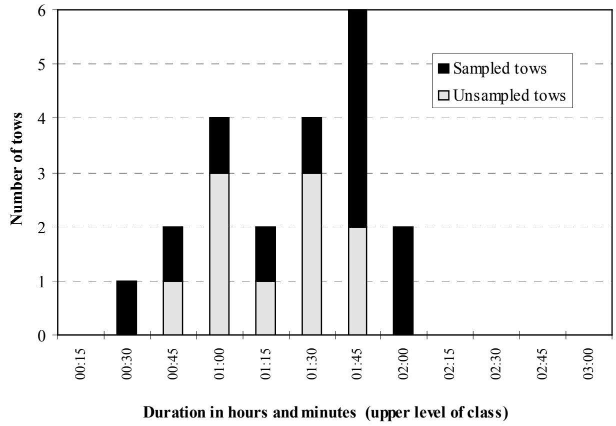


Figure 8 : Frequency distribution of the duration of anchovy tows (total number of tows=21).

3.1.3 Catch, by-catch and discards of fish

3.1.3.1 Catch composition in the sample

3.1.3.1.1 Global composition (target, by-catch, discards)

Anchovy, the targeted species, accounted for **69 %** by weight of the 6.55 tons of fish caught in the sampled tows (Figure 9). The proportion of non-targeted species was very low (3 % by weight in the total catch). The proportion of observed **discards** was **29 %.** However this obtained image shows a selectivity lower than the real overall selectivity in the fishery.

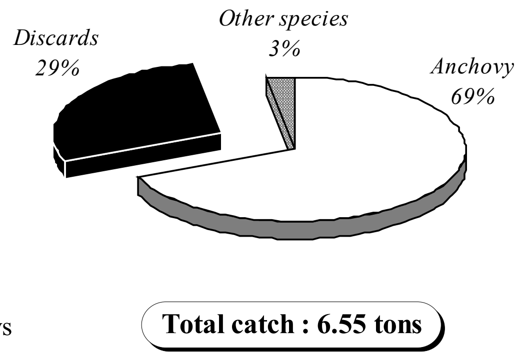


Figure 9 : Composition of the catch in the sampled tows (% by weight).

3.1.3.1.2 Variability between tows

The weight of landed and discarded fish in each sampled tow is shown in. **Anchovy was found in each sampled haul** : its landings varied from less than 50 kg to 900 kg. Most of the discards were not high in quantity except for two tows : discards of pilchard and Atlantic horsemackerel reached 400 kg in tow « 15-6 » and nearly 1.2 tons in tows « 15-7 ». Trip 15 seemed to be different from the other.

No sampled tow was observed to be completely

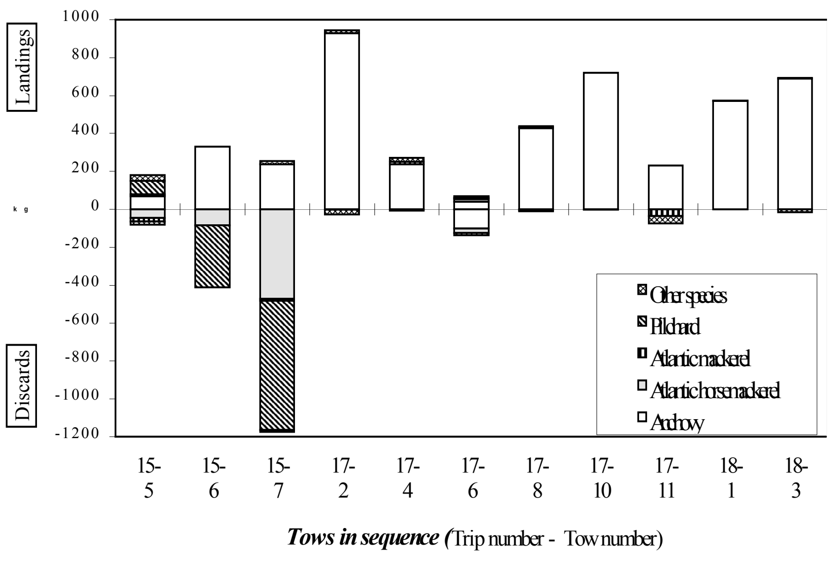


Figure 10 : Landed and discarded fish (kg) in each sampled tow.

discarded, but it was the case in some unsampled tows. In the tow 17-2 a great number (near 5000 individuals) of « swimming crabs » were caught and discarded : this was not mentioned on Figure 10. Generally speaking, **significant variability** was observed between the catches of each tow. Reliability of the results could be affected.

3.1.3.2 Discards (composition, rate and reason per species)

3.1.3.2.1 Discard composition

Discards of **anchovy**, the targeted species, represented only **5 %** by weight. The main discarded species were **Atlantic horsemackerel** (33 %) and **pilchard** (54 %) (Figure 11).
No marine mammal catch was recorded.

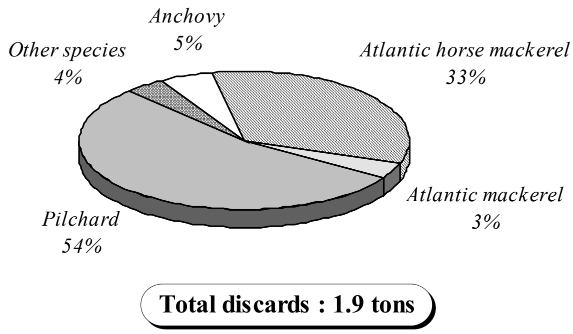


Figure 11 : Composition of discards in the sampled tows

3.1.3.2.2 Variability in the discarding rate

No species was totally rejected. Anchovy were always retained except in one tow where the discarding rate was 0.7 but the catch was low. The other species were often completely discarded and sometimes landed.

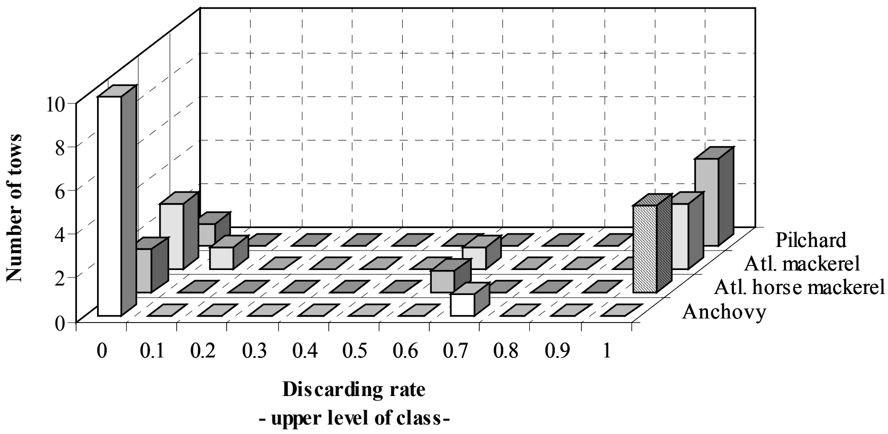


Figure 12 : Distribution of the discarding rate for the main discarded species in the anchovy trawling.

3.1.3.2.3 Reasons for discarding

The reasons of discarding are shown in Figure 13. **Most species were discarded because of high grading**. When the catches were mixed, sorting became tedious and sometimes fishermen were faced with the prospect of discarding the main part of the catch.
Anchovy and Atlantic mackerel were discarded because of being undersized. Two species (poutassou and sunfish) were caught but were unmarketable.

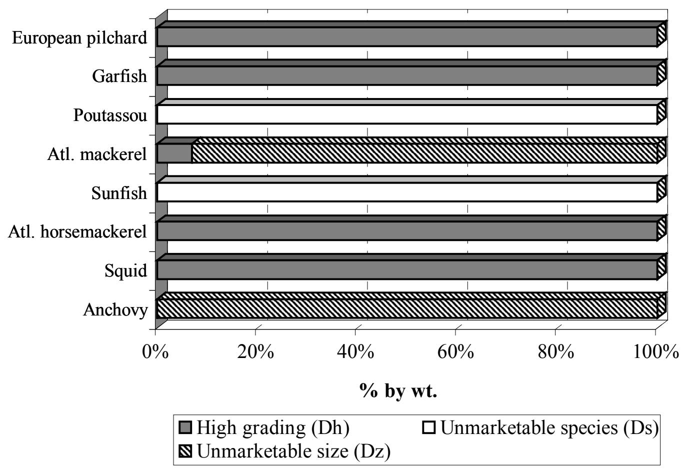


Figure 13 : Causes of discards for all the caught species in the anchovy fishery.

3.1.3.3 Size composition

3.1.3.3.1 Anchovy

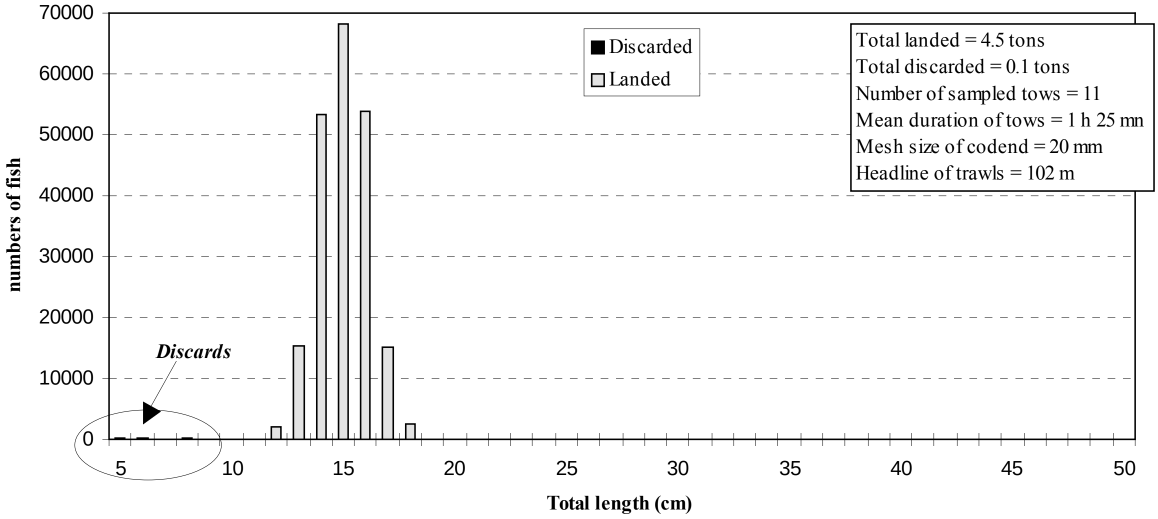


Figure 14 : Size composition of the sampled target species (anchovy).

The minimum legal size for anchovy is 12 cm in Area 3. **The size selectivity appears very good** (Figure 8). The mean size of the landed anchovy was near 15 cm (« moule T2 »). Generally the mean size in landings is less than 15 cm and varies according to the quarter (PROUZET and METUZALS, 1995). During the second quarter, the mean size decreased to 12.6 cm (catches near the shore). Such a decrease was not observed in our data.

3.1.3.3.2 Atlantic horsemackerel

The minimum legal size for horsemackerel is 15 cm. Only the larger individuals (length > 30cm) were retained. Most of the discarded individuals ranged between 10 and 15 cm (Figure 9).

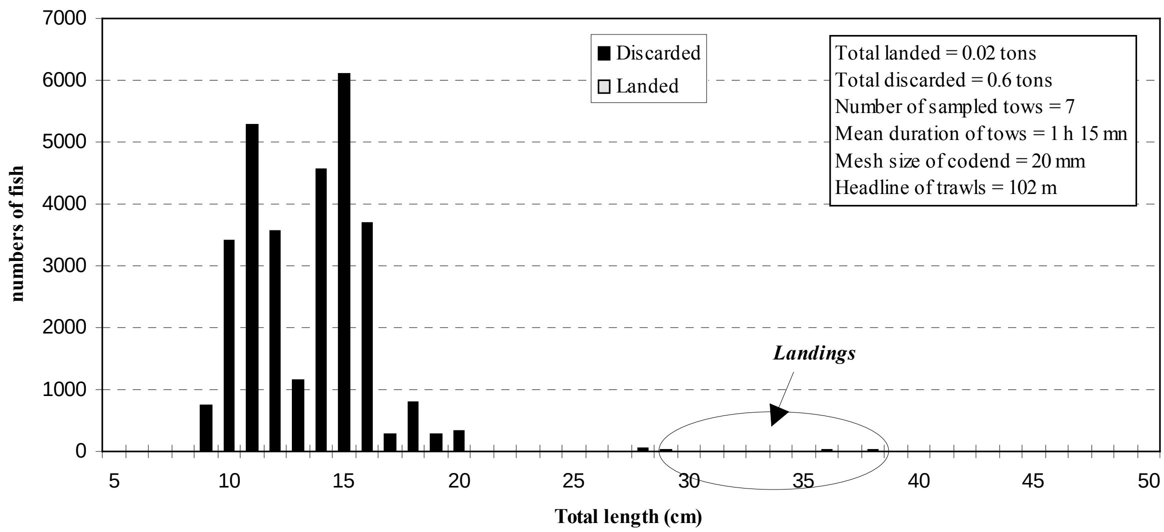


Figure 15 : Size composition of horsemackerel in the sampled tows.

3.1.3.3.3 Pilchard

An EC minimum landing size for pilchard does not exist. Discarding was not related to the size of individuals (Figure 10). The main reason for discarding pilchard was that sorting was too tedious.

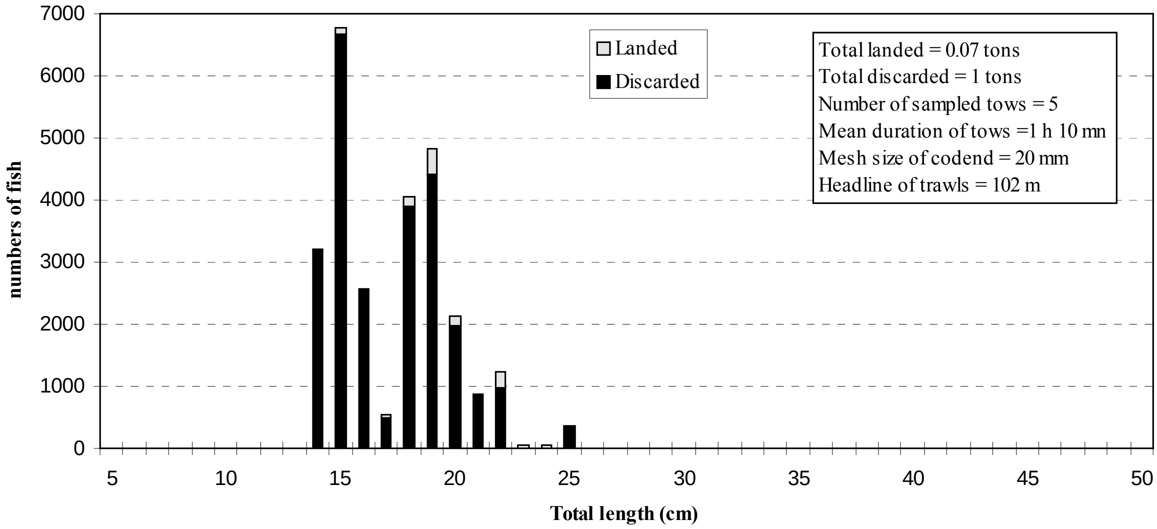


Figure 16 : Size composition of pilchard in the sampled tows.

3.1.3.3.4 Atlantic mackerel

The minimum legal size for mackerel is 20 cm. Discards concerned mainly individuals below the MLS (Figure 11).

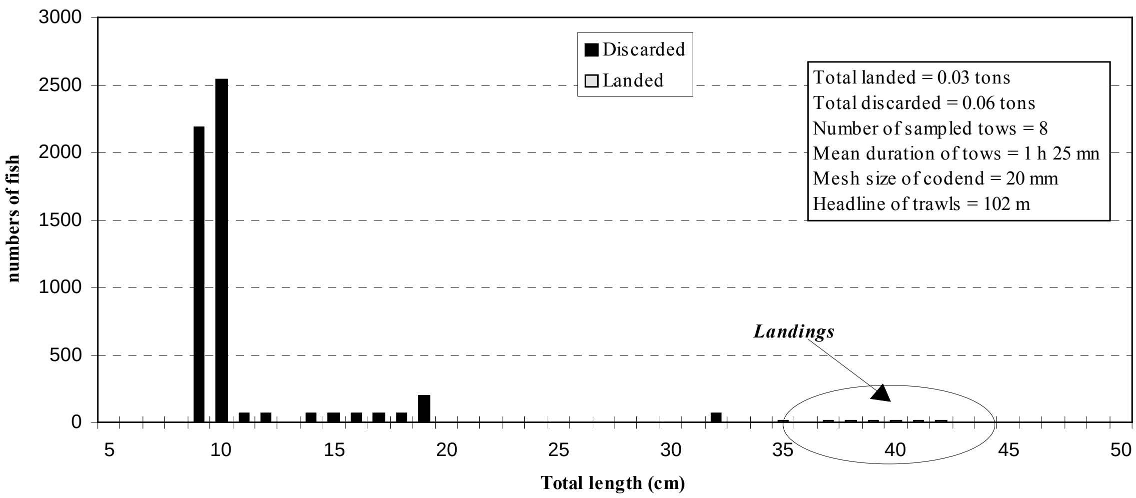


Figure 17 : size composition of mackerel in the sampled tows.

3.1.4 Marine mammal by-catch

No marine mammal by-catch was observed in the sampled tows. But the size of our sample was low (15 hours of towing), further observations would be necessary.

3.2 DISCUSSION

3.2.1 Critique of the sampling effort and reliability of the results

3.2.1.1 Assessment of the sampling rate for this fishery

By using landings of target species, the sampling rate was equal to 0.03 %, it became equal to 0.02 % by using the fishing time on this target. One estimate of the sampling rate for this fishery can be the mean of this two sampling rate (0.027 %).

	In the sampling	For the fishery (1994)	Sampling rate
Landings of anchovy (in tons)	4.5	14 495	0.031 %
Fishing time	15	68 700	0.022 %

3.2.1.2 Intervals of confidence

The intervals of confidence for the discarding rate and the rate of the target species in the catches were as follows.

	Ratio estimation	Interval of confidence (95%)	
		lower limit	upper limit
Rate of target by weight	68.5%	40.5%	96.6%
Discarding rate by weight	28.7%	0.5%	56.9%

A significant variability was observed between the catches of each tow and the sampling rate was very low. That is the reason why the interval of confidence appeared to be so large. Result accuracy was affected : the discarding rate was included between 0.5% and 57%. The true discarding rate is probably closer to the lowest limit than to the highest one. Further investigation would be necessary to give a better estimate of the discarding rate in the fishery.

3.2.2 Selectivity of the fishery

3.2.2.1 Species selectivity

The assessment of the rate of anchovy in the catches (ranged between 40.5% and 96.6%) showed apparently medium selectivity by species. The main by-catch of this fishery were pilchard, Atl. horse mackerel and Atl. mackerel.

The present EC regulation prescribes the use of a minimal stretched mesh size of 16 mm in area 3, with a 50 % minimal percentage of target species. The percentage of other protected species does not exceed 10 % in the retained catch.

3.2.2.2 Size selectivity

Our observation shows a good size selectivity for the targeted species. But size of anchovy caught varies according to quarter, and our samples were taken only during the second quarter. Perhaps selectivity is not so good for the whole year.

3.2.3 Factors determining by-catch and discards

Generally speaking, shoals never contain one single species. More species tend to mix during the night than the day. That is why anchovy trawling is a day activity.

When shoals are mixed up, sorting became very tedious, and several decisions can occurr :

- discarding of the whole catch
- retaining only anchovy
- retaining all marketable fish.

The decision also depends on the filling up of the hold. This is the reason why the proportion of discards may vary greatly.

3.2.4 Interaction with marine mammals

No mammal was observed in the sampled tows. But catches of marine mammal seem to be a scarce event, so greater sampling would bring us further information in order to make a more accurate decision.

3.3 CONCLUSION

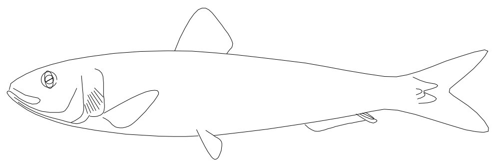
For this type of fishery, only 15 hours of towing were sampled : the sampling rate was around 0.03 %, and the variability between trips and into trip appeared to be significant. So sampling must be completed to give an accurate conclusion.

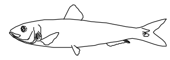
selectivity seemed to be high for anchovy, and low for the main by-catch (Pilchard, Atl. Mackerel and Atl. horsemackerel). By-catches were observed mainly during one trip at the beginning of the main fishing season and the selectivity in this fishery is probably higher than the average obtained in this study such as shown by the two other trips.

A proportion of catches was discarded due to the tediousness of sorting. Mixed catches should be avoided, but this seemed to be difficult. The rate of mixed catches may vary according to the fishing areas, to seasons, and also between the day and the night. But there is a lack of data to make any assertion about this. According to fishermen, night towing must be avoided because of an increased by-catch during the night.

Considering the importance of this pelagic fishery (more than 14 000 tons landed in 1994), an extensive study must be undertaken to give a clearer perspective as to the real quantity of fish discarded, whatever the reason.

4. BY-CATCH AND DISCARDING IN THE FRENCH PILCHARD TRAWL FISHERY : RESULTS AND DISCUSSION





4.1 RESULTS

4.1.1 Sampling effort

Two pairs of boats were chosen for this fishery. Two trips were sampled (one trip by each pair). During these trips, the same type of gear was used. In the same trip, some tows targeted hake (the number of hake tows is indicated in brackets on Table 5). In all, three hours of towing were sampled.

Trip	Gear	Unsampled tows	Sampled tows
8	Pelagic	0 (0)	1 (1)
9	Pelagic	0 (1)	3 (0)

Table 5: Number of tows by trip.

4.1.2 Characteristics of the sampled tows

These two sampled boats came from the same port La Turballe. They always worked in pairs. The trawl was generally towed in midwater. During these trips, pilchard tows were carried out after hake tows.

An inner bag was put in the codend of the trawl in order to reduce the stretched mesh size. The headline of trawl measured 114 m in length, and the vertical aperture varied fron 20 to 27 m.

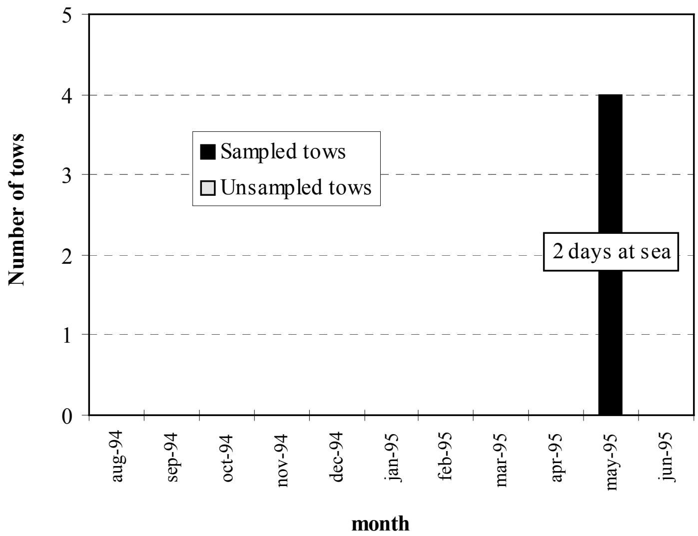


Figure 18 : Seasonality of sampling effort.

4.1.2.1 Period of observation

Two trips were observed (one trip per boat) with a total duration of 2 days : trips were very short in order to land fresh fish. These two trips occurred in May 1995 (Figure 6). During this period, the smaller pelagic boats from La Turballe targeted anchovy. During these two trips, all the 4 tows were sampled.

4.1.2.2 Location of observed tows

The sampled tows were located in Subdivision VIII a, not far from the port La Turballe.

These tows took place near the 15 mile boundary. Water depth was near 30-40 m.

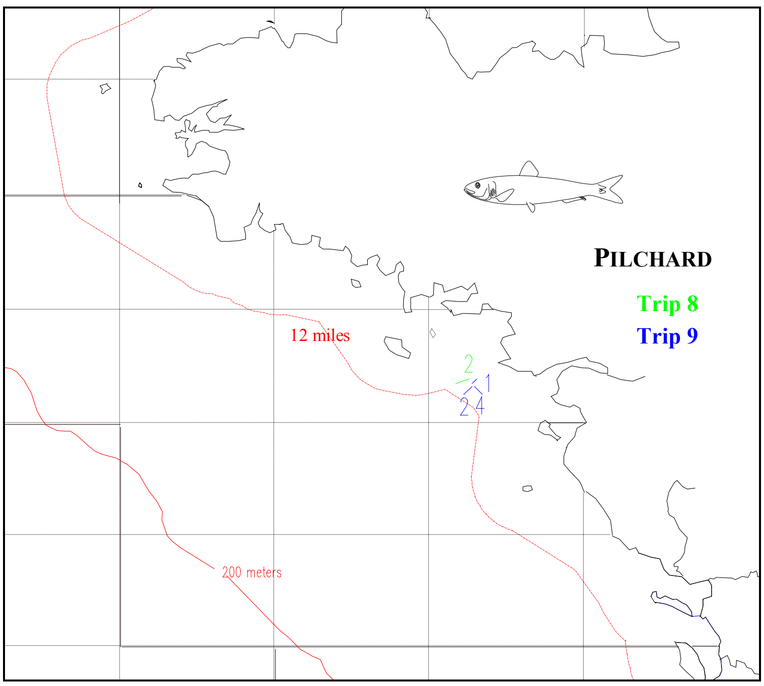


Figure 19 : Location of the observed tows in pilchard trawling. (One colour per trip / the number of the tow is indicated near the location).

4.1.2.3 Duration of the observed tows

Tows occurred during the day before or after hake tows. The duration of sampled tows varied from 30 mn to 1 hour. The distribution of the duration is shown in Figure 8. Pilchard tows were short to provide fish of good quality.

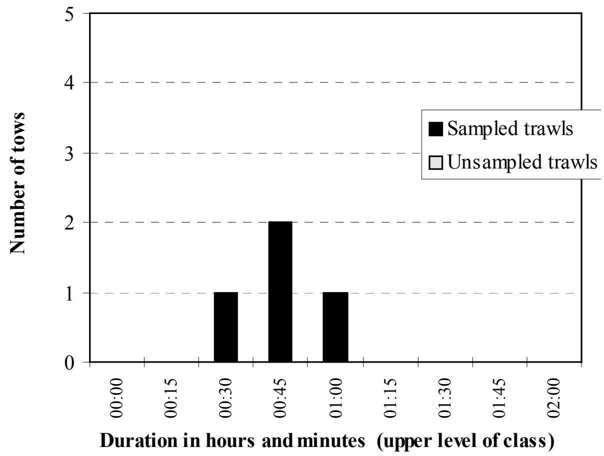
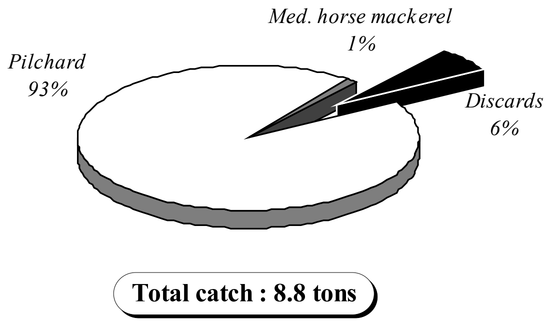


Figure 20 : Frequency distribution of the duration of pilchard tows (total number of tows=4).

4.1.3 Catch, by-catch and discards of fish

4.1.3.1 Catch composition in the sample

4.1.3.1.1 Global composition (target, by-catch, discards)



Pilchard, the target species, accounted for **93 %** by weight of the 8.8 tons of fish caught in the sampled tows (Figure 9). Non-targeted species in the landings were only **Mediterranean horsemackerel** at a very low proportion (1%). The proportion of total discards was also very low (6%).

Figure 21 : Composition of the catch in the sampled tows (% by weight).

4.1.3.1.2 Variability between tows

The weight of landed and discarded fish in each sampled tow is shown in Figure 22. Each sampled haul contained pilchard. But variability between tows appeared to be high **: Pilchard landings varied from 100 kg to 5.6 tons**.

One non-targeted species (Med. horsemackerel) appeared in each tow but in very small quantities. Discards reached less than 200 kg per tow. Pilchard was always present in the discards but in small quantities. No sampled tow was completely discarded.

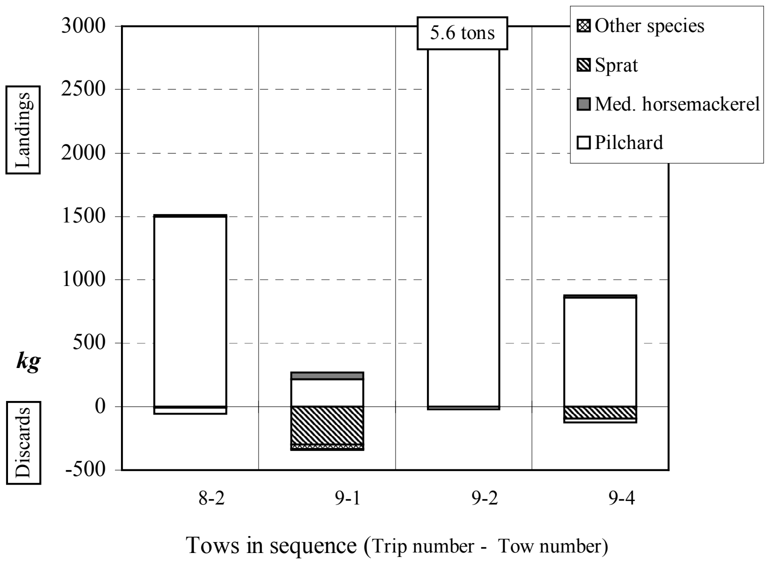


Figure 22 : Landed and discarded fish (kg) in each sampled tow.

4.1.3.2 Discards (composition, rate and reason per species)

4.1.3.2.1 Discard composition

The total discarded weight was low (0.51 ton). The main discarded species were **sprat** and less so **pilchard**. **Sprat** represented **78%** by weight of the total discards. The targeted species, **pilchard**, was observed in the discards (**15 %** of the total discards). Atlantic mackerel and garfish were the other species discarded (Figure 23).
No marine mammal catch was recorded.

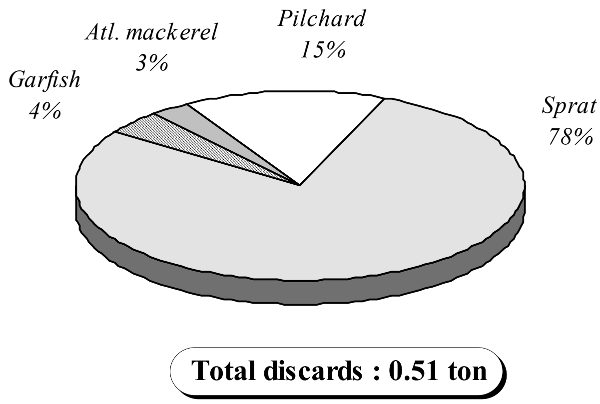


Figure 23 : Composition of discards in the sampled tows

4.1.3.2.2 Variability in the discarding rate

In each tow, pilchard was sorted with a discarding rate equal or less than 0.1. The other species were all discarded.

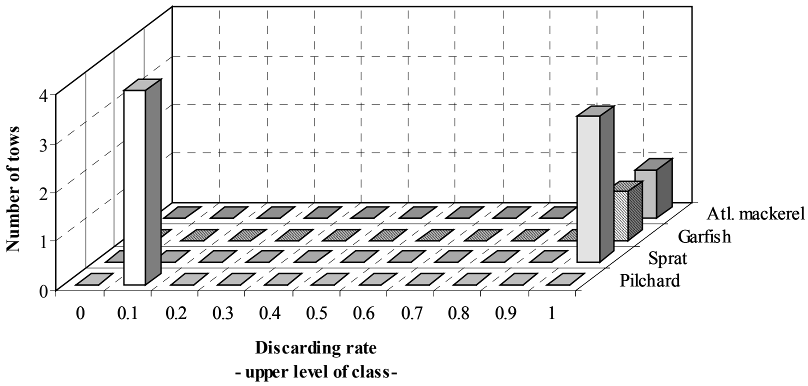


Figure 24 : Distribution of the discarding rate for the main discarded species in pilchard trawling.

4.1.3.2.3 Reasons for discarding

The reasons for discarding are shown in Figure 25. Discarded pilchards were damaged individuals. Sprat, mackerel and garfish were discarded because they were unmarketable.

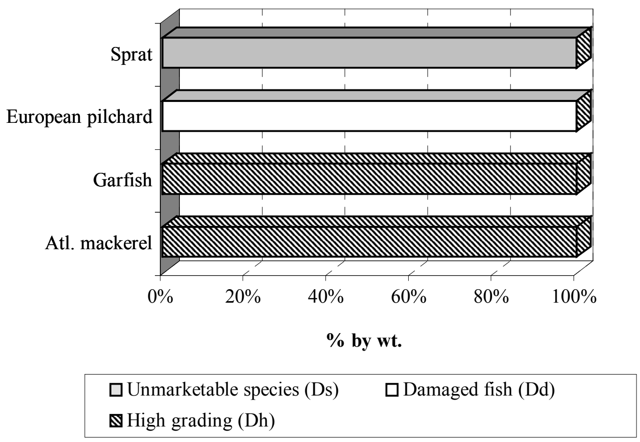


Figure 25 : Causes of discards in the sampled pilchard tows for the main species.

4.1.3.3 Size composition

4.1.3.3.1 Pilchard

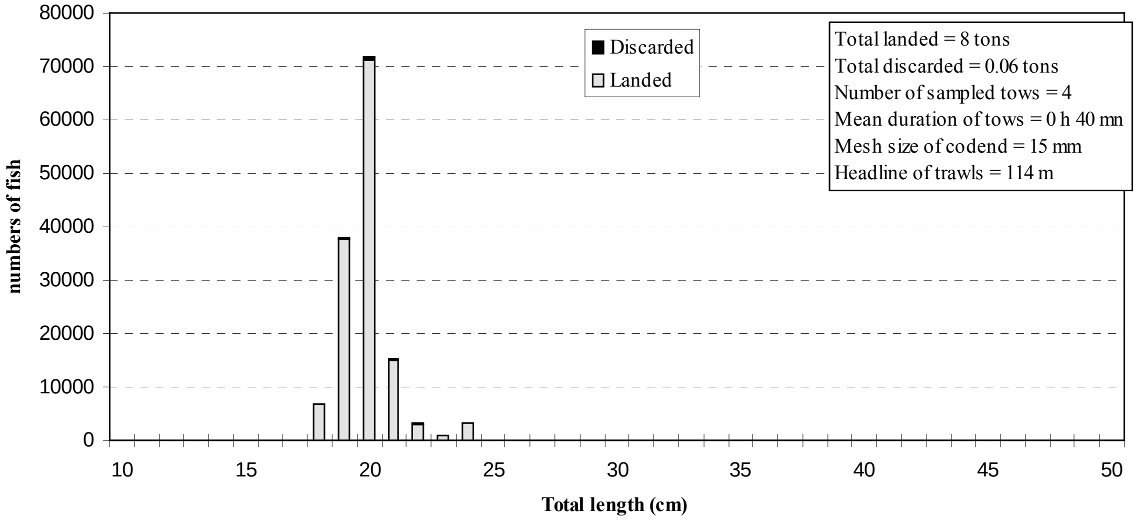


Figure 26 : Size composition of the sampled target species (pilchard).

There is no minimum landing size for pilchard. Discards were very low in each size class (Figure 26). The size selectivity seemed to be good for the target species. But the size of pilchard may vary during the year, and our sample contained only one month of observation.

4.1.3.3.2 Sprat

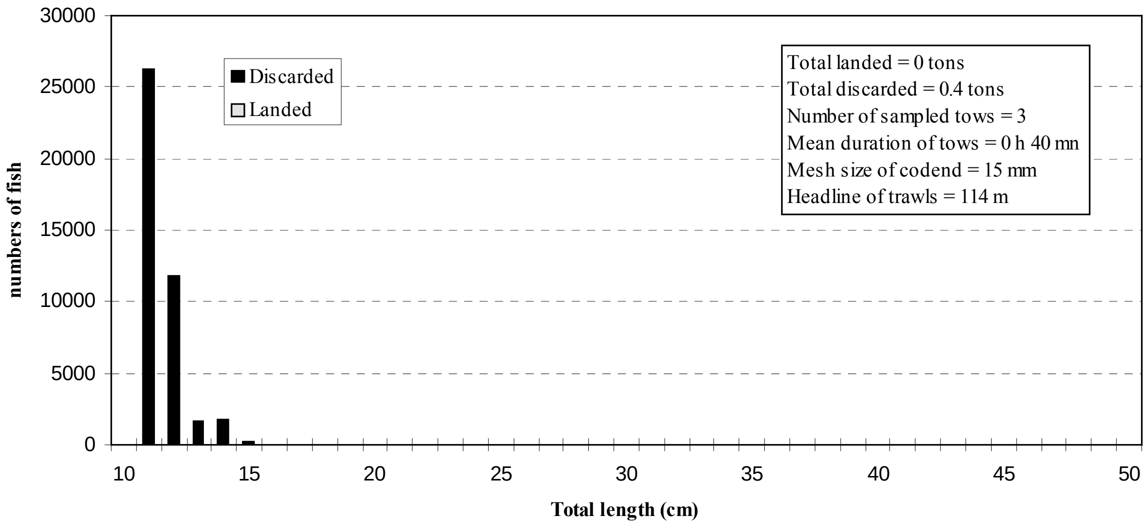


Figure 27 : Size composition of the main discarded species (sprat)

There is no minimum landing size for sprat. The size composition ranged between 10 and 15 cm (Figure 27). There appeared a lack of selectivity for this species. All sprat were discarded.

4.1.4 Marine mammal by-catch

No mammal catch was reported during these sampled trips (in all, 3 hours of towing).

4.2 DISCUSSION

4.2.1 Critique of the sampling effort and reliability of the results

4.2.1.1 Assessment of the sampling rate for this fishery

One estimate of the sampling rate in this fishery could be the mean of these two sampling rates, that is to say 0.11 %.

	In the sampling	For the fishery (1994)	Sampling rate
Landings of pilchard (in tons)	8.2	3 704	0.22 %
Fishing time (in hours)	3	44 755	0.01 %

4.2.1.2 Intervals of confidence

The intervals of confidence for the discarding rate and the rate of the target species in the catches reflect the small sample size.

	Ratio estimation	Interval of confidence (95%)	
		lower limit	upper limit
Rate of target by weight	93.2%	76.9%	100.0%
Discarding rate by weight	5.9%	0.0%	19.9%

Because of the small size of the sampling, conditions for computing intervals of confidence are not well-respected. So the computed interval of confidence is perhaps under-estimated. Further sampling would be necessary.

4.2.2 Selectivity of the fishery

There was high selectivity as the targeted landings accounted for 93 % of the total catch. However sprat discards probably could be lower if fishermen did not put an inner bag in the trawl. They used the inner bag to avoid pilchards becoming enmeshed in the cod-end. Further investigations would be useful to study the effect of the inner bag on the quantity of the by-catch.

The EC regulations permit targeting this species with a minimal stretched mesh size of 20 mm.

4.2.3 Interaction with marine mammals

No mammal was caught in the observed tows. But the total duration of samples tows was too short (2h 45 mn). Catch of marine mammals was a scarce event, the size of the sample must be increased in further investigations.

4.3 CONCLUSION

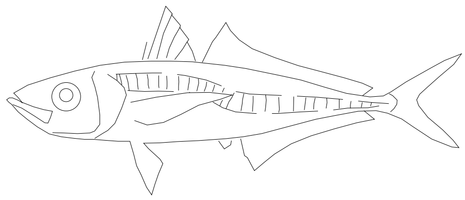
For pilchard trawl pelagic fishery, only three hours of towing were sampled. The sampling rate was very low (0.1 %). Nevertheless this study constituted a first approach to this fishery.

It appears that the selectivity is high :the catch was 93 % of targeted fish and sprat was the main by-catch of this fishery. For one landed ton of pilchard, pelagic trawlers discarded 50 kg of sprat and only 10 kg of damaged pilchard. Further observation should be necessary to certify this estimate.

An inner bag was used in this fishery to avoid pilchards being meshed in the cod-end and being damaged. The presence of this inner bag may have some effect on the catch (diversity, quantity). But according to fishermen, it seems to be indispensable for this type of fishery.

Further investigation should be carried out on this fishery, which ranked fourth in the French pelagic fishery table (with 3 704 tons of pilchard landed in 1994).

5. By-catch and discarding in the French Med. horsemackerel trawl fishery : Results and Discussion



5.1 Results

5.1.1 Sampling effort

One pair of boats was selected for sampling and two trips were studied. Similar types of gear were used during these trips. Trip « 4 » targeted successive species: some tows targeted horsemackerel, and other tows targeted sea bass (the number of hake tows is indicated in brackets, Table 6). Table 6 gives the number of tows in each trip. In all, **18 hours of towing** were sampled.

Trip	Gear	Unsampled tows	Sampled tows
4	Pelagic	2 (3)	4 (3)
5	Pelagic	5	3

Table 6 : number of tows by trip.

5.1.2 Characteristics of the sampled tows

The two boats always worked as a pair. They seek horsemackerel with the assistance of an echo-sounder. The immersion depth of the trawl was determined according to data from the netsond.

The stretched mesh size of the codend was 65 mm, the headline of the trawl varied from 133 to 195 m in length.

5.1.2.1 Period of observation

Two trips (on the same boat) were studied with a total duration of 9 days. The first trip occurred in Winter (January-February) and the second in March (Figure 28).

During this period, **7 out of 21 tows were sampled**.

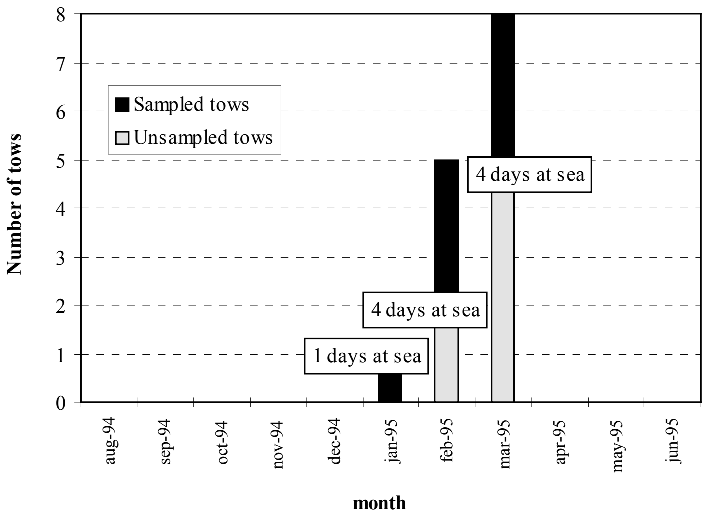


Figure 28 : Seasonality of sampling effort.

5.1.2.2 Location of observed tows

All the observed tows were located in Subdivision VIII a. The fishing area of these trips was not far from the shore, near the 12 mile boundary. In this area, the water depth was around 100 meters and immersion of the trawl varied from 60 to 100 m.

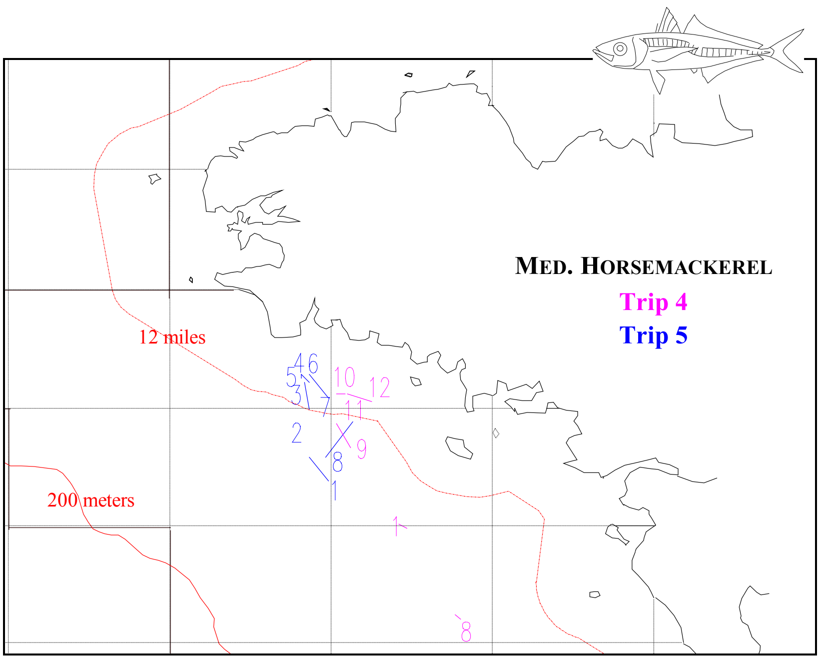


Figure 29 : Location of the observed tows of the two trips targeting Med. horsemackerel.

5.1.2.3 Duration of the observed tows

Tows occurred both night and day. The mean duration of sampled tows was 6 hours, but it varied from 4 to 8 hours. The distribution of the durations is shown in Figure 30. The sampled tows appear to be slightly longer than the duration for all the tows.

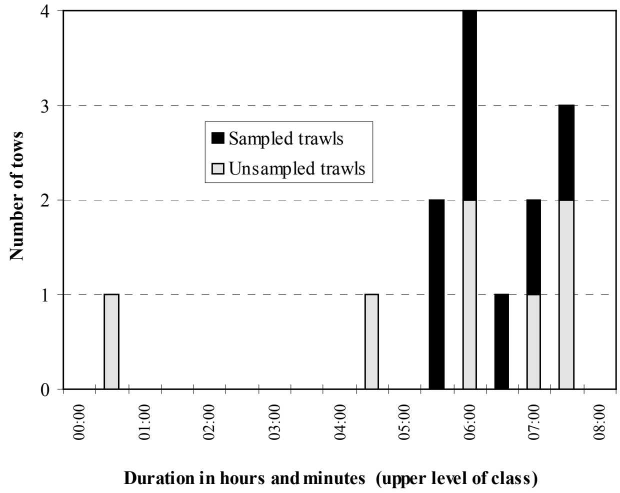
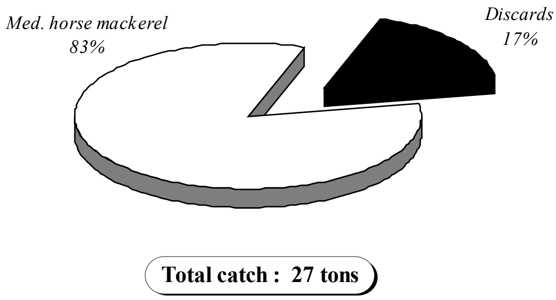


Figure 30 : *Frequency distribution of the duration of horsemackerel tows (total number of tows=21).*

5.1.3 Catch, by-catch and discards of fish

5.1.3.1 Catch composition in the sample

5.1.3.1.1 Global composition (target, by-catch, discards)



Horsemackerel, the targeted species, accounted for **83 %** by weight of the 27 tons of fish caught in the sampled tows (Figure 31). There were no non-target species in the landings. The proportion of **discards** was **17 %** of the total catch. The diversity in the catches was very low.

Figure 31 : Composition of the catch in the sampled tows (% by weight).

5.1.3.1.2 Variability between tows

The weight of landed and discarded fish in each sampled tow is shown in Figure 32. With the exception of the first tow, each sampled trawl caught horsemackerel. The horsemackerel landings varied from less than 1 ton to 7 tons. For most of the sampled tows, discards were less than 500 kg. No sampled tow was observed to be completely discarded. Discarding in tow 4-12 appeared was due to gear failure.
Concerning the catch diversity, **the variability between tows was not high**.

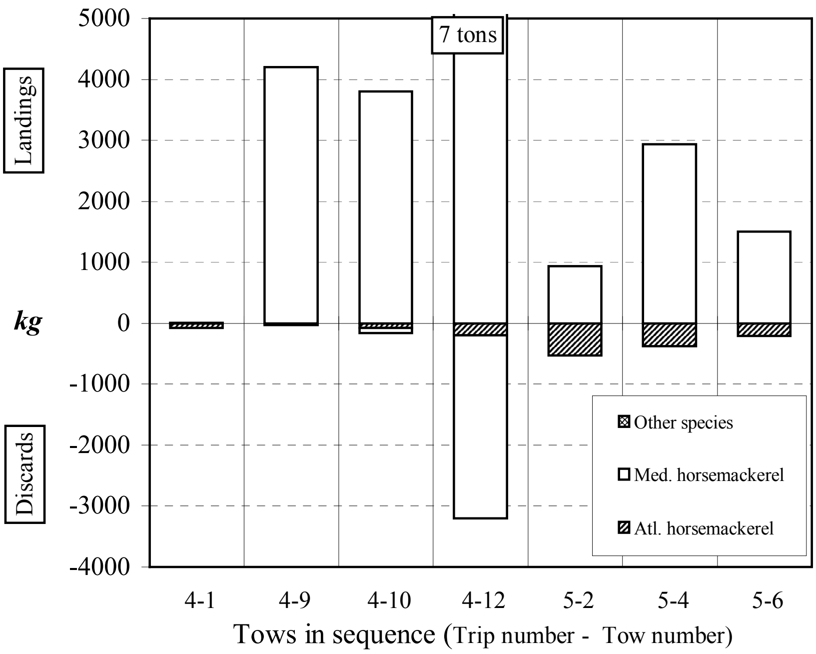


Figure 32 : Landed and discarded fish (kg) in each sampled tow.

5.1.3.2 Discards (composition, rate and reason per species)

5.1.3.2.1 Discard composition

Discards included **Mediterranean** and **Atlantic horsemackerel** (Figure 33). Discarding of the Mediterranean species was only caused by gear failure. Atlantic horsemackerel appeared to be the most frequently discarded species for this fishery. No observation of marine mammal catch was recorded in the sampled fishery.

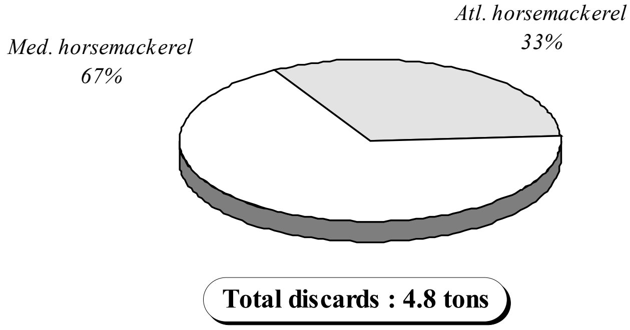


Figure 33 : Discard composition in the sampled tows

5.1.3.2.2 Variability in the discarding rate

Atlantic horsemackerel was totally rejected (discarding rate equal to 1) in each tow. The discarding rate for Med. horsemackerel did not exceed 0.3 and was often nil.

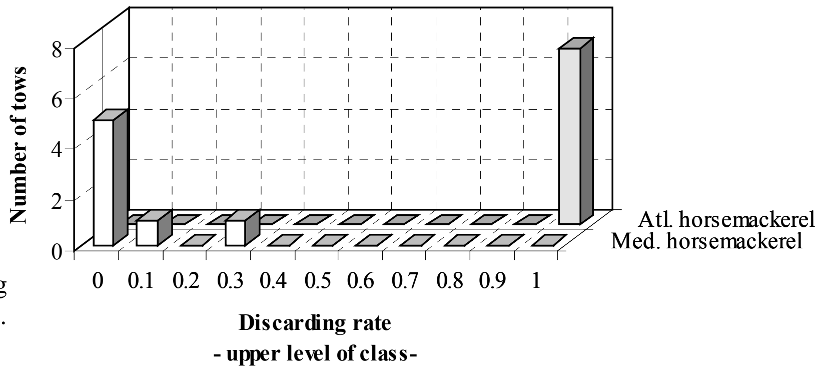


Figure 34 : Distribution of the discarding rate for the discarded species in the Med. horsemackerel trawl fishery.

5.1.3.2.3 Reasons for discarding

The reasons for discarding are shown in Figure 35. Most of the target species **Med. horsemackerel discards** were **unintentionnal** as they were lost during the hauling operations (codend damaged). Atlantic horsemackerel was discarded due to **highgrading**. It was the same for mackerel, but this species was very rare in the catches.

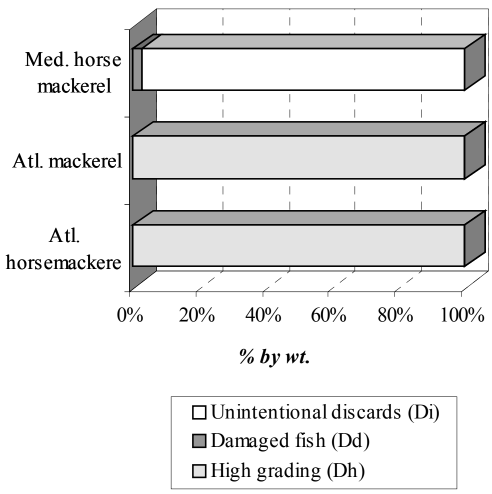


Figure 35 : Causes of discards in the sampled horsemackerel tows.

5.1.3.3 Size composition of horsemackerel

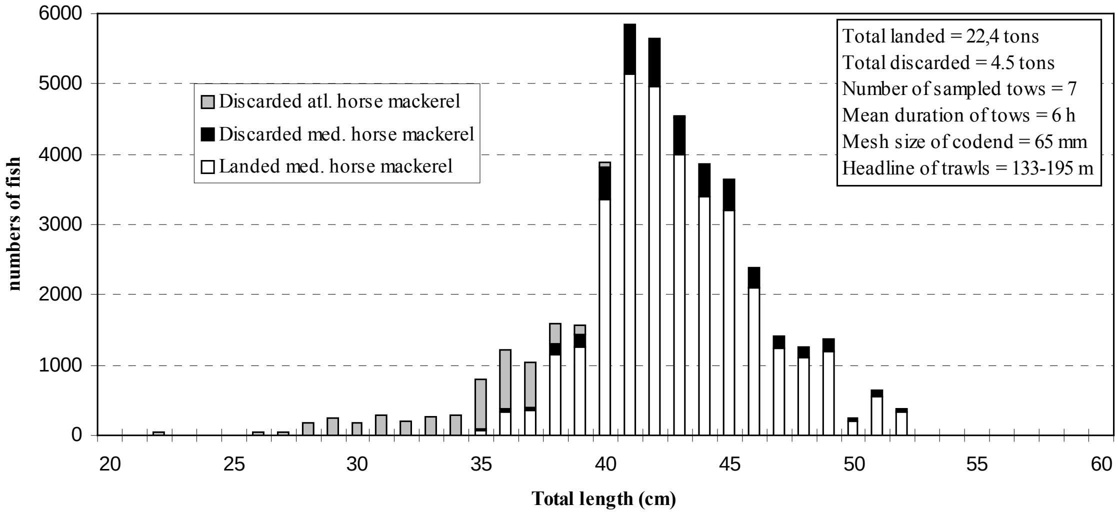


Figure 36 : Size composition of horsemackerel (Med. and Atl.) in the sampled tows.

The minimum legal size for horsemackerel is 15 cm. The Mediterranean horsemackerel was larger than the Atlantic species. The catches were of individuals longer than the MLS (Figure 36). The discards were of all the Atl. horsemackerel and of some of the Med. species across the whole size range.

5.1.4 Marine mammal by-catch

No marine mammal by-catch was recorded in the sampled tows but the period of sampling was very short.

5.2 DISCUSSION

5.2.1 Critique of the sampling effort and reliability of the results

5.2.1.1 Assessment of the sampling rate for this fishery

The mean of these two sampling rates gives an estimate of 0.35 % for the sampling rate.

	In the sampling	For the fishery (1994)	Sampling rate
Landings of horsemackerel (in hours)	22.4	3 235	0.69 %
Fishing time (in tons)	18	114 124	0.02 %

5.2.1.2 Intervals of confidence

The intervals of confidence for the discarding rate and the rate of the targeted species in the catches were as follows.

	Ratio estimation	**Interval of confidence (95%)**	
		lower limit	upper limit
Rate of target by weight	83.0%	71.6%	94.4%
Discarding rate by weight	17.0%	5.5%	28.4%

The variability in the catch between tows was observed to be low. This is the reason why the interval of confidence appeared to be narrow and the accuracy of the results pretty good.

The discarding rate was included between 5.5 % and 28.4 %, the rate of horsemackerel in the catches was near 83 % (between 71.6% and 94.4%).

5.2.2 Selectivity of the fishery

5.2.2.1 Species selectivity

Diversity of the catch appeared to be very poor. The species selectivity of this fishery seemed very good. The targeted landings amounted to 83 % of the total catch. And the by-catch was made up of only one species, the Alt. horsemackerel, which was completely discarded.

5.2.2.2 Intraspecific selectivity

Discarding of the target species was of individuals of any size. This discarding was unintentional : catch were lost during hauling. Apart from this problem, all the caught Med. horsemackerel were landed. So the intraspecific selectivity appeared to be very accurate.

5.2.3 Factors determining the by-catch and discards

Med. and Atl. horsemackerel were often in the same shoal. This is why Alt. horsemackerel is the main by-catch for this fishery. It would be impossible to avoid this by-catch. Gear failure when excess catch occurs can also be an unavoidable reason for discarding.

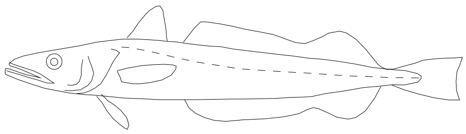
5.2.4 Interaction with marine mammals

No catch of marine mammals was observed during the sampled tows of 42 hours duration. But catches of marine mammals seem to be a scarce event, so a larger sample would bring us further information to give a more accurate estimate.

5.3 CONCLUSION

The sampling rate was not high in this fishery. But the variability in the catch between trips and within trips seemed to be low. This gave rise to quite reliable results.
In this fishery which ranked fifth in the French pelagic fisheries with a landing of 3200 tons of horsemackerel, the selectivity appeared to be really sensitive : the target species accounted for 83 % of the weight fish caught. The by-catch species was Atlantic horsemackerel, which was discarded : for one ton of landing of Mediterranean horsemackerel, only 70 kg of the Atlantic species were discarded by this pelagic activity.
Further investigations would be useful to confirm the efficiency of this fishery in terms of little waste.

6. BY-CATCH AND DISCARDING IN THE FRENCH HAKE TRAWL FISHERY : RESULTS AND DISCUSSION



6.1 RESULTS

6.1.1 Sampling effort

Seven pairs of pelagic boats were selected during this sampling and a total of seven trips were studied. The number of tows for each trip is given in Table 7. Four trips (numbers 3, 13, 14 and 16) out of seven trips used two gears (pelagic and otter trawl). Furthermore, trips « 8 » and « 9 » targeted successively hake and pilchard, and trip « 12 » separately targeted albacore or hake. In all, **314 hours** of towing were sampled.

Trip	Gear	Unsampled tows	Sampled tows
3	Pelagic	8	6
	Otter	4	3
8	Pelagic	0 (0)	1 (1)
9	Pelagic	1 (0)	0 (3)
12	Pelagic	2 (0)	10 (18)
13	Pelagic	3	13
	Otter	7	0
14	Pelagic	5	13
	Otter	19	0
16	Pelagic	1	9
	Otter	17	1

Table 7 : number of tows by trip.

6.1.2 Characteristics of the sampled tows

The 7 sampled vessels always worked in pairs. In order to catch hake, the trawl was generally towed close to the bottom, and sometimes it was used with a footrope. The stretched mesh size was more or less constant (65-70 mm) except for one tow (13-4) where the used trawl had a mesh size of 100 mm. The headline of trawl varied from 100 to 200 m in length, and the vertical aperture depended on the water depth of fishing, especially for the inshore trawling.

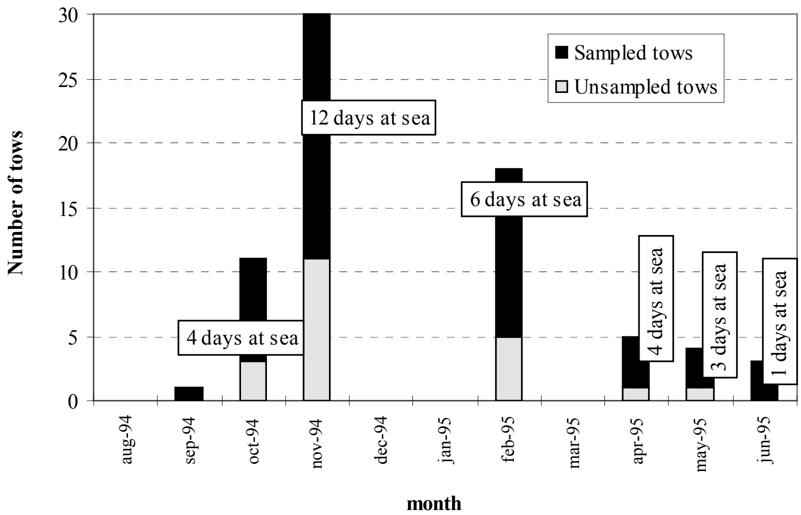


Figure 37 : Seasonality of sampling effort.

6.1.2.1 Period of observation

Six trips were observed, (one trip per boat) with a total duration of 30 days. (Figure 37). The observations were spread out over the whole year. A total of 52 tows were sampled out of 73 tows by the boats studied.

6.1.2.2 Duration of the observed tows

Most of the tows occurred **during the night** (because hake stayed close to the bottom during the day, and moved up during the night). **The mean duration of sampled tows was 6 h 30 mn**, ranging from 3 to 9 hours. The distribution of duration is shown in Figure 38.
The sampled tows had the same distribution of durations as the unsampled ones.

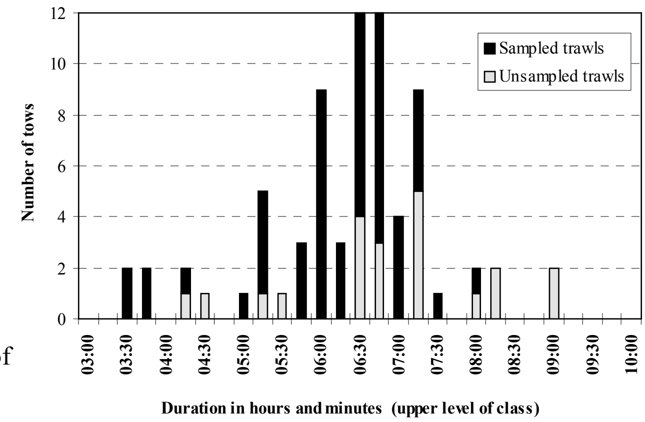


Figure 38 : Frequency distribution of the duration of hake tows (Total number of tows=73).

6.1.2.3 Location of observed tows

The observed tows were located in Subdivision VIII a and VIII b.

The fishing area of three sampled trips was near the shore (less than 20 miles). Whereas trip 14 and 16 covered another fishing area, further from the shore (more than 40 miles).

Near the shore, the water depth was less than 50 meters, and the trawl aperture covered the entire water column. In the second area, the water depth was greater and fishing methods were not the same. This difference may influence the composition and quantity of the catches.

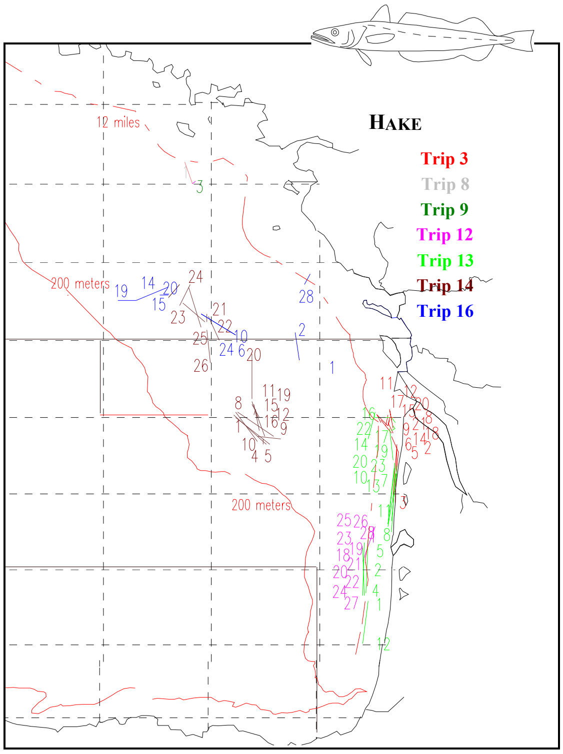


Figure 39 : Location of the observed tows for each trip targeting hake.

6.1.3 Catch, by-catch and discards of fish

6.1.3.1 Catch composition in the samples

6.1.3.1.1 Global composition (target, by-catch, discards)

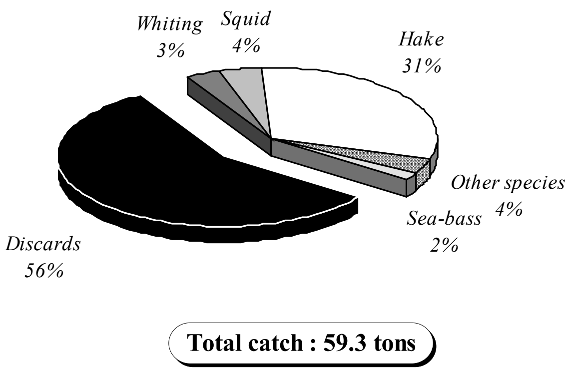


Figure 40 : Composition of catch in the sampled tows (% by weight).

Retained hake only accounted for 31 % by weight of the 59.3 tons of fish caught in the sampled tows (Figure 40). Squid and whiting were also secondary targeted species, because of their high commercial values. So the proportion of all targeted species accounted for 38 %. Another retained by-catch fish was sea bass (2%).

Discards accounted for 56 % of the total catch. This high percentage indicates low selectivity in fishing operations.

A lot of jellyfish (which were not included in this pie chart) were caught during trip 13.

6.1.3.1.2 Variability between tows

The weight of fish landed and discarded in each sampled tow is shown in Figure 41. Each sampled trawl caught **hake** and most caught whiting. **Landings varied from less than 100 kg to 900 kg**.

There were **no catches of whiting** during trip 14 and trip 16 (except for the two nearest tows from the shore). This observation is explainable because whiting is an inshore species which does not generally exceed an isobath of 100 m.

Discards were sometimes important. They varied from 0 kg to 8.7 tons but there was no completely discarded tow in our observations.

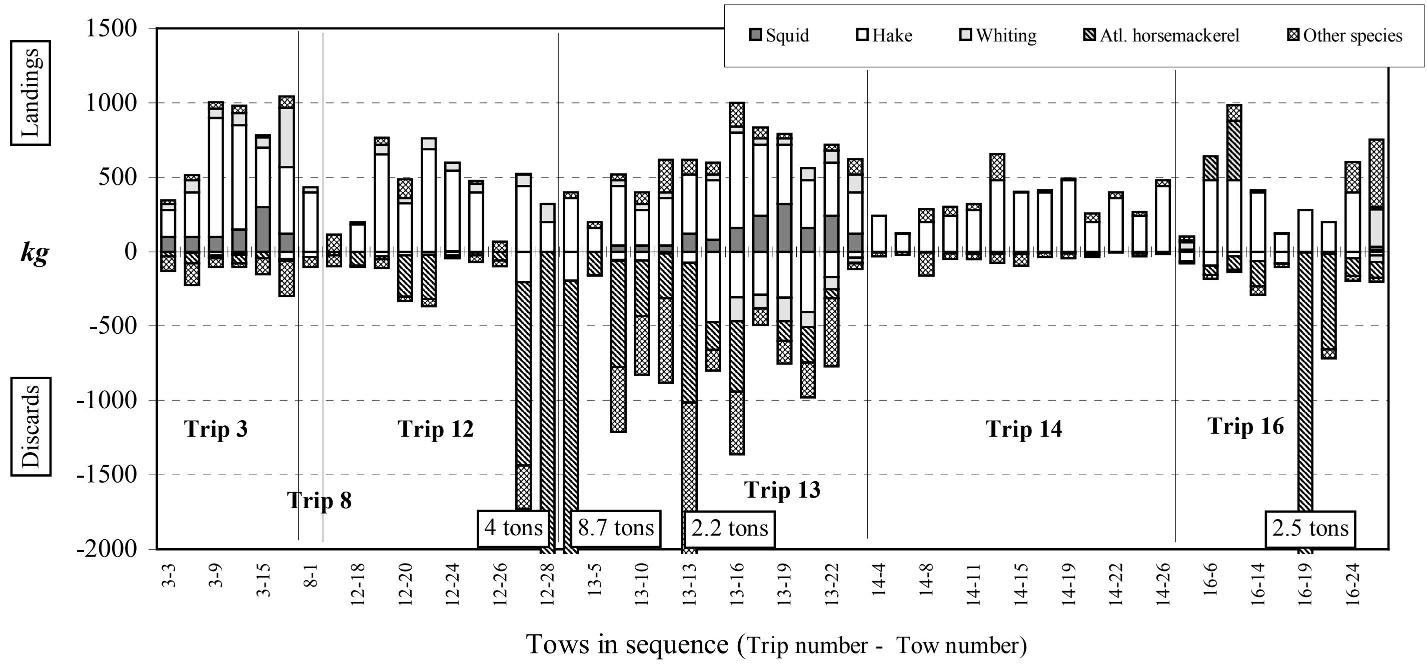


Figure 41 : Fish (kg) landed and discarded in each sampled tow.

Discards showed great differences between trips. During trip « 14 », discards were virtually nil. During trip « 13 », many discards were observed. Such a difference could be multifactorial :

- Seasonal variability (November for trip 13 / February for trip 14)
- Fishing areas (Inshore / Offshore)
- Fishing methods : distance between the trawl and the sea bottom, aperture of the trawl in relation to the height of the waterspout.

Discards of horsemackerel often occurred in great quantity because this fish generally shoals in high numbers . This is the reason why horsemackerel took a great place in the discards. This species was not present in the catches of trip 14. No explanation can be given for this. It is not a difference due to mesh size in use and it does not seem to be a seasonnal effect according to fishermen interviews.

6.1.3.2 Discards (composition, rate and reason per species)

6.1.3.2.1 Discard composition

Several species were discarded. However the main discarded species was Atlantic horsemackerel with 67% of weight. The other discarded species were hake (10%), pilchard (7%), Atlantic mackerel, sprat, whiting and Atlantic bonito (Figure 42). Hake trawling presented an unusually large number of species in the discards.

Four common dolphins (*Delphinus delphis*) were caught.

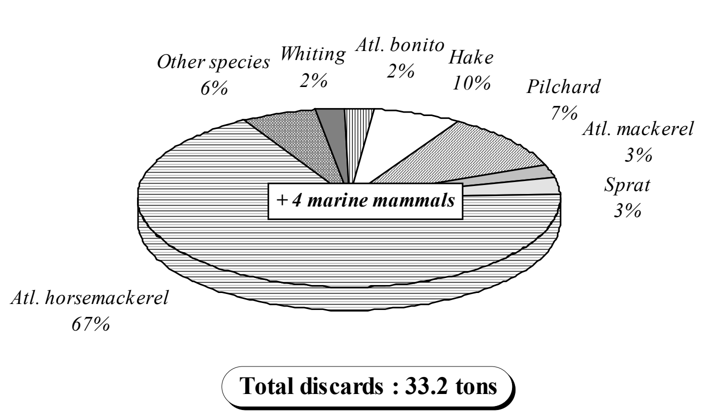


Figure 42 : Composition of discards in sampled tows

6.1.3.2.2 Variability of the discarding rate

For five species (horsemackerel, pilchard, mackerel, sprat, and bonito), the discarding rate was equal to 1 in most of the tows (Figure 43), but a part of these by-catches was sometimes landed.

For hake, there were many tows where the discarding rate was low (around 0.1). Some tows were found to have a discarding rate of nearly 0.5, and for one tow 90 % of hake catches were discarded (but in low quantities). Only 4 of the 52 sampled tows studied showed not discard at all.

For half of the tows, **whiting** catches were almost all landed, for the others the discarding rate varied from 0.2 to 1.

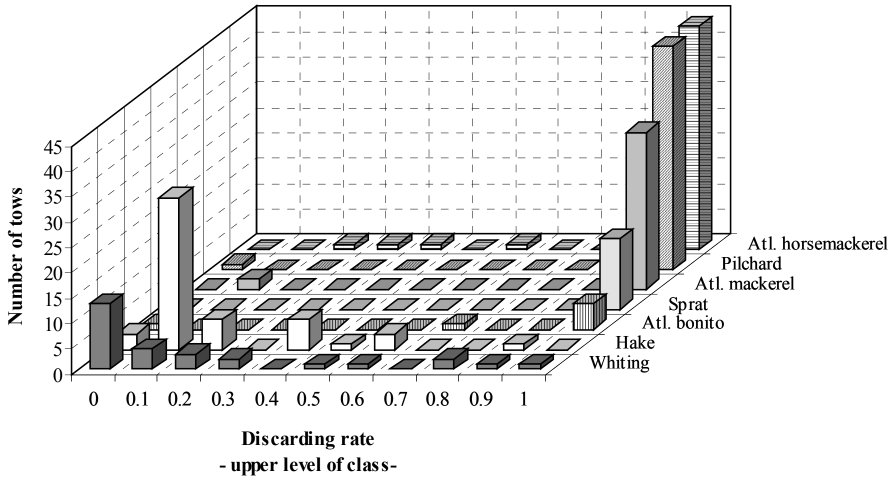


Figure 43 : Distribution of the discarding rate for the main discarded species in the hake trawling.

6.1.3.2.3 Reasons for discarding

Hake, whiting and black bream were mainly discarded because of **small size**. Partly damaged hake catches were also discarded.

Two **unmarketable** fish species appeared in the discards (sprat and poutassou).

Cuttlefish and Atl. horsemackerel were discarded partly because of their unmarketable sizes.

The other species were discarded mostly because numbers were too low to be profitably marketed.

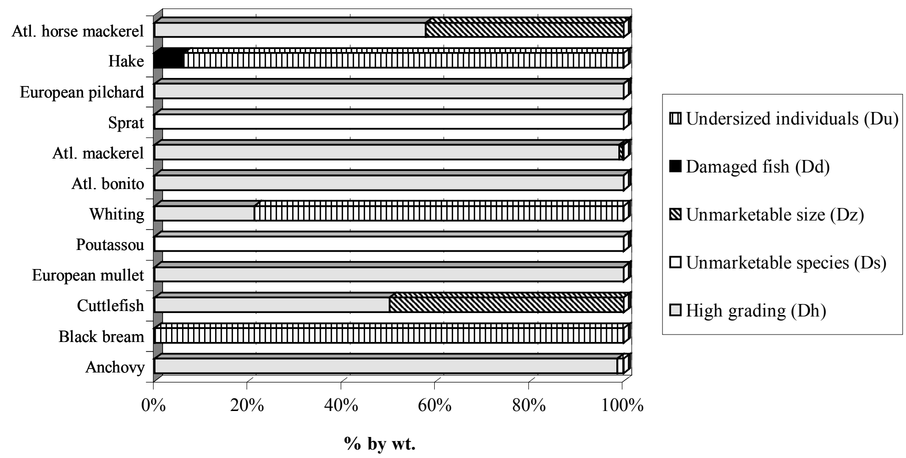


Figure 44 : Causes of discards in the sampled hake tows.

6.1.3.3 Size composition

6.1.3.3.1 Hake

The minimum legal size (MLS) for hake is 27 cm in Area 3 where this fishery was located. A great number of individuals lower than MLS were caught and some of them were landed (Spanish market) (Figure 45). These results show a poor size selectivity for the targeted species as almost half of the catches by number was discarded.

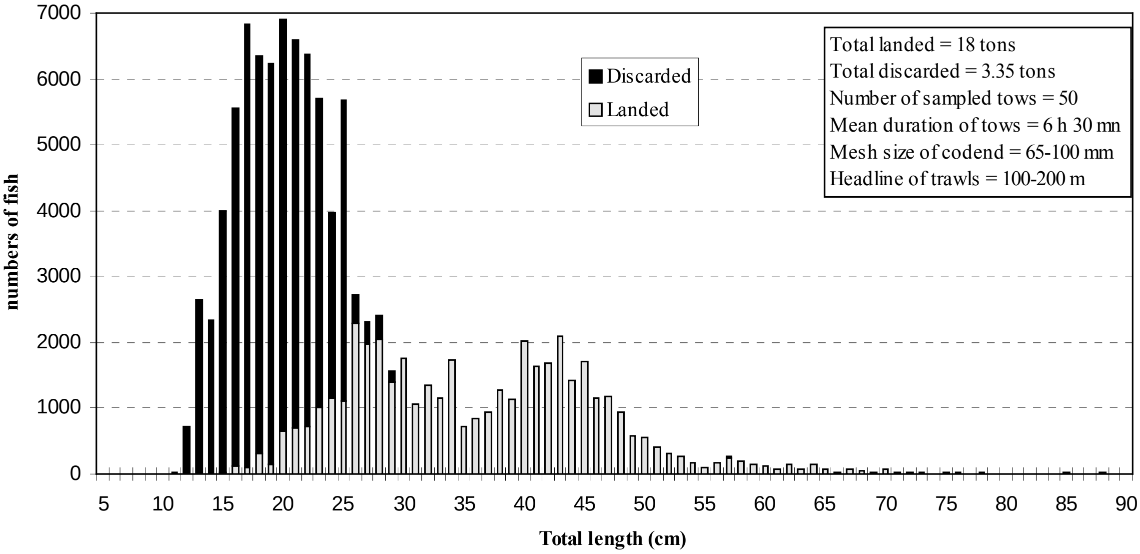


Figure 45 : Size composition of hake (target species).

A great part of the discarded hake came from trips 12 and 13. Trip 12 took place on the hake nursery opposite the « bassin d'Arcachon » (Guichet, unpublished). Tow of trip 13 were located on the « vasière de la Gironde » which was also a hake nursery. This explains the great quantity of undersized individuals.

Moreover, the males become pubescent at the length of 40 cm, the females at 57 cm (Quéro, 1984). Therefore a great part of hake catches was composed of immature individuals.

6.1.3.3.2 Whiting

The minimum legal size for whiting is 23 cm in the area concerned. Figure 46 shows the size

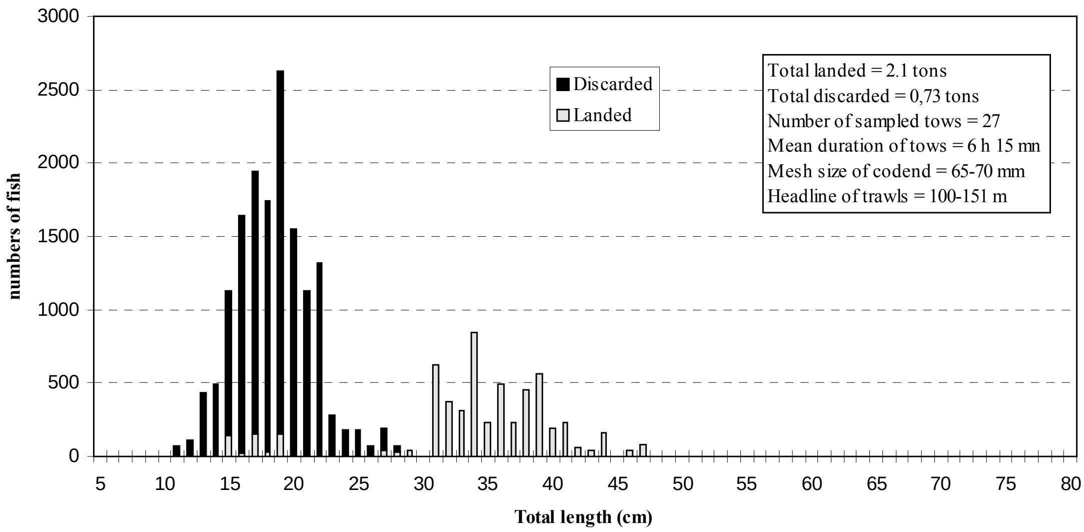


Figure 46 : Size composition of whiting (secondary target species).

composition of the observed catch. It appears that there is a lack of size selectivity for this by-catch species (which was sometimes targetted). A great part of these discards came from inshore trips as for hake, because whiting is an inshore species.
Whiting become pubescent at the length of 30 cm (Dardignac, 1984). Nearly all the whiting landings were above this size.

6.1.3.3.3 Horsemackerel

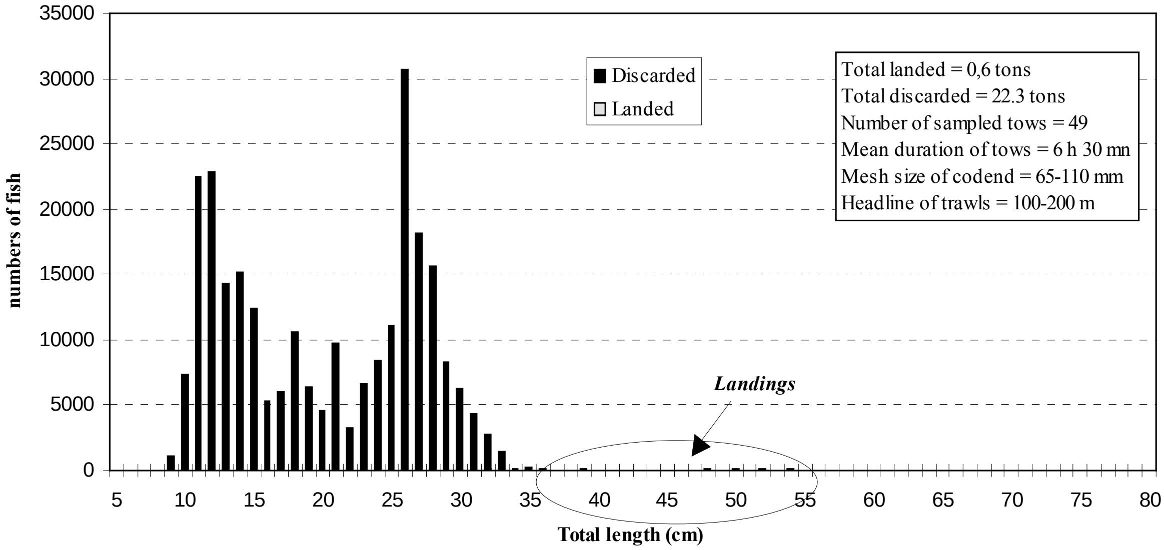


Figure 47 : Size composition of Atl. horsemackerel present in the samples of the hake trawling.

The minimum legal size is 15 cm for horsemackerel in this area. Only a few individuals greater than 35 cm were landed (Figure 47).

6.1.3.3.4 Pilchard

The minimum legal size for pilchard is 10 cm (Area 3). The catch was constituted of individuals of legal size. Most were discarded (Figure 48).

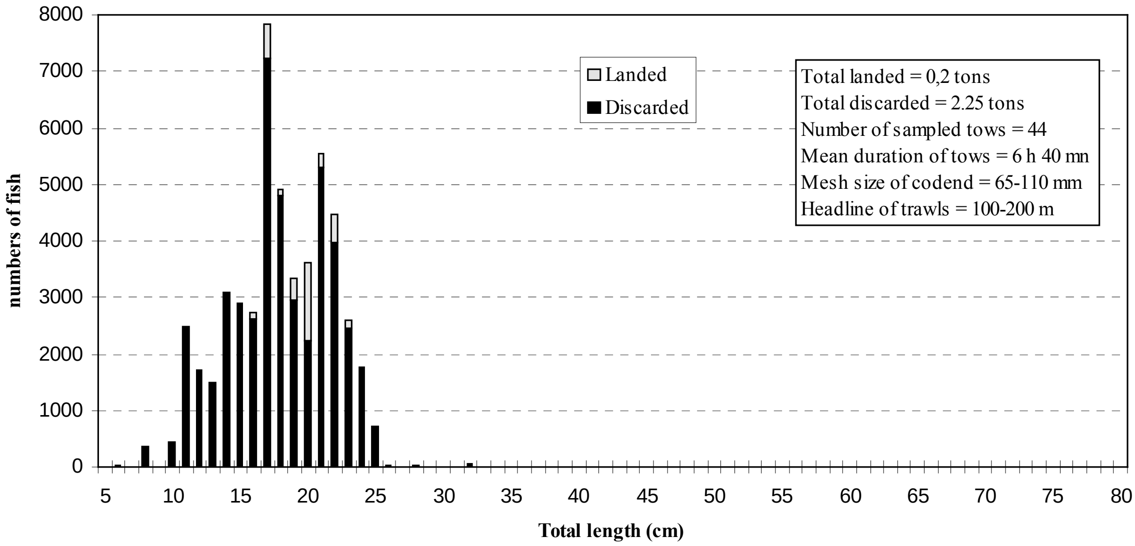


Figure 48 : Size composition of pilchard.

6.1.4 Marine mammal by-catch

Four common dolphins (*Delphinus delphis*) were recorded during this observation : one during trip 14, and three during trip 16 .

During trip 14 (tow 23), the main characteristics of the tow were as follows :

- the footrope of the trawl was located just above the sea bottom
- location depth : 100 meters
- trawl aperture height : 50 meters.

This dolphin was immediately discarded and so was taken into account.

During trip 16 (tow 1), the main charateristics of the tow were as follows :

- the footrope of the trawl was located at 1 meter above the sea bottom
- location depth : 60 meters
- trawl aperture height : 30 meters.

There were two females (203 and 197 cm long) and one male (180 cm long) in the same tow. Dead mammals were discarded without any attempt to make them sink.

6.2 DISCUSSION

6.2.1 Critique of the sampling effort and reliability of the results

6.2.1.1 Assessment of the sampling rate

The value of the sampling rate obtained with these two methods of calculation is quite similar. We used the mean (0.31 %) to calculate interval of confidence.

	In the sampling	For the fishery (1994)	Sampling rate
Landings of target species (hake+whiting)	18.4 + 1.78	3 310 + 1 507	0.42 %
Fishing time	314	155 791	0.20 %

6.2.1.2 Interval of confidence

The interval of confidence for the discarding rate and the rate of the targeted species are given in the following table :

	Ratio estimation	Interval of confidence (95%)	
		lower limit	upper limit
Rate of target by weight	30.2%	17.7%	42.6%
Discarding rate by weight	56.1%	38.0%	74.2%

The accuracy of assessment was near 20 % for the discarding rate and near 13 % for the rate of the target in the catches. This accuracy could be improved by increasing the number of sampled trips because great variability was observed between trips. Nevertheless, these results gave a good idea of the main characteristics of this fishery.

6.2.2 Selectivity of the fishery

6.2.2.1 Species selectivity

In this fishery there is an obvious lack of species selectivity. The landed main target accounted only for 31 % of the total catch. There were many species in the by-catch, and only a few were retained. Percentage of discards was high (56 % by weight). It is the highest discarding rate of all the pelagic trawl fisheries investigated.

6.2.2.2 Size selectivity

Discards contained a great quantity of undersized species (especially hake, whiting and Atl. horsemackerel). The intraspecific selectivity appeared to be very poor. The stretched mesh size could be increased. By using a data of selectivity given from bibliography (Dardignac and Verdelhan, 1978 ; Dahm, 1980 ; and Dardignac, 1984), the 25 percent retention length is equal to 26 cm for a mesh size of 80 mm, and 29 cm for a mesh size of 90 mm. Nevertheles these results may vary according to several factors especially the quantity of the catches in the trawl.

Mesh size (mm)	50	60	70	80	90	100	110
L50 (cm)	20 (19)	24 (23)	28 (26)	32 (30)	36 (34)	40 (38)	44 (41)
L25 (cm)	16 (16)	19 (19)	23 (22)	26 (26)	29 (29)	32 (32)	36 (35)
L75 (cm)	24 (22)	29 (26)	33 (30)	38 (35)	43 (39)	48 (43)	52 (47)

Figure 49: 50, 25, and 75 per cent retention length according to the mesh size (Selection Factor = 4 (Dardignac and Verdelhan, 1978 ; Dahm, 1980) and Selection Ratio = 0.385 (Dardignac and Verdelhan, 1978). The number into brackets is computed with a selection factor equal to 3.75 and a selection ratio equal to 0.3 (Dardignac, 1984).

The poor length selection observed in this fishery on hake is also due to the great quantity of unavoidable horsemackerel in the catches which has a negative effect on the selectivy. Some fishermen say they use a 100 mm mesh size to avoid the mackerel by-catch in some areas.

In order to avoid a catch of hake of year group 0 and 1 (which were discarded), the minimum mesh size needs to be increased to 90 mm (L25=29 cm). Moreover with this minimum mesh size, L25 for whiting became equal to 31 cm (Dardignac,1984). Whiting became pubescent from 30 cm and it appeared that they were landed from a size of 30 cm (Figure 46). So **a minimum mesh size of 90 mm** appeared to be beneficial to hake and whiting (the main by-catch of this fishery) by considering the data of selectivity.

6.2.3 Factors determining the by-catch and discards

6.2.3.1 Fishing method

Observed trips could be classified into two different groups. Trip 3, 12, and 13 which took place near the shore were distinguishable from trip 14 and 16 (offshore trawling). In the first group (inshore trawling), the water depth was not greater than 50 meters, so the aperture of the trawl was nearly

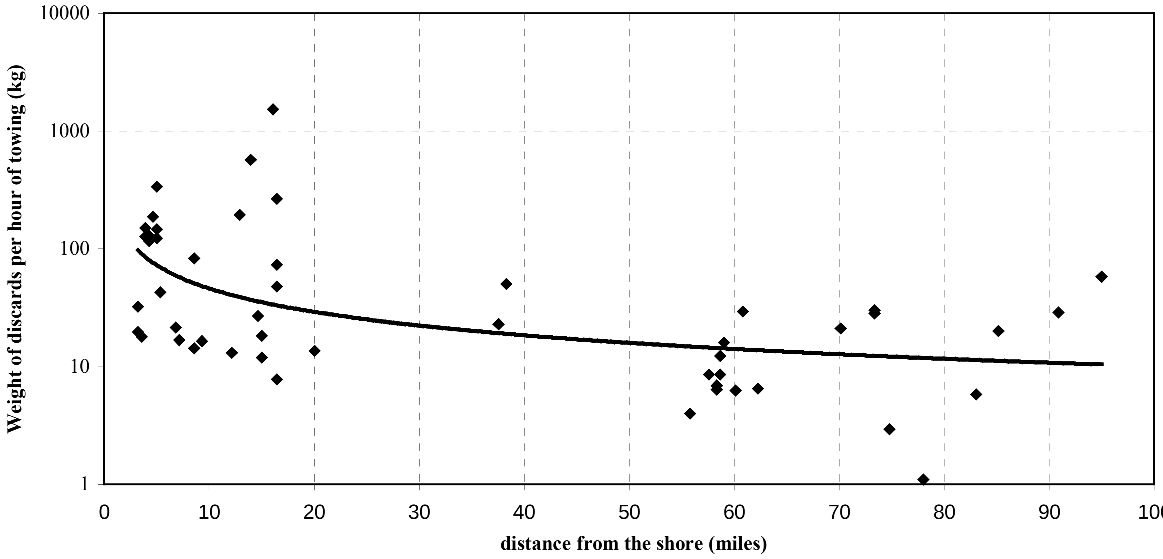


Figure 50 : Relationship between quantity of discards per hour of towing and the distance of tows from the shore.

equal to the height of the water column. In the second group (offshore trawling), the depth was greater. Discards (all merged species) seemed to be more higher in the first group (Trip 3, 12 and 13) than in the second (Trip 14 and 16). (Figure 50).
By-catch and discards seemed to be influenced by the fishing area and the fishing method (vertical aperture of the trawl and mesh size). According to fishermen interviews it seems that an appropriate mesh size of 100 mm avoids big bycatches of horsemackerel. Further investigation would be useful to check these points.

6.2.3.2 Fishing on nursery

For hake, some tows (Trip 12) were located on a well-known hake nursery (Guichet, 1996), and other tows were outside or at the boundary of this hake nursery (Trip 14). Figure 51 showed the great difference between the size composition of hake caught in the nursery and those caught outside the nursery. Outside the nursery, fish of year group 0 were not present in the catches, whereas fish of year group 4 were very well-represented. In the nursery, it was the opposite for the catches. In this case, fishing on nursery generated a lot of discards because of the poor-selectivity of the trawl.

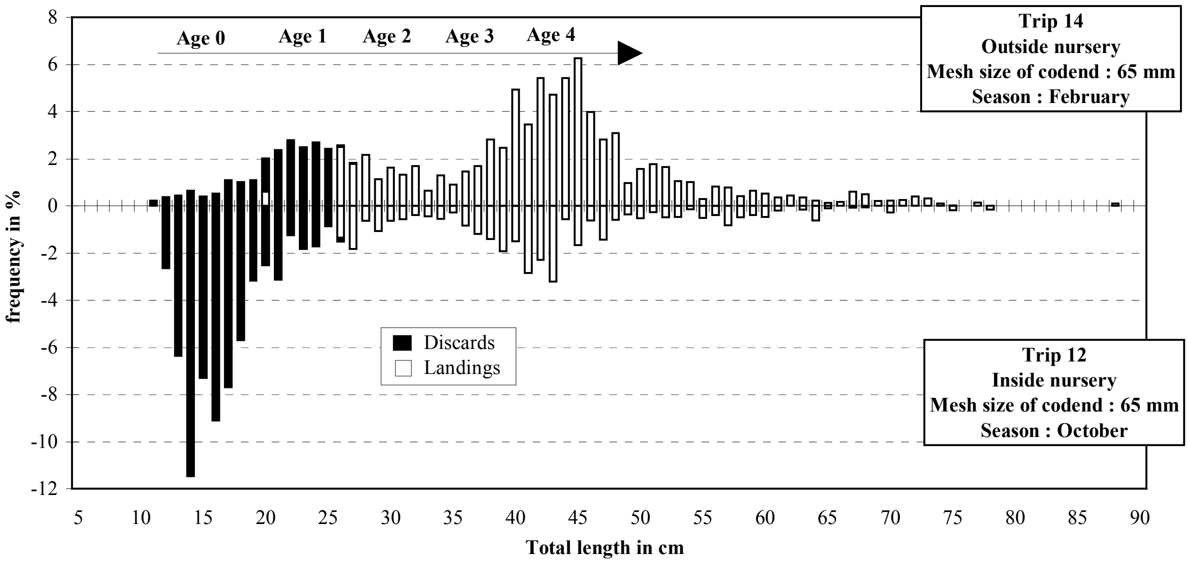


Figure 51 : Comparison between length frequencies of hake caught inside a nursery (Trip 12) and outside (Trip 14).

For whiting (the main by-catch of this fishery), it appeared that the offshore trips (14 and 16) did not catch whiting. Whiting is an inshore species, however present in the 12 mile area. Fishing in the offshore area would avoid whiting by-catch, but sometimes this species is mainly targeted.

6.2.4 Interaction with marine mammals

Two incidental catches of mammals were observed. A total of 4 common dolphins were caught in 315 trawling hours.

6.3 CONCLUSION

More than 300 hours of towing were sampled. A great variability appeared between and within trips. Further sampling (by area) would improve the accuracy of these results. Nevertheless, this study gives a good preliminary result and clears several points.

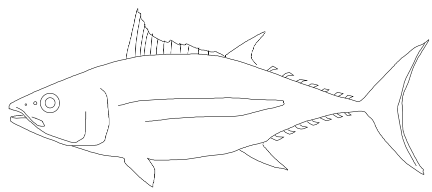
The species selectivity in this fishery was poor (only 31 % of landed hake, and more than 50 % of discards in the catches). The size selectivity was no better : more than half of the catches of hake by number was lower than MLS and was discarded.
For one landed ton of hake, the pelagic trawling discards more than 1 ton of Atlantic horsemackerel, and near 180 kg of hake. But it appeared variable between trips, and some trips produced less discards than others.

Those differences between trips demonstrated that :

- *a greater part of discards of hake would be avoided if trawlers did not fish in the nursery area or/and if the stretched mesh size were increased to 90 mm. Those regulations would be applied to the pelagic trawler for which hake exceeds 30 % by weight of the retained species.*
- *Inshore trawling seems to generate more discards than offshore (especially for whiting) ;*
- *Catch in great quantity of horsemackerel often appears and results in an increase of discarding. According to fishermen, an appropriate mesh size of 100 mm would allow to avoid these big catches.*
- *Trawling in a shallow area with a vertical aperture equal to the depth may increase discarding.*

With more than 3 000 tons landed in 1994, this pelagic trawl fishery exerts significant pressure on hake resources. But it represents the second pelagic fishery in terms of value. Further regulation must take this fact into account.

7. BY-CATCH AND DISCARDING IN THE FRENCH TUNA TRAWL FISHERY : RESULTS AND DISCUSSION



7.1 RESULTS

7.1.1 Sampling effort

Three pairs of boats were selected for this sampling and four trips were studied. The number of tows for each trip is given in Table 1. No different types of gear were used during these trips. Trip « 12 » targeted successive species : some tows targeted tuna and others targeted hake (the number of hake tows is indicated in brackets, Table 1). In all, **265 hours of towing** were sampled.

Trip	Gear	Unsampled tows	Sampled tows
1	Pelagic trawl	9	10
2	Pelagic trawl	14	8
11	Pelagic trawl	0	7
12	Pelagic trawl	0 (2)*	18 (10)*

Table 8 : Number of tows by trip.

7.1.2 Characteristics of the sampled tows

The three sampled boats always worked in pairs. The position and the duration of the tow varied according to several factors such as sounder detections, catches obtained with fishing lines during the day.... Tuna shoals were detected at the trawl entry by a netsond fixed to the headline of the trawl. The trawl was usually towed near the surface at a speed of 3.5-4.5 miles per hour. The stretched mesh size of the codend varied from 80 to 110 mm, the headline of trawl from 140 to 160 m in length.

7.1.2.1 Period of observation

Four trips were observed with a total duration of 50 days. These 4 trips occurred between August and October 1994 (Figure 52). This seasonal fishery usually begins in August and ends in November. During these observations, 43 out of 66 tows were sampled.

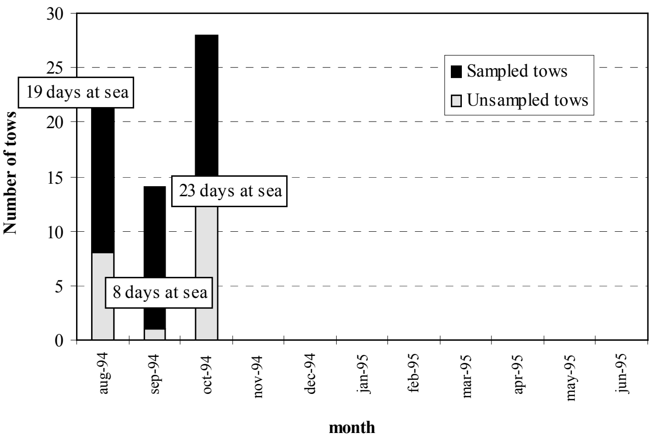


Figure 52 : Seasonality of sampling effort.

7.1.2.2 Duration of the observed tows

Tows occurred **during the night**. The mean duration of the sampled tows was **6 h 10 min**, but it varied from 2 to 12 hours. The distribution of the duration is shown in Figure 8. It appears that the duration of the sampled tows did not differ from the duration of the unsampled ones.

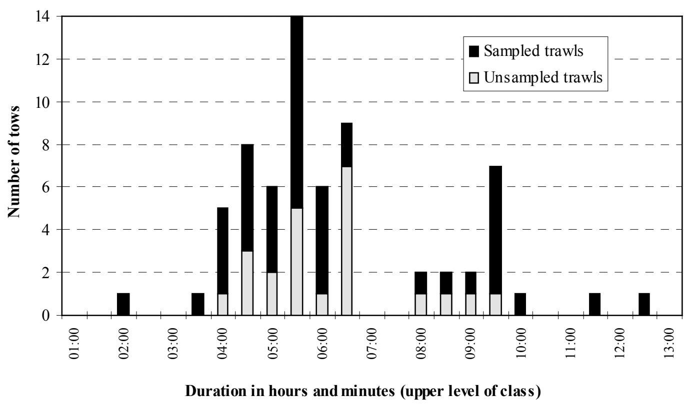


Figure 53 : Frequency distribution of the duration of tuna tows (total number of tows = 66).

7.1.2.3 Location of observed tows

A great part of the observed tows were located in the south part of the Bay of Biscay. The depth of this fishing area was above 200 meters

The fishing area of this pelagic fishery appeared to be very wide (some tows were very far from the shore (west of VIII d)).

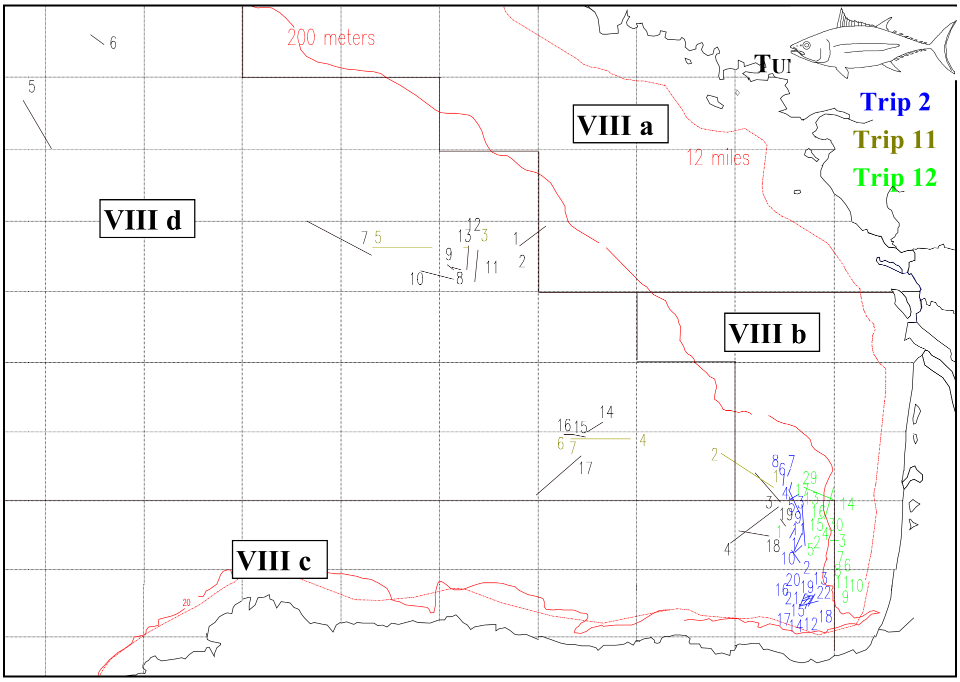
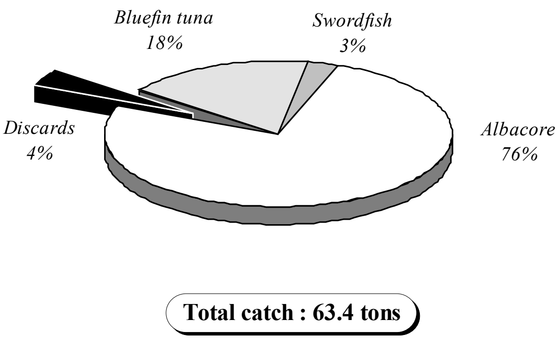


Figure 54: Location of observed tows in tuna trawl fishery (One colour per trip / the number of the tow is indicated near the location).

7.1.3 Catch, by-catch and discards of fish

7.1.3.1 Catch composition in the samples

7.1.3.1.1 Global composition (target, by-catch, discards)



The two targeted species, **albacore** and **bluefin tuna**, accounted for **93 %** by weight out of the 63.4 tons of fish caught in the sampled tows (Figure 55). The main non targeted species was swordfish (3%). The proportion of discards was found to be **very low** (4%) in this fishery.

Figure 55 : Composition of catch in the sampled tows (% by weight).

7.1.3.2 Variability between tows

The weight of landed and discarded fish in each sampled tow is shown in Figure 56. All the sampled tows contained albacore, but there was a high variability between hauls : **albacore** landings varied from less than 100 kg to 11 tons. **Bluefin tuna** was often caught with albacore. Their landings varied from 0 kg to more than 5 tons. **Swordfish**, the main non-targeted species, did not appear in each trip. For example there was no catch of swordfish in trip 2. This trip occured in October, near the shore, where this species is perhaps not present at this time (seasonal migration). Moreover in a trip, swordfish was not always seen.

For most of the sampled tows, discards occurred in low quantities (less than 100 kg). In some hauls, no discard was observed. The composition of discards in different tows turned out to be quite constant : **sunfish** was often caught and discarded.

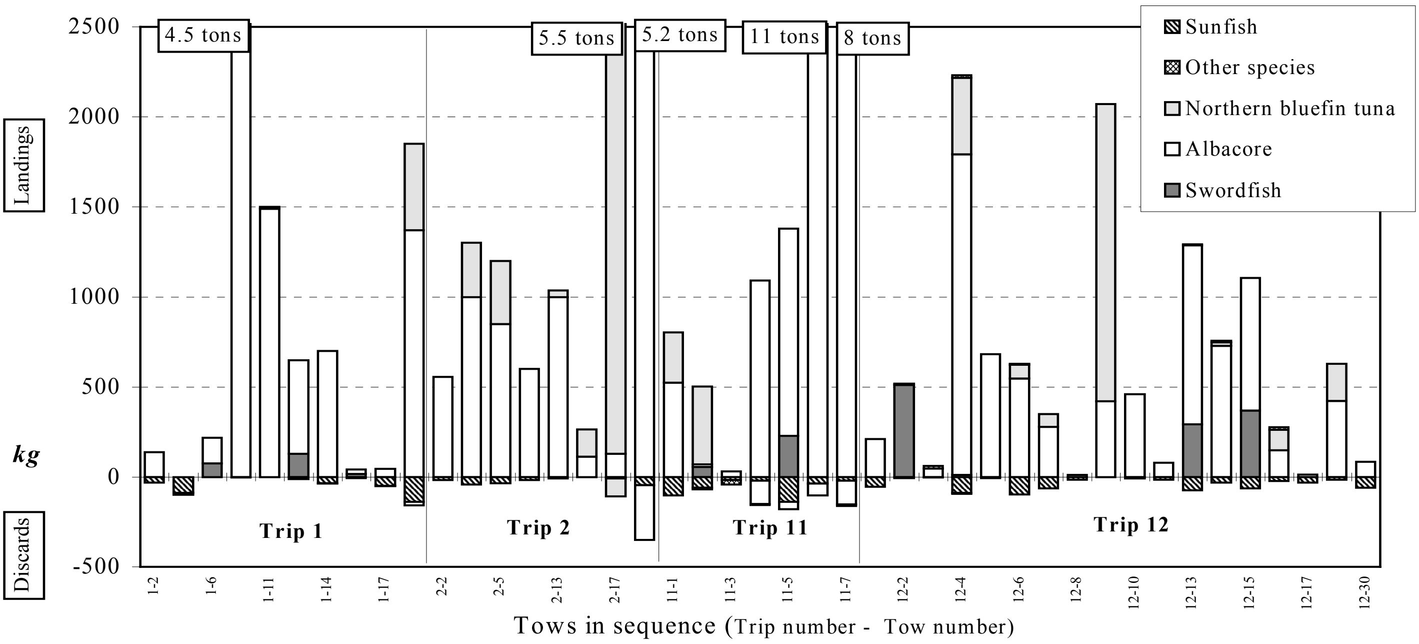


Figure 56 : Landed and discarded fish (kg) in each sampled.

Generally speaking, there was **no great variability**, but variability between tows on the same trip appeared to be higher than variability between trips.

7.1.3.3 Discards (composition, rate and reasons per species)

7.1.3.3.1 Discard composition

Generally speaking, **diversity** in tuna trawling discards appeared to be **low**.

Sunfish was the main discarded species. These fish were often alive when they were discarded. **Tuna** was sometimes discarded and represented **32 %** by weight in total. The other discarded species (less than 3 %) were blue shark and black fish (*Centrolophus niger*). No small species were found among the discards.

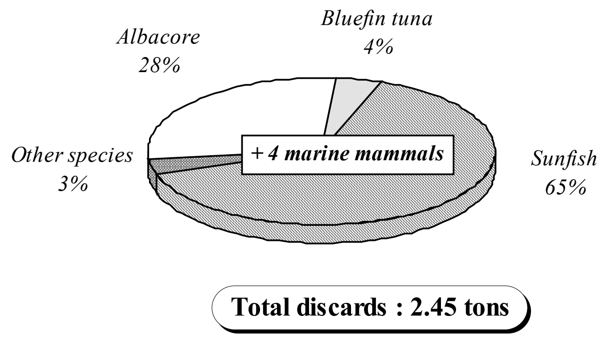


Figure 57 : Discard composition in the sampled tows

Four marine mammal catches were recorded in trip « 12 » during the 11th tow.

7.1.3.3.2 Variability in the discarding rate

The sunfish catch was totally discarded. When there were tuna discards in a tow, the discarding rate was never greater than 20%.

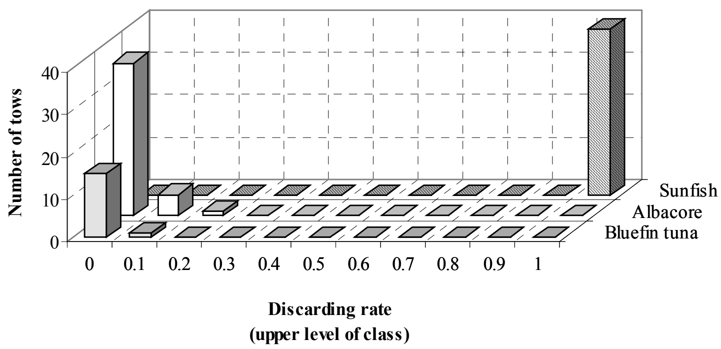


Figure 58 : Distribution of the discarding rate for the main discarded species in tuna trawling.

7.1.3.3.3 Reasons for discarding

The reasons for discarding are shown in Figure 59. **Tuna** were discarded because they were **damaged :** these damages occured when catches of one tow were very high (compressed fish).

Sunfish and the other species were discarded **for marketable reasons** : sunfish has no market value, the other species were of low market value.

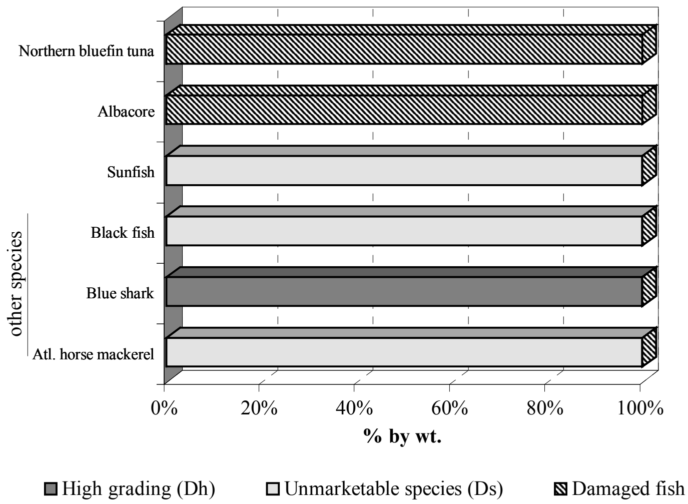


Figure 59 : Causes for discards in the sampled tuna tows for all the caught species.

7.1.3.4 Size composition

7.1.3.4.1 Albacore

There is no minimum landing size for albacore. The size composition was found to be between 53 and 90 cm (Figure 60), there were also some catches of bigger individuals (from 135 cm). The very low discarding rate was not related to size of individuals.

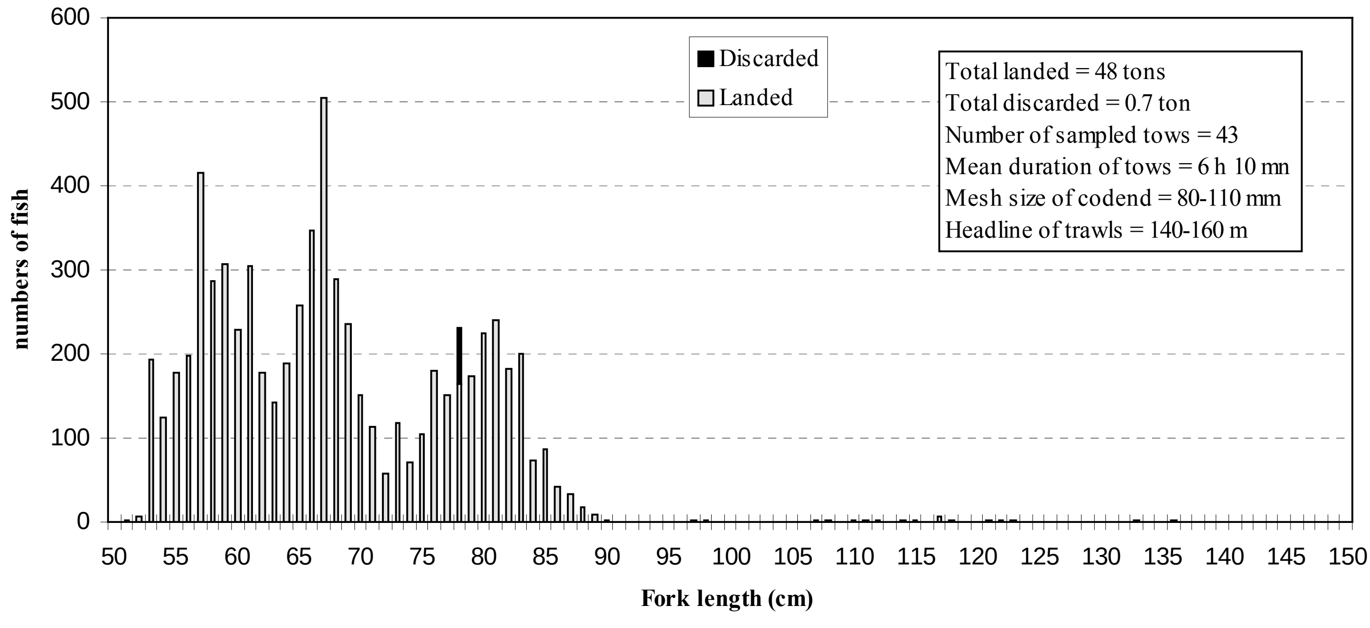


Figure 60 : Size composition of albacore.

A previous study on pelagic fishery (IFREMER-IEO, 1990) obtained a size composition close to this one. Pelagic trawlers caught albacore from 2 to 5 years old. So they targeted the same age fish (2 or 3 year old) than the other fisheries (drift net, troll, and bait boat), but they were able to catch big albacore (5 years old and more) like bait boats and unlike drift nets which only caught 2 or 3 year old fish (IFREMER-IEO, 1990; GOUJON et al., 1993). The absence of older albacore is due to the migration of this fish, which leaves the North Atlantic when it is 5 year old.

An albacore becomes pubescent at the age of six, so all the catch is composed of immature individuals.

This size composition was obtained from four trips between August and November. It appeared that there was a great difference between the size compositions of albacore fished at the beginning of the fishing season, and those fished at the end (Figure 61).

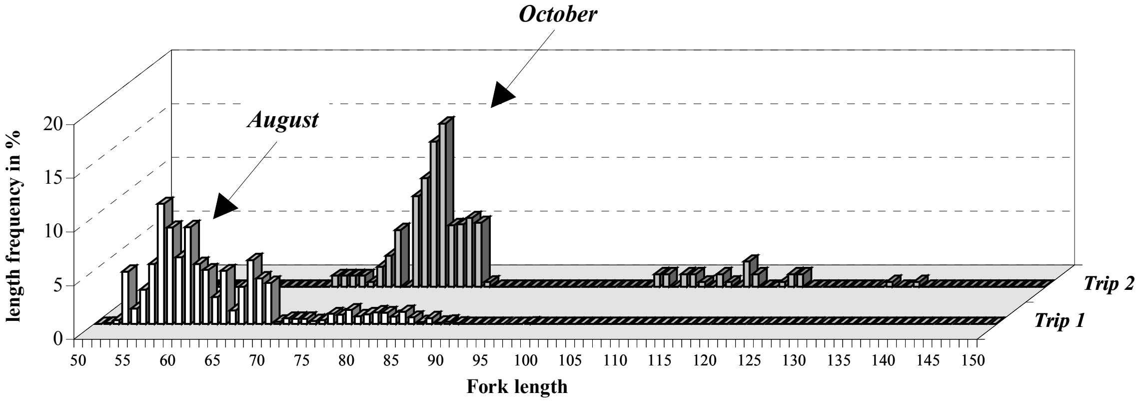


Figure 61 : Difference between length frequency compositions of albacore caught in the August (trip1) and in the October (trip2). These two trips took place in the same area.

7.1.3.4.2 Northern bluefin tuna

A recommendation for a minimum landing size (fork length) for bluefin tuna is around 70 cm (6,4 kg) according to the ICCAT regulation. Most bluefin tunas were found to be between 90 and 145 cm long (Figure 62). The low discarding rate appeared to affect the whole size composition.

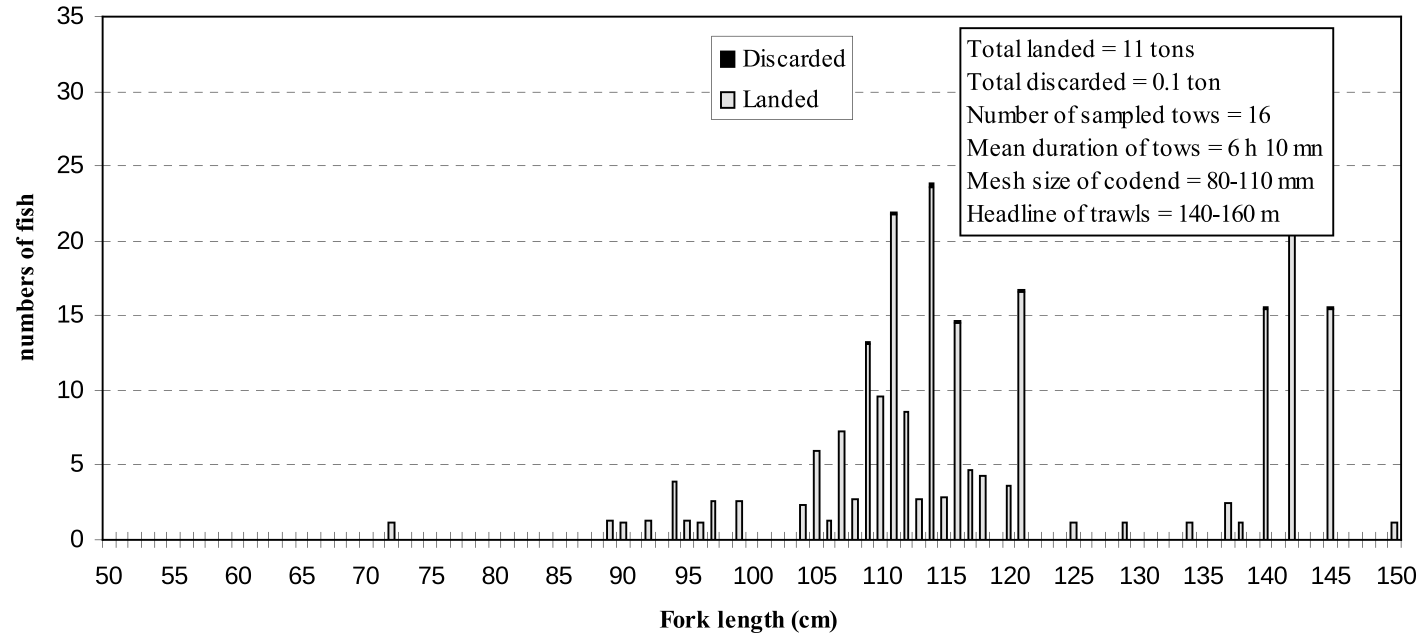


Figure 62 : Size composition of bluefin tuna.

7.1.3.4.3 Swordfish

The minimum landing size for swordfish is 125 cm (maxillar length) according to the ICCAT regulation. The fish caught during these trips varied from 99 cm to 320 cm. The mean was 198 cm. Only two individuals were lower than the minimum size.

In the tuna drift net fishery, during the Summer, the size of the catches varies from 70 cm to 245 cm (GOUJON et al., 1993). The pelagic fishery seems to catch bigger individuals, but there is a lack of data to confirm this observation.

7.1.3.4.4 Sunfish

The size composition of sunfish ranged between 30 and 75 cm. Most of the individuals were between 33 and 55 cm long (Figure 63). All the catches were discarded.

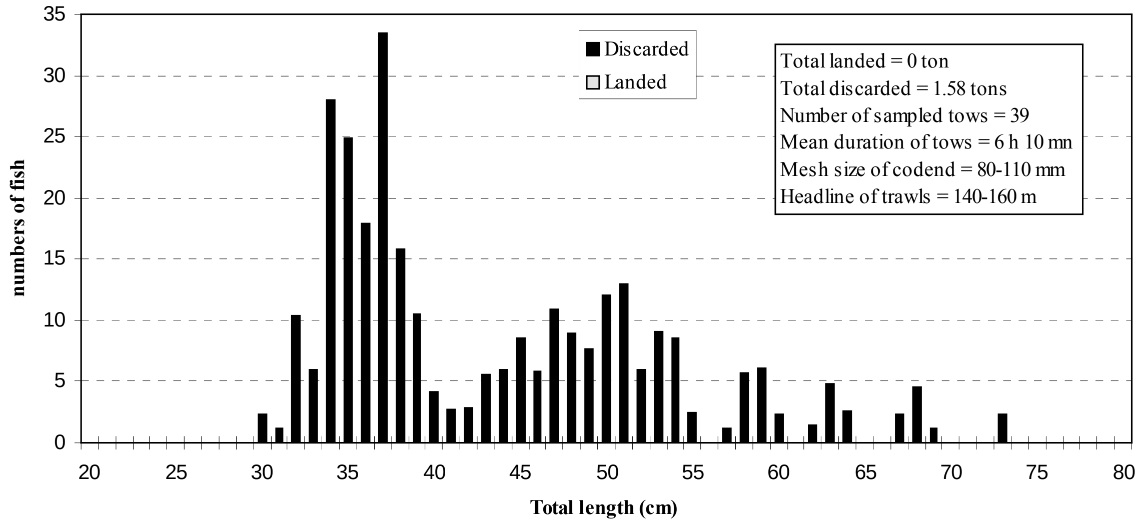


Figure 63: size composition of the main discarded species : sunfish (number of individuals = 299)

7.1.4 Marine mammal by-catch

Only one observation of marine mammal catch was recorded for the sampled pelagic tuna trawling. Four marine mammal catches were recorded on trip « 12 » in the same tow. There were three common dolphins (*Delphinus delphis*) and one bigger dolphin, probably a bottlenose dolphin (*Tursiops truncatus*). This happened during tow number 11. The main characteristics of this tow were as follows :

- It was at the end of September 1994.
- The fishing area was in the extreme south of the Bay of Biscay near the shore (in the 20 mile coastal zone ;
- The trawl was towed near the surface at a speed of 4 miles per hour during the night between '01.40 and 06.50';
- Technical characteristics of the trawl were as follows :
  - mesh size of codend :110 mm ;
  - headline : 130 m ;
  - aperture : 38 m.

7.2 DISCUSSION

7.2.1 Critique of the sampling effort and reliability of the results

265 hours of towing were sampled. In 1994, fishing time allocated to albacore and bluefin tuna by the French pelagic trawlers was high as 24 600 hours. The sampling rate was equal to 1.1 %. Considering the landings of albacore, this rate was likely to be the same (2 %). So one estimate of the sampling rate on this fishery can be the mean of these two values (1.16 %). This permits us to calculate the intervals of confidence for the discarding rate and the rate of the target species in the catches.

	Ratio estimation	Interval of confidence (95%)	
		lower limit	upper limit
Rate of target by weight	75.9%	58.5%	93.2%
Discarding rate by weight	3.9%	2.3%	5.5%

The accuracy of the discarding rate was very high (because of its low variability). So results were reliable.

7.2.2 Selectivity of the fishery

7.2.2.1 Species selectivity

The very low discarding rate (less than 5%) shows good species selectivity during the fishing operations. The few discards that occurred were mainly unmarketable sunfish. Furthermore, this species was often alive when it was discarded. It would be useful to know the survival rate of discarded sunfish.

Concerning landings, a great part is composed of albacore (mean 76 %), the rest is composed of bluefin tuna and sworfish (a lesser proportion).

7.2.2.2 Size selectivity

Pelagic trawlers targeted immature albacore from 2 to 5 years old. Pubescent individuals (6 years or over) are not present on this fishing area because of migration. At the beginning of the fishing season (August), pelagic trawlers caught 2 or 3 year old fish, and older fish by the end.

There was little discard due to small size, so size selectivity is good.

7.2.3 Factors determining by-catch and discards

By-catch in tuna trawling did not represent a great proportion in the catches. The main by-catch (bluefin tuna) was sometimes targeted. Swordfish was incidentally caught which could not be avoided.

Discards of target species were very low and only because of damaged fish. Lower duration of tow, and lower quantities of catch by tow would avoid the discarding of damaged fish.

7.2.4 Interaction with marine mammals

Four mammals were caught in 265 hours of towing in a tow of trip 12. The interaction with marine mammals does not seem to be very frequent.

Morever, catches of marine mammals seems to be scarce. More sampling data is needed to give a statistic on estimated marine mammal catches.

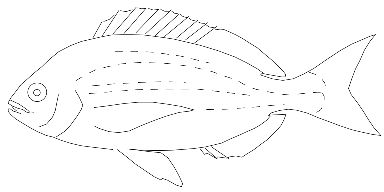
7.3 CONCLUSION

In this fishery, 260 hours of towing were sampled. Because of consistency in the catch, results seemed to be reliable.
Selectivity of this fishery appeared to be good : the discarding rate is approximately 4 %. There is no discard because of small size.
For one landed ton of albacore, a pelagic trawler discards 33 kg of sunfish, and 14 kg of albacore. Discards of sunfish seems to be unavoidable, but this species is often alive when it goes back into the sea. Discards of damaged albacore or bluefin tuna only occur when the catch in a tow is too great.

At the beginning of the fishing season (August) pelagic trawlers targeted fish of the same age (2 or 3 year old) as the other fisheries of surface (drift net, troll, and bait boat). But they were able to catch older individuals (4 and 5 year old) especially from the middle of the fishing season (October). This observation is relevant to studies of fleets interaction.

This seasonal fishery, which ranked third in value in 1994, appeared to be very selective through our sampling.

8. BY-CATCH AND DISCARDING IN THE FRENCH BLACK BREAM TRAWL FISHERY : RESULTS AND DISCUSSION



8.1 RESULTS

8.1.1 Sampling effort

Two pairs of boats were selected for this study, and one trip per pair was sampled. The number of tows for each trip is shown in Table 9. Only one gear was used per trip. The same species was always targeted during the trips. In all, **9 hours of towing** were sampled.

Trip	Gear	Unsampled tows	Sampled tows
7	Pelagic trawl	2	2
10	Pelagic trawl	0	1

Table 9 : Number of tows by trip.

8.1.2 Characteristics of the sampled tows

The two sampled boats worked always in pairs. To catch black bream, they worked in shallow areas and the footrope of the pelagic trawl was generally towed one meter above the bottom.

The stretched mesh size of the codend varied from 90 to 100 mm, the headline of the trawl from 119 to 134 m in length and the aperture between 15 and 18 m.

8.1.2.1 Period of observation

Two trips were observed (one per boat) with a total duration of 5 days (Figure 64). All the observations were made in May and June 1995.

During this period of time, 3 out of 5 tows were sampled.

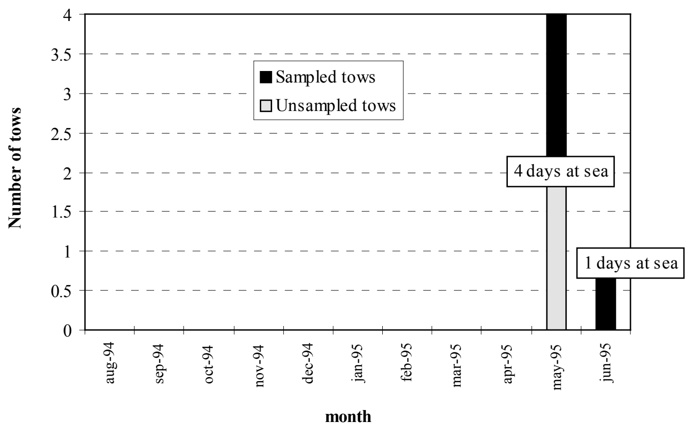


Figure 64 : Seasonality of sampling effort.

8.1.2.2 Location of observed tows

The observed tows were located in subdivision VII e. Most of the time, black bream trawlers worked in the Channel Islands area.

In this area, water depth varies from 20 to 35 meters.

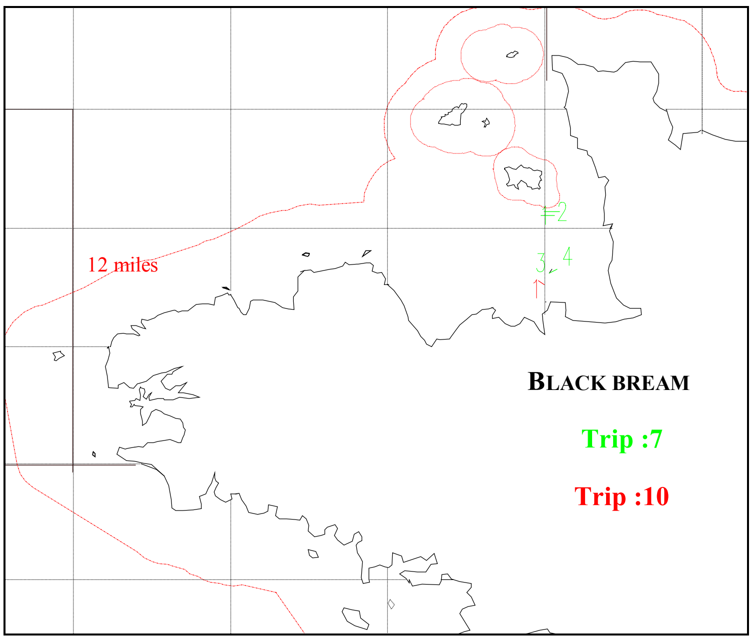


Figure 65 : Location of observed tows in tuna trawl fishery (One colour per trip / the number of the tow is indicated near the location).

8.1.2.3 Duration of the observed tows

Tows occurred **only during the night**. The mean duration of the sampled tows was **3 hours**, but it was found to vary from 1 to 7 hours. The distribution of tow durations is shown in Figure 66.

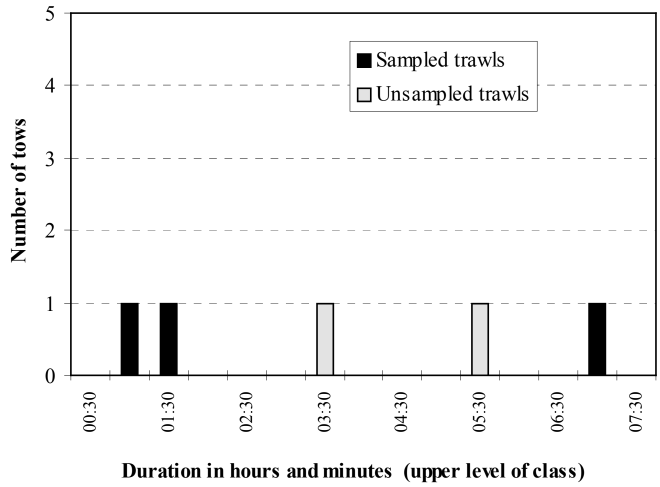
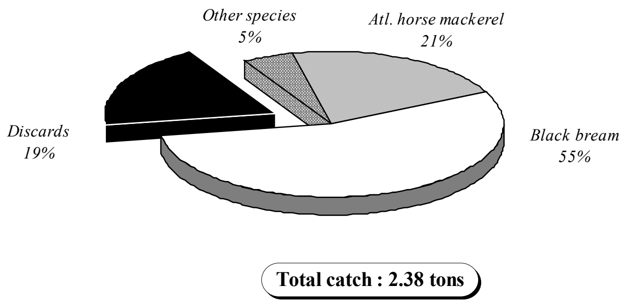


Figure 66 : Frequency distribution of the duration of black bream tows (total number of tows=5).

8.1.3 Catch, by-catch and discards of fish

8.1.3.1 Catch composition in the samples

8.1.3.1.1 Global composition (target, by-catch, discards)



Black bream, the target species, accounted for **55 %** by weight in the 2.38 tons of fish caught in the sampled tows (Figure 67). The main non targeted species was **Atlantic horsemackerel** (31%) : these species were landed as bait. The proportion of discards reached **19%** of the total catch.

Figure 67 : Composition of catch in the sampled tows (% by weight).

8.1.3.1.2 Variability between tows

The weight of landed and discarded fish in each sampled tow is shown in Figure 68. Each sampled trawl caught black bream. Black bream landings varied from 200 kg to 700 kg. No discard occurred in the second tow (7-3). A great diversity appeared in tow 10-1. The variability between tows and between trips seemed to be high. But the number of tows is too low to give an accurate impression of this variability.

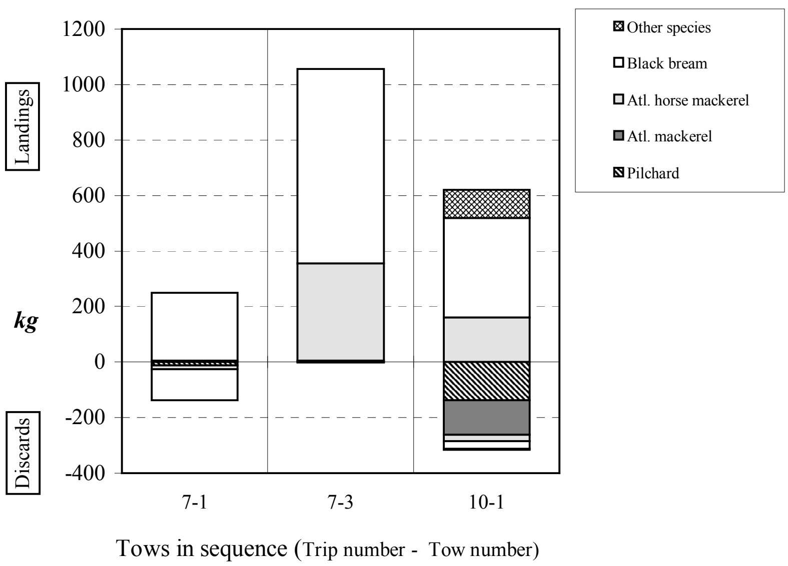


Figure 68 : Landed and discarded fish (kg) in each sampled tow.

8.1.3.2 Discards (composition, rate and reason per species)

8.1.3.2.1 Discard composition

The main discarded species were **black bream**, **pilchard and Atlantic mackerel** : these three species were represented in equal proportions in the discards (Figure 69). Atlantic horsemackerel was also found, but in smaller quantity (8%).
No marine mammal catch was recorded during these trips.

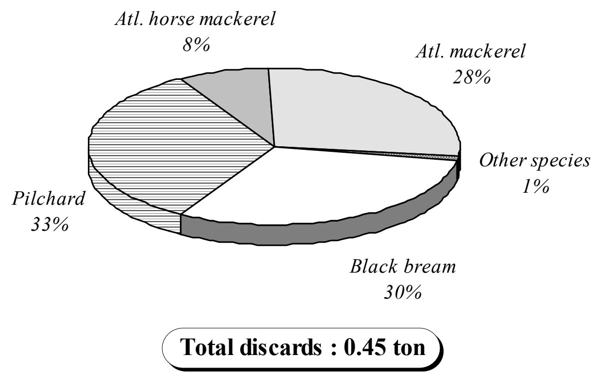


Figure 69 : Composition of discards in the sampled tows.

8.1.3.2.2 Variability in the discarding rate

The discarding rate per tow for black bream reached 40%. Atlantic mackerel and Atlantic horsemackerel were sometimes all landed, and sometimes all discarded. Pilchard caught in black bream tows was always discarded.

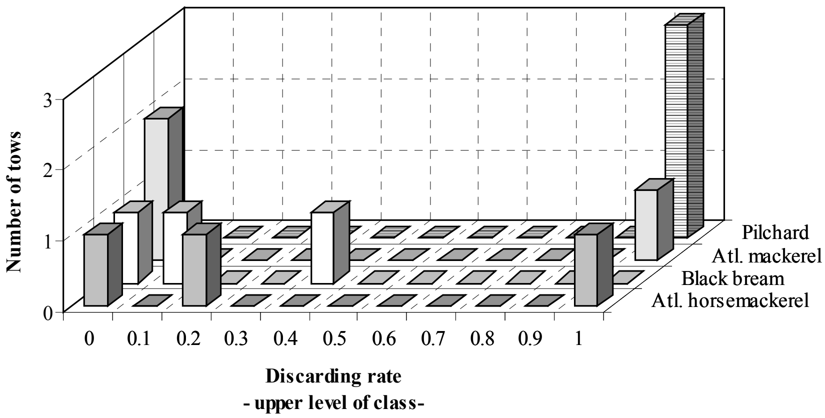


Figure 70 : Distribution of the discarding rate for the main discarded species in the black bream trawling.

8.1.3.2.3 Reasons for discarding

The reasons for discarding were shown in Figure 71. Most species were discarded because they were locally unmarketable. The black bream discards were either due to **damaged fish** or **undersized individuals**.

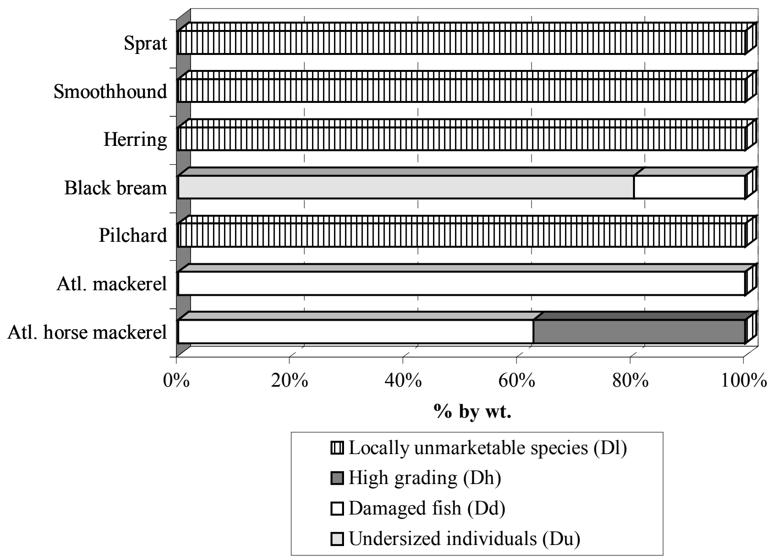


Figure 71 : Causes of discards in the sampled black bream tows.

8.1.3.3 Size composition

8.1.3.3.1 Black bream

The minimum landing size for black bream is 23 cm. Most bream were between 20 and 30 cm (Figure 72). A quarter of the individuals were below the MLS. These caugth small individuals were landed for bait. Target catches were sometimes damaged in the trawl by the horsemackerel bycatch.

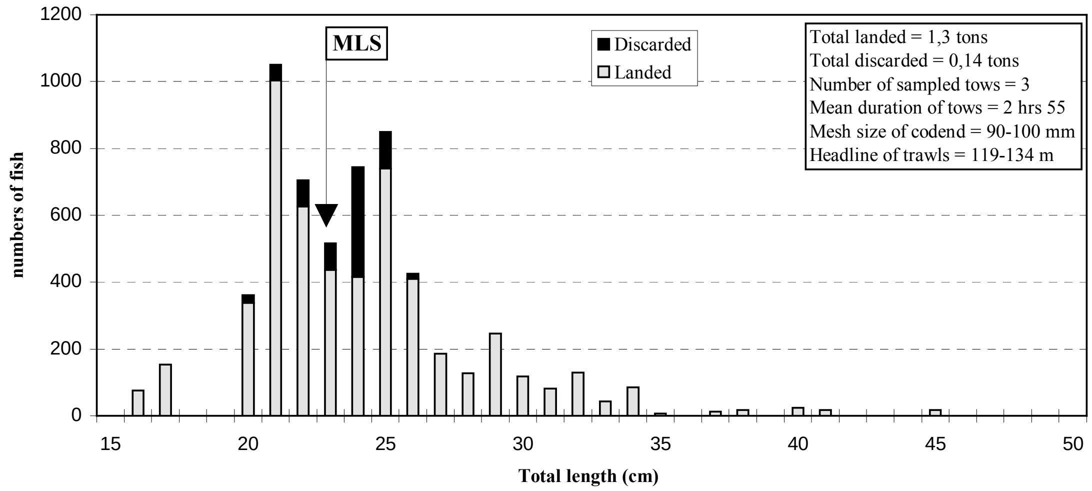


Figure 72 : Size composition of the sampled target species (black bream).

These results suggest that the gear was **not length selective enough** for the target species. Selectivity studies are needed in the fishery to determine the most appropriate mesh size. For the red seabream, factor selectivity is equal to 2.5 (DARDIGNAC, 1984). So the L50 is equal to 25 cm for a mesh size of 100 mm. A minimum mesh size of at least 100 mm could be applied.

Mesh size (mm)	50	60	70	80	90	100	110
L50 (cm)	13	15	18	20	23	25	28

8.1.3.3.2 Atlantic horsemackerel

The minimum landing size is 20 cm for horsemackerel. Discards occured for individuals below the MLS (Figure 73).

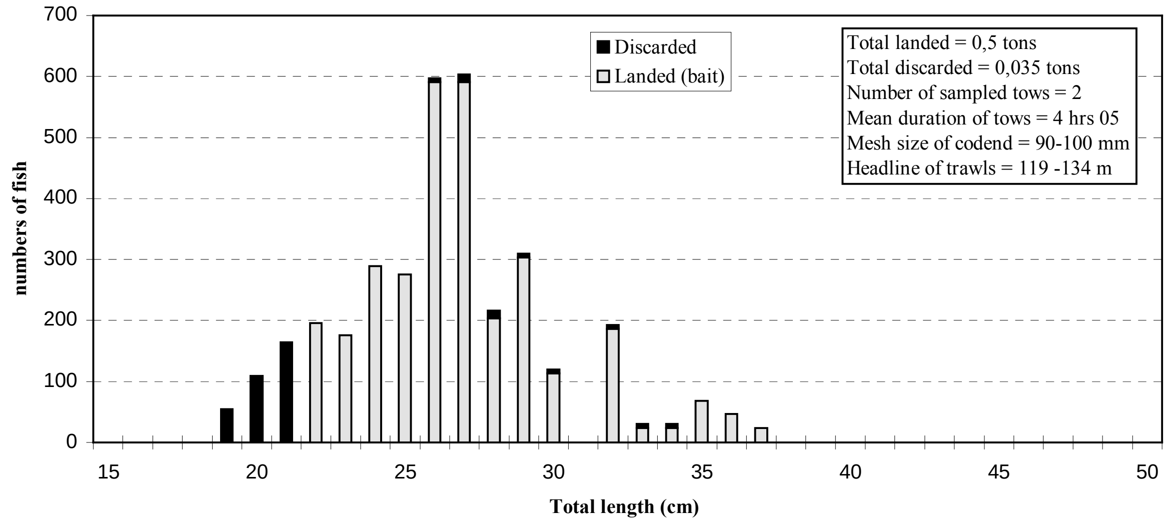


Figure 73 : Size composition of horsemackerel.

8.1.4 Marine mammal by-catch

None observed

8.2 DISCUSSION

8.2.1 Critique of the sampling effort and reliability of the results

8.2.1.1 Assessment of the sampling rate

One estimate of the sampling rate for this fishery can be the mean of this two value (0.1 %).

	In the sampling	For the fishery (1994)	Sampling rate
Landings of black bream (in tons)	1.3	691	0.19 %
Fishing time (in hours)	9	102 713	0.01 %

8.2.1.2 Interval of confidence

The intervals of confidence for the discarding rate and the rate of the targeted species are given in the following table :

	Ratio estimation	Interval of confidence (95%)	
		lower limit	upper limit
Rate of target by weight	54.9%	30.4%	79.3%
Discarding rate by weight	19.1%	0.0%	50.0%

This interval appeared to be very great. This is due to the lack of observation in our sampling, and the great variability between tows. An increased sample size would give a more accurate assessment.

8.2.2 Selectivity of the fishery

8.2.2.1 Species selectivity

Black bream, the target species, accounted only for **55 %** by weight. There seems to be a great diversity of species in some tows. The species selectivity seems to be poor. In this fishery, the fishermen worked in shallow areas and the footrope of the pelagic trawl was generally towed one meter above the bottom : this working method may explain the observed diversity in the catches.

8.2.2.2 Size selectivity

The targeted species represented 30 % of the discards by weight. The undersized individuals represented 40 % of the black bream catch in numbers. Half of the undersized individuals were landed for bait. Discards also occurred in the main by-catch of horsemackerel for size reasons. The size selectivity seems to be poor.

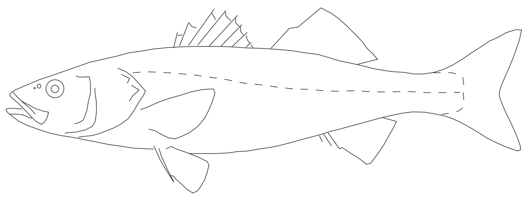
8.2.3 Interaction with marine mammals

No incidental catch of mammals was recorded during the 15 hours of towing.

8.3 CONCLUSION

Only 15 hours of towing were sampled. Even though the variablity appeared to be high and affected the reliability of the results.
This study however demonstrate the existence of a lack of selectivity for this fishery. Landed black bream accounted for 55 % by weight of the catch. For one ton of landed black bream, pelagic trawlers discard 110 kg of pilchard, 100 kg of black bream, and 100 kg of Atl. mackerel. 40 % by number of black bream were undersized.
The size selectivity of the gear could be improved by an increase in mesh size in this fishery. This measure may also improve the species selectivity. A minimum mesh size of at least 100 mm should be applied, when black bream exceeds 30 % by weight of the retained species. Further selectivity studies are required to define more appropriate mesh size.
Further investigation deserves to be carried out into this fishery, which landed 690 tons in 1994.

9. BY CATCH AND DISCARDING IN THE FRENCH SEA BASS TRAWL FISHERY : RESULTS AND DISCUSSION



9.1 RESULTS

9.1.1 Sampling effort

Two pairs of boats were selected and two trips were studied for this sampling. The number of tows for each trip was given in Table 10. Trip 4 targeted successive species : some of its tows targeted sea bass, and others targeted Mediterranean horsemackerel. (the number of horsemackerel tows is indicated in brackets, Table 1). In all, **73 hours of towing** were sampled.

Trip	Gear	Unsampled tows	Sampled tows
4	Pelagic	3 (2)	3 (4)
6	Pelagic	8	7

Table 10 : Number of tows by trip

9.1.2 Characteristics of the sampled tows

The two sampled ships worked always in pairs. To catch sea bass, they worked on spawning areas, where adults were concentrated. The trawl was generally towed under the surface (from 10m to 50 m depth).

The stretched mesh size of the codend varied from 65 (trip 4) to 85 mm(trip 6), the headline of trawl from 133 to 195 mm in length and the vertical aperture between 40 and 60 m.

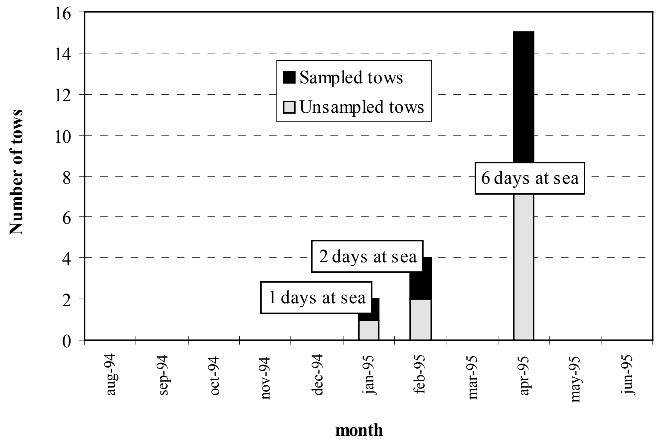
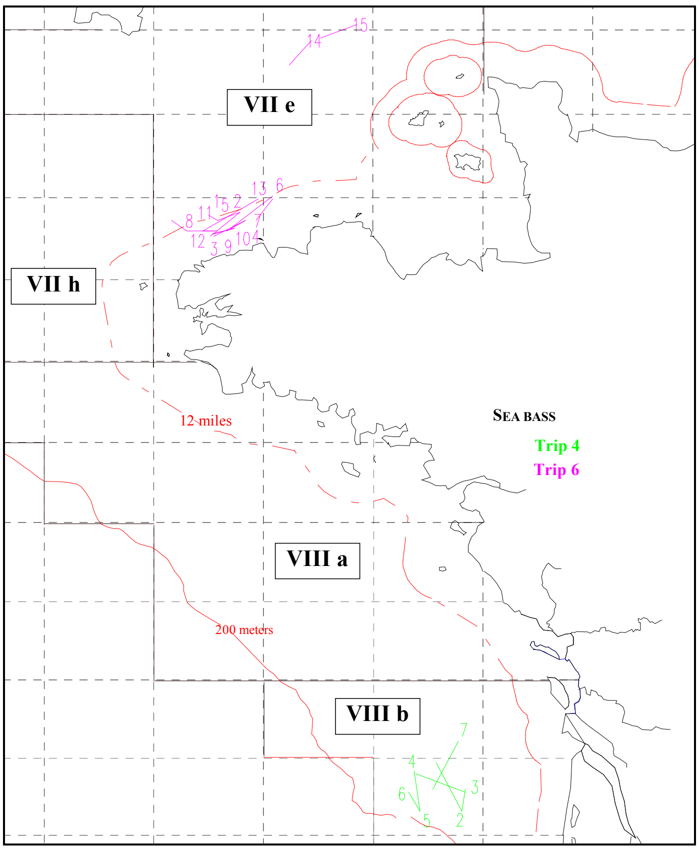


Figure 74 : Seasonality of sampling effort.

9.1.2.1 Period of observation

Two trips were observed (one per boat) with a total duration of 9 days. The first trip occurred in winter (January-February) and the second in April (Figure 74). January to April is the period of this seasonal fishery.

During this period, 10 tows over 21 tows were sampled.



9.1.2.2 Location of observed tows

Observed tows were located in Subdivision VII e and VIII b.

In Subdivision VII e, trawlers were not far from the shore. The water depth of this fishing area was near 100 meters.

Their location depended on several factors. But when a trawler caught sea bass in a fishing area, it informed the others by VHF.

Generally speaking, pelagic trawlers target sea-bass on spawning areas.

Figure 75 : Location of the observed tows.

9.1.2.3 Duration of the observed tows

Tows occurred during nights and days. The mean duration of the sampled tows was 7 hours 20 hanging from 6 to 9 hours. The distribution of durations is shown on Figure 76.

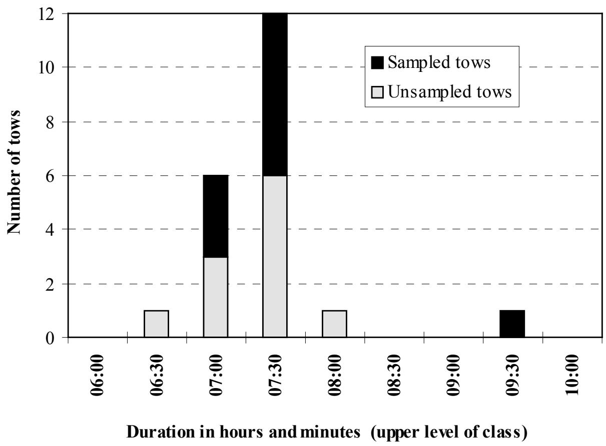
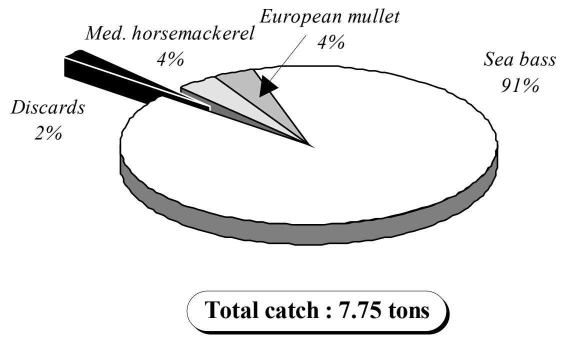


Figure 76 : Frequency distribution of the duration of sea bass tows (total number of tows=21).

9.1.3 Catch, by-catch and discards of fish

9.1.3.1 Catch composition in the sample

9.1.3.1.1 Global composition (target, by-catch, discards)



Sea bass, the target species, accounted for **90 %** by weight of the 7.75 tons of fish caught in the sampled tows (Figure 77). The main non target species were European mullet (4%) and Mediterranean horsemackerel (4%). The proportion of total **discards** was **very low** (2%).

Figure 77 : Composition of catch in sampled tows (% by weight).

9.1.3.1.2 Variability between tows

The tonnage of landed and discarded fish in each sampled tow is shown in Figure 78. Each sampled trawl caught sea bass. Sea bass landings varied from less than 50 kg to 5 tons. Non-target species (Med. horsemackerel and European mullet) did not appear in every tow. For most of the sampled tows, discards reached less than 10 kg. No sampled tow was wholely discarded. Landings of sea bass may vary in great proportion between tows. Variability between trips also seems to be important.

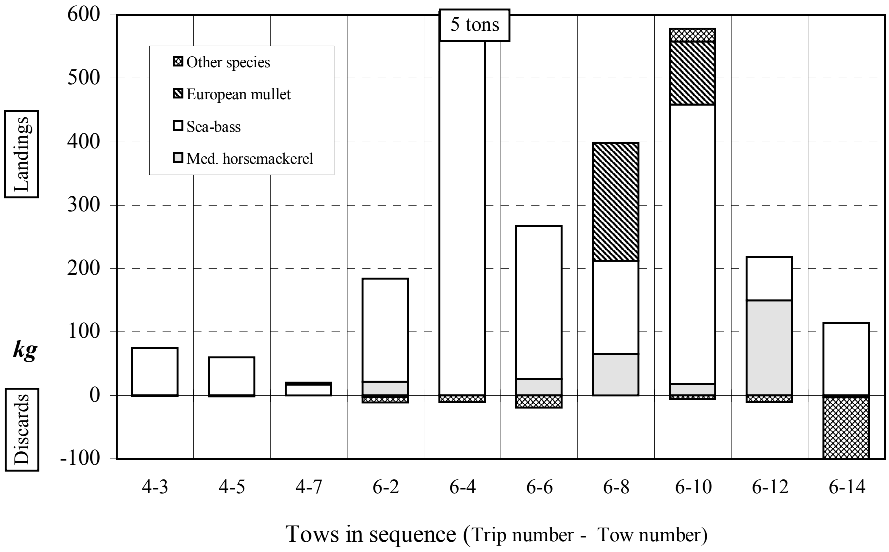


Figure 78 : Landed and discarded fish (kg) in each sampled tow.

9.1.3.2 Discards (composition, rate and reason per species)

9.1.3.2.1 Discard composition

Discards included Atlantic mackerel, European pilchard, lumpsucker, garfish and Atlantic herring (Figure 79). **Sea bass** was **nearly never discarded** in the sampled tows.
A marine mammal catch was recorded in tow « 4-3 ».

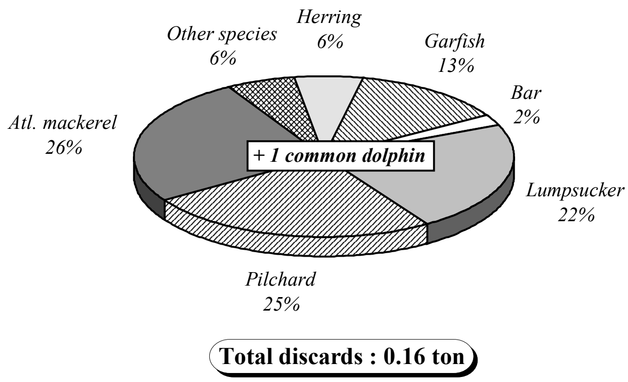


Figure 79 : Discard composition in sampled tows. *(this composition was only computed on 160 kg).*

9.1.3.2.2 Variability in the discarding rate

Most discarded species were totally rejected (discarding rate equal to 1), except for pilchard which was sometimes landed. The target species (sea bass) had a very low discarding rate due to the fact that fishing occurred on spawning grounds where adults were concentrated.

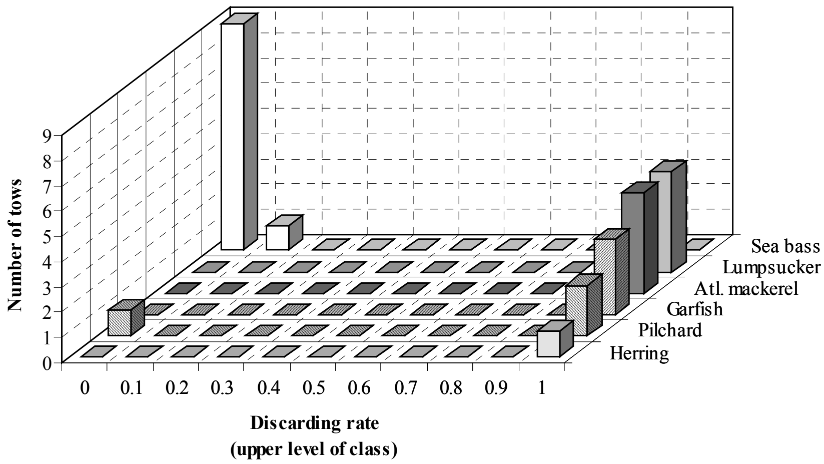


Figure 80 : Distribution of the discarding rate for the main discarded species in sea bass trawling.

9.1.3.2.3 Reasons for discarding

The reasons of discarding are shown in Figure 81. Most species were discarded because of high grading. Sea bass discards were rare and were only of undersized individuals. Lumpsucker is not a marketable species, and it was discarded.

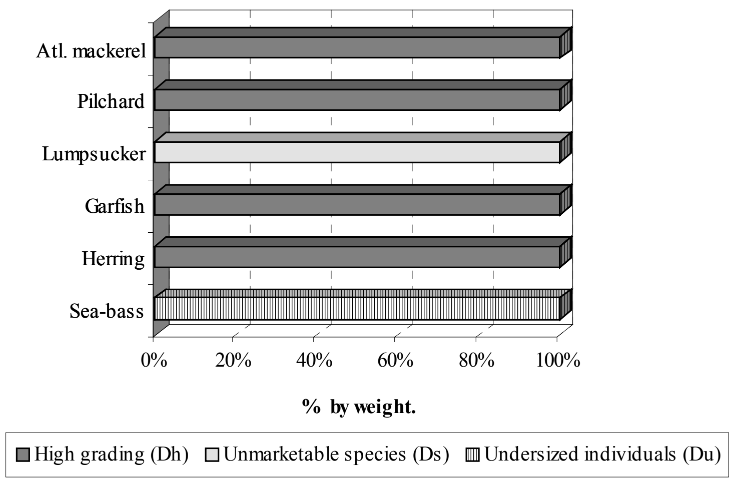


Figure 81 : Causes of discards in the sampled sea bass tows for the main species.

9.1.3.3 Size composition

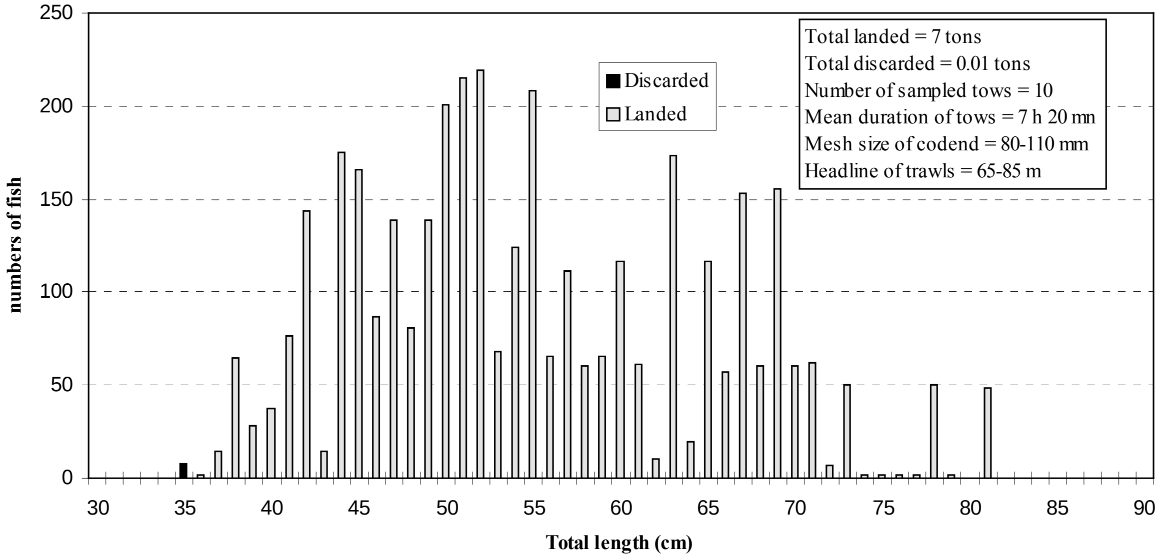


Figure 82 : Size composition of the sampled target species (sea bass).

The minimum legal size for sea bass is 36 cm. **Size selectivity appeared to be very good** (Figure 82). This is due to the fact that fishing occured on adults concentrated in the spawning grounds. A great part of catches of sea-bass were 5 years old and over.

9.1.4 Marine mammal by-catch

One marine mammal was recorded in tow « 4-3 » : it was a common dolphin (*Delphinus delphis*) male measuring 1.8 m. It was the only catch of marine mammals in the sampled pelagic sea bass trawling.

9.2 DISCUSSION

9.2.1 Critique of the sampling effort and reliability of the results

9.2.1.1 Assessment of the sampling rate for this fishery

There is a great difference between these two values of sampling rate. One estimate could be the mean of this two value (1.6 %).

	In the sampling	For the fishery (1994)	Sampling rate
Landings of sea bass (in tons)	7	217	3.2 %
Fishing time (in hours)	73	112 101	0.07 %

9.2.1.2 Intervals of confidence

The intervals of confidence for the discarding rate and the rate of the target species in the catches shows that results were reliable.

	Ratio estimation	Interval of confidence (95%)	
		lower limit	upper limit
Rate of target by weight	90.3%	74.2%	100.0%
Discarding rate by weight	2.0%	0.0%	5.9%

9.2.2 Selectivity in the fishery

The target landings represented 90.3 % of the total catch. The main important by-catch species landings are European mullet and Med. horsemackerel, but they represented only 8%.
The target species was nearly never discarded. Small individuals of target species are rare in the discards as the fishery target adults concentrated on spawning grounds are targeted in this fishery.
So the selectivity of this fishery appears to be really good. The present EC mesh size regulation has no specific restriction for bass and the 80 mm stretched mesh size is permitted. A minimum mesh size of 100 mm or 110 mm (when sea bass exceeds 30 % of the retained species) could be applied what may permit to avoid by-catch.

9.2.3 Factors determining by-catch and discards

The two studied trip did not occured in the same area. Fishing area of trip 4 was in VIII b, whereas during trip 6, the pelagic trawler fished in VII e. This fact may explain the difference between these 2 trips concerning quantity and diversity of by-catch. Futher investigations would be useful.

9.2.4 Interaction with marine mammals

One marine mammal was incidentally caught during 68 towing hours.

9.3 CONCLUSION

With 68 sampled hours of towing, results seem to be reliable. It appears that sea bass, the target species, accounts for 90 % by weight of the catch and discards are very low. The size selectivity for sea bass is also really good : the great part of the catch are 5 years old and over.
For one landed ton of sea-bas, pelagic trawlers discard less than 6 kg of Atl. mackerel and pilchard.
This fishery, which ranks ninth, appears to be very « clean », but exerts significant pressure on sea bass ressources
.

INDEX

Chapter II :

By-catch and Discarding in the SW England Pelagic Trawl Fisheries

Authors :

T.P. LEWIS, N.J.C. TREGENZA, I. RAPPEL

1. DESCRIPTION OF THE SW ENGLAND PELAGIC TRAWL FISHERIES

1.1. GENERAL DESCRIPTION OF THE UK PELAGIC FISHERIES

A description of the UK pelagic activity in the western Channel was carried out by Tetard, Boon et al.(1995) :

Target and by-catch species : pelagic trawls are used by both single and pair-boats, in seasonal (October to March) fisheries for pelagic species. Mackerel, scad, sprat and pilchard are targeted in these fisheries. Scad is usually taken only as a by-catch. Mixed catches of mackerel, pilchard and herring are also often made when vessels are involved in directed fishing for mackerel or sprat.

Fleets : the number of vessels engaged in the métier varies, depending on abundance, availability of fish and marketing prospects. Some visiting Scottish vessels are also involved. About six non-sector midwater trawlers routinely work on mackerel and pilchard during the period December-March. Visiting Scottish vessels are usually based on Plymouth and the Klondykers in Weymouth Bay. Larger local vessels (>10 m) are located at Falmouth, Plymouth, Brixham, Torquay and Teignmouth. The size of the vessels range between 14-35 m if we except the boats (<12m) fishing on sprat part-time. Local SFC by-laws do not allow vessels longer than 18.3 m to operate within the 3 mile limit.

Landings : in the years 1989-90, 4819 tons of mackerel , 1378 tons of scad, 1331 tons of sprat and 1331 tons of pilchard were landed by 25 vessels.

Regulation : when fishing for mackerel, vessels are controlled by regulations applicable to the « Mackerel Box ». The EC regulation for mesh size in use for herring pilchard and mackerel is 40 mm (40-45 mm is commonly in use).

1.2. DESCRIPTION OF THE MACKEREL PELAGIC TRAWL FISHERY

The main pelagic trawl fishery from south-west England is for mackerel. In the winter of 93/94 this fishery consisted of 15 boats with a mean GRT of 158 tons, range 75-475. Two boats are registered in Plymouth, 2 in Northern Ireland and 9 in Scotland. The fishery is within ICES area VIIe.

Mackerel trawling is carried out by boats singly or in pairs. The technique used is very similar and is described in detail for a pair below, with a diagram of the net in Appendix II.

1.2.1. Mackerel Trawling techniques

The mackerel boat studied pair trawls with a partner boat. The skipper's aim is to catch only large mackerel as prices for mixed catches or small fish are much lower. A description of the gear is given in Appendix II.

Mackerel are found using fish-finding echo-sounders which are in use all the time the boats are at sea. The location and echo image of significant shoals encountered are recorded digitally and can be referred to whenever needed to decide on search or trawling strategy.

After landing a catch the boats set out again for the fishing grounds and either try to relocate a large mackerel shoal fished previously, or try to find a new shoal. The search pattern depends on experience, intuition, and information obtained from other fishermen.

In January 1994 no shoals could be found and no trawling took place until the last week of the month.

When a shoal appears on the echo-sounder the size of the shoal and the species of fish are assessed. The main problems are detection of the size of the fish and the proportion of pilchard or scad in the shoal. Mackerel have a small swim bladder and give a much weaker echo to low frequencies than the other two species which give a stronger echo at both low and high frequencies. The echo-sounder displays low and high frequency images together to assist in making these distinctions, which are nevertheless not entirely reliable, particularly on fish size.

Once an adequately large and pure shoal has been found by one boat, both boats position themselves to attack it. They come together to allow the towing warp to be passed across from the boat which is carrying the net.

The lifting bag of the net and the dog rope attached to it are pushed over the stern by hand, until the drag created by the forward movement of the boat is sufficient to pull the net out of the boat.

The boats then steam through the location of the shoal. Because the fish are swimming this location is uncertain, and in most tows the boats make several runs (legs) in different directions targeting the same shoal, or targeting other shoals previously found in the vicinity. Horizontal scanning echo-sounders (ASDIC) allow the pair of boats to identify whether the main concentration of fish in a shoal is in the line of their trawling or whether they need to move to one side as they approach it.

The vertical position of the net is adjusted to the depth of the shoal by changing the length of the towing warps. In most shoals pilchard were found with the mackerel and were presumed to dive more readily in response to the disturbance caused by the boat, so the trawl was towed through the top half of the shoal to minimise the pilchard catch.

Echo-sounders on the net opening transmit information to the boat both on the position of the net in the water column, and on fish entering the net. Two stretch detectors at different positions in the lifting bag cause a bell to ring when approximately 45 and then when 90 tonnes of fish has been caught. No 'swilly hole' for the escape of excess catch was present in the nets used. Such holes are made in the net ahead of the fine mesh lifting bag.

When a good catch has been made, or when hope has been lost, the boats come together and one of them takes complete control of the net which is hauled in to the stern of this boat. The dog rope is taken forwards and used to pull the lifting bag forwards alongside the boat taking the catch. The buoyancy of the net gives some indication of the species caught.

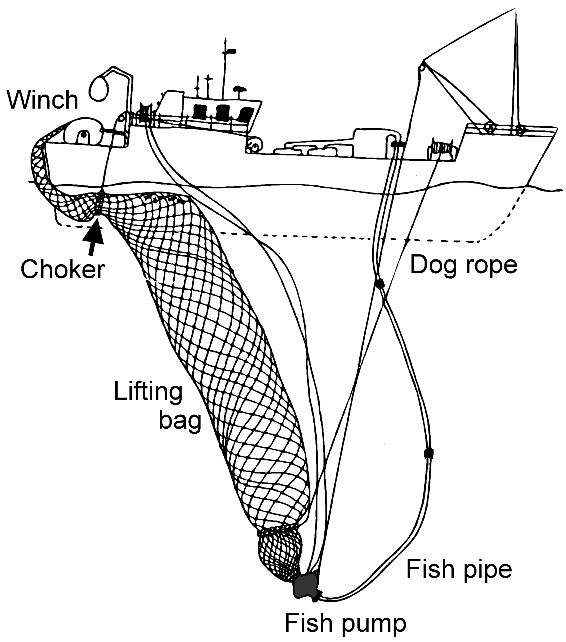


Figure 83 : Arrangement for selective pumping of mackerel.

If the catch is thought to be commercial the lifting bag is lifted beside the boat and the pump is attached. These operations take place over the side of the boat because the full lifting bag is not brought inboard at any point. The catch cannot be sampled at this stage as it falls away from the lifted end of the net.

The pump is a hydraulically or electrically powered centrifugal pump. It is lowered by a winch taking the lifting bag down with it. The net and catch tends to float upwards from the pump forming a column of water (Figure 83).

In this column mackerel sink relative to pilchards or scad which are much more buoyant. This provides a powerful sorting mechanism which can be used to separate out a large percentage of pilchard in a shoal. By stopping pumping when pilchards start to come through in large numbers the pilchards are left in the net. The pump is then removed and the pilchards are flushed out of the open lifting bag end as the net is wound on to the winch.

The fish arrive on the boat from the pump and flow into and along distributor channels to the fish holds. They can be seen and sampled at this stage. Samples are also taken by the fishermen who count individuals of each species present in a full box of known size. These box counts give a quick and useful measure of the fish size and the heterogeneity of the catch.

The six fish holds are filled with refrigerated (chilled) seawater and the fish that has been pumped aboard. In the tanks pilchard come to the surface and accurate sampling is difficult. Methods that have been used, but which were impractical in this study, are to ascertain the upper level of a mackerel catch where it has had a chance to settle, or to use deep sampling from the tank using a brail (a large scoop net with a heavy metal frame).

A further process is sometimes used to remove unwanted pilchard from the catch in the holds. By pumping in an excess of seawater the tanks are caused to overflow onto the deck. This causes some of the more buoyant fish to float out with the water flow. These discarded fish are mostly pilchard or scad.

The catch is sold to several destinations, with klondykers (non-EU vessels) purchasing the largest number of catches from the boat studied. These klondykers are either factory ships or freezer trawlers. The latter have less capacity for sorting mixed catches. Klondykers purchased mackerel, pilchard and scad. Shore based markets were used twice. One catch of pilchards was sold in Newlyn, Cornwall, UK, where a traditional pilchard processing industry continues, and one mackerel catch was landed at Weymouth where it was transferred into lorries for onward transport. Transhipment of the catch at sea was done either using a brail or a pump.

1.3. DESCRIPTION OF THE PILCHARD PELAGIC TRAWL FISHERY

1.3.1. Pilchard fleet in SW England

The main fisheries for pelagic species to the south-west of England have shown great fluctuations for over 200 years. The main target species has most often been pilchard *Sardina pilchardus,* but this fishery in 1993 was represented by a only a single pelagic trawler of 32m registered length, 192 tonnes GRT. The fishery is within ICES area VIIe.

The fishery has been of great importance to Devon and Cornwall in the past and as early as 1662 a law was made prohibiting the use of drift nets within one and a half leagues (about 8km) of the shore from June to November to protect the seine fishery for pilchard. Two villages, Saint Ives and Lelant, in west Cornwall recorded a seine catch of 4,000 tons of pilchard in one day - 1st November 1847 - using rowed boats and manpower only.

1.3.2. Pilchard trawling techniques

This was very similar to the technique used for mackerel except that trawling was carried out by a single boat, which did not have refrigeration of its seawater tanks.

Searching was made more difficult by the fact that only one boat was searching specifically for pilchards. Small shoals of pilchard are easily identified using acoustic fish finders by the strong echo at low frequencies which arises from their swim bladder. This contrasts with mackerel. At higher frequencies the difference between the species is less.

The trawling technique is the same as that used for mackerel except that as pilchard are thought to dive when disturbed by the boat the footrope of the trawl was generally kept within a few fathoms of the bottom.

Catch evaluation is made by looking at the net when it is pulled alongside the boat. Pilchard are seen closest to the surface and may obscure large numbers of mackerel beneath them. Some assessment of the proportion of species is made from how buoyant the net appears to be. A net full of pilchard is so buoyant it looks like a whale breaking surface. A net that does not break surface probably has mainly mackerel even if the fish visible at the top are pilchard. A tightly packed net may not allow movement of pilchard to float to the top and consequently the proportion of mackerel may be more easily identified. This process requires considerable skill, and is prone or error.

Pumping the catch aboard used the same methods as in the mackerel fishery, except that no attempt was made to concentrate pilchards. Pilchard tend to become concentrated at each end of the lifting bag when it is alongside the boat, with the mackerel causing the middle of the bag to sink. Consequently to obtain the whole pilchard catch requires pumping the whole of it aboard.

Some separation was made by pumping the mackerel-rich middle of the catch in the lifting bag to a different tank from the pilchard-rich parts ahead of, and behind it.

When mackerel was the main species caught the catch was landed to shore in Plymouth or Weymouth, or to klondykers near Weymouth. Advance negotiation of pilchard sales is needed at times, because this market is small and relatively uncertain.

2. METHODOLOGY

2.1. METHODS FOR MACKEREL TRAWLING

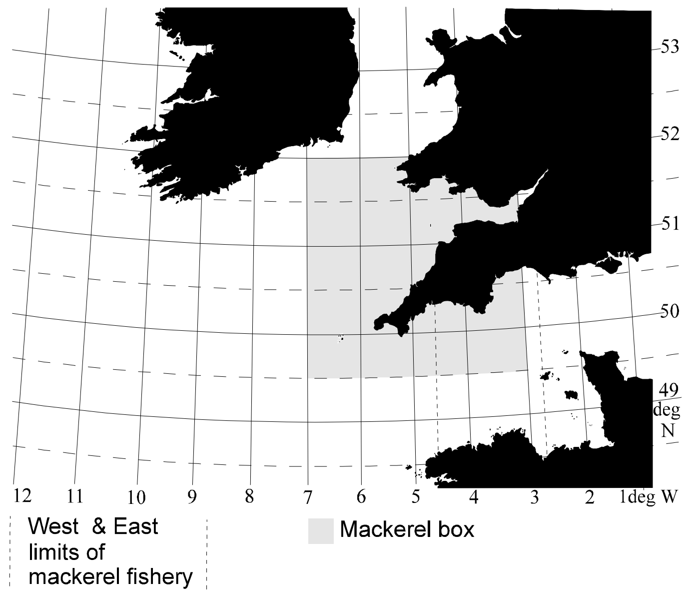
2.1.1. Agreement with the fishery

Before this contract was defined, agreement had been obtained from the skippers and part-owner of a pair of mackerel trawlers for a study of the interactions between cetaceans and fisheries. This was to be carried out by placing observers on one boats during normal fishing to the SW of England in winter. The skipper was subsequently approached to extend the study to include fish discards. This consent was given partly because the fishermen felt that they were being wrongly accused within the industry of damaging levels of discarding of pelagic fish.

2.1.2. Observation

An observer (T.P.L.) with previous experience with the Cornwall Trust for Nature Conservation of fisheries observation on smaller boats offshore and in poor sea conditions was on board for as much time as possible from 3rd November 1993 to 25 February 1994. The winter included several periods of bad weather when the observer was on stand-by or on the boat, but the boat did not go to sea.

The fishery was pursued in the western part of the Channel between Longitudes 2º 45' W and 5º W . Exact location of fishing effort has been reserved on the request of the fishermen on grounds of commercial interest.



Location of Mackerel fishery.

2.1.3. Fish catch assessment

When whole catches were pumped aboard the boat the catch weight was taken as the estimate made by the skipper from the data from the net sensors and the volume taken into the holds. A sample was taken from mid-catch. Fish measurements were overall length to the cm. below.

Whole catches are sometimes discarded. These are 'slipped' by opening the end of the net and winching the net in without ever bringing the catch on board. The fishermen's estimate of the catch size was then used. The way in which these estimates are made by the fishermen is described in the first chapter.

Other factors affecting assessment are :

1. About half the tows are pumped to the boat in the pair which does not have an observer on board. The pair boat in this case was smaller and took catches which were thought to be about equal to the capacity of her holds. When the catch was pumped to the pair boat its composition

was assessed from the fishermens' box count for that catch by applying mean figures for lengths derived from all catches retained and fully sampled.

2. The mixture of species may vary along the length of the catch in the lifting bag of the net. This was assessed by taking two or more box samples during pumping. The main problem arises when part or all of the catch is slipped. In this circumstance the only samples, if any, will come from the extreme end of the catch in the lifting bag.

3. Pumping usually continues until there are no more fish coming through, or until the percentage of pilchard starts rising. When a large part of the catch was pilchard and was slipped by selective pumping the discard was assessed by subtracting the pumped catch from the skipper's estimate of total catch before pumping. This estimate is based on the signals from the net sensors and from the look of the catch as the net is hauled alongside the boat for pumping. In most tows a much smaller quantity of fish - the 'tail end discard' - is washed out of the open end of the net before it is hauled on to the boat. Darkness and sea conditions make the estimation of this quantity difficult even for species which float. We estimate the range of uncertainty to extend from half to five times the figure given as the estimate, but the total remains small. For mackerel, which sink, no visual estimate of tail-end discards is possible. Because of the steeply rising percentage of pilchard pumped at the end of the catch it seems likely that the quantity of mackerel in the whole tail-end discard does not rise in proportion to the total quantity of pilchards. We estimate that this tail-end discard of mackerel is usually very small, perhaps ranging from a few kg. to 100kg.

4. Entangled fish in the net are crushed when the net is wound on to the winch. This volume varies with catch size, and is small in relation to catch size. We estimate it to be much less than 1%.

5. Flotation discarding of pilchard or scad is also carried out by pumping water into the tanks until the hatches lift and water and fish overflow onto the decks. This results in sudden and unpredictable releases, as the boat rolls, of fish from any one or more of the 6 tanks. The fish wash over the side. Visual estimates were that this was a small component of pilchard and scad discarding.

2.1.4. Cetacean bycatch assessment

As part of the assessment of the exposure of the fishery to cetaceans a continuous detailed record was kept of boat activity, speed, seastate, daylight, and watch periods. These data in conjunction with the characteristics of the observation point are the main determinants of sighting efficiency and were collected to allow an estimate of cetacean prevalence. This detailed record covers 1 214 hours at sea.

Assessment of cetacean bycatches in this fishery is uncertain because a bycaught cetacean would be too large to come through the fish pump. If buoyant its presence might well not be recognised at any point, but fishermen have said that they have sometimes detected a dolphin bycatch because it obstructed the pump intake and reduced the flow rate. In the final clearing of the net with the end open a cetacean would be discharged at a distance behind the boat where it is unlikely to be seen, particularly as all fishing was done at night. Most cetaceans are around neutrally buoyant when caught in gillnets (Berrow *et al*., 1994).

2.2. METHOD FOR PILCHARD TRAWLING

2.2.1. Agreement with the fishery

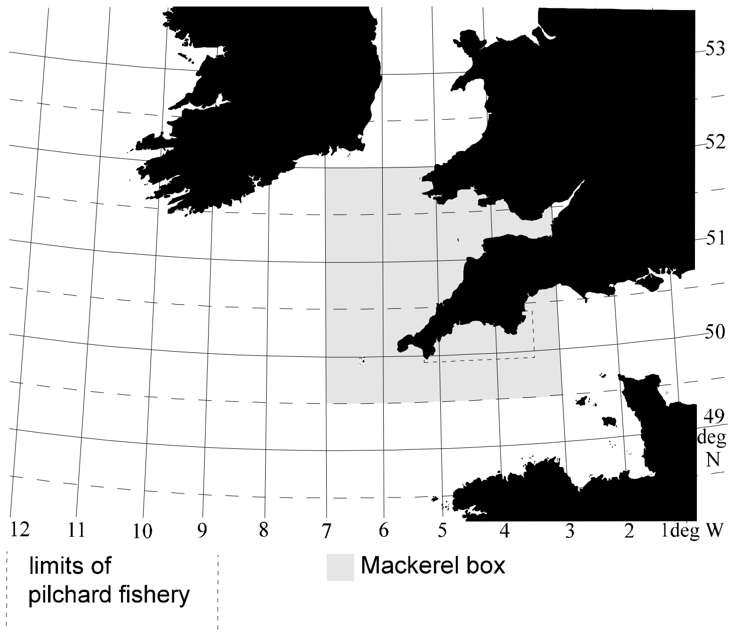
Before this contract was defined agreement had been obtained from the skippers and the owner of a pelagic trawler for an on-board observer study of the interactions between cetaceans and fisheries during the winter of 93/94. The owner was subsequently approached for agreement to extend the study to include fish bycatches and discards. This consent was more problematic because of the difficulties caused in this fishery by the mackerel box.

2.2.2. Observation

The pilchard boat was intending to fish only for pilchard in the winter of 93/94. This boat had fished for mackerel or pilchard in several previous winters. The observer (I.R.) had previous experience, with the Cornwall Trust for Nature Conservation, of fisheries observation on smaller boats offshore and in poor sea conditions.

The pilchard fishery was pursued within the Mackerel Box between 3deg 30' W and 5 deg W, and north of 50deg N.

The pilchard boat suffered a series of problems including loss of gear, gear failure, crew changes and very poor catches in a season in which pilchard proved hard to find. The boat finally abandoned the fishery soon after Christmas and returned to beam trawling.



Location of Pilchard fishery.

The observer was on board for 350 hours on 17 days between 1st Nov. and 18th Dec. 1993 for all the time for which consent could be obtained from the skipper, but did not include all the fishing time of this boat.

2.2.3. Fish catch assessment

Observation was based on the assessment of catch size and the sampling of fish flowing from the hopper on deck to the fish tanks on the same basis as used in the mackerel fishery.

The skipper of the pilchard boat had changed before the start of the observation. The new skipper, who was himself new to pelagic fishing, did not welcome observation and imposed constraints, such as taking the fish samples himself. This has limited the quality and volume of detailed information of this fishery. Biased data have been left out.

3. BY-CATCH AND DISCARDING IN THE SW ENGLAND MACKEREL TRAWL FISHERY : RESULTS AND DISCUSSION

3.1. RESULTS

3.1.1. Sampling effort

The mackerel boat fished from early November to early March with a break for Christmas. Observation included time at sea on 59 days, and observation of 36 tows of which 34 were sampled. In January none of the boats were successful in finding mackerel. Most of the other pelagic trawlers in the SW abandoned the fishery. The boat studied was one of 4 that stayed on in the SW hoping for better fishing towards the end of the season. This had happened in 1993, and did occur again in 1994.

3.1.2. Characteristics of the sampled tows.

36 tows were observed. Few mackerel shoals were found early in 1994, and consequently no tows were observed during the first four weeks of 1994. The distribution through the season of days of observation and of tows occurring during those days is shown in Figure 84.

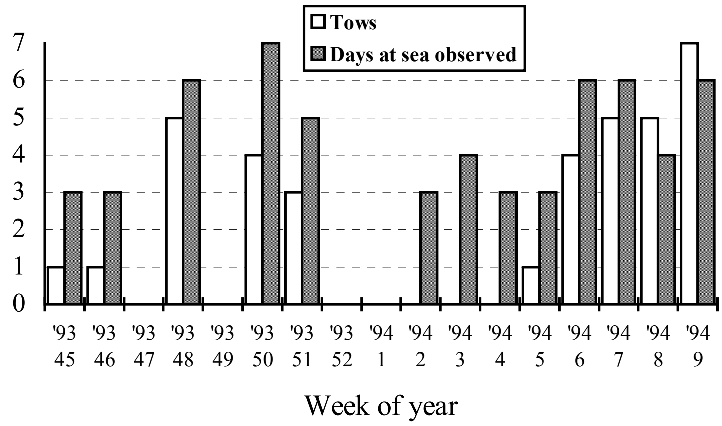


Figure 84 : Periods of observation and tows observed.

All trawling occurred during the hours of darkness. The mean duration of tows was 2 hours. The distribution of durations is shown in Figure 85.

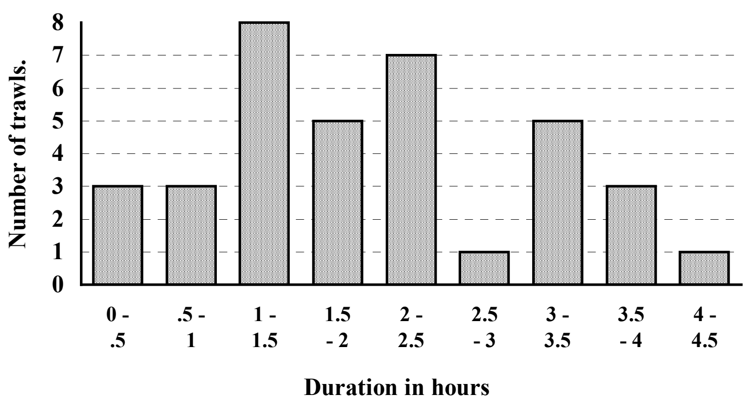


Figure 85. Duration of mackerel tows.

232 n.miles were covered in 72 hours of observed tows Only a few tows rapidly fill the net. The relationship between tow duration and catch is shown in Figure 86.

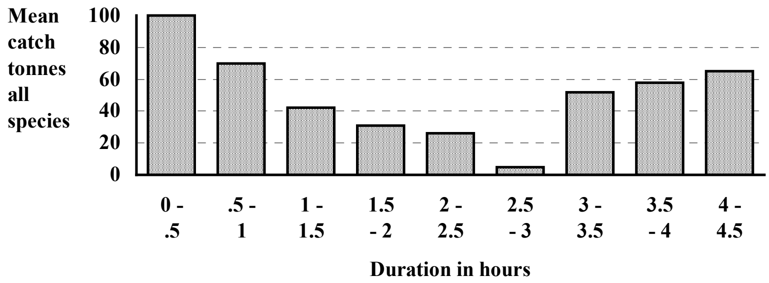


Figure 86 : Relationship between tow duration and catch

The net used is shown diagramatically in Appendix II. A small mesh lifting bag (cod end) was used to minimise enmeshment of fish, which damages them and makes the net difficult to clean and to handle. 'Blinding' of the meshes by fish is believed to prevent any substantial selection of larger fish by use of larger mesh sizes. The tow parameters are detailed in Table 11.

	Tow Duration hrs:mins	Number of Legs	Mean Speed nm/hr	Sea-state	Depth m. Head line	Foot rope	Bottom	Ht. off Bottom m.	Vertical Opening m.
mean	02:00	2.7	3.2	3.1	37	58	66	7	21
SD	01:09	1.5	0.6	0.8	10	10	7	7	2
Max	04:45	6	4.4	5.0	55	71	80	26	24
Min	00:22	1	1.8	1.5	15	33	44	0	16

Table 11. Mackerel trawling - tow parameters

3.1.3. Catch, bycatch and discards

3.1.3.1.Catch composition in the sample

36 tows were made catching an estimated 1608 tonnes of all species, of which 1421 tonnes was mackerel. Two catches pumped to the pair boat are not included in this total, and would probably amount to about another 70 tonnes. The mean haul was 47 tonnes per tow of all species.

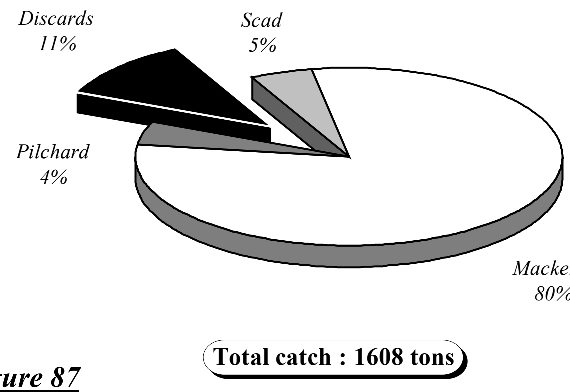


Figure 87

1164 tonnes of mackerel (82% by wt.) was sampled directly or through box counts when the fish was pumped to the pair boat. Bycatches were almost entirely of pilchard and scad which were the main species caught in some tows. No other species accounted for more than 2 specimens in the total of 2466 fish measured in the samples taken. Specimens of other species picked out of the catch included one each of Cod (*Gadus morhua*) 100cm, Saithe (*Pollachius virens*), Bib (*Trisopterus luscus*) 33cm, Plaice (*Pleuronectes platessa*) 30cm, Monkfish (*Lophius piscatorius*) 80cm, Squid (*?sp.*) 25cm and Sprat (*Sprattus sprattus*).

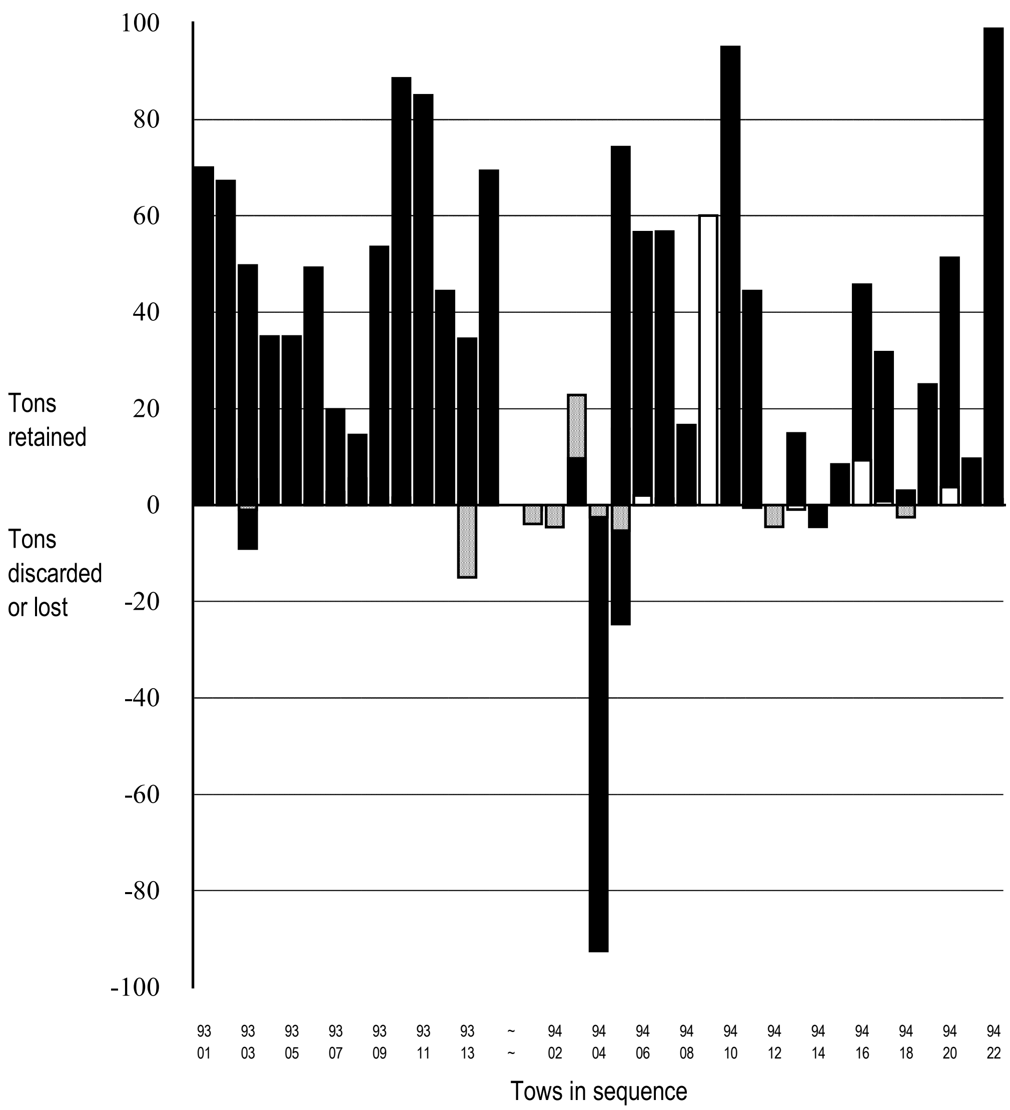
Table 12 summarises the entire catch studied.

Mackerel catch	1421t	88% by wt.
Pilchard bycatch	109t	7% by wt.
Scad bycatch	78t	5% by wt.
All species	1608t	
% of all species retained		89% by wt.

Table 12. Species in total observed catch by weight.

Discards arose mainly from a few events. The pattern of catches in relation to major discards is shown below -

Fig. 88. Catch and discard in the mackerel fishery.



Black = mackerel Grey = pilchard White = scad

Using the tow as the sampling unit, the catch statistics by species, weight and disposal are shown in Table 13.

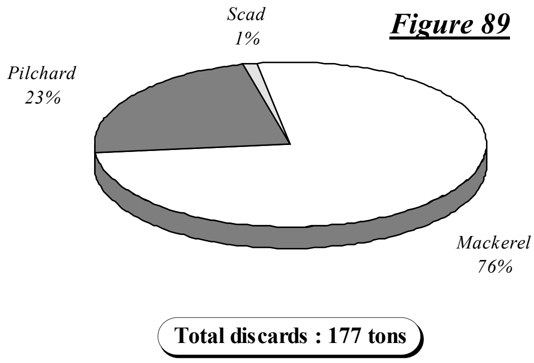
	mean catch tonnes	± 95% confidence limits
Whole haul	47.3	±23%
Mackerel caught	41.8	±26%
Mackerel retained	37.9	±28%
Mackerel discarded	3.9	±140%
Pilchard caught	3.2	±59%
Pilchard retained	2.0	±78%
Pilchard discarded	1.2	±82%
Scad caught	2.3	±151%
Scad retained	2.3	±154%
Scad discarded	.04	±147%

Table 13. Tow statistics - species by weight.

3.1.3.2.Discards (composition and reasons)

Discards by weight for each species as a percentage of all discards are shown in the pie chart (figure 89).

Figure 89



All tows were intended to catch mackerel. The main species actually caught was :

Mackerel	33 tows
Pilchard	2 tows
Scad	1 tows

Table 14. Percentage of discards by weight in each species.

discards	**mean**	**95% CI**
Mackerel discarded or lost	9%	0 - 22% by wt.
Pilchards discarded or lost	38%	0 - 69% by wt.
Scad discarded	2%	0 - 4% by wt.

3.1.3.2.1.Mackerel discarding

Discards of whole catches occurred on 5 occasions.

One was the large catch of small mackerel (tow 94/04 on the chart above) which caught 92.5 tonnes of mackerel. This haul of was distinctively different from all others sampled. The fish were mainly above the 20cm minimum landing size, and had a mean weight of 92g. Discarding was because the sale value would have been low, i.e. high grading.

Four whole small catches of around 5 or 6 tonnes were slipped. One of these was composed mainly of pilchard (tow 94/02). The others were not thought worth hauling as this might force a return to port without a worthwhile catch, or the labour of dumping the catch from the hold. Large parts of catches were discarded or lost twice -

One gear failure, a rupture of the flexible pipe from the fish pump, caused a loss of catch including 25 tonnes of mackerel from the largest catch made - 120t (tow 94/05).

One catch filled the hold of the smaller boat and 9 tonnes of mackerel were pumped to the larger boat, but these were later dumped (tow 93/03).

Details of the composition of each tow are given in Table IIa in Appendix II.

These bycatches and discarding events were not evenly spread through the season. A cluster of 5 events occurred when shoals were first found after a month of fruitless searching in January 1994. The first two tows at this time were only 5 or 6 tonnes and mainly pilchard. The third was also pilchard and was taken to Newlyn for sale to a pilchard processor, although this may have been unprofitable for the boat. The fourth was the large haul of small mackerel and in the fifth tow more fish were taken than in any other tow and a gear failure occurred.

This sequence, which has a major impact on the figures for both bycatch and discarding, can be seen as reflecting a temporary loss of good judgement on the part of the skipper arising from a degree of desperation.

	Mackerel caught millions	Mackerel discarded %
Whole catch estimate	10.7	21%
Catch sampled excluding tow 94/04	6.7	4%
Catch sampled including tow 94/04	9.0	25%

Table 15. Mackerel discards by number.

	Wt. tonnes	% by wt.	% by number
Inability to detect small size of fish in shoal	93	68%	85%
Gear failure (unintentional discard)	24	18%	8%
Catch too small / mixed to be worth landing (high grading)	11	8%	4%
Part of catch too small / mixed to be worth landing (high grading)	9t	7%	4%

Table 16. Causes of mackerel discards.

3.1.3.2.2. Pilchard discarding

All the pilchard in the catch would be discarded if there was an easy method of doing so. The method used by the klondyker to calculate the value of the catch is such that the presence of pilchard depresses the value of the mackerel, even though the pilchard are given a positive value. This is because the weight of each species is calculated directly from box counts of fish, and pilchards are smaller than mackerel.

	Wt.	% by wt.
Discard by selective pumping (Unmarketable size)	20.8	59%
Gear failure (Unintentional discard)	5.6	16.0%
Catch too small or too mixed (high grading)	5.6	16.0%
Inability to detect small size of mackerel	2.4	6.7%
Tail end discards (high grading)	0.8	2.3%
Total	35.2t	

Table 17. Methods & causes of pilchard discards

Selective pumping may segregate pilchard by size to some extent. As the available samples are mostly of those pilchard within the main mass of mackerel pumped aboard no calculation of relative pilchard numbers discarded from different causes has been made.

3.1.3.2.3. Scad discarding

Scad occurred as a significant bycatch only in the first quarter of 1994. The level of discarding was very low. One large catch was of almost pure scad and was sold as such (Tow 94/09).

3.1.3.3. Size compositions

3.1.3.3.1. Mackerel

Discarding of mackerel is mainly of small fish. The average weight of all mackerel caught in the last quarter of 1993 was 235g and in the first quarter of 1994 was 231g. The small mackerel in the sample from tow 94/04 in the first quarter of '94 were predominantly 1 year old fish with an average weight of 91g, in contrast to the other hauls in the first quarter of '94 in which 2 year old fish were predominant.

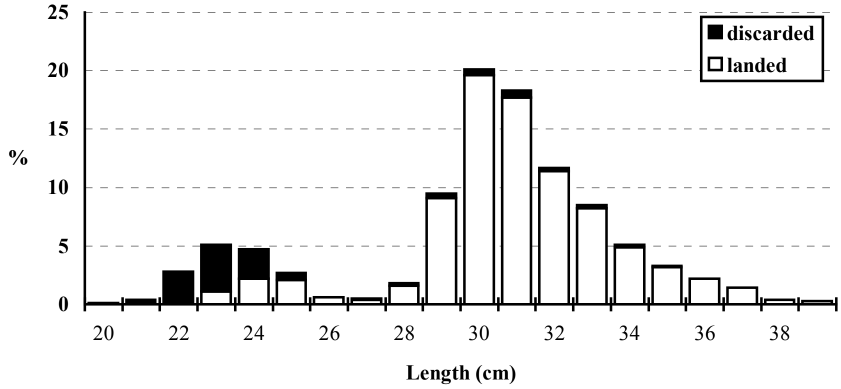


Fig 90. Length/frequency distribution of mackerel in all sampled tows.

3.1.3.3.2. Pilchard

Figure 91 shows the length frequency of pilchard measured. These have not been adjusted to catch size as the sampling of pilchard is likely to create a size selection bias. The average weight in the fourth quarter of 1993 was 150g and in the first quarter of 1994 was 146g.

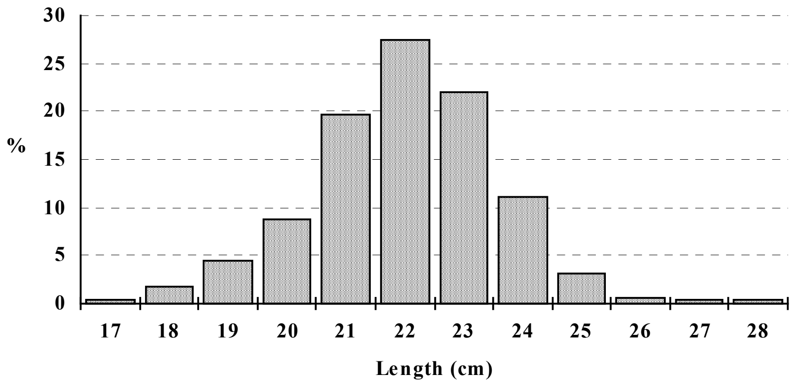


Fig 91. Length/frequency distribution of pilchard in all samples in the mackerel fishery in '93 and '94

3.1.3.3.3. Scad

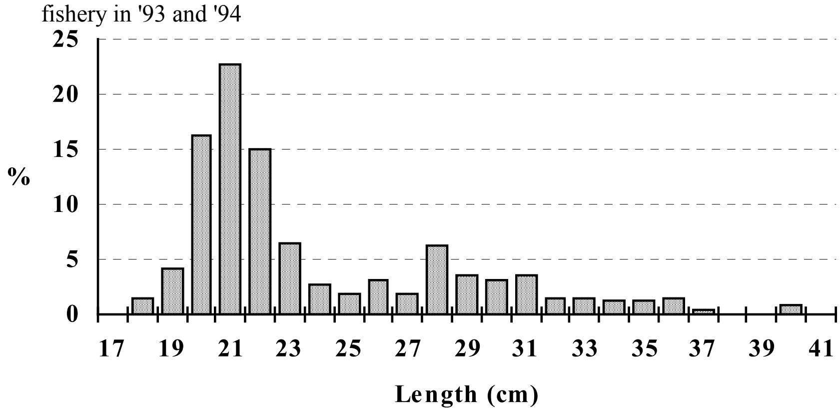


Figure 92 : Length/frequency distribution of scad in the mackerel fishery in '93 and '94.

3.1.3.4.Accuracy of bycatch assessment

The main source of uncertainty in making any quantitative extrapolation from the findings is the fact that bycatch and discarding totals are dominated by a few large events whose frequency distribution could not be accurately established without a very extensive study.
The uncertainty inherent in whole catch weight estimates is probably less than plus or minus 20%. Sampling bias from sampling near either end of the pumping process was evident. Average lengths and weights have been applied to box counts from the main body of the catch where only end samples were accessible. These box counts show good correspondence to measured samples in other catches.

The uncertainty inherent in the use of length/weight relationships makes little contribution to overall uncertainty on weight of discards or bycatch because in most large catches one species is strongly predominant.

3.1.4. Cetacean interactions

No cetacean bycatch was observed. A detailed record of conditions relevant to cetacean sightings was kept. This covered 511 hours of daylight during 23% of which a dedicated sea watch for cetaceans was maintained, and 703 hours of darkness. During sea watches the seastate was Beaufort 2 or less for 48 hours, and Beaufort 3 for 43 hours.

Common dolphins (*Delphinus delphis)* were seen twice during this study. They approached the boat briefly. On both occasions the boat was searching for fish at the time and was at the western end of the fishery.

Date	Time	Number	mins	Long	Speed	Sea	Fathoms
25/11/94	15 50	4	1	4^{o} 34'	5.2	3	46
06/12/94	13 42	4	6	4^{o} 44'	5.5	3.5	46

Table 18 : Common dolphin sightings

It is concluded that Common Dolphins were exposed minimally to this fishery during this period of observation, and no inference can be drawn from this study about the potential for bycatch of this species by this fishery. Another boat in the SW mackerel fleet reported a catch of 3 to 5 dolphins during this study.

3.2. DISCUSSION

3.2.1. Factors determining bycatch

Pelagic fisheries differ from demersal fisheries in the very large number of fish caught in a single haul. This makes separation of the catch by species or size impractical except for large boats, and costly in time for klondykers or fish processors. Consequently bycatches reduce the value of a catch and skippers aim to avoid them at all times.

The factors leading to bycatches are :

1. An absence of unmixed shoals, or inability to find them quickly enough. This is likely to be worse when the stock of the target species is low, or when fishing for it extends into periods when shoaling behaviour is less strong in those areas accessible for fishing.
2. Inability to detect the species composition of shoals. However it is evident that after a difficult period of one month with no shoals found the mackerel boat skipper was attacking almost any shoal that could be found and this resulted in a series of very mixed catches being made. When shoals were more numerous a more discriminating selection of target shoals was worthwhile. Consequently this factor is also exacerbated by low stock levels.

3.2.2. Factors determining discarding

The discarding of mackerel in the mackerel fishery in this study was dominated by high grading - discarding of small fish of low value due to great uncertainty in the assessment of the fish size composition of shoals from the echo-sounder image. However, when shoals are easy to find there is a disincentive to attacking a shoal with a doubtful acoustic image. Consequently the catching of small fish is also linked to stock levels, distribution and shoaling behaviour.

The same factors that determine bycatch, above, also determine the discarding of mackerel in mixed and small catches.

The discarding of pilchard in the mackerel fishery is driven by the reduction it causes in the value of the mackerel catch and the availability of a practical method of segregating and discarding large fractions of pilchard. The level of discarding is determined by the same factors as determine bycatch.

The discarding of scad in the mackerel fishery is much as for pilchard, but because the scad shoals were less mixed with mackerel in this study the discard rate was very low.

4. BY-CATCH AND DISCARDING IN THE SW ENGLAND PILCHARD TRAWL FISHERY : RESULTS AND DISCUSSION

4.1. RESULTS

4.1.1. Characteristics of the sampled tows

15 tows were observed, with an average duration of 137 minutes, maximum 4.2hrs. 14 were during daylight. Trawling was observed in wind speeds up to Beaufort Force 4. Tows were made close to the bottom in an average sea depth of 55m, at an average speed of 4.0 n.miles/hr. Collision with static nets and with another pelagic trawl were recorded on one occasion each.

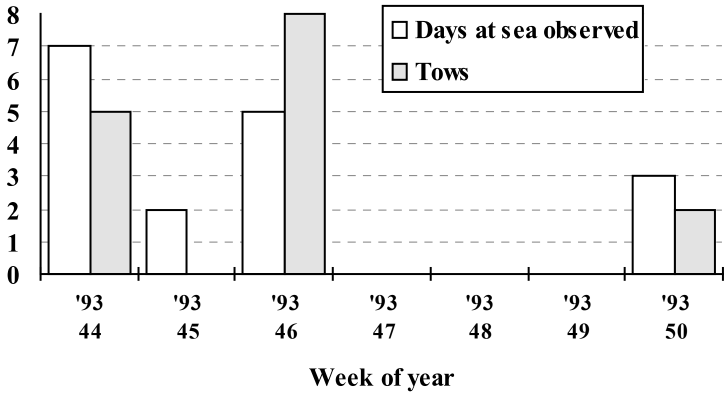


Figure 93 : Days at sea observed in pilchard fishery

4.1.2. Catches and Bycatches of fish

Of 14 tows observed 7 yielded 3 tonnes or less each (Figure 94). In 2 cases this was due to gear failure - a net tear, and failure of an echo sounder when only a small catch had been obtained. In 1 case there was no catch after 4hrs of trawling. 3 tows caught mainly mackerel, and one of these caught almost entirely mackerel.

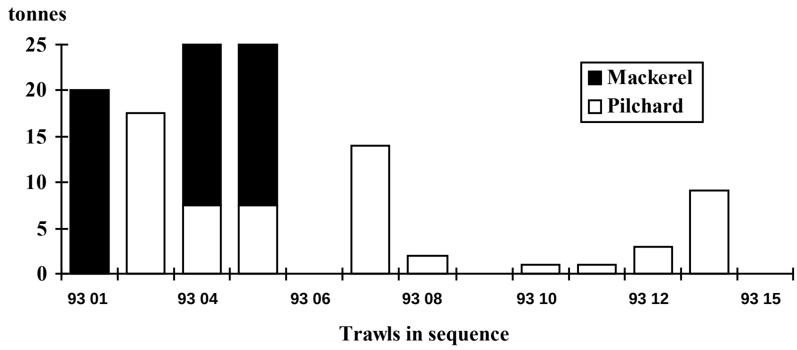


Figure 94 : Weight of catch in sampled pilchard tows.

Sampled tows caught 117.5 tonnes of fish, of which 62.5 tonnes were pilchard and 55 tonnes were mackerel. Bycatches in the samples were all Mackerel. A small number of Scad *Trachurus trachurus*, Whiting *Merlangius merlangus*, John Dory *Zeus faber* and Bass *Dicentrarchus labrax* were also seen in the catch. The bycatch of John Dory occurred during the only night tow, which was slipped and was not quantitatively sampled. No quantitative estimate of discarding in this fishery has been made because the sampled tows are clearly unrepresentative of the whole. Nevertheless 2 tows out of 15 were discarded or lost, which could indicate a discarding rate of **13 %.**

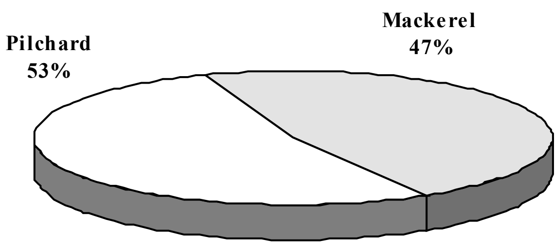


Figure 95 **Total landed : 117.5 tons**

4.1.3. Discards of fish

No sampled catch was discarded, and no sorting of mixed catches was attempted. Discards of uncertain weight occurred when a mixed catch at night was slipped, and when the net was torn. Crew members reported that the boat had slipped a catch on most days of a week during one period when the observer was not able to obtain a berth the boat. These discards were due to the catches being mainly mackerel and within the Mackerel Box.

An impression was obtained from the klondyker to which some mixed catches were sold that the pilchard content of the catch would be discarded by the klondyker, because they already had more pilchard than they wanted. At present pilchard trawling is economically marginal and it was not resumed in the winter of 94/95.

4.1.4. Size compositions

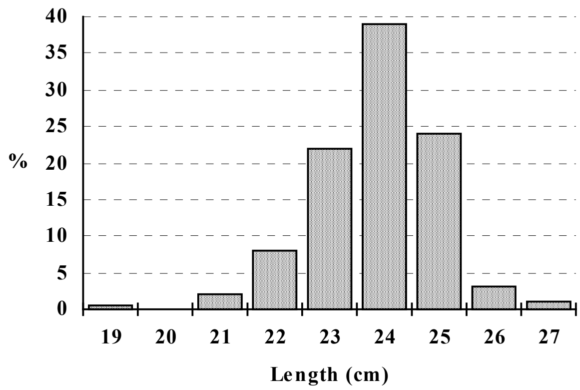


Fig 96. Pilchard landed in the pilchard fishery

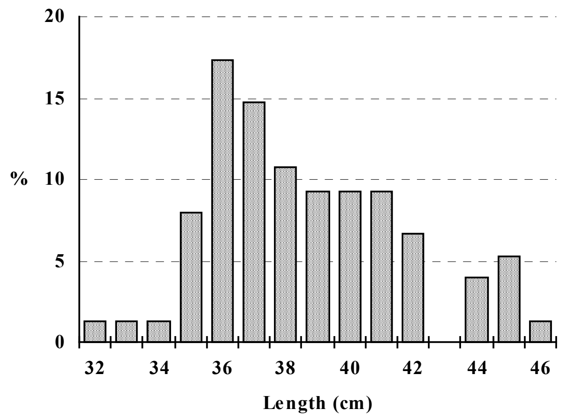


Fig 97. Mackerel landed in the pilchard fishery - 4th qtr '93.

4.1.5. Cetacean bycatch

No cetacean bycatch was observed. No cetaceans of any species were seen. A detailed record of conditions relevant to cetacean sightings was kept after the first 5 days at sea. This covered 79 hours of daylight during 52% of which a dedicated sea watch for cetaceans was maintained, and 120 hours of darkness. During sea watches the seastate was Beaufort 2 or less for 12 hours, and Beaufort 4 for 55% of the total time. These conditions would give a good chance of making a sighting of common dolphins if they were present at the time in moderate or high densities.

It is concluded that common dolphins were not significantly exposed to this fishery during this period of observation and no conclusion can be drawn from this study about the potential for bycatch of this species by this fishery.

4.2. DISCUSSION

4.2.1. Bycatch in the Pilchard Fishery

This is determined by the mixture of mackerel with pilchard in the shoals and the difficulty of detecting mackerel in the presence pilchards. However mixed catches are sold and the mackerel may represent the main value of such a catch. When this is frequent the fishery is not accurately described as a pilchard fishery.

4.2.2. Discarding in the Pilchard Fishery

The evidence of this study indicates the main causes of pilchard discards in the pilchard trawl fishery could be :

1. mixed catches with a large proportion of mackerel. This can be 'high grading', or because a heavily mixed catch is unmarketable at a particular time.
2. small catches. These do not warrant a return to port, and cannot be retained for long without deterioration.
3. gear failures.

The pilchard discard rate is likely to be much higher when shoals are harder to find because of 2 and 3 above.

In rank order the main causes of mackerel discards in the pilchard trawl fishery are probably :

1. fear of litigation if otherwise saleable catches of mainly mackerel are retained within the Mackerel Box.
2. mixed catches.
3. small catches.
4. gear failures.

The mackerel discard rate is also likely to be much higher when shoals are harder to find because of 2 and 3 above.

In this fishery the skill of the fishermen is a factor, through success in finding and recognising the size and composition of shoals, and in minimising the frequency of small catches and of gear failures.

The strength of the market for each species is also of fundamental importance in determining the effect of the admixture of non-target species on the value of the target catch. It also determines the levels of discarding by fish processors which do not form part of this study.

5. CONCLUSION

5.1. IMPLICATIONS FOR THE COMMON FISHERIES POLICY

The problems of bycatch and discarding in this mackerel fishery appear relatively manageable in comparison with those of demersal fisheries taking mixtures of commercial species. Three significant points arise from the findings that indicate that both bycatches and discards are likely to increase when fish are hard to find :

1. *A rise in mackerel stocks in relation to fishing effort would, without any other changes, probably diminish both bycatches and discarding in the mackerel fishery. A fall might lead to higher fishing mortality from a fleet of unchanged size.*
2. *Zonal policies that effectively exclude pelagic fishing from fish-rich areas and force effort into relatively fish-poor areas could raise levels of bycatch and discarding.*
3. *Time closures of fisheries at times of strongest shoaling could also raise levels of bycatch and discarding.*

A rise in pilchard stocks relative to mackerel, which has happened in the past, could expand the pilchard fishery and create an increase in discarding in both fisheries. It would increase the effect of the Mackerel Box as a generator of discards of mackerel from pilchard trawling.

The economic context, particularly the cost of separating mixed catches, is a factor in the discarding of both pilchard and mackerel.

Common dolphin bycatches in these fisheries probably vary greatly between different years and are difficult to quantify. As this speices is subject to bycatch in several pelagic trawl fisheries, and in gill net fisheries a precautionary approach is justified with efforts to reduce bycatch in each fishery.

Obtaining consent for observation from the fishermen was the biggest single problem in assessment at sea. Movement towards a situation in which all fisheries expect to be assessed for fishery and other ecological impacts could be linked to a long term policy that both damaging or unassessed fisheries would be subject to greater downward pressure in future policy development.

5.2. IMPLICATIONS FOR FURTHER ASSESSMENT

Further assessment of bycatch and discards could usefully address the economic factors that underlie most of the relevant decisions. These range from the fishermens' decisions on which shoals to attack and which catches to reject, to the processors' pricing of mixed and pure catches of each species.

The assessment of cetacean bycatches can clearly be strongly influenced by seasonal and other changes in distribution of cetaceans. Future studies addressing cetacean bycatch need to include some assessment of cetacean prevalence to aid interpretation of the results.

In pelagic trawling with catch pumping there is a major problem of detecting bycatches of cetaceans, especially in darkness. A very large mesh 'dolphin retaining' net fastened inside the lifting bag to retain any cetacean caught might solve this problem without affecting fishing performance of the net, but would probably not be welcomed by the fishermen.

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Chapter III :

By-catch and Discarding in the Dutch Pelagic Trawl Fishery

Author :

A.S. Couperus

1. INTRODUCTION

The Dutch contribution on by-catch and discarding in the pelagic trawl fisheries gives a description of the Dutch freezer trawler fleet, its target species and fishing areas through the different seasons. Although the fleet only consists of a small number of vessels, the individual vessels are large and thus the fleet has a large capacity. The target species and fishing areas vary in the course of the year according to a more or less regular pattern. Different fisheries can therefore be distinguished.

Data have been collected at sea during 4 trips made by an observer between January 1994 and March 1995, covering roughly 3% of the yearly effort of the fleet. Horsemackerel was the target species during all 4 trips, and the fishing grounds were in different parts of ICES area VII. Although it was the intention to include a trip on a vessel fishing in the North Sea (ICES area IV) the destination of the trip was changed at the time when the vessel left the harbour. This example just illustrates some of the difficulties encountered when trying to collect data from specific fisheries.

In an earlier study Corten (1990) reported on the by-catch and discarding in the Dutch pelagic fishery for herring.

2. DESCRIPTION OF THE DUTCH PELAGIC FISHERIES

2.1. LANDINGS

The Dutch freezer trawler fleet catches about 300.000 ton of fish each year. The composition of the catches has gradually changed over the years. Since 1990 the majority of the landings consists of horsemackerel. The total catch (bycatch included) for each species since 1986 is given in Figure 98.

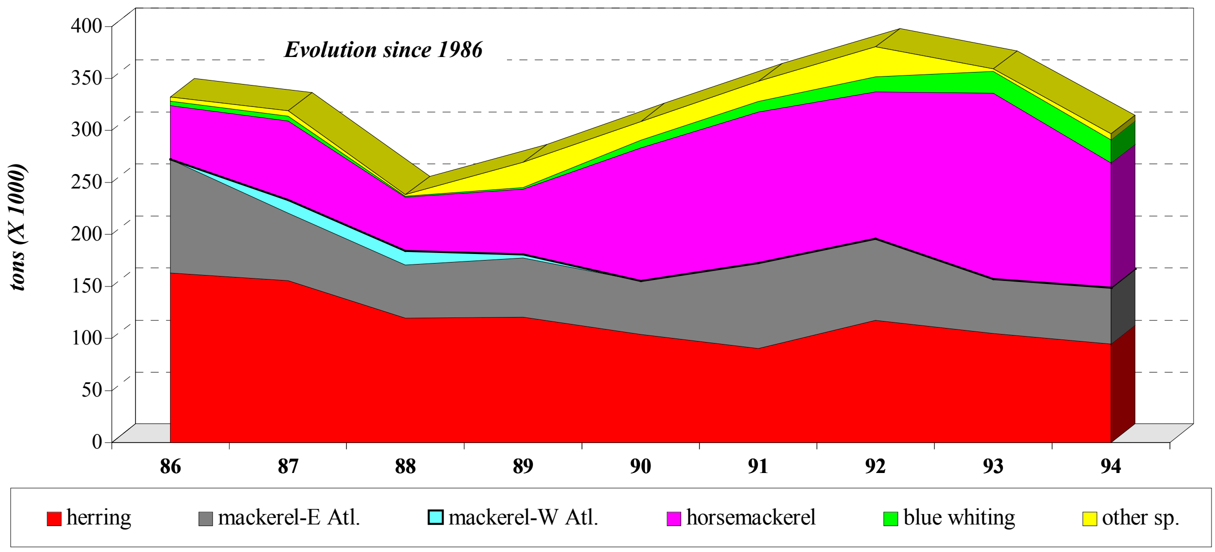


Figure 98 : Total catch by Dutch freezertrawlers and one pair of pairtrawlers with freezing facility from 1986 till 1994. In the period 1987-1989 some trawlers have been fishing off the east coast of America. The category « other species » includes pilchard, greater argentine and some squid. Squid has been caught near the Falkland Islands by one trawler in 1989 and 1990.

2.2. FLEET DESCRIPTION

The Dutch fleet of freezer trawlers consists (at the beginning of 1995) of 12 vessels. Since 1970 the size and the engine power of the vessels has dramatically increased whereas the number of vessels has decreased. The largest trawlers at the end of the 70's had engines of about 2.000 hp and a storing capacity of 400 ton. In 1981, trawlers of 3.000 hp and 900 ton stores were built. From 1980 onwards the smaller ships quikly disappeared from the fleet (Figure 99).
Nowadays the smallest trawler has a length of 70 m, an engine of 3.200 hp and 900 ton storing capacity. The four largest trawlers are 115-120 m long, have a capacity of 3.000 to 5.000 tons and engines of 8.000 to 10.000 hp. On average half the engine power is used for propulsion, the rest is used for freezing.

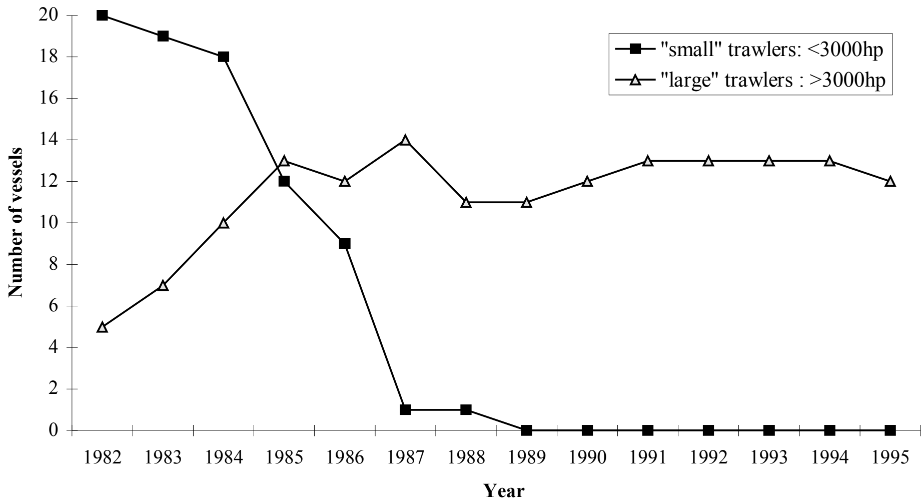


Figure 99 : Evolution in vessel size - number of vessels on 1 January since 1982.

The duration of each fishing trip depends mainly on the catch rates. Usually the vessel will return only if the freezing stores are full. Smaller vessels make trips of two and a half, up to four weeks. Larger vessels stay at sea for three to five weeks. If catches are really poor, trips may extend even beyond five weeks. Depending of trip duration, the crew stays at home for 3 to 5 days between two trips (one day for a week at sea).

Apart from 12 Dutch vessels, there are 3 German, 3 English and 3 French freezer trawlers owned by Dutch firms via partnership companies. Most of these vessels have crews which are partly Dutch. All these vessels, exept for one of German origin, are built in the Netherlands and are of the same type as the Dutch trawlers. The total number of vessels fishing for four Dutch firms is 21 (situation January 1995).

Usually several freezer trawlers are fishing together in close vicinity near concentrations of the target species. The fish shoals are so far apart that they have to be searched for, using sonar and echo sounder. By staying together the skippers enlarge the chance of finding the shoals. Most skippers are very cooperative in providing their colleagues with information about fishing positions and catches.

2.3. FISHING AREA AND TARGET SPECIES

In descending order of importance, the target species are horsemackerel (*Trachurus trachurus*), herring (*Clupea harengus*), mackerel (*Scomber scombrus*), blue whiting (*Micromesistius poutassou*) and greater argentine (*Argentina silus*). The most important fishing grounds are situated on the continental slope west of the British Isles, in the Channel, along the British eastcoast and in the northern North Sea.

The fishing areas differ by season and to a lesser extent by year. The annual differences are due to changes in the behaviour of the fish or to changes in the market situation. Since the shipowner firms concentrate on different markets and quota also differ between firms, the fleet is usually spread over a number of different areas. Before a particulair ship leaves the harbour it is difficult or impossible to predict the fishing area. The choice of fishing area is usually a last minute decision, and may change during the trip.

A summary of this information is given in Table IIIb in Appendix III.

- **January:** part of the fleet is fishing southwest of Ireland and in the northern Gulf of Biscay for horsemackerel. Some trawlers are fishing north of Scotland and Shetland for mackerel.
- **February**: the mackerel trawlers are following the mackerel shoals along the shelf edge on their way to the spawning area southwest of Ireland. Towards the end of the month they will meet the other part of the fleet still fishing for horsemackerel southwest of Ireland.
- **March**: the whole fleet is fishing (south)west of Ireland along the edge of the continental shelf. The main target species is horsemackerel, but the catches contain a considerable amount of mackerel. By the end of the month, some trawlers will start fishing for blue whiting at the Porcupine Bank to save their mackerel quotum.
- **April**: the fishery for horsemackerel and mackerel southwest of Ireland continues while part of the fleet is fishing for blue whiting on the Porcupine Bank and west of Scotland.
- **May**: some trawlers are still fishing for horsemackerel and to a lesser extent for mackerel southwest of Ireland. The trawlers west of Scotland start to catch greater argentine and herring along with blue whiting. Some trawlers are fishing for herring in the central and northern North Sea.
- **June**: part of the fleet is fishing for horsemackerel southwest of Ireland and for greater argentine, herring and mackerel west of Scotland. Most vessels, however will fish for herring in the central and northern North Sea.
- **July**: most trawlers are targetting herring in the North Sea, along the shelf edge north of Shetland as well as north and west of Scotland.
- **August**: the fishery for spawning herring at the east coast of Britain (off Peterhead and Flamborough/Whitby) starts. If the catches are disappointing, the vessels will either try to catch herring west of Scotland, or horsemackerel west of Ireland and in the western approaches of the English Channel (under Cornwall).
- **September**: more than half the fleet may be found south of Cornwall and (south)west of Ireland fishing for horsemackerel and to a lesser extent for herring. Some trawlers are fishing for spawning herring at the east coast of England.
- **October**: the fishery for wintering mackerel (north)west of Shetland starts. Some trawlers may catch horsemackerel, often mixed with mackerel and herring west of Ireland and Scotland. The most important fishery however is for horsemackerel under Cornwall and in the northern Bay of Biscay.
- **November**: the situation remains more or less the same as in October. At the end of the month, the fishery for spawning herring starts in the Channel.
- **December**: in order to be home the last two weeks of the year, the trawlers only make short trips. The main target is spawning herring in the Channel. In some years, trawlers may catch horsemackerel south of Cornwall and in the northern Bay of Biscay.

2.4. FISHING TECHNIQUES

The pelagic trawls used have enormous dimensions. The height of the opening varies from 30 to 60†m, the horizontal spread of the wings from 80 to 120 m. Mesh size in the front part of the net may be up to 30 m. Towards the codend the meshes become gradually smaller. In the codend the stretched mesh size is 4 cm. The size of the trawls is indicated by the number of meshes around the opening of the trawl, if the meshes would have a stretched size of 20 cm, and extends from 4000 to 9000 meshes. The trawl is generally towed a few meters above the bottom, but often the ground rope touches the bottom. The Dutch pelagic trawl fishery is more or less specialized in trawling close to the bottom. Trawling depth is dependent on the target species: 600-800m for greater argentine, 300-500m for blue whiting, 100-400m for mackerel and horsemackerel, 50 - 200m for herring. The duration of one tow may vary from five minutes to more than ten hours. The duration depends on the recordings seen on the netsonde and the signals received from the sensors in the codend.

If the skipper decides to take a sharp turn during the tow, he will "turn on the doors": the fishing line is heaved until the trawl doors break surface and the net itself is closed just under the water surface. After turning the fishing line is paid out again. This whole operation, from the start of winding until the end of paying out the warp, takes about 10-20 minutes at water depths of 200 m.

Hauling starts with winding up the fishing line till the doors have surfaced. The doors are picked out and the net is wound up till only the codend - with the catch - is in the water. The catch is either pumped out of the codend or brought aboard by tying off "boxes". When tying off boxes the uttermost end of the codend is hoisted on board. Since one box measures about four tons, a catch of 50 ton is brought on board by tying off ten to fifteen boxes. Each box is opened above a gutter on deck. If a pump is used the catch runs through a tube with a diameter of about 35 cm into the gutter. A separator is connected to the tube approximately halfway. Here the water flows off through a grid. During pumping the codend remains in the water. Half the Dutch fleet is using a pump to empty the codend. The other half, plus eight of the trawlers under foreign flag, are tying off boxes.

Since the rate at which the fish can be processed (sorted, frozen, wrapped and labelled) is limited, part of the catch is stored for a maximum of three days in cooling tanks at a temperature of 0°C. Storing capacity per tank is 20-30 tons. A middlesized trawler is able to store about 200 tons in - mainly - cooled tanks. The part of the catch which is processed right away is stored for some hours in a tank which is not cooled or in the gutter on dek, both called "the hold". The fish falls through an opening (diameter 50 cm) at the bottom of the gutter into one of the tanks. As soon as one tank is full, it is closed and another one is opened.

2.5. THE PRODUCTION-LINE

The catch is led from the cooling tanks to a grading machine which sorts the fish by body width. Crew members sort the fish by size, species and quality at a conveyor belt. At this stage part of the catch (consisting of unwanted species, damaged fish etc.) is removed from the conveyor belt and discarded: it drops in another gutter and is washed overboard with a flow of water. While the tanks are right under the stern deck, sorting of the catch and processing take place on the shelter deck in front of the tanks.

The sorted fractions of the catch are transported by conveyor belts towards a number of "frosters" each consisting of 40 or 52 plate freezers. These freezers produce frozen blocks of about 20 kg of whole fish in about 4 hours. In full production, a middlesized trawler can produce approximately 6000 of these blocks per day. The blocks are wrapped with cardboard and labelled in the midship and are then stored at a temperature of -20°C in the front part of the ship. The smallest trawler has a storing capacity of 47.000 packages, while the largest trawlers can store 150.000 packages. Although one trawler has a capacity of 250.000 packages, it normally lands only about two third of the maximum capacity.

2.6. DESCRIPTION OF THE VESSELS THAT PARTICIPATED IN THIS STUDY

- **Vessel 1** is one of the newest trawlers, built in 1989. Length 115m; engine 9.000 HP. In contrast with the two other trawlers, the catch is brought on board by means of a pump. There are 12 cooling tanks with a storing capacity of 25 tons each. The ship has 34 plate freezers of which only 29 were used. With 29 plate freezers more than 9.000 packages of approximately 20 kg can be produced per day. The packages are stored on pallets. This way 150.000 packages can be stored. Without pallets the capacity is more than 200.000 packages. The crew consits of 40 people.

- **Vessel 2** is a 10 year old freezertrawler. Length 88m; engine 4.400 HP. It has 12 cooling tanks, which is exeptional for its size. With 24 plate freezers it has a freezing capacity of about 6.000 packages per day. The freezer can store 82.000 packages. The crew number is 30.
- **Vessel 3** is built in 1987. Length 91m; 5050 HP. The number of cooling tanks is 7. It has 26 plate freezers and a storage capacity of 75.000 packages. Due to the combination of a strong engine, a relatively small storage capacity and a large number of plate freezers this trawler makes relatively short trips: usually less than 3 weeks. There are 27 crewmembers.

3. METHODOLOGY

3.1. AGREEMENT WITH FISHERMEN

Thanks to the longlasting contacts between the Dutch firms of shipowners and RIVO-DLO, permission for the Dutch observer programme was easily obtained from the "Redersvereniging van de Nederlandse Zeevisserij" (Company of Shipsowners of the Dutch Sea Fisheries).

3.2. OBSERVATIONS AT SEA

In the period January 1994 to March 1995 an observer made four trips on board three different freezertrawlers. From information already available, it was known that most incidental by-catches of dolphins occur in February and March. The effort has therefore been focused on these two months (Table 19).

Trip no.	Vessel no.	Period	Target species	Bycatch & secondary target	ICES area's
1	1	29/1-6/2 1994	Horsemackerel	mackerel	VIIb,j,(c)
2	1	4/3-28/3 1994	Horsemackerel	mackerel	VIIh,j
3	2	24/8-26/9 1994	Horsemackerel	mackerel pilchard	VIIh,e,l
4	2	13/3-30/3 1995	Horsemackerel	mackerel blue whiting	VIIj

Table 19: Period, target species and ICES area's of the trips conducted during this observer programme.

Two trips have been made in February and March 1994 during the fishery for horsemackerel and mackerel. The third trip in August/September coincided with the fishery for horsemackerel in the western approaches of the Channel. This trip was originally planned to observe discards and bycatches during the fishery for spawning herring at the British east coast since this fishery seems to be associated with the occurrence of whitebeaked dolphins (Couperus, 1994). The last trip was conducted in March 1995.
All the tows were observed for mammal by-catch and around half of them were sampled for fish studies.

3.3. CATCH ASSESSMENT

The observer was present on the bridge during shooting and hauling of the net, from where the whole operation could be observed. Position and time were noted at the beginning of each haul. The time was noted again when hauling started. Total weight of the catch of each haul was estimated by counting the number of boxes or by counting full cooling tanks.

If possible, a sample of the total catch was taken with a fish basket out of the hold or at the outlet of a cooling tank. However, in a some cases a sample was taken by collecting fish at random from the conveyor belt before the grading machine.

The weight of each species in each sample was taken with a weigh-beam (max. 50 kg). Each specimen was measured to the cm-below (the graphs show the lower limits of cm-classes). The number of fishes in each class was raised to the total catch and discards. The landings were calculated by substraction of the discards from the total catch. The target was to measure at least 50 specimens of all major species in each length sample (landings and discards).

During trip 1, 2 and 3 discard samples were taken during processing by collecting all fishes from the litter gutter at a certain point in time. The total weight of discards was calculated from the (estimated) processing speed (tons/hour) and the total catch. This suggests an accurate estimation of the discard weight. However, processing speed differs by haul. Furthermore, the exact speed is very hard to detect by an observer: he would have to stay continuosly at the conveyor belt to note every break. The processing speed used for the calculation was estimated by crew members and not by the observer. The discard percentage has also been checked by visual inspection of the conveyor belt. In all cases the estimated discards part was about the same (less than 25% deviation) in both methods. During trip 4 the discard part was estimated only by visual inspection of the conveyor belt.

3.4. INCIDENTAL DISCARDING

A distinction was made between discards that were removed from the conveyor belt during processing (sorted out discards) and releases of (a part of) the total catch (incidental discards).

The total catch was slipped from the trawl of five hauls. In these cases it was not possible to take a sample. A rough estimate of the quantity has been made together with crewmembers. For commercial species (horsemackerel and mackerel) the length composition has been calculated from the total catch of that trip. Part of the total catch was slipped or pumped out of a cooling tank on two occasions. Of these hauls samples have been taken.

3.5. MARINE MAMMAL BY-CATCH

All hauling operations have been observed from the bridge. After the pumping operation, the empty codend with the connected pump-inlet is hoisted on board. When the inlet is uncoupled from the codend, large objects like sea mammals will fall in the gutter. If boxes were tied off, the observer checked each box when openend. Only if the last part of the catch was slipped out of the trawl by-caught cetaceans might have been missed. This happened in four of 216 hauls.

All specimens were sexed, bodylength was measured and 2-4 teeth were extracted for age determination. Injuries, which were visually detectable from the outside, were described. Shortly after being landed on deck, the body temperature was measured either with a flexible probe which was led 45 cm into the body via the anus or with a pin thermometer. The pin was stabbed in the belly of the animal after removing a few square cm of blubber in order to get deeper into the body. Temperatures collected in this way must be considered to be minimum estimates, because the pin does not reach the middle of the body.

Several tissue samples for toxicological, morphological and pathological research were collected and the stomach was preserved for food analysis. The skull was collected for Dutch musea of natural history.

4. BY-CATCH AND DISCARDING IN THE DUTCH HORSEMACKEREL TRAWL FISHERY : RESULTS AND DISCUSSION

4.1. RESULTS

4.1.1. Sampling effort

Figure 100 shows the periods of observation and the observed number of tows per week. In all the observer spent 102 days on board and observed 216 hauls. Thus, roughly 3% of the yearly effort of the fleet has been covered.

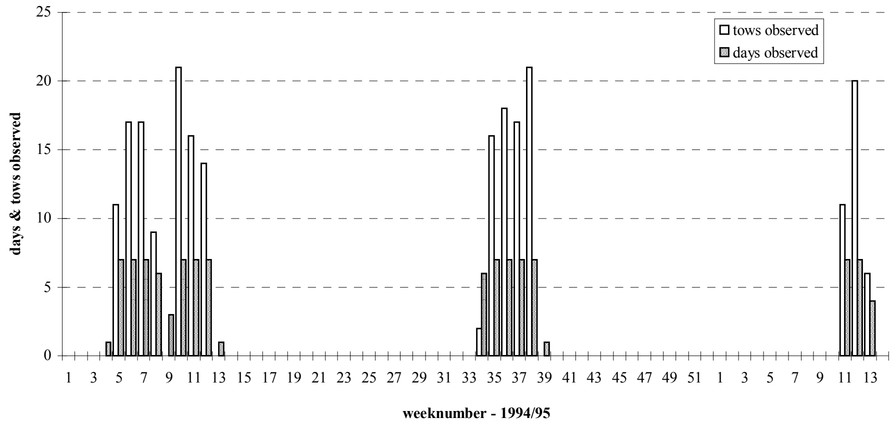


Figure 100 : Period of observation

55% of the observed hauls have been sampled for length distributions of fish landings and discards (Table 20). Since the sampled hauls were comparatively large, the part of the catch that has been covered was rather higher (74%).

Trip no.	Number of hauls during the trip	Number of hauls sampled	% of hauls sampled	% of total catch covered	Average sample of tot. catch kg (dev.)	Average sample of discards kg (dev.)
1	54	30	56	79	24(4)	11(6)
2	51	27	53	63	26(5)	13(6)
3	74	40	54	68	17(2)	7(4)
4	37	22	59	85	23(3)	9(2)

Table 20 : Overview of samples taken during trip 1-4.

4.1.2. Characteristics of the sampled tows

Figure 4 (next page) shows the trawl positions. Trawling occurred during day and night. The average duration of a haul was 4 hours. The frequency of haul durations is shown in Figure 5. During trip 3 the skipper kept the haul durations relatively short to maintain a high quality of the horsemackerel landed. Western horsemackerel have a high fat content at this time of the year (July - November) and good prices can be made if the fish is fresh and undamaged.

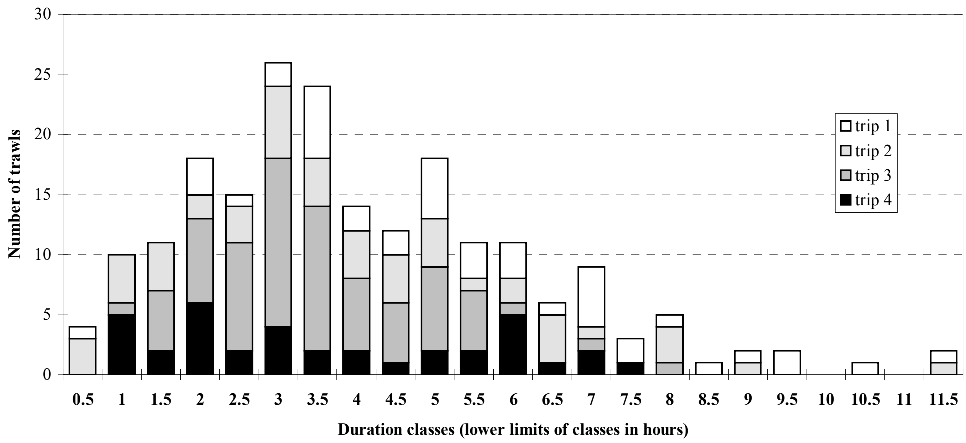


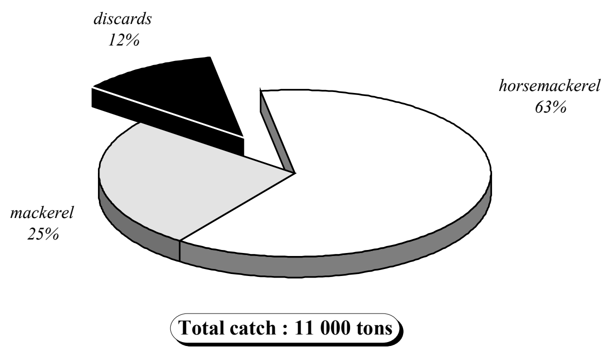
Figure 101 : Frequency of haul durations

Figure 102 : Trawlpositions during the four trips of this study.

4.1.3. Catch, by-catch and discards of fish

4.1.3.1. Composition of the total catch and discard

Table IIIa (in Appendix III) gives an overview of all landings and discards in tons for each trip. In Figure 103, 104 and 105 the landings and discards of all trips are summarized (details by trip are given in Appendix III, Figures IIIa et IIIb).



Figue 103: Composition of the total catches

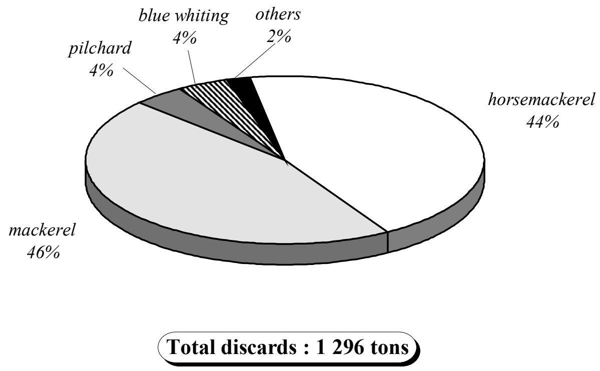


Figure 104 : Compositions of the discards

Although horsemackerel was the target species during all trips, 25% of the landings consists of mackerel (30.8% of the total catch). This is mainly caused by high mackerel catches at the end of February and in March during trip 2 and 4. The amount of mackerel discards sorted out during these trips was three to four times higher than in trip 1 that covered the month of February.

Overall 11.8% of the total catch was discarded. Half of the discards was sorted out at the conveyor belt. The other half was discarded during seven incidents. Of the discards 5.2% consisted of horsemackerel. The major part was lost in one accident (see trip 2). The part which was sorted out systematically (high grading) was 1.4% of the total catch.

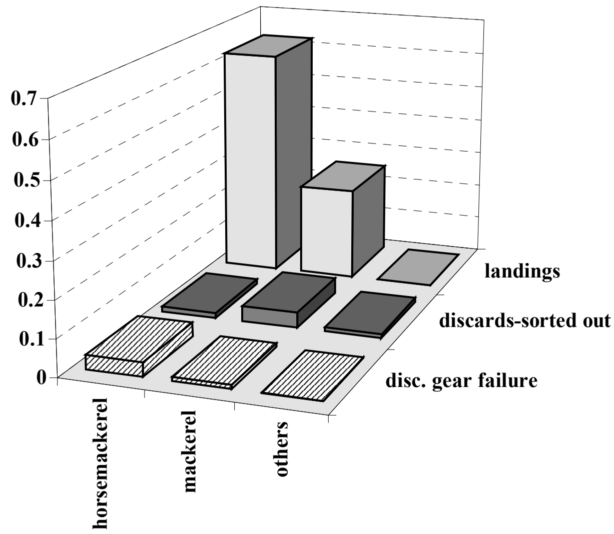


Figure 105 : Landings and discards by species

4.1.3.2. Variability within and between trips

- **Trip 1**

Vessel 1. Period: week 5-8, 1994. The estimated total catch was 3395 tons, mainly consisting of horsemackerel (Figure IIIa in Appendix III). Figure 106 shows the landings and discards per haul. In the second half of the trip mackerel appeared in the catches. Mackerel was kept on board. The discards (86 tons; 3%; Figure IIIb in Appendix III) consisted of mackerel, horsemackerel and other species. All horsemackerel and mackerel was discarded (sorted out) because of damage, small size, quotum considerations or grading problems.

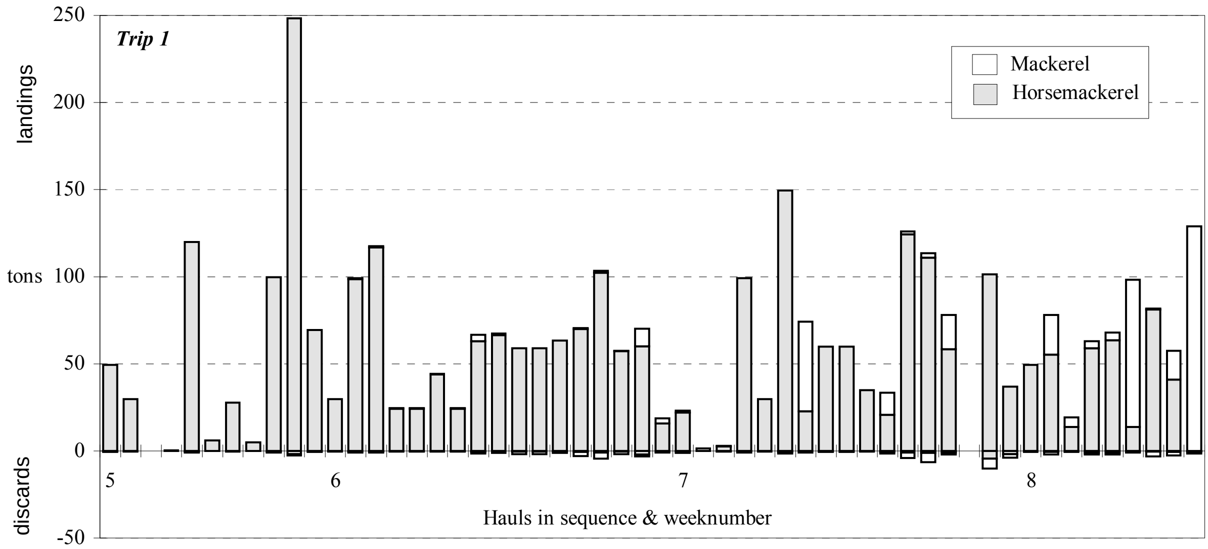


Figure 106 : Landings and discards by haul during trip 1 - week 5-8, 1994; 54 hauls

- **Trip 2**

Vessel 1. Period: week 10-13, 1994. The estimated total catch was 3939 tons. Although horsemackerel was the target species, almost half of the landings consisted of mackerel (Figure IIIa in Appendix III). During the trip catches consisted of (a mixture of) horsemackerel and mackerel (Figure 107). The total quantity of discards was 664 tons (Figure IIIb in Appendix III). About 400 tons of horsemackerel was discarded during an accident in haul no. 18. During hauling the codend was lost because the catch was too heavy. It is likely that the catch consisted of horsemackerel because enmeshed fishes in the front part of the net belonged to this species. Since such a trawler should normally be able to bring a catch of 300-350 tons safely on board, a total catch of 400 tons has been assumed. The length/frequency distribution was calculated from the total catch of the whole trip. In haul no. 24 the catch consisted entirely of boarfish (*Capros aper*), an unmarketable species. This catch was slipped and estimated to be 10 tons.

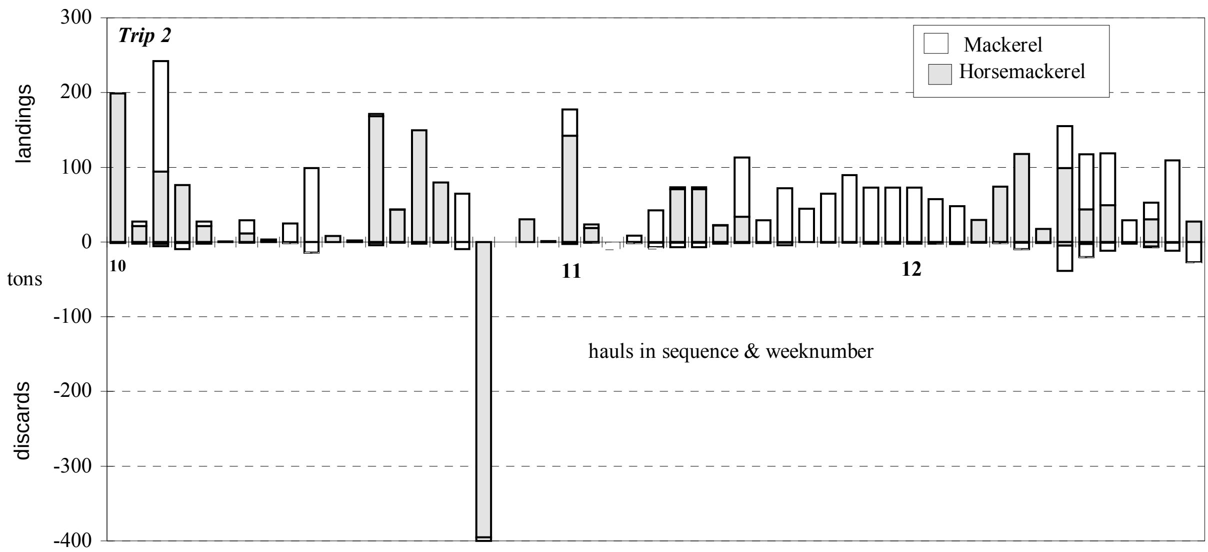


Figure 107 : Landings and discards by haul during trip 2 - week 10-13, 1994; 51 hauls

- The remaining discards (254 tons) consisted of sorted out horsemackerel and mackerel. This is about three times as much as during trip 1 (same vessel!). The reasons for sorting out were mainly "high grading". A large amount of mackerel was discarded after a gale, because the mackerel was damaged by the sharp bony parts of horsemackerel in the cooling tanks. For this reason, about 51 tons were removed from the conveyor belt (part of haul 45 and 46).
-
- **Trip 3**

Vessel 2. Period: week 34-38, 1994. The estimated total catch was 1714 tons, mainly horsemackerel (Figure IIIa in Appendix III). Horsemackerel was the main species caught in all hauls. However some hauls consisted of a rather large amount of pilchard and mackerel (Figure 108). Discards (166 tons, 10%) consisted of sorted out mackerel, pilchards, some damaged horsemackerel and some other species (Figure IIIb in Appendix III). All pilchards appeared to be damaged during their stay in the cooling tanks and were therefore removed from the conveyor belt during processing. Mackerel was sorted out for various reasons (damage, size, grading limitations).

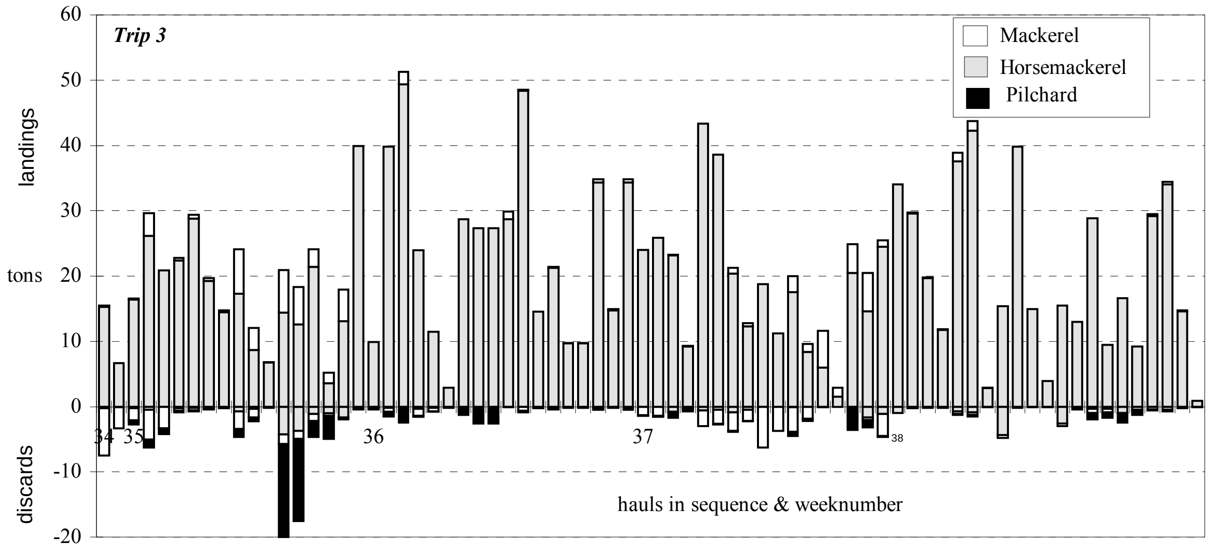


Figure 108 : Landings and discards by haul during trip 3 - week 34-38, 1994; 74 hauls

Horsemackerel and mackerel were much smaller then during the other trips. Figure 9 shows that even very small horsmackerel was kept on board.

- **Trip 4**

Vessel 3. Period: week 11-13, 1995. The estimated total catch was 1949 tons. Whereas horsemackerel was the target species, mackerel was the main species in 22 of 30 catches of more than 20 tons (Figure 109). Little more than half of the landings consisted of mackerel (Figure IIIa in Appendix III). The discards (378 ton, 19%) consisted mainly of mackerel (Figure IIIb in Appendix III). All blue whiting was heavily damaged and therefore discarded during processing. Horsemackerel was discarded for reasons of small size, damage, grading limitations (see discussion) and storage capacity. Most mackerel was discarded during the last nine hauls of the trip. After having processed half of the catch of haul 29 the skipper decided for the rest of the trip to remove all mackerel from the conveyor belt to save the mackerel quotum. In haul no. 32 and 34 the catch consisted of mackerel and was slipped. These catches were estimated to be 40 and 60 tons. In haul no. 35, the catch consisted of one box (about 4 tons) of mackerel and the catch was released right away via the conveyor belt. The length/frequency distributions of these catches were calculated from the composition of the total mackerel catch.

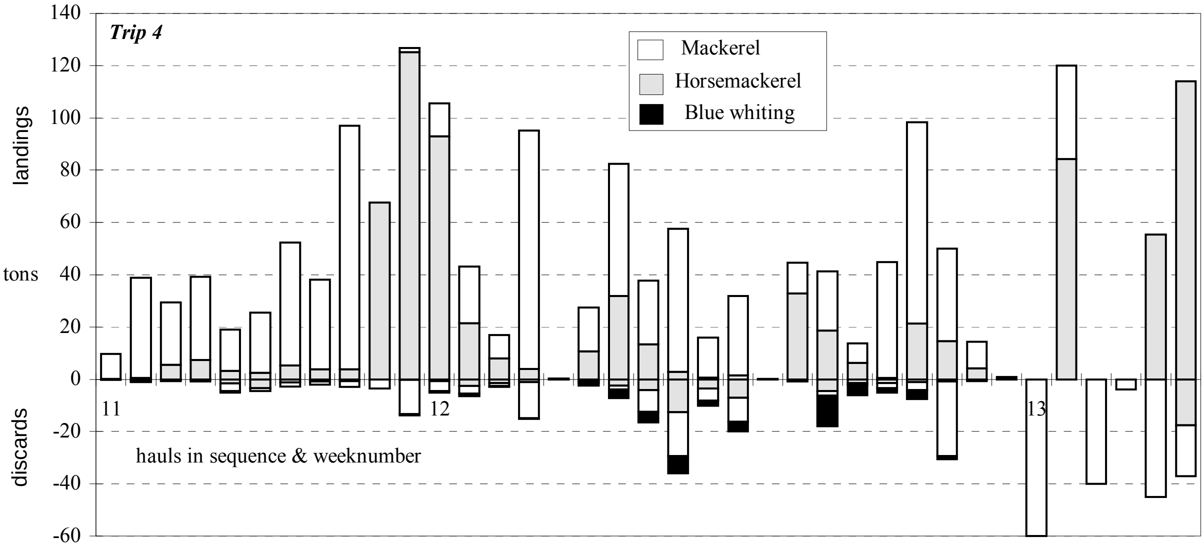


Figure 109 : Landings and discards by haul during trip 4 - week 11-13, 1995; 37 hauls

Part of the total catch has been discarded for storage capacity reasons on two occassions. In haul no. 15, an estimated 10 tons of the catch has been slipped out of the trawl because the tanks were full. In the last haul (no. 37), the contents of one cooling tank (18 tons horsemackerel and two tons mackerel) were discarded (via the conveyor belt) because the stores were full .

4.1.3.3.Size compositions

Figure 110 and 111 shows the length/frequency distributions of horsemackerel and mackerel. In the fishery southwest of Ireland (trip 1, 2 and 4) horsemackerel was caught in size classes 26 - 38 cm; sizes of mackerel varied between 27 and 44 cm.

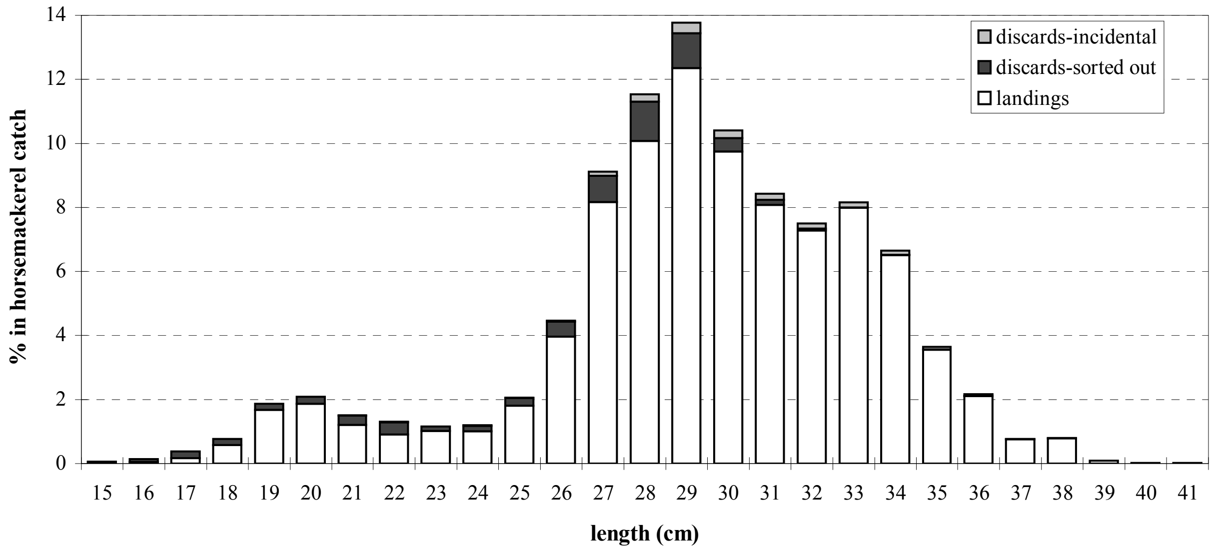


Figure 110 : Length/frequency distributions of horsemackerel (All trips).

Both horsemackerel and mackerel caught off Cornwall and in the Gulf of Biscay (trip 4) in August/September were much smaller.

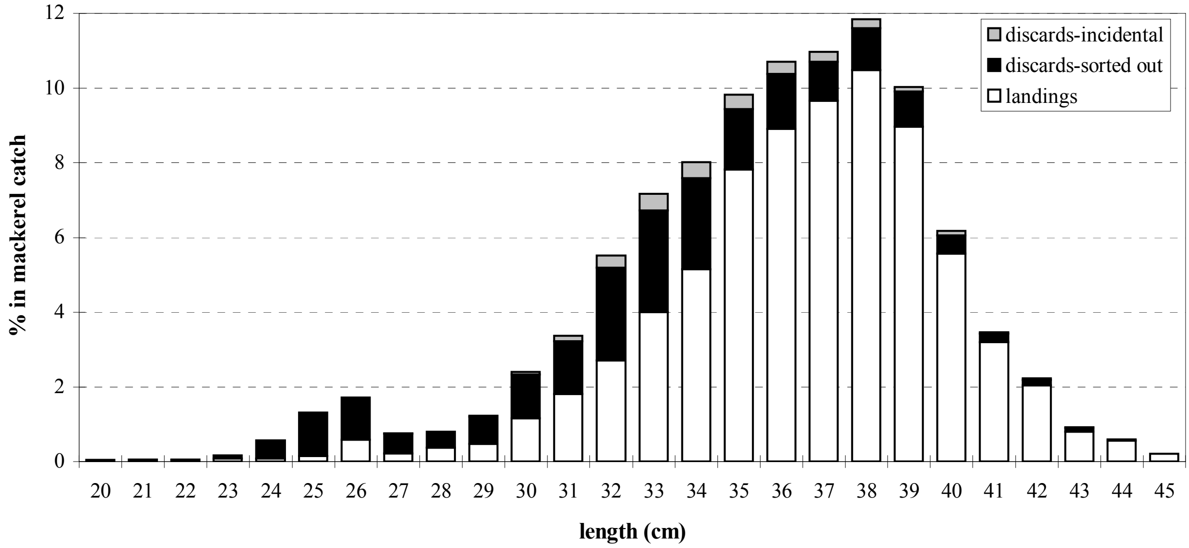


Figure 111 : Length/frequency distributions of mackerel (All trips).

4.1.4. Marine mammals by-catch

A total of six by-catch incidents of dolphins occurred during the three trips southwest of Ireland. In trip 3 there were no incidental by-catches. Table IIIc (in Appendix III) gives the data for each incident. Table IIId (in Appendix III) presents additional data for each specimen.

The number of by-catches is too low for further analysis. However a few aspects are worth mentioning:

- The species involved are common dolphin (*Delphinus delphis*) and white-sided dolphin (*Lagenorhynchus acutus*).
- The dolphins caught in trip 1 were located with their beaks towards the inlet of the pump, which explanes the scratches on the head. These were caused by the pointed fishbones of mackerel and horsemackerel running at high speed along the dolphin's head. The two common dolphins of the first by-catch incident in trip 2 were located with their tail towards the inlet. The flukes of the smaller specimen were torn of during pumping and were found later on the conveyor belt.
- In five out of six incidents the bulk of the catch consisted of mackerel.
- In five out of six incidents the body (minimum) temperatures were rather high. This suggests that the dolphins got trapped (and died) during - or shortly before hauling. The state of rigor mortis of one specimen and the red colored scratches in two of the three specimens also indicate that the animals died shortly before - or during the hauling operation.
- All incidents occurred during the night or early morning. Unfortunately it is not known exactly how many hauling operations were conducted during night or dawn. However, as fishing went on day and night during all trips, and night hauls mostly have a longer duration, more hauling operations must have been conducted in daylight than at night.

4.2. DISCUSSION

4.2.1. Fish

The reasons for discarding different parts of the catch are not well understood, but they are variable. Horsemackerel, mackerel, blue whiting and pilchard of good quality (any size, undamaged and fresh) are always marketable. However, the mackerel quotum is too low to avoid discards, even if only caught as by-catch. On average, every vessel is able to catch its annual mackerel quotum in one or two trips. The skipper and the crew members at the conveyor belt are well aware that the quotum for mackerel gets full anyhow and try to save part of the quotum for the rest of the year. If possible the skipper will try to leave the larger part of the quotum to the period October - January when the fish are fat. However, another important consideration is that mackerel occurs as by-catch during the entire year and is in fact more easy to catch than the two major target species, horsemackerel and herring. Keeping mackerel on board is a way to fill the stores faster and to keep the trips short.

In addition to quotum limitations, mixed catches in terms of size and species composition present a problem. The grading machine and the conveyor belt allow the crew to sort the catch in 4 different species/size components. If the catch consists of more than 4 components some of these will be discarded, even if they are marketable in principle.Therefore mixed catches generally result in more discards because of grading problems. Not surprisingly mackerel will often be the species to be sorted out at first. However, if big and middlesized mackerel represent the majority of the catch, horsemackerel of different sizes, will propably be discarded.

The part of the catch that is discarded because of direct damage caused by the fishing operation has not been assessed. For horsemackerel it is propably less than 1%, but for mackerel this percentage is higher, because the bony parts of horsemackerel cause damage in mixed catches.

The four trips described in this report cover about 3% of the effort of the fleet on a year basis. However, only the fishery for horsemackerel in February/March southwest of Ireland and the fishery for horsemackerel in late summer in the western approaches of the Channel have been investigated. It is therefore not possible to make a reliable quantitative estimate of the total amount of annual discards for the whole fleet. The experience presented shows that the Dutch pelagic fishery is a very selective one. Of the total catch 7% was sorted out during the four trips, and 5% was lost in a few incidents (bursting net, limited storing capacity and quotum limitations). In these cases one cannot really speak of "discarding", but in our figures these quantities have also been included because for stock assessments it is important to know how much fish is actually killed by the industry. The largest problem in this fishery is undoubtedly the imbalance between the quotas for horsemackerel and mackerel. This imbalance occasionally forces fishermen to discard mackerel, in order to keep the total landings of this species within the company quota.

According to the fishermen, it becomes gradually more difficult since 1993 to find horsemakerel and to avoid the bycatch of mackerel. This is propably due to the decrease of the stock of western horsemackerel. For several years the fishery for horsemackerel has been based on the extremely large yearclass of 1982 (Anon. 1994). If there is not produced a similar strong yearclass in the near future, the horsemackerel stock will keep decreasing. If the fleet does not find other fishing area's outside EU-waters, it is to be expected that discarding of by-caught mackerel will increase in the coming years.

4.2.2. Marine mammals

The number of by-caught mammals does not warrant further analysis. The observations of dolphins being caught during the night or in the early morning, mainly with mackerel catches, are similar with the findings of another project (Couperus, 1994). In this project, concerning the by-catch of marine mammals by Dutch freezer trawlers, skippers have been asked to report and if possible to land incidental by-caught dolphins for research purposes.

In five of six incidents the high body temperature, the state of rigor mortis and red colored injuries indicate that the dolphins got trapped during hauling. As explained in section 2, it regularly occurs during fishing that the net is hauled to the surface to change the towing direction ("turning on the doors"). This procedure is likely to increase the number of by-caught animals, compared to a haul of the same duration in which the towing direction is not changed meanwhile.

Preliminary results of Couperus (1994) indicate that 90% of the recorded by-catch incidents occur in the period January-April. The most frequently by-caught species is the Atlantic white-sided dolphin (85%), followed by common dolphin (7%) and pilot whale (7%) and bottlenosed dolphin (1%). These percentages contrast highly with the observations of free living cetaceans which were mostly common dolphins and pilot whales and also with the by-catches in the French driftnet fishery for albacore. The albacore fishery operates in September in almost the same area but in deeper water. Here no white-sided dolphins have been caught in 1989 and 1990 (Goujon et al). In this fishery striped dolphin (Stenella coeruleoalba; 64-69%) and common dolphin (24%) were the main by-caught species.

The number of dolphins taken from January to April by freezer trawlers varies considerably from year to year. From 1993 and 1995 relatively low numbers of incidents have been recorded, whereas in 1994 many more were recorded. It is not possible to estimate, on the basis of our observations, the average annual by-catch with any precision. According to reports of the fishermen, the years 1993 and 1995 were more represenitive for the 'normal' situation than 1994. For a reliable estimate, it is imperative that the observer program is continued for at least another 2 years.

5. CONCLUSIONS

Fish: the total amount of discards, incuding slipping, varied from 3% to 19% of the total catch, on average 11.8 %. Half of the discards consisted of horsemackerel, the other half of mackerel. Other species were negligable. While horsemackerel was the target species, 30.8% of the total catch consisted of mackerel. Part of this (5.4% of the total catch) was discarded for quotum considerations or for reasons of high grading. Most of the horsemackerel discards was related to one accident. The part which was sorted out systematically (high grading) was 1.4 % of the total catch.

Since only 3 % of the annual effort of the fleet has been covered by this project, it is not possible to make an account of the yearly discards of the fleet.

The results of the three observer trips in February and March southwest of Ireland suggest that mackerel catches and discards at the end of February and March are much higher than in the first half of February.

Marine mammals: six by-catch incidents occurred, in which nine animals (five white-sided dolphins and four common dolphins) were involved. The dolphins were caught during three trips in the fishery for horsemackerel southwest of Ireland in February and March. Information from another research project indicates that most incidents occur from January to April.

INDEX

Chapter IV :

By-catch and Discarding in the Celtic Sea Pelagic Trawl Fisheries

Authors :

S. BERROW, M. O'NEILL AND D. BROGAN

1. INTRODUCTION

There is little information on fisheries interactions in Irish waters but recent work has attempted to quantify the incidental capture of marine mammals in gillnet fisheries in Ireland (Berrow, Tregenza & Hammond, 1994). Estimate of whiting discards is reported to be around 20 % (Anon., 1992) in the Irish fishery without any precise reference of a particular study. As part of a collaborative study of the impact of fisheries on non-target species the incidental capture and discarding practices in Irish pelagic fisheries were to be studied.

2. DESCRIPTION OF THE PELAGIC TRAWL FISHERIES IN IRELAND

2.1. LANDINGS

Pelagic fisheries account for 83% (1992 figures) of the total fish landed into Irish ports. The pelagic fleet is highly specific with three species (herring, *Clupea harengus*, horsemackerel, *Trachurus trachurus*, mackerel, *Scomber scombrus*) accounting for 97% of total landings (Figure 112). Mackerel and horse mackerel are fished mainly by the pelagic fleet operating out of Killybegs, Co Donegal and the main herring fishery operates off the South and South-west coast, in the Celtic Sea.

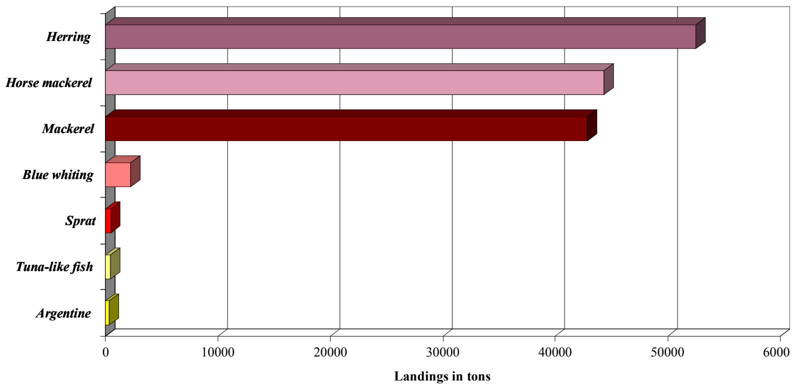


Figure 112 : Total landings of fish (tonnes) at Irish ports in 1992.

In the Celtic sea fishery, most herring was landed during December 1994 and January, 1995 into Cobh, Co Cork and Dunmore East, Co Waterford (Table 21). The TAC for this herring fishery during 1994-95 season was 18,000 tonnes.

Port	October 1994	November 1994	December 1994	January 1995	February 1995
Cobh	916	1216	2418	1700	895
Dunmore East	125	362	3403	1769	
Dingle	198	64	453	826	1027
Castletownbere	647	936	250	126	
Fenit	53	57			
Baltimore	451	111	9		
Schull	55				
TOTAL	2444	2746	6533	4421	2039

Table 21 : Landings (tonnes) of herring from the Celtic Sea herring fishery, 1994-95 (from data supplied by the Department of the Marine).

2.2. DESCRIPTION OF THE FLEETS

2.2.1. Mackerel/Horse mackerel pelagic fishery

There were 59 vessels registered in Ireland with a license to fish mackerel/horse mackerel during 1994-95. They ranged in size from 15.4 to 64.9m in length (Figure 113) and from 34.3 to 1988 GRT (Figure 114) but most licensed boats were between 16-34m and <400 GRT, however the majority of the total tonnage landed is caught by the large RSW (Refrigerated Seawater) tank boats.

Prior to the 1994-95 season there were 22 RSW involved in this fishery. Seven of these vessels are around 25m in length, nine are 33m and six 45-57m however new vessels have recently joined the Irish pelagic fleet. Irish boats travel to the Northern North Sea in October at the start of the mackerel season to fish and land their catch into local ports such as Bergen, Norway or Lerwick, Shetland. The fishery operates out of Irish ports from around January to April depending on the movement of the fish. The season ends in April/May when the fish disperse into deeper water off South-west Ireland to spawn and they are no longer economic to fish. Most fish are landed into Killybegs, Co Donegal and Castletownbere, Co Cork.

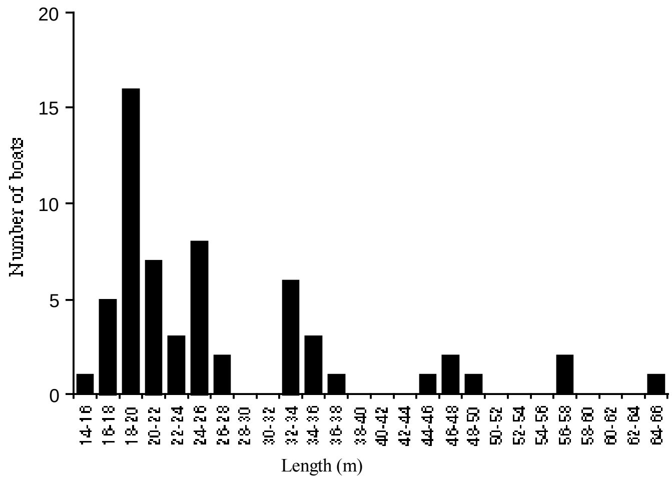


Figure 113 : Registered length of licensed mackerel boats, 1994-95.

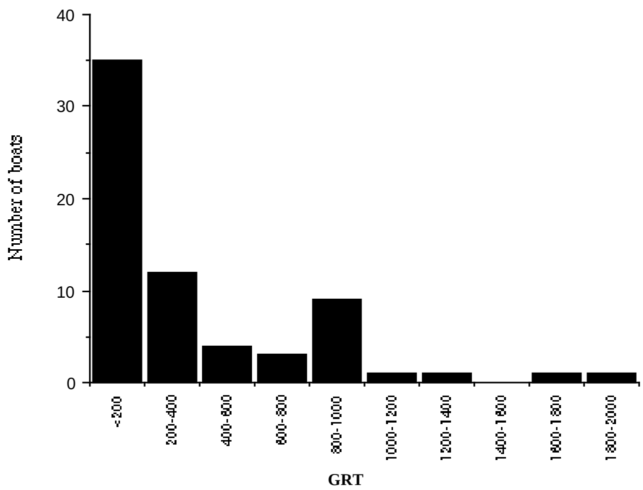


Figure 114 : Registered GRT of licensed mackerel fleet, 1994.

2.2.2. Celtic Sea herring fishery

The Celtic Sea herring fishery is perhaps the most important single fishery within the Irish fishing industry (Molloy, 1994). In 1992 the fishery was estimated to be worth IR£3.5 million and the majority of the catch is utilised by the Japanese roe market.

The stock that supports this fishery migrates inshore to traditional spawning beds between Carnsore Point, Co Wexford and Loop Head, Co Clare. Spawning takes place during November and January and the stock is managed as two main spawning components i.e. the autumn and winter spawning components or stocklets (Molloy, 1994).

There was a rapid increase in international catches of herring from the Celtic Sea to 30,000-40,000 tonnes per annum during the 1950's and 1960's following an increase in fishing effort from the Dutch fleet and introduction of paired mid-water trawling by the Irish fleet which increased their efficiency. The catch peaked in 1970 at around 44,000 tonnes but declined through the 1970's due to the quotas being set too high and eventually the Celtic Sea fishery was closed in 1977 as a fisheries conservation measure. The fishery was reopened in 1982 and the Department of the Marine has attempted to allow a Total Allowable Catch (TAC) of around 20,000 tonnes per annum. According to Molloy (1994) if this TAC is to be maintained, it is essential to eliminate discarding in this fishery.

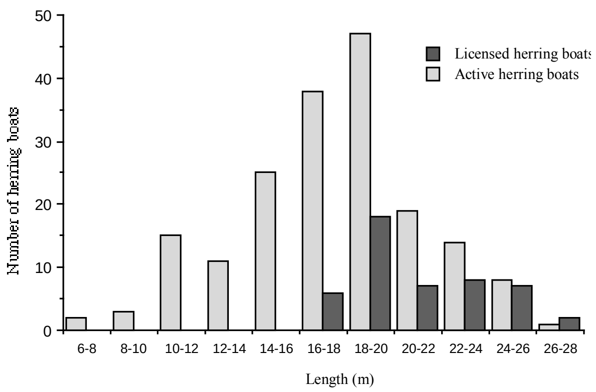


Figure 115 : Registered length of the Irish herring fleet, 1994-95.

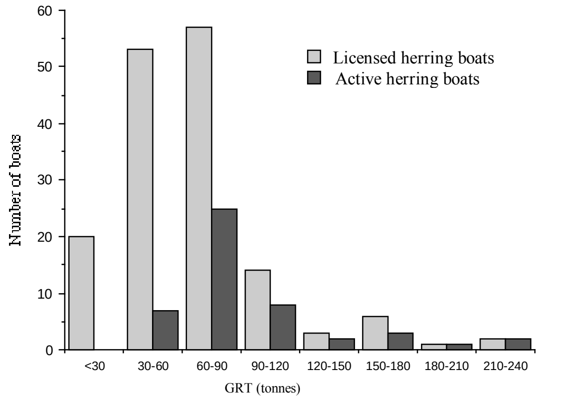


Figure 116 : Registered GRT of licensed and active herring boats, 1994-95.

There were 184 Irish registered vessels licensed to fish herring in the Celtic Sea during the 1994-95 season but only 49 vessels actually fished during the season. Licensed boats ranged from 7.6 to 25.7m in length (Figure 115) and from 20 to 233 Gross Registered Tonnes (GRT) (Figure 116) but only the larger vessels actually entered the fishery. The 1994-95 Celtic Sea herring fishery opened on the 9/10/94 and closed on 17/2/95. The number of vessels fishing increased from 20 at the beginning to a peak of 49 during January (Figure 117).

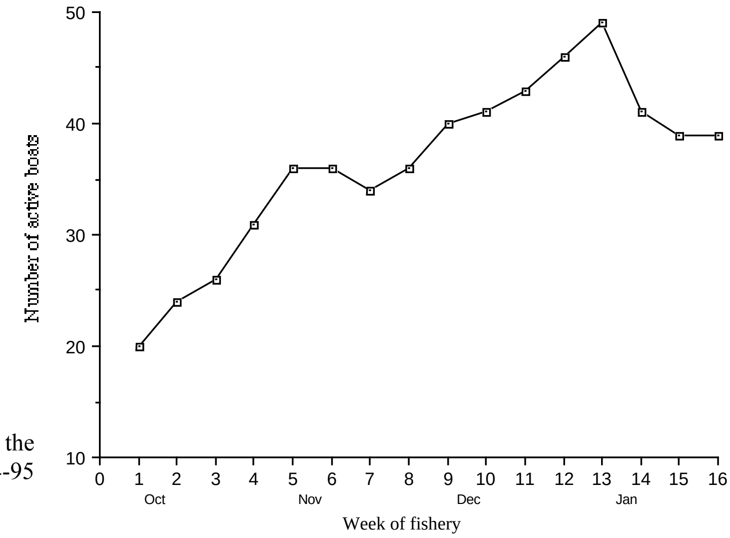


Figure 117 : Number of boats active in the Celtic sea herring fishery 1994-95 (Week1=9/10/94)

3. METHODOLOGY

3.1. AGREEMENT

The Killybegs Fishermens Organisation (KFO) was approached in October, 1993 for co-operation with this study to place fishery scientists onboard these RSW vessels to record bycatch and discarding practices in the mackerel fishery. No co-operation was obtained and it was not possible to study this fishery.

The Irish South & West Fishermens Organisation was approached and after consultation with the herring fishermen provided full co-operation for this study to be carried out during the 1994-95 Celtic Sea herring season.

3.2. OBSERVATIONS AT SEA

Fishery scientists accompanied commercial fishing vessels for the duration of a fishing trip. All monitored vessels were pair trawlers where a single mid-water trawl is towed by two vessels one on each side of the net and were between 21-25m in length and 78-200 GRT. The dimensions of the net openings were around 15-20m high and 20-30m across and were towed at around 4 knots. Only the catch by the vessel with the fisheries scientist onboard was monitored as it was not possible to observe the partner vessel. All vessels monitored lifted the catch into the vessel and did not use fish pumps which enabled direct access to the catch on each lift.

3.3. CATCH ASSESSMENT

On each fishing trip a record was kept of the location of the vessel, the time, duration and depth of each tow and depth of water. The tonnage of fish caught was estimated by recording the number of lifts into the vessel, recording the number of bins filled when unloading the catch and from consultation with the fishermen who can often asssess very accurately the amount of fish caught.

On recovery of the catch into the boat each tow was sampled by collecting a box of fish (45-50kg) from the middle of the tow whenever possible. All species in the sample box were identified and measured (total length). Species noted in the catch but not recorded in the sample box were also recorded but not quantified. For larger species such as marine mammals the unit of sampling was the tow as the whole catch brought into the vessels was observed.

Non-target species caught are expressed as a proportion of total weight and individual fish are assumed to be on average the same weight as herring. As the most frequently recorded non-target species were whiting and mackerel of lengths 25-30cm this assumption seems reasonable. Raising factors with which the sample statistics are raised to the total catch are therefore expressed simply as the number and proportion of fish in the sample.

4. BY-CATCH AND DISCARDING IN THE IRISH HERRING TRAWL FISHERY : RESULTS AND DISCUSSION

4.1. RESULTS

4.1.1. Characteristics of the sampled tows

A total of 85 observer days were spent at sea between October 23rd 1994 and January 27th 1995. During this period a total of 78 tows were monitored with a total fishing effort of 6,065 minutes towing (Table 22). Most fishing effort was monitored during December, 1994 (43%), with only 5% sampled in October, 1994. During the study period 1,258 tonnes were monitored and assuming a TAC for the fishery of 18,000 tonnes (J. Molloy pers. comm.), then 7% of the TAC for this fishery was monitored.

Month	Observer days at sea	Number of tows	Duration of tows(minutes)	Proportion of total sampled tows (%)
October	3	4	330	5
November	27	18	1740	29
December	23	30	2580	43
January	32	26	1415	23
TOTAL	85	78 (1)	6065	100

Table 22. Number of days at sea and fishing effort sampled. (1) : one tow was not sampled.

The number of observer days at sea and tows sampled is shown in Figure 118. There was a peak in observer days at sea during November (Week 46) but was similar during December and January. The number of tows per day at sea was greatest in December (Weeks 50 and 51) and January (Week 2).

Herring shoals are located by echo-sounders, sounding below the vessel. Once a suitable shoal is located the net is shot.

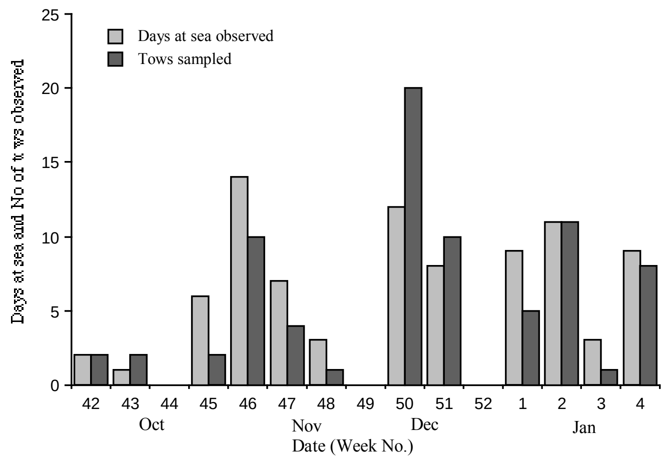


Figure 118 : Observer days at sea and tows sampled during Celtic Sea herring fishery, Oct 1994 - Jan 1995.

4.1.1.1. Duration

78 tows monitored most were between 20-120 minutes in duration with a peak at 100 minutes (Fig. 119). One tow was only 10 minutes in duration and the maximum was 170 minutes.

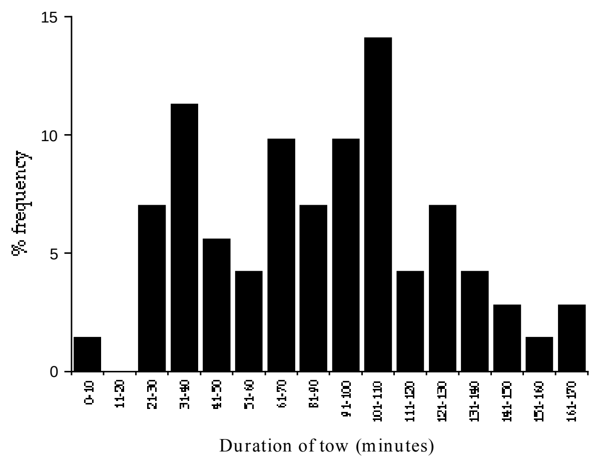


Figure 119 : Frequency distribution of the duration of tow (n=78).

4.1.1.2.Location

Most observed fishing effort was carried out close inshore in ICES VIIg 01, VIIg 02 and VIIa 20 (Figure 120). The number of fish and quality of the autumn spawning stock of herring was poor this year and this is reflected by the small amount of fishing effort off South-west Ireland (ICES VIIj 06 and VIIj 09).

The depth of water fished is shown in Figure 121. Depth of water fished ranged from 25-75m in depth with a peak at 26-30m and 46-50m. Fishing effort had a similar distribution to water depth with two peaks at 21-25m and 31-40m. This reflects the boats attempt to catch spawning herring which tend to occur closer to the sea bed.

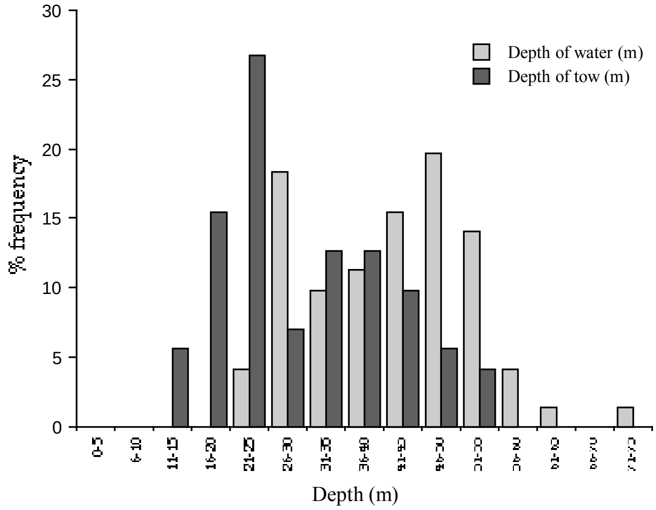


Figure 121 : Frequency distribution of depth of water and depth of tow (n=78).

Figure 121 : Map of fishing effort and ICES blocks

4.1.2. Catch, by-catch, and discards of fish

4.1.2.1. Catch composition in the samples

The most striking characteristic of the sampled fish catch is the very high selectivity of the fishery. Herring accounted for 95% by weight of the total fish landed (Figure 122).

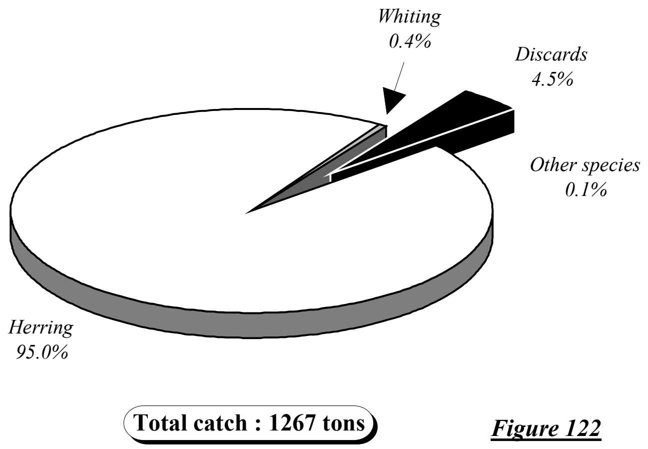


Figure 122

The presence of bycaught species in the entire catch were recorded for 46 tows. Of the 20 species recorded, whiting *Merlangius merlangus* was the most frequently recorded non-target species occurring in 37 of monitored trawls with mackerel (15 tows) and cod *Gadus morhua* (13 tows) also regularly recorded. Recorded in the other category were species recorded in less than 4 tows and this included scad, megrim *Lepidorhombus whiffiagonis*, hake *Merluccius merlucciu*s, red *Aspitrigla cuculus* and grey gurnard *Eutrigla gurnardus*, dragonet *Callionymus lyr*a, conger *Conger conger*, dab *Limanda limanda*, monkfish *Lophius piscatorius*, lesser spotted dogfish *Scyliorhinus canicula*, spurdog *Squalus acanthias*, squid *Todoropsis* and octopus *Eledone cirrhosa*.

4.1.2.2. Variability between tows

The proportion of herring, the target species, in the sample from each tow ranged from 75.6-100% but accounted for over 98% of the sample on 60 (78%) tows (Fig. 123).

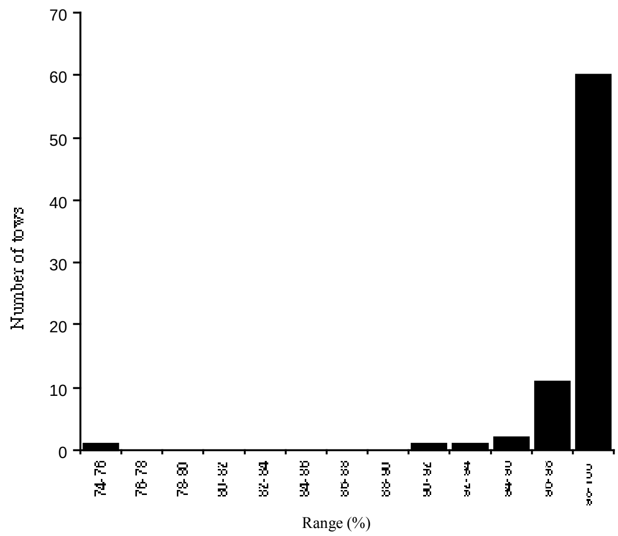


Figure 123 : Proportion of herring (%) in sample from each tow (n=77).

The tonnage of fish landed and discarded in each tow is shown in Fig. 124. The total amount of monitored fish caught in each ICES block is shown in Table 23. Most fish (45%) were caught in ICES block VIIa 20 and the total amount of fish caught on all the sampled trips was 1,266 tonnes. Most fish (44%) was caught and landed during December, 1994 and the least (3%) in October 1944 (Table 4).

Table 23. Total fish caught and discarded (tonnes) in each ICES block.

ICES block	Landed	Discarded	Total
VIIj 06	53	1	54
VIIj 09	31.4		31.4
VIIg 01	563		563
VIIg 02	177.3	2	179.3
VIIg 03	106.8	53.5	160.3
VIIa 20	278.4		278.4
TOTAL	1209.9	56.5	1266.4

4.1.2.3.Discards

Of the 1,266 tonnes caught during the sampling trips 56.5 tonnes (fig. 125) were discarded at sea which is an overall rate of 4.7% (Table 24). Most fish were discarded in January. Of the 56.5 tonnes of fish discarded 53.5 (95%) was caught in ICES block VIIg 03 with only 2 tonnes (4%) caught in VIIg 02 and 1 tonne in VIIj 06. If we compare this discard rate to the total amount caught in each area then one half (50 %) of all the fish caught in ICES VIIg 03 was discarded but less than 2% in VIIg 02 and VIIj 06.

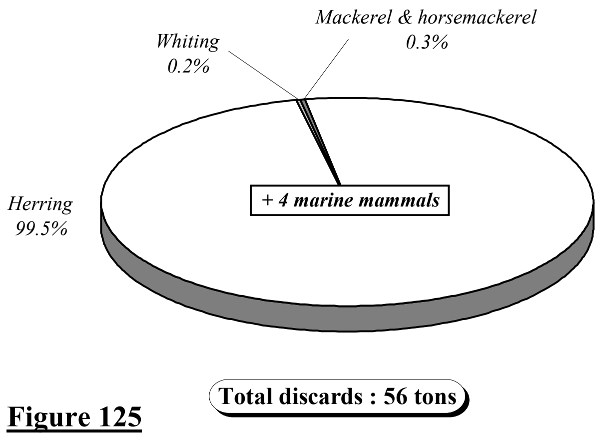


Figure 125

Reasons for discarding (Table 25) at sea varied but most fish were discarded due to poor quality and quota restrictions which resulted in the fishermen only landing high quality fish to maximise the profits from their quota. One catch was discarded due to a high proportion of small herring in the catch and one for a high proportion of mackerel (6.4%) which may have been rejected at the market. Both these catches were very small (1 and 2 tonnes) and not worth landing. Early in the season (October/November) few fish were being caught and markets were accepting all fish including poor quality fish. As the fishing improved and more fish were being landed the markets were more selective only wanting herring with a high proportion of spawn. During December and January fishing vessels were restricted by the Department of the Marine which allocated weekly quotas to each boat to ensure the TAC for the fishery was not exceeded. These restrictions combined with market demands resulted in one discard of poor quality fish to maximise financial returns on fish landed. Thus most discarding was for trade reasons but overall discard rates were low during the 1994/95 season.

Month	Landed	Discarded	Proportion of total (%)
October	31.4	1	3.2
November	178.7	6.9	3.9
December	544.6	12.6	2.3
January	455.2	36	7.9
TOTAL	1209.9	56.5	4.7

Table 24. Total fish observed caught and discarded in the Celtic Sea Herring fishery, 1994-95.

Reasons for discarding	Weight discarded (tonnes)	% of total discards
Unmarketable species	2	3.5
Undersized fish (herring)	1	1.8
Poor quality (herring)	17.5	31
High grading (herring)	36	63.7

Table 25. Reasons for fish discarding.

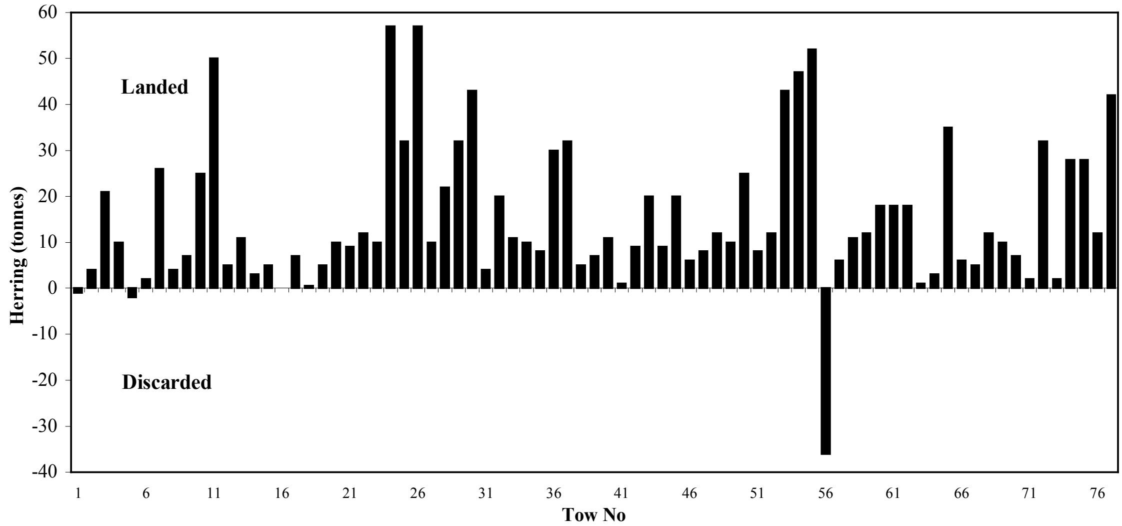


Figure 124 : Herring landed and discarded on each tow (from 23/10/94 to 25/1/95)

4.1.2.4.Size compositions

4.1.2.4.1.Herring

Herring made up 99.5% of the total weight of fish landed. The mean length of herring varied between tows and months but the modal length was around 26-27cm (total length) for each month with a second peak at 22cm in November and smaller fish (12-13cm) occurring in December and January (Fig. 126).

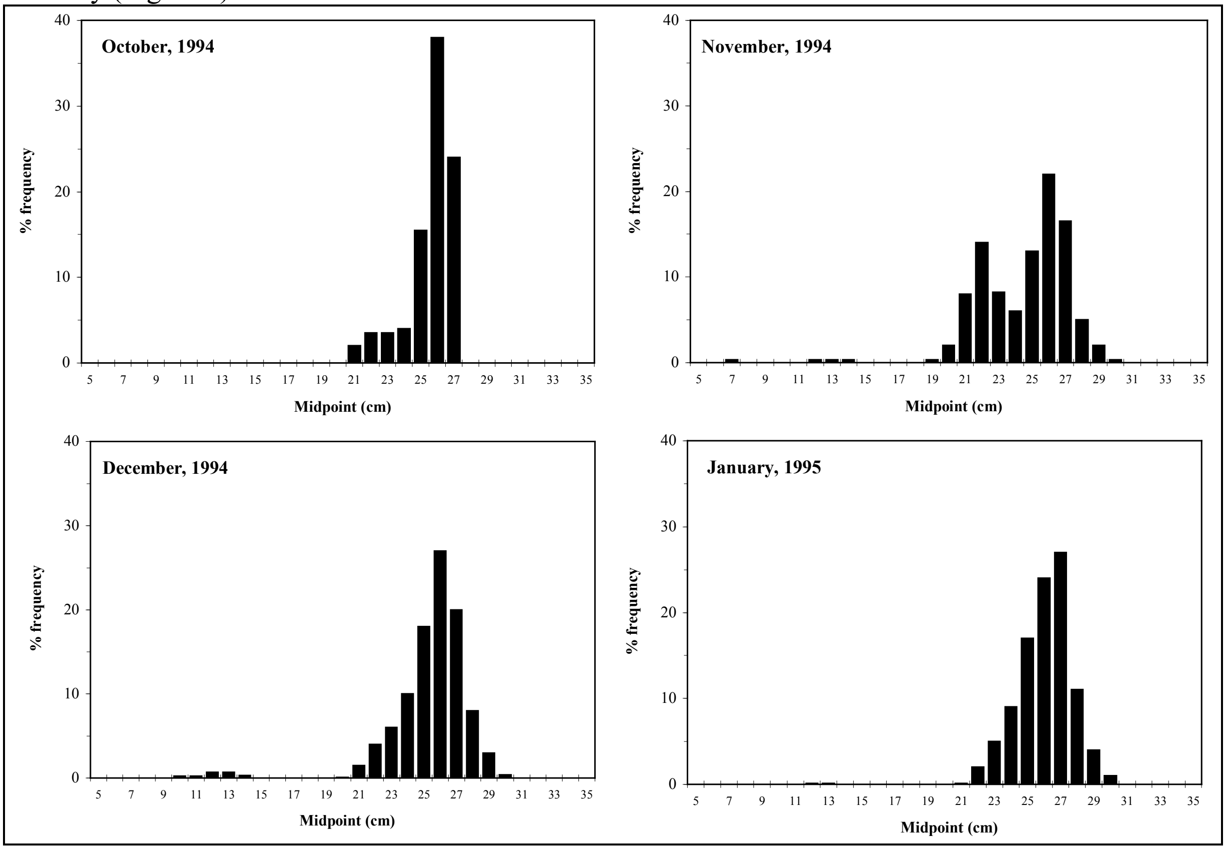


Figure 126 : Monthly length frequency distribution of landed herring.

Figure 127 shows the length frequency distribution of landed (all months) and discarded herring. Discarded fish were smaller than landed fish.

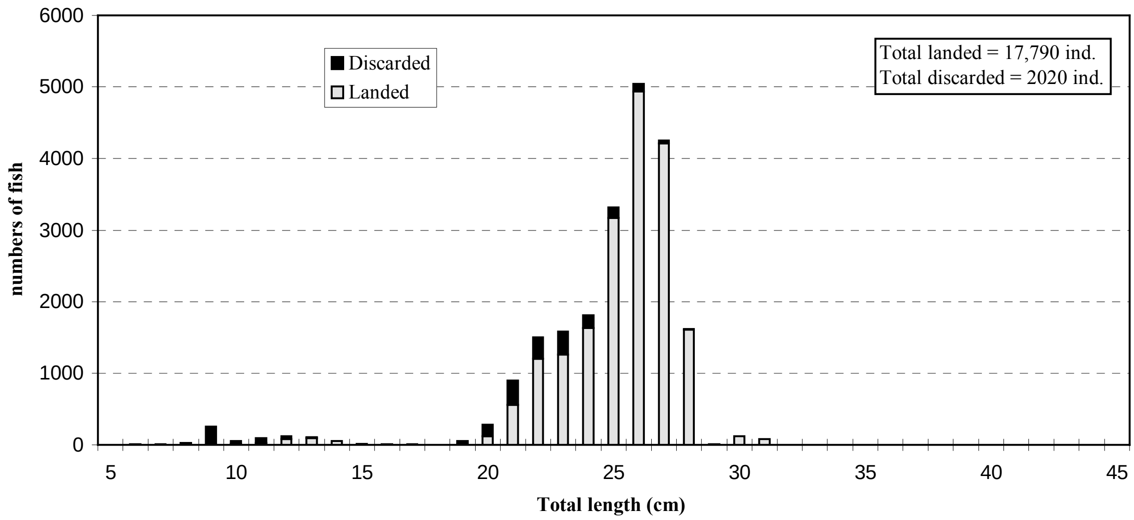
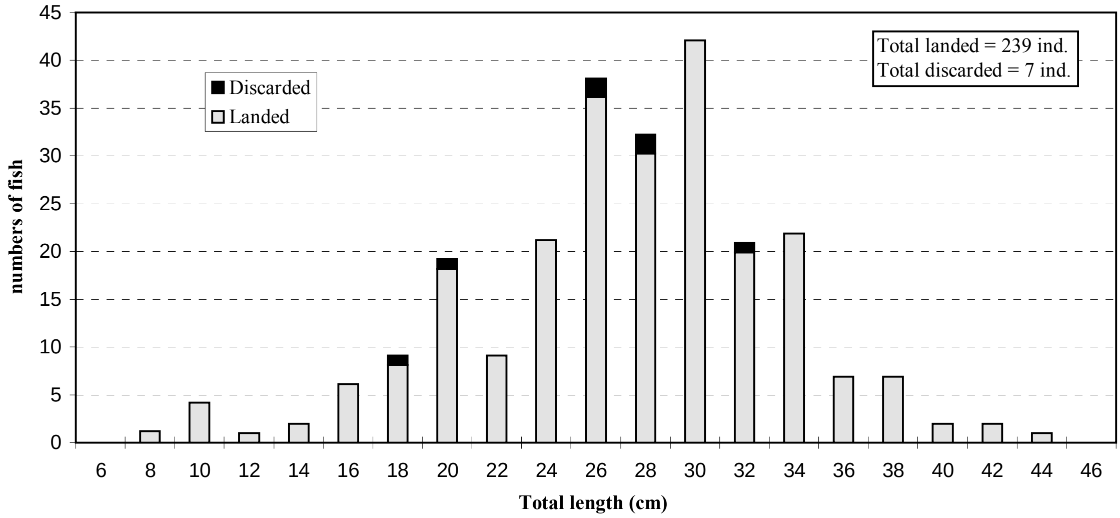


Figure 127 : Length frequency distribution of landed herring (all months).

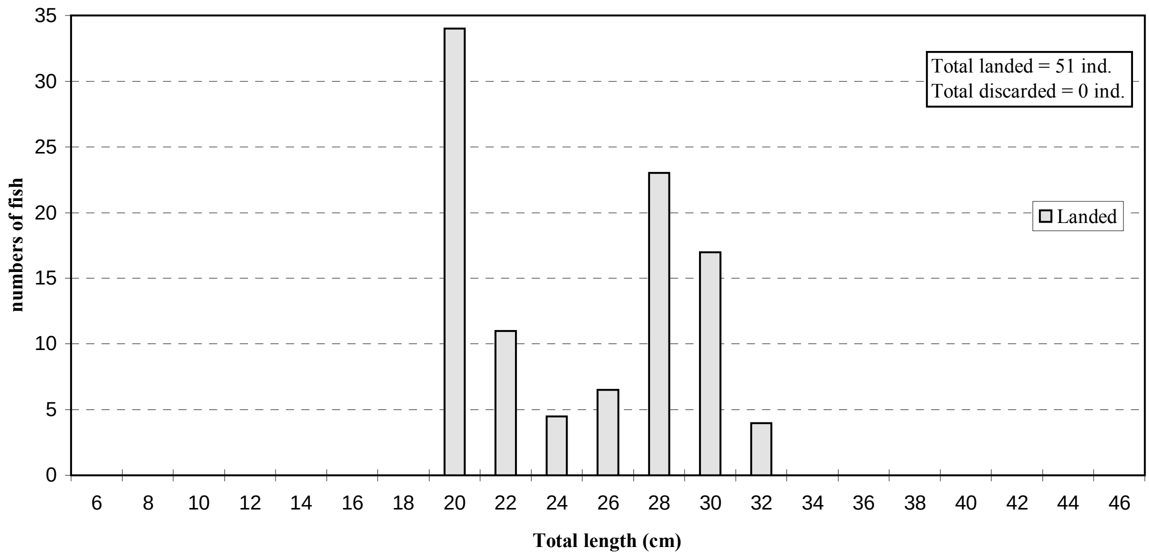
4.1.2.4.2.Whiting

Whiting were the most frequently recorded non-target species in the present study. Sizes ranged from 9-43cm (total length) but peaked at 26-30cm (Fig. 17) only slightly larger than the herring caught. There was no difference in size between landed and discarded whiting. Landed whiting along with other whitefish were occasional sold at auction by the crew but had no commercial value to the fishery.



4.1.2.4.3.Mackerel

Mackerel were the second most frequently recorded non-target species. Mackerel ranged in size from 19-34cm in length with a mean of 24.8cm. The length frequency distribution is shown in Fig. 18. Horse-mackerel or scad measured 18-23cm (mean 20.6cm) in length but were only rarely recorded.



4.1.3. Marine mammal by-catch

The only marine mammals recorded were single grey seals *Halichoerus grypus* which were recorded from 4 tows. All individuals were adults measuring 1.7-1.9m and when sexed (n=2) were male. Post-mortem examination showed that seals had been feeding on herring at the time of death.

4.2. DISCUSSION

Pelagic fisheries in Ireland are very specific being reliant on three species, mackerel, horse-mackerel and herring and account for 83% by weight of fish landed into Irish ports. Despite this large fishing effort their is virtually nothing known about the incidental capture of non-target species including marine mammals or the discarding of fish at sea.

4.2.1. Discarding practices

Molloy (1994) stated that to maintain the TAC for the Celtic Sea herring fishery discards must be eliminated. The overall discard rate in the 1994/95 Celtic Sea herring fishery was 4.7 %. The discard rate was probably less than previous years as the low abundance of herring especially earlier in the season meant market demand was high and quota restrictions limited. When discarding did occur it was usually for reasons associated with market demands such as high grading for quality and size. Undoubtedly the heavy reliance on the Japanese roe market encourages discarding when fish quality is poor or fish are spent. Diversification of markets may help to minimise discarding.

4.2.2. Marine mammal bycatch

There is little information on the interaction between pelagic fisheries and cetaceans in Ireland. Berrow & Rogan (in prep.) found only one reference in the literature concerning incidental capture in trawl nets involving a single minke whale off Co Sligo. There is evidence to suggest that a bycatch of white-sided dolphins occurs in mackerel fisheries off the Irish coast as the distribution of strandings reflect fishing effort and dolphins have been found with recently ingested mackerel in their stomach (Berrow & Smiddy, 1989; Berrow & Stark, 1990). There is also some evidence of a possible interaction between harbour porpoises and herring fisheries of the Cork coast; Smiddy (1984; 1985) found a seasonal peak (November and December) in harbour porpoise strandings which matched the distribution of fishing effort in the area. Anecdotal information suggests that up to 50 dolphins may be taken in a single tow by Irish pelagic trawlers.

During the present study no cetaceans were caught in any of the monitored trips in the Celtic Sea herring fishery. Four harbour porpoises seen at the mouth of Cork Harbour (51_45'N, 8_13'W) on 11 January were the only cetaceans observed during fieldwork.

Four grey seals were caught during monitored trips at a rate of 1 seal per 19.5 tows (1516 minutes tow time) or 1 seal per 316.5 tonnes of fish caught.

There was no pattern in the capture of seals which may help to identify possible methods of minimising this bycatch but seals were frequently seen feeding near to the trawl net during towing but were not always captured in the net on hauling suggesting they are opportunistic feeders around trawls. Although seals are frequently seen near to nets they are rarely caught and it is unlikely that this catch rate will affect the grey seal population as they are common in Irish waters.

The results of this study on the incidental capture of marine mammals by Irish pelagic fisheries is inconclusive. There is no or minimal incidental capture in the Celtic Sea herring fishery but other pelagic fisheries need to be studied. As one of the biggest fisheries in Ireland and certainly the fishery with the largest vessels, the mackerel/horse-mackerel fishery based in Killybegs, Co Donegal should be studied to quantify incidental capture.

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Chapter V :

By-catch and Discarding in Pelagic Trawl Fisheries :

General Discussion and Conclusion

Authors in alphabetic order:

H.J.L. HEESSEN, Y. MORIZUR, S. POUVREAU,
AND
N.J.C. TREGENZA.

GENERAL DISCUSSION AND CONCLUSION

1. FISH

The main species (first target or secondary target) caught by the investigated pelagic fisheries are as follows :

- Small pelagic species :
  Anchovy (VIII a, b)
  Pilchard (VIII a ; VII e)
  Herring (VII g)
  Mackerel (VII e)
  Horsemackerel (VII d, e, h, j ; VIII a)

- Large pelagic species :
  Albacore (VIII a, b, c, d)
  Bluefin tuna (VIII a, b, c, d)

- Semi-demersal or demersal species :
  Sea bass (VII e ; VIII b)
  Black bream (VII e)
  Hake (VIII a, b)
  Whiting (VIII a, b)

1.1. Comparison between the investigated fisheries

1.1.1. Sampling effort

Sampling effort varied from 3 hours to 486 hours of towing in the fisheries.
The less investigated fisheries (<50 tow hours) were French pilchard, French black bream, French anchovy, UK pilchard
The more investigated fisheries (>100 tow hours) were Dutch horsemackerel, French hake, French tuna, Irish herring.

An estimate of the sampling rate in each fishery as a fraction of annual effort sampled) is given in the following table :

Table 26 : Comparison between the estimates of the sampling rate in each studied fishery.

Fishery	Sampling rate
French anchovy trawl fishery	0.03 %
French pilchard trawl fishery	0.11 %
French horsemackerel trawl fishery	0.35 %
French hake trawl fishery	0.31 %
French tuna trawl fishery	1.60 %
French black bream trawl fishery	0.10 %
French sea bass trawl fishery	1.60 %
Dutch horsemackerel trawl fishery	3.00 %
UK SW mackerel trawl fishery	4 %
SW England pilchard trawl fishery	28 %
Celtic sea herring trawl fishery	7.00 %

1.1.2. Selectivity in the fishing operations

The main results of this study are summarized in the Table 27. The percentage by weight of the landed target in the catches varied from 31 % to 95 % according to the fisheries. The total discarding rate varied between 2 % and 56 %.

Per ton of target species landed, the discards ranged between 20 kg and 1 510 kg (Table 28). Fisheries can be rank from the lowest discarded quantity to the highest discarded quantity as follows : French sea bass (20 kg), French tuna, Irish herring, French pilchard, UK mackerel, Dutch horsemackerel, French horsemackerel, UK pilchard, French black bream, French anchovy, and French hake trawl fishery (1 810 kg).

The French hake trawl fishery discards by far the most fishes. A great part of them is horsemackerel. In this fishery trawls are close to the bottom and sometimes near the shore. These two factors partly explain the high level of discards.

The total discarding rate in the French anchovy fishery is probably overestimated in this study due to one trip (out of 3) which occurred at the beginning of the fishing season. The two others at the main fishing season contained lower by-catches.

FISHERIES	Total discarding rate (all species)	% of the landed target in the catches	% of the target in the discards	Trawling hours observed
French anchovy trawling (VIII a, b)	(29%)	(69%)	5%	15 h 30 mn
French pilchard trawling (VIII a)	6%	93%	15%	2 h 45 mn
French horsemackerel trawling (VIII a)	17%	83%	67%	18 h 20 mn
French hake trawling (VIII a, b)	56%	31 % (hake)	10%	314 h
French black bream trawling (VII e)	19%	55%	30%	8 h 50 mn
French sea bass trawling (VII e, VIII b)	2%	91%	2%	73 h
French tuna trawling (VIII a, b, c, d)	4%	76 % (albacore)	28%	265 h 30 mn
Irish herring trawling (VII g)	4.5%	95%	99.5%	101h
UK mackerel trawling (VII e)	11%	80%	76%	72h
UK pilchard trawling (VII e)	(13%)	53% (in the landings)	(50%)	37 h 30 mn
Dutch horse mackerel trawling (VII d, e, h, j)	12%	63%	44%	486 h

Table 27 : Discarding rate by weight and percentages of the target in the catches and in the discards by fishery. Numbers of trawling hours indicate reliability of the results.

FISHERIES	Total discards per landed ton of the target species	Main discards and non target species landed	Discards per landed ton of the target species	Landings of non target species per landed ton of the target species	Trawling hours observed
French anchovy trawling (VIII a, b)	0.42 ton	**Anchovy**	0.02 ton		15 h 30 mn
		Atlantic horsemackerel	0.14 ton		
		Pilchard	0.23 ton		
French pilchard trawling (VIII a)	0.06 ton	**Pilchard**	0.01 ton		2 h 45 mn
		Med. horsemackerel		0.01 ton	
		Sprat	0.05 ton		
French horsemackerel trawling (VIII a)	0.20 ton	**Med. horsemackerel**	0.14 ton		18 h 20 mn
		Atl. horsemackerel	0.07 ton		
French hake trawling (VIII a, b)	1.81 tons	**Hake**	0.18 ton		314 h
		Atl. horsemackerel	1.20 tons		
		Pilchard	0.13 ton		
		Sea bass		0.06 ton	
		Squid		0.13 ton	
		Whiting		0.10 ton	
French black bream trawling (VII e)	0.35 ton	**Black bream**	0.10 ton		8 h 50 mn
		Pilchard	0.11 ton		
		Atl. mackerel	0.10 ton		
		Atl. horsemackerel	0.03 ton	0.38 ton	
French sea bass trawling (VII e, VIII b)	0.02 ton	**Sea bass**	0.000 ton		73 h
		Atl. mackerel	0.006 ton		
		Pilchard	0.006 ton		
		Lumpsucker	0.005 ton		
		Garfish	0.003 ton		
		Herring	0.001 ton		
		Med. horsemackerel		0.04 ton	
		European mullet		0.04 ton	
French tuna trawling (VIII a, b, c, d)	0.05 ton	**Albacore**	0.014 ton		265 h 30 mn
		Sunfish	0.033 ton		
		Bluefin tuna	0.002 ton		
		Swordfish		0.04 ton	
Irish herring trawling (VII g)	0.05 ton	**Herring**	0.049 ton		101 h
		Whiting	<0.0001 ton	0.0040 ton	
		Mackerel	<0.0001 ton	0.0006 ton	
UK mackerel trawling (VII e)	0.14 ton	**Mackerel**	0.10 ton		72 h
		Pilchard	0.03 ton	0.05 ton	
		Horsemackerel		0.06 ton	
UK pilchard trawling (VII e)	<0.25 ton	**Pilchard**	0.07 ton		37 h 30 mn
		Mackerel	0.07 ton	0.82 ton	
Dutch horse mackerel trawling (VII d, e, h, j)	0.19 ton	**Horsemackerel**	0.083 ton		486 h
		Mackerel	0.085 ton	0.41 ton	
		Blue whiting	0.008 ton		
		Pilchard	0.006 ton		
		Hake	0.001 ton		

Table 28 : Weight of discards per landed ton of the target species.

1.2. Factors determining the by-catch

Most factors determining by-catch are due to the biology of the involved species. For example mackerel and horsemackerel are often mixed in the shoal and caught at the same time. Some species are not mixed in the same shoal, but occupy the same depth level and are successively caught during trawling (for example whiting and hake).
Among the factors related to the fishing method, mesh size is one of the most frequent factors. In several case, an increase of the mesh size would probably reduce the quantity of by-catch (for example, in hake trawling, some fishermen increase the mesh size from 65 to 100 mm in order to avoid horsemackerel by-catch).
The eight most important factors are quoted by fishery in Table 29.

		Factors due to the biology of the species							
				Factors due to fishing method					
FISHERIES	**Main by-catches**	**Species mixed with the target in the shoal**	**Species with the same biotope as the target**	**Towing in areas where by-catch are present**	**Towing during season when by-catch are present**	**Towing during an hour of the day when by-catch are present**	**Mesh size**	**Aperture of the trawls / seawater depth**	**Secondary target**
French anchovy trawling (VIII a, b)	Atl. horsemackerel		**1**	**3**	**3**	**2 (if night towing)**			
	Pilchard	**1**	**2**			**3 (if night towing)**			
French pilchard trawling (VIII a)	Med. horsemackerel		**2**			**3 (if night towing)**	**1 (inner bag)**		
	Sprat	**2**				**3 (if night towing)**	**1 (inner bag)**		
French horsemackerel trawling (VIII a)	Atl. horsemackerel	**1**							
French hake trawling (VIII a, b)	Atl. horsemackerel						**1**	**2**	
	Pilchard						**1**	**2**	
	Sea bass							**1**	
	Squid		**1**						
	Whiting		**1**	**2 (inshore species)**					**3**
French black bream trawling (VII e)	Pilchard					**2 (night towing)**	**1**	**3 (shallow area)**	
	Atl. mackerel					**2 (night towing)**	**1**	**3 (shallow area)**	
	Atl. horsemackerel					**2 (night towing)**	**1**	**3 (shallow area)**	
French sea bass trawling (VII e, VIII b)	Atl. mackerel			**(2)**			**1**		
	Pilchard			**(2)**			**1**		
	Lumpsucker			**(1)**					
	Garfish			**(1)**					
	Herring			**(1)**					
	Med. horsemackerel			**2**			**1**		
	European mullet	**1**		**2**					
French tuna trawling (VIII a, b, c, d)	Sunfish		**1**						
	Bluefin tuna		**2**						**1**
	Swordfish		**1**						
Irish herring trawling (VII g)	Whiting								
	Mackerel								
UK mackerel trawling (VII e)	Pilchard	**1**	**2**					**(1)**	
	Horsemackerel	**2**	**1**					**(1)**	
UK pilchard trawling (VII e)	Mackerel	**1**	**2**						
Dutch horse mackerel trawling (VII d, e, h, j)	Mackerel	**1**			**2**				
	Blue whiting		**1**						
	Pilchard		**1**						
	Hake		**1**						

Table 29 : Importance of factors determining the by-catch by species in each fishery coded from 1 (most important) to 3 (less important).

1.3. Factors determining the discards

1.3.1. Typology of the reasons for discarding

A diagram of the successive operations is presented below. Discards can occur at each stage for several reasons (trade, technical or regulation reasons).

market

determines

target species

↓

damaged fish ← **fishing operations** → Lost fish

↓

Incidental (technical) reasons

↓

catch

↓

(locally) unmarketable species ← **target species** → protected species

↓

unmarketable sizes ← **size/MLS** → undersized individuals

↓

high-grading (to seek higher quality fish) ← **quota** → achieved quota

↓

high-grading (to reduce separation costs) ← **% by-catch%** → achieved by-catch%

↓

high-grading (limit on number of species retained) ← **processing**

↓

high-grading (to maximise profit from space in the) ← **storage place**

↓ ↓ ↓

discards for trade reasons | **retained catch (landings)** | **discards for regulation reasons**

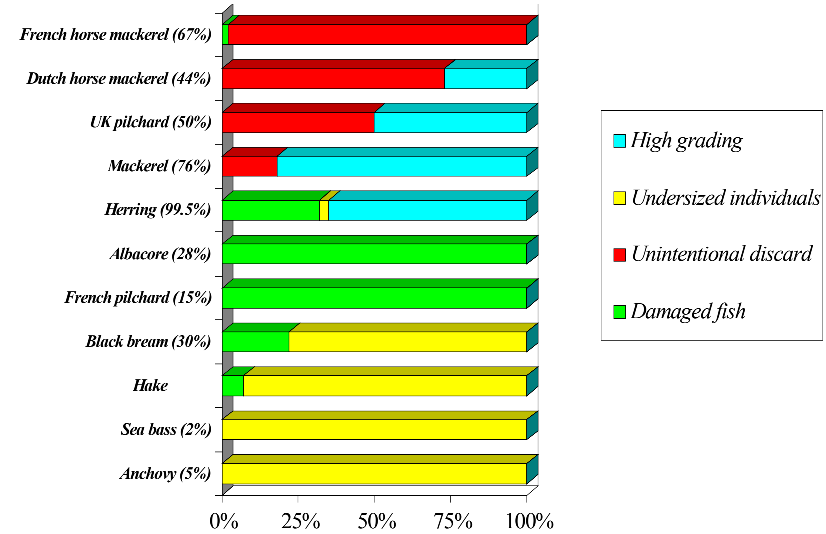
The main reasons concerning discarding in pelagic trawl fisheries are presented below.

1.3.2. Reason for discarding the target species

There are four main reasons for discarding target species :

- Undersized fish

The fisheries concerned are anchovy, sea bass, hake, and black bream. For anchovy and seabass, the discarding rate of the target is very low (< 5%), so this lack of selectivity is insignificant. But for hake and black bream fisheries, a lack of selectivity result in discarding undersized target species.



- Damaged fish

In some fisheries, the target species is discarded because of being damaged. In some cases, it is because the species is quite fragile (pilchard). In other cases, it is due to the fishing method : for example albacore is damaged when catch is the trawl is too big.

- High grading

For some pelagic species, shoals are sometimes mixed, and sorting becomes too time consuming. So discards of target species occur because of high grading.

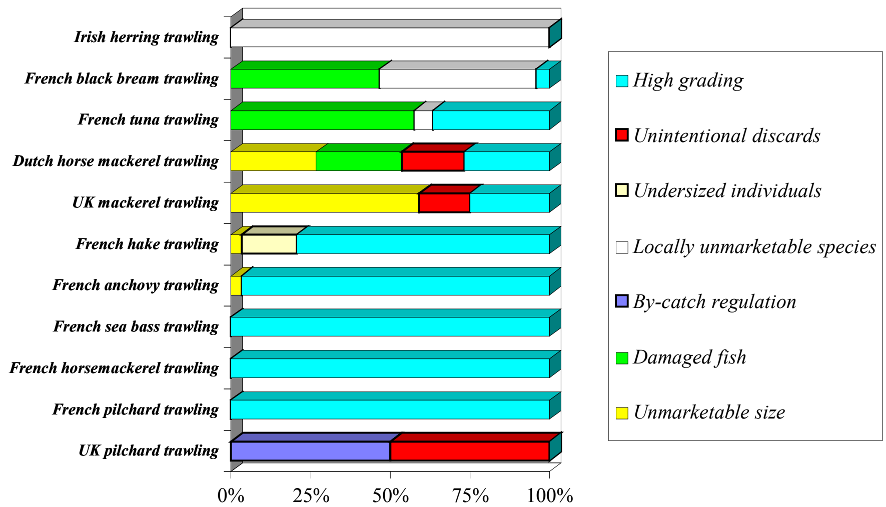
- Unintentional discards

Sometimes a part of catch is lost, because of gear failure for example. In that case, the target species cannot be retained.

1.3.3. Reason for discarding other marketable species

- High-grading

Most reasons for discarding marketable species are high grading (storage capacity, process, sort too tedious...)



- Market factors

In some cases, the absence of a local market for some species results in discarding marketable species. Discards of fish too small for the market also occur.

- Regulation (Box, MLS)

For the UK pilchard trawling, when the allowed percentage of by-caught mackerel is exceeded, fishermen discard the haul.

In Dutch horsemackerel trawling mackerel is discarded as a result of a relatively small quotum for this species, and because mackerel and horsemackerel occur in mixed shoals from the second half of February onwards.

Discards of undersized individuals (lower than the MLS) occur only in four fisheries. So, generally speaking, size selectivity appears quite high in the pelagic trawling activity.

- Technical factors

Two other factors result in discarding marketable fish :

1. Damaged fish
2. Gear failure (unintentional discards)

These factors are fairly difficult to be avoided.

1.4. Recommendations for the common policy

- **Mesh size :**

The selectivity of fishing operations need to be improved in some fisheries targeting non-pelagic species (hake and black bream fisheries).
In the French hake fishery, the landed main target hake accounted for only 31 % of the total catch by weight and around half of the target catches (hake and whiting) in numbers were below MLS. The present minimum legal mesh size is 65 mm in Region 3. A minimum mesh size of 90 mm could be enforced by regulation in order to decrease discards when hake or whiting exceed 30 % of the retained species.
In the black bream fishery, discards amount to 19 % of the total catch. A quarter of the target individuals were below the MLS (23 cm) and mostly landed for bait. The present legal mesh size is 80 mm (in Region 2), a minimum mesh size of 100 mm (or 110 mm) could be applied when black bream exceed 30 % of the retained species. A such regulation could be applied also for sea bass when sea bass exceeds 30 % of the retained species. Nevertheless the selectivity of that fishery was found to be high mainly because adults were aggregated during the spawning season.

- **Closed areas**

In the French hake trawl fishery, a greater part of the discards of hake would be avoided if trawlers did not fish in nursery areas. Furthermore inshore trawling seems to generate more discards than offshore. A closure -even seasonal- in some areas may reduce the quantity of discards in this fishery. Further investigations would be necessary to establish such a regulation.

- **Detection of the species :**

Detection of species in shoals can improve the selectivity in some fisheries (pelagic species). Research on identification by using backscattered narrow-band signals are carried out by several institutes. Results are not yet at the level required to give a high probability of discrimination and identification (Scalabrin et al., 1995).

- **Collaboration with the fishermen / agreement**

These observations at sea were readily accepted in Ireland or France as depending only of the agreement of skippers. There is no regulation to enforce them to accept scientific observation. Such regulation might be a useful part of European policy. The initiative could be given to the fisheries by a general principle that, over a period of time, those fisheries that had not been adequately observed could be phased out.

- **Further investigation**

This study only covers a fraction of what could be done. For example for the Dutch fishery, we only looked at the fishery targetting horsemackerel, and only in a small part of the year. So further investigations will be necessary to confirm these first results, especially in the French pelagic trawl fisheries (anchovy ; pilchard ; black bream according to seasons ; hake according to areas) and other fisheries need to be investigated (Irish mackerel, French mackerel and French herring).

2. Marine Mammals

2.1. Bycatch observed

Three species of marine mammal were definitely observed as bycatches :

- Common dolphin, *Delphinus delphis*. 13 specimens
- Atlantic white-sided dolphin, *Lagenorhynchus acutus* 5 specimens
- Atlantic Grey Seal, *Halichoerus grypus* 4 specimens

with one uncertain identification

- Bottlenose dolphin, *Tursiops truncatus* 1 specimen

The 18 cetaceans were distributed through 11 trawls. One group of two and 3 groups of 3 were recorded. This clumping of bycatches of cetaceans confirms anecdotal evidence, which also suggests that much larger groups are sometimes caught.
All bycaught mammals were apparently healthy and all were free within the lifting bag of the net except for one dolphin which was entangled in the forward lines of the net. They were usually adult animals and were distributed among several fisheries :

Pelagic fishery	Species of marine mammals	number
French tuna trawling	Bottlenose dolphin?	1
French tuna trawling	Common dolphin	3
French hake trawling	Common dolphin	4
French bass trawling	Common dolphin	1
Dutch horsemackerel trawling	Common dolphin	4
Dutch horsemackerel trawling	Whitesided dolphin	5
		18 cetaceans
Irish herring trawling	Atlantic grey seal	4 seals

The number of mammal bycatches is too low to allow confident discrimination of most of the factors which are thought to lead to entrapment of mammals in the NE Atlantic, but the pattern of bycatch can usefully be compared with the published data for pelagic trawl bycatches in the NW Atlantic. These have been studied by the US government since 1977, and the results reported up to 1988 by Waring *et al.* (1990) include observation of 538 bycatches. Their findings indicate that each of these factors may be significant determinants of cetacean bycatch :

- Target species of the fishery
- Prevalence of mammals coincident with the fishery
- Susceptibility of mammal species to entrapment
- Tow duration
- Level of tow in water column
- Size of net opening
- Haulback speed
- Gear design
- Daylight

2.1.1. Target species of the fishery

In the Irish study grey seals were observed feeding on the target fish species around the nets, and this may be true in many fisheries. Waring *et al.* (1990) found in mackerel and squid fisheries that bycatch rates for pilot whales, *Globicephala melas,* and common dolphins varied with the target species and catch. In these fisheries the cetaceans caught had usually been eating the target species of the fishery in which they were caught. In this study the experience of the Dutch fishery indicates common dolphins and white-sided dolphins having a preference for mackerel over horsemackerel, since bycatches of these cetaceans started to occur when mackerel began to appear in the catches. Data on the prey species of cetaceans caught in this study are not yet available but some stomach contents were collected. Tuna caught in the tuna fishery are probably too large to be the prey of the dolphins caught in that fishery.

2.1.2. Prevalence of mammals

The prevalence of mammals in the area of the fishery clearly must, at some level, be a determinant of bycatch rates. The Irish study was the only one to record the presence of seals in the area of the fishery and the only one to record their capture. In this study the UK mackerel fishery had no cetacean bycatch although 72 hours of towing were observed. This is consistent with the very low prevalence of dolphins in the area during the study. Dolphin sightings in winter (Berrow *et al,* 1992) in 1992 and 1993 around 100 km to the west of the UK mackerel fishery were approximately 25 times as frequent as recorded in this study, and the stranding of very fresh dolphins in the area of the mackerel fishery indicates that in some years dolphins do enter the area of this fishery. Dolphin sightings were made on three Dutch trips, while the only trip which caught horsemackerel as the predominant species had no dolphin sightings and no bycatch of dolphins. The Irish study recorded no dolphin sightings and no dolphin bycatch.

We conclude that low or zero bycatch rates may reflect a low or zero prevalence of mammals at the time of observation. Clearly mammal distribution does not mirror that of their prey species, and variations in this relationship may account for variability in catch rates in pelagic fisheries. This factor makes extrapolation of bycatch rates across widespread fisheries very uncertain.

2.1.3. Susceptibility of mammal species to entrapment

In this study the Irish herring fishery was operating in an area where porpoises are known to be present throughout the year, and was targeting species they are known to eat. (Berrow *et al.* 1994. Evans, 1992) The species has even been called the 'herring hog' in some localities. However none were caught in the herring fishery, or in Dutch trip 3 or the UK fisheries which also operated in areas with porpoises. Porpoises are known to be very difficult to see from fishing boats but the Irish observers did record one group. It seems likely that the absence of porpoise captures is due to behavioural characteristics. It may be that they do not approach nets closely while dolphins do, and such a difference would correspond to the behavioural differences of porpoises and dolphins at the surface in response to boats. However, Smiddy (1984, 1985) reports an association between porpoise strandings on the Cork coast and the herring fishery. Waring *et al.* (1990) note significant variations in entrapment rates which are independent of location and season and could be explained by behavioural characteristics and changes in prey species.

2.1.4. Tow duration

The Dutch observer recorded body temperatures of cetaceans and found most of them to be only a few degrees below normal temperature in life. This finding is of great interest as it suggests that cetaceans die in the net close to the time of hauling, which may indicate that some aspect of the haulback process is a major determinant of bycatch, and may be susceptible to future modification.
Tow duration was not studied by Waring *et al.* (1990) and does not emerge as a factor from our smaller data set although it may be one. No temperature measurements were made on seals.

2.1.5. Level of tow in water column

In fisheries on the continental shelf the trawl net opening may occupy more than half of the water column. The data of this study gives no indications of level of tow as a significant independent determinant of mammal bycatches. Fish and squid are known to show diurnal variation in time spent at different levels in the water column. Waring *et al.* (1990) suggest that this may explain some of the complex pattern of difference in day/night bycatch rates for common dolphins and pilot whales which they found. This variable would be almost impossible to disentangle from the depth of the target shoal without doing experimental fishing at the wrong level to catch fish. However it might prove possible to identify large differences in bycatch rates if they were related to the last few metres of proximity of the net to the surface or bottom.

2.1.6. Daylight

All Dutch dolphin bycatches were in nets hauled at night or close to dawn. French dolphin bycatches were recorded between 02.00 hrs and 08.00 hrs in the night. Waring *et al.* (1990) found that common dolphin bycatches in the mackerel fishery were at 27% of the expected rate during the day, while pilot whale bycatches were 123% of the expected rate during the day, and they treat diurnal variations as arising from associated changes such as fish or squid behaviour. In this study further analysis of data from the Dutch fishery may be capable of showing whether the bias towards night bycatches of common dolphins is due to changes is target fish behaviour or to other factors.
The size of pelagic trawl openings used in most of these fisheries exceeds the visibility distances commonly reported by human divers in the N.E. Atlantic.

2.1.7. Size of net opening

In this study the number of dolphin bycatches are too few to allow distinction of net size factors. Waring *et al.* (1990) suspect that the size of the net opening may be a significant factor determining pilot whale bycatches. Seal bycatches were in nets with comparatively small openings

2.1.8. Haulback speed

In this study the Dutch finding on temperature of cetaceans suggests that such a factor might be involved. Detailed records of net handling techniques at the end of trawls were not recorded in this study. Waring *et al.* (1990) suggest this may be a determinant of pilot whale bycatch because they are sometimes seen feeding around the net mouth at this time.

2.1.9. Gear design

This also cannot be analysed from the data of this study. Waring *et al.* (1990) suggest it may explain differences between fleets of different nations working in the same fisheries, but offer no suggestions as to which aspects of the gear may be significant.

2.1.10. Detectability of bycatch

The UK mackerel study reports that mammal bycatches may be missed when catches are pumped aboard at night.

2.2. Assessment of the catch rate

The mammal catch is summarized in Table 30. Dutch tows which were not sampled for fish have been included as these were observed for cetacean bycatches.

Fishery	Mammals	Tows	Towing hours
Irish herring	4 seals	78	101
Dutch horsemackerel	9 dolphins	216	841
UK mackerel	0	36	72
UK pilchard	0	12	35
French tuna	4 dolphins	43	265
French bass	1 dolphin	10	73
French hake	4 dolphins	52	338
French - all other	0	24	63
Overall cetacean catch	18 dolphins	471	1788

Table 30 : Marine Mammal bycatch by fishery

The overall rate, including all fisheries observed, was one dolphin per 100 hours of towing or 3.8 dophins per 100 tows. The rate varies from 1.1 to 1.5 dolphin per 100 towing hours in those fisheries where cetacean bycatch occurred.
The 95% confidence limits of the overall rate is 0.4 to 1.6 dolphins per 100 towing hours and represents the uncertainty of the average as a measure of the actual rate in the 'composite fishery' studied. The « composite fishery » represented by aggregation of all specific fisheries data does not provide a reliable basis for an extrapolation of the bycatch rate observed to the entire pelagic industry. Year on year variation is not represented by these confidence limits. The Dutch horsemackerel fishery in february and march was at a time of year chosen because it was thought to be the season of highest cetacean bycatches, and the study was thought to have been made in a year (1994) of high bycatches. Strandings data (Kuiken *et al*., 1994) indicate that the study may have been in a winter of low bycatches for the UK mackerel fishery.

Extrapolation has been made for the seal bycatch in the Irish herring fishery, as this is more uniform in terms of location and bycaught species than other fisheries studied. This yields an estimate of 60 seals in the winter of '94/95.

2.3. Biological significance of marine mammal bycatches.

The marine mammal populations subject to bycatch in these fisheries are also subject to bycatch in other fisheries. Common dolphins and bottlenose dolphins are caught in the tuna drift net fishery and in smaller numbers in set gill nets in the Celtic Sea. Whitesided dolphins are believed to be caught in the pelagic fishery for mackerel from the west coast of Ireland where reports of 50 in a single trawl have been heard.
Stock assessment of these species is still very limited. Stock boundaries are not known for any cetacean species affected by these fisheries. Population estimates have been made for the Celtic Shelf in the multinational SCANS survey of 1994 (Hammond *et al.* 1995) and for the area of the tuna drift net fishery. For common dolphins these were 61 888 (Goujon *et al* 1993) in the area of the tuna fishery and 74 449 on the Celtic Shelf and for *Lagenorhynchus* dolphins (whitesided and whitebeaked dolphins) 11 760 on the Celtic Shelf. Recent estimates of the natural rate of increase of otherwise unstressed populations of small cetaceans have ranged from 4% (Palka, P., 1994; Woodly, 1991) to a maximum of 10% each year (Barlow, 1991).

2.4. Other observations : Cetacean strandings and pelagic trawling.

The review of cetacean strandings in France (Collet and Mison in Appendix VI) shows a striking pattern of irregular winter strandings of large numbers of adult common dolphins on the Atlantic coast. The greatest peak, of more than 600 cetaceans reported in two days at the end of February 1989 in Landes and Vendee was entirely unprecedented in the strandings record. A proportion of animals in recent years have had signs of capture. No evidence was noted of infectious disease, which is the only natural cause of sudden increases in mortality known to affect cetaceans in winter. It is thought that location of death, wind and sea conditions strongly affect whether a dead cetacean strands.

No close correlation exists between quarterly figures for pelagic fishing effort (not provided here) and strandings but the analysis is subject to several confounding factors - variable wind strengths and directions, inequalities of reporting effort, etc. and a correlation may exist on a finer scale than tested.

A similar pattern of irregular winter strandings of adult common dolphins has appeared in recent years on the coast of Cornwall, SW England. Few animals had clear external signs of capture in fishing gear but very detailed post-mortem examination, with toxicology, histology etc. by Kuiken *et al*. (1994) lead to the conclusion that the peak in mortality of 1991/92 was due to a winter mackerel trawl fishery. A study of causes of death of harbour porpoises in the UK (Baker *et al.* 1992) has shown that for that species fishery interactions are the main cause of death of stranded animals. However tagging experiments on discarded porpoises in the Celtic Sea by the Cornwall Trust for Nature Conservation showed no stranding of tagged animals from the coasts around the Celtic Sea, indicating that stranding may only reflect bycatch close to the coast. (Berrow *et al.* 1994)

Our interpretation is that pelagic fisheries fit the available evidence significantly better than any other possible cause for the winter peaks in common dolphin strandings. The number of these strandings has declined in recent year and it has been suggested that this may be due to fishermen opening the abdomen on the animals before discarding to ensure that the carcass sinks. Such action by fishermen has not been observed at sea when discarding mammals in this study.

2.5. Avoidance of cetacean bycatches

At present no feasible action has been identified which would enable pelagic trawl fisheries to avoid cetacean bycatches. Confining trawling to daylight hours is impossible to enforce and not yet of established benefit. Shortening trawl duration would require more trawls to be made, and if there is a higher risk at the end of trawling this would increase bycatches.

Turning during tows may create a higher risk for cetaceans that have entered the trawl mouth, and some research on this is planned in New Zealand where large bycatches of dolphins have been recorded in pelagic trawls.

Other possibilities include transmission of sounds to frighten dolphins away; large mesh nets across the net mouth to discourage cetacean entry; and cod-end escape devices. All these might affect fish catches. The European Commission is at present funding the CETA-SEL project which is attempting to discover the behaviour of dolphins around the net using acoustic and other methods.

2.6. Implications for the Common Fisheries Policy

Bycatches of oceanic dolphins in pelagic trawling are not insignificant and require continued monitoring, because of the continuous changes in fishing practises, target species and fishing areas. Observation should not be restricted to those fisheries offering to take observers, and policy development could usefully seek to support fisheries that have obtained or actively assisted ecological impact evaluation. In any further research directed at marine mammal bycatches some measure of cetacean prevalence is important to aid the interpretation of the results.

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By-catch and Discarding in Pelagic Trawl Fisheries :

APPENDIX

APPENDIX I :

FRENCH PELAGIC TRAWL FISHERIES

LENGTH/WEIGHT RELATIONSHIPS

Les relations taille-poids utilisées sont extraites de :

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SIZE COMPOSITION OF EACH TARGET SPECIES

Species	**Anchovy**		***Albacore***		***Bluefin tuna***		***Sea bass***		***Black bream***	
	Landed	*Discarded*	*Landed*	*Discarded*	*Landed*	*Discarded*	*Landed*	*Discarded*	*Landed*	*Discarded*
Size (cm)	**4490**	**100**	**48063**	**693**	**11089**	**0**	**7000**	**3**	**1305**	**138**
2	0	0	0	0	0	0	0	0	0	0
3	0	14	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	14	0	0	0	0	0	0	0	0
6	0	14	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	14	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0
12	1980	0	0	0	0	0	0	0	0	0
13	15359	0	0	0	0	0	0	0	0	0
14	53347	0	0	0	0	0	0	0	0	0
15	68333	0	0	0	0	0	0	0	0	0
16	53759	0	0	0	0	0	0	0	76	0
17	15188	0	0	0	0	0	0	0	153	0
18	2445	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	338	23
21	0	0	0	0	0	0	0	0	1004	47
22	0	0	0	0	0	0	0	0	626	78
23	0	0	0	0	0	0	0	0	437	78
24	0	0	0	0	0	0	0	0	415	329
25	0	0	0	0	0	0	0	0	740	110
26	0	0	0	0	0	0	0	0	410	16
27	0	0	0	0	0	0	0	0	186	0
28	0	0	0	0	0	0	0	0	128	0
29	0	0	0	0	0	0	0	0	246	0
30	0	0	0	0	0	0	0	0	118	0
31	0	0	0	0	0	0	0	0	82	0
32	0	0	0	0	0	0	0	0	129	0
33	0	0	0	0	0	0	0	0	44	0
34	0	0	0	0	0	0	0	0	86	0
35	0	0	0	0	0	0	0	8	6	0
36	0	0	0	0	0	0	2	0	0	0
37	0	0	0	0	0	0	14	0	13	0
38	0	0	0	0	0	0	64	0	18	0
39	0	0	0	0	0	0	28	0	0	0
40	0	0	0	0	0	0	37	0	24	0
41	0	0	0	0	0	0	77	0	18	0
42	0	0	0	0	0	0	144	0	0	0
43	0	0	0	0	0	0	15	0	0	0
44	0	0	0	0	0	0	175	0	0	0
45	0	0	0	0	0	0	166	0	18	0
46	0	0	0	0	0	0	87	0	0	0
47	0	0	0	0	0	0	138	0	0	0
48	0	0	0	0	0	0	80	0	0	0
49	0	0	0	0	0	0	139	0	0	0
50	0	0	0	0	0	0	201	0	0	0
51	0	0	1	0	0	0	215	0	0	0
52	0	0	7	0	0	0	220	0	0	0
53	0	0	194	0	0	0	68	0	0	0
54	0	0	124	0	0	0	124	0	0	0
55	0	0	177	0	0	0	208	0	0	0
56	0	0	198	0	0	0	66	0	0	0
57	0	0	415	0	0	0	111	0	0	0
58	0	0	287	0	0	0	60	0	0	0
59	0	0	307	0	0	0	66	0	0	0
60	0	0	229	0	0	0	116	0	0	0
61	0	0	305	0	0	0	61	0	0	0
62	0	0	178	0	0	0	10	0	0	0
63	0	0	143	0	0	0	173	0	0	0
64	0	0	190	0	0	0	20	0	0	0
65	0	0	257	0	0	0	116	0	0	0
66	0	0	347	0	0	0	57	0	0	0
67	0	0	503	0	0	0	153	0	0	0
68	0	0	290	0	0	0	60	0	0	0

SIZE COMPOSITION OF EACH TARGET SPECIES (...)

Species	Anchovy		*Albacore*		*Bluefin tuna*		*Sea bass*		*Black bream*	
	Landed	*Discarded*	*Landed*	*Discarded*	*Landed*	*Discarded*	*Landed*	*Discarded*	*Landed*	*Discarded*
Size (cm)	**4490**	**100**	**48063**	**693**	**11089**	**0**	**7000**	**3**	**1305**	**138**
69	0	0	236	0	0	0	156	0	0	0
70	0	0	152	0	0	0	60	0	0	0
71	0	0	114	0	0	0	62	0	0	0
72	0	0	57	0	1	0	7	0	0	0
73	0	0	117	0	0	0	50	0	0	0
74	0	0	70	0	0	0	2	0	0	0
75	0	0	104	0	0	0	2	0	0	0
76	0	0	181	0	0	0	2	0	0	0
77	0	0	151	0	0	0	2	0	0	0
78	0	0	164	68	0	0	50	0	0	0
79	0	0	174	0	0	0	2	0	0	0
80	0	0	224	0	0	0	0	0	0	0
81	0	0	241	0	0	0	48	0	0	0
82	0	0	183	0	0	0	0	0	0	0
83	0	0	201	0	0	0	0	0	0	0
84	0	0	73	0	0	0	0	0	0	0
85	0	0	87	0	0	0	0	0	0	0
86	0	0	42	0	0	0	0	0	0	0
87	0	0	34	0	0	0	0	0	0	0
88	0	0	18	0	0	0	0	0	0	0
89	0	0	8	0	1	0	0	0	0	0
90	0	0	1	0	1	0	0	0	0	0
91	0	0	0	0	0	0	0	0	0	0
92	0	0	0	0	1	0	0	0	0	0
93	0	0	0	0	0	0	0	0	0	0
94	0	0	0	0	4	0	0	0	0	0
95	0	0	0	0	1	0	0	0	0	0
96	0	0	0	0	1	0	0	0	0	0
97	0	0	1	0	3	0	0	0	0	0
98	0	0	1	0	0	0	0	0	0	0
99	0	0	0	0	3	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0	0	0
102	0	0	0	0	0	0	0	0	0	0
103	0	0	0	0	0	0	0	0	0	0
104	0	0	0	0	2	0	0	0	0	0
105	0	0	0	0	6	0	0	0	0	0
106	0	0	0	0	1	0	0	0	0	0
107	0	0	3	0	7	0	0	0	0	0
108	0	0	3	0	3	0	0	0	0	0
109	0	0	0	0	13	0	0	0	0	0
110	0	0	3	0	10	0	0	0	0	0
111	0	0	3	0	22	0	0	0	0	0
112	0	0	1	0	9	0	0	0	0	0
113	0	0	0	0	3	0	0	0	0	0
114	0	0	3	0	24	0	0	0	0	0
115	0	0	1	0	3	0	0	0	0	0
116	0	0	0	0	15	0	0	0	0	0
117	0	0	7	0	5	0	0	0	0	0
118	0	0	3	0	4	0	0	0	0	0
119	0	0	0	0	0	0	0	0	0	0
120	0	0	0	0	4	0	0	0	0	0
121	0	0	1	0	17	0	0	0	0	0
122	0	0	3	0	0	0	0	0	0	0
123	0	0	3	0	0	0	0	0	0	0
124	0	0	0	0	0	0	0	0	0	0
125	0	0	0	0	1	0	0	0	0	0
126	0	0	0	0	0	0	0	0	0	0
127	0	0	0	0	0	0	0	0	0	0
128	0	0	0	0	0	0	0	0	0	0
129	0	0	0	0	1	0	0	0	0	0
130	0	0	0	0	0	0	0	0	0	0
131	0	0	0	0	0	0	0	0	0	0
132	0	0	0	0	0	0	0	0	0	0
133	0	0	1	0	0	0	0	0	0	0
134	0	0	0	0	1	0	0	0	0	0
135	0	0	0	0	0	0	0	0	0	0

SIZE COMPOSITION OF EACH TARGET SPECIES (...)

Species	***Hake***		***Whiting***		***Med. Horsemackerel***		***Atl. Horsemackerel***	***Pilchard***	
	Landed	*Discarded*	*Landed*	*Discarded*	*Landed*	*Discarded*	*Discarded*	*Landed*	*Discarded*
Size (cm)	**17692**	**3355**	**1930**	**733**	**22382**	**3080**	**1490**	**8176**	**75**
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0
9	0	10	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	19	0	68	0	0	0	0	0
12	0	720	0	110	0	0	0	0	0
13	0	2655	0	432	0	0	0	0	0
14	0	2323	0	494	0	0	0	0	0
15	36	3968	140	987	0	0	0	0	0
16	129	5428	16	1628	0	0	0	0	0
17	100	6730	156	1788	0	0	0	0	0
18	305	6042	32	1706	0	0	0	6663	0
19	152	6070	156	2468	0	0	0	37559	0
20	648	6265	0	1553	0	0	0	71192	0
21	699	5884	0	1128	0	0	0	15013	0
22	730	5645	0	1314	0	0	52	3067	0
23	1020	4670	0	285	0	0	0	942	0
24	1153	2816	0	181	0	0	0	3244	0
25	1103	4575	0	180	0	0	9	0	0
26	2277	442	0	71	0	0	38	0	0
27	1972	329	43	143	0	0	47	0	0
28	2039	368	27	44	0	0	174	0	0
29	1394	179	41	0	0	0	235	0	0
30	1755	0	0	0	0	0	182	0	0
31	1047	0	619	0	0	0	289	0	0
32	1342	0	376	0	0	0	201	0	0
33	1163	0	308	0	0	0	264	0	0
34	1728	0	843	0	0	0	296	0	0
35	726	0	230	0	75	10	710	0	0
36	837	0	492	0	339	47	833	0	0
37	933	0	234	0	348	48	651	0	0
38	1270	0	451	0	1145	158	287	0	0
39	1136	0	562	0	1267	174	135	0	0
40	2013	0	189	0	3362	463	55	0	0
41	1640	0	227	0	5145	708	0	0	0
42	1679	0	59	0	4956	682	0	0	0
43	2093	0	39	0	3983	548	23	0	0
44	1416	0	161	0	3403	468	0	0	0
45	1712	0	0	0	3205	441	0	0	0
46	1153	0	43	0	2086	287	0	0	0
47	1176	0	84	0	1232	170	0	0	0
48	944	0	0	0	1111	153	0	0	0
49	567	0	0	0	1196	165	0	0	0
50	543	0	0	0	209	29	0	0	0
51	400	0	0	0	556	77	0	0	0
52	321	0	0	0	332	46	0	0	0
53	273	0	0	0	2	0	0	0	0
54	161	0	0	0	2	0	0	0	0
55	101	0	0	0	0	0	0	0	0
56	165	0	0	0	2	0	0	0	0
57	233	23	0	0	0	0	0	0	0
58	186	0	0	0	0	0	0	0	0
59	145	0	0	0	0	0	0	0	0
60	129	0	0	0	0	0	0	0	0
61	74	0	0	0	0	0	0	0	0
62	150	0	0	0	0	0	0	0	0
63	80	0	0	0	0	0	0	0	0
64	140	0	0	0	0	0	0	0	0
65	75	0	0	0	0	0	0	0	0
66	14	0	0	0	0	0	0	0	0
67	61	0	0	0	0	0	0	0	0
68	51	0	0	0	0	0	0	0	0

SIZE COMPOSITION OF EACH TARGET SPECIES (...)

Species	Hake		Whiting		Med. Horsemackerel		Atl. Horsemackerel	Pilchard	
	Landed	Discarded	Landed	Discarded	Landed	Discarded	Discarded	Landed	Discarded
Size (cm)	**17692**	**3355**	**1930**	**733**	**22382**	**3080**	**1490**	**8176**	**75**
69	17	0	0	0	0	0	0	0	0
70	62	0	0	0	0	0	0	0	0
71	20	0	0	0	0	0	0	0	0
72	31	0	0	0	0	0	0	0	0
73	25	0	0	0	0	0	0	0	0
74	8	0	0	0	0	0	0	0	0
75	30	0	0	0	0	0	0	0	0
76	15	0	0	0	0	0	0	0	0
77	11	0	0	0	0	0	0	0	0
78	24	0	0	0	0	0	0	0	0
79	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0
81	0	0	0	0	0	0	0	0	0
82	0	0	0	0	0	0	0	0	0
83	0	0	0	0	0	0	0	0	0
84	0	0	0	0	0	0	0	0	0
85	23	0	0	0	0	0	0	0	0
86	0	0	0	0	0	0	0	0	0
87	0	0	0	0	0	0	0	0	0
88	32	0	0	0	0	0	0	0	0
89	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0
91	0	0	0	0	0	0	0	0	0
92	0	0	0	0	0	0	0	0	0
93	0	0	0	0	0	0	0	0	0
94	0	0	0	0	0	0	0	0	0
95	0	0	0	0	0	0	0	0	0
96	0	0	0	0	0	0	0	0	0
97	0	0	0	0	0	0	0	0	0
98	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0	0
102	0	0	0	0	0	0	0	0	0
103	0	0	0	0	0	0	0	0	0
104	0	0	0	0	0	0	0	0	0
105	0	0	0	0	0	0	0	0	0
106	0	0	0	0	0	0	0	0	0
107	0	0	0	0	0	0	0	0	0
108	0	0	0	0	0	0	0	0	0
109	0	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	0	0	0
112	0	0	0	0	0	0	0	0	0
113	0	0	0	0	0	0	0	0	0
114	0	0	0	0	0	0	0	0	0
115	0	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0	0	0	0
117	0	0	0	0	0	0	0	0	0
118	0	0	0	0	0	0	0	0	0
119	0	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0	0
121	0	0	0	0	0	0	0	0	0
122	0	0	0	0	0	0	0	0	0
123	0	0	0	0	0	0	0	0	0
124	0	0	0	0	0	0	0	0	0
125	0	0	0	0	0	0	0	0	0
126	0	0	0	0	0	0	0	0	0
127	0	0	0	0	0	0	0	0	0
128	0	0	0	0	0	0	0	0	0
129	0	0	0	0	0	0	0	0	0
130	0	0	0	0	0	0	0	0	0
131	0	0	0	0	0	0	0	0	0
132	0	0	0	0	0	0	0	0	0
133	0	0	0	0	0	0	0	0	0
134	0	0	0	0	0	0	0	0	0
135	0	0	0	0	0	0	0	0	0

APPENDIX II :

UK PELAGIC TRAWL FISHERIES

DIAGRAM OF THE NET

LENGTH/WEIGHT RELATIONSHIPS

In analysing the results estimates of numbers are based on these data using length/weight relationships derived by MAFF from samples of mackerel from ICES Division VIIe -

1993 Quarter 4. Weight = 0.001559 length$^{3.466833}$

1994 Quarter 1. Weight = 0.002036 length$^{3.397101}$

and for pilchard -

1993 Quarter 4. Weight = 0.022608 length$^{2.679537}$

1994 Quarter 1. Weight = 0.007234 length$^{3.020219}$

Length/weight relationships for scad were not available for this area and the relationship used comes from the Institut Francais de Recherche pour l'Exploitation de la Mer from the Golfe de Gascogne.

Scad weight = 0.00719 length$^{3.03271}$

MACKEREL TRAWLING - LENGTH OF MACKEREL

Tow	Mackerel trawling Length of mackerel (cms)																						
	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
4th quarter 1993																								
M93/01	0	0	0	0	0	0	0	0	3	15	30	24	20	20	7	5	5	3	1	1	0	0		134
M93/02	0	0	0	0	0	0	0	1	1	8	16	19	8	12	8	5	4	2	0	1	0	0	0	85
M93/03	0	0	1	7	12	8	1	0	3	21	35	22	11	9	8	2	3	2	0	1	0	0	0	146
M93/07	0	0	0	4	9	7	2	3	1	6	27	11	7	7	4	6	3	1	0	0	0	0	0	98
M93/08	0	0	0	2	7	5	0	1	3	20	16	17	8	4	2	3	1	0	0	0	0	0	0	89
M93/09	0	0	0	2	3	2	1	0	1	12	28	15	9	4	2	1	0	0	0	0	0	0	0	80
M93/10	0	0	0	0	0	1	0	0	2	7	13	22	14	4	3	3	2	0	0	1	0	0	0	72
M93/11	0	0	0	0	0	0	0	0	0	4	14	16	17	14	6	4	3	3	2	0	0	0	0	83
M93/12	0	0	0	0	0	0	0	1	3	8	23	20	11	6	3	3	1	1	1	0	0	0	0	81
M93/14	0	0	0	0	0	1	0	0	1	9	21	16	11	13	9	6	3	1	0	0	0	0	0	91
1st quarter 1994																								
M94/02	0	0	0	2	3	1	1	0	0	0	1	0	0	0	1	1	0	0	1	1	0	0	0	12
M94/03	0	0	0	0	0	1	2	1	0	1	2	3	4	2	3	2	0	1	0	0	0	0	0	22
M94/04	1	5	32	46	27	6	0	1	2	1	0	1	1	0	0	0	0	0	0	0	0	0	0	123
M94/05	0	0	0	1	2	2	1	0	2	7	8	14	7	9	4	2	1	1	0	0	0	0	0	61
M94/06	0	0	0	0	0	0	0	0	0	1	9	15	10	9	7	4	2	1	0	0	0	0	0	58
M94/07	0	0	0	0	0	0	0	0	0	2	4	4	6	3	2	1	0	0	0	0	0	0	0	22
M94/08	0	0	0	0	0	0	0	0	0	1	5	5	4	5	4	2	2	1	0	0	0	0	0	29
M94/10	0	0	0	0	0	0	0	0	1	4	16	22	14	4	6	5	3	2	1	0	0	1	1	80
M94/13	0	0	0	0	0	1	1	0	1	3	10	4	3	5	3	5	3	3	2	0	0	0	0	44
M94/15	0	0	0	1	3	3	0	0	0	1	5	7	11	7	12	8	7	4	2	1	1	0	0	73
M94/17	0	0	0	0	0	0	0	0	2	14	26	18	17	9	8	3	2	1	0	0	0	0	0	100
M94/20	0	0	0	0	1	2	1	0	2	8	25	19	10	6	2	2	1	1	0	0	0	0	0	80
M94/21	0	0	0	0	0	0	0	0	2	3	14	21	12	6	8	2	2	4	3	1	1	0	0	79
M94/22	0	0	0	5	11	11	4	2	4	22	38	23	10	4	1	0	1	1	0	0	0	0	0	137

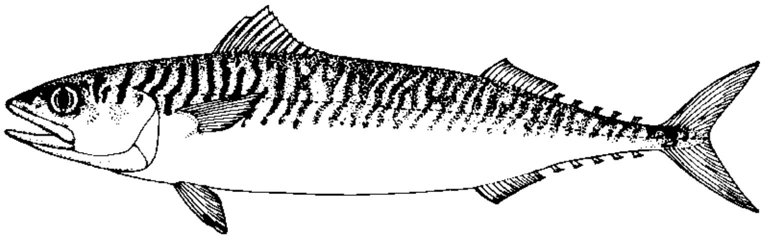
MACKEREL TRAWLING - THE TOWS

Table II a : Mackerel trawling - weight of catch, retained catch and average fish wt

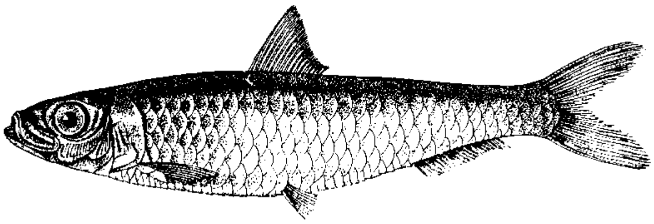
Tow	Total Haul tonnes	Tonnes of mackerel caught	Tonnes of pilchard caught	Tonnes of scad caught	Tonnes of mackerel retained	Tonnes of pilchard retained	Tonnes of scad retained
93/01	70	70.0			70.0		
93/02	70	67.2	2.8		67.2	2.8	
93/03	65	58.7	6.3		49.7	5.3	
93/04	(35)						
93/05	(35)						
93/06	50	49.2	0.8		49.2	0.8	
93/07	22.5	19.8	2.7		19.8	2.7	
93/08	20	14.5	5.5		14.5	5.5	
93/09	55	53.5	1.5		53.5	1.5	
93/10	90	88.5	1.5		88.5	1.5	
93/11	85	85.0			85.0		
93/12	50	44.4	5.6		44.4	5.6	
93/13	50	34.5	15.5		34.5	0.5	
93/14	70	69.3	0.7		69.3	0.7	
94/01	5	1.1	3.9				
94/02	6	1.3	4.6	0.1			
94/03	32.5	9.7	22.8		9.7	22.8	
94/04	95	92.5	2.5				
94/05	120	98.9	21.1		74.2	15.8	
94/06	59	56.6	0.5	2.0	56.6	0.5	2.0
94/07	58	56.7	1.3		56.7	1.3	
94/08	17	16.6		0.4	16.6		0.4
94/09	60			60.0			60.0
94/10	95	95.0			95.0		
94/11	46	44.4	0.9	0.7	44.4	0.4	0.2
94/12	5	0.5	4.5				
94/13	15.8	14.9		0.9	14.9		0.1
94/14	5	4.5	0.5				
94/15	8.5	8.4	0.1		8.4	0.1	
94/16	55	45.7		9.3	45.7		9.3
94/17	32.5	31.7		0.8	31.7		0.8
94/18	5.5	3.0	2.5		3.0		
94/19	25	25.0			25.0		
94/20	55	51.3		3.7	51.3		3.7
94/21	10	9.6		0.4	9.6		0.4
94/22	100	98.8	1.2	0.0	98.8	1.2	

THE SPECIES

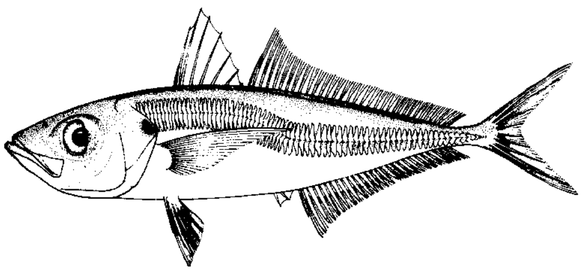
Scomber scombrus
Mackerel
Atlantic Mackerel



Sardina pilchardus
Pilchard



Trachurus trachurus
Scad
Horsemackerel



APPENDIX III :

DUTCH PELAGIC TRAWL FISHERIES

Table III a : Overview of all landings and discards in tons for each trip. Total discards were 11.8 percent.
* others = sum of blue whiting, pilchard, hake, boarfish, and whiting.

	horsemackerel	mackerel	others*	blue whiting	pilchard	hake	boarfish	whiting
TRIP 1								
landings	2934	375	0	0	0	0	0	0
discards-sorted out	27	49	10	7	0	3	0	0
TRIP 2								
landings	1752	1523	0	0	0	0	0	0
discards-sorted out	36	207	11	2	0	1	8	0
disc. gear failure:			0					
accidental	400	0	0	0	0	0	0	0
unmarketable sp.	0	0	10	0	0	0	10	0
TRIP 3								
landings	1486	62	0	0	0	0	0	0
discards-sorted out	38	70	60	4	54	1	0	1
TRIP 4								
landings	733	838	1	1	0	0	0	0
discards-sorted out	52	148	44	42	0	2	0	0
disc. gear failure:			0					
quotum	0	104	0	0	0	0	0	0
storing capacity	18	12	0	0	0	0	0	0

	horsemackerel	mackerel	others	total
TRIP 1-4				
landings	6905	2798	1	9704
discards-sorted out	153	474	125	752
disc. gear failure	418	116	10	544
total	7476	3388	136	11000

	horsemackerel	mackerel	others	total
TRIP 1-4				
landings	**62.8%**	**25.4%**	**0.0%**	**88.2%**
discards-sorted out	1.4%	4.3%	1.1%	6.8%
disc. gear failure	3.8%	1.1%	0.1%	4.9%
total discards	**5.2%**	**5.4%**	**1.2%**	**11.8%**

By-catch and discarding in pelagic trawl fisheries

area* month:	Northern Gulf of Biscay	*Southwest of Ireland*	*West of Ireland*	Porcupine Bank	*West of Scotland*	*North of Scotland*	*North of the Shetland's*	Northern North sea	Central North sea	British East coast	Channel	Under Cornwall
January	horsemackerel	horsemackerel				mackerel	mackerel					
February		horsemackerel (mackerel)	horsemackerel (mackerel)		mackerel	mackerel						
March		horsemackerel mackerel	horsemackerel mackerel	blue whiting								
April		horsemackerel mackerel		blue whiting	blue whiting (mackerel) (herring)							
May		horsemackerel mackerel			blue whiting greater argentine herring			herring	herring			
June		horsemackerel (mackerel)			herring greater argentine mackerel (horsemackerel)	herring	herring	herring	herring			
July		horsemackerel (mackerel)			herring (mackerel) (horsemackerel)	herring (mackerel) (horsemackerel)	herring	herring	herring			
August		horsemackerel (mackerel)	horsemackerel (mackerel)		herring (mackerel)					herring	horsemackerel	
September	horsemackerel	horsemackerel	herring horsemackerel mackerel							herring	horsemackerel	horsemackerel
October	horsemackerel		horsemackerel (herring) (mackerel)		herring horsemackerel mackerel		mackerel (herring)					
November	horsemackerel		horsemackerel (mackerel)		herring horsemackerel mackerel	herring horsemackerel mackerel	mackerel				horsemackerel herring	
December	horsemackerel										herring horsemackerel	horsemackerel

Table IIIb: Seasonal distribution and target species of Dutch freezer trawlers by fishing area. Species between brackets : secondary/occasional target or bycatch. * *Italics* : fishery at the continental shelf edge.

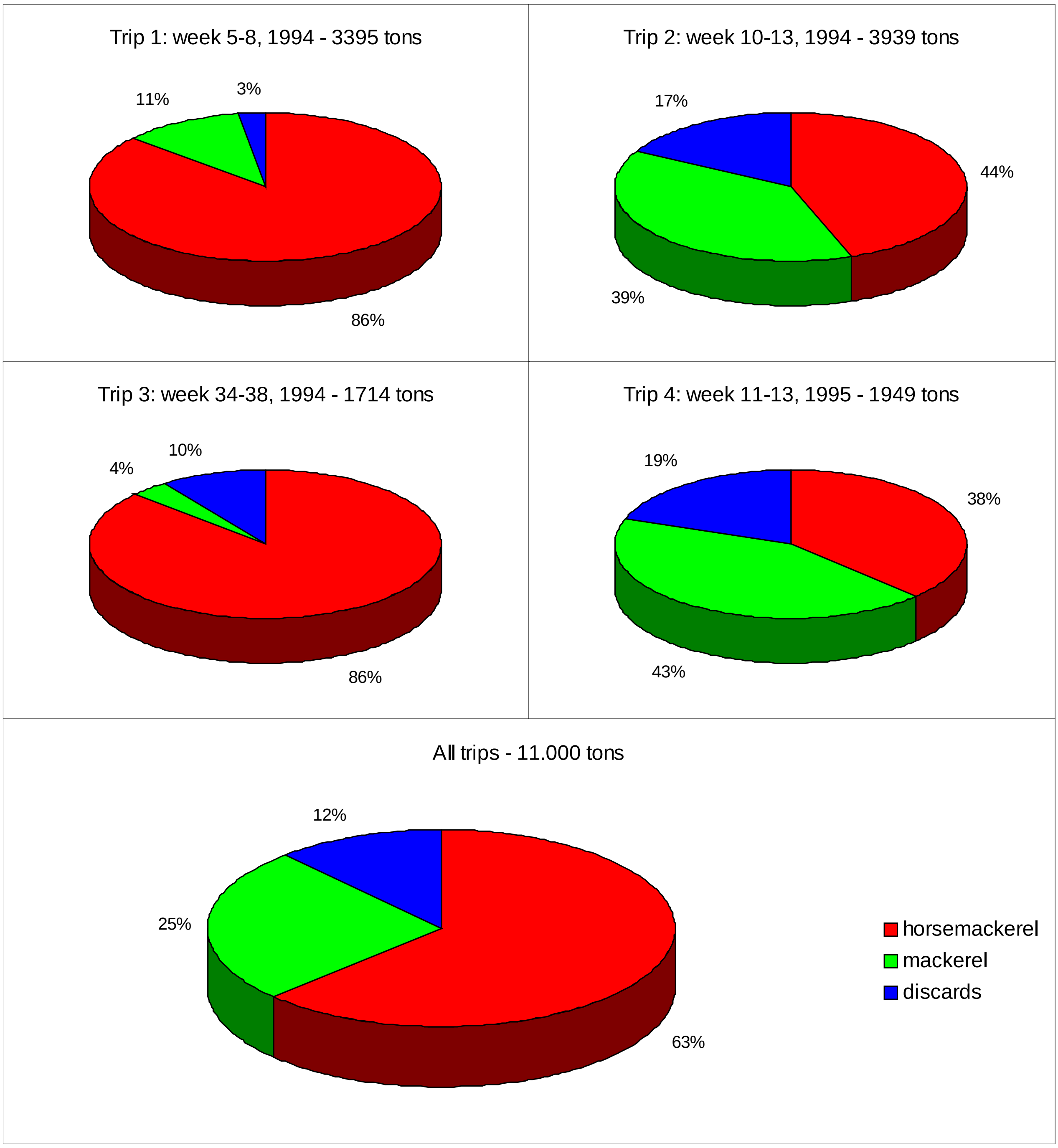


Figure III a : Composition of the total catches

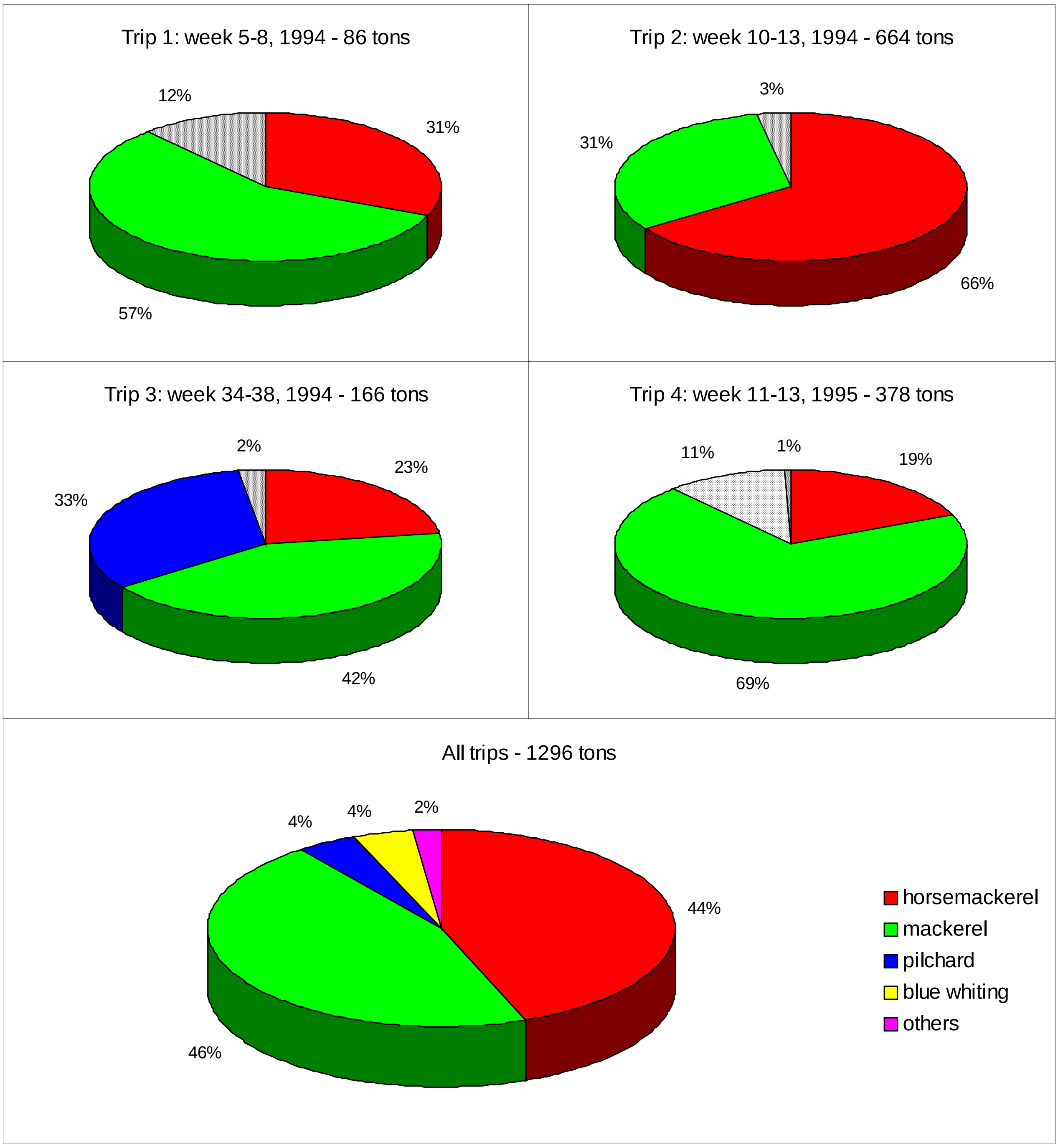


Figure III b : Composition of the total catches

Table IIIc. Data on by-catch incidents. * hmk = horsemackerel; mk = mackerel

trip	date	darkness at hauling	geogr. position	haul no.	haul duration (hrs & min.)	catch*	bycaught species	no.	dissection code
1	180294	dawn	51°31N-11°24W	39	4.45	35 tons hmk	common dolphin	1	DD 940218
1	220294	night	51°31N-11°14W	51	6.15	100 tons mk	white-sided dolphin	1	LAC 940223
1	230294	night	52°09N-11°45W	54	8.20	140 tons mk	white-sided dolphin	1	LAC 940224
2	180394	dawn	48°56N-10°39W	33	12.40	50 tons mk	common dolphin	2	DD 940318 PWS-5
2	220394	dawn	49°34N-11°07W	40	4.30	50 tons mk	common dolphin	1	DD 940322
4	220395	night	50°56N-11°06W	16	6.25	no catch	white-sided dolphin	3	LAC 950322-1
									LAC 950322-2
									LAC 950322-3

Table IIId : Data on by-caught cetaceans

Dissection-code	*Species*	*Sex*	*Length (cm)*	*Blubber thickness (mm)*	*Body temp. after landing (°C)*	*Comments*
DD940218	DD	m	203	14	35.8**	Scratches on the head (color not examined)
LAC940223	LAC	m	247	13	38	rigor mortis, red scratches on the head
LAC940224	LAC	m	263	12.5	34.2*	red scratches on the head
DD940318	DD	m	200	18	36.1	flukes missing
PWS-5	DD	m	212	22	36.3	
DD940322	DD	f	192	14	26.6	scratches on the body (not red)
LAC950322-1	LAC	m	233	16	36.2*	
LAC950322-2	LAC	m	230	18	36.9*	
LAC950322-3	LAC	f	200	12	30.7*	

DD = common dolphin (Delphinus delphis) ; LAC = white-sided dolphin (Lagenorhynchus acutus)

* : In these cases the body temperature was measured with a pin thermometer by removing a few square cm blubber and sticking the 12 cm pin in the belly.

** : Measured with a pin thermometer in the back, without removing blubber.

APPENDIX IV :

IRISH PELAGIC TRAWL FISHERIES

size compositions for Irish herring fishery		
Herring		
Total length (c	Landed	Discarded
5	0.8724	0
6	6.543	0
7	0.644	8.08
8	5.972	20.2
9	0	252.5
10	11.944	40.4
11	25.264	70.7
12	79.555	40.4
13	90.709	16.16
14	52.344	0
15	10.905	0
16	4.362	0
17	6.543	0
18	1.9629	0
19	14.125	40.4
20	121.93	161.6
21	555.172	343.4
22	1201.89	303
23	1260.206	323.2
24	1628.43	181.8
25	3173.72	141.4
26	4937.11	101
27	4212.55	40.4
28	1609.9	4.04
29	5.4525	0
30	117.774	0
31	78.516	0
32		

size compositions for Irish herring fishery						
Whiting				Mackerel		
Total length (c	Landed	Discarded		Total length (c	Landed	Discarded
6	0	0		6	0	0
8	1.23	0		8	0	0
10	4.182	0		10	0	0
12	0.984	0		12	0	0
14	1.968	0		14	0	0
16	6.15	0		16	0	0
18	8.122	0.98		18	0	0
20	18.208	0.98		20	34	17.34
22	9.102	0		22	11	5.61
24	21.156	0		24	4.5	2.295
26	36.17	1.96		26	6.5	3.315
28	30.266	1.96		28	23	11.73
30	42.066	0		30	17	8.67
32	19.93	0.98		32	4	2.04
34	21.894	0		34	0	0
36	6.888	0		36	0	0
38	6.888	0		38	0	0
40	1.968	0		40	0	0
42	1.968	0		42	0	0
44	0.984	0		44	0	0
46	0	0		46	0	0
					100	51

APPENDIX V :

LIST OF THE SCIENTIFIC NAMES OF THE SPECIES

English name	***Scientific name***
Anchovy	Engraulis encrasicolus
Mediterranean horsemackerel	Trachurus mediterraneus
Pilchard	Sardina pilchardus
Atlantic horsemackerel	Trachurus trachurus
Sprat	Sprattus sprattus
Hake	Merluccius merluccius
Sea bass	Dicentrarchus labrax
Whiting	Merlangius merlangus
Squid	Loligo sp.
Black bream	Spondyliosoma cantharus
Lumpsucker	Cyclopterus lumpus
Herring	Clupea harengus
Garfish	Belone belone
Mullet	Mugil cephalus
Albacore	Thunnus alalunga
Bluefin tuna	Thunnus thynnus
Sworfish	Xiphias gladus
Atlantic mackerel	Scomber scombrus
Sunfish	Mola mola
Poutassou	Micromesistius poutassou
Mediterranean mackerel	Scomber japonicus

APPENDIX VI :

ANALYSE OF CETACEAN STRANDINGS ON THE FRENCH COAST

APPENDIX VII :

FRENCH PELAGIC FLEET TYPOLOGY

Description de l'activité et segmentation de la flotte pélagique française.

A. Biseau, M. Jezequel et Y. Morizur

Cette analyse concerne uniquement le chalutage pélagique à caractère artisanal qui représente la plus grande partie de ce métier. Par conséquent le navire industriel Scombrus qui travaille en Mer du Nord et en Manche-Est a été éliminé. Les bateaux retenus opèrent essentiellement sur la façade atlantique (depuis le sud du Golfe de Gascogne à la Mer Celtique y compris la Manche-Ouest). La typologie permet une description synthétique des activités de cette flotte et une classification en flottilles les plus homogènes possibles afin de servir de base à un plan d'échantillonnage.

analyse typologique

Une base de données "bateau par bateau" a été constituée pour l'année 1992 par traitement des fichiers statistiques de production (appelés "CPR"). Ceci a nécessité la réalisation d'un logiciel "PELAG" écrit en fortran 77 par A. Biseau (RH/Lorient). L'année 1992 est la plus récente des années disponibles. 371 bateaux ayant armé au pélagique au cours de l'année y ont été recensés. La base contient des informations sur l'effort de pêche (bateau, mois, engins utilisés, zones de pêche fréquentées) et sur les productions par espèce.

La classification des engins et leur nomenclature est celle utilisée par le système statistique français :

932 chalut pélagique tracté par 1 navire
935 chalut pélagique à maillage <20 mm tracté par 1 navire
939 plusieurs chaluts tractés par 1 navire
942 chalut pélagique tracté par 2 navires (boeufs)
945 chalut pélagique à maillage <20 mm tracté par 2 navires (boeufs)
949 plusieurs chaluts tractés par 2 navires (boeufs).

Ces codes "engins" ont servi à la sélection des marées ayant un caractère pélagique. Certains navires travaillent en paires (boeufs). Les navires ne travaillant pas en paires utilisent un chalut à panneaux.
D'autres engins (chalut de fond notamment) peuvent toutefois être mis en oeuvre au cours de certaines marées (voyages) par ces navires.

Les 21 espèces pélagiques les plus importantes en production ont été individualisées. Les autres espèces ont été regroupées dans une variable "Autres". Les variables espèces considérées sont les suivantes:

ANCH - anchois
SARD - sardine
CHIN - chinchard
MER1 - merlu
GERM - germon
MAQU -maquereau
BAR - bar
DORG - dorade grise
MER2 -merlan
THOR - thon rouge
MULE -mulet
HARE - hareng
SEIC - seiche
ENCO - encornet blanc
ESPA - espadon
LIEU - lieu jaune
TACA - tacaud
ORPH - orphie
DORY -dorade royale
DORO -dorade rose
SPRA - sprat
AUTR - Autres especes

Les variables géographiques retenues sont :

le sud du golfe de gascogne (SG) identifiable au secteur VIIIb
le nord du golfe de gascogne (NG) délimité par le secteur VIIIa
la mer Celtique (MC) comme ensemble des secteurs VIIf,g,h,j
la Manche (MO) identifiable au secteur VIIe
le Large du Golfe (LA) rassemblant le reste des secteurs du Golfe et notamment VIIId, VIIIc, VIIIe.

Les variables quantitatives utilisées sont des pourcentages de l'activité totale pour la période considérée. Ces pourcentages concernent l'utilisation des engins, la fréquentation des secteurs et la production des espèces. Dans la problématique qui nous intéresse, les profils d'espèces permettent de prendre en compte la notion de métier au sens le plus fin. Les pourcentages dans l'utilisation des engins ont été calculés par rapport à l'ensemble des engins utilisés et pas uniquement par rapport aux engins à caractère pélagique.
La variable enginsAutres qui représente environ 50 % de l'utilisation des engins de pêche pour les navires pratiquant le métier du pélagique n'a pas été prise en compte dans les analyses.

Une analyse multivariée a été réalisée sur l'ensemble des variables décrites ci-dessus en utilisant chaque navire comme observation. L'utilisation des pourcentages a rendu possible le choix de l'analyse en composante principales (ACP) non normée. Cette technique qui utilise la matrice de variance-covariance attribue plus de poids aux variables à forte variance et donc aux variables saisonnières. Bon nombre d'espèces pélagiques sont concernées par les phénomènes saisonniers.
Cette analyse a été menée dans un premier temps sur une base globale à l'échelle de l'année et susceptible de mieux rendre compte des stratégies d'exploitation des navires.

A) sur une échelle **annuelle** :

L'histogramme des valeurs propres présenté ci-dessous montre que les 5 premiers axes maximum résument près de 80 % de l'information totale contenue dans le jeu de données.

STATISTIQUES SOMMAIRES DES VARIABLES CONTINUES EFFECTIF TOTAL : 371
POIDS TOTAL : 371.00

NUM . IDEN - LIBELLE	EFFECTIF	POIDS	MOYENNE	ECART-TYPE	MINIMUM	MAXIMUM
1 . 932 - 932	371	371.00	2.78	12.98	0.00	100.00
2 . 935 - 935	371	371.00	0.10	1.02	0.00	15.00
3 . 942 - 942	371	371.00	36.70	39.26	0.00	100.00
4 . 945 - 945	371	371.00	1.21	4.38	0.00	52.00
5 . 939 - 939	371	371.00	6.02	15.85	0.00	93.00
6 . 949 - 949	371	371.00	6.50	15.71	0.00	100.00
7 . MO - MO MANCHE OCCIDENTA	371	371.00	6.12	22.02	0.00	100.00
8 . MC - MC MER CELTIQUE	371	371.00	1.45	9.24	0.00	100.00
9 . NG - NG NORD GASCOGNE	371	371.00	52.62	41.18	0.00	100.00
10 . SG - SG SUD GASCOGNE	371	371.00	36.19	40.51	0.00	100.00
11 . LA - LA LARGE AUTRES	371	371.00	3.61	12.28	0.00	100.00

HISTOGRAMME DES 33 PREMIERES VALEURS PROPRES

NUMERO	VALEUR PROPRE	POURCENT.	POURCENT. CUMULE	
1	331.8549	33.72	33.72	**
2	178.3690	18.12	51.85	***
3	119.9385	12.19	64.03	*****************************
4	89.8610	9.13	73.16	**********************
5	56.3969	5.73	78.89	**************
6	42.2957	4.30	83.19	***********
7	37.0413	3.76	86.96	*********
8	27.0957	2.75	89.71	*******
9	18.7391	1.90	91.61	*****
10	16.0047	1.63	93.24	****
11	15.1990	1.54	94.78	****
12	11.9902	1.22	96.00	***
13	10.1958	1.04	97.04	***
14	9.6675	0.98	98.02	***
15	5.8130	0.59	98.61	**
16	4.0614	0.41	99.02	*
17	3.2289	0.33	99.35	*
18	2.0091	0.20	99.56	*
19	1.4974	0.15	99.71	*
20	1.3690	0.14	99.85	*
21	0.4392	0.04	99.89	*
22	0.3447	0.04	99.93	*
23	0.2495	0.03	99.95	*
24	0.2153	0.02	99.98	*
25	0.0959	0.01	99.98	*
26	0.0886	0.01	99.99	*
27	0.0307	0.00	100.00	*
28	0.0139	0.00	100.00	*
29	0.0074	0.00	100.00	*
30	0.0036	0.00	100.00	*
31	0.0023	0.00	100.00	*
32	0.0019	0.00	100.00	*

1

L'axe 1 oppose les pêches réalisées au Sud Gascogne de celles du Nord Gascogne. Le Sud Gascogne se caractérise par l'abondance dans les captures des espècesAutres alors que le Nord Gascogne se caractérise par la sardine. Le Sud-Gascogne se différencie aussi du Nord-Gascogne par l'usage plus fréquent de plusieurs chaluts à 1 navire alors que le Nord Gascogne est le lieu de pêche des boeufs. L'axe 2 oppose les especes Autres à l'anchois.

Le plan 1x2 représente 52 % de l'information initiale. La Manche Ouest y est bien identifiée avec de la dorade grise, de la seiche, du merlan. La Mer Celtique y est mal représentée. La dorade rose, royale, le lieu jaune, l'orphie, le sprat, le hareng, l'espadon seraient des captures accessoires aux productions peu importantes.

L'histogramme des valeurs propres indique que les deux premiers axes suffisent à résumer l'information essentielle. Toutefois le plan 1x3 permet une description selon 3 secteurs principaux. (NG, SG, MO). L'axe 3 oppose le Golfe de Gascogne à la Manche Occidentale. L'anchois qui caractérise le Golfe s'oppose à la dorade grise qui est capturée par des chaluts travaillant en boeufs avec des maillages supérieurs à 20 mm.

POINTS=CON,X=VEC 1,Y=VEC 3

```
 NOMBRE DE POINTS A REPRESENTER :   33

 TRAITEMENT DES POINTS A PLUS DE  2.30 ECARTS-TYPES DU CENTRE
 POINTS ELOIGNES :
 +--------------------------+----------+----------+
 |      IDENTIFICATEUR      | ABSCISSE | ORDONNEE |
 +--------------------------+----------+----------+
 |           NG             |   37.777 |    6.925 |
 |           SG             |  -36.037 |    7.935 |
 |           ANCH           |    5.110 |   27.556 |
 +--------------------------+----------+----------+

 NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE:          3

 NOMBRE DE POINTS REPRESENTES :   33

 POINTS MULTIPLES
 ----------+-----------+-----------+--------+---------------------------------------------------------------------------------
           | ABSCISSE  | ORDONNEE  | NB. DE |
  POINT VU | APPROCHEE | APPROCHEE | CACHES |      POINTS CACHES
 ----------+-----------+-----------+--------+---------------------------------------------------------------------------------
    932    |    0.00   |    1.46   |    1   | ANCH
    SEIC   |   -0.98   |   -0.10   |    1   | MULE
    935    |    0.00   |   -0.10   |    9   | DORY SPRA DORO TACA ORPH LIEU ESPA ENCO HARE
    THOR   |    0.00   |   -0.88   |    2   | BAR  MAQU
 ----------+-----------+-----------+--------+---------------------------------------------------------------------------------
0  4 POINTS MULTIPLES,  13 POINTS CACHES
```

```
                                                           AXE 1  *  AXE 3
 AXE 3
      ----------------------SG  -----------------------932 --------------------------------NG  -------------------------
     |                                             945  |                                                                |
     |                                                  |  949                                                           |
     |                                                  |                                                                |
 0   +------------------------------------------SEIC935 -----------------------------------------------------------------|
     |                        939         MER2          |                                                                |
     |                                                 THOR                                                              |
     |                                                 MC                                     SARD                       |
     |                                                  |                                                                |
     |                                                  |                                                                |
     |                                                  |                                                                |
     |                                                 LA                                                                |
     |                                                  |                                                                |
    AUTR                                               GERM                                                              |
-4   +                                                  |                  CHIN                                          |
     |                                                  |                                                                |
     |                                                  |                                                                |
     |                                            DORG  |  MER1                                                          |
     |                                                  |                                                                |
     |                                                  |                                                                |
     |                                                  |                                                                |
-8   +                                                  |                                                                |
     |                                                  |                                                                |
     |                                                  |                                                                |
     |                                                  |                                                                |
     |                                                  |                                                              942
     |                                                  |                                                                |
      ---+---------------+---------------+------MO  -----+---------------+---------------+---------------+---------------+
        -12              -8              -4              0               4               8              12              16
                                                                                                                      AXE 1
```

POINTS=CON,X=VEC 1,Y=VEC 2

NOMBRE DE POINTS A REPRESENTER :   33

TRAITEMENT DES POINTS A PLUS DE 2.30 ECARTS-TYPES DU CENTRE
POINTS ELOIGNES :

IDENTIFICATEUR	ABSCISSE	ORDONNEE
942	15.264	-33.138
NG	37.777	9.717
SG	-36.037	-12.644

NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE: 3

NOMBRE DE POINTS REPRESENTES :   33

POINTS MULTIPLES

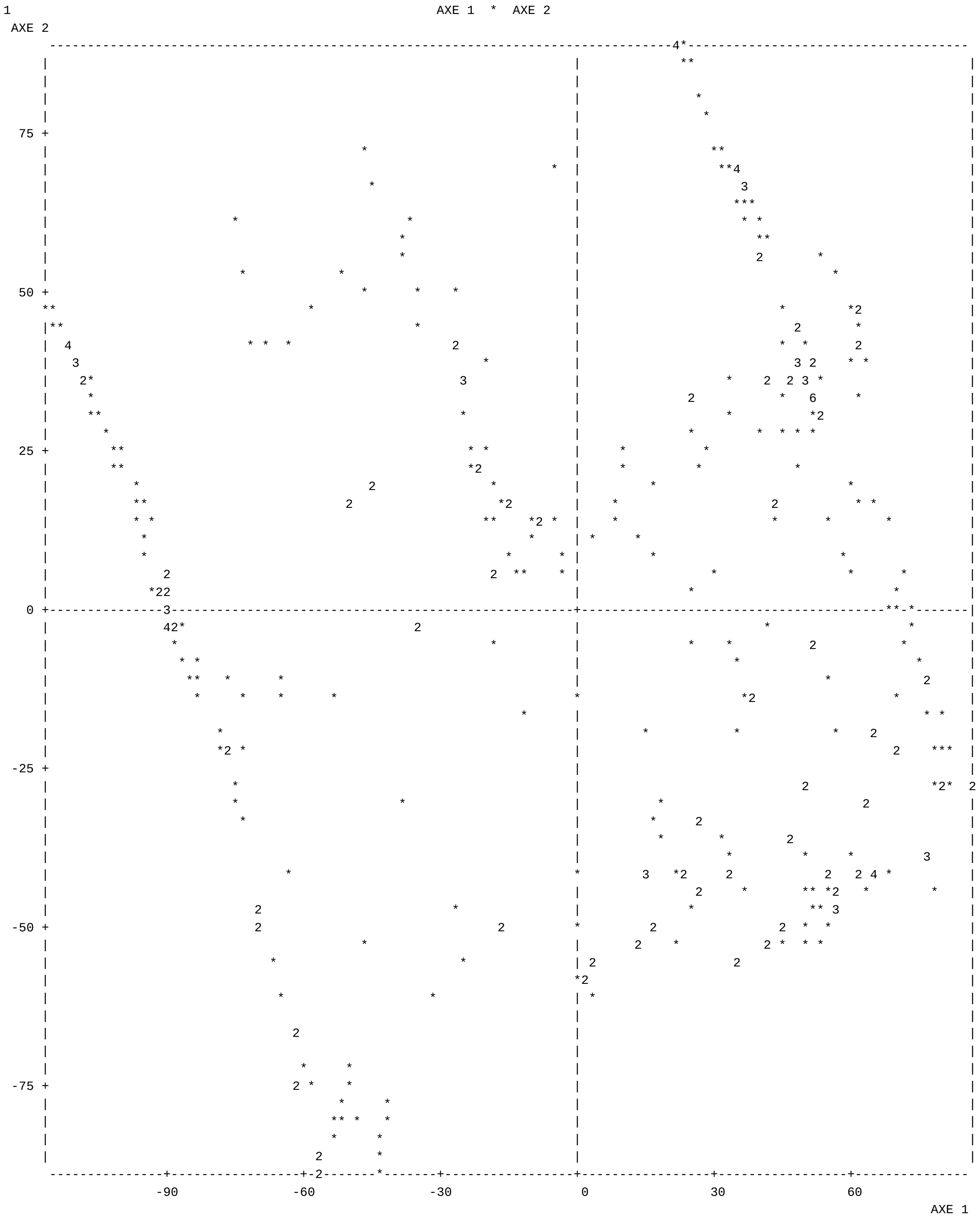
POINT VU	ABSCISSE APPROCHEE	ORDONNEE APPROCHEE	NB. DE CACHES	POINTS CACHES
DORO	0.03	0.05	7	DORY LIEU ORPH SPRA 935 HARE ESPA
LA	0.03	-0.88	1	BAR

0 2 POINTS MULTIPLES,   8 POINTS CACHES

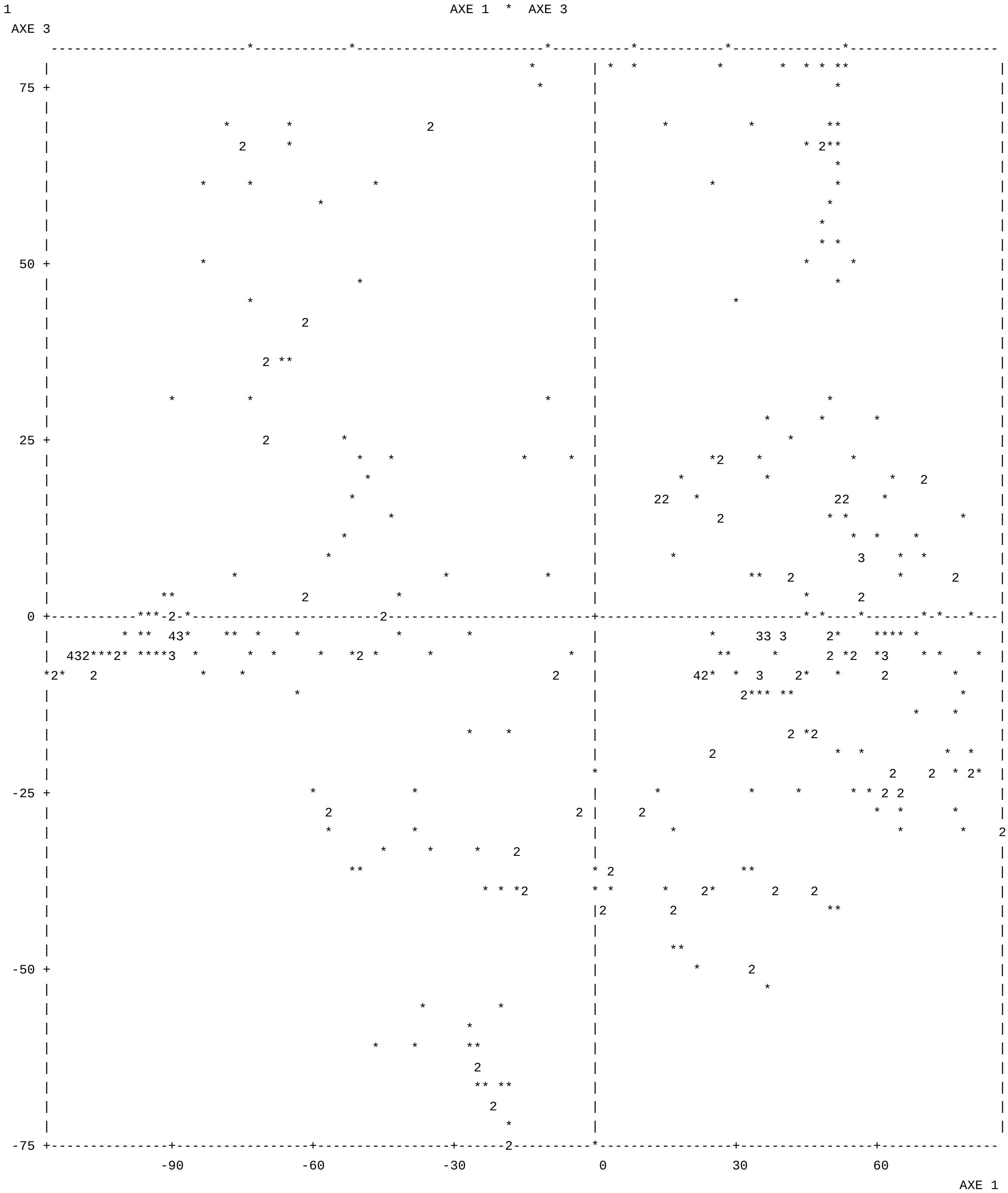
```
1                                                       AXE 1  *  AXE 2
   AXE 2
       AUTR-----------------------------------------------------------------------------------------------------------------
        |                                                               |                                                   |
  15.0  +                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
  12.5  +                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
  10.0  +                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
   7.5  +                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                              939                              |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
   5.0  +                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                         SEIC |                                                   |
        |                                                      MO       |                                                   |
   2.5  +                                                               |                                                  NG
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                      DORG    932                                                  |
        |                                                               |                                                   |
        |                                          MER2                MC                                                   |
        |                                                         TACA |                                                   |
        |                                                         MULEENCO                                                 |
   0.0  +--------------------------------------------------------------DORO-------------------------------------------------|
        |                                                               |                                                   |
        |                                                         MAQUTHOR                                                SARD
        |                                                              LA                                                   |
        |                                                               |  949                                              |
        |                                                         945  |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
  -2.5  +                                                         GERM |                                                   |
        |                                                               |                                                   |
        |                                                               |                          CHIN                     |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
       SG                                                               |                                                   |
        |                                                               |                                                   |
  -5.0  +                                                               |      MER1                                         |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
  -7.5  +                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        |                                                               |                                                   |
        +---------------+---------------+---------------+---------------+---------------+--942 ----ANCH-+---------------+---
       -12              -9              -6              -3               0               3               6               9
                                                                                                                         AXE 1
 ----------
```

La représentation des navires dans le plan 1x2 et dans le plan 1x3 ne fait pas apparaître de groupes bien isolés mais un continuum montrant la diversité des types d'exploitation.

```
          POINTS=IND,X=VEC 1,Y=VEC 2

 NOMBRE DE POINTS A REPRESENTER :  371

 TRAITEMENT DES POINTS A PLUS DE  2.30 ECARTS-TYPES DU CENTRE

 NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE:         1

 NOMBRE DE POINTS REPRESENTES :  371

  70 POINTS MULTIPLES,  93 POINTS CACHES

 IDENTIFICATION DES POINTS
      * : UN SEUL POINT
      N : N POINTS SUPERPOSES
      X : 10 POINTS SUPERPOSES OU PLUS
```



```
          POINTS=IND,X=VEC 1,Y=VEC 3

NOMBRE DE POINTS A REPRESENTER :  371

TRAITEMENT DES POINTS A PLUS DE  2.30 ECARTS-TYPES DU CENTRE

NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE:          5

NOMBRE DE POINTS REPRESENTES :  371

 68 POINTS MULTIPLES,  83 POINTS CACHES

IDENTIFICATION DES POINTS
     * : UN SEUL POINT
     N : N POINTS SUPERPOSES
     X : 10 POINTS SUPERPOSES OU PLUS
```



-Les espèces structurantes sont l'anchois, les espècesAutres, la sardine, le chinchard. Ces espèces permettent de caractériser les secteurs géographiques: Sud-Gascogne, Nord-Gascogne et la Manche-Occidentale. Les chaluts pélagiques à maillage >20 mm seraient surtout utilisés dans le Nord Gascogne alors que les navires unitaires à plusieurs chaluts seraient surtout utilisés dans le Sud-Gascogne.

B) sur une base **annuelle découpée en trimestres** :

Chacune des variables précédentes se trouvent découpées en 4 modalités correspondant à chacun des trimestres. Les % attribués à chaque modalité ont été calculés par rapport aux 371 navires ayant pratiqué au moins pour partie le chalutage pélagique. Les % cumulés dans chacun des trimestres sont toujours inférieurs à 100 car les navires armant au pélagique en l'espace d'une année ne sont pas tous actifs sur ce métier lors de chacune des périodes considérées.
132 variables actives sont utilisées ici. Certaines peuvent être nulles et se retrouveront automatiquement exclues de l'analyse. Des statistiques sommaires renseignent sur la moyenne et la variance des variables découpées en modalités trimestrielles.

STATISTIQUES SOMMAIRES DES VARIABLES CONTINUES EFFECTIF TOTAL : 371
POIDS TOTAL : 371.00

NUM	IDEN	LIBELLE	EFFECTIF	POIDS	MOYENNE	ECART-TYPE	MINIMUM	MAXIMUM
1	9321	9321Trimestre 1	371	371.00	3.35	16.54	0.00	100.00
2	9351	9351Trimestre 1	371	371.00	0.16	1.48	0.00	18.00
3	9421	9421Trimestre 1	371	371.00	27.99	37.57	0.00	100.00
4	9451	9451Trimestre 1	371	371.00	3.54	11.41	0.00	97.00
5	9391	9391Trimestre 1	371	371.00	2.49	12.56	0.00	100.00
6	9491	9491Trimestre 1	371	371.00	10.91	25.60	0.00	100.00
7	MO1	MO1 MANCHE OCCIDENTA	371	371.00	4.63	18.28	0.00	100.00
8	MC1	MC1 MER CELTIQUE Tri	371	371.00	1.30	6.89	0.00	100.00
9	NG1	NG1 NORD GASCOGNE Tr	371	371.00	27.85	38.13	0.00	100.00
10	SG1	SG1 SUD GASCOGNE Tri	371	371.00	33.25	41.67	0.00	100.00
11	LA1	LA1 LARGE AUTRES Tri	371	371.00	0.35	1.61	0.00	13.00
12	AUT1	AUT1Autres especes T	371	371.00	4.94	15.67	0.00	100.00
13	MEU1	MEU1merlu Trimestre	371	371.00	11.42	18.84	0.00	90.00
14	MEA1	MEA1merlan Trimestre	371	371.00	4.74	15.35	0.00	79.00
15	LIE1	LIE1lieu jaune Trime	371	371.00	0.71	5.91	0.00	78.00
16	TAC1	TAC1tacaud Trimestre	371	371.00	0.50	2.04	0.00	23.00
17	BAR1	BAR1bar Trimestre 1	371	371.00	4.99	10.07	0.00	54.00
18	DOY1	DOY1dorade royale Tr	371	371.00	0.04	0.28	0.00	3.00
19	DOO1	DOO1dorade rose Trim	371	371.00	0.01	0.12	0.00	1.00
20	DOG1	DOG1dorade grise Tri	371	371.00	1.25	6.81	0.00	66.00
21	ORP1	ORP1orphie Trimestre	371	371.00	0.15	0.54	0.00	5.00
22	CHI1	CHI1chinchard Trimes	371	371.00	9.99	20.09	0.00	93.00
23	MUL1	MUL1mulet Trimestre	371	371.00	0.96	3.73	0.00	31.00
24	HAR1	HAR1hareng Trimestre	371	371.00	0.06	0.69	0.00	9.00
25	SAR1	SAR1sardine Trimestr	371	371.00	1.23	7.59	0.00	87.00
27	ANC1	ANC1anchois Trimestr	371	371.00	22.85	34.99	0.00	100.00
31	MAQ1	MAQ1maquereau Trimes	371	371.00	2.33	9.33	0.00	100.00
32	SEI1	SEI1seiche Trimestre	371	371.00	0.37	1.86	0.00	25.00
33	ENC1	ENC1encornet Trimes	371	371.00	0.70	3.00	0.00	34.00
34	9322	9322Trimestre 2	371	371.00	2.09	13.17	0.00	100.00
36	9422	9422Trimestre 2	371	371.00	39.59	45.15	0.00	100.00
37	9452	9452Trimestre 2	371	371.00	0.39	1.84	0.00	15.00
38	9392	9392Trimestre 2	371	371.00	7.21	22.27	0.00	100.00
39	9492	9492Trimestre 2	371	371.00	3.75	14.55	0.00	100.00
40	MO2	MO2 MANCHE OCCIDENTA	371	371.00	5.33	20.55	0.00	100.00
41	MC2	MC2 MER CELTIQUE Tri	371	371.00	0.05	0.34	0.00	4.00
42	NG2	NG2 NORD GASCOGNE Tr	371	371.00	37.89	44.42	0.00	100.00
43	SG2	SG2 SUD GASCOGNE Tri	371	371.00	25.67	40.31	0.00	100.00
44	LA2	LA2 LARGE AUTRES Tri	371	371.00	0.61	3.77	0.00	45.00
45	AUT2	AUT2Autres especes T	371	371.00	9.53	23.05	0.00	100.00
46	MEU2	MEU2merlu Trimestre	371	371.00	20.21	29.48	0.00	99.00
47	MEA2	MEA2merlan Trimestre	371	371.00	0.95	3.17	0.00	41.00
48	LIE2	LIE2lieu jaune Trime	371	371.00	0.07	0.55	0.00	6.00
49	TAC2	TAC2tacaud Trimestre	371	371.00	0.44	1.75	0.00	22.00
50	BAR2	BAR2bar Trimestre 2	371	371.00	0.60	2.12	0.00	17.00
52	DOO2	DOO2dorade rose Trim	371	371.00	0.08	0.73	0.00	8.00
53	DOG2	DOG2dorade grise Tri	371	371.00	3.26	14.30	0.00	84.00
54	ORP2	ORP2orphie Trimestre	371	371.00	0.24	0.68	0.00	5.00
55	CHI2	CHI2chinchard Trimes	371	371.00	9.48	16.92	0.00	84.00
56	MUL2	MUL2mulet Trimestre	371	371.00	0.68	2.34	0.00	21.00
57	HAR2	HAR2hareng Trimestre	371	371.00	0.02	0.36	0.00	7.00
58	SAR2	SAR2sardine Trimestr	371	371.00	10.27	24.13	0.00	95.00
60	ANC2	ANC2anchois Trimestr	371	371.00	7.86	21.76	0.00	100.00
64	MAQ2	MAQ2maquereau Trimes	371	371.00	3.20	5.48	0.00	35.00
65	SEI2	SEI2seiche Trimestre	371	371.00	2.30	11.03	0.00	84.00
66	ENC2	ENC2encornet Trimes	371	371.00	0.11	0.42	0.00	3.00
67	9323	9323Trimestre 3	371	371.00	2.05	11.64	0.00	100.00
68	9353	9353Trimestre 3	371	371.00	0.15	2.13	0.00	39.00
69	9423	9423Trimestre 3	371	371.00	37.83	43.95	0.00	100.00
71	9393	9393Trimestre 3	371	371.00	6.40	18.30	0.00	100.00
72	9493	9493Trimestre 3	371	371.00	2.95	12.80	0.00	93.00
73	MO3	MO3 MANCHE OCCIDENTA	371	371.00	1.42	11.54	0.00	100.00
74	MC3	MC3 MER CELTIQUE Tri	371	371.00	0.30	5.20	0.00	100.00
75	NG3	NG3 NORD GASCOGNE Tr	371	371.00	37.48	45.01	0.00	100.00
76	SG3	SG3 SUD GASCOGNE Tri	371	371.00	25.30	39.42	0.00	100.00
77	LA3	LA3 LARGE AUTRES Tri	371	371.00	7.72	21.39	0.00	100.00
78	AUT3	AUT3Autres especes T	371	371.00	11.00	25.36	0.00	100.00
79	MEU3	MEU3merlu Trimestre	371	371.00	6.54	12.38	0.00	91.00
80	MEA3	MEA3merlan Trimestre	371	371.00	1.91	5.27	0.00	43.00
81	LIE3	LIE3lieu jaune Trime	371	371.00	0.03	0.24	0.00	3.00
82	TAC3	TAC3tacaud Trimestre	371	371.00	0.37	1.49	0.00	15.00
83	BAR3	BAR3bar Trimestre 3	371	371.00	0.23	1.26	0.00	14.00
84	DOY3	DOY3dorade royale Tr	371	371.00	0.02	0.16	0.00	2.00
85	DOO3	DOO3dorade rose Trim	371	371.00	0.02	0.16	0.00	2.00
86	DOG3	DOG3dorade grise Tri	371	371.00	1.03	6.03	0.00	83.00
87	ORP3	ORP3orphie Trimestre	371	371.00	0.02	0.13	0.00	1.00
88	CHI3	CHI3chinchard Trimes	371	371.00	4.56	9.56	0.00	57.00
89	MUL3	MUL3mulet Trimestre	371	371.00	1.28	5.97	0.00	57.00
90	HAR3	HAR3hareng Trimestre	371	371.00	0.66	5.13	0.00	69.00
91	SAR3	SAR3sardine Trimestr	371	371.00	10.40	22.45	0.00	96.00
93	ANC3	ANC3anchois Trimestr	371	371.00	15.23	26.69	0.00	100.00
94	THR3	THR3thon rouge Trime	371	371.00	2.89	8.12	0.00	79.00
95	GER3	GER3germon Trimestre	371	371.00	12.68	25.75	0.00	100.00
96	ESP3	ESP3espadon Trimestr	371	371.00	0.60	1.75	0.00	16.00
97	MAQ3	MAQ3maquereau Trimes	371	371.00	1.02	3.42	0.00	33.00
98	SEI3	SEI3seiche Trimestre	371	371.00	0.85	4.19	0.00	51.00

99 . ENC3 - ENC3encornet Trimes	371	371.00	0.66	2.56	0.00	22.00
100 . 9324 - 9324Trimestre 4	371	371.00	2.11	10.53	0.00	100.00
101 . 9354 - 9354Trimestre 4	371	371.00	0.09	1.71	0.00	33.00
102 . 9424 - 9424Trimestre 4	371	371.00	18.15	36.16	0.00	100.00
103 . 9454 - 9454Trimestre 4	371	371.00	0.06	0.81	0.00	12.00
104 . 9394 - 9394Trimestre 4	371	371.00	1.37	7.84	0.00	70.00
106 . MO4 - MO4 MANCHE OCCIDENTA	371	371.00	1.09	10.33	0.00	100.00
107 . MC4 - MC4 MER CELTIQUE Tri	371	371.00	1.22	9.91	0.00	100.00
108 . NG4 - NG4 NORD GASCOGNE Tr	371	371.00	27.06	42.72	0.00	100.00
109 . SG4 - SG4 SUD GASCOGNE Tri	371	371.00	1.95	10.08	0.00	96.00
110 . LA4 - LA4 LARGE AUTRES Tri	371	371.00	2.90	13.21	0.00	100.00
111 . AUT4 - AUT4Autres especes T	371	371.00	2.70	11.56	0.00	100.00
112 . MEU4 - MEU4merlu Trimestre	371	371.00	1.14	4.18	0.00	39.00
113 . MEA4 - MEA4merlan Trimestre	371	371.00	1.00	4.46	0.00	39.00
114 . LIE4 - LIE4lieu jaune Trime	371	371.00	0.08	0.33	0.00	2.00
115 . TAC4 - TAC4tacaud Trimestre	371	371.00	0.15	0.77	0.00	10.00
116 . BAR4 - BAR4bar Trimestre 4	371	371.00	0.15	0.91	0.00	16.00
117 . DOY4 - DOY4dorade royale Tr	371	371.00	0.02	0.17	0.00	2.00
119 . DOG4 - DOG4dorade grise Tri	371	371.00	0.91	5.56	0.00	64.00
121 . CHI4 - CHI4chinchard Trimes	371	371.00	3.84	14.59	0.00	98.00
122 . MUL4 - MUL4mulet Trimestre	371	371.00	0.08	0.43	0.00	5.00
123 . HAR4 - HAR4hareng Trimestre	371	371.00	0.14	1.27	0.00	16.00
124 . SAR4 - SAR4sardine Trimestr	371	371.00	0.78	6.11	0.00	70.00
125 . SPR4 - SPR4sprat Trimestre	371	371.00	0.05	1.04	0.00	20.00
126 . ANC4 - ANC4anchois Trimestr	371	371.00	17.41	34.06	0.00	100.00
127 . THR4 - THR4thon rouge Trime	371	371.00	0.96	6.21	0.00	77.00
128 . GER4 - GER4germon Trimestre	371	371.00	3.61	14.96	0.00	94.00
129 . ESP4 - ESP4espadon Trimestr	371	371.00	0.25	1.18	0.00	12.00
130 . MAQ4 - MAQ4maquereau Trimes	371	371.00	0.44	2.26	0.00	31.00
131 . SEI4 - SEI4seiche Trimestre	371	371.00	0.22	1.11	0.00	12.00
132 . ENC4 - ENC4encornet Trimes	371	371.00	0.16	0.87	0.00	8.00

EDITION DES VALEURS PROPRES (DIVISEES PAR 100)

APERCU DE LA PRECISION DES CALCULS : TRACE AVANT DIAGONALISATION .. 345.5627
SOMME DES VALEURS PROPRES 345.5625

HISTOGRAMME DES 39 PREMIERES VALEURS PROPRES

NUMERO	VALEUR PROPRE	POURCENT.	POURCENT. CUMULE	
1	87.8615	25.43	25.43	**
2	44.3830	12.84	38.27	***
3	41.2309	11.93	50.20	**************************************
4	24.4369	7.07	57.27	***********************
5	19.7908	5.73	63.00	*******************
6	13.1957	3.82	66.82	*************
7	10.9022	3.15	69.97	**********
8	9.1698	2.65	72.63	*********
9	8.8434	2.56	75.19	*********
10	7.6993	2.23	77.41	********
11	6.9964	2.02	79.44	*******
12	6.3923	1.85	81.29	******
13	5.1503	1.49	82.78	*****
14	4.9859	1.44	84.22	*****
15	4.3165	1.25	85.47	****
16	4.0073	1.16	86.63	****
17	3.4430	1.00	87.63	****
18	2.9542	0.85	88.48	***
19	2.7101	0.78	89.27	***
20	2.5074	0.73	89.99	***
21	2.2854	0.66	90.65	***
22	2.1779	0.63	91.28	**
23	2.0084	0.58	91.86	**
24	1.7946	0.52	92.38	**
25	1.7381	0.50	92.89	**
26	1.7051	0.49	93.38	**
27	1.5674	0.45	93.83	**
28	1.4609	0.42	94.26	**
29	1.3865	0.40	94.66	**
30	1.2622	0.37	95.02	**
31	1.1854	0.34	95.37	**
32	1.1027	0.32	95.69	**
33	1.0722	0.31	96.00	*
34	0.9733	0.28	96.28	*
35	0.9479	0.27	96.55	*
36	0.8863	0.26	96.81	*
37	0.8197	0.24	97.05	*
38	0.7497	0.22	97.26	*
39	0.7358	0.21	97.47	*

POINTS=CON,X=VEC 1,Y=VEC 2

NOMBRE DE POINTS A REPRESENTER : 117

TRAITEMENT DES POINTS A PLUS DE 2.30 ECARTS-TYPES DU CENTRE
POINTS ELOIGNES :

IDENTIFICATEUR	ABSCISSE	ORDONNEE
9421	-25.032	15.005
NG1	-25.620	4.440
9422	-36.051	21.304
NG2	-34.372	4.633
SG2	15.024	16.968
MEU2	-11.820	15.985
9423	-35.449	16.031
NG3	-28.168	-20.324
SG3	14.099	26.828
GER3	-3.076	14.253
9424	-24.900	-3.269
NG4	-19.846	-23.405
ANC4	-13.592	-17.923

NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE: 13

NOMBRE DE POINTS REPRESENTES : 117

POINTS MULTIPLES

POINT VU	ABSCISSE APPROCHEE	ORDONNEE APPROCHEE	NB. DE CACHES	POINTS CACHES
MC1	-0.86	0.72	1	THR4
MAQ1	0.00	0.72	1	MEA3
ENC1	0.00	0.37	3	9452 MUL2 ESP3
TAC1	0.86	0.37	3	ENC3 MUL3 DOG3
MEU4	-0.86	0.02	3	MUL1 SAR1 LA2
LA1	0.00	0.02	37	DOY1 LIE2 ORP2 BAR2 ENC2 BAR3 9351 ESP4 MC3 MO4 DOO2 LIE1 TAC3 9353 SEI1 9454 SEI4 MO1 LIE3 HAR4 HAR1 DOY3 MC2 TAC2 ORP3 MUL4 SPR4 ENC4 TAC4 DOO3 HAR2 DOO1 ORP1 BAR4 9354 LIE4 DOY4
DOG4	-0.86	-0.33	1	MEA4
MAQ3	0.00	-0.33	2	HAR3 DOG1
9394	0.86	-2.09	1	9322

```
0  9 POINTS MULTIPLES,  52 POINTS CACHES
1                                                        AXE 1  *  AXE 2
   AXE 2
         ----------MEU2--------------------------------GER3----------------------------------------SG3 SG1 ----------------
        |                                                           |                                                      SG2
        |                                                           |                                                       |
        |                                                           |                                                       |
  12.5  +                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
  10.0  +                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
       9421                            MEU1                         |                                                       |
       9422                                                         |                                                       |
   7.5  +                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                              CHI2                         |                                                       |
       9423                                                    MEU3 |                                                       |
        |                                          LA3              |                                                       |
        |                                                           |                                                       |
   5.0  +                                      9491                 |                                                       |
        |              CHI1                                         |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                                                      9451 |                                                       |
        |                                      ANC1                 |                                                       |
        |                                                  THR3     |                                              AUT2     |
   2.5 NG1                                                          |  9493                                                 |
        |                                                           |  9492                                                AUT3
       NG2                                         CHI3    SG4      |                                      9392             |
        |                                                           |                                                       |
        |                                                      LA4  |          AUT19391                                     |
        |                                          BAR1    MAQ2MC1 MAQ1MEA2                                                 |
        |                                                      GER4ENC1TAC1    MEA1                                         |
   0.0  +------------------------------------------------------MEU4LA1 SEI3-------------------------------------------------|
        |                                              CHI4    DOG4MAQ3MO3 DOG2                    9393                     |
        |                                                      SAR4MAQ4MC4 SEI2                                             |
        |                                                           |      MO2                                              |
        |                                                          ANC2                                                     |
       9424                                                         |  AUT4                                                 |
        |                                                          93239394                                                 |
  -2.5  +                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                                                          9324                                                     |
        |                                                           |  9321                                                 |
        |                                                           |                                                       |
       SAR2                                                         |                                                       |
  -5.0  +                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |  SAR3                                                     |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
  -7.5  +                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
 -10.0 NG3                                                          |                                                       |
        |                                                           |                                                       |
        |                                                           |                                                       |
         ------ANC3-+--NG4 ANC4-------------+-----------------------+-----------------------+-----------------------+-------
                   -10                      -5                       0                       5                      10
                                                                                                                         AXE 1
```

```
----           POINTS=CON,X=VEC 1,Y=VEC 3
```

NOMBRE DE POINTS A REPRESENTER : 117

TRAITEMENT DES POINTS A PLUS DE 2.30 ECARTS-TYPES DU CENTRE
POINTS ELOIGNES :

IDENTIFICATEUR	ABSCISSE	ORDONNEE
9421	-25.032	5.250
NG1	-25.620	-11.010
SG1	7.582	31.532
ANC1	-4.101	26.692
9422	-36.051	1.866
NG2	-34.372	-14.247
SG2	15.024	23.582
ANC2	-0.042	13.676
9423	-35.449	5.601
NG3	-28.168	8.668
ANC3	-11.388	13.753
9424	-24.900	3.677
NG4	-19.846	17.325
ANC4	-13.592	19.301

NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE: 14

NOMBRE DE POINTS REPRESENTES : 117

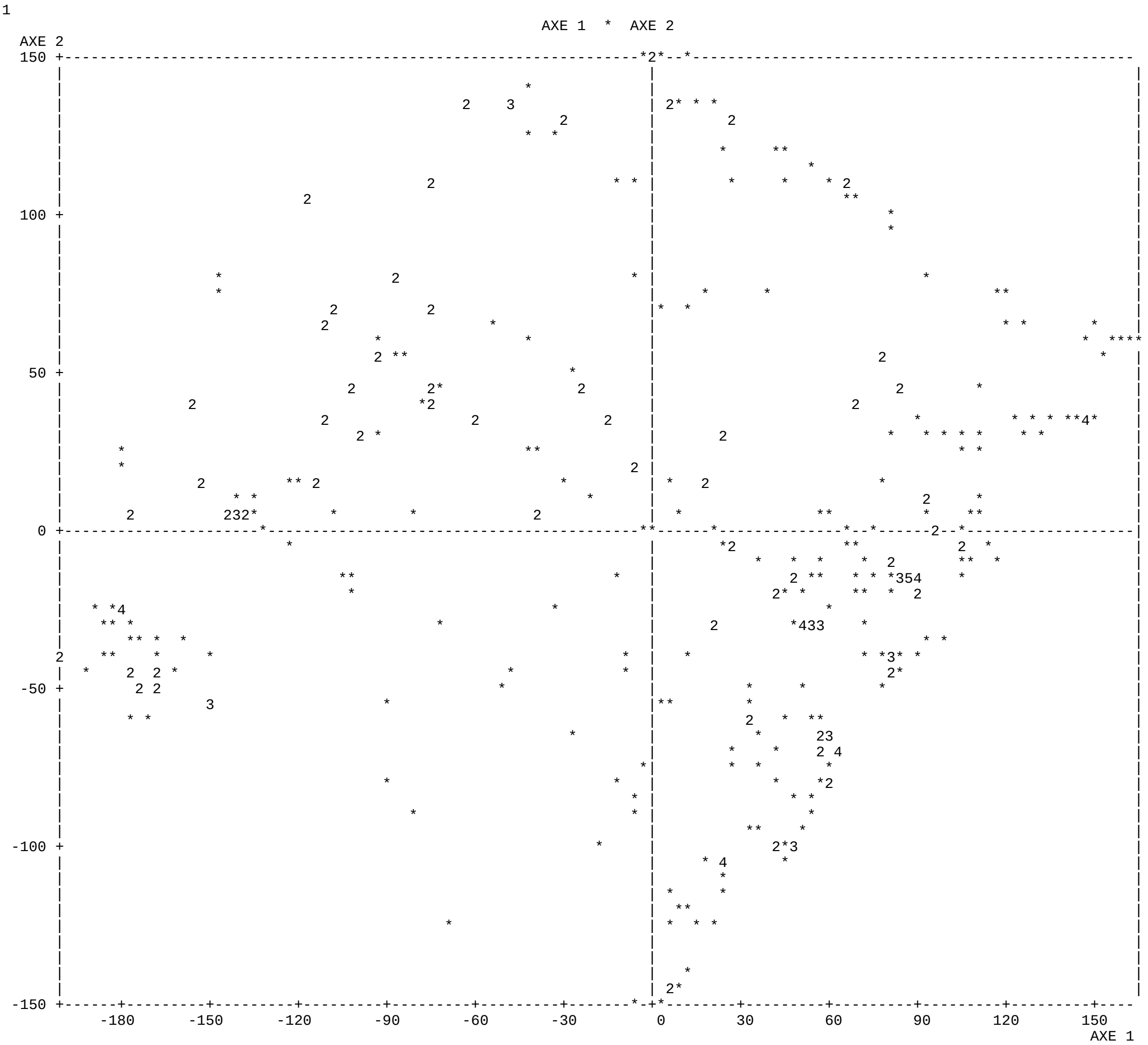
POINTS MULTIPLES

POINT VU	ABSCISSE APPROCHEE	ORDONNEE APPROCHEE	NB. DE CACHES	POINTS CACHES
9423	-13.58	2.00	1	9424
MAQ4	0.00	0.45	3	9452 9394 9354
BAR3	0.00	0.06	37	DOO2 TAC3 LA1 HAR1 MUL2 MC2 MEA3 LIE3 BAR2 BAR4 DOO1 LIE2 ORP3 TAC2 MUL4 TAC1 SPR4 DOY4 9351 ORP2 HAR2 ORP1 MAQ3 LA2 ENC4 ENC2 TAC4 DOO3 SEI1 9454 MAQ1 HAR4 LIE4 9353 DOY1 SEI4 DOY3
ENC3	0.97	0.06	2	MUL3 MEA2
MEU4	-0.97	-0.33	2	SAR4 MEA4
ESP3	0.00	-0.33	5	MC3 ESP4 DOG4 ENC1 LIE1
DOG3	0.97	-0.33	2	SEI3 9492
THR4	-0.97	-0.72	1	SAR1
HAR3	0.00	-0.72	1	DOG1
AUT4	0.97	-1.49	1	MO3
GER4	-0.97	-2.65	1	LA4

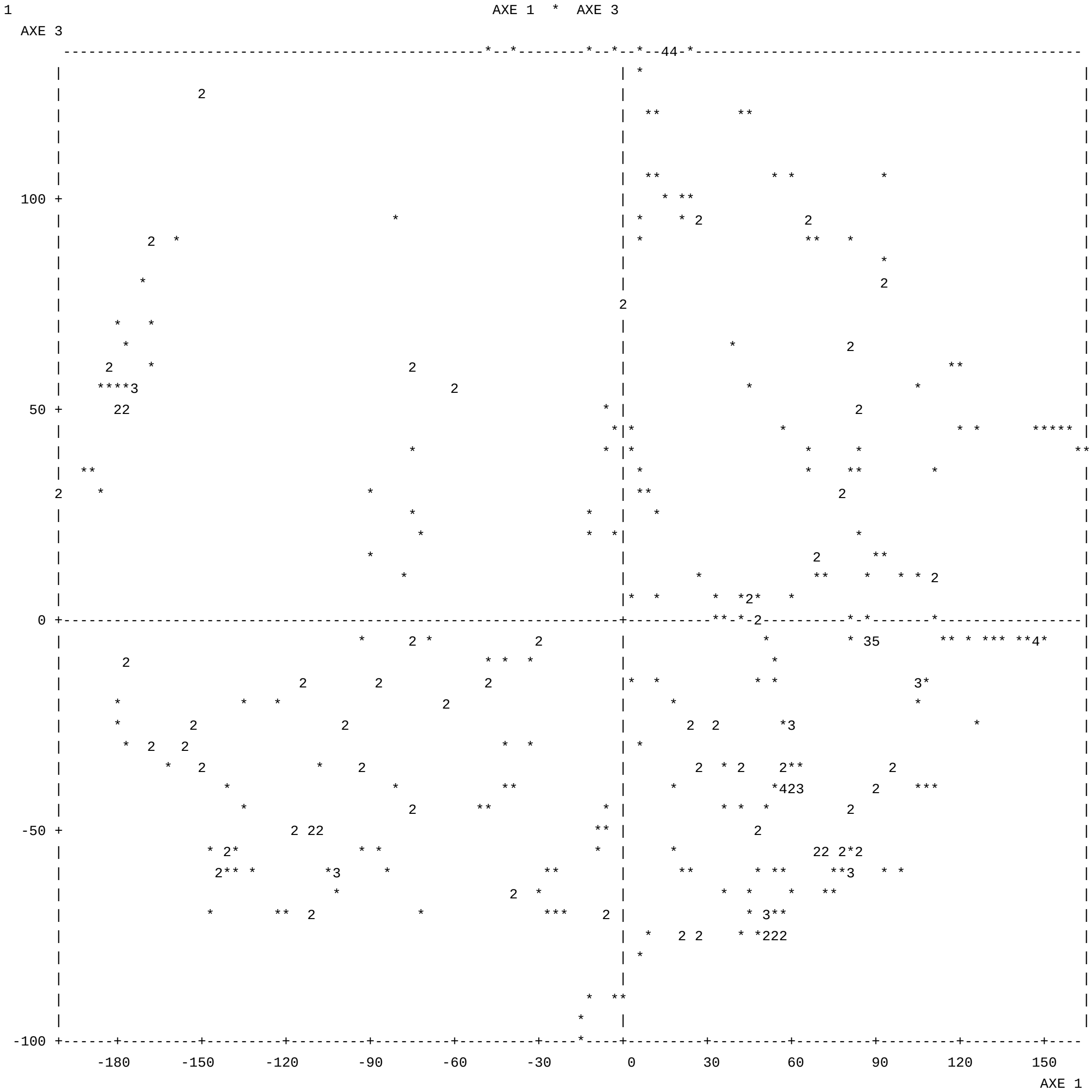
0 11 POINTS MULTIPLES, 56 POINTS CACHES

```
1                                                      AXE 1  *  AXE 3
 AXE 3
      ----------NG4 --------ANC3ANC4-------------------ANC1ANC2----SG1 ------------SG2 --------------------------------SG3
     |                                                      |                                                          |
     |                                                      |                                                          |
  8  +                                                      |                                                          |
     |                                                      |                                                          |
     |                                                      |                                                          |
     |                                                      |  9321                                                    |
     |                                                      |                                                          |
     |                                                      |                                                          |
     |                                                      |                                                          |
     |                                                 9451 |                                                          |
     |                                                     9324                                                        |
     |                                                      |                                                          |
  4 NG3                                                     |                                                          |
     |                                                      |                                                          |
     |                                                      |                                                          |
    9421                                                   9323                                                        |
     |                                                      |  9322                                                    |
    9423                                                    |                                                          |
     |                                                 MEU3 |                                                          |
     |                                                      |                                                          |
    9422                                                    |                                                          |
     |                                         BAR1GER3    MAQ49493    9391                                            |
  0  +-------------------------------------------------MAQ2MUL1BAR3ENC3------------------------------------------------|
     |      SAR3                                       MEU4ESP3DOG3    AUT1            9393                            |
     |                                             CHI3THR3THR4HAR3    MEA1                             AUT2AUT3        |
    SAR2                               CHI2                MC1 MO4 MC4                                                 |
     |                                             SG4      |  AUT4                           9392                     |
     |      MEU2                                            |      SEI2                                                |
     |                                 MEU19491    CHI4     |      DOG2                                                |
     |                                                 GER4 |                                                          |
     |                                                      |                                                          |
     |                                                      |                                                          |
 -4  +                                         LA3         MO1                                                         |
     |                                                      |      MO2                                                 |
     |                                                      |                                                          |
     |                                                      |                                                          |
      --NG2 NG1 ----CHI1-----+---------------+---------------+---------------+---------------+---------------+-----------
           -12              -8              -4               0               4               8              12
                                                                                                                 AXE 1
```

```
          POINTS=IND,X=VEC 1,Y=VEC 2

 NOMBRE DE POINTS A REPRESENTER :  371

 TRAITEMENT DES POINTS A PLUS DE  2.30 ECARTS-TYPES DU CENTRE

 NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE:         4

 NOMBRE DE POINTS REPRESENTES :  371

  71 POINTS MULTIPLES,  95 POINTS CACHES

 IDENTIFICATION DES POINTS
      * : UN SEUL POINT
      N : N POINTS SUPERPOSES
      X : 10 POINTS SUPERPOSES OU PLUS
1
```



```
        POINTS=IND,X=VEC 1,Y=VEC 3

 NOMBRE DE POINTS A REPRESENTER :  371

 TRAITEMENT DES POINTS A PLUS DE  2.30 ECARTS-TYPES DU CENTRE

 NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE:        13

 NOMBRE DE POINTS REPRESENTES :  371

  73 POINTS MULTIPLES,  92 POINTS CACHES

 IDENTIFICATION DES POINTS
      * : UN SEUL POINT
      N : N POINTS SUPERPOSES
      X : 10 POINTS SUPERPOSES OU PLUS
```



Un groupe de 20-30 navires semble bien individualisé. Il pêche la sardine aux trimestres 2 et 3 en boeufs. Selon le plan 1x2, il faudrait distinguer au moins 6 groupes plus ou moins homogènes.

Une classification hiérarchique ascendante (CAH) a été réalisée à partir des coordonnées sur les 5 premiers axes. Ceci a pour effet d'éliminer le bruit de l'information de départ. La hiérarchisation de la population conduit à une représentation en dendrogramme. L'indice d'agglomération (niveau) peut être représenté sous forme d'histogramme décrivant le rapport d'inertie interclasse/intraclasse. C'est un élement indispensable pour le choix de la partition.

1

CLASSIFICATION HIERARCHIQUE : DESCRIPTION DES 49 NOEUDS D'INDICES LES PLUS ELEVES

NUM.	AINE	BENJ	EFF.	POIDS	INDICE	HISTOGRAMME DES INDICES DE NIVEAU
693	682	614	10	10.00	23.92708	*
694	623	650	21	21.00	24.02251	*
695	638	683	7	7.00	24.75326	*
696	585	692	4	4.00	25.02568	*
697	676	649	12	12.00	28.14234	*
698	610	609	13	13.00	28.42432	*
699	554	674	20	20.00	33.50974	*
700	662	655	18	18.00	37.47264	*
701	667	675	15	15.00	38.43871	*
702	688	653	14	14.00	38.89222	*
703	664	689	28	28.00	40.63060	*
704	620	698	20	20.00	45.57493	*
705	666	658	15	15.00	45.61747	*
706	616	684	14	14.00	47.04987	*
707	680	639	11	11.00	47.76266	*
708	628	678	14	14.00	48.51687	*
709	690	687	27	27.00	51.35835	*
710	661	597	15	15.00	51.47153	*
711	701	671	19	19.00	53.14068	*
712	708	672	23	23.00	66.78020	*
713	699	642	24	24.00	67.83554	*
714	693	656	18	18.00	67.98825	*
715	679	696	11	11.00	75.54453	*
716	702	686	19	19.00	78.31461	*
717	711	633	23	23.00	82.29350	*
718	669	695	21	21.00	83.89851	*
719	694	685	27	27.00	84.41349	**
720	697	652	20	20.00	88.75626	**
721	673	712	34	34.00	101.92921	**
722	668	716	27	27.00	102.36481	**
723	707	529	13	13.00	102.97289	**
724	700	723	31	31.00	127.47582	**
725	615	706	20	20.00	143.05072	**
726	719	714	45	45.00	240.94038	***
727	715	709	38	38.00	252.09323	***
728	713	721	58	58.00	302.42947	****
729	718	728	79	79.00	308.73932	****
730	720	705	35	35.00	364.21921	*****
731	725	722	47	47.00	372.38824	*****
732	691	729	89	89.00	463.48816	******
733	732	717	112	112.00	596.81323	********
734	724	726	76	76.00	868.84442	***********
735	733	727	150	150.00	944.92157	************
736	704	734	96	96.00	1309.96338	****************
737	730	731	82	82.00	1372.31458	*****************
738	703	737	110	110.00	1458.35254	******************
739	736	710	111	111.00	1858.34338	***********************
740	739	735	261	261.00	2808.03442	***********************************
741	740	738	371	371.00	6728.79834	**

La CAH indique, dans ce jeu de données, 2 groupes pertinents composés de :

- 121 navires travaillant en boeufs au Nord-Gascogne le chinchard, le merlu, le bar au trimestre 1, le chinchard, la sardine, le maquereau au trimestre 2, l'anchois, le chinchard et la sardine au trimestre 3.
- 250 navires travaillant surtout au Sud-Gascogne les trimestres 2, 3 et 1 sur des profils espèces caractérisés par les espèces "Autres" (trimestres 2 et 3). Ces navires pratiquent la pêche en solo avec plusieurs chaluts. Ce groupe est surtout caractérisé par l'absence des caractères propres à l'autre groupe.

Un découpage de la base en base trimestrielle semble donc nécessaire pour obtenir une structuration plus forte en groupes homogènes pouvant servir de base à un échantillonnage reposant sur une stratification en trimestres.

C) sur une base **par trimestre.**

Successivement seront étudiés chacun des trimestres; On ne cherchera pas à suivre le devenir d'un bateau ou d'un groupe de navires d'un trimestre à un autre. L'approche annuelle précédente est donc complémentaire.

Les % utilisés dans l'analyse sont ceux déterminés par la précédente analyse sur une base annuelle découpées en trimestre. Aucun calcul n'a donc été realisé à l'échelle trimestrielle. C'est ce qui explique que la somme des % d'activité dans un trimestre est inférieur à 100. Les jeux de données trimestriels sont constitués par simple sélection des modalités.

Une partition double sera systématiquement réalisée de manière à envisager deux types de situation : bonne et mauvaise collaboration avec les pêcheurs. En effet, une partition de la flotte en 2 ou 3 groupes est suffisante en cas de mauvaise collaboration, alors qu'une partition en 4 à 6 groupes peut s'avérer idéale en cas de bonne collaboration (environ 12 voyages étudiés par trimestre).

trimestre 1 :

250 navires ont armé au pélagique au cours de ce trimestre. Ils constituent l'ensemble des observations pour cette période. Certaines espèces sont absentes des captures: le sprat, le thon rouge, le germon, l'espadon.

```
1

 EDITION DES VALEURS PROPRES (DIVISEES PAR     100)

 APERCU DE LA PRECISION DES CALCULS : TRACE AVANT DIAGONALISATION .. 107.6119

                                      SOMME DES VALEURS PROPRES .... 107.6119
 HISTOGRAMME DES 29 PREMIERES VALEURS PROPRES
```

NUMERO	VALEUR PROPRE	POURCENT.	POURCENT. CUMULE	
1	39.4964	36.70	36.70	**
2	18.4971	17.19	53.89	**************************************
3	14.5794	13.55	67.44	******************************
4	8.1549	7.58	75.02	*****************
5	6.0043	5.58	80.60	*************
6	4.4211	4.11	84.71	*********
7	3.8700	3.60	88.30	********
8	3.3564	3.12	91.42	*******
9	2.1094	1.96	93.38	*****
10	1.3475	1.25	94.63	***
11	1.1170	1.04	95.67	***
12	0.9971	0.93	96.60	***
13	0.8837	0.82	97.42	**
14	0.7871	0.73	98.15	**
15	0.7618	0.71	98.86	**
16	0.4999	0.46	99.32	**
17	0.2812	0.26	99.58	*
18	0.1773	0.16	99.75	*
19	0.1242	0.12	99.86	*
20	0.0493	0.05	99.91	*
21	0.0386	0.04	99.95	*
22	0.0282	0.03	99.97	*
23	0.0188	0.02	99.99	*
24	0.0067	0.01	100.00	*
25	0.0027	0.00	100.00	*
26	0.0012	0.00	100.00	*
27	0.0003	0.00	100.00	*
28	0.0002	0.00	100.00	*
29	0.0000	0.00	100.00	*

1

L'histogramme des valeurs propres fait apparaître 3 axes pertinents qui seront utilisés ultérieurement pour la classification. Ils résument 67.5 % de l'information. Ceci traduit une grande hétérogénéité dans les activités de la flottille au cours du premier trimestre. L'axe 1, qui résume 36.7 % de l'information initiale, oppose le Nord-Gascogne (chinchard, merlu) au Sud-Gascogne (anchois).L'axe 2 oppose les engins "pélagiques en boeufs" aux plusieurs chaluts-2 navires. Les chaluts pélagiques à boeufs sont utilisés pour le merlu dans le Nord du Golfe et pour le bar en Manche-Ouest, des petits maillages sont aussi utilisés pour la pêche de l'anchois. L'axe 3 oppose les chalutages en boeuf aux espècesAutres qui sont surtout capturées par de navires opérant successivement avec plusieurs chaluts et ciblant probablement le merlan.

```
1
                                                                    POINTS=CON,X=VEC 1,Y=VEC 2

 NOMBRE DE POINTS A REPRESENTER :   29

 TRAITEMENT DES POINTS A PLUS DE  2.30 ECARTS-TYPES DU CENTRE
 POINTS ELOIGNES :
 +--------------------------+----------+----------+
 |      IDENTIFICATEUR      | ABSCISSE | ORDONNEE |
 +--------------------------+----------+----------+
 |           9421           |  -13.689 |   32.351 |
 |           9491           |   -6.033 |  -21.266 |
 |           NG1            |  -35.301 |  -10.916 |
 |           SG1            |   39.497 |    5.877 |
 +--------------------------+----------+----------+

 NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE:          4
 NOMBRE DE POINTS REPRESENTES :   29

 POINTS MULTIPLES
 ----------+-----------+-----------+--------+-----------------------------------------------------------------------------------
           | ABSCISSE  | ORDONNEE  | NB. DE |
  POINT VU | APPROCHEE | APPROCHEE | CACHES |      POINTS CACHES
 ----------+-----------+-----------+--------+-----------------------------------------------------------------------------------
    LA1    |   -0.16   |    0.52   |    2   | MUL1 DOG1
    ORP1   |   -0.16   |    0.00   |    4   | 9351 DOY1 HAR1 DOO1
    TAC1   |   -0.16   |   -0.52   |    2   | SEI1 ENC1
 ----------+-----------+-----------+--------+-----------------------------------------------------------------------------------
0  3 POINTS MULTIPLES,   8 POINTS CACHES
1                                                      AXE 1  *  AXE 2
 AXE 2
      --------------MEU1------------9421---------------------------------------------------------------------------------
     |                                       |                                                                           |
     |                                       |                                                                           |
  5  +                                  BAR1 |                                                                           |
     |                                       |                                                                           |
     |                                       |                                                                           |
     |                              MO1      |                                                                          SG1
     |                                       |                                                                           |
     |                                       |                                                                           |
     |                                       |                                                                           |
     |                                       |              9451                                                         |
     |                                  MC1 MAQ1                                                                         |
     |                                      LA1                                                                          |
  0  +----------------------------------SAR1ORP1----MEA1-----------------------------------------------------------------|
    CHI1                                    TAC1                                                                         |
     |                                       |  9391                                                                     |
     |                                      LIE1                                                                         |
     |                                       |                                                                           |
     |                                       |  AUT1                                                                     |
     |                                       |              9321                                                         |
     |                                       |                                                                           |
    NG1                                      |                                                                           |
     |                                       |                                                                           |
 -5  +                                       |                                                                           |
     |                                       |                                                                           |
     |                                       |                                                                           |
     |                                       |                                                                           |
     |                                       |                                                                           |
     |                                       |                                                                           |
     |                                       |                                                                           |
      -------+---------------+------9491-----+---------------+---------------+---------------+---------------+----------ANC1
            -10              -5               0               5              10              15              20
                                                                                                                      AXE 1
```

POINTS=CON,X=VEC 1,Y=VEC 3

NOMBRE DE POINTS A REPRESENTER : 29

TRAITEMENT DES POINTS A PLUS DE 2.30 ECARTS-TYPES DU CENTRE
POINTS ELOIGNES :

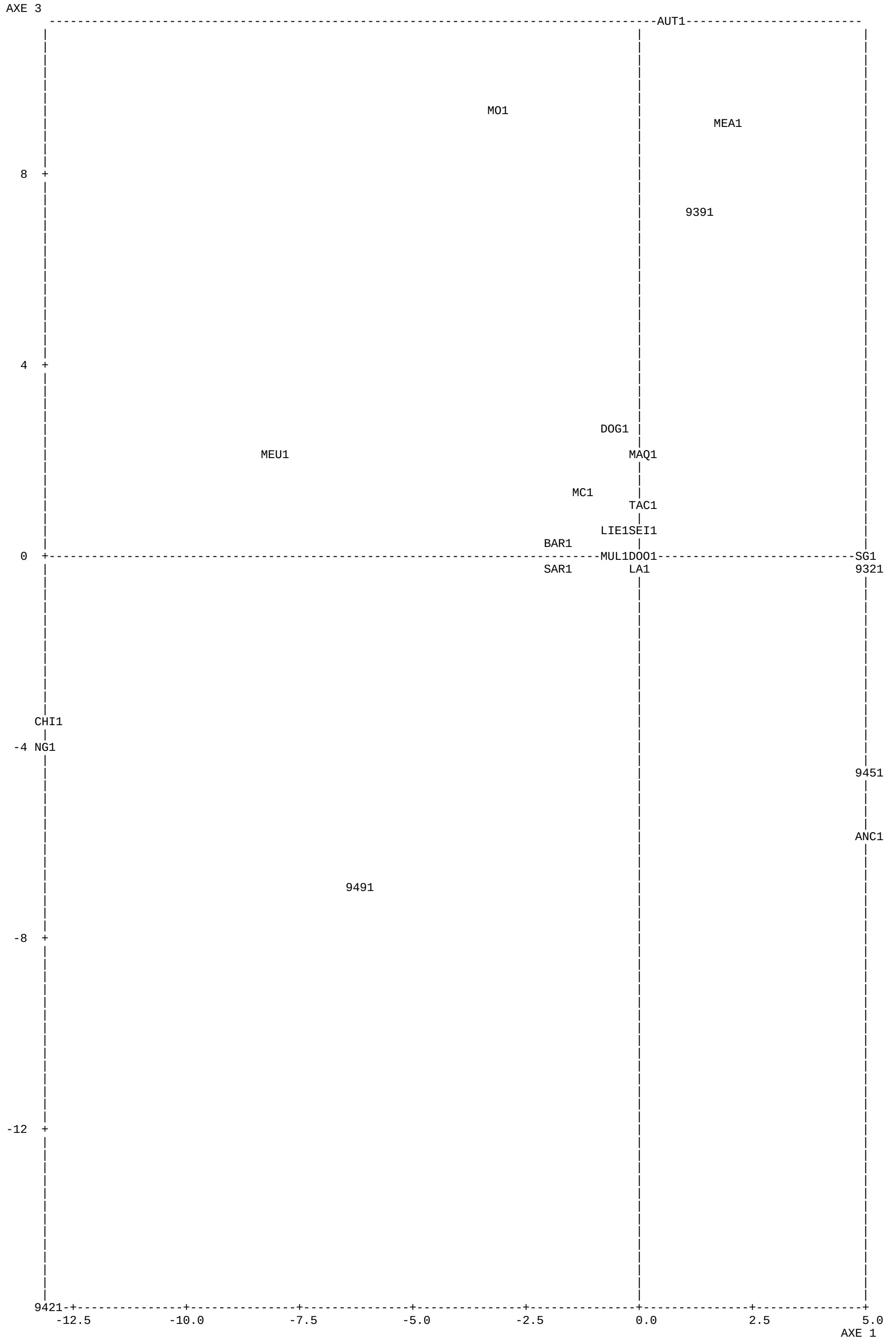
IDENTIFICATEUR	ABSCISSE	ORDONNEE
NG1	-35.301	-10.169
SG1	39.497	-0.164
ANC1	24.071	-25.996

NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE: 3
NOMBRE DE POINTS REPRESENTES : 29

POINTS MULTIPLES

POINT VU	ABSCISSE APPROCHEE	ORDONNEE APPROCHEE	NB. DE CACHES	POINTS CACHES
LIE1	-0.54	0.52	1	ENC1
DOO1	0.10	-0.01	4	DOY1 9351 HAR1 ORP1

0 2 POINTS MULTIPLES, 5 POINTS CACHES
1 AXE 1 * AXE 3



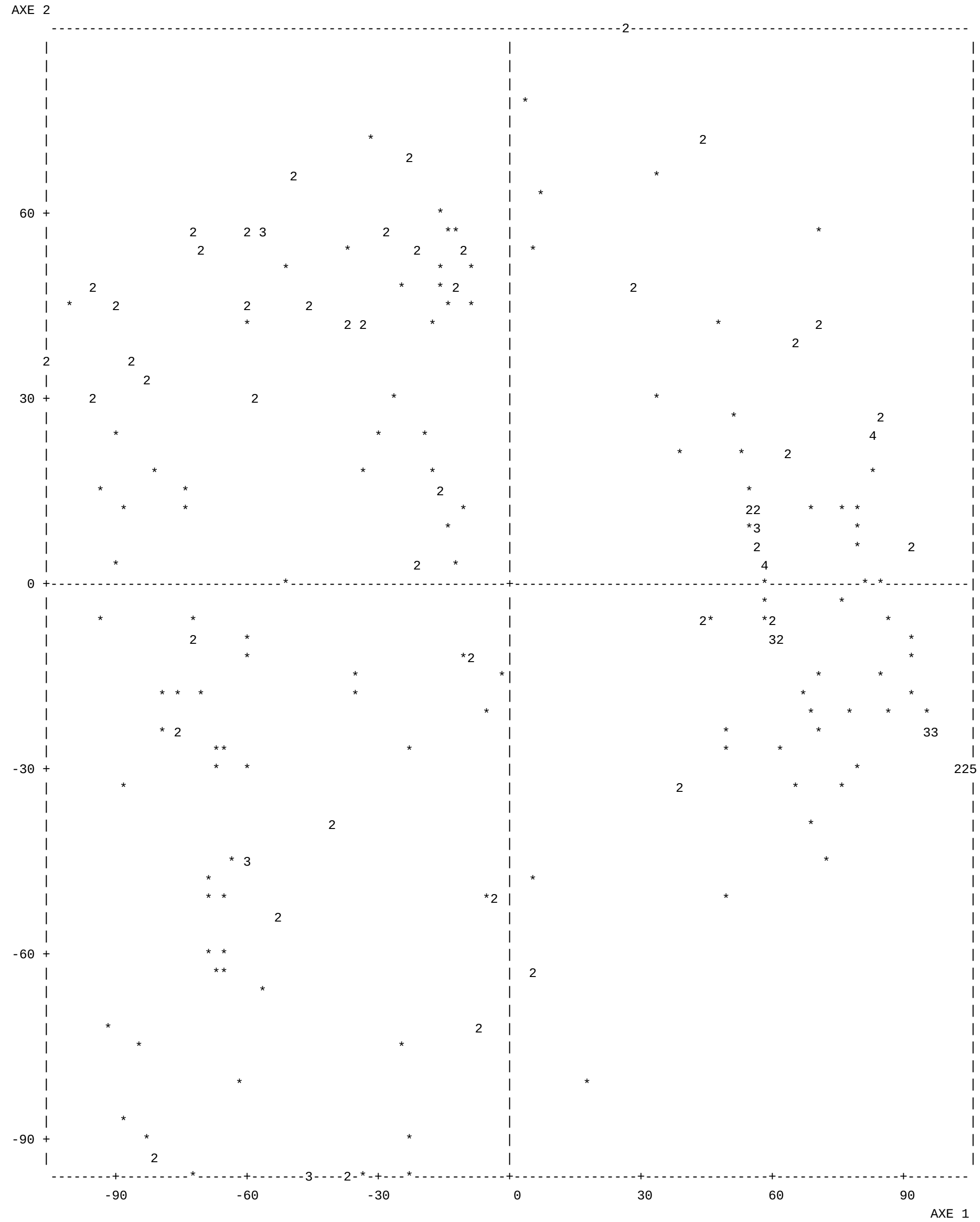
POINTS=IND,X=VEC 1,Y=VEC 2

NOMBRE DE POINTS A REPRESENTER : 250

TRAITEMENT DES POINTS A PLUS DE 2.30 ECARTS-TYPES DU CENTRE
NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE: 4
NOMBRE DE POINTS REPRESENTES : 250
 59 POINTS MULTIPLES, 73 POINTS CACHES

IDENTIFICATION DES POINTS
     * : UN SEUL POINT
     N : N POINTS SUPERPOSES
     X : 10 POINTS SUPERPOSES OU PLUS

1   AXE 1 * AXE 2



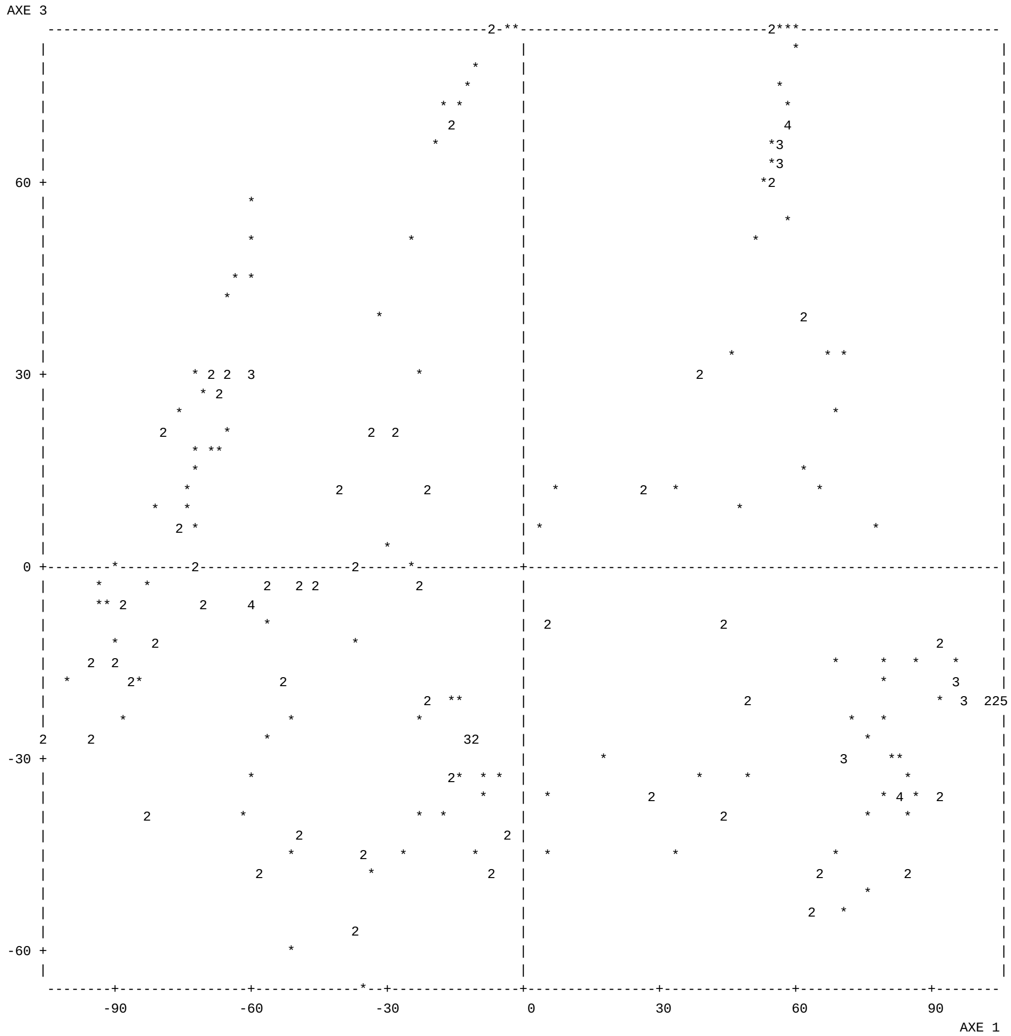
POINTS=IND,X=VEC 1,Y=VEC 3

NOMBRE DE POINTS A REPRESENTER : 250

TRAITEMENT DES POINTS A PLUS DE 2.30 ECARTS-TYPES DU CENTRE
NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE: 7
NOMBRE DE POINTS REPRESENTES : 250
64 POINTS MULTIPLES, 80 POINTS CACHES

IDENTIFICATION DES POINTS
* : UN SEUL POINT
N : N POINTS SUPERPOSES
X : 10 POINTS SUPERPOSES OU PLUS

1 AXE 1 * AXE 3



CLASSIFICATION HIERARCHIQUE : DESCRIPTION DES 49 NOEUDS D'INDICES LES PLUS ELEVES

NUM.	AINE	BENJ	EFF.	POIDS	INDICE	HISTOGRAMME DES INDICES DE NIVEAU
451	392	36	3	3.00	3.30818	*
452	274	49	3	3.00	3.47053	*
453	365	433	8	8.00	3.49975	*
454	448	335	11	11.00	3.64732	*
455	427	423	6	6.00	3.74124	*
456	283	393	4	4.00	3.84445	*
457	419	407	11	11.00	3.87955	*
458	378	439	7	7.00	3.88557	*
459	417	445	13	13.00	4.19775	*
460	409	434	7	7.00	4.33693	*
461	444	424	15	15.00	4.59357	*
462	410	304	5	5.00	4.70294	*
463	347	432	20	20.00	4.75195	*
464	272	408	7	7.00	4.91294	*
465	395	208	4	4.00	5.46346	*
466	438	462	11	11.00	6.36962	*
467	420	387	11	11.00	7.52366	*
468	437	425	6	6.00	7.61709	*
469	457	436	16	16.00	7.83211	*
470	449	443	9	9.00	7.90476	*
471	450	452	8	8.00	8.08759	*
472	435	426	18	18.00	11.95789	*
473	458	451	10	10.00	12.16915	*
474	464	446	20	20.00	12.34955	*
475	442	431	6	6.00	13.07765	*
476	440	404	25	25.00	14.33658	*
477	422	411	11	11.00	14.82623	*
478	441	465	11	11.00	17.83532	*
479	447	459	17	17.00	17.87480	*
480	469	456	20	20.00	18.84115	*
481	480	454	31	31.00	25.97637	*
482	463	460	27	27.00	28.02764	*
483	455	474	26	26.00	28.05481	*
484	453	479	25	25.00	29.02584	*
485	467	461	26	26.00	29.98331	*
486	485	475	32	32.00	40.93740	**
487	473	470	19	19.00	50.89097	**
488	472	468	24	24.00	54.18507	**
489	466	476	36	36.00	76.40420	***
490	487	478	30	30.00	102.21728	***
491	471	488	32	32.00	105.16714	***
492	483	484	51	51.00	125.75851	****
493	482	481	58	58.00	134.22908	****
494	489	477	47	47.00	180.86627	*****
495	491	492	83	83.00	323.90582	*********
496	490	486	62	62.00	331.76062	**********
497	493	494	105	105.00	1002.25494	****************************
498	496	495	145	145.00	1311.33252	************************************
499	497	498	250	250.00	2947.99097	***

SOMME DES INDICES DE NIVEAU =7257.29199

Une Classification Ascendante Hiérarchique (CAH) a été menée à partir des coordonnées sur les 3 premiers axes. Les indices de niveau suggèrent une partition en 2 ou 4 classes conformément à nos hypothèses de travail. A chaque partition, une consolidation autour des centres de classe est réalisée par 10 itérations à centres mobiles. De ce fait on ne trouvera pas toujours, dans les effectifs, de correspondances parfaites entre les deux partitions, ceci est dû à certains navires peu typés qui changent d'affectation au cours des différentes consolidations.

La répartition en 2 ou 4 classes se présenterait comme suit :

- groupe a : 147 navires pêchant en boeufs au Nord-Gascogne soit le chinchard soit le merlu. Certains de ces navires pêchent, en Manche-Ouest et en Mer Celtique, le bar et la dorade grise.
  - -groupe a1 : les boeufs à maillage > 20 mm dirigés sur le merlu, le bar et le chinchard dans le Nord du Golfe qui représentent 77 navires.
  - -groupe a2 : les boeufs (62 navires) travaillant avec plusieurs engins dans le Nord du Golfe de Gascogne et pêchant le chinchard, les céphalopodes et le lieu jaune .
- groupe b : 103 navires exploitant l'anchois et occasionellement le merlan dans le sud du golfe.
  - -groupe b1 : 44 navires équipés de plusieurs chaluts à 1 navire dirigés sur le merlan et capturant des espècesAutres et des tacauds dans le Golfe de Gascogne ainsi que la dorade grise en Manche Occidentale.
  - -groupe b2 : 67 navires nettement dirigés sur l'anchois dans le Golfe de Gascogne et travaillant soit en boeufs soit avec des chaluts à panneaux.

trimestre 2 :

258 navires ont eu une activité pélagique au cours de ce trimestre. Les espèces suivantes à production nulle ne sont pas intervenues dans l'analyse : sprat, dorade royale, thon rouge, germon et espadon.

Selon l'histogramme des valeurs propres, 2 ou 5 axes seraient pertinents. L'axe 1 résume à lui-seul 42.5 % de l'information contenue dans le jeu de données. Il oppose les activités du Nord du Golfe de Gascogne aux activités du Sud du Golfe. L'axe 2 met en opposition l'anchois aux espèces Autres, les merlu et chinchard à la sardine. Le plan 1x2 illustre 52 % des informations initiales. L'axe 3 oppose la dorade grise de Manche-Ouest au merlu.

```
1
0
 APERCU DE LA PRECISION DES CALCULS : TRACE AVANT DIAGONALISATION .. 116.3336
                                      SOMME DES VALEURS PROPRES .... 116.3335

 HISTOGRAMME DES 27 PREMIERES VALEURS PROPRES
```

NUMERO	VALEUR PROPRE	POURCENT.	POURCENT. CUMULE	
1	49.4294	42.49	42.49	**
2	18.1647	15.61	58.10	******************************
3	13.1226	11.28	69.38	**********************
4	11.0318	9.48	78.87	******************
5	8.2555	7.10	85.96	**************
6	4.7636	4.09	90.06	********
7	3.5839	3.08	93.14	******
8	2.1729	1.87	95.01	****
9	1.8820	1.62	96.62	****
10	1.5647	1.34	97.97	***
11	1.0583	0.91	98.88	**
12	0.4405	0.38	99.26	*
13	0.3527	0.30	99.56	*
14	0.1851	0.16	99.72	*
15	0.1181	0.10	99.82	*
16	0.0763	0.07	99.89	*
17	0.0520	0.04	99.93	*
18	0.0388	0.03	99.97	*
19	0.0219	0.02	99.98	*
20	0.0078	0.01	99.99	*
21	0.0038	0.00	99.99	*
22	0.0029	0.00	100.00	*
23	0.0019	0.00	100.00	*
24	0.0013	0.00	100.00	*
25	0.0008	0.00	100.00	*
26	0.0003	0.00	100.00	*
27	0.0000	0.00	100.00	*

```
1
0
```

1

POINTS=CON,X=VEC 1,Y=VEC 2

NOMBRE DE POINTS A REPRESENTER :   27

TRAITEMENT DES POINTS A PLUS DE 2.30 ECARTS-TYPES DU CENTRE
POINTS ELOIGNES :

IDENTIFICATEUR	ABSCISSE	ORDONNEE
9422	32.374	24.799
NG2	38.865	-15.339
SG2	-38.313	16.589

NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE: 3
NOMBRE DE POINTS REPRESENTES :   27

POINTS MULTIPLES

POINT VU	ABSCISSE APPROCHEE	ORDONNEE APPROCHEE	NB. DE CACHES	POINTS CACHES
BAR2	0.04	0.00	7	MC2 HAR2 ENC2 ORP2 LA2 LIE2 DOO2
TAC2	-0.98	-0.41	1	MEA2

0 2 POINTS MULTIPLES,   8 POINTS CACHES

1   AXE 1 * AXE 2

```
 AXE 2
  12  +------------------------------------------------------------------------------------------------------------------MEU2
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                              9422
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                              ANC2                                 |                                               |
   8  +                                                                   |                                               |
      |                                                                   |                                               |
     SG2                                                                  |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                  CHI2                         |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
   4  +                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                          DOG2    9452    MAQ2                                     |
   0  +------------------------------------------------------------------BAR2---------------------------------------------|
      |                                                          9322TAC2MUL2                                             |
      |                                                                   |                                               |
      |                                                              MO2  |                                               |
      |                                                              9492 |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
  -4  +                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                              NG2
      |                                                          SEI2     |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                              SAR2
  -8  +                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
      |                                                                   |                                               |
 -12  +                                                                   |                                               |
      |                                                                   |                                               |
     AUT2                                                                 |                                               |
       ---+------9392-----+---------------+---------------+---------------+---------------+---------------+---------------+
         -16             -12              -8              -4               0               4               8              12
                                                                                                                       AXE 1
```

POINTS=CON,X=VEC 1,Y=VEC 3

NOMBRE DE POINTS A REPRESENTER :   27

TRAITEMENT DES POINTS A PLUS DE 2.30 ECARTS-TYPES DU CENTRE
POINTS ELOIGNES :

IDENTIFICATEUR	ABSCISSE	ORDONNEE
9422	32.374	2.031
MO2	-0.831	18.332
NG2	38.865	-10.294
SG2	-38.313	-7.759
MEU2	12.289	-18.909

NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE: 5
NOMBRE DE POINTS REPRESENTES :   27

POINTS MULTIPLES

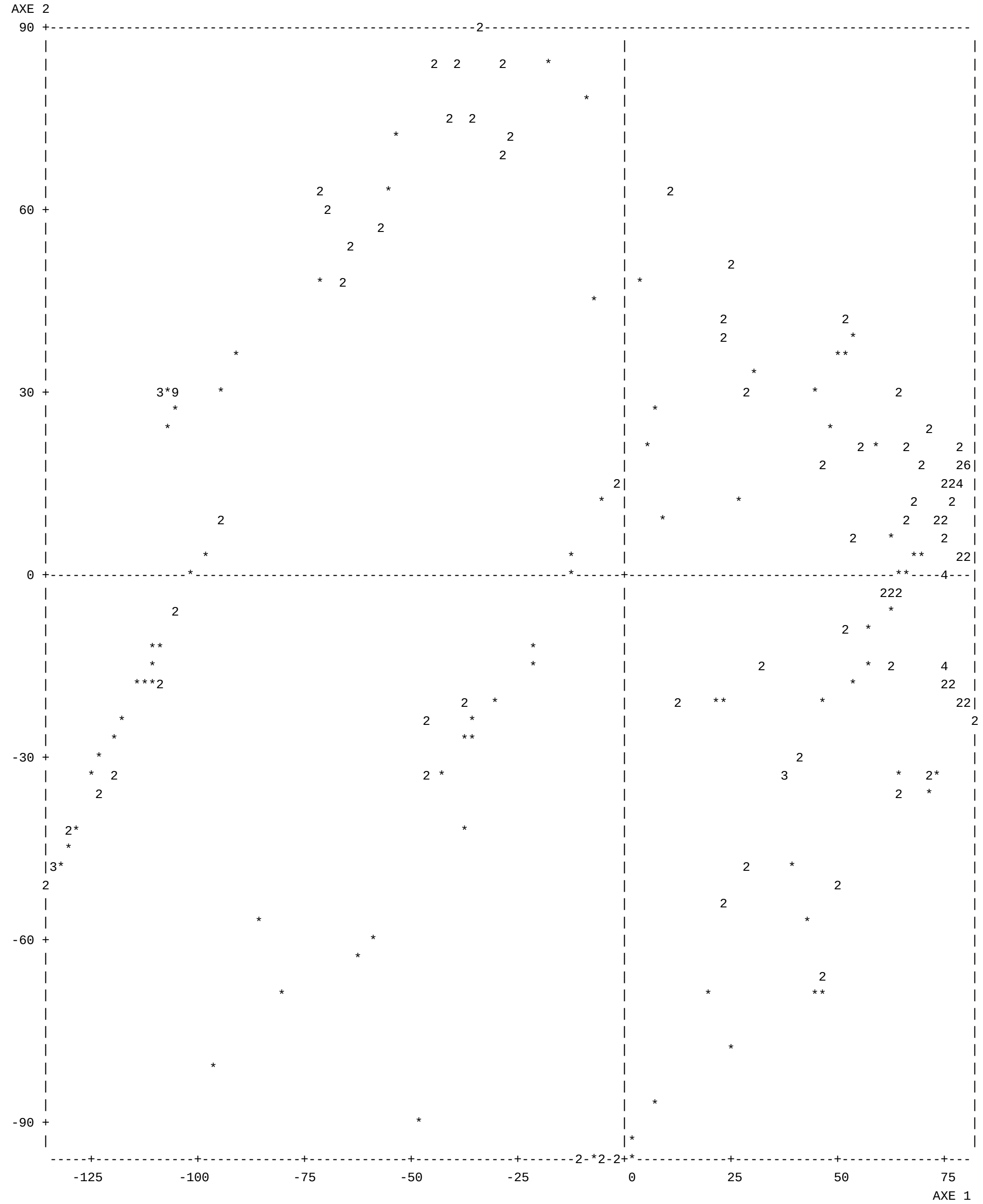
POINT VU	ABSCISSE APPROCHEE	ORDONNEE APPROCHEE	NB. DE CACHES	POINTS CACHES
ORP2	0.04	0.32	2	9452 BAR2
ENC2	0.04	-0.09	6	HAR2 MC2 LIE2 LA2 DOO2 MUL2
MEA2	-0.98	-0.50	1	TAC2

```
0  3 POINTS MULTIPLES,   9 POINTS CACHES
1                                                          AXE 1  *  AXE 3
 AXE 3
       ----------------------------------------------------------DOG2MO2 --------------------------------------------------
  12  +                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                             SAR2
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
   8  +                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                              ANC2                                  |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
   4  +                                                          9322      |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |     MAQ2                                      |
      |                                                                    |                                             9422
      |                                                                  ORP2                                              |
   0  +------------------------------------------------------------------ENC2----------------------------------------------|
      |                                                              MEA2  |                                               |
      |                                                                    |                                               |
      |                                                                    |                 CHI2                          |
      |                                                          SEI2      |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
     SG2                                                             9492  |                                             NG2
      |                                                                    |                                               |
  -4  +                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
      |                                                                    |                                               |
     AUT2-+------9392-----+--------------+--------------+--------------+--------------+--MEU2---------+--------------+
         -16             -12              -8             -4              0               4               8              12
                                                                                                                    AXE 1
```

POINTS=IND,X=VEC 1,Y=VEC 2

```
NOMBRE DE POINTS A REPRESENTER :  258
TRAITEMENT DES POINTS A PLUS DE  2.30 ECARTS-TYPES DU CENTRE
NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE:         6
NOMBRE DE POINTS REPRESENTES :  258
 79 POINTS MULTIPLES,  99 POINTS CACHES

IDENTIFICATION DES POINTS
     * : UN SEUL POINT
     N : N POINTS SUPERPOSES
     X : 10 POINTS SUPERPOSES OU PLUS
```

1 AXE 1 * AXE 2



POINTS=IND,X=VEC 1,Y=VEC 3

```
NOMBRE DE POINTS A REPRESENTER :  258
TRAITEMENT DES POINTS A PLUS DE  2.30 ECARTS-TYPES DU CENTRE
NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE:        15
NOMBRE DE POINTS REPRESENTES :  258
 76 POINTS MULTIPLES,  99 POINTS CACHES

IDENTIFICATION DES POINTS
     * : UN SEUL POINT
     N : N POINTS SUPERPOSES
     X : 10 POINTS SUPERPOSES OU PLUS
1                                                             AXE 1  *  AXE 3
 AXE 3
  60 +----------------------------------------*----------------------*4-*--2-2--3-**-------------------------------------------
     |                                                                           |                                             |
     |                                                                           |                                             |
     |                                                                           |                                             |
     |                                                                           |                                             |
     |                                                                           |                                             |
     |                                                                           |                                             |
     |                                                                           |                                 2           |
     |              3                                                            |                                             |
     |                                                                           |             *                              22
  30 +               *                                                           |                        **   2         **222 |
     |                                                                           |                         2 *2     2    2     |
     |                X                                                          |                           *      22     4   |
     |                        *          2                                       |                                   *         |
     |               *      *                      *                             |                                  * *        |
     |                                   *                                       |                       *           2         |
     |                                    2                      2               |               2                             |
     |                                                                           |                     *                       |
     |                                                  2    2                   |                         2                   |
     |                                       2                                   |                *                   2    2   |
   0 +---------------------------------------------------------------------------+------------2------------*-----*---------2---|
     |                                           2        2       2              |            2             *             2    |
     |              *                                      2                     |           **                 2      2   2   |
     |              2                                                            |    *         *2                *           2|
     |                                                                           |          *                         2      2 |
     |        *  *    2                                                          |2  *  2                               2  2   |
     |        *    *    *                       *                               *|                 2                        2  |
     |     ** *   **                                              2            * |                                             |
     |         *          *      *                            2             ** * |     2                             2         |
     |  2          *        2       *                 *2    2             *   *  |             2          *    *               |
 -30 +   *  *                                                             * *    | *                          ** *           6 |
     23**   *                                          2               *         |                           *      *  * 2  2  |
     |                     *                2                                    |                                   *  *  2 26|
     |                                            *                              |                    2                        |
     |                                                                           |                    *       2                |
     |                                                                           |            *                                |
      -----+-------------+-------------+-------------+-------------+-------------+------------*+--------2----+-------------+---
         -125          -100           -75           -50           -25             0            25           50            75
                                                                                                                          AXE 1
```

CLASSIFICATION HIERARCHIQUE : DESCRIPTION DES 49 NOEUDS D'INDICES LES PLUS ELEVES

NUM.	AINE	BENJ	EFF.	POIDS	INDICE	HISTOGRAMME DES INDICES DE NIVEAU
467	439	364	14	14.00	3.10661	*
468	407	369	6	6.00	3.29686	*
469	454	33	9	9.00	3.31891	*
470	95	419	3	3.00	3.83451	*
471	455	395	10	10.00	3.92417	*
472	432	381	7	7.00	4.29503	*
473	411	406	15	15.00	5.14022	*
474	409	456	6	6.00	5.39108	*
475	448	418	10	10.00	5.84941	*
476	450	424	11	11.00	5.85089	*
477	457	426	10	10.00	5.94071	*
478	417	460	10	10.00	6.47382	*
479	469	437	13	13.00	6.93880	*
480	441	393	7	7.00	7.57060	*
481	459	458	5	5.00	7.76799	*
482	453	140	8	8.00	7.80879	*
483	452	434	18	18.00	8.49350	*
484	467	476	25	25.00	9.29046	*
485	435	446	9	9.00	11.09306	*
486	483	466	25	25.00	12.04455	*
487	425	478	12	12.00	12.80866	*
488	464	423	18	18.00	12.94363	*
489	462	416	14	14.00	14.10867	*
490	442	470	6	6.00	15.29725	*
491	479	429	17	17.00	15.99748	*
492	474	99	7	7.00	18.56703	*
493	445	468	26	26.00	19.73853	*
494	472	444	13	13.00	24.04224	*
495	493	477	36	36.00	25.77393	*
496	461	463	12	12.00	28.37877	*
497	484	471	35	35.00	30.14264	*
498	494	490	19	19.00	43.95497	*
499	496	443	15	15.00	46.44928	*
500	485	492	16	16.00	63.27547	**
501	488	481	23	23.00	63.56477	**
502	480	491	24	24.00	65.94292	**
503	486	487	37	37.00	71.88769	**
504	501	489	37	37.00	98.09862	***
505	498	465	25	25.00	98.95628	***
506	497	482	43	43.00	102.14433	***
507	502	499	39	39.00	129.66745	***
508	495	503	73	73.00	145.78317	****
509	475	505	35	35.00	183.25403	****
510	507	473	54	54.00	599.62329	*************
511	506	508	116	116.00	699.70734	***************
512	509	511	151	151.00	858.45728	******************
513	504	510	91	91.00	1126.53027	************************
514	513	500	107	107.00	1328.57886	****************************
515	514	512	258	258.00	3836.59790	***

SOMME DES INDICES DE NIVEAU =**********

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La classification ascendante hiérarchique (CAH) réalisée sur les coordonnées des individus par rapport aux 5 premiers axes montre qu'une partition en 2 ou 7 classes selon l'option choisie serait pertinente (indices de niveau ci-dessus).

La partition fait apparaître:

- a) un groupe Nord Gascogne composé de 150 navires travaillant en boeufs et pêchant la sardine, le merlu et le chinchard. Ce groupe a une petite activité en Mer Celtique. Il peut être décomposé en 3 sous-groupes:

  - a1: classe de 78 navires travaillant en boeufs sur le merlu, le chinchard et réalisant des incursions en Mer Celtique.
  - a2 : classe composée de 42 navires exploitant la sardine, le maquereau.
  - a3 : classe de 33 navires ciblant la seiche et le lieu jaune, travaillant en boeufs et utilisant divers chaluts. Des incursions seraient réalisées vers le Large.

- b) un groupe Sud-gascogne qui comprend 108 individus exploitant la dorade grise, l'encornet, l'anchois, le merlan, le tacaud et les espècesAutres. Ces navires travaillent aussi en Manche Occidentale.

  - b1 : 16 navires ont une activité centrée sur la Manche Occidentale. Ils y exploitent la dorade grise et le bar. Du hareng et du maquereau sont également capturés.
  - b2 : 17 navires pêchent l'anchois du Golfe au chalut à panneaux;
  - b3 : 35 navires travaillant en boeufs exploitent le chinchard, la dorade rose et le merlu. Ces navires utilisent parfois des petits maillages dirigés sur l'anchois.
  - b4 : 37 navires exploitant les espècesAutres avec plusieurs chaluts à 1 navire. Des pêches importantes de tacaud, de merlan, d'encornet, de seiche et de mulet y sont réalisées.

trimestre 3 :

268 navires ont été recensés dans la flotte pélagique au cours de cette période. Le chalut pélagique à maillage<20 mm et tracté en boeuf n'y a pas été répertorié. Le sprat est l'espèce absente des captures de cette période.

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STATISTIQUES SOMMAIRES DES VARIABLES CONTINUES   EFFECTIF TOTAL : 268

POIDS TOTAL : 268.00

NUM	IDEN	LIBELLE	EFFECTIF	POIDS	MOYENNE	ECART-TYPE	MINIMUM	MAXIMUM
1	9323	9323Trimestre 3	268	268.00	2.84	13.61	0.00	100.00
2	9353	9353Trimestre 3	268	268.00	0.21	2.51	0.00	39.00
3	9423	9423Trimestre 3	268	268.00	52.37	43.73	0.00	100.00
5	9393	9393Trimestre 3	268	268.00	8.85	21.01	0.00	100.00
6	9493	9493Trimestre 3	268	268.00	4.09	14.91	0.00	93.00
7	MO3	MO3 MANCHE OCCIDENTA	268	268.00	1.97	13.54	0.00	100.00
8	MC3	MC3 MER CELTIQUE Tri	268	268.00	0.42	6.11	0.00	100.00
9	NG3	NG3 NORD GASCOGNE Tr	268	268.00	51.88	45.36	0.00	100.00
10	SG3	SG3 SUD GASCOGNE Tri	268	268.00	35.02	42.56	0.00	100.00
11	LA3	LA3 LARGE AUTRES Tri	268	268.00	10.68	24.52	0.00	100.00
12	AUT3	AUT3Autres especes T	268	268.00	15.22	28.74	0.00	100.00
13	MEU3	MEU3merlu Trimestre	268	268.00	9.06	13.76	0.00	91.00
14	MEA3	MEA3merlan Trimestre	268	268.00	2.65	6.04	0.00	43.00
15	LIE3	LIE3lieu jaune Trime	268	268.00	0.04	0.28	0.00	3.00
16	TAC3	TAC3tacaud Trimestre	268	268.00	0.52	1.74	0.00	15.00
17	BAR3	BAR3bar Trimestre 3	268	268.00	0.32	1.47	0.00	14.00
18	DOY3	DOY3dorade royale Tr	268	268.00	0.02	0.19	0.00	2.00
19	DOO3	DOO3dorade rose Trim	268	268.00	0.02	0.19	0.00	2.00
20	DOG3	DOG3dorade grise Tri	268	268.00	1.43	7.05	0.00	83.00
21	ORP3	ORP3orphie Trimestre	268	268.00	0.02	0.15	0.00	1.00
22	CHI3	CHI3chinchard Trimes	268	268.00	6.32	10.74	0.00	57.00
23	MUL3	MUL3mulet Trimestre	268	268.00	1.77	6.96	0.00	57.00
24	HAR3	HAR3hareng Trimestre	268	268.00	0.92	6.01	0.00	69.00
25	SAR3	SAR3sardine Trimestr	268	268.00	14.40	25.30	0.00	96.00
27	ANC3	ANC3anchois Trimestr	268	268.00	21.08	29.37	0.00	100.00
28	THR3	THR3thon rouge Trime	268	268.00	4.00	9.32	0.00	79.00
29	GER3	GER3germon Trimestre	268	268.00	17.56	28.85	0.00	100.00
30	ESP3	ESP3espadon Trimestr	268	268.00	0.83	2.01	0.00	16.00
31	MAQ3	MAQ3maquereau Trimes	268	268.00	1.41	3.95	0.00	33.00
32	SEI3	SEI3seiche Trimestre	268	268.00	1.17	4.90	0.00	51.00
33	ENC3	ENC3encornet Trimes	268	268.00	0.91	2.97	0.00	22.00

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APERCU DE LA PRECISION DES CALCULS : TRACE AVANT DIAGONALISATION .. 112.3925

SOMME DES VALEURS PROPRES 112.3925

HISTOGRAMME DES 31 PREMIERES VALEURS PROPRES

NUMERO	VALEUR PROPRE	POURCENT.	POURCENT. CUMULE	
1	47.1134	41.92	41.92	***
2	23.6556	21.05	62.97	***
3	12.5969	11.21	74.17	**********************
4	7.4327	6.61	80.79	*************
5	4.9334	4.39	85.18	*********
6	3.6283	3.23	88.40	*******
7	3.1293	2.78	91.19	******
8	2.1702	1.93	93.12	****
9	1.6512	1.47	94.59	***
10	1.3574	1.21	95.80	***
11	1.1700	1.04	96.84	**
12	0.8858	0.79	97.63	**
13	0.6642	0.59	98.22	**
14	0.4635	0.41	98.63	*
15	0.4241	0.38	99.01	*
16	0.3077	0.27	99.28	*
17	0.2399	0.21	99.49	*
18	0.2090	0.19	99.68	*
19	0.1572	0.14	99.82	*
20	0.0695	0.06	99.88	*
21	0.0565	0.05	99.93	*
22	0.0342	0.03	99.96	*
23	0.0223	0.02	99.98	*
24	0.0097	0.01	99.99	*
25	0.0088	0.01	100.00	*
26	0.0005	0.00	100.00	*
27	0.0004	0.00	100.00	*
28	0.0003	0.00	100.00	*
29	0.0002	0.00	100.00	*
30	0.0001	0.00	100.00	*
31	0.0001	0.00	100.00	*

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L'histogramme des valeurs propres laisse apparaître que l'essentiel de l'information est extrait avec les trois premiers axes. L'axe 1 résume 42 % environ des informations. Le plan 1x2 représente 63 % de l'information initiale. L'axe 1 oppose à nouveau le sud du Golfe au nord du Golfe où sont pêchés l'anchois et la sardine. L'axe 2 oppose les espècesAutres au germon. L'axe 3 oppose les germoniers oeuvrant au Large aux pélagiques travaillant en boeufs dans le Golfe soit au Nord pour exploiter la sardine et l'anchois soit au Sud pour les espècesAutres.

POINTS=CON,X=VEC 1,Y=VEC 2

NOMBRE DE POINTS A REPRESENTER : 31

TRAITEMENT DES POINTS A PLUS DE 2.30 ECARTS-TYPES DU CENTRE
POINTS ELOIGNES :

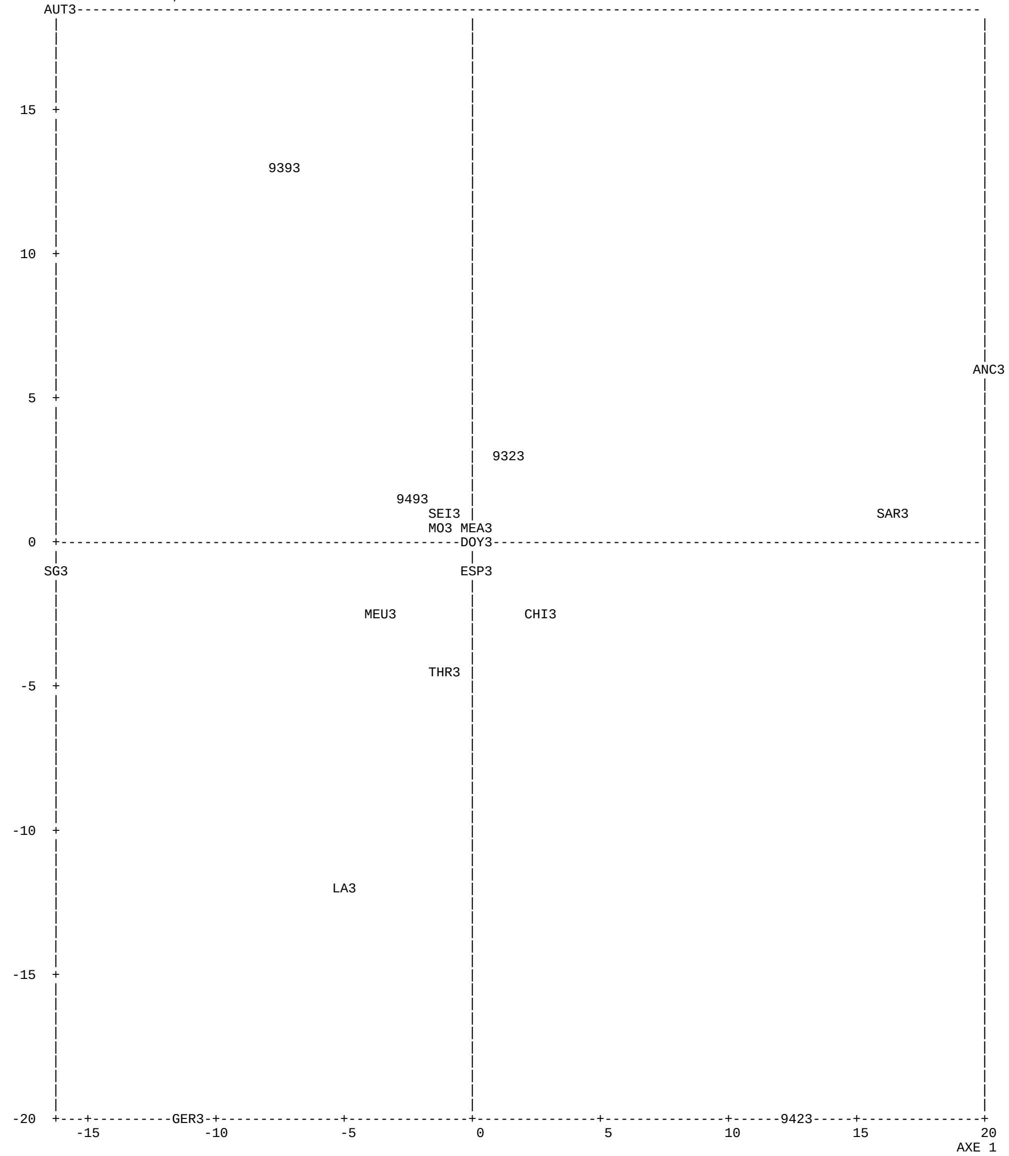
IDENTIFICATEUR	ABSCISSE	ORDONNEE
9423	21.078	-32.938
NG3	42.433	13.202
SG3	-36.999	-2.597

NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE: 3
NOMBRE DE POINTS REPRESENTES : 31

POINTS MULTIPLES

POINT VU	ABSCISSE APPROCHEE	ORDONNEE APPROCHEE	NB. DE CACHES	POINTS CACHES
ANC3	19.59	5.93	1	NG3
SEI3	-1.22	0.99	1	MUL3
MO3	-1.22	0.49	2	ENC3 DOG3
MEA3	0.00	0.49	3	TAC3 MAQ3 MC3
DOY3	0.00	0.00	6	BAR3 DOO3 ORP3 HAR3 9353 LIE3

0 5 POINTS MULTIPLES, 13 POINTS CACHES



POINTS=CON,X=VEC 1,Y=VEC 3

NOMBRE DE POINTS A REPRESENTER :   31

TRAITEMENT DES POINTS A PLUS DE 2.30 ECARTS-TYPES DU CENTRE
POINTS ELOIGNES :

IDENTIFICATEUR	ABSCISSE	ORDONNEE
9423	21.078	17.014
NG3	42.433	2.338
SG3	-36.999	18.778
LA3	-4.303	-18.862

NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE: 4

NOMBRE DE POINTS REPRESENTES :   31

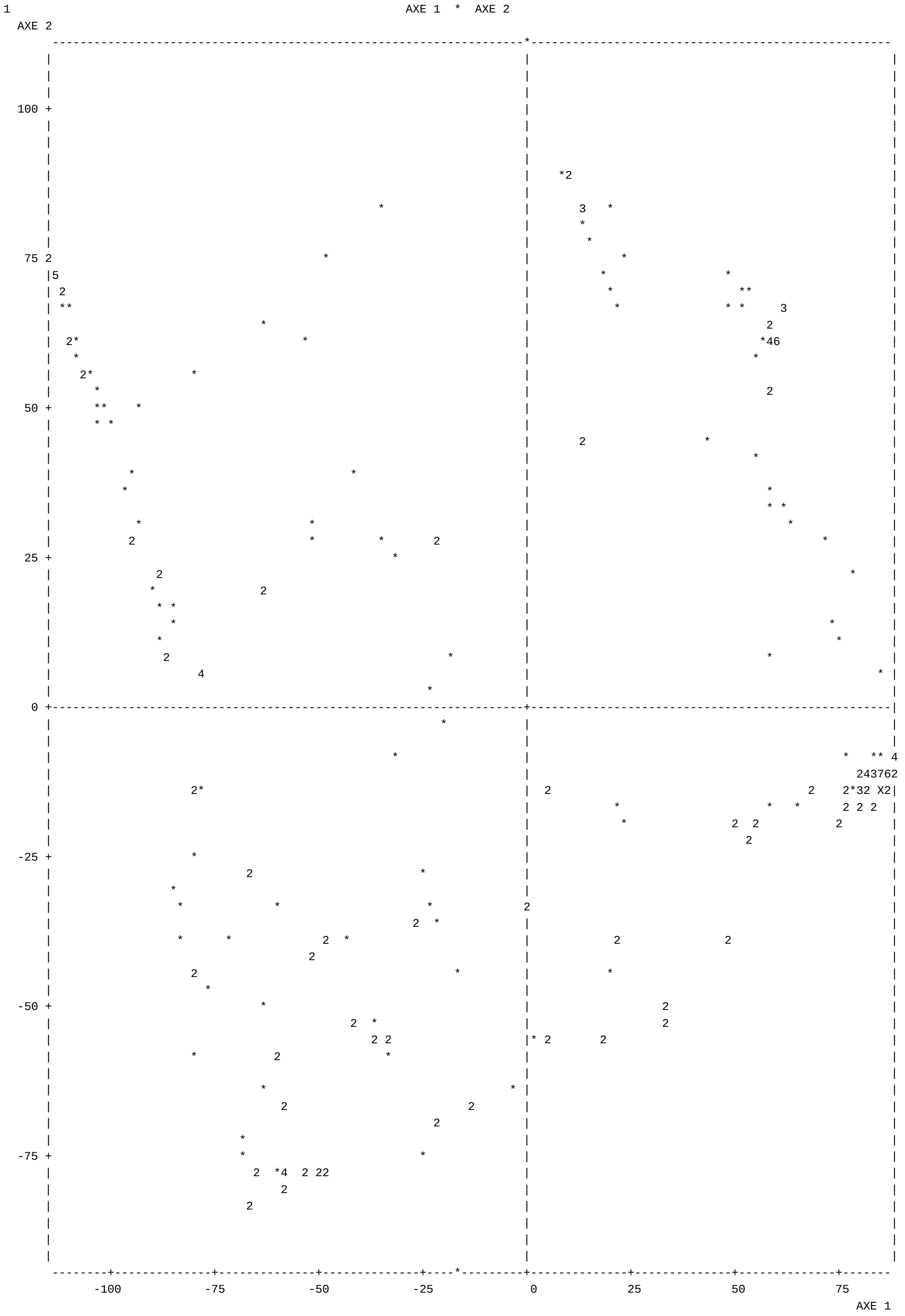
POINTS MULTIPLES

POINT VU	ABSCISSE APPROCHEE	ORDONNEE APPROCHEE	NB. DE CACHES	POINTS CACHES
SEI3	-1.22	0.00	2	ENC3 DOG3
TAC3	0.00	0.00	6	9353 DOO3 BAR3 DOY3 LIE3 ORP3
HAR3	0.00	-0.50	1	MC3

```
0  3 POINTS MULTIPLES,   9 POINTS CACHES
1                                                       AXE 1  *  AXE 3
 AXE 3
       --------------SG3 --------------------------------------------------------9423------------------------SAR3---------
   5  +                                                   |                                                               |
      |                                                   |                                                               |
     AUT3                                                 |                                                               |
      |                                                   |                                                               |
      |                                      MEU3         |                                                               |
      |                                                   |                                                               |
      |                                                   |      CHI3                                                     |
      |                          9393            9493     |                                                               |
      |                                              MUL3MEA3                                                            NG3
      |                                                  MAQ3                                                            ANC3
   0  +----------------------------------------------SEI3TAC3-------------------------------------------------------------|
      |                                                  HAR3                                                             |
      |                                                  ESP3                                                             |
      |                                                   |  9323                                                         |
      |                                              MO3  |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
      |                                              THR3 |                                                               |
      |                                                   |                                                               |
  -5  +                                                   |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
 -10  +                                                   |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
      |                                                   |                                                               |
       ---+----------GER3-+---------------+------LA3 -----+---------------+---------------+---------------+---------------+
         -15             -10              -5               0               5              10              15              20
                                                                                                                       AXE 1
```

POINTS=IND,X=VEC 1,Y=VEC 2

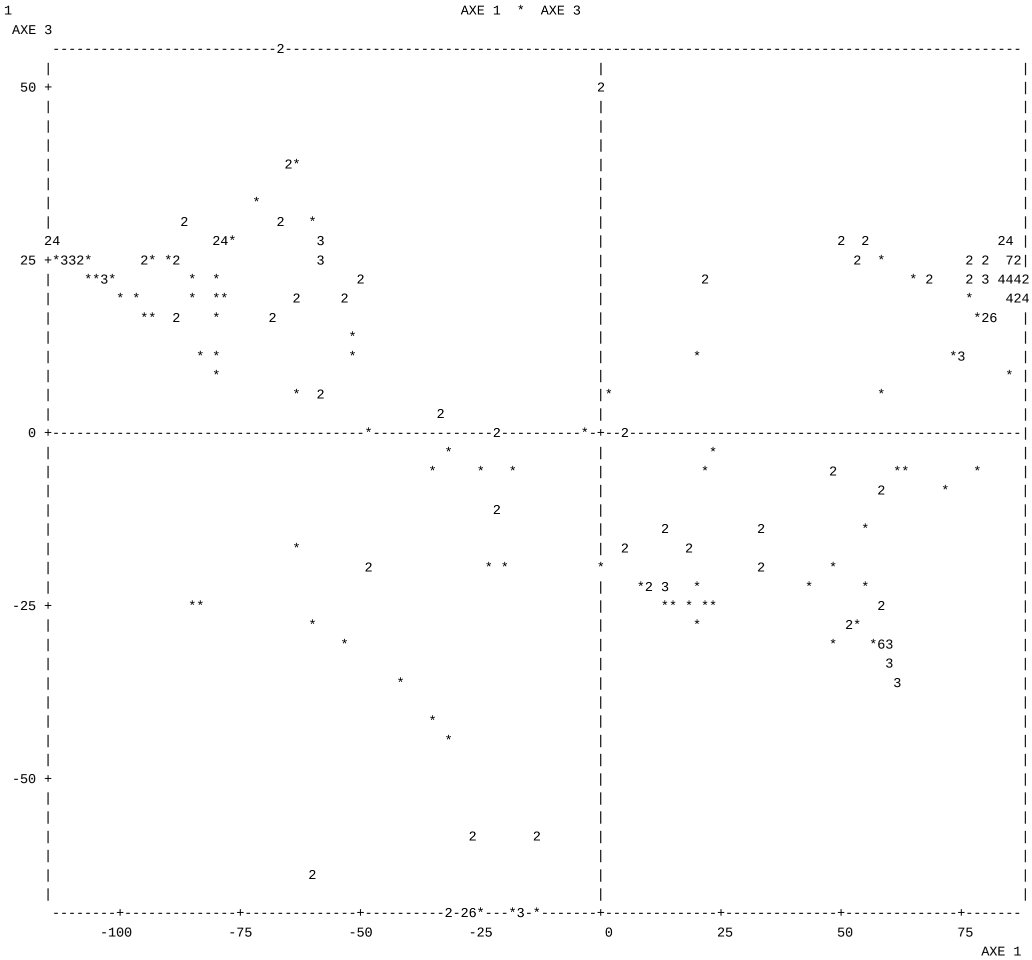
```
NOMBRE DE POINTS A REPRESENTER :  268
NOMBRE DE POINTS REPRESENTES :  268
 67 POINTS MULTIPLES, 106 POINTS CACHES

IDENTIFICATION DES POINTS
     * : UN SEUL POINT
     N : N POINTS SUPERPOSES
     X : 10 POINTS SUPERPOSES OU PLUS
```



POINTS=IND,X=VEC 1,Y=VEC 3

NOMBRE DE POINTS A REPRESENTER : 268
TRAITEMENT DES POINTS A PLUS DE 2.30 ECARTS-TYPES DU CENTRE
NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE: 15
NOMBRE DE POINTS REPRESENTES : 268
73 POINTS MULTIPLES, 118 POINTS CACHES

IDENTIFICATION DES POINTS
* : UN SEUL POINT
N : N POINTS SUPERPOSES
X : 10 POINTS SUPERPOSES OU PLUS



CLASSIFICATION HIERARCHIQUE : DESCRIPTION DES 49 NOEUDS D'INDICES LES PLUS ELEVES

NUM.	AINE	BENJ	EFF.	POIDS	INDICE	HISTOGRAMME DES INDICES DE NIVEAU
487	473	403	22	22.00	1.58308	*
488	327	425	5	5.00	1.80970	*
489	277	383	4	4.00	1.87490	*
490	461	450	21	21.00	2.11435	*
491	452	462	15	15.00	2.25643	*
492	465	437	13	13.00	2.45912	*
493	460	456	11	11.00	2.52992	*
494	285	455	4	4.00	2.55411	*
495	318	85	3	3.00	2.59880	*
496	459	241	3	3.00	2.98940	*
497	284	481	6	6.00	3.56641	*
498	480	273	8	8.00	4.10667	*
499	109	492	14	14.00	4.16172	*
500	482	487	63	63.00	4.36286	*
501	491	477	19	19.00	4.42339	*
502	490	479	26	26.00	4.58624	*
503	467	457	11	11.00	5.24531	*
504	496	468	5	5.00	5.87319	*
505	321	295	4	4.00	5.92545	*
506	453	458	7	7.00	5.96913	*
507	488	476	11	11.00	5.99016	*
508	483	478	10	10.00	6.60277	*
509	475	485	8	8.00	7.61073	*
510	448	486	24	24.00	7.83603	*
511	507	472	15	15.00	8.95408	*
512	494	470	9	9.00	9.73186	*
513	499	294	16	16.00	9.86140	*
514	505	495	7	7.00	11.02512	*
515	471	497	9	9.00	11.08167	*
516	506	269	9	9.00	12.17008	*
517	493	474	15	15.00	12.31052	*
518	498	489	12	12.00	15.62543	*
519	517	503	26	26.00	18.15998	*
520	500	442	70	70.00	21.13982	*
521	484	509	11	11.00	25.26582	*
522	518	516	21	21.00	26.40385	*
523	512	501	28	28.00	34.33747	*
524	511	514	22	22.00	37.45333	*
525	504	515	14	14.00	46.66544	*
526	523	521	39	39.00	54.12655	**
527	520	508	80	80.00	63.77665	**
528	502	513	42	42.00	78.81187	**
529	519	525	40	40.00	132.61617	***
530	510	529	64	64.00	208.60756	*****
531	527	522	101	101.00	311.00180	*******
532	526	524	61	61.00	646.65668	*************

```
 533   528   531   143    143.001047.66406   *********************
 534   530   532   125    125.001357.89819   ****************************
 535   534   533   268    268.004001.71899   *********************************************************************************

SOMME  DES  INDICES  DE  NIVEAU =8336.59961
```

Une classification hiérarchique ascendante (CAH) a été réalisée sur les 3 premiers axes. Tenant compte de l'histogramme des indices de niveaux, une partition en 2 classes et une partition en 5 classes ont été opérées.

Les partitions indiquent les classes suivantes :

- a: 137 navires travaillant en Nord-Gascogne sur l'anchois et la sardine.
  - a1: 90 navires exploitant en boeufs les petits pélagiques (anchois, sardine, chinchard).
  - b1: 47 navires travaillant au chalut pélagique à panneaux (chalut -1 nav) l'anchois et dont les captures contiennent l'orphie.
- b: 131navires opérant en Sud-Gascogne ou au Large sur le germon, le thon rouge et l'espadon.
  - b1 : 22 thoniers travaillant au Large le thon rouge, le germon et l'espadon.
  - b2 : 49 bateaux exploitant dans le sud du Golfe les thonidés et le merlu.
  - b3 : 60 bateaux qui se caractérisent par une diversité d'espèces capturées (le tacaud, le mulet, le bar, l'encornet, la seiche, les dorades et surtout les espècesAutres) et la mise en oeuvre de plusieurs chaluts (dont le chalut de fond).

trimestre 4 :

127 navires uniquement sont armés au pélagique au cours de cette période. La dorade rose et l'orphie sont les espèces absentes.

EDITION DES VALEURS PROPRES (DIVISEES PAR 10)

APERCU DE LA PRECISION DES CALCULS : TRACE AVANT DIAGONALISATION .. 857.9665
SOMME DES VALEURS PROPRES 857.9665

HISTOGRAMME DES 30 PREMIERES VALEURS PROPRES

NUMERO	VALEUR PROPRE	POURCENT.	POURCENT. CUMULE	
1	307.3233	35.82	35.82	**
2	215.7663	25.15	60.97	***
3	82.2282	9.58	70.55	**********************
4	64.7591	7.55	78.10	*****************
5	41.7696	4.87	82.97	***********
6	33.3937	3.89	86.86	*********
7	30.5217	3.56	90.42	********
8	23.3027	2.72	93.13	*******
9	19.7813	2.31	95.44	******
10	11.9687	1.40	96.84	****
11	10.6813	1.24	98.08	***
12	6.3344	0.74	98.82	**
13	4.3383	0.51	99.32	**
14	1.9677	0.23	99.55	*
15	1.1966	0.14	99.69	*
16	0.8668	0.10	99.79	*
17	0.5727	0.07	99.86	*
18	0.3323	0.04	99.90	*
19	0.2560	0.03	99.93	*
20	0.2012	0.02	99.95	*
21	0.1774	0.02	99.97	*
22	0.0842	0.01	99.98	*
23	0.0499	0.01	99.99	*
24	0.0413	0.00	99.99	*
25	0.0336	0.00	100.00	*
26	0.0080	0.00	100.00	*
27	0.0051	0.00	100.00	*
28	0.0025	0.00	100.00	*
29	0.0020	0.00	100.00	*
30	0.0006	0.00	100.00	*

1

L'histogramme des indices de niveaux indique que 2 axes suffisent à résumer l'information. Le plan 1x2 représente 61 % de l'information dont près de 36 % pour l'axe 1. Cet axe oppose le germon du Large à l'anchois du Nord du Golfe. L'axe 2 oppose les navires travaillant avec des panneaux à ceux opérant en paires (boeufs). On dénote une opposition entre le bloc "Mer Celtique + Manche-Ouest", caractérisé par les espècesAutres, et le Sud du Golfe où des captures de chinchard et de thon rouge sont réalisées.

POINTS=CON,X=VEC 1,Y=VEC 2

```
NOMBRE DE POINTS A REPRESENTER :   30
TRAITEMENT DES POINTS A PLUS DE  2.30 ECARTS-TYPES DU CENTRE
POINTS ELOIGNES :
+--------------------------+----------+----------+
|      IDENTIFICATEUR      | ABSCISSE | ORDONNEE |
+--------------------------+----------+----------+
|          9424            |   -0.205 |   44.074 |
|          NG4             |   31.045 |    2.232 |
|          ANC4            |   38.333 |   -0.804 |
+--------------------------+----------+----------+

NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE:          3
NOMBRE DE POINTS REPRESENTES :   30
POINTS MULTIPLES
----------+-----------+-----------+--------+------------------------------------------------------------------------------
          | ABSCISSE  | ORDONNEE  | NB. DE |
 POINT VU | APPROCHEE | APPROCHEE | CACHES |      POINTS CACHES
----------+-----------+-----------+--------+------------------------------------------------------------------------------
   MUL4   |    0.00   |    0.27   |    1   | HAR4
   DOY4   |    0.00   |    0.00   |    4   | BAR4 9454 LIE4 SEI4
   9354   |    0.00   |   -0.27   |    2   | SPR4 TAC4
----------+-----------+-----------+--------+------------------------------------------------------------------------------
0  3 POINTS MULTIPLES,   7 POINTS CACHES
1                                                      AXE 1  *  AXE 2
 AXE 2
      --------------------------------------CHI4----------------------------------------9424-----------------------------
     |                                                                                   |                               |
     |                                                                                   |                               |
  6  +                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
  3  +                                      SG4                                          |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                              SAR4 |                               |
     |                                                          THR4            MEU4     |                               |
     |                                                                                   |                               |
     |  LA4                                                                     MEA4     |                               |
     |                                                                          ESP4ENC4MUL4                            NG4
  0  +----------------------------------------------------------------------------------DOY4----------------------------ANC4
     |                                                                      DOG4        9354                             |
     |                                                                                   |  MAQ4                         |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
    GER4                                                                                 |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                  MC4                              |                               |
 -3  +                                                      MO4                          |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |      9394                     |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
 -6  +                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                               |
     |                                                                                   |                              9324
     +-----------+-----------+-----------+------AUT4-+-----------+-----------+-----------+-----------+-----------+-------
    -14         -12         -10          -8          -6          -4          -2           0           2           4
                                                                                                                    AXE 1
```

POINTS=CON,X=VEC 1,Y=VEC 3

NOMBRE DE POINTS A REPRESENTER : 30
TRAITEMENT DES POINTS A PLUS DE 2.30 ECARTS-TYPES DU CENTRE
POINTS ELOIGNES :

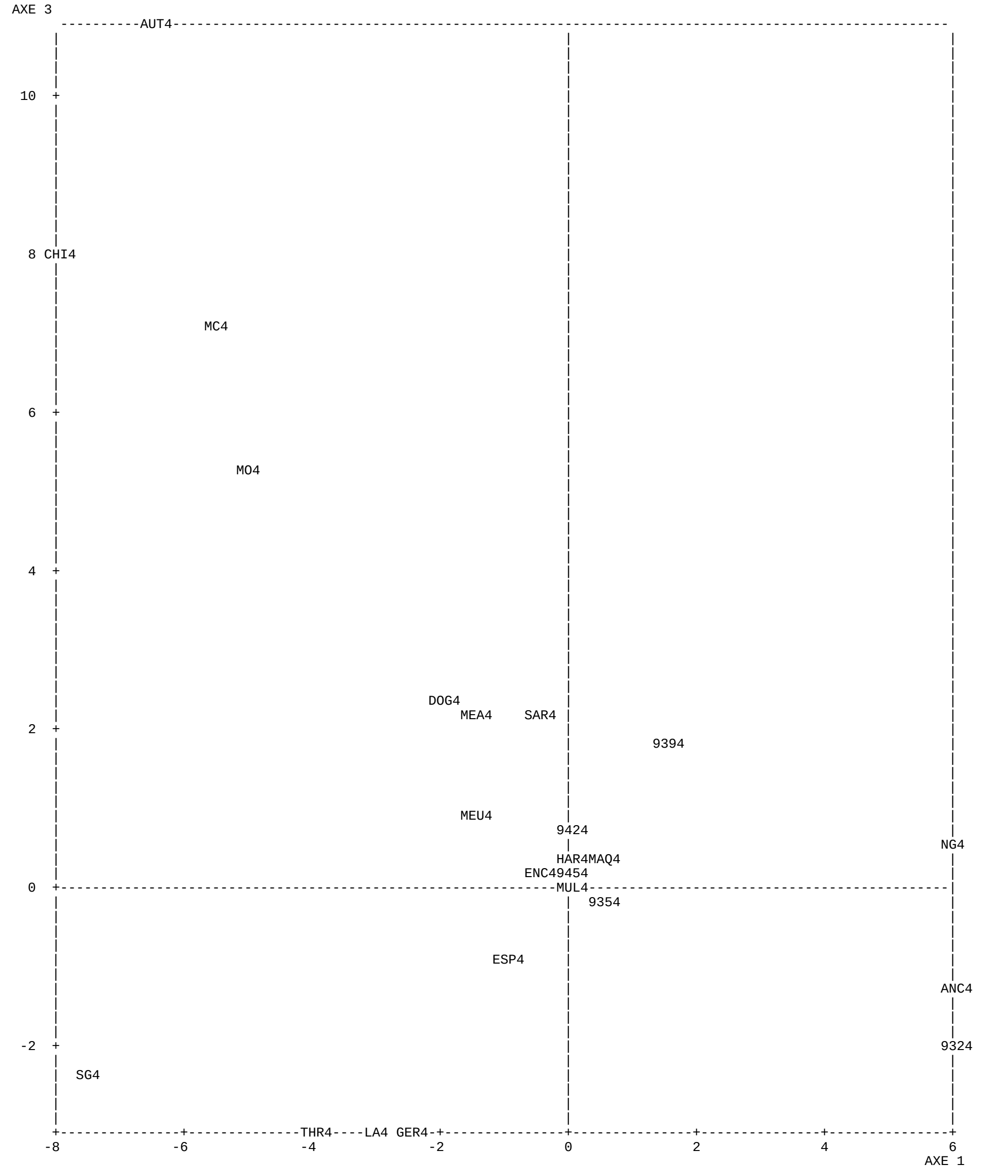
IDENTIFICATEUR	ABSCISSE	ORDONNEE
NG4	31.045	3.334
LA4	-13.491	-13.356
ANC4	38.333	-8.395
GER4	-13.933	-16.043

NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE: 4
NOMBRE DE POINTS REPRESENTES : 30

POINTS MULTIPLES

POINT VU	ABSCISSE APPROCHEE	ORDONNEE APPROCHEE	NB. DE CACHES	POINTS CACHES
HAR4	-0.02	0.36	1	TAC4
9454	-0.02	0.17	3	BAR4 SEI4 LIE4
MUL4	-0.02	-0.01	2	DOY4 SPR4

0 3 POINTS MULTIPLES, 6 POINTS CACHES
1 AXE 1 * AXE 3



POINTS=IND,X=VEC 1,Y=VEC 2

```
 NOMBRE DE POINTS A REPRESENTER :  127
 NOMBRE DE POINTS REPRESENTES :  127
  29 POINTS MULTIPLES,  35 POINTS CACHES

 IDENTIFICATION DES POINTS
      * : UN SEUL POINT
      N : N POINTS SUPERPOSES
      X : 10 POINTS SUPERPOSES OU PLUS
1                                                        AXE 1  *  AXE 2
 AXE 2
      -----------------------------------2---*--------------------------*------------------------------------------------------
     |                                 *                                            |                                          |
     |                                                                             *|    2                                     |
  50 +                **                                                  *         |    *  2                                  |
     |                      2                     2       *                  2      |                                          |
     |                            2                                                 |                 * 2    22*4 522  32      |
     |                                                         *                    |                                          |
     *                                                                              |                                          |
     |                                                                              |                                          |
     |                                                                              |                                          |
     |                                                                              |                                  *       |
     |                                                                              |                              2           |
     |                   2                                              **          |                                          |
  25 +                                                                              |                             2            |
     |                                                         2                    |                                          |
     |                                                                              |                      *                   |
     |                                *                                 *           |                                    *     |
     |                                                                              |                                          |
     |                                                                              |                                          |
     |                                *                                             |                                          |
     |                                                                              |                                          |
     |                                                                              |                   *                      |
     |                                                                              |                                          |
   0 +--------------------------------------------------------------------*---------+------------------------------------------|
     |                                                                              |                                          |
     |                                                                              |                                          |
     |                                                                              |                                          |
     |                                                                              |                                          |
     |                                                                              |                                          |
     |                                                                              |                     *            *       |
     |                                                                              |                                          |
     |                                                                              |                                          |
     |                     *                                                      * |                                          |
 -25 +   *                                                                          |                         *                |
     |                     *                                         *              |                                          |
     |                                                               *              |                                          |
     |                                                                              |                                          |
     |            *             2                          *                        |                                  *       |
     |            *                                        *                        |                              *  *        |
     |                                                                              |                                          |
     *                                                                              |                                          |
     |         2                                                                    |    *                                     |
     |                                                                              |                                          |
 -50 +                                                              *               |                  *    **   2 *  22 2     |
     |                                                              * *             |                                 * *2*    |
     |                                                                              |                           * * 2 *        |
     |                                                                              |                                        * |
     |                   *                                          *               |      *                                   |
     |                   2                                        *                 |                  *                     * *
     |                   *                                                          |                                          |
     |                                                                              |                                          |
     |                                                                              |                                          |
      --------+---------*---------+---------+---------+---------+---------+---------+---------+---------+---------+---------+--
           -105       -90       -75       -60       -45       -30       -15          0        15        30        45        60
                                                                                                                          AXE 1
```

```
                                                                    POINTS=IND,X=VEC 1,Y=VEC 3
 NOMBRE DE POINTS A REPRESENTER :  127

 TRAITEMENT DES POINTS A PLUS DE  2.30 ECARTS-TYPES DU CENTRE
 NOMBRE DE POINTS RAMENES SUR LE BORD DU GRAPHIQUE:          7
 NOMBRE DE POINTS REPRESENTES :  127
  33 POINTS MULTIPLES,  48 POINTS CACHES

 IDENTIFICATION DES POINTS
      * : UN SEUL POINT
      N : N POINTS SUPERPOSES
      X : 10 POINTS SUPERPOSES OU PLUS
1                                                        AXE 1  *  AXE 3
 AXE 3
      ---------------2----*---------------------------------------------------------------------------------------------------
     |                                                                            |                                           |
     |                                                          *                 |                                           |
     |                             2                                              |                                           |
     |                2                          *                                |                                           |
  50 +                                                           *                |                                           |
     |                                                                            |                                           |
     |                                                            *               |                                           |
     |                  2                                             *           |                                           |
     |                                                             *              |                                           |
     |                                                                            |                                           |
     |                                2                                           |                                           |
     |                                    *                           2           |                                           |
     |                                                                          * |                                           |
     |                                                                  2         |      *                                    |
  25 +                                                                    2       |    2                                      |
     |                                                                            |                                           |
     |                                                                            |    *                                      |
     |                                                                            |                                           |
     |                                                                           *|                                           |
     |                                                       2                    |                                           |
     |                              *                                             |       2                                   |
     |                                                                            |                  *                        |
     |               2                                                            |    *                                      |
     |                                                                            |                   *    **                 |
   0 +----------------------------------------------------------------------------+-----------------**---**-22-*--------------|
     |                                                                            |                        * *22****          |
     |                                                      *                     |                    2         842 *        |
     |                                                                            |                            *  *   42      |
     |                                                                            |                                 *34 *     |
     |                                                                            |                                    *4*    |
     |                                          2                      *          |                                         * |
     |                                                                            |                                         * *
     |             *                                    *                         |                                           |
     |                   2     2                                                  |                                           |
 -25 +                                                                            |                                           |
     |                                                  2                         |                                           |
     |                                                            2               |                                           |
     |                                                                            |                                           |
     |                                                                            |                                           |
     |                                                                            |                                           |
     |                                                                            |                                           |
     |                                                                            |                                           |
     |                       2                                                    |                                           |
     |                                                                            |                                           |
 -50 *--------+-------------2--+---2-**---------+----------------+----------------+----------------+----------------+---------
            -100              -75            -50              -25                0               25               50
                                                                                                                         AXE 1
```

CLASSIFICATION HIERARCHIQUE : DESCRIPTION DES 49 NOEUDS D'INDICES LES PLUS ELEVES

NUM.	AINE	BENJ	EFF.	POIDS	INDICE	HISTOGRAMME DES INDICES DE NIVEAU
205	183	193	12	12.00	0.41766	*
206	184	112	5	5.00	0.51354	*
207	99	141	3	3.00	0.60037	*
208	171	151	4	4.00	0.66845	*
209	186	4	4	4.00	0.74030	*
210	109	78	2	2.00	0.74302	*
211	168	40	3	3.00	0.75561	*
212	204	120	4	4.00	0.90497	*
213	88	34	2	2.00	0.95198	*
214	209	9	5	5.00	1.02406	*
215	165	190	14	14.00	1.09386	*
216	182	189	5	5.00	1.10807	*
217	207	94	4	4.00	1.26552	*
218	83	70	2	2.00	1.27079	*
219	150	191	4	4.00	1.35117	*
220	203	147	5	5.00	1.40758	*
221	217	197	7	7.00	1.47623	*
222	86	210	3	3.00	1.59360	*
223	146	211	5	5.00	1.83966	*
224	144	199	4	4.00	1.97596	*
225	179	170	4	4.00	2.04393	*
226	185	194	12	12.00	2.24009	*
227	201	205	19	19.00	2.37903	*
228	24	49	2	2.00	2.43883	*
229	208	218	6	6.00	2.44117	*
230	222	5	4	4.00	4.18950	*
231	149	220	7	7.00	4.24754	*
232	227	198	22	22.00	4.49239	*
233	212	213	6	6.00	5.87213	*
234	232	195	25	25.00	6.05351	*
235	226	215	26	26.00	6.81160	*
236	214	200	10	10.00	8.38605	*
237	202	224	8	8.00	8.49484	*
238	113	231	8	8.00	8.61068	*
239	225	228	6	6.00	9.83827	*
240	229	219	10	10.00	12.76452	*
241	238	196	10	10.00	14.66936	*
242	221	235	33	33.00	17.95022	*
243	216	239	11	11.00	20.29083	*
244	240	206	15	15.00	25.39626	*
245	234	233	31	31.00	28.55077	*
246	223	236	15	15.00	33.68483	**
247	241	237	18	18.00	43.99549	**
248	245	230	35	35.00	45.95896	**
249	246	242	48	48.00	227.67679	********
250	244	243	26	26.00	250.66867	*********
251	250	247	44	44.00	639.44983	**********************
252	248	249	83	83.00	1356.34436	**
253	251	252	127	127.00	2408.90552	***

SOMME DES INDICES DE NIVEAU =5230.89893

Une Classification Ascendante Hiérarchique (CAH) des observations a été réalisée sur les coordonnées par rapport aux 2 premiers axes. Selon les options, 2 ou 6 classes ont été retenues :

Les deux segmentations se décrivent comme suit :

- a) : un groupe de 79 navires opèrant dans le Nord du Golfe sur l'anchois.

  a1: 34 de ces navires travaillent en boeufs sur l'anchois.

  a2 : 17 navires ont une activité importante sur la sardine et le hareng. Ils travaillent aussi en paires.

  a3 : 32 navires travaillent l'anchois avec un chalut à panneaux.

- b) : 48 navires travaillent parfois au Large ou au Sud du Golfe sur le germon, l'espadon, le thon rouge. Ce groupe est aussi caractérisé par la capture des espècesAutres et l'encornet.

b1: 16 navires exploitent le chinchard, l'espadon, le thon rouge, l'encornet et le merlu. Des incursions sont réalisées dans le Large pour exploiter les thonidés.

b2 : 13 bateaux sont caractérisés par les espècesAutres et le tacaud et par la mise en oeuvre de plusieurs chaluts.

b3 : 15 navires pêchent en Manche Occidentale (dorade grise) ou au Large (germon et espadon).