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FINAL REPORT

DIVERSIFICATION TRIALS WITH ALTERNATIVE TUNA FISHING TECHNIQUES INCLUDING THE USE OF REMOTE SENSING TECHNOLOGY

TENDERER:	Bord Iascaigh Mhara Irish Sea Fisheries Board P.O. Box 12 Crofton Road Dun Laoghaire Co. Dublin Ireland Tel: +353 1 2841544 Fax: +353 1 2841123
ASSOCIATE:	Marine Institute Fisheries Research Centre Abbotstown Castleknock Dublin 15. Ireland Tel: +353 1 8210111 Fax: +353 1 8205078

ABSTRACT

The summer driftnet fishery for Albacore tuna has become increasingly important for the Irish fleet since 1990 and has resulted in reduced fishing pressure on traditional quota species during the summer months. However the driftnet fishery has also been the cause of much controversy, resulting in a total EU ban by the end of the year 2001. In order to offset the negative social and economic repercussions of this ban, dedicated commercial trials funded by the EU to establish alternative tuna fishing techniques including pair pelagic trawling, mechanised trolling and surface longlining were carried out as part of a two year project. This project also aimed to assess whether remote sensing technology being used in other parts of the world to identify optimal fishing area to aid catching of Bluefin tuna, could be applied to specifically target Albacore tuna in the North Atlantic.

During 1998 and 1999 four pairs of Irish vessels were chartered to fish with tuna pair pelagic trawls. These vessels fished off the South-west coast of Ireland and also in the Bay of Biscay. In 1998 catches were poor with only 65 tonnes of Albacore landed, although these preliminary trials concentrated on perfecting the trawling techniques. Largely due to improved understanding of the fishery and fishing methods in conjunction with extensive gear modifications, catches increased to 166 tonnes of Albacore tuna in 1999. The vessels achieved daily catch rates of 1 - 1½tonnes per vessel per night, which are consistent with catch rates reported by French pelagic vessels participating in the same fishery.

For the two years of the project three vessels participated in commercial trials with mechanised trolling equipment. In 1998 catches were poor with only 1½ tonnes caught. Again due to a better understanding of the fishery and methods including a better understanding of fish detection and location, catches in 1999 increased to 12 tonnes. However, economic analysis showed that for this method to be viable daily catch rates of around 400-500kg are required, compared to the best catch rate obtained of only 258kg for 6 days during the trials. Therefore it was concluded that further work was required to perfect this technique fully in order to be able to compete effectively with the Spanish trolling fleet.

In 1999 one vessel was fitted with a surface longline system but based on the results of this trial and from the results from similar experiments carried out by IFREMER in France, this type of gear does not appear a viable alternative to driftnetting for Albacore. From a thirty day period only one Albacore was caught, with a by-catch of Blue shark, Bluefin tuna and Swordfish.

Biological data routinely gathered over the two years showed that pair pelagic trawls tended to target older, 4, 5 and 6 year old Albacore in contrast to driftnets in the fishery off the South-west coast of Ireland. From a stock management perspective this is considered highly desirable given the concerns expressed by ICCAT in recent years at the state of the Northern Albacore stock. In the Bay of Biscay the catch from the pair pelagic vessels was largely made up of 1 and 2 year old fish. This applies equally, however, to the trolling, pole-and-line and gillnet fleets that exploit this stock as well as the pair pelagic vessels in this area. The biological data for the trolled caught Albacore showed a similar length frequency distribution to the driftnet data, with the catch made up of predominantly 2 and 3 year old fish.

The analysis of catch data from the 1999 results indicate that Albacore catches are influenced by temperature fronts and that catches are higher closer to the fronts. This would strongly indicate that sea surface temperature information would be beneficial to fishermen. However, cloud cover in the Northern hemisphere, which prevents consistent data being gathered would seem to be a limitation to employing remote sensing technology in the tuna fisheries off the South-west coast of Ireland.

To conclude the project a final workshop was held in November 1999, and fishermen, Irish and French netmakers, sales agents and fishermen's representatives met to discuss and review the findings of the project. It was clear from the results that while surface longlining was not worth further consideration, pair pelagic trawling and trolling are viable alternatives for Irish fishermen to pursue when the driftnet ban is introduced in 2002.

Key Words: Albacore; Tuna; Ireland; North Atlantic; Pair Pelagic; Mechanised Trolling; Surface Longlining; Remote Sensing; ICCAT

RÉSUMÉ

Depuis 1990, la pêche estivale du thon blanc au filet dérivant n'a cessé de prendre de l'envergure pour la flotte irlandaise, réduisant ainsi la pression exercée sur la pêche des espèces traditionnelles à quota pendant les mois d'été.

Toutefois, la pêche au filet dérivant a aussi causé beaucoup de controverse et il en résulte une interdiction totale par l'UE à la fin de l'an 2001. Afin de compenser les répercussions négatives, tant sociales qu'économiques de cette interdiction, l'UE a subventionné un projet d'essais commerciaux sur deux ans afin d'établir des techniques alternatives de pêche au thon telles que le chalutage pélagique en boeuf, la pêche à la traîne mécanisée et la palangre flottante. Ce projet devait aussi étudier si le sondage à distance, utilisé à l'étranger pour identifier les zones optimales de pêche et aider à la capture du thon rouge, pouvait être spécifiquement appliqué au thon blanc de l'Atlantique nord.

En 1998 et 1999 quatre paires de bateaux irlandais furent affrétés pour pêcher le thon avec des chaluts pélagiques en boeuf. Ces bateaux ont pêché au large de la côte sud-ouest de l'Irlande ainsi que dans la baie de Biscay. En 1998 les captures furent médiocres et, malgré les essais préliminaires qui s'étaient appliqués à parfaire les techniques de chalutage, seulement 65 tonnes de thon blanc furent débarquées. En 1999, dû en grande partie à une meilleure compréhension des pêcheries et des méthodes de pêche relatives aux grandes modifications apportées aux équipements, les captures de thon blanc ont augmenté et sont passées à 166 tonnes. Les bateaux ont atteint une capture journalière d'1 à 1 tonne et demi par bateau par nuit, tonnage qui est de l'ordre des taux de captures annoncés par les bateaux français de pêche pélagique participant à la même pêche.

Durant les deux années du projet, trois bateaux ont participé à des essais commerciaux sur l'équipement de pêche à la traîne mécanisé. En 1998 les captures furent médiocres, atteignant seulement 1 tonne et demi. L'année suivante, et de nouveau dû à une meilleure compréhension de la pêche et des méthodes de détection et de localisation du poisson, les captures augmentèrent, passant à 12 tonnes en 1999. Toutefois, une analyse économique montre que pour que cette méthode soit quotidiennement viable il faut que le taux de capture soit d'environ 400-500 kg ; or le meilleur taux de capture obtenu pendant les essais ne s'est monté qu'à 258 kg pour 6 jours. Aussi, il a été conclu qu'il fallait retravailler cette technique afin d'être à même de concurrencer de manière effective la flotte espagnole de pêche à la traîne.

En 1999 un bateau fut équipé d'un système de palangre flottante. Cependant, d'après les résultats de cet essai et ceux obtenus sur des expérimentations similaires conduites par IFREMER en France, ce type d'équipement en tant qu'alternative de la pêche au filet dérivant du thon blanc n'apparaît pas comme viable. Sur une période de trente jours la capture n'a compté qu'un thon blanc ; furent aussi capturés du requin bleu, du thon rouge et de l'espadon.

Les données biologiques rapportées au cours des deux années ont montré que les chaluts pélagiques en bœuf avaient tendance à prendre des thons blancs plus âgés de 4, 5 et 6 ans, ce qui contraste avec la

pêche au filet dérivant au large de la côte sud-ouest de l'Irlande. Si l'on prend la gestion des stocks en perspective cette tendance est très désirable compte tenu des inquiétudes exprimées ces dernières années par ICCAT au sujet de l'état des stocks de thon blanc du nord. Dans la baie de Biscay les captures des bateaux de pêche pélagique armés en boeuf étaient surtout constituées de poissons d'1 ou 2 ans ; l'exploitation excessive de ces jeunes poissons a été ressenti comme problématique à long terme. Toutefois, cela s'applique également aux flottes de pêche à la traîne, à la canne et au filet maillant qui exploitent ces stocks, ainsi qu'aux bateaux pélagiques armés en boeuf opérant dans cette zone. En terme de longueur du poisson, les données biologiques pour le thon capturé à la perche ont montré une fréquence de distribution similaire à la pêche au filet dérivant ; la capture fut surtout constituée de poissons âgés de 2 ou 3 ans.

L'analyse des données de captures à partir des résultats de 1999 indique que les captures de thon blanc sont influencées par des fronts de température et que les captures sont plus importantes plus près des fronts. Ceci démontrerait que la température de la surface de la mer est une information qui serait très bénéfique aux pêcheurs. Toutefois, la couche nuageuse dans l'hémisphère nord, qui empêche l'obtention de données, semblerait limiter l'emploi du sondage à distance dans la pêche du thon au large de la côte sud-ouest de l'Irlande. Afin de conclure le projet, un ultime séminaire fut tenu en novembre 1999 ; pêcheurs, fabricants de filets irlandais et français, agents commerciaux et représentants de pêcheurs se sont rencontrés pour discuter des résultats de ce projet. Les résultats ont clairement fait apparaître que si les essais de pêche à la palangre flottante ne valaient pas la peine d'être poursuivis, le chalutage pélagique en boeuf et la pêche à la traîne constituaient pour les pêcheurs irlandais des alternatives viables pour faire face à l'interdiction du filet dérivant en 2002.

Key Words: Thon blanc; Thon; L'Irlande; L'Atlantique nord; Chalutage pélagique en boeuf ; Pêche à la traîne mécanisée ;Pêche à la palangre flottante ; Sondage à distance ; ICCAT

1. INTRODUCTION

Albacore tuna (*Thunnus alalunga* Bonnaterre, 1788) is a large species with a cosmopolitan distribution in temperate and tropical waters of all oceans and in the Mediterranean Sea. Fish are most abundant in surface waters of 15.6 - 19.4ºC; larger Albacore tend to be found in deeper waters and can tolerate wider temperature ranges than smaller specimens (Collette and Nauen 1983). In the Atlantic and Mediterranean (on the basis of available biological information) for assessment purposes, there is considered to be three stocks - Northern, Southern, and Mediterranean (Anon. 1988). In the eastern Atlantic the northern stock is exploited using surface gears including driftnets, trolling, pole and lines and pelagic trawls (Glanville, 1988); Albacore tuna are also occasionally caught using longline in an area from the west of Ireland to the Azores. In the western-central Atlantic a Chinese Taipei longline fleet exploits the northern stock, mainly as a by-catch to fisheries for yellowfin and bigeye tuna.

The summer driftnet fishery for Albacore tuna has assumed considerable importance for Ireland since 1990 and has resulted in reduced fishing pressure on a number of traditional 'quota' whitefish species during the months of July - September. However the driftnet fishery has also been the cause of much controversy, resulting in a total ban under Council Regulation (EC) No. 1239/98[1] by the end of the year 2001. In order to offset the negative social and economic repercussions of this ban, funding was sought from the EU[2] to carry out dedicated commercial trials to establish new techniques including pair pelagic trawling, mechanised trolling and surface longlining. This project commenced in July 1998 and was completed in late 1999. Pair pelagic trawling, mechanised trolling and surface longlining were chosen as the most applicable alternatives available to the Irish fleet as they are the methods most likely to provide economically viable returns. Additional funding was also received under the EU PESCA scheme for one pair of vessels during the two years of the project.

IFREMER carried out technical trials using pair pelagic trawls in 1987[3] and subsequently this method became established as a legitimate tuna fishing technique in the French fleet. The techniques employed were very similar to those already in use by French fishermen for other species, and little education to change over to this method was required. This was not the case in Ireland as the method differs considerably from traditional Irish pelagic trawling experience.

In 1994 BIM conducted a short series of trials[4], involving one pair of vessels, to make a preliminary assessment of the potential of this technique for Irish tuna fishermen. These trials could not be considered a commercial success, largely due to the fact that the trials were on a very small scale with only one pair of vessels funded over a short period of time. From a technical perspective there was also a lack of understanding of the French method of fishing. The trials in addition indicated serious fish

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[1] Council Regulation (EC) No. 1239/98 of 8 June 1998 amending Regulation (EC) No. 894/97 laying down certain technical measures for the conservation of fishery resources

[2] 1998 call for proposals for studies in support of the CFP.

[3] George J.P. 1987. Essais de pêche du germon au chalut-boeuf pélagique. IFREMER report No. DIT/87.05.IPCM.

[4] Daly J., McCormick R. and Molloy J., 1994. A report on the 1994 Experimental Fishery for Tuna and the Commercial gill-net fishery in the Bay of Biscay. Unpublished report.

quality problems, related to codend construction, tow duration, and on board handling, which need to be addressed if this method is to be considered a viable option to driftnetting. Tuna are difficult to detect on standard echosounders or sonars and research in this area is also required.

Technology has impacted little on trolling in recent years, apart from the type of lure used and attempts to mechanise the hauling of the lines to reduce the level of manpower required, notably in America and New Zealand. The level of research in this area is very limited. Significant training of Irish crews to achieve the optimum rigging of gear to match ambient weather conditions, detection of fish and on board handling is required to make this method potentially viable.

Complex ocean currents develop over Ireland's continental shelf that results in a mosaic pattern of sea surface temperature profiles and primary productivity on the continental shelf. Therefore, the fishing locations of a particular vessel are unlikely to be optimal with respect to oceanic conditions except infrequently, and merely by chance. For highly migratory species like tuna this means a lot of time and hence money is spent searching for fish concentrations. Remote sensing technology to identify optimal fishing areas has been used in America to aid catching of Bluefin tuna and it seems likely that this technology can be applied to specifically target Albacore tuna in the North Atlantic.

OBJECTIVES AND OUTLINE OF WORK PLAN

OBJECTIVES

The main objectives of this project were as follows:

- To evaluate alternative methods of fishing for Albacore Tuna, and ascertain whether catches can be maintained at an economic level.
- Development of remote sensing technology to enhance fish catch by locating areas with sea surface temperatures and productivity preferred by tuna.
- Collection of biological data on Albacore Tuna to provide an input into future stock assessment work on the North Atlantic Albacore Tuna stock.
- Provision of workshops introducing the alternative fishing techniques and advising on onboard handling practices.

SUMMARY OF WORK COMPLETED

YEAR 1: 1998

During 1998 five pairs of vessels were rigged out to fish with tuna pair pelagic trawls. These preliminary trials concentrated on perfecting the trawling techniques along with gathering biological data on tuna catches and by-catch.

Mechanized trolling equipment was installed on three vessels. Again, initial trials concentrated on perfecting trolling techniques and optimising gear rig to climatic conditions. Two retired French tuna skippers, along with a trolling expert (now based in Ireland) were contracted to assist with the trials.

In October 1998 a workshop was organised for those fishermen involved in the 1998 experimental trials. Representatives from BIM, the Marine Institute, IFREMER, *Comité National des Pêches Maritimes et des Élevages Marins,* Seafish, the French and U.K. tuna industries, as well as netmakers from France and Ireland attended. The findings from the 1998 fishery were discussed and recommendations for 1999 drawn up, including gear modifications and fishing methods employed. A format for the provision of sea surface temperature and primary productivity data was also agreed. IFREMER outlined the results of their trials with surface longline gear, while a Gear Technologist from S.F.I.A. reported on the U.K. fishing industry's perspective on potential alternative methods. A second workshop was held in June 1999 when a group of eight Irish fishermen travelled to France and met with their French counterparts. Discussions with pelagic skippers were held at four major tuna fishing ports, Douarnanez, Concarneau, Lorient and La Turballe, with representatives of producers' organisations and with Jean Roullot of the netmaking firm, Le Drezen.

YEAR 2: 1999

Five pairs of vessels participated in the experimental pair pelagic trawl fishery in 1999. A further four pairs, funded by the Irish Government, brought the total number to 16 vessels. During this second year of trials more consideration was given to optimising fishing operations by improved rigging of the gear. This included the use of low drag Dyneema netting and differing codend constructions, as well as better matching of trawl size to the horsepower of the trials vessels. Also during the second year emphasis was placed on fish location and detection using echosounders and sonars, and on remote sensing technology to identify tuna fishing areas.

Mechanised trolling equipment was installed on three vessels in year 2 and extensive experimentation was carried out with different lure designs and fishing practices to maximize tuna catches. Efforts were also continued to identify fresh and added value markets for line caught fish overseas and within Ireland. As with the pair pelagic trials methods of fish location and detection were investigated, with the three vessels utilizing the remote sensing information.

The biological data collection programme begun in year 1 was continued and expanded upon in year 2 (1999), with data collected from the pair pelagic vessels, trollers and also from the driftnet fleet for comparison purposes.

One of the major recommendations made at the first workshop was that consideration should be given to carrying out trials with surface longlines for Albacore Tuna to assess it's viability as an alternative to driftnetting. BIM already possessed a mechanised surface longline system, and this was installed on a 22m vessel during year 2. These trials aimed to assess the viability of this method of fishing for Albacore tuna through testing differing combinations of gear rigging, different baits and fishing operations.

To conclude the project a final workshop was held in late November 1999, and over 50 delegates, including fishermen, Irish and French netmakers, sales agents and fishermen's representatives met to discuss and review the findings of the project. A report of this workshop is given in Section 6.0.

MATERIALS AND METHODS

INTRODUCTION

At the outset it had been planned to use vessels with a track record in the tuna fishery. However, apart

previously were rigged for driftnetting and without significant modification were totally unsuited to fish with either

of the vessels participating in the pair pelagic trials were boats that targeted herring with pair pelagic trawls in the late autumn and winter and thus had previous -watering techniques.

equipment in terms of deck layout.

considered to be most relevant to the fishery including experience and performance during 1998, vessel suitability in terms of size, power

deck layout with respect to the trolling and longline vessels. Participating vessels and their

F METHODS

PAIR ELAGIC T

A total of twelve pair pelagic trawls were utilised during Year 1 of the trials, eight o

French made, with the other four being supplied by Irish net manufacturers. In year 2 an additional three French nets and one Irish net were purchased and a number of modifications made to some of the

ets used by the four pairs in years one and two are given in Appendix II.

The French pelagic trawls used were all of a similar design manufactured with their foreparts in 18 metre or larger mesh in 10mm polyester (terylene), tapering to 4 metre mesh in 8mm polyester. The

braided nylon rope. The main body of these nets was manufactured in braided nylon twine and terminated with a codend of mesh size between 8

causing less damage to fish. By Irish standards the choice of materials used in the construction of the French trawls is unusual. The Irish tuna trawls used were of a much more conventional pelagic trawl

gn and differed in that the front sections were constructed in nylon, with the headline and footropes mounted on 24mm braided polyester rope rather than wire.

In year 2, three of the existing French trawls were modified by replacing part of the body sections

the weight and bulk of netting compared with nylon to be significantly decreased without sacrificing strength or performance. This effectively reduces tw

Table 1. Participating Vessels

Pelagic Trawling Trials

Year 1: 1998

Vessel Name	Skipper	Home Port	Length & HP
Menhaden	Larry Murphy	Castletownbere	27m/1000 HP
Sea Spray	Kevin Sheehan	Castletownbere	26m/700 HP
Albatross	Danny O'Driscoll	Castletownbere	25m/720 HP
Karen Rose	Anthony Sheehy	Baltimore	26m/600 HP
Mulroy Bay	John O'Regan	Schull	22m/550 HP
DeLinn	Hugo Boyle	Rossaveal	21m/540 HP
Shearwater II	Denis Whelan	Castletownbere	26m/600 HP
Oilean Cleire	Sean O'Driscoll	Castletownbere	24m/650 HP
Wave Crest	Declan Power	Castletownbere	19m/325hp
Atlantic Warrior	John O'Donnell	Dingle	19m/500hp

Year 2: 1999

Vessel Name	Skipper	Home Port	Length & HP
Menhaden	Larry Murphy	Castletownbere	27m/1000 HP
Sea Spray	Kevin Sheehan	Castletownbere	26m/700 HP
Albatross	Danny O'Driscoll	Castletownbere	25m/720 HP
Solan	John O'Regan	Schull	23m/465 HP
DeLinn	Hugo Boyle	Rossaveal	21m/540 HP
Eilean Croine	Eric Murphy	Castletownbere	33m/1000 HP
Ocean Reaper	Ebby Sheehan	Castletownbere	23m/850 HP
Mary Lorraine	Johnny Walsh	Kinsale	19m/425hp
Heroine	Lenny Hyde	Crosshaven	21m/425hp

Mechanised Trolling Trials

Year 1: 1998

Vessel Name	Skipper	Home Port	Length & HP
Les Marquis	Jerry O'Driscoll	Kinsale	19m/425 HP
Noz Dei	Pat O'Mahony	Kinsale	17m/365 HP
Floralie	Jim Tormey	Dingle	18m/287 HP

Year 2: 1999

Vessel Name	Skipper	Home Port	Length & HP
Les Marquis	Jerry O'Driscoll	Kinsale	19m/425 HP
Noz Dei	Pat O'Mahony	Kinsale	17m/365 HP
Warren Locke	Tommy Conneely	Rossaveal	18m/425 HP

Surface Longline Trials

Year 2: 1999

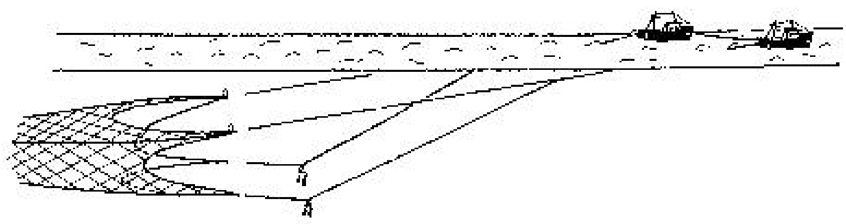
Vessel Name	Skipper	Home Port	Length & H.P.
Fiona Patricia	Damian Turner	Castletownbere	22m/650hp

300 meshes x 100mm of 210/46, 210/23 and 2.2mm Dyneema twine. In addition to the Dyneema section replacement 4 panel c

3mm braided nylon were made up for the French nets as it had been found in Year 1 that the existing codends were too narrow. Other replacement codends were constructed in 120mm x 4mm b polyethylene instead of nylon. These codends were considerably lighter than nylon codends, which again helped to reduce drag. Based on the experiences gained in the first year, the Irish net purchased in

art with the large mesh section extended much further back to reduce the twine surface area. The French system and the Irish system of fishing differ

and 2.)



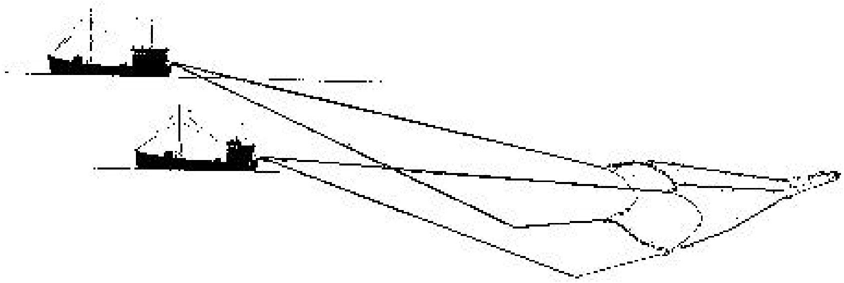


Figure 1 (Upper Diagram) French tuna rig towing off one wire. Figure 2 (lower Diagram) Irish tuna rig towing off two wires.

For the French system each vessel uses only one single warp into which is connected twin bridles of 150-180 metres in length. The vertical mouth opening of the trawl is maintained by using large (100kgf or greater) polyform floats mounted at the centre of the headline and on the wingends and footrope weights rigged on a basis of 1kg per HP per side, in addition to 7.5m chain extensions on the footrope. French vessels tend to carry two weights each so that the lead vessel can shoot away both weights and simply pass over their single wire to their partner, who merely connect it to the bridles. It has been found to give vertical openings of between 18-25 fathoms depending on net design, and is quick and relatively safe to work. The French normally begin the season with 5m strops on the headline buoys and shoot only 5m of single warp along with the bridles. As the season progresses the fish tend to congregate at greater depths and so the strops are increased or the floats are taking off altogether and headline set at 20m depth.

The Irish rig differs insofar as each vessel uses 12-
wingend weights and 75 –
one single warp per vessel, with this rig two warps joined to the upper and lower bridles per side are

footrope and headline are staggered. This can range from 1fm in the headline for a lower headline

using this method the lead vessel passes over the bridle ends by heaving line and then connect them into the respective warps. Fishing in this manner
between 16 to 29 fathoms were obtained using both Irish and French net designs. Appendix III gives a summary of the main gear parameters recorded during the trials.

Using either method the vessels tow close together at between 0.1 0.15 nautical miles apart. In order to be effective towing speeds must be in excess of 3.5 knots, and vessels must have sufficient horsepower
his was found to be
one of the major difficulties during the trials for the Irish vessels, particularly towing into bad weather.

alleviate these problems in year 2.

On the basis of the first year's trials it was decided by some of the pairs to replace the two large buoys mounted at the centre of the headline with a string of 15 or 20 x 3 or 5 litre purse seine floats or a
dard 20 or 30 cm trawl floats. This string of floats was lashed
tightly to the centre of the headline and in some cases was placed in a net bag. It was felt that this
tation to
keep the headline on the surface. Also during year 2 one of the pairs employing the Irish method
-fathom
er bridles allowed the vessels to shoot more warp,
increase boat separation and therefore increase the swept area. It was also felt that these bridles helped

It should be noted tha
detect tuna schools as an adjunct to trawling at night. During year 1, catches on the lures were very sporadic, with the largest catch being 30 fish taken by the "Mulroy Ba
the vessels caught no fish on the lures at all throughout the whole period. All of these vessels were constructed in steel, and anecdotal evidence suggests that steel hulled vessels usually do not make good
ue to the noises they generate. In year 2 once again all of the pairs trolled lures during
the days and some of the vessels consistently caught fish on the lines during the day. With more lines
daily catch rate. Once again the wooden
vessels the De Linn, Solan and Albatross caught more fish than the other steel vessels.

MECHANISED TROLLING

Figure 3 Hydraulic Tuna Trolling Gurdies & Stern Puller

A total of three American mechanised trolling systems were purchased during year 1. These systems comprised of two 5-spool hydraulic tuna gurdies, mounted port and starboard and 1 single hydraulic tuna puller mounted on the stern (see figure 3). Each vessel was also rigged with two 10-12 metre outrigger tapered booms or tangons, consisting of 6 metre steel pipes with 5-6 metre fibreglass or aluminium tapered tips. These poles were set at an angle of 30° to the horizontal whilst fishing (see figure 4). From a combination of the lines mounted on the poles and the lines worked across the transom, a total of 10-15 lines could be worked, depending on fishing conditions. The main lines were constructed in 3-4mm diameter round blue braided nylon line ranging from 10-75 metres in length, on to which was fixed a 10 metre monofilament trace terminating in a single weighted lure. Rubber shock absorbers were attached to the mainline to help absorb the momentum of striking tuna. A variety of lure designs consisting of feathers, plastic squid etc. were tested all mounted above a double barbless hook. Figure 5 shows an example of the typical lure tested during year 1. The lines were deployed from dawn to dusk and towed at a speed in excess of 5 knots, with a total fishing time of around 13-14 hours per day.

Figure 4 Vessel with tangons in fishing position

The same three systems were installed on the trials vessels in early July 1999. No real modifications were made to the gear and in fact any gear changes made during the second year of trials were largely restricted to different American and Spanish lure design and using barbed as well as barbless hooks. The Spanish tend to use much smaller barbed hooks with small pieces of red, yellow or blue bunting placed on the curve, with the lures made of coloured horsehair, usually topped with a plastic squid. One of the vessels altered the rigging of his lines to mirror the Spanish way of rigging. This involved varying the length and depth of the lines, with the outer two lines on the tangon (“Punta” and “Contra

Punta" in Spanish) being weighted and the two inside lines ("Medio" and "Berrel") fished on the surface, the "medio" being a long line of 85m and the inside "berrel" much shorter at 40m. Off the stern, 4 lines were fished the two outside lines being 50metres in length with the two inside lines, placed at the middle of the stern fishing in the wake of the vessel.

Figure 5 Tuna Lure

SURFACE LONGLINING

BIM already possessed a mechanised surface longline system, purchased in 1994 from Lindgren-Pitman in America and this was installed on the "Fiona Patricia" in June 1999. This entailed fitting a mainline spool for the monofilament backline midships on the port side of the vessel. This spool was 58cm diameter x 77cm width and constructed in marine grade aluminium and stainless steel with direct drive hydraulic motors and level winders, as shown in Figure 6. A line setter was positioned off centre to port on the stern gunwale, positioned to give a direct lead from the spool via one hanging block to the setter (see Figure 7). Leader/Buoy line carts were also installed to allow storage of longer leader lines and buoy lines, although in practice were rarely used.

The mainline used for this system was 35nm of 3.6 mm monofilament line stored on the spool in one continuous length. Branch lines / snoods were constructed of 2mm monofilament, in two sections of 5 metres and 2 metres long. A 60 gram, leaded swivel was used to connect the two sections with an 8/0 longline snap clip at one end and a hook at the other end. Three types of hooks were used; number 9/0 and 8/0 tuna hooks and a 12/0 Circle hook. All hooks and snoods were stored in hook line tubs. Anything between 10-15 nm of gear was generally shot. This was divided into 6 or 7 sections by placing dan-poles or radio buoys at given intervals along the line. Buoy lines of 6–15 fathoms in length, were constructed from 6mm three stranded polyester. The buoys used were 300 mm, red thermoplastic floats. In order to vary the fishing depth the number of hooks to buoys was varied from 1 buoy: 4 hooks for surface fishing to 1 buoy to 10 hooks or more for fishing deeper.

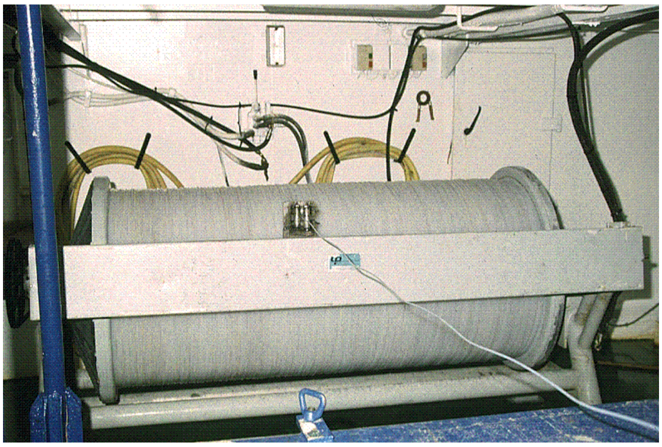


Figure 6: Lindgren-Pitman mainline spool.

The gear was normally set over a period of about 2 hours and was timed so that the last section was shot as night began to fall, although this was varied so that gear was set during daylight hours as well.

The gear was set downwind with the vessel steaming at 9 – 9.5 knots. A bin containing the snoods was placed at the stern for shooting. A crewmember selected a snood from the bin. He passed the end with the snap to the man closest to the line setter. The hook was then passed to the man on his other side for baiting. Baits used included squid and pilchards. Once the hook was baited, a chemical light stick and/or luminous "glow beads" were attached approximately 2 metres up from the hook. The snood was then ready to be snapped on to the mainline. The baited hook was thrown clear, and the snap was clipped on to the mainline.

Hauling usually commenced at first light, although again this was varied so that all times of the day were fished. The line was hauled on the starboard side over a block, directly on to the line spool. One crew member was responsible for controlling the speed of hauling and also unclipped the snoods as they came aboard. The snoods were passed to another man who hauled them back into a bin, in preparation for the following set. Damaged lines were repaired as they were hauled and a number of pre-prepared lines were available to speed up this operation. Hauling speed was generally about 5 knots. Hauling up to 1000 hooks and 17-20nm of line could be completed in around 4 hours.

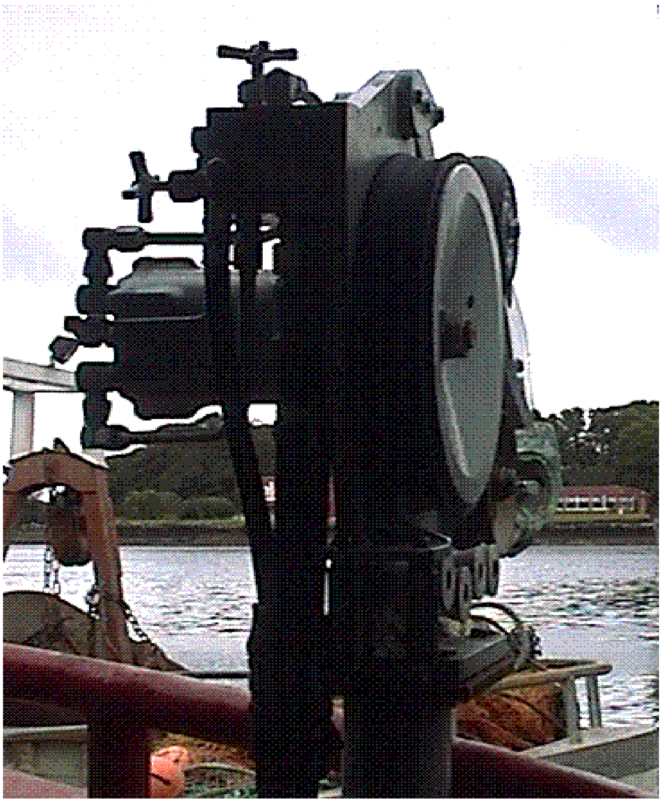


Figure 7: Lindgren-Pitman Line Setter

BIOLOGICAL MATERIAL AND METHODS

Biological and fisheries information collected during 1998 and 1999 came from two sources; biological observers and gear technologists at sea aboard commercial vessels participating in the trials, and port sampling on commercial catches landed by Irish driftnetters. Poor catches using the mechanised trolling systems and time limitations in year one of the project meant that biological data was only collected on the pelagic trawlers. In year 2 observer coverage was extended to include the trolling and longline vessels in addition to the pair pelagic boats. The observers collected data on time and location of shooting and hauling for each tows as well as on the catch and by-catch in each haul. The catch and by-catch were identified according to an identification sheet prepared by the Marine Institute. The observers also measured sub-samples of tuna, swordfish and sharks when present in each haul (fork length,cm). A full list of personnel involved with the trials is given in Appendix IV.

The sampling of the commercial driftnet caught tuna took place in the first and third weeks of September during 1998 and throughout the whole season in 1999. Albacore catches from six randomly selected driftnetters were also examined. A sub-sample of the tuna was measured (fork length, cm) and weighed, while a further sub-sample was measured only. Age estimates were made using growth parameters estimated using MULTIFAN and published in SCRS 1998 where, Von Bertalanffy K=0.217, L = 122.8.

REMOTE SENSING TECHNOLOGY

In the Celtic Sea region of the fishing trials, there are several hydrographic and/or bathymetric features, which are likely to influence the catch of Albacore tuna. A brief explanation for the presence of these features is outlined below, as well as the general association of tuna with physical/biological structure in the water column. This does not include all of the physical and environmental parameters that may influence tuna catches; only the major features that are currently well described in the scientific literature.

The Celtic Sea area has a vast continental shelf (as defined by the 200m depth contour) as compared to most of Europe (Celtic Shelf: Figure 8). The Celtic Shelf ends abruptly to the south, where the shelf drops rapidly to depths over 2000m at the Celtic Shelf-Break. To the west of the Celtic Shelf the transition from the shelf to deeper waters is more gradual than to the south, and the Goban Spur and Porcupine Bank are the two areas where shallow waters extend the furthest into the Atlantic Ocean. The Porcupine Bight is an indentation of deep waters between the Goban Spur and Porcupine Bank, where the oceanography is largely undefined at present. Each of these locations are discussed further below as each is responsible for oceanographic conditions that may impact the catch of tuna, termed fronts. These are generally areas where there are abrupt changes in the physical characteristics, temperature or salinity.

CELTIC SHELF-BREAK FRONT

It is well established that during the months of approximately April through October, the surface water over the Celtic-Shelf Break (between depth contours of approximately 200m-2000m) is 1-2^{0}C colder than surrounding waters. This feature is known as the Celtic Shelf-Break front (Figure 9: Box 1). This front is actually made of two distinct fronts: one at approximately the 200m depth contour (warm water to the north on the Celtic Shelf) and the other at approximately the 1000m depth contour (warm water to the south). This cold band of water is present regardless of the direction of the wind. These fronts are highly turbulent, and are generally visible to the naked eye and can be seen as surface turbulence and distinct changes in the movement of waves at the surface. The fronts undulate along the depth contours; therefore the exact position of the front can change by many 10's of km and is thus not completely defined by the depth contours.

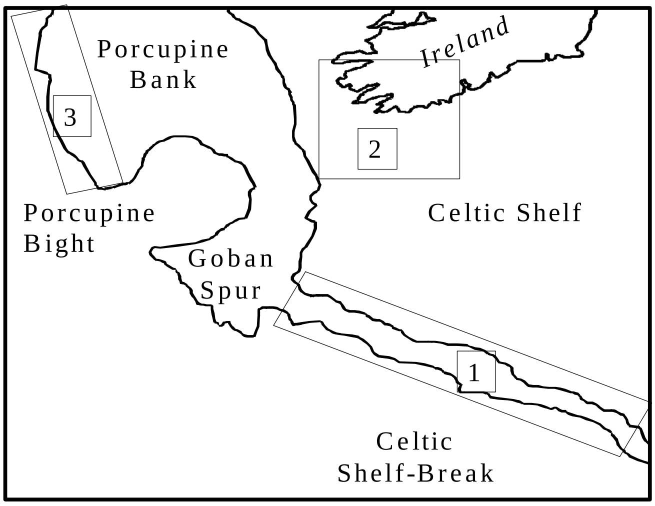


Figure 8. Expected locations for low tuna catch (dotted lines).
Box 1: The confines of the Celtic Shelf-Break front.
Box 2: Coastal upwelling and salinity fronts.
Box 3: Taylor column front.

Although not completely understood, it is thought that vertical mixing from tidal water movement is responsible for the cool surface waters (Pingree and Mardell 1981). As these fronts are likely the result of vertical mixing, nutrients are continually brought to the surface, which can lead to a higher standing stock of both phytoplankton and zooplankton (Le Fevre 1986). Unlike some frontal areas, there is not thought to be a distinct plankton accumulation at the fronts, but instead a general accumulation of plankton within the confines of the two fronts.

COASTAL FRONTS

Along the coast of Kerry and west Cork, two distinct types of fronts are present, an upwelling front and a salinity front. Both fronts appear as the surrounding waters become stratified with warm surface water overlying cold bottom water, generally in the months of April through October. These are termed coastal fronts (Figure 9; Box 2). While the salinity front is present regardless of wind direction, its location can greatly change with wind direction (movement many 10's km E-W). The upwelling front is dependent upon the wind; it is only present with West and North winds, and collapses with East or South winds. As wind direction and strength determine the location and strength of these fronts, they are only generally associated with the area indicated in Figure 9. These fronts can sometimes be seen by the naked eye as above, but often their position can only be detected by directly measuring water salinity and temperature, or by using remote sensing data.

The upwelling front is established from wind-driven surface currents moving warm surface water away from the coast, which is replaced by cooler nutrient rich deep water. This is evidenced as a temperature change of up to 3^0C at the surface, and is generally associated with a marked increase in phytoplankton production.

The salinity front, which is located just west of the upwelling front (10's of km), is established as runoff from rivers (predominantly the Shannon) mixes with ocean water to produce a water mass of lower salinity than Atlantic waters. Water of different salinities does not mix well, and differences of salinity of just a few 0.1 ppt can prevent mixing of water masses resulting in this type of coastal front. It is unknown how this specific front affects zooplankton and phytoplankton, but other salinity fronts may, but not always, accumulate zooplankton and have an associated change in phytoplankton production.

PORCUPINE BANK FRONT

On the western side of the Porcupine bank, water depth drops from 300m to 3000m over a short distance. During the summer months, there is no noticeable change in surface water temperature below the Porcupine bank and the deeper oceanic waters. However, thermal stratification of the water over the bank occurs, resulting in a mass of cold bottom water, of different temperature to open ocean waters (McMahon et al. 1995). This is the result of a type of frontal system known as a Taylor column (Figure 9: Box 3), which essentially prevents deeper Atlantic water from moving onto the shelf. (i.e. Unlike the fronts previously described this is front is observed as differences in water temperature at depth and not at the surface). This front is generally along the 300-400m contour to the west of the Porcupine bank, and forms, as do the other fronts, from approximately April through October each year. This front is present regardless of the direction of the wind, but will not be visible to the naked eye. Although there is no difference in surface temperatures, there is a large increase in phytoplankton production to the west of the front (personal data), which can be detected with remote sensing data. It is unknown how this front affects most zooplankton, but fish eggs and larvae generally accumulate just to the west of the Taylor column.

PORCUPINE BIGHT AND THE GOBAN SPUR REGION - TRANSIENT FRONTS

Due to their location, the Porcupine Bight and Goban Spur are continually producing transient fronts. Transient fronts simply means that the fronts are not a permanent feature of the area, and their formation is unpredictable through space and time. Factors such as the direction of current, the direction of the wind and tidal state influence the fronts direction and position. They can be produced when water from the North Atlantic Drift passes onto the continental shelf (White et al.

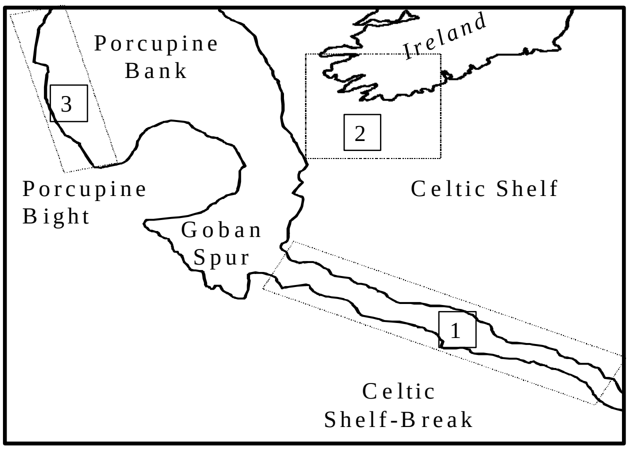


Figure 9. Expected locations for low tuna catch (dotted lines).
Box 1: The confines of the Celtic Shelf-Break front.
Box 2: Coastal upwelling and salinity fronts.
Box 3: Taylor column front.

1995), or when water of slightly different temperatures meets due to the movement of surface currents and/or winds. Due to their variability, a low proportion may be observed visually, as these fronts tend to be of less than 1^0C surface temperature change, and often do not exist long enough to cause a noticeable change in surface phytoplankton production. The amount of time a transient front has been present is generally correlated with the accumulation of both phytoplankton and zooplankton found at the front: the longer a front has been present the more plankton are found.

Transient fronts are not fixed to any geographical location. As these fronts are not direct the result of the interaction of bathymetry and the water mass, they are not fixed to the area directly above specific bathymetry. Therefore, when formed, the fronts may move in any direction, although surface currents and winds often guide the direction in which they move. Due to their mobility, transient fronts need to be continually tracked by either on-board temperature recorders or by remote sensing data.

THE RELATION OF FRONTS TO THE BIOLOGY OF TUNA

Fronts in the ocean tend to be areas where phytoplankton are abundant, although the mechanism for high phytoplankton abundance may be due to either accumulation or enhanced productivity (Le Fevre 1986). While the relationship between phytoplankton abundance at fronts and zooplankton abundance is not well understood, fishing effort for tuna and other pelagic species is nearly always concentrated at the edge of fronts (Uda 1938, Fournier 1978). Therefore, as fishermen have known for years, pelagic fish species tend to be concentrated near fronts, and knowing where fronts are located can greatly enhance the catch of fish species including tuna.

Research into Bluefin tuna has indicated that the fish occur near the edges of fronts, occasionally crossing the fronts from one side to the other (Block et al. 1997). Furthermore, Bluefin tend to swim in warm, clear water, whereas their prey (mostly shoaling species) tend to be found in cooler, turbid water such as that found in the upwelling areas and the Celtic Shelf-Break described above). Therefore, Bluefin are thought to accumulate along the edges of fronts where they can move across the fronts, depending on whether or not they are actively feeding.

Albacore tuna biology is much less researched, however, as their primary prey species are similar to those of the Bluefin, their biology in relation to fronts is also expected to be similar. Some specific points of interest are that Albacore prefer water of 14^0C - 20^0C, they prefer clear blue water (Case I waters), and can preferentially be found on the warm side of upwelling fronts (Anon, 2000).

Based on the above information, at the onset of this project it was predicted that Albacore tuna would 1) be in higher abundance near fronts; 2) tend to be found on the warm side of fronts and 3) be found in greater abundance on fronts showing a greater change in productivity (hence turbidity) across the front.

3. RESULTS

PART I: 1998

PAIR PELAGIC TRAWLING

Five pairs of pelagic vessels completed a total of 212 days fishing with the first pair going to sea on the 11th August 1998 and continuing until mid October (full details of each trip are given in Appendix V). Figure 10 shows the main areas worked by the vessels, with the most productive fishing being attained in an area approximately 150 miles to the south-west of Ireland (50°- 52°N and 13-14°W). Catches were generally poor with approximately 65 tonnes of Albacore Tuna (IR£80,000), 8 tonnes of Bluefin Tuna (IR£20,000) and 20 tonnes of Swordfish (IR£42,000) landed by the 8 vessels. Other species[5] caught as by-catch included Blue Shark (*Prionacce galuca*), Porbeagle Shark (*Lamna nasus*), Rays Bream (*Brama brama*), Sunfish (*Mola mola*), Kingfish (*Lampris guttatus*) and Garfish (*Belone belone*).

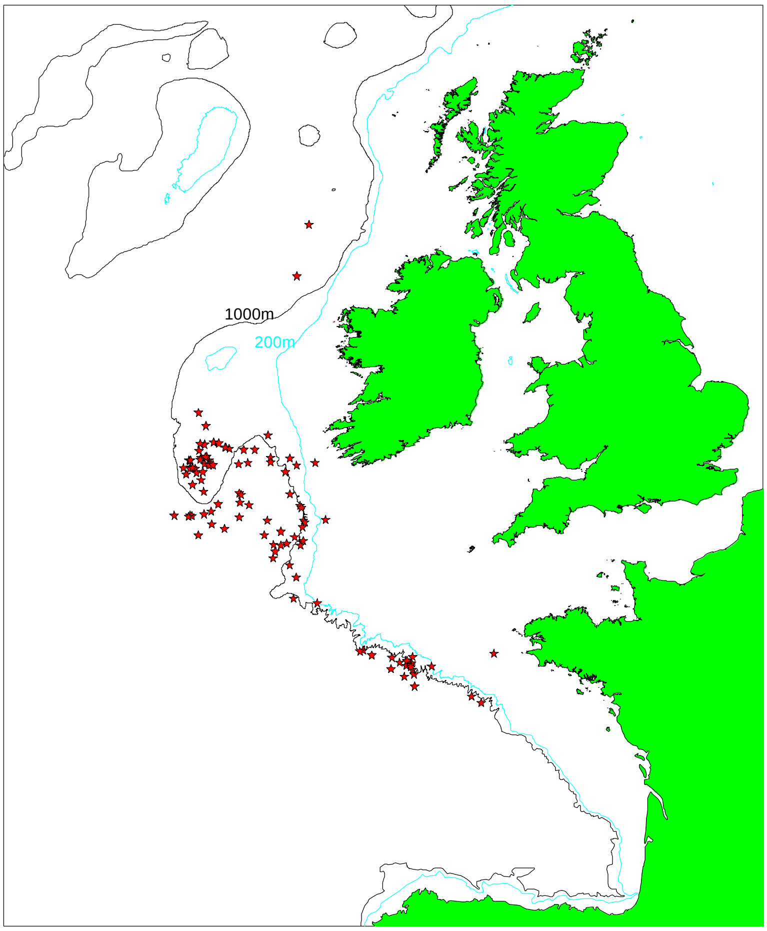


Figure 10: Principal fishing areas during 1998 exploratory trials.

Only two of the pairs caught any significant quantities of tuna during the course of the trials, and only one landing made by the "Albatross" and "Karen Rose" of approximately 15 tonnes of Albacore and 1½ tonnes of Swordfish and Bluefin Tuna could be considered close to providing economically viable returns. It should be noted, however, that French pelagic vessels reported the worst year since 1987 (when they began pelagic trawling for tuna), with catches down some 20-25% on 1997[6]. Five pairs of Scottish

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[5] A full list of species caught is given in Appendix VI.

[6] Urvois, P. 1998. Albacore: the Albacore fishing season ends. Le Marin October 1998.

vessels who participated in the fishery (for the first time) reported very poor catches and they stopped fishing after a 3–4 week period.

Prices for Albacore tuna ranged from a low of IR£1/kg to IR£2.40/kg for large, good quality, fish (average price IR£1.50/kg). Two pairs of vessels landed tuna directly into the French port of Douarnenez and these sold at auction for between 16-18 FF/kg. The Bluefin tuna landed made from IR£2.00/kg up to IR£4.00/kg, averaging IR£2.50/kg. As these fish were caught in trawl nets the quality was not particularly high, and this was reflected in the low returns. Several of the Bluefin were sold at auction in Douarnenez, making between 25-40FF. Prices for swordfish also showed considerable variation making anything from IR£1.20-3.50/kg, and between 25-35FF/kg. Average price was IR£2.20/kg. Quality was very variable and this was again reflected in the prices obtained.

MECHANISED TROLLING

Three trolling vessels completed a total of 85 days fishing during 1998, with the first two vessels going to sea on the 17th August 1998 and continuing until late September (full details of each trip are given in Appendix V). As with the pair trawling trials, catches were very poor with the three vessels landing a total of 1½tonnes of Albacore tuna (valued at approximately IR£3,750). Two vessels (these boats generally worked together) accounted for 98% of the fish caught on lures. The other vessel, which started fishing trials in late August, caught very few fish. This was partially due to bad weather, which prevented the vessel working in the desired areas. The best catch rate attained was 28 fish for one day. In general fish were from 5 to 7kg in weight, although some much larger fish (over 12kg) were also caught. It is considered unusual for this method of fishing to catch large Albacore tuna and this can be considered an encouraging sign. It should be noted that, while the catches were extremely poor, Spanish line boats had the worst season for 10 years, which was thought to be largely due to a heavy phytoplankton bloom forcing the tuna to be deeper than normal and not taking lures. Similarly the Irish tuna driftnet boats (which tow lines during the day) caught very little fish on their lines during the entire season.

As the numbers of fish landed were so small the majority of the fish were sold to local restaurants or fishmongers. Prices ranged from IR£2.20 – IR£3.50/kg, with all of the fish landed of excellent quality. Average price was IR£2.50/kg. There was considerable interest in these fish from a number of Irish multiple retail outlets, and a number of fish were sent as samples to these outlets. Also on a visit to Spain in September 1998 contacts were made with the Fishermen's Co-op in Bermeo in the Basque region. This Co-op is a major buyer of Albacore tuna, and expressed an interest in buying Irish tuna as long as it was line caught. For this method to succeed a premium market for line caught fish must be created.

BIOLOGICAL RESULTS

Biological information was collected from 105 hauls taken by pair-pelagic vessels during 1998; haul positions are plotted in Figure 11. Tows were made only at night between the hours of 19:00 and 08:00 and lasted, in general, from 4 to 6 hours.

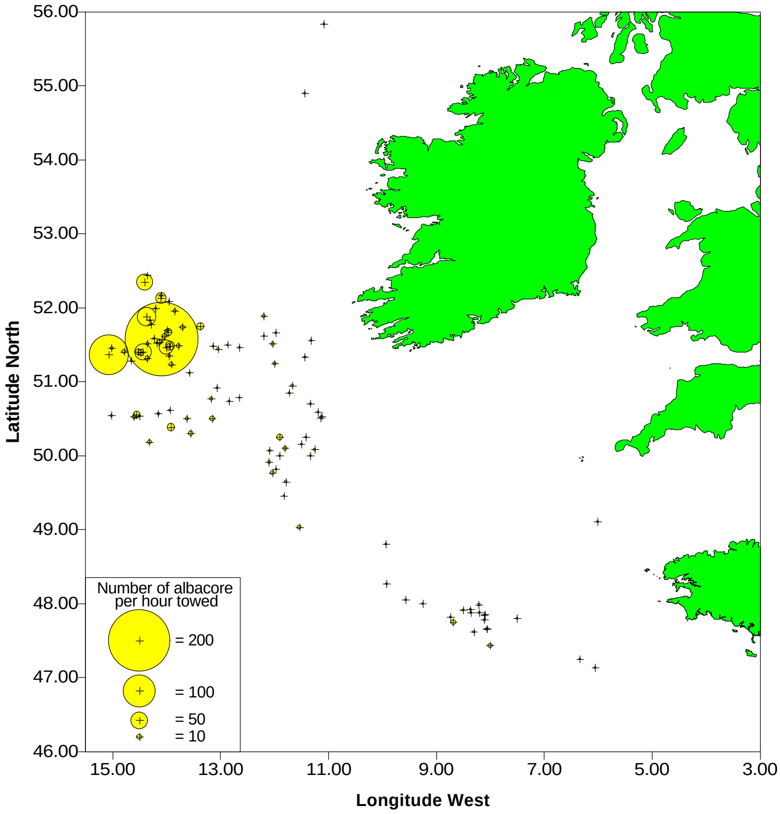

Figure 11: The haul positions and catches of Albacore on observed trips aboard pelagic trawlers during 1998.

TABLE 2 CATCH TAKEN BY PELAGIC TRAWLERS 1998

Trip number	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Albacore Tuna	427	135	17	66	1,592	2,270	4,507
Bluefin tuna	2	41	0	3	42	3	91
Swordfish	13	17	1	59	38	40	168
Ray's Bream	20	0	0	0	0	8	28
Blackfish	3	0	0	0	0	0	3
Horse Mackerel	0	0	0	0	*	*	*
Mackerel	0	0	*	*	0	0	*
Herring	0	0	*	*	0	0	*
Garfish	0	0	1	0	0	0	1
Sunfish	29	0	9	22	8	10	78
Blue Shark	0	0	0	0	0	1	1
Electric Ray	0	0	0	0	0	1	1
Porbeagle Shark	0	1	0	0	0	0	1
Leather back turtle	0	0	0	0	1	0	1
Cetaceans	0	0	1	28**	6	0	35

*Species occurred - numbers not recorded.
** Includes 1 haul when 23 individuals were caught

Albacore tuna were caught in 68% of hauls, swordfish in 60% and Bluefin tuna in 9% of the tows made. Sunfish were the commonest by-catch species occurring in 25% of tows, dolphins occurred in 5% and Ray's Bream in 2% of the tows. The total numbers caught (commercial and by-catch species) for each trip are summarised in Table 2. Trips 5 and 6 were the most successful in terms of Albacore catches with 1,592 and 2,270 caught respectively. The total catch of commercial species caught during all 6 trips was 4,507 Albacore tuna, 91 Bluefin tuna and 168 swordfish.

The CPUE of Albacore (number caught per hour fished) during the 6 trips ranged between 0 and 238 Albacore/hour. Figure 12 illustrates the CPUE for all 105 tows: 33% of tows caught no Albacore tuna, and 68% of tows caught less than 5 Albacore per hour.

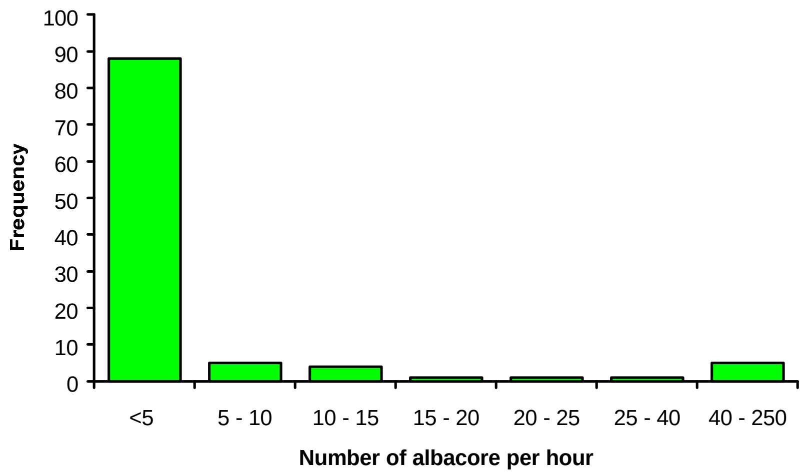

Figure 12: Number of Albacore caught per hour during 1998 exploratory fishing trials using pair pelagic trawls. (For tows monitored by on-board observers)

The length frequencies of Albacore tuna caught by vessels participating in the trials are presented in Figure 13. Fork length ranged from 49 to 111 centimetres, and a number of distinct modes are evident. The smallest mode centres on 53cm, a second mode on 63cm, with other less distinct modes at greater fork lengths. The length frequencies of fish sampled from commercial driftnet catches are presented in Figure 14. The minimum and maximum length of tuna caught in driftnets were 52cm and 115cm respectively. Distinct modes are also apparent in the driftnet tuna; the smallest at 53cm, the next at 62cm, the third mode is at 74cm and again with other less distinct modes at greater fork lengths.

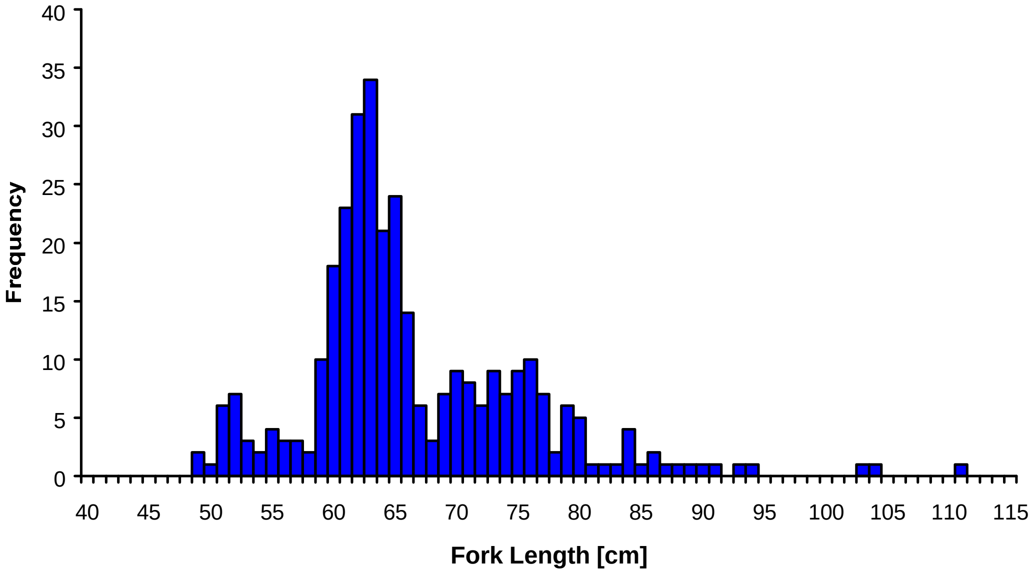

Figure 13: The length frequencies of the Albacore tuna caught using pelagic trawls during 1998

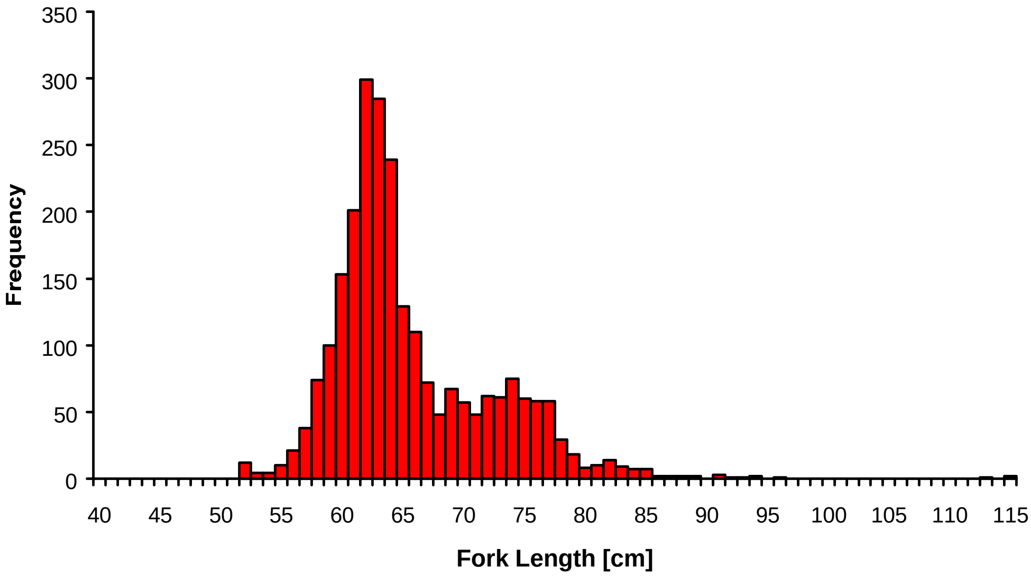

Figure 14: The length frequencies of the Albacore tuna caught using drift nets during 1998

The age composition of the sampled albacore is presented in Table 3 and figure 15. Age slicing was carried out using Multifan with an assumed growth curve[7] as used by the Albacore Species Working Group of ICCAT. The dominant age group of both pair-pelagic and driftnet caught tuna is 2-years with

[7] Von Beralanffy Growth Curve parameters: K = 0.217 L   = 123cm

smaller numbers of both 1-year and 3-year old fish. Driftnets caught marginally more 2-year old fish than pelagic trawls, whereas pelagic trawls encountered more 4, 5, and 6-year-old fish than driftnets.

Table 3: Age composition of Albacore tuna caught using pelagic trawls & driftnets during 1998.

	Pelagic Trawl		**Driftnet**	
Age	No	%	No	%
1	60	19%	422	17%
2	184	58%	1,598	65%
3	58	18%	399	16%
4	12	4%	37	1%
5	3	1%	5	0%
6	2	1%	2	0%
7	1	0%	1	0%
8	1	0%	2	0%

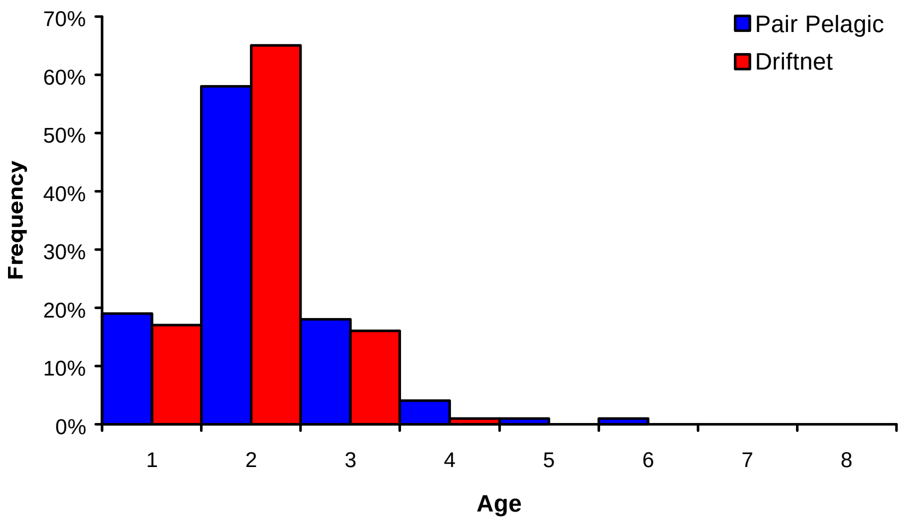

Figure 15: Age distribution of albacore caught using pelagic trawls & driftnets during 1998

The relationship between and weight of commercially caught albacore tuna is shown in figure 16: associated regression details are given in the figure. The length/weight relationship for Albacore tuna in this study is similar to previous studies in the north Atlantic (Santiago, 1992). In Santiago's length/weight relationship a =0.00001339 and b =3.107 compared to the values obtained here of a = 0.00003647 and b = 2.8692. The lower value of "b" in this study is probably due to a lack of samples of larger fish rather than any fundamental differences in growth.

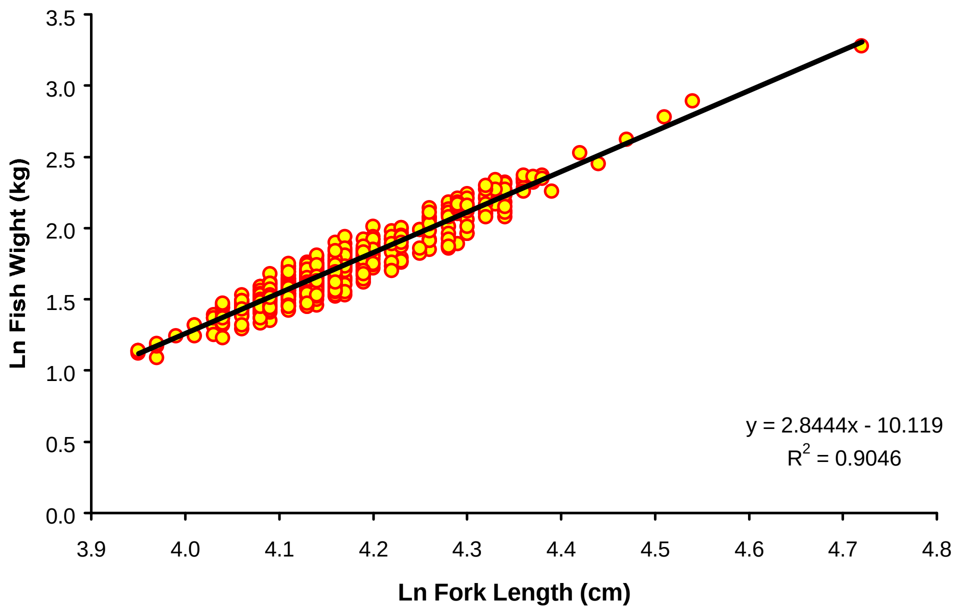

Figure 16: The relationship between length and weight for driftnet caught Albacore tuna (1998).

REMOTE SENSING TECHNOLOGY

Catches of albacore recorded during the 1998 pair trawling trials were analysed to investigate the effect of temperature fronts on catches using temperature information obtained from weekly composite images of sea surface temperature. Initially catch was plotted against the distance to the nearest front with both variables log transformed. While a weak but significant inverse relationship was obtained (figure 17) the distance variable explained only 8% of the total variation in albacore catch (R^2 = 0.082 p = 0.01). Including the phase of the moon in the model (figure 18) explained a further 3% of the variation (R^2 = 0.112 p = 0.282).

A number of other variables were tested; temperature change across the front, temperature at the fishing location, chlorophyll change across the front and chlorophyll change at the fishing location, however none of these contributed significantly to the model fit.

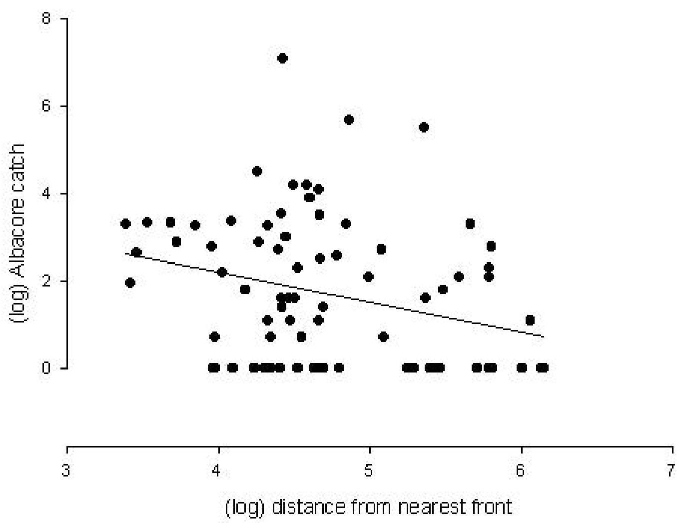

Figure 17. Albacore catches and distance to the nearest front.

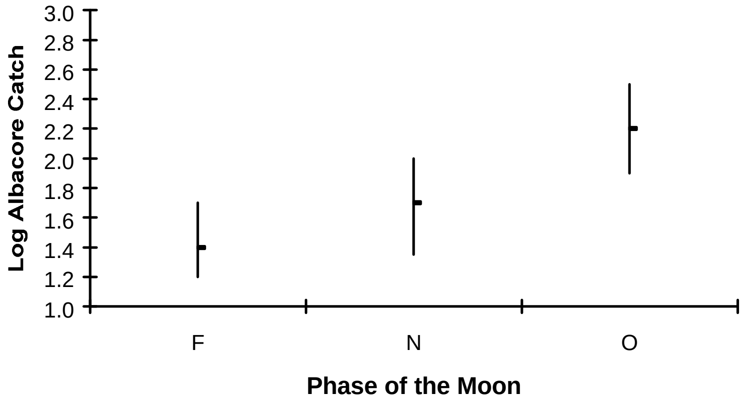

Figure 18. Mean Albacore catch for each phase of the moon.

A second analysis was performed in which a 2nd order regression was fitted to a reduced data set that included only results where distance from the nearest front was less than 65 kilometres. In this model the distance variable explained 34% of the variation in Albacore catch (R^2 = 0.3357 p<0.05) and the regression curve suggests that catch begins to decrease at a distance of 46km from the nearest front. Including the phase of the moon in the model (figure 19) increases the amount of 'explained' variation to 50 % (R^2 = 0.496 p = 0.14).

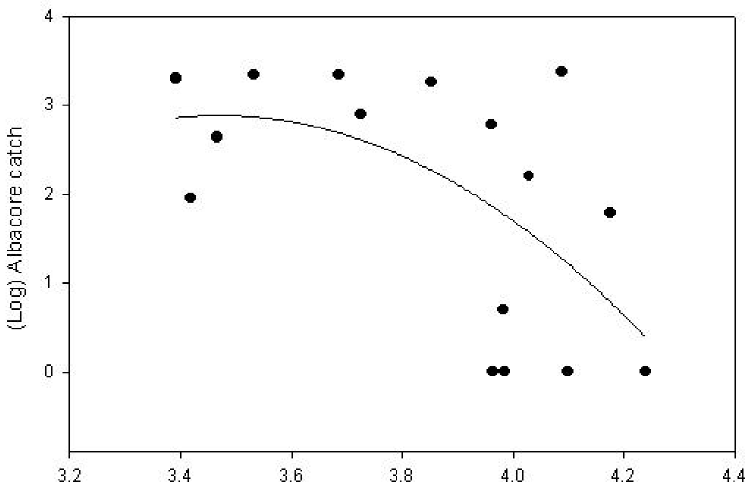

Figure 19. Albacore catches plotted against distance from nearest front for distance <65km

PART 2: 1999 RESULTS

PAIR PELAGIC TRAWLING

During 1999, five pairs of vessels completed a total of 199 days at sea, with each pair fishing for 40 days (average duration of trip 6-10 days). Three of the pairs began trials work on the 9th August with the final pair going to sea on the 16th August. All of the work was completed by late September. Two of the pairs (Menhaden & Sea Spray and Eilean Croine & Ocean Reaper) fished off the south-west coast of Ireland between 50°- 52°N and 13-14°W, alongside the Irish driftnet fleet and the Spanish trolling fleet. These vessels also worked in an area bounded by 50º - 51ºN and 11º - 12ºW. The remaining vessels (Solan & De Linn, Karen Rose & Albatross and Mary Lorraine & Heroine) fished in the Bay of Biscay alongside the French pair pelagic fleet (44º - 45ºN and 2º - 4ºW; *La Chappelle Bank* and *Fer á Cheval*). Figure 20 shows the main areas fished during 1999 by the pair pelagic vessels.

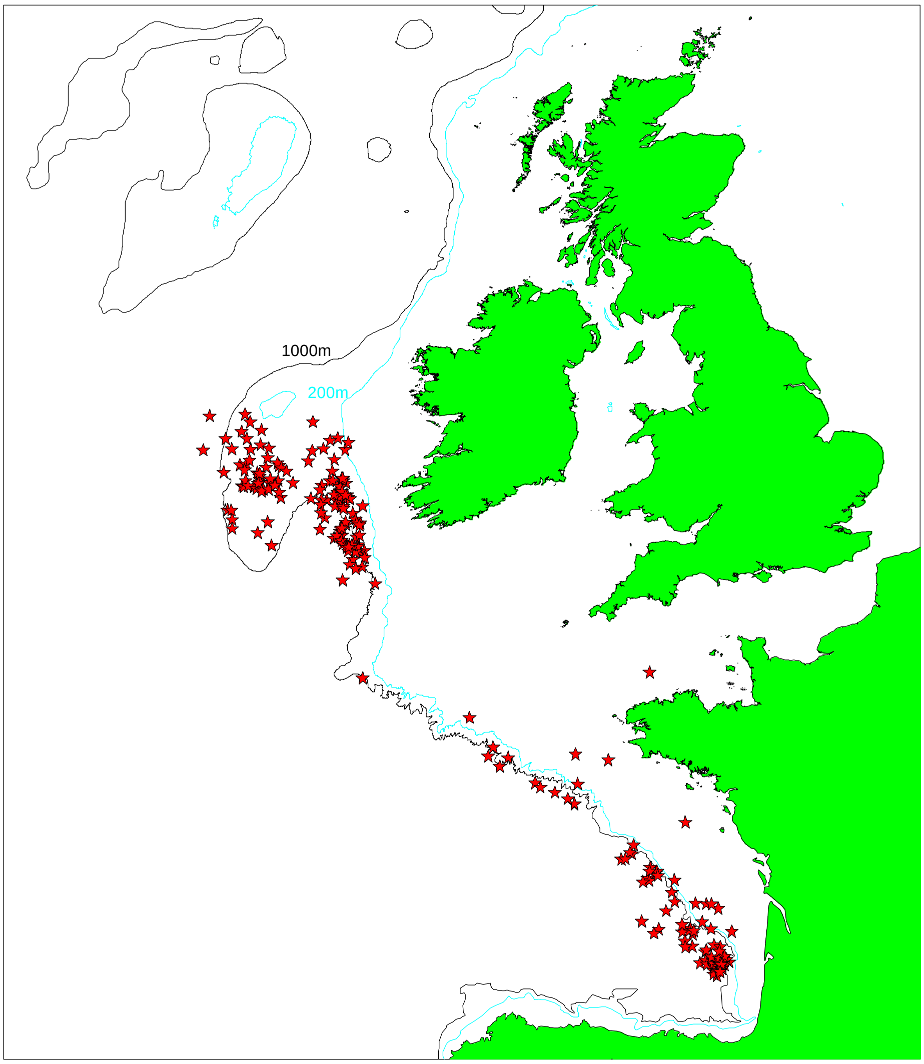

Figure 20: Main Area targeted during the trials by the vessels during 1999

Catches in 1999 were considerably improved on 1998 figures: the total catch of Albacore tuna was 166 tonnes (IR£212,000) with a by-catch of 9½tonnes of Bluefin Tuna (IR£12,000) and 11 tonnes of Swordfish (IR£33,000). Small quantities of Skipjack Tuna were also landed although these were generally sold as Albacore. Other commercial species caught included bigeye tuna, porbeagle, blue and thresher shark, along with a few sailfish and blue marlin (appendix VI). The pair-pelagic vessels consistently caught fish with average daily catch rates of 1-1½tonnes; on several trips this increased to more than 3 tonnes per night. These catch rates are consistent with those reported by French pelagic vessels participating in the fishery. On the other hand, catches were sporadic at times (a feature of this method of fishing) and some tows yielded little or no return particularly around the time of the full moon.

Prices for albacore tuna ranged from IR£1 to IR£1.40 per kilogram. This includes fish that were landed directly into the French ports of Lorient, Hendaye and La Rochelle. Although these prices were below the average paid for French tuna (12.8ff or IR£1.52 per kilogram) the quality of the fish landed was, in some cases poor and this had a bearing on the returns received. (All of the tuna landed were sold to the cannery market). The small quantity of Bluefin tuna landed made from IR£0.82 to IR£1.40 per kilogram while Swordfish made from IR£1.50 to IR£3.50 per kilogram with an average price of IR£3.00 per kilogram.

MECHANISED TROLLING

In 1999 three trolling vessels completed a total of 120 days at sea between mid July and the end of September. Each vessel fished for a total of 40 days with trips lasting between 6 and 7 days. Fishing effort was concentrated on two areas, bounded by 50º - 51ºN & 11º- 12ºW and 51º 30'- 52ºN & 13º40' - 14ºW. Where possible the vessels worked together alongside Spanish line boats. Two of the vessels (Noz Dei and Warren Lock) attained daily catch rates of over 300kg quite consistently and landed over 1000kg of tuna on 6 separate trips. At the start of the season these daily catch rates were similar to the catch rates of Spanish line boats working in the same area. The remaining vessel, Les Marquis, (which is constructed of steel and fitted with a Kort nozzle) did not fish as well until the very last trip when the vessel caught better quantities of fish. As with the 1998 trials, periods of bad weather (heavy swell conditions) hampered the vessels and also restricted catch rates, as did very bright, calm days when catches tended to drop.

Overall catches improved dramatically from 1998 with the three vessels landing a total of 12 tonnes of Albacore tuna (IR£21,000). Other species caught included one small swordfish and several wreck fish (*Polyprion americanus).* Prices for Albacore ranged from IR£1.50 to IR£3.00 per kilogram (average price IR£2.00 per kilogram) and the majority of the fish were sold locally to restaurants and fishmongers. Once again a number of Irish Multiple Retail outlets demonstrated considerable interest in these fish and samples were sent to a number of them. At least one of these chains is planning to run a promotional campaign with line caught tuna as a result of the trials.

Surface Longlining

The vessel MFV "Fiona Patricia" engaged in the surface longline trials, went to sea in mid-June and completed five trips (35 fishing days) finishing in early August. The vessel worked a number of areas from as far south as 48ºN, 10º30'W up to 51ºN, 15ºW and tended to work close to the Irish driftnet fleet, which at the time were reporting very good catches of Albacore.

The results of these trials were very disappointing with only 1 Albacore tuna of 11kg caught over the whole period and this despite constant variation of the gear, fishing the gear both night and day and trying different baits. However the vessel did land a by-catch of approximately 3000kg of swordfish, 550kg of Bluefin and 8000kg of Blue and Porbeagle Shark. As would be expected of this method, the quality of fish landed was excellent and swordfish prices averaged from IR£3 to IR£5 per kilogram, while Bluefin obtained from IR£6.50 to IR£11 per kilogram. As 70% of the catch consisted of Blue Shark, average price IR£0.20 to IR£0.70 per kilogram, overall financial returns were poor. Similar trials carried out by IFREMER during 1998 and lasting 21 days also gave poor returns with some 150 kg of large Albacore taken. This was put down to a number of mitigating factors such as the wrong hook size and wrong bait, while the time of the year (late September) was far from ideal. However, repeat trials on this vessel in 1999 had a similar outcome to the trials on the "Fiona Patricia" and not one single Albacore was caught over a 30-day period.

Biological Results

Biological information was collected from 313 hauls taken by pair-pelagic vessels during 1999; haul positions are shown in Figure 20. Tows were generally made at night between the hours of 19:00 and 08:00 and lasted, in general, from 4 to 6 hours (average tow time across 313 hauls was 5 hours). From the total catch of 35,420 albacore 6,643 pair-pelagic were measured, 3,788 from the Bay of Biscay and 2,855 from the South West Coast of Ireland.

TABLE 4 CATCH TAKEN BY PELAGIC TRAWLERS 1999

Trip number	Total
Albacore	35,420
Swords	232
Bluefin	313
Sunfish	275
Bigeye	77
Thresher	7
Porbeagle	1
Luvar	4
Blueshark	9
Opah	1
Rays bream	4
Billfishes	9

Albacore tuna were caught in 82% of hauls, swordfish in 38% and Bluefin tuna in 15% of the tows made. Sunfish were, once again, the commonest by-catch species occurring in 13% of tows. Thirteen hauls (4%) recorded Albacore catches in excess of 500 fish. The total numbers caught (commercial and by-catch species) are summarised in Table 4.

During August, off the South West Coast of Ireland, the average catch of Albacore per haul was 119 fish for a mean tow time of 272 minutes. Overall catch rates were 113 Albacore per haul. The CPUE of Albacore (number caught per hour fished) during the 313 hauls ranged between 0 and 356 Albacore/hour. Figure 21 illustrates the CPUE for all hauls: 18% of tows (57 out of 313 hauls) caught no Albacore tuna, and 44% of tows (140 out of 313 hauls) caught less than 5 Albacore *per hour*. This compares favourably with 33% and 68% respectively in 1998. In addition, 35% of tows (n = 110) recorded Albacore catches in excess of 100 fish.

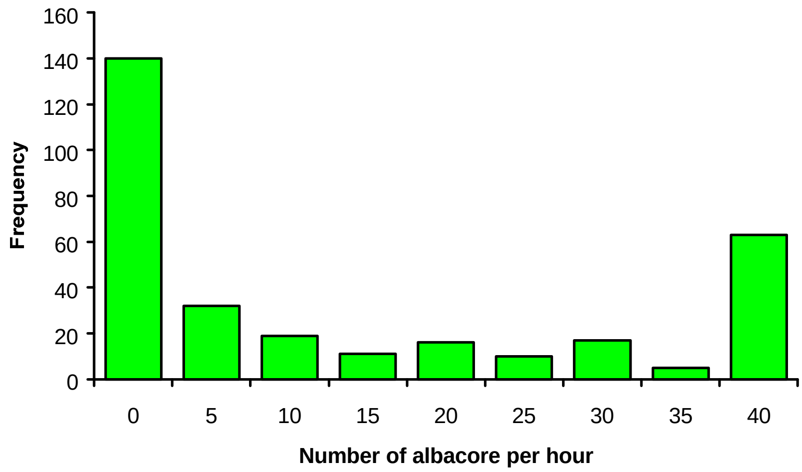

Figure 21: Number of Albacore caught per haul during 1999 pair pelagic fishing trials.

The length frequencies of Albacore tuna caught by vessels participating in the trials are presented in Figure 22. Fork length ranged from 50 to 127 centimetres, and a number of distinct modes are evident. The smallest mode centres on 56cm, a second on 65-67cm, and a third on 75-78 cm, with other less distinct modes at greater fork lengths. The length frequencies of fish sampled from commercial driftnet catches are presented in Figure 23. The minimum and maximum length of tuna caught in driftnets were 50cm and 113cm respectively. Distinct modes are also apparent in the driftnet tuna; the smallest at 65cm, the next at 73cm, and again with other less distinct modes at greater fork lengths. Length frequency for the three Albacore fisheries (Driftnetting, Pair-trawling, and Trolling) is summarised in Figure 24. In addition a total of 313 Bluefin and 232 Swordfish were observed with fork length measurements taken for 175 and 70 respectively. These ranged in size for the Bluefin from 93 cm to

213 cm and 45cm to 264cm for the Swordfish. The length frequency distributions are show in Figure 25 and 26. (All Bluefin and Swordfish were taken in pair pelagic trawls).

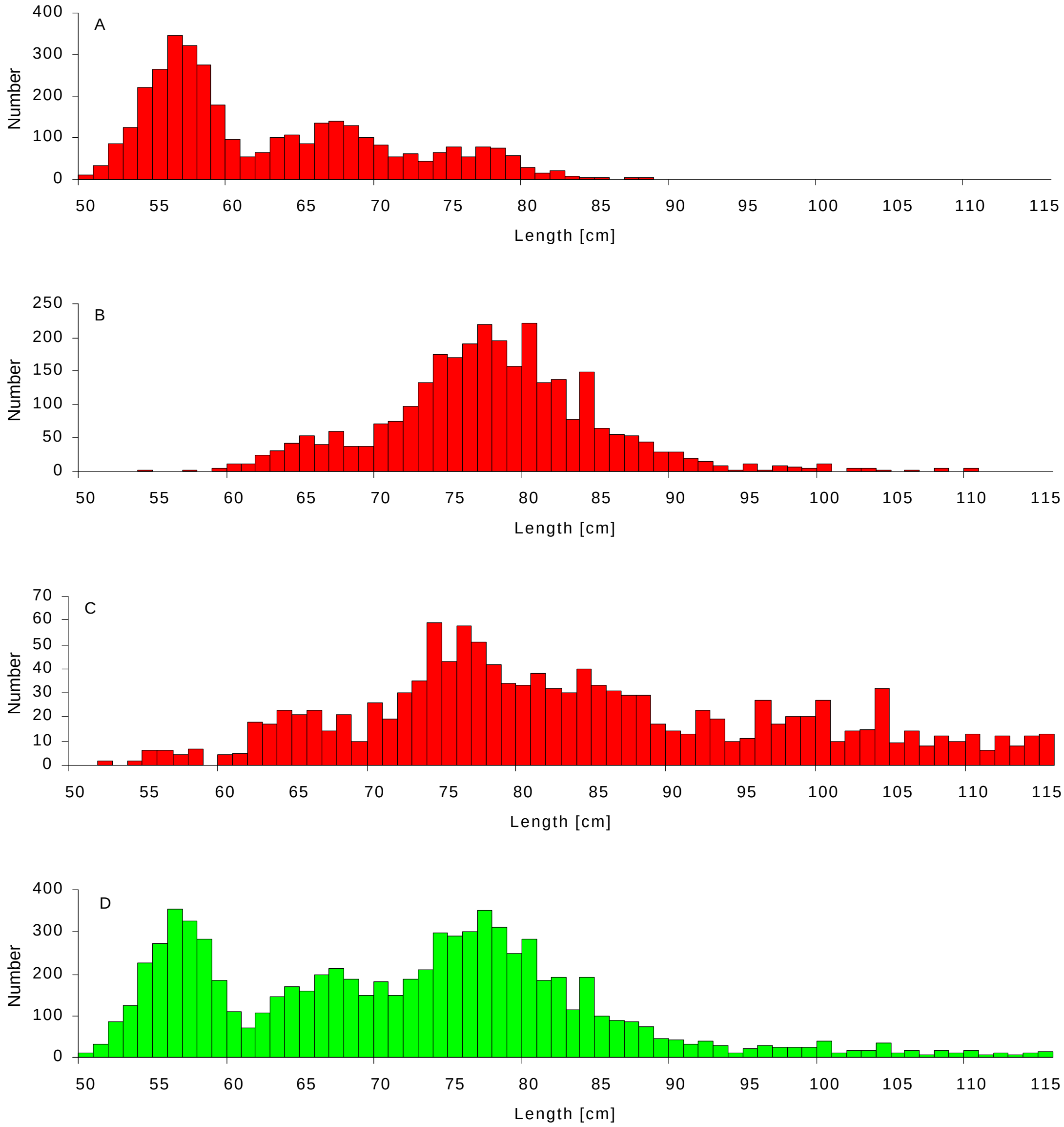

Figure 22: Length frequency of Albacore tuna sampled from pair-trawl catches taken during A) August - September 1999, Bay of Biscay (n = 3,597); B) August 1999, SW Ireland (n = 2936); C) September 1999, SW Ireland (n = 1,281); and D) Combined (n = 7,814).

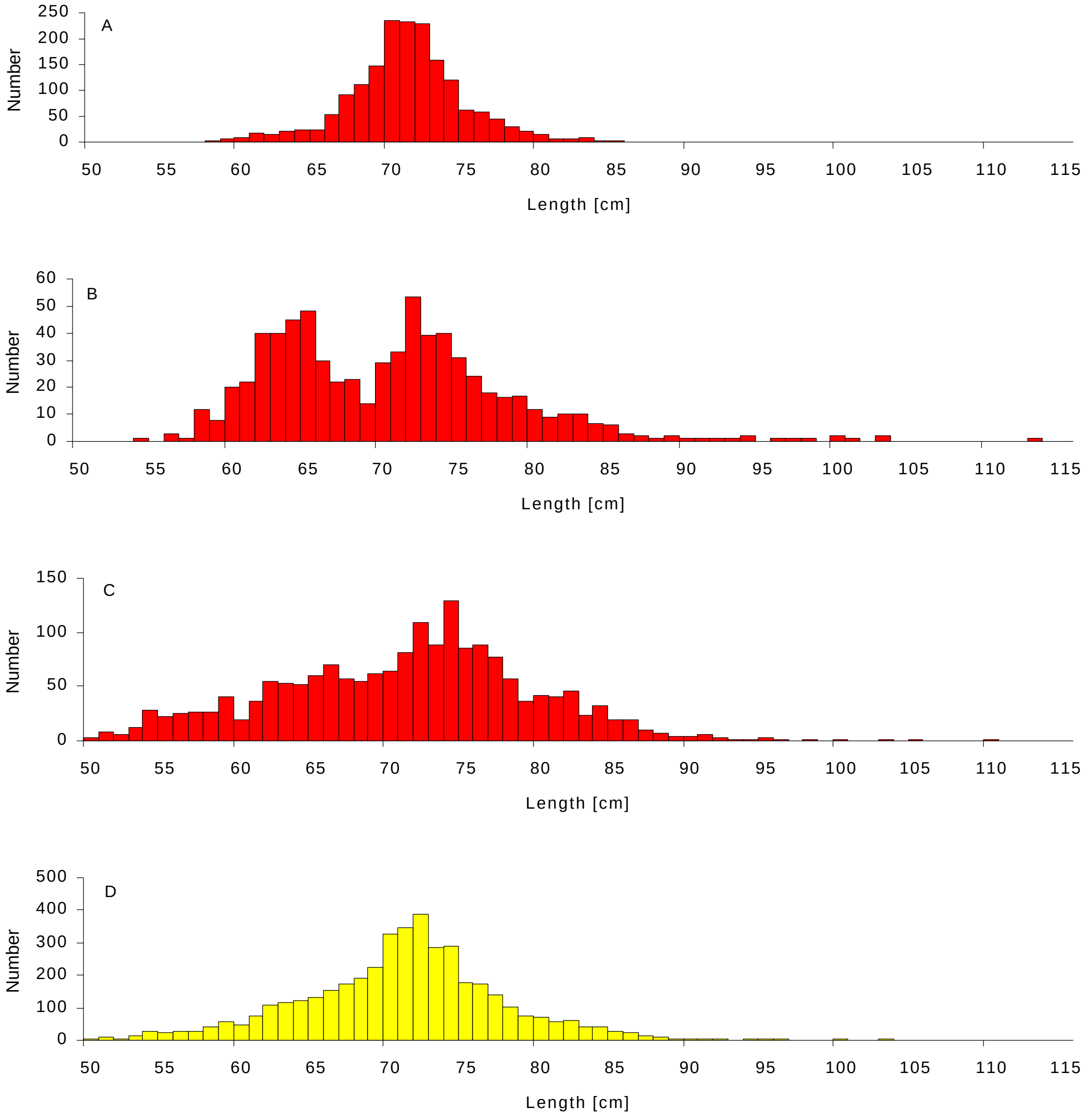

Figure 23: Length frequency of Albacore tuna sampled from commercial driftnet catch taken during A: July 1999 (n = 1,749); B: August 1999 (n = 706); C: September 1999 (n = 1,806); and D: July - August 1999 combined (n = 4,261).

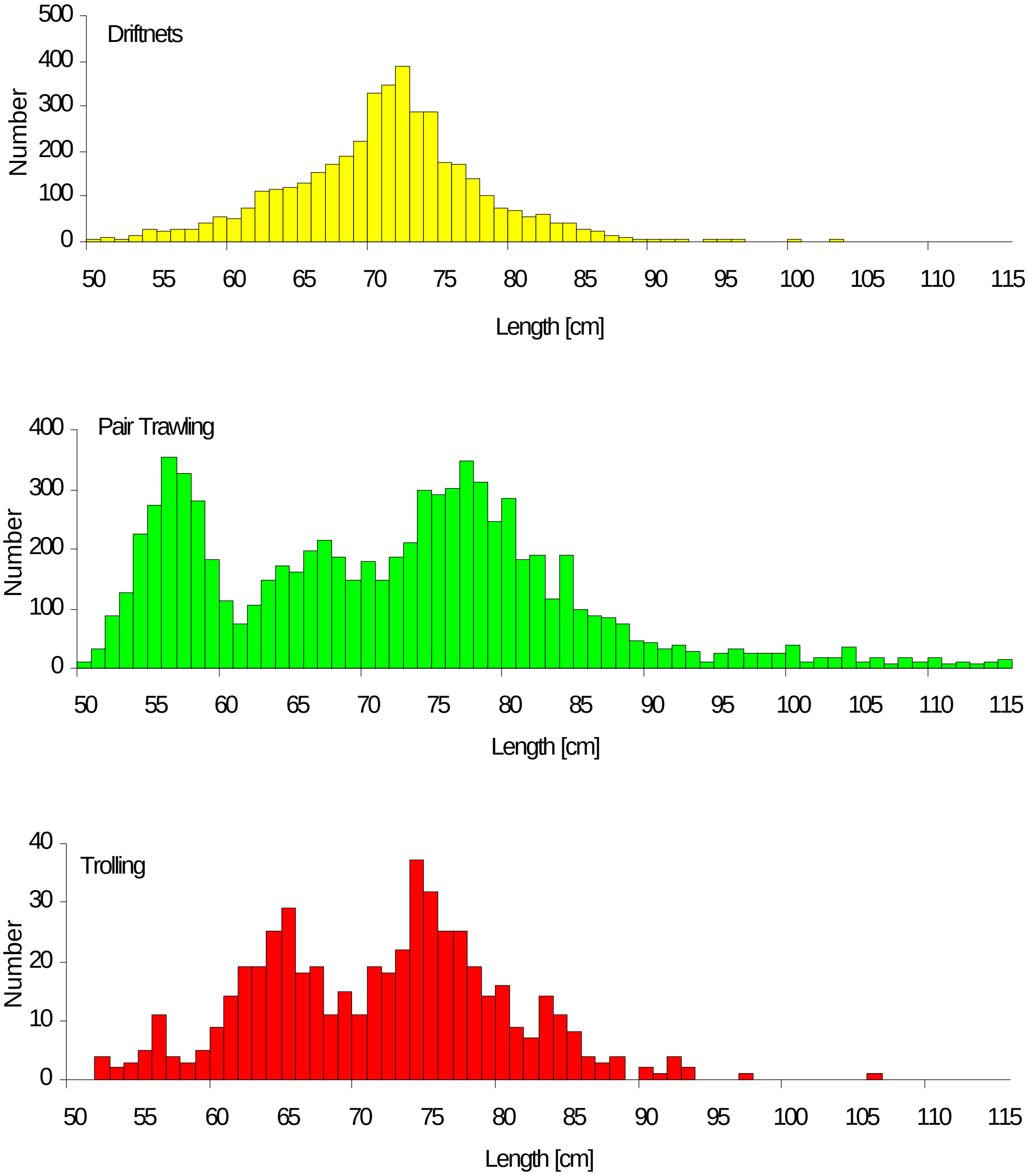

Figure 24: Length frequency of Albacore tuna sampled from A) Driftnets, July - August 1999 (n = 4,261); B) Pair-trawlers August - September 1999 (n = 7,814); and C) Trollers August 1999 (n = 524).

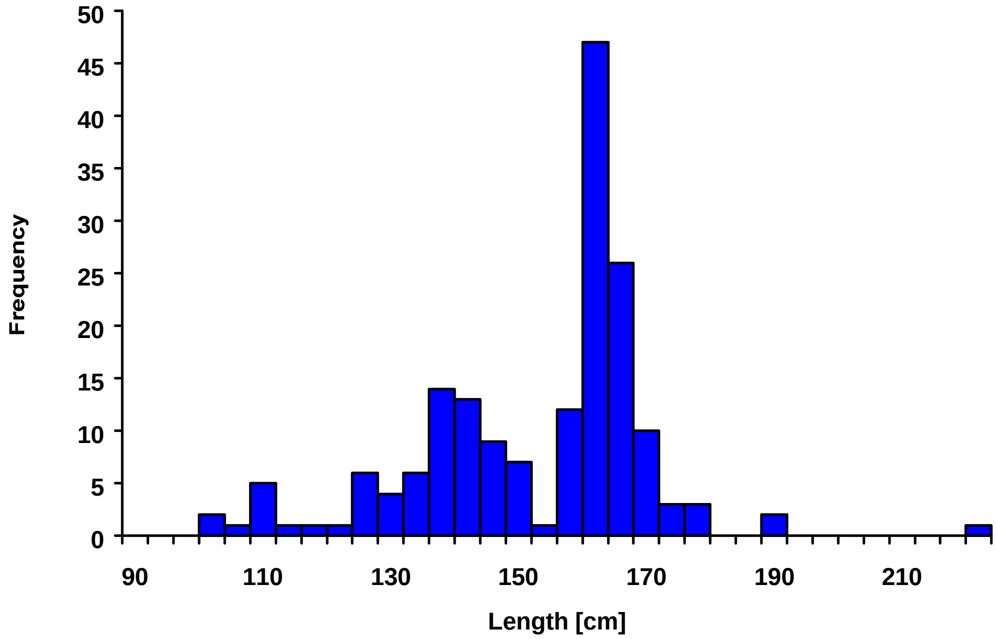

Figure 25: Length frequency of Bluefin tuna catch (n = 175).

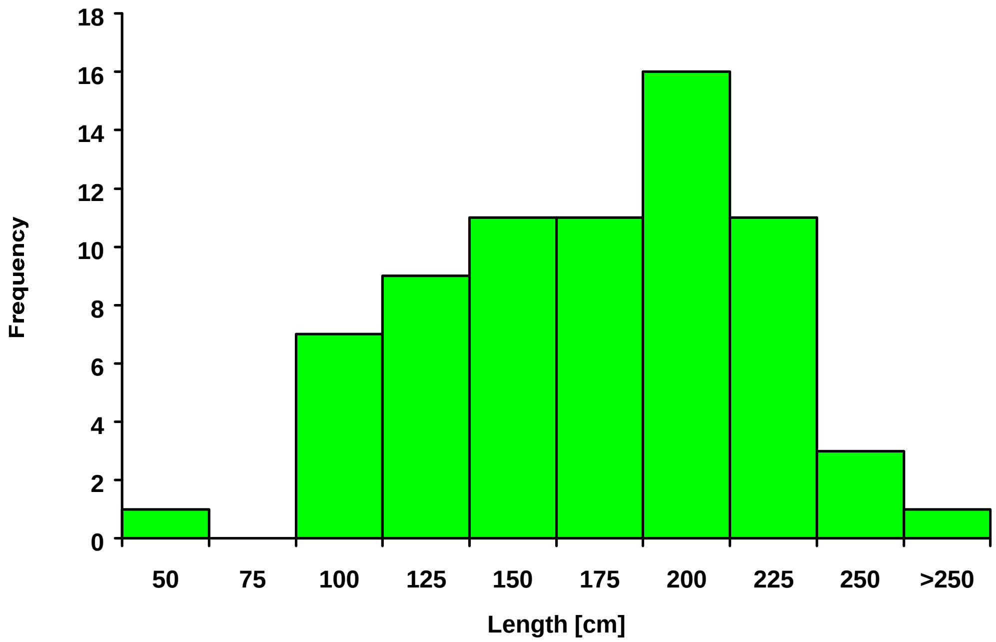

Figure 26: Length frequency of Swordfish catch (n = 70).

LUNAR PHASE

Lunar phase may have affected fishing in the Bay of Biscay insofar as the best catches were made on the darkest nights between the last quarter and the first quarter (Figures 27 and 28). Off the South West Coast cloud cover is likely to mitigate the influence of lunar phase on catch rates.

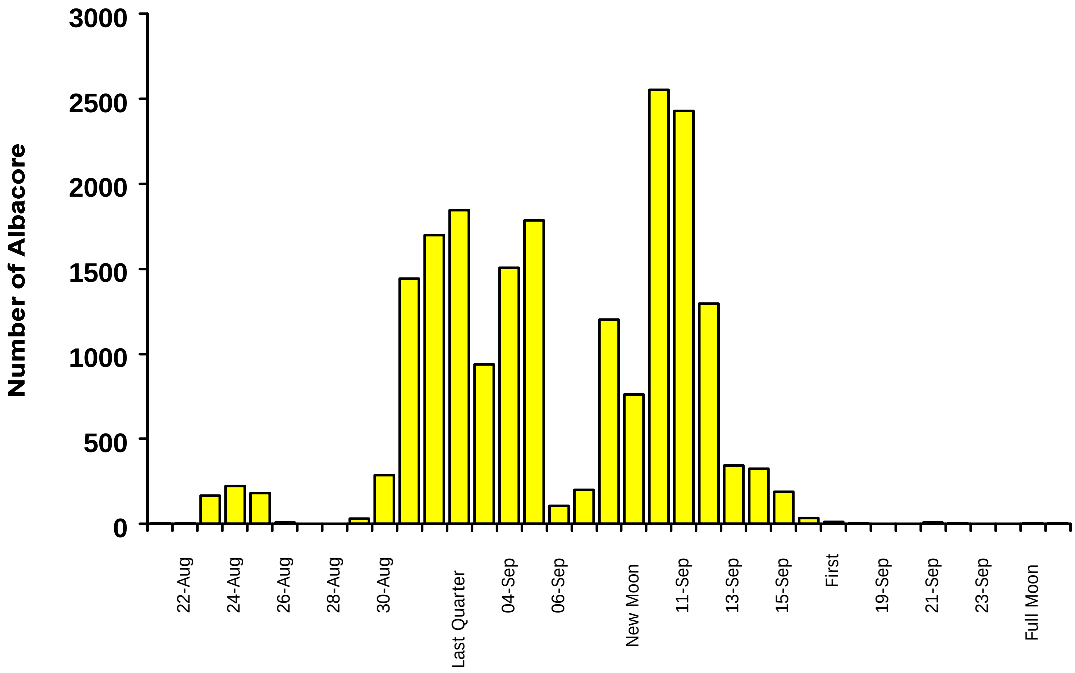

Figure 27: Trawled Biscay Albacore with Lunar Phase

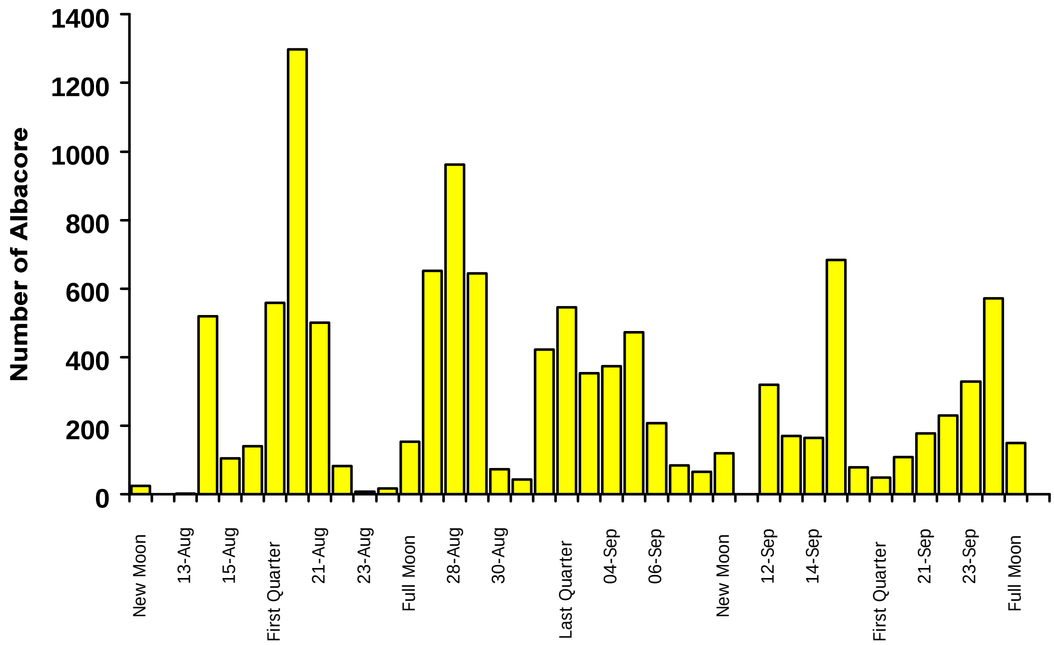

Figure 28: Trawled Albacore off the South West Coast of Ireland with Lunar Phase.

AGE COMPOSITION

The age composition of the sampled albacore is presented in Table 5 and Figure 29. Age slicing was, once again, carried out using *Multifan* with an assumed growth curve[8] as used by the Albacore Species Working Group of ICCAT. The dominant age group of both pair-pelagic and driftnet caught tuna is 2-years with smaller numbers of both 1-year and 3-year old fish. Driftnets caught marginally more 2-year old fish than pelagic trawls, whereas pelagic trawls encountered more 4, 5, and 6-year-old fish than driftnets. The trolling vessels tended to catch 2 and 3 year old Albacore with a small proportion of 4 year olds.

Table 5: Age composition of Albacore tuna caught using pelagic trawls & driftnets during 1999.

	Pelagic Trawl				**Driftnet**		**Trolling**	
	Bay of Biscay		SW Ireland					
Age	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**
1	**1996**	**56%**	**0**	**0%**	**175**	**4%**	**0**	**0%**
2	**1161**	**32%**	**854**	**13%**	**2579**	**61%**	**293**	**56%**
3	**438**	**12%**	**2185**	**33%**	**1431**	**34%**	**206**	**39%**
4	**0**	**0%**	**1660**	**25%**	**43**	**1%**	**22**	**4%**
5	**1**	**0%**	**1135**	**17%**	**20**	**0%**	**2**	**0%**
6		**0%**	**609**	**9%**	**8**	**0%**	**0**	**0%**
7		**0%**	**84**	**1%**	**0**	**0%**	**1**	**0%**
8		**0%**	**0**	**0%**	**5**	**0%**	**0**	**0%**

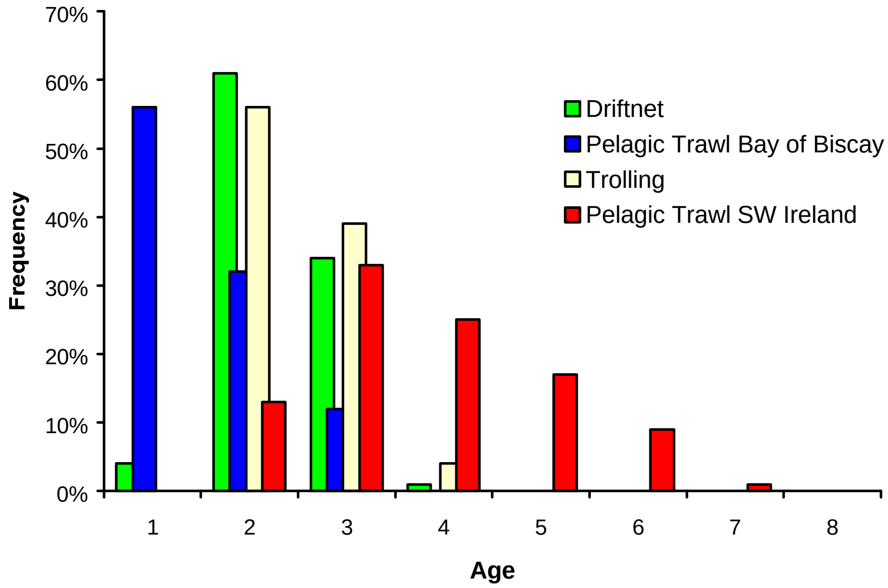

Figure 29: Age distribution of albacore caught by pelagic trawls, driftnets & by Trolling – 1999.

[8] Von Beralanffy Growth Curve parameters: K = 0.217 L = 123cm

CETACEAN BYCATCH

Cetacean by-catch consisted of four species as is shown in Table 6. Two leatherback turtles were also recorded as by-catch but both specimens were returned to the sea alive.

TABLE 6: RECORDED CETACEAN BY-CATCH

Common Name	Species	Number
Common Dolphin	Delphinus delphis	127
Striped Dolphin	Stenella coeruleoalba	8
Atlantic Whitesided Dolphin	Lagenorhynchus acutus	2
Pilot Whale	Globicephala melas	8
Leatherback Turtle	Dermocheles coriacea	2

Of all 145 cetaceans taken, 98 (68%) were taken in just 10 hauls with 1 haul accounting for 30 animals. Conversely 282 or 90% of hauls recorded no cetacean bycatch at all (see figure 30).

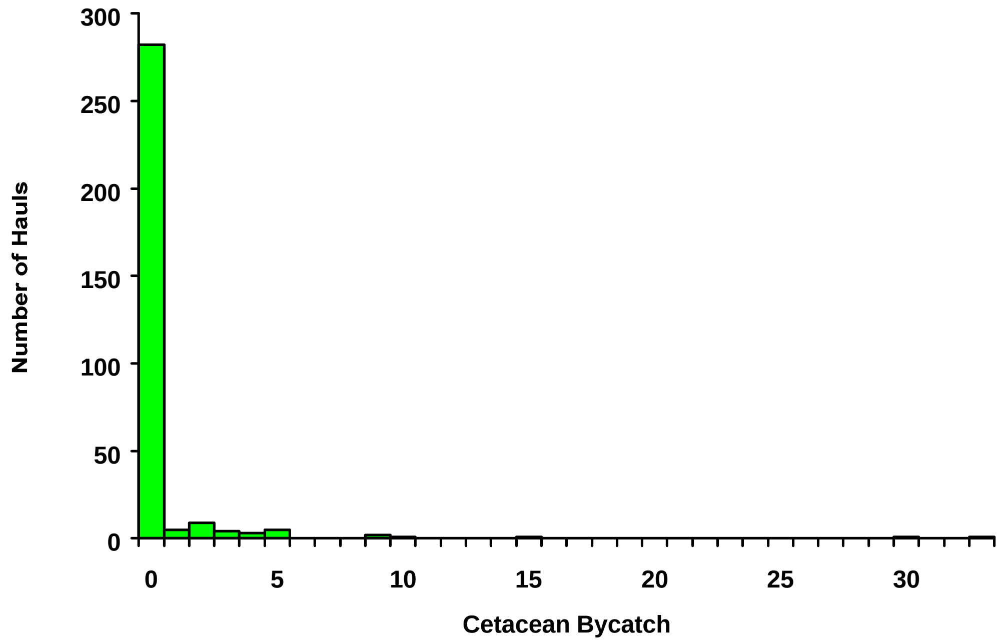

Figure 30: Incidence of Cetacean bycatch in pair pelagic trawls during 1999. (Number of Hauls = 313, number of cetaceans = 145).

To determine potential ways of reducing or avoiding cetacean bycatch, the correlation between cetacean by-catch and a range of factors was tested by way of Pearson Product-Moment Correlations. The results are shown in Table 7 and indicate that bycatch levels are significantly ($p < 0.05$) influenced by depth of water during the tow. A cetacean by catch was recoded on only one occasion when the depth of water during the tow exceeded 500m.

Table 7: Correlation of Cetacean and a Range of Factors

	Pearson Product Moment Correlation
Total Cetacean By-catch	1
Time of Haul	-0.053
Depth	**-0.154**
Latitude	0.078
Longitude	-0.082
Towing Speed	0.029
Water Temp	-0.048
Albacore Catch	-0.076
Tow time	-0.008

There was a recorded by-catch of seabirds on the "Warren Lock", mainly of juvenile gannets. The numbers are given in Table 8. Additional reporting from the other two vessels confirms similar by-catch levels. Reports from the pair pelagic vessels, which towed lines during the day also indicate seabird catches.

TABLE 8: RECORDED SEABIRD BY-CATCH

Common Name	Species	Number
Gannet	Sulla bassana	17
Fulmar	Fulmaris glacialis	3
Great Shearwater	Puffinus gravis	3

REMOTE SENSING TECHNOLOGY

During the 1999 tuna trials fishing information was collected for 273 hauls from August 10th to September 9th. Of these, 148 hauls fell within the Celtic sea area for which sea surface temperature images were available and were included in the analysis. Catches of Albacore were analysed to investigate the effect of temperature fronts on catches; temperature information was obtained from real-time (individual satellite passes) and weekly composite images (average image constructed from all passes within a given week) of sea surface temperature. Chlorophyll data was obtained from real-time Sea WiFS images and included in the analyses. The remote sensing data was purchased through the Remote Sensing Data Analysis Service (RSDAS) at Plymouth, U.K.

ANALYSIS OF FACTORS EFFECTING ALBACORE CATCH

There was a weak but significant inverse relationship between Albacore catch and distance to the nearest front (measured from the midpoint each tow). As the data was not normally distributed, the Albacore variable was log transformed and the distance variable was square root transformed. The distance variable explained 5% of the variation in Albacore catch ($R^2 = 0.047$ $p = 0.0081$). See Figure 31.

At first glance the relationship between Albacore catch and distance to front appears very poor. However, this model includes fishing data from 6 vessel pairs that were fishing under varying conditions. Therefore it is to be expected that there will be a large amount of variation, or back-ground noise in this model that could not be explained by the distance variable. Some of this variation can be attributed to the phase of the moon. Variation in catch between vessel pairs due to differences in fishing activity maybe expected. In addition, from knowledge of the oceanography of the region, it is expected that transient fronts in the Porcupine Bight and Goban Spur will have more of an effect on tuna catch than permanent fronts such as the Porcupine Bank front. In other words the relative position of the nearest front (e.g. near the Porcupine Bank, near the Goban Spur etc.) will also affect the Albacore catch. Catch will also be affected by the direction of the haul with higher catches expected when fishing is towards the front rather than parallel or away from it.

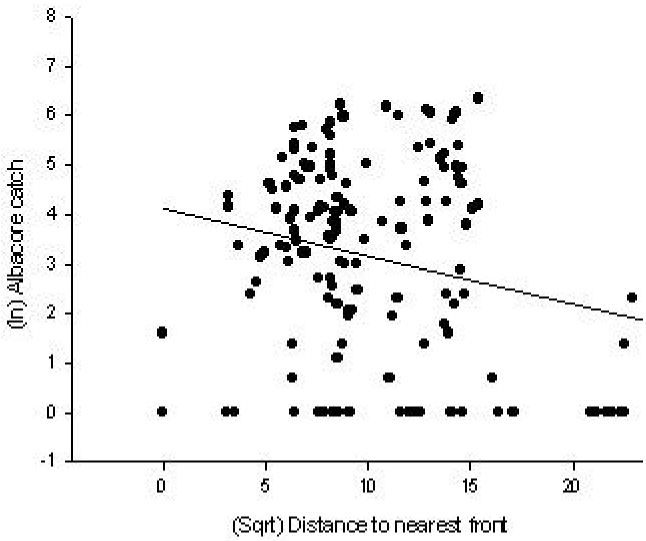

Figure 31: Albacore catches & distance to nearest front.

When these additional factors (phase of the moon, vessel pair, direction of fishing and position of the nearest front) were added to the model as categorical variables, a further 29% of the variance was explained. This model is summarised in Table 3.

TABLE 8. RESULTS OF MULTIPLE REGRESSION ANALYSIS USING DISTANCE TO NEAREST FRONT AND CATEGORICAL VARIABLES TO EXPLAIN VARIATION IN ALBACORE CATCH

Variable	DF	F ratio	P value	R squared
Vessel pair	5	4.872	0	0.337
Position of nearest front	3	3.840	0.011	
Distance to nearest front	1	1.098	0.297	
Direction of fishing	2	2.525	0.084	
Phase of moon	2	1.336	0.267	

Each of these variables were then analysed separately in order to assess the nature of their individual effects. An analysis of variance confirmed that the phase of the moon had a small but significant effect on Albacore catch (R^2 = 0.032 p=0.013), with lowest catches during the full moon. Average catch differed significantly between vessel pairs (R^2= 0.199 p = 0.000) for catches within the study area.

The effect of fishing direction was not significant on its own (R^2 = 0.005, p=0.717). However the variable was important in explaining additional variation in the overall model. Also, there was a trend in the data which indicted that catch was higher when fishing was towards the front. This is graphed in Figure 32. Other variables which could potentially influence catch were identified and their contribution to the variation in Albacore catch investigated:. temperature change across the front, temperature at the fishing location, chlorophyll change across the front and chlorophyll change at the fishing location. However none of these variables could explain any significant.

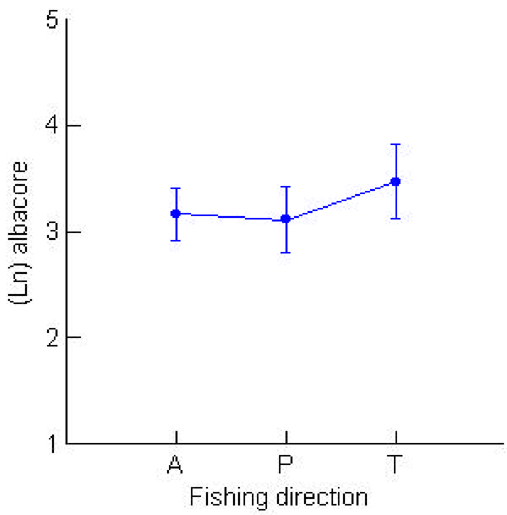

Figure 32. Mean Albacore catch for each fishing direction. A: Away from front P: Parallel to front T: towards front.

A further analysis was carried out to investigate the effect of individual fronts, as different fronts were expected to have different effects on Albacore catch, due to their oceanographic characteristics. All fronts identified during the trials were numbered and then grouped according to their position. The organisation of fronts is outlined in Table 9. The fronts at the Porcupine Bank were expected to have little or no effect on Albacore catch. A regression analysis found this to be the case (R^2 = 0.018 p = 0.27).

Five transient fronts were identified, two at the Goban Spur and three at the Porcupine Bight. Of these, three fronts were found to have a significant effect on catch. These were the fronts on the Goban Spur (4 and 8) and one of the fronts at the Porcupine Bight (10). It should be noted that for the two fronts on the Porcupine Bight which did not have a significant effect on Albacore catch, fishing effort was concentrated in an area too far from the front (> 65km) for an effect to be observed.

TABLE 9 LOCATION OF THE FRONTS IDENTIFIED FROM SEA SURFACE TEMPERATURE MAPS DURING THE 1999 TUNA TRIALS

Front	Position	Latitude	Longitude
1	Porcupine Bight	50° 35’	-12° 29’
2	Porcupine Bank (West)	51° 18’	-14° 50’
3	Porcupine Bight	49° 55’	-13° 20’
4	Goban Spur	48° 54’	-11° 13’
5	Porcupine Bank (West)	51° 32’	-14 ° 37’
6	Porcupine Bank (East)	51° 51’	-13 ° 4’
8	Goban Spur	50° 40’	-11° 25’
9	Porcupine Bank (West)	51° 48	-14° 6’
10	Porcupine Bight	50° 32’	-12° 13’
11	Porcupine Bank (East)	51° 10’	-14° 45’

When the data from fronts 4, 8 and 10 were pooled in a second order regression, the distance variable explained 29% of the variation in Albacore catch ($R^2 = 0.29$ p = 0.0001) with catch increasing moving towards the front (Figure 33 and Table 11). A multiple regression was carried out using data relating to these three fronts, 49 points. Distance to front explained 32% of the variation in Albacore catch. A further 27% of the variation was explained by adding the phase of the moon, fishing direction and vessel pair to the model. This model shows that, as with the full data set, a good deal of variation in Albacore catch is attributable to the fishing technique. In this model however, more background variation has been removed by focusing on fronts which have significant effects on catch. The results of this analysis shows that for fronts in the Goban Spur and one front in the Porcupine Bight, Albacore catch increases moving towards the front.

TABLE 10. RESULTS OF A MULTIPLE REGRESSION USING DATA RELEVANT TO IMPORTANT FRONTS (4, 8 AND 10)

Variable	DF	F ratio	P value	R squared
Distance to nearest front	1	10.85	0.002	0.586
Direction of fishing	5	3.82	0.008	
Vessel pair	2	1.647	0.209	
Phase of moon	2	2.033	0.148	

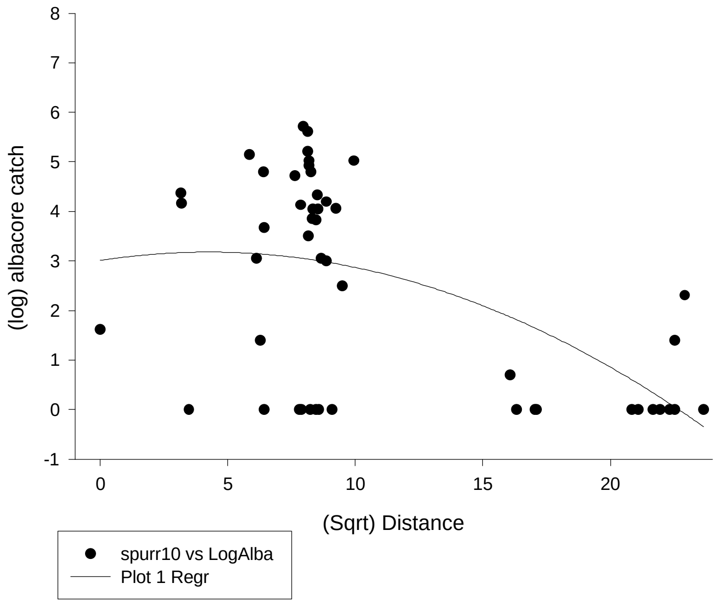

Figure 33. Graph showing relationship between Albacore catch and distance to front for all-important fronts

ANALYSIS OF BLUEFIN TUNA AND SWORDFISH CATCHES

Correlations among catches of blue fin tuna, swordfish and Albacore tuna were explored. Blue fin and swordfish catches were not significantly correlated with Albacore catch (Pearson correlation coefficient = -0.015, and 0.014 respectively p = 1.000 after correction for multiple comparisons). There was a significant relationship between Bluefin catch and distance from front (R^2 = 0.11, $p < 0.001$).

When the vessel pair and fishing direction variables were added to the model 32% of the variation in Albacore catch were explained. These results are outlined in Table 11. These results indicate that catches of Bluefin tuna are influenced by fronts and fishing technique in a similar way to Albacore catches.

TABLE 11. MULTIPLE REGRESSION SHOWING FACTORS WHICH EFFECT BLUEFIN TUNA CATCHES

Variable	DF	F ratio	P value	R squared
Distance to nearest front	1	8.6	0.004	0.321
Vessel pair	4	1.8	0.131	
Direction of fishing	3	6.4	0.001	

4. DISCUSSION

PAIR PELAGIC TRAWLING

The catches made by the 5 pairs of vessels during year 1 were very poor, although as stated earlier, catches made by French and Scottish pair pelagic vessels were also at very low levels during the 1998 season. Adverse weather conditions throughout the whole trial period also created problems for the vessels. Catch rates increased dramatically during year 2 and Irish vessels fishing alongside French pair teams performed equally well, achieving satisfactory catch rates in excess of 1½ tonnes per vessel/per night on many occasions. Catch rates, however, were still sporadic throughout year 2, which would appear to be a feature of this method of fishing for tuna.

During year 1 a number of issues were highlighted from a technical, biological and fish quality perspective that needed to be addressed in Year 2. From a technical perspective during the trials and at the subsequent workshops held in December and in June, all of the skippers recommended a number of modifications required to the trawl designs being used, due to the fact that it was found that many of the trawls proved difficult to tow at the desired speeds of over 4 knots, especially in bad weather. These recommendations were addressed by the Irish and French netmakers before the commencement of trials in year 2. For the Irish designed nets, the large meshes in the wings of the trawl were extended back further to the body of the trawl to reduce drag. Several of the existing French nets were modified by replacing belly sheet sections with Dyneema netting, which is much stronger than conventional nylon allowing thinner twine diameters to be used and thus reducing drag. Both of these features proved successful and the skippers involved reckoned that these modifications increased towing speed by around ½ knot or more. There were a few problems with the Dyneema sections tearing under load, particularly in bad weather and it was felt this was due to the reduced elasticity of Dyneema compared to nylon. It was felt that perhaps heavier Dyneema be used or the length of the section constructed in Dyneema reduced.

After year 1 many of the skippers felt that the extension piece and codends on the French designed nets were too narrow, which meant that fish, particularly swordfish, tended to stick leading to loss of catch and damage to fish. It was also felt that codend mesh size should be increased from 80/85mm to 120mm and different materials such as PA or PE tested, as it was felt that this would reduce drag and also help to improve fish quality. During year 2 new codend and extension piece sections were constructed as per agreed specifications from both PA and PE. Both materials were suitable, although from a cost point of view, the codends constructed in PE were preferred, if potentially slightly weaker. It had been feared that large swordfish would cause undue damage to the codends constructed in polyethylene but this was not found to be the case. With regard to mesh it was concluded that 120mm mesh size performed better and tended to result in improved quality fish, unless there were large catches.

As most of the vessels involved in these trials had experience with working pair pelagic trawls for herring, the shooting and hauling of the gear did not prove to be any real problem, except with the floats occasionally fouling the big meshes at the mouth of the net. During year 2 this was overcome by using a string of purse floats lashed to the headline instead of the big polyform floats. This proved very successful and as long as there was adequate floatation on the wingends the gear seemed to fish well enough. Having tried the French system of fishing, as described earlier, all of the skippers reverted to the Irish rig, as they found it easier to work and also found it gave greater control over the vertical opening of the net as well as the position of the net in the water column. When fish were present it yielded equally good catch rates. This was an unexpected outcome as the French skippers employed to assist with the trials in year 1 were very sceptical of the Irish rig.

As with any form of pair trawling it is essential that both vessels are pulling equally, and it was agreed by the skippers involved that it would be beneficial to fit warp tensions meters in order to maintain even towing. Alternatively, as several of the pairs did, the towing power of the vessels can be easily matched by attaching a long length of warp between the sterns of the vessels and the two vessels then pull apart in opposite directions. One vessel then increases or decreases revs until both boats are stationary. This exercise is repeated at different towing revs in order to establish optimums for both vessels.

The use of the extra plaited Polyethylene rope (Karat rope) bridles between the 12 fathom combination bridles and the warp proved relatively successful at certain times. As stated earlier it was felt these bridles helped to herd tuna into the net, while allowing the vessels to shoot more warp and increase boat separation and so increasing the overall area being covered. This increased distance between the vessels also meant a reduction in the noise and turbulence generated by the two vessels going back towards the net, which may potentially frighten tuna schools.

All of the skippers experienced difficulties using their existing headline transducers due to the fact that the nets were being towed on the surface and the pressure on the transducer cable was almost doubled compared with fishing pair pelagic trawls for herring. Also the cable tended to foul on the floats on the headline and subsequently chafe through. One solution to this was described by French skipper Jean Michel Carrere of the mfv “Armor” who covers part of the cable with flexible hose or rope to reduce wear and tear on the cable itself. It was also suggested that the Scanmar cableless net monitoring system would be a better option, although this was only partially tested during the trials.

One of the major problems found during year 1, was the location of tuna shoals and the signs to look for. The sea area involved is vast and it became apparent that it is vital to have information available on the location of fish from other vessels, particularly from the French pelagic fleet. Other indications such as catching fish during the day on the lines, from the limited sea surface temperature data collected from the vessel’s own equipment and bird or sea mammal activity were also useful but often mis-leading. On a number of occasions vessels either saw large numbers of tuna feeding on the surface or caught fish on the lines but on shooting that evening in the same area caught very little fish in the trawl.

The remote sensing data was a further source of information for fish location in year 2 and is discussed later in the section.

Linked to the problems of fish location, was that of fish detection. The French report that Albacore mark like circumflex accents with emphasis on one side (^), although they rarely would expect to observe tuna marks until it is completely dark. Many of the skippers reported seeing marks on their echosounders and sonars that they thought were tuna and these sometimes corresponded to reasonable catches, but a better understanding of the marks to look for is still required. This was highlighted most during year 1 of the trials, when at certain times the French boats caught tuna at depths of between 20-25 fathoms below the surface, having identified good marks of fish at these depths. The Irish vessels fishing with the French boats at this time also saw these marks but did not realise they were tuna, and consequently continued to fish on the surface with the result they caught next to no fish. During year 2 the skippers became more adept at looking for tuna marks, which were described as typically being dense red with lighter patches of orange or yellow in a "tadpole" or boomerang shape. The lower frequencies ~ 50kHz tended to be the best for detection. Tuna entering the mouth of nets were often seen on the netsounder swimming upwards to the top sheet of the trawl and then turning and diving towards the footrope. It is for this reason that it is important for vessels to have sufficient horsepower to increase towing speed if fish are marked in the mouth of the net. As the trials progressed a number of the skippers also began to use their sonar to detect shoals of fish and help them to manoeuvre and stay on these marks whilst towing.

Following discussions with the French representatives at the December 1998 workshop it was agreed that some consideration should be given to carrying out trial tows at deeper depths during the day, when it is thought large Albacore tend to shoal. Therefore different vessels tried towing during the day but apart from a couple of swordfish and solitary tuna these trial tows proved unsuccessful. As these tows were largely "blind", for one trip at the start of September 1999 a Simrad "EK 500" scientific echosounder interfaced to a PC running version 5.3 of the Simrad "EP500" echo processing software was fitted on board the "Eilean Croine"[9]. The objective was to create a library of echo traces that would depict the characteristic form associated with shoals of tuna, and also to collect acoustic data prior to and during fishing to locate the depth ranges over which tuna are thought to be found at different times of the day. The full report of this work is given in Appendix **--** . The results of these trials were inconclusive as it was found difficult to distinguish tuna marks and impossible to determine at what point along the tow the fish were caught. During the day marks were observed between 50 and 200m on the EK-500 but they were not felt sufficiently heavy for the vessels to shoot.

Based on the results of year 1 and 2, some incidental catches of cetaceans in this fishery, as with most other pelagic fisheries, would seem inevitable, and zero-fishing mortality would seem unlikely. This is backed up by the findings of the EU funded CETASEL study, which looked at the prevention of

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[9] Breslin J.J. Experimental Tuna Acoustic Survey Report November 1999. Marine Institute Report, 15pp.

cetacean by-catches in pelagic trawls [10]. From all available evidence obtained it would appear that the majority of cetacean by-catches in pelagic trawls are isolated incidents, when relatively large numbers can be captured. With increasing experience in the tuna fishery and by observing a number of simple fishing practices as outlined in the CETASEL report it is firmly believed these by-catches will be reduced to negligible levels. Such practices include only having running lights showing whilst towing; shooting the trawl earlier or later to avoid the period 1 hour either side of dusk, when cetaceans are actively feeding; avoiding towing in areas where cetaceans are seen during the day or alternatively submerging the headline to a depth of at least 20 metres; and shooting and hauling as quickly as possible. All of the pairs involved in the trials were strongly urged to follow these guidelines. It is also interesting to note that analysis of the catch data indicated that cetacean by-catch was strongly influenced by the depth of water during the tow. If the vessels stayed outside the 500m depth contour cetacean by-catch was negligible.

During the course of year 2 discussions were held with acoustic experts in Loughborough University, who participated in the CETACEL project into the possibility of developing a practical underwater acoustic alarm system to reduce cetacean by-catch further. This alarm system would be used to deter cetaceans from entering the mouth of nets during periods when their capture is believed to be at highest risk. From work carried out as part of the CETASEL project these risk periods appear to relate to net geometry changes which can occur during course changing manoeuvres and when hauling the trawl. It was suggested that to “clear the net” of dolphins prior to any manoeuvre which might cause net geometry changes would require an underwater sound source that can transmit suitable “aversive” acoustic signals at sufficient source level to create an exclusion zone in the front end of a trawl. Such proposed deterrent devices are similar to the devices being successfully deployed on gillnets in different fisheries to reduce by-catches of Harbour Porpoises. It is planned to look further into this deterrent idea during the year 2000 tuna season, subject to funding being made available.

While not as big a problem in year 2, the weather still remains a limiting factor in the pair pelagic fishery, particularly off the south-west coast of Ireland. Heavy swell conditions which can form quickly in this area can result in serious trawl damage, as tremendous strain is put on the headline which is rigged tighter than the footrope. This is partly the reason why the French trawls are mounted on stainless steel wire. Many of the skippers found during the trials that it was unwise to shoot the gear in poor conditions and given that the fishing is restricted to night time only, this resulted in considerable loss of fishing time. The full moon also would appear to have a significant influence on the pair pelagic fishery. During the trials in year 2 this was particularly evident in the Bay of Biscay, when around the full moon the two Irish pairs remained fishing and caught very little, whereas the French fleet tied up until the moon had diminished in strength. Off the south-west coast the moon does not seem to have the same influence, probably because there is more cloud cover and the moon is not as bright. Again this is evidenced from the trials by the fact that two pairs fishing in this area during the full moon continued to have decent catches, when cloud cover was heavy. This lunar influence can be explained by the fact

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[10] Amundin M., De Haan D., Dremière P.Y., Hansen K., Kastelein R.A. and Woodward B., 1997. “Prevention of by-catch of small cetaceans in pelagic trawls by technical means (Project CETASEL)”. Proc. Int. Council for the Exploration of the Seas

that all bait species are diurnal by nature, staying deep during daylight and rising to the shallower water as the light diminishes. Light from the moon penetrates the water and influences the depth and density of the bait – the so-called "scattering" layer. The effect builds up from the first quarter and trials off in the last, because the quarter moon phases peak in the sky during low light periods of sunrise and sunset. Reflected moonlight creates a ceiling above which bait will not rise and around which it concentrates. During the full moon this period can be very deep and hence the tuna will remain at deeper depths [11].

During both year 1 and year 2, it was found that the length of tow, usually 4-4½hours, and catch size largely determined the quality of the fish. Quality varied considerably from tow-to-tow with some Albacore reaching the deck alive and therefore just caught, with others having been in the trawl for a long time showing significant scale loss, soft skin and often with tail and pectoral fins broken or missing. This phenomenon was particularly noticeable with larger bulk catches of over 1 tonne (approximately 300 fish), when damaged fish at times made up 20-25% of the total catch by number. The presence of swordfish in the catch also reduced quality as they tended to leave stab wounds in many of the tuna. It had been intended in the second year of trials to use codend catch sensors to better regulate catch size but time restrictions meant this was not tested properly. Anecdotal evidence from two of the Scottish skippers who participated in the fishery during September suggested that codend sensors were a very good idea, as on two occasions they had big hauls (over 10 tonnes) when the sensors went "fired" after only a short period of time towing. If they had not had the sensors fitted they would have almost certainly continued towing resulting in a lot of damaged fish, if not the loss of the codend altogether. Many French fishermen have reported losing very big catches of tuna at times and also having to dump high proportions of tuna from large catches due to poor quality caused by the fish being in the net too long before being brought aboard.

Also related to fish quality, it was found during the trials that it is very important that vessels have their fish hold laid out for shelving or alternatively use insulated fish bins. On advice from the French skippers, all fish were iced belly up with no more than 2 layers to every shelf. It was found important that all parts of the body surface should be iced to avoid ice pockets forming. The general rule advised was a tonne of ice to a tonne of tuna.

During year 1 and to a greater extent in year 2 another issue that arose was competition for space between the different métiers participating in the fishery. On several occasions, particularly off the south-west coast of Ireland pelagic trawlers fouled driftnet gear, resulting in severe gear damage. Until driftnets are phased out this will remain a problem for pair pelagic vessels particularly as tuna tend to congregate in small discrete areas, which both types of vessels are trying to target. From time-to-time difficulties were also encountered with Spanish hake longline vessels, which shot long lengths of gear in the vicinity of the tuna grounds. On some occasions in the Bay of Biscay there were over 20 pairs of French and Irish vessels fishing in the same general area. This again led to difficulties, although most

Conf, Baltimore, USA.

[11] Flanagan W. and Gaw E.R., 1998. "By the light of the moon". World Fishing, April 1998.Page 15.

of the Irish vessels had experienced this type of congestion before in the Celtic Sea herring fisheries, and where able to work without any undue problems.

MECHANISED TROLLING

The American mechanised systems installed on the three vessels worked well, and could be fished by a crew of four, compared to the Spanish line boats which work crews of 10 men or more and have 13-15 individual line haulers. One slight criticism, though, found with the system employed, particularly in the second year was that many big fish were lost due to the stretch limits of the rubber shock absorbers being exceeded. This was an unexpected problem caused by the fact that the fish encountered off the south-west coast were much larger than the size run of fish targeted with this style of gear off the American coast. The Spanish do not use shock absorbers, leaving their haulers in free-spool when fishing, so that when a fish takes the lure the line runs out freely until the clutch is engaged. For bigger fish this would seem preferable.

As learned on a trip to Spain it is important that the vessel's have clean hulls and are well anti-fouled with a dark colour and are not excessively noisy due to damaged propeller blades, loose and noisy propeller shafts or rudder stocks. Judging from the results it is also felt that the presence of Kort nozzle reduces catches, as the “Les Marquis”, which has a nozzle fitted caught consistently less fish than the other vessels. The skipper of this vessel reported, however, on his last trip if he constantly kept turning the vessel so that the lines stayed out of the wake catch rates increased dramatically. Generally, though, it is felt vital that Irish fishermen wishing to participate in this fishery, take more care to reduce the noise of their vessels by routinely checking for all potential noise sources before the start of the tuna season.

Up to 14 lines were usually deployed, although this was reduced to 11 when there was a big swell or strong cross winds, as the lines tended to tangle. The Spanish overcome this by weighting the outside lines on the tangons, and when one of the vessels tried this the results were much more satisfactory, both in terms of catch rates and reduced tangling. Dawn and dusk appeared to be the best times of the day at the start of the season, although later in September when the days were usually duller fishing picked up. As mentioned previously very bright, calm days or heavy swell conditions resulted in poor catches. It was found vitally important for the vessel to do a lot of manoeuvring when coming on fish, as witnessed by the movements of the Spanish trollers working alongside. These vessels seem particularly adept at staying with fish, and this technique is one that Irish skippers will only learn through time and experience.

Purple/black and green/yellow squid proved to be the most effective lure colours. Later in the trials it was found by adding a strip of yellow or red bunting, as used by the Spanish boats these lures worked even better. The smaller coloured feather lures caught very few fish on any of the boats and anecdotal evidence suggests these lures only work well in the Bay of Biscay on smaller tuna. The crews of the vessels felt that the barbless hooks used exclusively in year 1 were not as efficient as the barbed hooks obtained for the year 2 trials, as they lost a number of fish when the hooks pulled out. It is interesting to note the majority of the Spanish boats use small barbed hooks. It was found during year 2 that on occasions when towing at 5¼knots or more the fish were badly hooked. On easing back, however, tuna caught tended to be hooked firmly in the bottom jaw and sometimes even swallowed the hook. At times it was found advantageous to set some of the lures deeper, and this was achieved again by easing back on the towing revs.

Good preparation of the gear and continued maintenance whilst fishing was found to be vital. In particular checking monfilament traces for kinks and replacing when damaged; checking all crimps are neat and renewing suspected weak links; replacing rusty or bent hooks; regularly cleaning both mainline and traces off seaweed, which make them visible to tuna; checking mainlines for damage or weak spots; checking rubber shock absorbers are set at their extremes; varying lures to match ambient conditions. In this respect it is felt vital that any boat participating in this fishery should appoint one crewman to be responsible for the gear and ensure everything is regularly checked.

One problem that arose, perhaps unexpectedly was the numerous encounters with seabirds, particularly juvenile gannets. These birds tended to foul the lines or dive at the lures, meaning that the crew had to constantly haul back the gear and untangle them. This problem, however, wasted a considerable amount of fishing time and also caused damage to the monofilament traces. The only conceivable solution to this problem is to sink the lures.

As with the pair pelagic trials, difficulties were encountered with fish detection and fish location. The remote sensing technology employed provided some information on a regular basis to assist the trolling boats, but again as with the pelagic trials cloud cover restricted the amount of data obtained. It is apparent from these trials that it is vitally important all vessels work together and communicate with one another in order to stay on fish. Again this was apparent from the Spanish fleet who worked as a unit rather than as lone operators, constantly relaying information to each other. Similar to the pelagic trials, during year 2 the trolling skippers became more adept at detecting tuna. The vessels found that if they marked fish at depths of 10-20 fathoms they tended to catch tuna. It is interesting to note that all of the Spanish line vessels have sonar on board to detect fish ahead of the vessel within a 120m radius either side and thus be able to turn quickly towards potential shoals. None of the trials vessels had sonar fitted and it is recommended that vessels wishing to participate in the fishery in the future should strongly consider fitting sonar to aid tuna detection.

All of the fish caught using this method, were of the highest quality. The fish once brought aboard were immediately bled by making a deep cut on the underside of the head between the gills. This punctures the main artery from the heart. The fish were then hosed down with the deckhouse to wash away the blood and also to cool the fish down. If possible fish were swung aboard without gaffing. Larger fish were gaffed in the head, never in the body. Some Spanish vessels tail larger fish rather than gaff them. As with the pelagic vessels it is strongly advised that trolling vessels are laid out for shelving or use insulated fish bins to maintain quality.

None of the fish were landed gutted in years 1 or 2, although it is known most French boats land their line caught fish gutted for the fresh market. Many of the Spanish boats put each individual tuna in transparent plastic bags, which helps to prevent ice burn, and also mark each fish with a green plastic ribbon tied around the tail to distinguish these tuna as line caught.

One final suggestion that was made by several of the skippers that it would be worthwhile to identify options for the vessels during darkness and also during periods of bad weather, when catch rates drop back. One option would be to work short floating longlines for blue and porbaeagle shark with a by-catch of swordfish and Bluefin tuna. This gear would be easy to install and would not impinge on the trolling gear.

Surface Longlining

As reported earlier the results from these trials were very poor, despite considerable experimentation. Trials by IFREMER over a two year period gave similar disappointing results. IFREMER's initial trials in 1998[12] illustrated a number of alterations to fishing practices to be looked at during 1999, including shooting gear at deeper depths and shooting the gear during daylight hours. Both of these options were tried in 1999 in these trials and by IFREMER but again results were poor. These findings would suggest that this type of gear is not a viable alternative to driftnetting for Albacore in the N.E Atlantic, except as a by-catch to longline fisheries for larger tuna and swordfish. This is borne out by ICCAT[13] who report that many countries that traditionally fished for Albacore with longlines in recent years have tended to target higher value bigeye, yellowfin and Bluefin tuna, with only a small by-catch of adult Albacore. Also the Albacore catch in the North Atlantic of the large Chinese Taipei fleet of longliners has declined by 80% since 1976 from 15,000 tonnes to less than 3,000 tonnes in 1998, suggesting either that this fishery is in a decline or is not economically viable at current catch levels if targeting Albacore tuna.

There are reports, however, of a French fishermen from St. Jean de Luz who had good catches with surface longlines in the south of the Bay of Biscay during the 1999 season. He is supposed to have achieved catch rates of 30/40 fish per 200 hooks, with the only differences between his gear and that worked in these and the other French trials was that the branch lines were much finer, the brine frozen sardine baits much smaller (50/kg) and the hooks set nearer the surface. He also tended to fish in much deeper water > 1500m to avoid catches of blue shark. (Alan Glanville, pers. comm.). Whether this warrants further trials in 2000 is open to question, because these catch rates at current prices for Albacore would barely make this a viable method, unless there was a significant by-catch of other species. This is not an option, though, for Irish vessels at present due to current EU quota restrictions for Bluefin tuna and Swordfish[14].

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[12] Morandeau F. 1998. Campagne germon effectuée à bord au "Teddy" navire de l'Ile d'Yeu, du 23.09 au 15.10.1998. Programme: CEE no. 98/09 reconversion filer maillant dérivant. Décembre 1998 – R.INT.DITI/GO/TP 98-23.

[13] ICCAT, 1999. Report of the Standing Committee on Research and Statistics (SCRS). Albacore 1999 SCRS Report. Madrid, Spain – October 11 to 15, 1999.

[14] Council Regulation (EC) No. 2742/1999 of 17 December 1999 fixing for 2000 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where limitations in catch are required and amending Regulation (EC) No 66/98 Annex F.

BIOLOGICAL RESULTS

Pelagic fish, like Albacore tuna, tend to have highly aggregated distributions caused by environmental differences and gradients, and as fishermen become more experienced catches may increase significantly. This would seem to be the case in the trials with the pair pelagic trawls as there was an overall increase in maximum CPUE from 238 Albacore/Hour in 1998 to 356 Albacore/ Hour in 1999, while the number of blank hauls i.e. hauls where less than 5 Albacore were caught, was reduced in 1999 compared to 1998 from 68% to 44%. Even accounting for the fact that 1998 was a poor year for pelagic trawling for Albacore this still would suggest improvement in catch rates linked to increased fishing performance. It would still seem, however, that catches from pair pelagic trawls are highly sporadic and whilst no figures are available the indications are that the CPUE for pelagic trawls remains well below the CPUE attained in the driftnet fishery.

The main commercial species encountered were Bluefin tuna and Swordfish. Bluefin tuna were present in 9% and 15% of the tows in 1998 and 1999 respectively. Very few Albacore were caught in tows with Bluefin tuna suggesting that both species may aggregate at different environmental gradients. The catch data from the vessels fishing in the Bay of Biscay would suggest higher catches of Bluefin in this area, particularly at the start of August. Both the French pair pelagic fleet and the Spanish Pole and Line vessels have been reported to make significant landings of small Bluefin from the South of Biscay annually.

Swordfish were commonly caught by the pair pelagic vessels, and were recorded in 60% of the tows in 1998 and 38% of tows in 1999. The numbers caught were low usually amounting to 1 or 2 individual fish. Unlike Bluefin, Swordfish were often caught in tows together with large numbers of Albacore suggesting the two species may have similar spatial distributions. The majority of swordfish tended to be caught in the areas fished off the South-west coast of Ireland and as the season progressed, catches of swordfish were more common. The size of fish caught, also seemed to increase through the season, and with the majority caught in late September being large individuals over 150cm in length.

The problem of cetacean by-catch and the possible solutions to reduce the level of incidental catches has already been discussed. Statistical analysis of the data shows a strong correlation between depth of water and by-catch levels, in that catches of cetaceans are low when fishing depth exceeds 500 metres. Further analysis of the data also shows that cetacean catches are much lower in the Bay of Biscay, where the most productive areas for Albacore tend to be off the edge of the Continental Shelf in depths of 2000 metres or more. The catch data would also suggest, to some degree, that if cetaceans are caught the area will not yield large catches of Albacore, and hence vessels should avoid areas where there is high cetacean activity.

Of the non-commercial by-catch species caught, Sunfish were the most common. They were always caught singly or pairs suggesting they have a wide spread distribution in low numbers. Other non-commercial, by-catch species occurred in less than 3% of hauls and no conclusions can be drawn about their distributions.

MULTIFAN computer program fixing the growth parameters was used in 1998 and 1999 to estimate the age structure of the exploited stock. During 1998 the length frequencies of tuna caught off the South-west coast using both pelagic trawls and driftnets were very similar, with both fisheries mainly exploiting 2-year-old Albacore, around 60-65cm in length. The pelagic trawl catches, however, contained more 4, 5 and 6 year old fish, 80cm+ in length, than the driftnet catches. This may be because the pelagic trawls catch fish deeper than driftnets and also as a result of the average mesh size of 180 – 190mm being used in the driftnet fishery being too small to catch the larger Albacore.

The length frequency data for 1999 for the pair pelagic trials when split into catches for the Bay of Biscay and for the South-west coast, show a very different age composition of Albacore between the two areas. Fish caught in Biscay were predominantly 1 and 2 year old tuna, compared to the 3, 4 and 5 year old fish caught off the South-west coast. As the season progressed the size of Albacore caught, particularly in the areas to the South-west, increased and towards the end of September catches were made up of smaller numbers of large > 90cm, equating to approximately 5 or 6 year old Albacore. As with 1998 the driftnet fleet tended to catch predominantly 2 and 3 year old fish of around 60-65cm and 70-75cm in length. The size of fish caught during the season remained fairly constant, unlike the catches from the pair pelagic trawls.

As maturation in Northern Albacore is thought to be at 90cm/age 5 years it is clear that both methods catch predominantly immature fish. The catch at age statistics reported by the SCRS 1998 show that the vast majority (93% in 1997) of Albacore caught in the North Atlantic are under 3 years of age. However, given that the pair pelagic fishery off the South-west coast tends to target larger fish as the tuna season progresses and that driftnetting is banned at the end of 2001, recruitment over-fishing will be reduced in the future. From a stock management perspective this is highly desirable given that concerns have been expressed in recent years by ICCAT as to the state of the Northern Albacore tuna stock. In contrast the stock in the Bay of Biscay seems to be largely made up of 1 and 2 year old Albacore. This is applicable not only to the pair pelagic fishery but also to the trolling, driftnet and Pole-and-Line fisheries.

The data for the trolled caught Albacore shows a similar length frequency distribution to the driftnet data, with the catches made up predominantly of 2 and 3 year old fish, although 4% of the measured Albacore were larger 4 year old fish compared to only 1% of the measured driftnet tuna. As with the pair pelagic trials, the size of fish caught increased as the season progressed.

The by-catch of seabirds would appear a problem in the troll fishery for Albacore. While the number caught i.e 23 individuals is small, when this is multiplied across the fleet of around 480 Spanish trolling vessels, working both off the South-west coast and in the Bay of Biscay, the potential impact on seabird populations is considered significant. Further work is required to determine fully the actual level of by-catch and to assess whether this does have a detrimental effect on seabird populations.

REMOTE SENSING TECHNOLOGY

As figure 34 indicates, there are three regions where catch is expected to be influence by the presence of fronts. Catch was particularly high in the northern area of Box 1 in 1999. In all three labelled Boxes on the diagram, transient fronts are the main type of front that will be encountered. Fronts should be tracked in this region by differences in sea-surface temperature (on-board recorders or remote sensing data), and the longer the life of the front the greater the chance of it attracting tuna.

Features near the Goban Spur (bottom of Box 1) and Boxes 2 & 3 were basically unfished during the tuna trials. It is expected that transient fronts in these areas will be a useful area for fishing, but this suggestion remains untested.

There are three regions where catch is expected to be lower than average. The Porcupine Bank Taylor column is a strong sub-surface front, but is generally beyond the geographic range of the majority of the tuna population. Further, as this front does not have a large temperature difference during the fishing season, tuna are unlikely to be concentrated near this front. This is supported by the results from the trials.

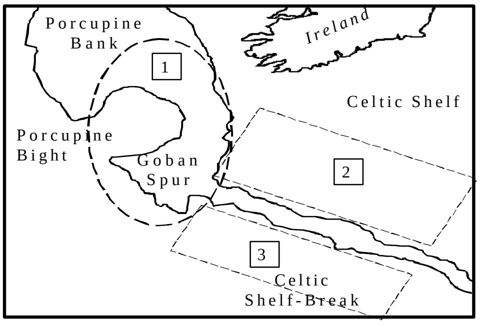

Figure 34 Locations where fishing near fronts is likely to be most useful. The numbered areas represent locations where transient fronts are common. See text for full explanation.

The Celtic Shelf-Break front typifies the type of front preferred by tuna (cold productive water in the Shelf-Break and warm unproductive water outside of the Shelf-Break). This is an unusual area in that phytoplankton production can be dominated by coccolithophorids, a highly reflective algae that makes the water extremely turbid which can be seen by eye, as the water takes on a milky appearance. Albacore tuna migrate along these fronts from the Bay of Biscay to the Porcupine Bight region in the spring, and return along it in the autumn. As this is a migration route but not a specific feeding or breeding area, it was not expected that tuna would aggregate within the fronts themselves. This is supported by the tuna trial data, as no (zero) Albacore tuna were caught in the vicinity of the shelf-break fronts despite some intensive effort. However, transient fronts periodically align themselves perpendicularly to the shelf-break fronts. In these instances, where the transient front meets the shelf-break front, it is expected that tuna may temporarily accumulate at these junctures, and may be a highly efficient location for fishing (although no data is currently available to test this suggestion). As historical data suggests this is a good location for fishing for many species of fish (Le Fevre 1986), so fishing on the warm sides of the fronts may yet be shown to be a highly productive area for tuna catch.

The upwelling and salinity fronts along the Cork/Kerry coast are probably too far outside of the temperature range and migration range of the tuna to be of much use. Anecdotal evidence from one fisherman claimed that Spanish fishermen were catching large numbers of tuna against these fronts early in 1999, but his claims are unsubstantiated at the present time and so these particular fronts are unlikely to be useful based on the current data available for Albacore tuna.

5. ECONOMIC ASSESSMENT

Three types of data were collected and analysed in order to assess the economic success of the trials: Expenses, Landings and Prices. Questionnaires on expenses were issued to each of the fishermen involved in the trials. Seven of the pair pelagic vessels and all three of the trolling vessels replied. Each vessel provided a breakdown of expenses per fishing trip under the following categories: Insurance, Diesel and Oil, Repayments, Ice, Food, Shares/Wages, Miscellaneous. Landing Figures and Prices were obtained from fishermen's sales dockets. The expenses data formed the basis of projected economic scenarios, which examine the required quantities of fish to be caught at various prices, in order to breakeven.

RESULTS

EXPENSES

The following Table shows the average daily expenses for pair pelagic and trolling vessels.

Table 13. Average Expenses Per Day

Fishing Method	Vessel Size (m)	Number of vessels	Expenses	95% CI (IR£)
Pair Pelagic	>24	3	1,294	255
Pair Pelagic	20 - 24	4	1,077	116
Trolling		3	867	51

LANDINGS & PRICES - PAIR TRAWLING

Detailed landings per trip were obtained from sales dockets. A total of 165.8 tonnes were landed by the 4 pairs with a value of IR£211,067. Prices for Albacore ranged from IR£0.80 **-** IR£1.50 per kg with an average price of IR£1.15.

LANDINGS & PRICES - TROLLING

The trolling landings are outlined in Appendix V. The 3 trolling vessels landed a total of 10.65 tonnes valued at IR£20,850. The prices obtained for the line caught fish ranged from IR£1.50 **-** IR£3.00 per kg with an average price of IR£2.00.

PROFITS

The breakdown of profit/loss for each pair of pelagic trawling vessels and each of the trolling vessels is outlined in Tables 14 a & b.

TABLE 14(A). BREAKDOWN OF PAIR PELAGIC REVENUE AND EXPENSES (IR£)

Pair Pelagic	From	To	Revenue	Expenses	Profit
Menhaden & Seaspray	09/08/99	14/08/99	9,978	18,116	-8,138
	17/08/99	23/08/99	11,005	18,116	-7,111
	25/08/99	03/09/99	16,300	25,880	-9,580
	05/09/99	09/09/99	2,677	12,940	-10,263
	11/09/99	18/09/99	4,599	20,704	-16,105
	20/09/99	22/09/99	11,780	7,764	4,016
Albatross & Karen Rose	09/08/99	14/08/99	12,844	15,528	-2,684
	15/08/99	18/08/99	66	10,352	-10,286
	19/08/99	26/08/99	7,159	20,704	-13,545
	28/08/99	04/09/99	13,272	20,704	-7,432
	05/09/99	09/09/99	2,069	12,940	-10,871
	13/09/99	17/09/99	7,889	12,940	-5,051
	19/09/99	23/09/99	8,148	10,352	-2,204
Solan & Delinn	09/08/99	15/08/99	11,233	18,116	-6,884
	19/08/99	26/08/99	2,323	20,704	-18,381
	29/08/99	05/09/99	9,058	20,704	-11,646
	06/09/99	12/09/99	18,199	18,116	83
	14/09/99	23/09/99	851	25,880	-25,029
Eilean Croine & Ocean Reaper	16/08/99	23/08/99	12,686	20,704	-8,018
	24/08/99	31/08/99	15,190	20,704	-5,514
	01/09/99	08/09/99	14,508	20,704	-6,196
	10/09/99	18/09/99	12,296	20,704	-8,408
	19/09/99	26/09/99	6,938	20,704	-13,766

TABLE 14(B). BREAKDOWN OF TROLLING REVENUE AND EXPENSES (IR£)

Trolling	From	To	Revenue	Expenses	Profit
Les Marquises	12/07/99	17/07/99	779	5,202	-4,424
	22/07/99	28/07/99	463	6,069	-5,606
	03/08/99	07/08/99	217	4,335	-4,118
	09/08/99	12/08/99	815	3,468	-2,654
	16/08/99	21/08/99	0	5,202	-5,202
	23/08/99	28/08/99	0	5,202	-5,202
	30/08/99	04/09/99	454	5,202	-4,748
Warren lock	11/07/99	17/07/99	3,096	5,202	-2,106
	22/07/99	27/07/99	693	5,202	-4,509
	04/08/99	12/08/99	4,714	7,803	-3,089
	15/08/99	25/08/99	1,750	9,537	-7,788
	30/08/99	06/09/99	787	6,936	-6,149
Noz Dei	19/08/99	15/08/99	2,662	6,069	-3,407
	16/08/99	24/08/99	0	7,803	-7,803
	30/08/99	08/09/99	2,022	8,670	-6,648
	11/09/99	17/09/99	168	6,069	-5,901
	20/09/99	26/09/99	2,232	6,069	-3,837

PRICE SCENARIOS

In the future, Irish vessels considering trawling or trolling for tuna may require information on the quantities of fish needed to be caught in order to cover their expenses.

Vessel Type	IR£
Pair Pelagic >24m	1,618
Pair Pelagic >20<24m	1,346
Trollers	1,084

Using the Expenses data from the Tuna Trials in 1999, it is possible to project the required quantities of tuna to be landed in order to breakeven.

The daily expenses figures presented in Table 13 can be adjusted to account for days spent travelling to and from the fishing grounds. For example, a typical fishing trip by an Irish vessel would involve 8 days fishing and 2 days steaming. In such a scenario a vessel would effectively need to catch 10 days fish in 8 days to cover it's average daily expenses. Therefore the original figures can be multiplied by 10/8.

The adjusted daily figures are shown in Table 15 (a-d). Based on these adjusted figures, the following breakeven scenarios can be projected. A vessel > 24m needs to land 1,348 kg of Albacore per day on a 10 day fishing trip at a price of IR£1.20 or 1079/kg at a price of IR£1.50 per kg etc. in order to breakeven.

Table 15(a). Daily Breakeven points for Pair Pelagic vessels >24m

Price (IR£/kg)	1.20	1.50	2.00	2.50
Albacore (kg)	1,348	1,079	809	647
No. of fish (5 kg)	270	216	162	129

Table 15(b). Daily Breakeven points for Pair Pelagic vessels >20<24m

Price (IR£/kg)	1.20	1.50	2.00	2.50
Albacore (kg)	1122	897	673	538
No. of fish (5 kg)	224	179	135	108

Table 15(c). Daily Breakeven points for Trolling vessels

Price (IR£/kg)	2.00	2.50	3.00	3.50
Albacore (kg)	542	434	361	310
No. of fish (5 kg)	108	87	72	62

Table 15(d). Breakeven points (kg of Albacore) per vessel per 10 day fishing trip (8 days fishing)

IR£/kg	1.20	1.50	2.00	2.50	3.00	3.50
>24m	10,784	8,624	6,472	5,178	--	--
>20<24m	8,973	7,178	5,384	4,307	--	--
Trollers	--	--	4,336	3,469	2,888	2,480

A vessel between 20 and 24m will need to catch 1122 kg of Albacore at a price of IR£1.20 or 897 kgs at a price of IR£1.50 per kg. Catches of 1½- 2 tonnes per night were consistently made by some of the Irish vessels operating in 1999. Through improved marketing of Irish caught Albacore tuna, a lower price threshold of around IR£1.50 per kg should be attainable. Irish pair trawlers should then be in an excellent position to profit from the Albacore fishery.

The highest daily catch rate attained by any of the Irish trollers over the course of a trip was 258 kg (1548 kg for 6 days), although daily catch rates of over 300kg were attained on a number occasions. From the projections in Table 15(c) it is evident that a significant improvement in landings and/or prices up to a level of 400kg is required if Irish vessels are to be successful in this fishery.

Although a loss was apparent for most of the fishing trips a number of factors affected the performance of the Irish vessels.

At the end of July, 15 pairs of vessels from La Turballe opened the Pair Pelagic season with more than 700 tons of Albacore caught in less than a week. The fish were caught in the "Fer á Cheval" area in the southern Bay of Biscay and were landed in the Basque Country and La Turballe[15]. The excellent landings continued for another 2 weeks with reports of some French vessels landing in excess of 100 tonnes during this period (pers. comm. Marcel Le Gac, Jean Michel Carrere (French Skippers)). The first Irish vessels arrived in the area in the middle of August and failed to avail of this early fishing bonanza, and when the Irish vessels did arrive they tended to fish through the full moon when landings were consistently poor, as opposed to the French fleet that coordinated their landings to coincide with this event. Nonetheless after the full moon at the end of August, Irish pairs continued to fish in this area alongside the French fleet, and while catches were not as spectacular the Irish boats competed very favourably.

As with any other type of fishery there is a learning curve associated with the Irish pair pelagic and trolling fisheries. As reported pair pelagic trawling began in France with IFREMER trials in 1987. Landings from pair trawling were only 1,100 tonnes for approximately 20 pairs of vessels in 1993. Therefore, each pair landed an average of 52 tonnes for the season, 5 years after the first trials had taken place. In 1999, 4 pairs of Irish vessels landed an average of 41 tonnes of tuna for the season only a year after the first trials began. Comparisons between the growth of the Irish and the French pair pelagic fisheries, would thus seem to be encouraging from an Irish perspective

The learning curve must be considerably steeper in a selective fishery such as trolling for tuna where fishing methods such as choice of lure, detection and location of fish are more difficult to learn, while the vessels being encouraged to enter this fishery are very much more weather dependent. Future co-operation with Spanish fishermen and development of a much larger fleet of trolling vessels would seem to be essential. The Spanish have a fleet of around 480 vessels, with up to 50 or 60 vessels working together to locate fish.

[15] Anon, 1999. "Germon: bon début des pélagiques. Ouest-France, 11th Aôut 199.

6. CONCLUSIONS

PAIR PELAGIC TRAWLING

- Satisfactory catch rates in excess of 1½tones per vessel/per night were achieved by Irish vessels both in the Bay of Biscay and off the South-west coast of Ireland. Catch rates, however, are sporadic and this would appear to be a feature of this method of tuna fishing.
- The Irish pelagic rig using two wires is equally effective as the French fork rig method.
- Both French and Irish designed trawls worked effectively at towing speeds in excess of 4 knots. It is important that the size of trawl is matched to the vessel pairing to maintain this towing speed and also so that vessels can increase towing speed if fish are marked in the mouth of the net.
- The use of Dyneema netting allows thinner twines to be used and reduces drag.
- Both PA and PE are suitable for codend construction and a mesh size of 120mm I.M. is recommended to improve fish quality.
- The use of a string of purse floats on the headline of the net is favourable to reduce fouling when shooting the gear compared with the use of big polyform floats as previously tried. It is very important, though to have sufficient floatation on the wings of the net when towing close to the surface.
- It is important that vessels are well matched. This can be achieved through the use of tension meters or carrying out stern-to-stern pulling trials.
- The use of Karat rope bridle extensions between the 12 fathom bridles and the warp can be successful at certain times in allowing the vessels to shoot more warp and increase boat separation. There is also is a reduction in the noise and turbulence going back towards the net.
- There is a problem with using headline transducers as the cable has a tendency to break when the net is being towed on the surface. One solution suggested is to cover the cable or else use cableless systems such as Scanmar.
- Location of tuna shoals remains a major problem. It appears good information from French or Scottish vessels and good co-operation between vessels is vital. Other signs such as temperature fronts, fish caught during the day on lines and sea mammal activity are useful indicators but can be mis-leading.
- Good low frequency echo sounders are essential to mark concentrations of tuna. Sonar is also useful to detect shoals of fish and help vessels to manoeuvre and stay on marks whilst towing. The trials clearly illustrated that if vessels saw no marks then there was little point in shooting.
- Trial tows during the day, at deeper depths proved inconclusive, and further experimentation is required to establish whether viable catch rates can be made at 50-200m during the day.

- Bad weather, particularly off the south-west coast of Ireland remains a limiting factor due to serious trawl damage.
- Tow duration is an important consideration to maintain fish quality, and the use of catch sensors is strongly recommended to keep catch levels at manageable levels.
- Competition for space with different fleet métiers remains a hindrance to the development of this type of tuna fishing, particularly off the south-west coast of Ireland, where a large fleet of French and Irish drift-netters fish. When the driftnet ban comes into effect after 2001 this competition for space will potentially be removed.
- It is very important that vessels participating in this fishery must have their holds laid out for shelving or alternatively use fish bins. To maintain quality tuna fish should be iced belly up with no more than 2 layers of fish to every shelf. All parts of the body surface should be iced to avoid ice pockets forming.

MECHANISED TROLLING

- Significant improvements in landings are required if trolling is to be a viable alternative to driftnets for Irish vessels. At a price level of IR£2.00-IR£2.50 daily catch rates of around 400-500kg are required for the vessels to be viable economically and during the trials the best catch rate obtained was 258kg for 6 days.
- While at times the trials vessels matched the daily catch rates of Spanish vessels, there is still a lot to be learned in terms of choice of lure to match ambient weather conditions. Through trial an error, it was found that the artificial octopus style lures fished best off the south-west coast of Ireland.
- Dawn and dusk appeared to be the best times of the day at the start of the season, although later on in the season when the days were generally duller fishing improved during the day. Very bright days or days with a heavy swell resulted in very poor catches.
- It is vitally important for the vessel to do a lot of manoeuvring when coming on fish, as witnessed by the Spanish vessel working in the same vicinity. It was found during the trials that by varying towing speed, the depth the lures fished at can be altered and this was found particularly useful on bright days when the tuna tended to be deeper.
- It is important for vessel’s to have clean hulls and anti-fouled with a dark red colour. Excessively noisy boats with damaged propellers blades and noisy shafts or rudder stocks make poor trollers. Kort nozzles also seem to reduce catches, although one of the trials vessels fitted with a nozzle found that if he constantly turned the vessel so that the lines stayed out of the wake of the vessel, his catches matched the other vessels.
- As with the pair pelagic trials fish location and detection remains a problems, and it is vital that Irish vessels work together and also try and liase with the large Spanish trolling fleet.

- Based on evidence from the Spanish vessels, the use of sonar to detect fish in front of the vessel while trolling is strongly advised.
- The American style of mechanized trolling equipment used during the trials worked effectively and required a crew of 4, as against the Spanish system which requires 10-12 men. The American system, may lose more big fish though, when the stretch limits of the rubber shock absorbers employed on the lines were exceeded.
- Good preparation of gear and continued maintenance whilst fishing is vital. In this respect it is recommended that one crewman should be appointed to be responsible for the gear and ensure everything is regularly checked.
- A problem arose with seabirds, particularly young gannets fouling the lines or diving at the lures. This meant lines had to be constantly hauled back and repaired and resulted in considerable down time.
- To maintain fish quality all fish caught should be bled immediately after landing. If possible should be swung aboard without gaffing. Larger fish should be gaffed in the head never in the body. Some Spanish vessels tail larger fish rather than gaff them.
- The benefit of landing fish gutted for the fresh market, while not tried during these trials, should be considered in the future, as there would seem to be a very lucrative market for fresh, gutted Albacore in France. With promotion there would appear to be potential for development of a home market for this product.
- It is considered worthwhile to identify options for the trolling vessels during darkness and also during periods of bad weather, when catch rates drop back. One option would to be work surface longlines for blue and porbeagle shark.

SURFACE LONGLINING

- Based on the results from the trials carried out in year 2, it is felt that this type of gear is not a viable alternative to driftnetting for Albacore. This is evidenced by the results from similar trials carried out by IFREMER over a two year period.
- There are reports of a French fisherman in the Bay of Biscay having reasonable catches of Albacore on very light longlines during the 1999 season, but at the current price levels the reported catch levels would barely make this economically viable.

BIOLOGICAL RESULTS

- Maximum CPUE for Albacore catches with pair pelagic trawls increased from 238 Albacore/Hour in 1998 to 356 Albacore/Hour in 1999, while the number of blank hauls i.e hauls were less than 5 Albacore were caught, reduced in 1999 compared to 1998 from 68% to 44%. This suggests improvement in catch rates linked to increased fishing performance.

- The main commercial species encountered as a by-catch were Bluefin tuna and Swordfish. Very few Albacore were caught in tows with Bluefin tuna suggesting both species may aggregate at different environmental gradients, where as Swordfish were often caught in tows with large numbers of Albacore suggesting these two species may have similar spatial distributions.
- Statistical analysis of the cetacean by-catch data suggests a strong correlation between depth of water and incidental catch levels, in that catches of cetaceans are low when fishing depth exceeds 500 metres. The data also indicates that if cetaceans are caught the area will not yield large ctaches of Albacore, and hence vessels should avoid areas where there is high cetacean activity.
- Multifan computer program fixing the growth parameters was used in 1998 and 1999 to estimate the age structure of the exploited stock. During 1998 the length frequency of Albacore caught off the South-west coast of Ireland using both pair pelagic trawls and driftnets were very similar, with both fisheries mainly catching 2-year old Albacore. The pelagic trawl catches, however, contained more 4,5 and 6 year old fish. This is probably due to differences in the gears and their respective fishing operation.
- Length frequency data for 1999 for the pair pelagic trials when split into catches for the Bay of Biscay and for the South-west coast, show a very different age composition of Albacore. Fish caught in the Bay of Biscay were predominantly 1 and 2 year old tuna, compared to the 3,4 and 5 year old fish caught off the South-west coast. As the season progressed in the fishery off the South-west coast, the size of Albacore caught increased with the catches towards the end of the season made up of small numbers of 5 and 6 year old fish. The driftnet fleet in 1999 tended to catch 2 and 3 year old fish throughout the season.
- As maturation in Northern Albacore is thought to be at 5 years it is clear both pair pelagic trawls and driftnets catch predominantly immature fish, although the pair pelagic fishery off the South-west coast targets larger fish as the season progresses. From a stock management perspective this is highly desirable given the concerns expressed by ICCAT in recent years. In contrast the stock in the Bay of Biscay seems to be largely made up of 1 and 2 year old Albacore. This applies equally to the trolling, pole-and-line and gillnet fleets that exploited this stock as well as the pair pelagic vessels.
- The catch data for the trolled caught Albacore show a similar length frequency distribution to the driftnet data, with the catch made up predominantly of 2 and 3 year old fish, although 4% of the measured Albacore were larger 4 year old fish compared to only 1% of the measured driftnet caught tuna.
- The by-catch of seabirds in the trolling fishery may be a problem when the recorded numbers in these trials are applied to the large fleet of Spanish vessels working in the Bay of Biscay and off the South-west coast of Ireland. The potential impact on seabirds is considered significant, but would require further assessment to determine the true level of by-catch.

REMOTE SENSING TECHNOLOGY

- The analysis of catch data from the 1999 results indicate that Albacore catches are influenced by temperature fronts and that catches are higher closer to the fronts. This would strongly indicate that sea surface temperature information would be beneficial to fishermen.
- Cloud cover, which restricts consistent data being gathered, would seem to be a limitation to employing remote sensing technology in the tuna fisheries off the south-west coast of Ireland.
- There is a definite trend in the fishing direction data, with higher catches occurring when fishing was towards the front.
- The front by front analysis carried out suggested that some fronts have a greater influence on catches than others. Fronts on the Goban Spur influenced catch, while the fronts on the Porcupine Bight did not appear to have an effect.

NOVEMBER 1999 WORKSHOP

A final one day workshop was held in November to conclude the project. Several of the fishermen, who participated in the trials gave an account of their experiences over the two year project and alluded to some of the problems they considered needed to be addressed for the fishery to be a success in the future using pair pelagic trawls and mechanized trolling systems. Speakers from BIM gave an overview of the trials including an appraisal of the technical issues including fishing gear and operations, the role of ICCAT, home and overseas markets, fish handling, fish quality and an economic assessment. The Marine Institute presented the biological data gathered over the course of the two years, while other speakers outlined how Remote Sensing Technology was used to identify tuna fishing areas, with an emphasis on how the information could be better utilized in the future.

It was clear from the results of the trials that while surface longlining was not worth pursuing any further, pair pelagic trawling and trolling are viable alternatives in their own right, with the perceived returns likely to be on a par with those gained from normal whitefish fishing.

The workshop concluded with an open forum at which there was a frank discussion on a number of key areas. Part of the discussion was taken up with the whole question of overseas tuna markets, access to these markets and ancillary services for vessels landing directly into France. There was considerable interest in the development of home markets for high quality line caught tuna.

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APPENDIX I - SPECIFICATIONS OF TRIALS VESSELS

PAIR PELAGIC VESSELS

MFV Sea Spray
Skipper: Kevin Sheehan
Built: Campletown, 1976
Registered Length: 22.97m
Draft: 2.97m
Hull: Steel, cruiser stern
Main Fisheries:
Herring Mackerel,Tuna
Home Port: Castletownbere
Overall Length: 25.93m
Beam: 7.23m
GRT: 153.13 tonnes
Engine: Alpha 700hp (522kW)

MFV Menhaden (S 135)
Home Port: Castletownbere
Overall Length: 26.97m
Beam: 7.32m
GRT: 152.78 tonnes
Engine: Stork 1000hp (746Kw)
Main Fisheries:
Herring, Mackerel, Tuna.
Skipper: Larry Murphy
Built: Cork, 1979
Registered Length: 25.02m
Draft: 3.90m
Hull: Steel, transom stern

MFV Karen Rose (D152)
Home Port: Baltimore
Overall Length: 25.83m
Beam: 6.72m
GRT: 101.87 tonnes
Engine: Blackstone, 600hp (448Kw)
Main Fisheries:
Whitefish (Spring/early Summer)
Tuna (Summer/Autumn)
Herring (Autumn/Winter)
Skipper: Anthony Sheehy
Built: Faversham, 1974
Registered Length: 24.17m
Draft: 2.39m
Hull: Steel, cruiser stern

MFV Albatross (G 75)
Home Port: Castletownbere
Overall Length: 24.99m
Beam: 7.32m
GRT: 138.52 tonnes
Engine: Caterpillar 720hp (537Kw)
Main Fisheries:
Whitefish (Spring/Summer/Autumn)
Herring (Autumn/Winter)
Skipper: Danny O'Driscoll
Built: Cobh, 1979
Registered Length: 23.8m
Draft: 3.05m
Hull: Wood, transom stern

MFV Delinn (SO 711)
Home Port: Rossaveal
Overall Length: 20.73m
Beam: 6.71m
GRT: 83.01tonnes
Engine: Caterpillar 540hp (403kW)
Main Fisheries
Whitefish (spring/ Summer)
Herring (autumn/winter)
Skipper: Hugo Boyle
Built: Downings, 1979
Registered Length: 19.05m
Draft: 2.99m
Hull: Wood, transom stern

MFV Mulroy Bay II (SO 600)
Skipper: John O'Regan
Built: Baltimore, 1976
Registered Length: 20.54m
Draft: 2.90m
Hull: Wood, cruiser stern
Main Fisheries:
Whitefish/Nephrops (spring/summer)
Herring (autumn/winter)
Home Port: Schull
Overall Length: 22.25m
Beam: 6.49m
GRT: 88.47tonnes
Engine: Grenaa 550hp (410kW)

MFV Oilean Cleire (D 610)
Home Port: Castletonwbere
Overall Length: 24.38m
Beam: 7.01m
GRT: 117.48 tonnes
Engine: Grenaa 650hp (485Kw)
Skipper: Sean O'Driscoll
Built: Baltimore, 1978
Registered Length: 22.86m
Draft: 3.23m
Hull: Wood, cruiser stern
Main Fisheries: Whitefish (all year round)

MFV Shearwater II (G 221)
Home Port: Castletownbere
Overall Length: 25.64m
Beam: 6.72m
GRT: 63.13 tonnes
Engine: Blackstone 600hp (448Kw)
Skipper: Denis Whelan
Built: Hessle, 1975
Registered Length: 23.77m
Draft: 2.47m
Hull: Steel, cruiser stern
Main Fisheries: Whitefish (all year round)

MFV Ocean Reaper (S229)
Skipper: Ebby Sheehan
Built: Fraserburgh, 1978
Registered Length: 23.28m
Draft: 3.25m
Hull: Wood, transom stern
Main Fisheries:
Whitefish (all year round)
Home Port: Castletonwbere
Overall Length: 23.28m
Beam: 7.01m
GRT: 80.95 tonnes
Engine: Caterpillar 600hp (448Kw)

MFV Eilean Croine (S 283)
Home Port: Castletonwbere
Overall Length: 33.1m
Beam: 7.3m
GRT: 230 tonnes
Engine: Werkspoor 1000hp (746Kw)
Main Fisheries:
Whitefish (spring/summer)
Pelagic (winter/autumn)
Skipper: Eric Murphy
Built: Baltimore, 1979
Registered Length: 33.1m
Draft: 4.65m
Hull: Steel

MFV Solan (S 228)
(Replaced the Mulroy Bay in Year 2)
Home Port: Castletownbere
Overall Length: 21.55m
Beam: 7.35
GRT: 121.62tonnes
Engine: Kelvin 465hp (347kW)
Main Fisheries:
Whitefish (spring/summer)
Herring (autumn/winter)
Skipper: John O'Regan
Built: Macduff, 1984
Registered Length: 21.55m
Draft: 3.90m
Hull: Wood, transom stern

MFV Heroine (C 291)
Home Port: Crosshaven
Overall Length: 21.24m
Beam: 6.09
GRT: 85.42tonnes
Engine: Caterpillar 425 hp (317kW)
Main Fisheries:
Whitefish (spring/summer)
Herring (autumn/winter)
Skipper: Lenny Hyde
Built: Eyemouth, 1971
Registered Length: 20.8m
Draft: 2.46m
Hull: Wood, cruiser stern

MFV Mary Lorraine (D 544)
Home Port: Kinsale
Overall Length: 19.81m
Beam: 6.64m
GRT: 103.37tonnes
Engine: Caterpillar 425hp (317Kw)
Main Fisheries:
Whitefish (spring/summer)
Herring (autumn/winter)
Skipper: Johnny Walsh
Built: Cobh 1976
Registered Length: 19.14m
Draft: 3.17m
Hull: Wood, transom stern

MFV Wave Crest (D 519)
Home Port: Castletownbere
Skipper: Declan Power

Overall Length: 21.31m
Beam: 6.13m
GRT: 91.38tonnes
Engine: Kelvin 425hp (317Kw)
Main Fisheries:
Whitefish (spring/summer)
Herring (autumn/winter)

Built: Fraserburgh 1965
Registered Length: 19.35m
Draft: 2.00m
Hull: Wood, cruiser stern

MFV Atlantic Warrior (SO 694)
Home Port: Dingle
Overall Length: 19.28m
Beam: 6.71m
GRT: 102.37tonnes
Engine: Kelvin 500hp (373Kw)
Main Fisheries:
Whitefish (spring/summer)
Herring (autumn/winter)

Skipper: John O'Donnell
Built: Dingle 1978
Registered Length: 19.28m
Draft: 3.35m
Hull: Wood, transom stern

TROLLING VESSELS

MFV Les Marquis
Home Port: Kinsale
Overall Length: 16m
Beam:
GRT: 33.21 tonnes
Engine: Caterpillar 395hp (294Kw)
Main Fisheries:
Whitefish/Nephrops

Skipper: Jerry O'Driscoll
Built: France
Registered Length: 16m
Draft:
Hull: Steel, transom stern

MFV Noz Dei (W 159)
Home Port: Kinsale
Overall Length: 17.43m
Beam: 5.94m
GRT: 50.54 tonnes
Engine: Caterpillar 365hp (272Kw)
Main Fisheries:
Whitefish/Nephrops

Skipper: Pat O'Mahony
Built: France, 1966
Registered Length: 17.43m
Draft: 2.45m
Hull: Wood, transom stern

MFV Warren Lock (D 161)
Home Port: Rossaveal
Overall Length: 18.51m
Beam: 5.64m
GRT: 47.08 tonnes
Engine: Cummins 320hp (239Kw)
Main Fisheries:
Whitefish/Nephrops (all Year round)

Skipper: Tommy Conneely
Built: France, 1968
Registered Length: 18.51m
Draft: 2.30m
Hull: Wood, transom stern

Mfv Floralie (SO 790)
Home Port: Dingle
Overall Length: 17.98m
Beam: 5.43m
GRT: 45.77 tonnes
Engine: Baudouin 287hp (214Kw)
Main Fisheries:
Whitefish/Nephrops

Skipper: Jim Tormey
Built: France, 1970
Registered Length: 16.73m
Draft: 16.73m
Hull: Wood, transom stern

SURFACE LONGLINE VESSEL

Mfv Fiona Patricia (T 100)
Skipper: Damian Turner
Built: France, 1971
Registered Length: 22.07m
Draft: 3.23m
Hull: Wood, cruiser stern
Main Fisheries: Seining (all year round)

Home Port: Castletownbere
Overall Length: 22.07m
Beam: 6.51m
GRT: 97.53 tonnes
Engine: Baudouin 650hp (485 Kw)

APPENDIX II - TRAWL SPECIFICATIONS

YEAR 1

Pair Number	Vessels	Engine Power	Size of Trawl Tested
1	Sea Spray	700hp	133 x 108m Le Drezen
	Menhaden	1000hp	151m x 108m Le Drezen/122 x 114m Gundry's
2	Karen Rose	600hp	133 x 108m Le Drezen/122 x 114m Gundry's
	Albatross	720hp	133 x 108m Le Drezen
3	Delinn	540hp	112.2m x 101m Swan Net/102m x 87m Le Drezen
	Mulroy Bay II	550hp	133 x 97m Le Drezen
4	Oilean Cleire	650hp	133 x 108m Le Drezen/110 x 102m Gundry's
	Shearwater II	600hp	133 x 108m Le Drezen/102 x 87m Le Drezen
5	Wave Crest	425hp	102 x 87m Gundry's
	Atlantic Warrior	600hp	102 x 87m Le Drezen

YEAR 2

Pair Number	Vessels	Engine Power	Size of Trawl Tested
1	Sea Spray	700hp	133 x 97m Le Drezen
	Menhaden	1000hp	133m x 108m Le Drezen (Dyneema)/122 x 114m Gundry's
2	Karen Rose	600hp	133 x 108m Le Drezen (Dyneema)
	Albatross	720hp	133 x 108m Le Drezen
3	Delinn	540hp	112.2m x 101m Swan Net/102m x 87m Le Drezen
	Solan	465hp	133m x 108m Le Drezen (Dyneema)/102m x 87m Le Drezen
4	Ocean Reaper	850hp	114 x 108m Le Drezen (Dyneema)
	Eilean Croine	1000hp	133 x 108m Le Drezen
5	Mary Lorraine	425hp	102 x 87m Le Drezen (Dyneema)
	Heroine	425hp	102 x 87m Gundrys/114 x 108m Le Drezen

APPENDIX III - PELAGIC TRAWL GEARTEST RESULTS

YEAR 1

TRIAL DETAILS

Vessels:	Karen Rose & Albatross
Date:	29/09/98
Area:	SW Ireland
Weather:	N/NE 5-6
Trawl Details	133 x 108m Tuna Pair Pelagic Trawl
Manufacturer	Le Drezen, France
Wingend Weights	575 kg Clump at each wingend
Floatation	2 x 76" floats on the headline & 2 x 57" floats on each wingend
Bridles	10 fm x 28mm combination top bridles & 10fm x 32mm combination bottom bridles
Warp	20mm

GEAR RESULTS

Warp Shot fm	Headline:Footrope Difference fm	Boat Separation nm	Headline Height fm	Towing Speed Knots
75	Level	0.1	16	3.8
75	Level	0.11	16.4	3.9
75	1½fm in footrope	0.11	18	4.0
100	Level	0.11	21.3	4.2
100	1½fm in footrope	0.11	21.3	4.6
100	1fm in headline	0.12	19.3	3.7
125	Level	0.12	24	4.0
125	1fm in footrope	0.12	25	3.6
125	1fm in headline	0.12	23	3.6

YEAR 2

Vessels:	Menhaden & Sea Spray
Date:	25/08/99
Area:	SW Ireland
Weather	SW 5-6
Trawl Details	756 metres Circumference Tuna Pair Pelagic Trawl
Manufacturer	Gundry's Ltd, Ireland
Wingend Weights	1500 kg Clump at each wingend
Floatation	1 x 76" floats on the headline & 2 x 76" floats on each wingend
Bridles	12 fm x 24mm Spectra rope bridles top and bottom
Warp	22mm

Warp Shot Fm	Headline:Footrope Difference fm	Boat nm	Separation	Headline Height Fm	Towing Speed Knots
150	3fm footrope	0.12		28	3.8
150	Level	0.14		26	4.5

Vessels	Delinn & Solan
Date	30/08/99
Area	Bay of Biscay
Weather	Calm
Trawl Details	102 x 87m Tuna Pair Pelagic Trawl
Manufacturer	Le Drezen, France
Wingend Weights	450 kg Clump at each wingend
Floatation	12 x 3 litre purse floats + 3 x 11" trawl floats on the headline & 2 x 76" floats on each wingend
Bridles	12 fm x 24mm combination top and bottom & 55 fathoms of 32mm plaited Polyethylene rope
Warp	18mm

Warp Shot fm	Headline:Footrope Difference fm	Boat nm	Separation	Headline Height Fm	Towing Speed Knots
75	3fm footrope	0.13		13.5	4.0
100	4fm footrope	0.14		16	3.9
125	4fm footrope	0.16		14	4.2

Vessels	Ocean Reaper & Eilean Croine
Date	01/09/99
Area:	SW Ireland
Weather:	S/SW 5
Trawl Details	114 x 96m Tuna Pair Pelagic Trawl with Dyneema Sections
Manufacturer	Le Drezen, France
Wingend Weights	800 kg Clump at each wingend
Floatation	16 x 5 litre purse floats on the headline & 2 x 76" floats on each wingend
Bridles	13 fm x 22mm combination top and bottom
Warp	18mm

Warp Shot fm	Headline:Footrope Difference fm	Boat nm	Separation	Headline Height Fm	Towing Speed Knots
100	level	0.12		17	5.0
100	3fm footrope	0.12		19	5.0

APPENDIX IV - LIST OF PERSONNEL INVOLVED WITH THE TRIALS

YEAR 1

CO-ORDINATOR	
Fergal Nolan	Bord Iascaigh Mhara
SCIENTIST & TECHNICAL STAFF	
John Browne	Marine Institute
John Molloy	Marine Institute
Colm Lordan	Marine Institute
Dominic Rihan	Bord Iascaigh Mhara
Ian Lawler	Bord Iascaigh Mhara
Liz Barnwall	Marine Institute
ON BOARD OBSERVERS	
Graham Johnson	Marine Institute
Cathal Laide	Marine Institute
Orla Lee	Marine Institute/UCD
John Boyd	Bord Iascaigh Mhara
Ronan Cosgrove	Bord Iascaigh Mhara
REMOTE SENSING	
Bret S. Danilowicz	UCD
TRAWLING ADVISORS	
Marcel Le Gac	Retired French tuna skipper
Louis Cariou	FAO/Retired French tuna skipper
TROLLING ADVISOR	
Alan Glanville	Retired tuna skipper

YEAR 2

CO-ORDINATOR	
Fergal Nolan	Bord Iascaigh Mhara
SCIENTIFIC & TECHNICAL STAFF	
John Browne	Marine Institute
John Molloy	Marine Institute
John Boyd	Marine Institute
Dominic Rihan	Bord Iascaigh Mhara
Ian Lawler	Bord Iascaigh Mhara
Liz Barnwall	Marine Institute
ON BOARD OBSERVERS	
Aisling O'Leary	Marine Institute
Geroid O'Sullivan	Marine Institute
Billy Waters	Marine Institute
Therese Mulvey	Marine Institute/UCD
Ronan Cosgrove	Bord Iascaigh Mhara
Paul Ivory	Bord Iascaigh Mhara
Fergal Guilfoyle	Bord Iascaigh Mhara
Sabeine Heine	Bord Iascaigh Mhara
REMOTE SENSING	
Bret S. Danilowicz	UCD
Deirdre Brophy	UCD
TRAWLING ADVISORS	
Marcel Le Gac	Retired French tuna skipper
TROLLING ADVISORS	
Alan Glanville	Retired tuna skipper
Myles Mulligan	Bord Iascaigh Mhara

APPENDIX V – DETAILS OF EXPLORATORY TRIALS

PELAGIC VESSELS

YEAR 1

	From	To	ICES Area	Albacore Tuna (kg)	Bluefin Tuna (kg)	Swordfish (kg)	Other (kg)	Total (kg)
Menhaden & Seaspray	11/8/98	20/8/98	VIIk	5,690	-	135	-	5,825
	23/8/98	28/8/98	VIIk	985	2019	166	92	3,096
	3/9/98	6/9/98	VIIk	205	-	20	-	225
	9/9/98	18/9/98	VIIk	2,014	737	770	-	3,521
	20/9/98	26/9/98	VIIk	4,087	2116	1,022	-	7,225
	27/9/98	3/10/98	VIIk	2,740	-	925	-	3,665
	4/10/98	10/10/98	VIIk	1,229	-	613	-	1,842
	11/10/98	16/10/98	VIIk	724	-	61	-	785
		TOTAL		**17,674**	**4872**	**3,712**	**92**	**26,350**
Wave Crest & Atlantic Warrior	08/9/98	11/9/98	VIIj	125	-	-	-	125
	14/9/98	25/9/98	VIIj	27	-	-	-	27
	2/10/98	5/10/98	VIIj	65	-	20	-	85
	5/10/98	9/10/98	VIIj	567	-	230	-	797
	18/10/98	23/10/98	VIIj	-	-	-	-	-
		TOTAL		**784**	**-**	**250**	**-**	**1,034**
Delinn & Mulroy Bay-II	2/9/98	6/9/98	VIIk	454	-	65	-	519
	10/9/98	12/9/98	VIIk	53	-	45		98
	15/9/98	24/9/98	VIIj,h; VIIIa,d	630	165	3,220	-	4,015
	25/9/98	30/9/98	VIIh	-	-	-	-	-
	2/10/98	9/10/98	VIIj; VIIIa,d	105	-	845	-	950
	14/10/98	22/10/98	VIIh,jVIIIa,d	145	-	765	-	910
		TOTAL		**1,387**	**165**	**4,940**	**-**	**6,492**
Shearwater & Oileann Cleire	16/8/98	25/8/98	VIIk	2,643	750	235	105	3,733
	27/8/98	2/9/98	VIIj,h	864	-	575	-	1,439
	3/9/98	12/9/98	VIIh	155	-	300	-	455
	15/9/98	27/9/98	VIIj	830	-	243	-	1,073
	27/9/98	9/10/98	VIIj	430	-	120	-	550
	12/10/98	24/10/98	VIIh	355	-	370	-	725
		TOTAL		**5,257**	**750**	**1,843**	**105**	**7,955**

PELAGIC VESSELS

YEAR 2

Vessel	From	To	ICES Area	Albacore kg	Bluefin kg	Swordfish kg	Other Species kg	Total kg
Menhaden & Seaspray	09/08/99	14/08/99	VIIk,j	4,824	486	477	0	5,787
	17/08/99	23/08/99	VIIj	6,912	0	577	0	7,489
	25/08/99	03/09/99	VIIk	10,262	974	875	0	12,111
	05/09/99	09/09/99	VIIk,j	1,663	0	205	76	1,944
	11/09/99	18/09/99	VIIk	2,489	86	586	0	3,161
	20/09/99	22/09/99	VIIj	8,996	100	588	0	9,684
	TOTAL			**35,146**	**1,646**	**3,308**	**76**	**40,176**
Albatross & Karen Rose	09/08/99	14/08/99	VIIj	8,175	0	324	0	8,499
	15/08/99	18/08/99	VIIj	47	0	0	0	47
	19/08/99	26/08/99	VIIIa-c	1,908	1,390	1,266	137	4,701
	28/08/99	04/09/99	VIIIc	11,317	1,346	396	0	13,059
	05/09/99	09/09/99	VIIIc	1,067	176	241	160	1,643
	13/09/99	17/09/99	VIIj	3,450	1,588	714	0	5,752
	19/09/99	23/09/99	VIIj	2,703	0	1,603	0	4,306
	TOTAL			**28,667**	**4,500**	**4,544**	**0**	**38,008**
Solan & Delinn	09/08/99	15/08/99	VIIj	6,270	0	818	894	7,982
	19/08/99	26/08/99	VIIIa,b	593	1,454	110	70	2,227
	29/08/99	05/09/99	VIIIc	6,657	803	242	196	7,898
	06/09/99	12/09/99	VIIIc	18,182	0	191	0	18,373
	14/09/99	23/09/99	VIIIa-c	525	75	105	0	705
	TOTAL			**32,227**	**2,332**	**1,466**	**1160**	**37,185**
Eilean Croine & Ocean Reaper	16/08/99	23/08/99	VIIj	10,430	0	321	90	10,,841
	24/08/99	31/08/99	VIIj,k	12,670	0	223	0	12,893
	01/09/99	08/09/99	VIIk	10,553	240	395	0	11,188
	10/09/99	18/09/99	VIIj,k	7,809	1,905	336	0	10,050
	19/09/99	26/09/99	VIIj,k	5,034	0	464	0	5,498
	TOTAL			**46,496**	**2,145**	**1,738**	**90**	**50,469**
Heroine & Mary Lorraine	11/08/99	18/08/99	VIIj	2,340	0	0	0	2,340
	23/08/99	29/08/99	VIIIa,b	3,150	0	452	0	3,602
	31/08/99	05/09/99	VIIIa-c	5,000	0	0	0	5,000
	06/09/99	16/09/99	VIIIa-c	10,294	0	0	0	10,294
	19/09/99	25/09/99	VIIj,k	0	0	0	0	0
	TOTAL			**20,786**	**0**	**452**	**0**	**20,786**

TROLLING VESSELS

1998

Vessel	From	To	ICES Area	Albacore kg
Les Marquis	24/8/98	30/8/98	VIIj	252
	1/9/98	5/9/98	VIIj	32
	14/9/98	20/9/98	VIIj	30
	21/9/98	25/9/98	VIIj	37
		TOTAL CAUGHT		351
Noz Dei	18/8/98	24/8/98	VIIk	534
	25/8/98	31/8/98	VIIc	75
	1/9/98	4/9/98	VIIe	42
	13/9/98	19/98	VIIj	84
	21/9/98	26/9/98	VIIj	56
		TOTAL CAUGHT		791
Floralie	26/8/98	3/9/98	VIIb,k	-
	15/9/98	21/9/98	VIIb,j	-
	22/9/98	28/9/98	VIIj	21
	29/9/98	4/10/98	VIIj,b	45
	5/10/98	9/10/98	VIIj,b	35
		TOTAL CAUGHT		101

1999

Vessel	From	To	ICES Area	Albacore kg
Les Marquis	12/07/99	17/07/99	VIIj	327
	22/07/99	28/07/99	VIIj	261
	03/08/99	07/08/99	VIIj	78
	09/08/99	12/08/99	VIIj	277
	16/08/99	21/08/99	VIIj	0
	23/08/99	28/08/99	VIIj	0
	30/08/99	04/09/99	VIIj	301
	TOTAL			1,244
Noz Dei	09/08/99	15/08/99	VIIj	1,331
	16/08/99	24/08/99	VIIj	0
	30/08/99	08/09/99	VIIj	1,237
	11/09/99	17/09/99	VIIj,k	112
	20/09/99	26/09/99	VIIj,k	1,116
	TOTAL			3,796
Warren lock	11/07/99	17/07/99	VIIj,k	1,548
	22/07/99	27/07/99	VIIj,k	408
	04/08/99	12/08/99	VIIj	2,247
	15/08/99	25/08/99	VIIj	1,021
	30/08/99	06/09/99	VIIj,k	342
	TOTAL			5,566

* It should be noted that these figures do not include small quantities of fish sold privately

SURFACE LONGLINE

Vessel	From	To	ICES Area	Albacore kg	Bluefin kg	Swordfish kg	Other Species kg	Total kg
Fiona Patricia	18/06/99	25/06/99	VIIj,k,	0	0	592	649	1,241
	29/06/99	03/07/99	VIIj,k	0	380	1,384	1,069	2,833
	15/07/99	22/07/99	VIIk	11	165	440	1,800	2,416
	25/07/99	29/07/99	VIIj,k,	0	0	22	1,750	1,772
	04/08/99	12/08/99	VIIk	0	5	624	1,789	2,418
TOTAL				**11**	**550**	**3,062**	**7,057**	**10,680**

APPENDIX VI - LIST OF FISH SPECIES CAUGHT DURING THE TRIALS.

(CLASSIFICATION AFTER WHITEHEAD ET AL. (1984, 1986) AND COMPAGNO (1984).

CHRONDRICHTYANS	CHONDRICHTHYES
Porbeagle shark	Lamna cornubica
Blue shark	Prinoace glauca
Thresher shark	Alopias vulpinus
Electric Ray	Torpedo nobiliana
TELEOSTS	TELEOSTOMI
Herring	Clupea harengus
Garfish	Belone belone
Horse mackerel	Trachurus trachurus
Ray's Bream	Brama brama
Mackerel	Scomber scombrus
Albacore tuna	Thunnus alalunga
Bluefin tuna	Thunnus thynnus
Bigeye tuna	Thunnus obesus
Skipjack tuna	Katsuwonus pelamis
Swordfish	Xiphias gladius
Atlantic Sailfish	Istiophorus albicans
Blue Marlin	Makaira nigricans
Black fish	Centrolophus niger
Sunfish	Mola mola
Opah	Lampris guttatus
Ribbonfish	Trachypterus trachypterus
Louvar	Luvarus imperialis
Wreckfish	Polprion americanum