FISHERIES OF BLUEFIN TUNA (*THUNNUS THYNNUS*) SPAWNERS IN THE NORTHEAST ATLANTIC

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SUMMARY

This paper analyzes the evolution of three symbolic eastern Atlantic fisheries of bluefin tuna spawners: the traps in the Strait of Gibraltar, the North Sea, Norwegian coastal waters and the Bay of Biscay, considering the development of these as indicators of the current spawning biomass in the eastern Atlantic to the west of Gibraltar, and reflects on the possible causes that led to their decline forty-three years ago. The official statistics of the database at ICCAT have been used (Task I) and in some cases, such as the traps, data of catches prior to 1950 are used, taken from other sources; catches are even presented from the XVI century. Regarding the subject described, the authors put forward different hypotheses, on which they consider a workshop might be held in order to discuss them further, and to this effect the scientists interested are encouraged to organize and participate in such a workshop with the support of the SCRS.

RÉSUMÉ

Le présent document analyse l'évolution de trois pêcheries symboliques de l'Atlantique Est visant les reproducteurs de thon rouge : les madragues dans le Détroit de Gibraltar, dans la mer du Nord, dans les eaux côtières norvégiennes et dans le Golfe de Gascogne, tout en considérant leur développement comme indicateurs de la biomasse reproductrice actuelle dans l'Atlantique Est, à l'Ouest de Gibraltar, et se penche sur les causes possibles ayant conduit à leur déclin il y a 43 ans. Les statistiques officielles de la base de données de l'ICCAT ont été utilisées (Tâche I) et, dans certains cas, comme pour les madragues, les données des prises antérieures à 1950 sont utilisées, extraites d'autres sources ; les prises sont même présentées à partir du XVI^{ème} siècle. En ce qui concerne le sujet décrit, les auteurs avancent différentes hypothèses, et envisagent la tenue d'un atelier afin de discuter plus avant de ces questions. A cet effet, les scientifiques intéressés sont encouragés à organiser et à participer à cet atelier, avec l'appui du SCRS.

RESUMEN

En este documento se analiza la evolución de tres pesquerías representativas de reproductores de atún rojo en el Atlántico este: las almadrabas del Estrecho de Gibraltar, del mar del Norte, en las aguas de la costa noruega, y del Golfo de Vizcaya, considerando el desarrollo de éstas como indicadores de la biomasa reproductora actual en el Atlántico este al Oeste de Gibraltar. En el documento también se reflejan las posibles causas que dieron lugar al descenso hace cuarenta y tres años. Se han utilizado las estadísticas oficiales de la base de datos de ICCAT (Tarea I) y en algunos casos, como en el de las almadrabas, se han utilizado datos de captura anteriores a 1950, extraídos de otras fuentes: se presentan incluso capturas para el siglo XVI. En cuanto al tema considerado, los autores plantean diferentes hipótesis, y consideran que podrían celebrarse unas Jornadas de trabajo para debatirlas con más detalle y, con este propósito, se insta a los científicos interesados a que organicen y participen en dichas Jornadas con el respaldo del SCRS.

KEYWORDS

Atlantic bluefin tuna, traps, Strait of Gibraltar, Bay of Biscay, North Sea, Norwegian coastal waters

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1. Introduction

Over forty years ago, in 1963, the traditional eastern Atlantic fisheries of bluefin tuna spawners (trap fisheries in the Strait of Gibraltar and purse seine in the North Sea and along the Norwegian coast) suffered a sharp decline in catches, such that they never again reached and regained the levels of recorded catch in the first half of the previous century. In the first case, several traps were reinstalled a few years afterwards, but catches since 1963 have never been close to the previous level. Their profitability is only possible thanks to the entrance of the Japanese market, which buys up catches for raw consumption in Japan and other Asian countries. The series showing the evolution of mean weights of annual catches points to a progressive ageing of the population since 1963.

In the case of the North Sea and Norwegian coast fisheries, they disappeared more or less entirely after the beginning of the 1980s.

Explaining the reasons for these events should be of interest to the scientific community, and in recent times several papers have been published in reference to them (Fromentin, 2002; Nøttestad and Graham, 2004; 2005).

Located between these two historical fisheries is that of the Bay of Biscay, which, although mainly made up of juveniles, also traditionally includes adults (group 5+) on the trophic migration from the Mediterranean to the North Sea/Norwegian coastal fisheries.

The interactions between the trap fisheries of spawners and that of the North Sea was described by Hamre (1963); but Nøttestad and Graham (2004, 2005) showed that, on their trophic feeding migration, this group of several year classes with adults passed through the fishery in the Bay of Biscay **(Figures 1a** and **1b).**

It is clear that the events taking place among the three fisheries are in parallel, and the reasons why are to be explained individually in the sections that follow. Diverse hypotheses are formulated here, which attempt to explain the underlying mechanisms and processes involved in this sudden change of migration and distribution of Atlantic bluefin tuna.

2. Material and methods

Most of the catch data of the Atlantic traps (Spain, Portugal and Morocco) come from the ICCAT database (Task I); nevertheless, some reviewed Spanish data have been used (1950-58) as well as statistics of catches that go beyond the limits available on that database, which are found in some old published papers (ICES, 1966; Lozano, 1958; and Rodríguez-Roda, 1964).

Catches have been transformed into number of fishes, using the mean annual weights of the trap fisheries of the Strait of Gibraltar, according to the information published by: Baken *et al*., 1980; Lozano, 1958; Rodríguez-Roda, 1964; 1978; 1980; 1983. From the North Sea and Norwegian coastal fisheries, the data published by Nøttestad and Graham (2005) have been used.

The evolution of the mean weight of catches has been drawn up from the catch statistics of Spanish traps as this is the most information we have been able to find. The source of information used to obtain these data was: Baken *et al*., 1980; ICCAT, Bd (Task I, since 1950); Lozano 1958; Rey *et al.* 1987; and Rodríguez-Roda 1964; 1978; 1980 and 1983).

Regarding the catch statistics in the Bay of Biscay (the Spanish part), the first years of the 1949-1974 series have been reviewed, and it is proposed that they be substituted in Task 1 of the ICCAT database. These years precede a recent review (Rodríguez-Marín *et al*., 2006) and have been published (Cort, 1990), see **Appendix Table 1**.

Fishing effort of group 5+ between 1974-2004 was estimated using our own published data (Cort, *op. cit.*), with log books and information from the Information and Sampling Network (RIM) of the IEO.

A CPUE index (group 5+) of the bait boat fleet of the Bay of Biscay since the beginning of the seventies was estimated using the following information:

- Catch/age table (1975-2004), used to draw up the standard abundance indices (Rodríguez-Marín *et al*., 2006).
- Catch/age table (1970-74) (Cort, *op. cit.*).

- Field data from French scientists who monitored the whole fishery at the beginning of the seventies (Spain did not begin to monitor until 1973). This published information (Bard, Bessineton, Cendrero and Dao, 1973; and Dao and Bessineton, 1974) contains interviews with Spanish fishermen, the monitoring of a selected fleet and biological samplings at Spanish ports (Fuenterrabía and Guetaria). These data were donated to the IEO.
- Biological samplings on board fishing vessels in 1973 and the estimation of the fishing yields of the fleet targeting group 5+ (data from the IEO).
- Catches by commercial lengths of the Spanish fishery between 1971-1973 (Cort and Cendrero, 1975).

For this figure to be compatible with the rest of the data in the series, a factor has been applied that takes into account the difference in the fishing power of vessels at the beginning of the seventies (vessels without sonar, fishing fundamentally with reels) and the actual vessels, which are much more powerful, use rods (in recent times they are equipped with hydraulic instruments to pull them in when specimens of over 50 kg are caught) and use the acoustic detection of fishes, which was not an option thirty years ago.

The CPUE index (group 5+) presented in this paper has been compared with the standard index (group 5+) of Rodríguez-Marín *et al*., (2006) to do so, the values of fishes/trip from the cited study have been transformed into fishes/day at sea, taking into account that the mean value of one trip is three days at sea (Rodríguez-Marín *et al*., *op. cit*.).

The present paper refers to and makes estimations of the juveniles of the Bay of Biscay and Moroccan fisheries (the Atlantic part); in both cases fishes of less than 20 kg are considered juveniles; that is to say, fishes aged between 1-3 years. The source of information since 1960 is the catch/age table from the database of ICCAT; estimations for the preceding years have been made based on published information (Cort, *op. cit*. and Furnestin and Dardignac, 1962).

2.1 Traps of the Strait of Gibraltar and Iberian-Moroccan bay

The Strait of Gibraltar is one of the most emblematic places where bluefin tuna are caught. The tradition of fishing at this site dates from several thousands of years ago, but there is paleo-anthropological evidence that leads us to believe that the last Neanderthal settlements (30 000 B.C.) in this area must have used bluefin tuna meat as part of their diet.

Thousands of years later, during the Roman Empire, bluefin tuna formed the basis of a considerable commercial activity both in and beyond the Mediterranean basin. In the proximities of the Strait of Gibraltar there are archeological findings that point to the importance of tuna during those centuries (http://perso.wanadoo.es/historiaweb/antiqva/baelo/index_baelo.htm). The few traps that remain today are, therefore, the heirs of an old tradition that should not be lost.

We will now study the evolution of the traps from actual and old catch statistics in an attempt to reveal the reasons that are leading to their disappearance. The first is a statistical series of catches over 110 years (1525-1635), published by De Buen (1925), and then another of the last 75 years (1929-2004) **Figures 2** and **3**.

The outstanding historical catches of the years 1555-1570 must be mentioned, in which essentially just two traps (Conil and Zahara) caught a mean of 58 000 tunas per fishing season, which may well have been 5 000 tonnes of tunas each. Twenty years later, the catches hardly reached 5 000 specimens per trap. This alternation of periods of abundant catches followed by others of scarcity were studied by Fromentin (2002) and Ravier and Fromentin (2004), who attributed long natural cycles (of 120 years) to the species. Now if we look at the catch series of the same traps four hundred years on **(Figure 3)**, we see trends similar to those above with a similar level of catches, although in this latter case the number of traps was somewhat greater. One of the aims of the present section is to find, if existing, a relationship between the sudden decline in the catches of the traps that occurred in 1963 and the important anthropogenic factors which took place a little more than ten years prior to this event. It was no other development than the new bluefin tuna fisheries including spawners and juveniles that did not exist in the previous centuries.

Figure 4 clearly shows the enormous development that fisheries underwent in the eastern Atlantic at the end of the nineteen forties.

From this figure we conclude the following:

Between 1949 and 1962, 338 803 tonnes of tunas were caught, a mean of 24 200 t/year. Of these, 82 % (279 004 t) were almost entirely spawners in the traps and North Sea fisheries and the remainder (59 799 t) were from juvenile fisheries in the Bay of Biscay and Morocco.

The transformation of these catches into numbers provided the following information:

Fisheries of spawners caught 1.6 million individuals in those years, a mean of 117 000 individuals/year. Strangely enough, this figure coincides with the highest recorded catches by the Spanish traps in the Strait of Gibraltar during the middle ages published by De Buen (1925), as previously cited.

Regarding juvenile fisheries (Bay of Biscay and Morocco), the catch was 6. 3 million specimens (450 000 fishes/year) during the same period of time (1949-1962), which is an annual mean of 450 000 fishes, a number that hardly differs from the mean of the 1960-2000 historical series: 308 000 individuals (from the catch/age table, ICCAT).

According to the values of F estimated for the juvenile part of the population (ages 1-3) of the eastern stock (ICCAT, 1998 stock assessment) a catch of this magnitude during years of supposedly greater abundance, would bring about F of 0.2, or perhaps less, which would not justify a great impact on the future adult population in those years. From 1970, with the development of purse seine fishing in the Mediterranean, F on juveniles did reach very high levels (> 0.7) in the last years.

Considering the above, the immediate consequences, from 1963, were the following:

1) The disappearance of the North Sea bluefin tuna fishery at the end of the seventies.
2) The drastic fall in the fishing yields of the traps, which were never again to see the levels reached in the first decades of the twentieth century, although since the beginning of the eighties they number practically the same as during the first half of the last century (4-6 traps: Rey *et al*., 1987; ICCAT). As a function of catches and number of traps that have been installed between 1929-2006, fishing yield/trap was and is as follows:
   - 1929-1962, 1200 t;
   - 1982-2005, 289 t;
   - 2002-2006, 200 t (using unpublished catches from 2006).
3) The increase in annual mean length of the tunas over time **(Figure 5).**

   From 1963 there is a change in the trend in mean weight of the annual catches, which goes from 134 kg during the 1929-1962 period to 190 kg between 1963-2005. This progressive increase reflects an aging of the population from approximately 10 years of age to over 15 years old.
4) The disappearance of group 5+ from the Bay of Biscay fishery.

2.2 Bay of Biscay

The traditional method for catching bluefin tuna in the Bay of Biscay was with troll. This system used to be used on sailing vessels and later with small motorboats.

From the end of the 1940s fishing with rods and live bait was adopted, a new system that led to an important development in the area as well as greater possibilities of exploitation of the bluefin tuna resource, as fishes of greater size present in the fishery could now be caught with much higher intensity.

Nevertheless, the fishery has been and still is fundamentally made up of juveniles, which remain in the region throughout the fishing season from the end of spring until beginning of the autumn. The largest specimens in group 5+ (50 kg > weight < 200 kg), which were traditionally present between the middle of July and the middle of August, were caught in greater quantity. The methods included using reels **(Figures 6** and **7)** fishing the tuna one by one, and with the vessel stationary; i.e. when a school of tunas had been found (the vessels did not have sonar), the vessel stopped over it and could spend one or several days making catches **(Figures 8** and **9)**.

Considerable catches of large specimens were made in this way, as occurred in the years 1971-1973 (Cort, 1990). This fishing method disappeared over time and nowadays, on the few occasions that arise to catch these spawners (as in 1999), catches are made with rods and from a vessel in movement.

The importance that the catch of specimens aged 5+ had at the beginning of this fishery was reflected in a sampling of lengths made in 1956 **(Figure 10)**, in which the dominance of age classes 5 and 6, belonging to the cohorts of 1951 and 1950 respectively, is confirmed. These have been cited by several authors as having been very abundant, among them Fromentin (2002) and Nøttestad and Graham (2004; 2005).

Fromentin (*op. cit.*), making reference to the catches of the Spanish Atlantic traps, wrote: "… *the cohorts born between 1947 and 1954 largely dominated the Spanish catches (the year-classes 1950 and 1951 were especially abundant during the 1957 and 1958 fishing seasons). The same year-classes dominated the catches of the southern Norwegian fisheries…"*.

This is further evidence of the interaction among the three fisheries we are studying.

Fishes aged 5+ may have been abundant in the Bay of Biscay fishery in 1957 and 1958, although no biological sampling is available. Very important catches were obtained in this fishery within those seasons **(Figure 11**, which includes the reviewed data of **Appendix Table 1**).

The aims of this section are summarised as follows:

1) To reveal the magnitude of group 5+ in the demographic composition of catches over the last three decades (1970-2004), and to make reference to the last years in which the highest catches of this group were recorded: the years 1971-1973.

2) To build a CPUE index for group 5+ (1970-2004).

3) To show that the different phases that appeared in the CPUE index coincided with the two other fisheries examined.

Point 1

Firstly, the proportion of juveniles caught in the Bay of Biscay fishery is always in majority, both in number of fishes and in weight, as shown by the following table:

TARGETED FISHING (In number)	**Time period 1970-2004**	Percentage
Age	**Catch/Age**	**%**
1	**1067864**	**29.1**
2	**1697255**	**46.3**
3	**569743**	**15.5**
4	**205474**	**5.6**
5	**83892**	**2.3**
6	**25850**	**0.7**
7	**9785**	**0.3**
8	**4485**	**0.1**
9	**100**	**0.0**
Total	**3664447**	**100.0**

Ages 1-4 : 96, 6 %
Group 5+: 3, 4 %

Biological parameters	TARGETED FISHING (In weight)	Time period 1970-2004	Catch * weight calculation	Percentage
Weight (kg)/age	Age	Catch/age	Catch * weight	%
4.5	1	1067864	4805386	9.81
10.5	2	1697255	17821172	36.37
19	3	569743	10825122	22.09
37	4	205474	7602532	15.52
55	5	83892	4614056	9.42
73	6	25850	1887070	3.85
94	7	9785	919769	1.88
113	8	4485	506831	1.03
125	9	100	12454	0.03
	Total	3664447	48994393	100.00

Ages 1-4 : 83, 8 %
Group 5+: 16, 2 %

Secondly, when analyzing the years 1971-1973 separately, noteworthy differences can be seen with respect to the remaining years with the highest catches of fishes aged 5+ were recorded from the entire series. These differences confirm the greater quantities of fishes caught; and specifically that the proportion of catches of ages 5+ in weight, increased significantly with up to 46 %.

1971-1973	Numbers	Percentage
Age	No. Fishes	%
1	26513	8
2	214605	64.6
3	37469	11.3
4	11280	3.4
5	21515	6.5
6	11211	3.4
7	6123	1.8
8	3691	1.1
9	0	0
Total	332407	100

Ages 1-4 : 87 %
Group 5+: 13 %

1971-1973		
Age	Weight	%
1	119308.5	1.8
2	2253352.5	34.7
3	711911	11
4	417360	6.4
5	1183325	18.2
6	818403	12.6
7	575562	8.9
8	417083	6.4
9	0	0
Total	6496305	100

Ages 1-4 : 54 %
Group 5+: 46 %

It must be mentioned here that the mean age of group 5+ throughout the whole series studied is 5 years, whereas in 1971-1973, it was higher, at 6 years.

Year	Mean weight, 5+ (kg)	Age (years)
1970	**66**	6
1971	**67**	6
1972	**70**	6
1973	**75**	6

Year	Mean weight, 5+ (kg)	Age (years)	Year	Mean weight, 5+ (kg)	Age (years)
1974	**65**	5	1989	**65**	5
1975	**61**	5	1990	**60**	5
1976	**63**	5	1991	**62**	5
1977	**64**	5	1992	**60**	5
1978	**60**	5	1993	**61**	5
1979	**62**	5	1994	**60**	5
1980	**68**	6	1995	**59**	5
1981	**65**	5	1996	**58**	5
1982	**65**	5	1997	**58**	5
1983	**60**	5	1998	**62**	5
1984	**65**	5	1999	**60**	5
1985	**60**	5	2000	**65**	5
1986	**62**	5	2001	**67**	6
1987	**61**	5	2002	**60**	5
1988	**65**	5	2003	**64**	5
			2004	**64**	5

Point 2

During the period 1971-1973 the presence of group 5+ was very considerable in the catch as a whole. We will now calculate a CPUE index for the year 1973, taking into account that information of a different nature is available: biological samplings, monitoring of the fleet, in-port surveys and observations on board fishing vessels.

The observations and biological samplings performed in surveys on board fishing vessels (August, 1973) provided evidence, on one hand, of the length composition **(Figure 12)** of group 5+, and on the other, the fishing yield of the fleet and the system of the catch using reels and live bait from a stationary vessel, as described in previous chapters.

The value of CPUE of the tuna fishing fleet has been estimated for 1973: **29 fishes/day,** using the information on in-port surveys, on-board observations and monitoring part of the fleet. Corrective factors have been applied which take into account the increase in fishing power achieved by the installation of sonar (Cort and Bard, 1980) and by fishing with rods in current times. The results reveal three distinct scenarios:

Description	1	2	3
1970	13	**16**	18
1971	27	**32**	38
1972	24	**29**	34
1973	**29**	**35**	**41**

It must be taken into account that the values for 1970-1972 have been estimated in proportion to the CPUE of 1973, considering that the number of vessels remained constant and therefore fishing effort is assumed to have remained the same (Cort, 1990).

Scenarios 2 and 3 contemplate increases of 20 % due to the differences in fishing power mentioned.

Table 1 and **Figure 13** are the definitive data of the series studied (selecting scenario 2) to which the standardised CPUE of group 5+ has been added (Rodríguez-Marín *et al.*, 2006), and the same trend is found.

Figure 13 includes the curve of fishing effort targeting group 5+, which has been estimated from in-port surveys and log books, taking into account the criterion that fishing on group 5+ is carried out, in general, over a short period of time between July and August.

The outstanding point in **Figure 13** is the increase in fishing effort between 1996 and 2000, years in which the Guetaria fleet (made up of bait boat vessels of greater TRB tonnage) that generally targets its activities at albacore tuna, *Thunnus alalunga*) joined the fishery records indicate that the catches of this fleet are mainly bluefin tuna juveniles, although fishing effort targeted at group 5+ is also confirmed.

On another point, the considerable increase in 1999 was due to the catch of fishes aged 5 years, belonging to the abundant 1994 cohort (Rodriguez-Marín *et al*., 2006).

Point 3

Considerable effort has been made to extend the historical series to pre-1970, A coming study will include data of the demographic structure of this fishery since the beginning of the use of live bait in 1950, will help to clarify the events that took place and the hypotheses presented in this document. Obtaining data from the 1950-1960 would be of great interest, given the large catches that were made during this period. The catches of some of those years (1956), as we have seen, were fundamentally made up of specimens from group 5+, but we have scarcely any information on those of the remainder and an attempt must be made to obtain some of these valuable data.

Regarding the last three decades, we see that since 1973 the apparent abundance of spawners (group 5+), traditionally present in the Bay of Biscay, has fallen and is now at the same level as that observed in the other two fisheries studied. Only the outstanding appearance of specimen aged 5+ in certain years (1979, 1999), which belong to abundant cohorts such as those of 1974 and 1994, prevents the curve from being practically flat over the last thirty years. This situation corroborates the interaction between this fishery and those of the Strait of Gibraltar traps and the North Sea/Norwegian coastal waters, as well as confirming that the biomass of spawning tunas in the Atlantic part of the eastern stock is very reduced.

2.3 North Sea and Norwegian coastal fisheries

Following the strong year classes of 1950 and 1952 there appears to have been very little recruitment to the stock. This has resulted in a decline in the annual catch and a change in the migration pattern of the fish (Hamre and Tiews, 1964). From 1965 onwards the vast majority of tuna catches were taken in the districts of Sogn and Fjordane and Hordaland in southwestern Norway. Very little tuna was also caught after late 1960's in the North Sea. Thus, the stock size of tuna declined at the same time as the distribution area and migration pattern along the west coast was drastically reduced, due to the diminished stock size. Fewer year classes were also present in the catches, indicating lack of proper recruitment providing less profitable tuna fishery. Norway basically experienced a massive stock and range collapse on the Atlantic bluefin tuna stock in the late 1960's. The average weight of tuna caught in Norwegian waters increased from <100 kg in the early 1950's to >350 kg in the late 1970's, showing the year by year increase in growth rate of individuals especially from the 1950 and 1952 year classes (Nøttestad and Graham 2004; Nøttestad and Graham 2005).

It is difficult to say what effect the increased catches in the more southern areas may have had on fishing opportunities for the Norwegian fleet. It is clear that there was a general collapse of the fishery in the North Sea and in Norwegian coastal waters in 1963, but the increase in especially purse seine catches reported from fisheries in the Mediterranean is completely opposite of the pattern in the more Northern areas.

It is important to ascertain if during this period the increased catches in the Mediterranean were a result of a biological shift in the stock, or due to increased fishing effort. It should be noted that the majority of tuna taken off the Norwegian coast were aged relatively old fish 10+ years. Catch at age statistics from the southern fisheries show very few fish older than five years in the stock, a strong signal of growth overfishing (Nøttestad and Graham 2004). This overfishing limited the northern distribution area and natural feeding migration pattern of bluefin tuna to a large extent. The relationship between these fisheries needs further research; this will require further data on fleet effort and technological change and more detailed information on tuna migration.

3. Conclusions

Using information from the fisheries of the Strait of Gibraltar traps, the Bay of Biscay, North Sea and Norwegian coastal waters as indicators of the spawning biomass (group 5+) in the eastern Atlantic, we find parallel events among the three that began their decline between 1963 and 1973. The cause of this decline must have been predominantly due to the over-fishing that took place ten years before.

The situation that the traps are now going through has been repeated on several occasions throughout the history of these ancient fishing gears (Ravier and Fromentin, 2004). Nevertheless, the great development of new fisheries in the eastern Atlantic from the middle of the 20th century has meant that the two situations cannot be directly compared.

The fishing yield of one trap is now approximately 200 t, six times less than in the first half of the twentieth century; further proof that points towards the imminent disappearance of this ancient fishery as a result of the intense overexploitation to which the stock has been subject to for decades.

The mean weight of the catches of the traps has increased from 134 kg (1929-1962) to 190 kg (1963-2005), which reveals a progressive ageing of the adult bluefin tuna population in the eastern Atlantic. The turning point came in 1963.

The F of juveniles in the eastern Atlantic, added to the F maintained since the beginning of the seventies in the western Mediterranean Sea, must be responsible for the progressive ageing of the adult population in the eastern Atlantic.

The vast information provided by the traps throughout history makes them extremely valuable as scientific observatories, which should be preserved in the future, no matter what conservation measures are adopted in the future.

The presence of specimens aged 5+ in the Bay of Biscay fishery has been very low since 1973, with only isolated appearances being recorded as a result of important cohorts passing through (1974 and 1994) in certain years.

There was a general collapse of the fishery in the North Sea and in Norwegian coastal waters from 1963 onwards. The drastic increase in especially purse seine catches reported from fisheries in the Mediterranean is completely opposite of the pattern in the more Northern areas, more or less trapping the highly migratory bluefin tuna stock within the Mediterranean Sea.

The majority of tuna taken off the Norwegian coast were aged relatively old fish 10+ years. Catch at age statistics from the southern Mediterranean fisheries show very few fish older than five years in the stock, a strong signal of growth overfishing. The overfishing limited and more or less blocked the northern distribution and natural feeding migration pattern of Atlantic bluefin tuna.

4. Workshop

The authors of the present documents describe and quantify specific and geographical and temporal facts on tuna biology and migration, which took place more than forty years ago, but which determined and set the stage for the future fisheries on eastern Atlantic bluefin tuna spawners. The true causes of these events are not known with complete certainty. However, in the present times of substantial crisis in the traditional eastern Atlantic bluefin tuna fisheries, and with a view to achieve their healthy future rebuilding, it would be a good reason for interested scientists to dedicate some time in compiling new data to help in clarifying such important causes of collapse. Papers could be presented at a workshop to be held in mid 2007.

Some of the questions to be dealt with, which have been mentioned throughout the present paper, would be:

- The enigma of 1963. What led to the fall of the traditional fisheries in that year?
- What influence did the massive fishing of juveniles in the fifties have on the fisheries of spawners? −Can demographic data be recovered that allow calculations of F to be made for that decade?
- What were the factors that influenced the continuous increase in the mean weight of the catches of spawners (traps)?
- What influence did the environmental parameters have on the bluefin tuna development?
- How can the progressive decrease in the bluefin tuna yields be stopped from the traps?
- What actions should be proposed to rebuild the traditional fisheries of spawners in a long-term sustainable manner for the bluefin tuna?

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Table 1. Catch, effort and standardized CPUE series of bluefin age 5 and over (1970-2004).

	CPUE, 5+	*Standard 5+ index*	*Catches, 5+* (♦)	*Effort*
1970	16		7,013 (●)	*(days at sea)*
1971	32		14,351 (●)	
1972	29		12,716 (●)	
1973	35		15,473 (●)	534
1974	5		2,860	529
1975	5	1,0	1,821	386
1976	4	0,7	1,650	386
1977	2	0,3	670	310
1978	11	2,3	4,012	366
1979	10	4,7	3,542	344
1980	12	6,3	4,892	394
1981	2	0,3	491	296
1982	4	1,0	1,380	365
1983	1	0,0	139	163
1984	6	0,3	1,634	290
1985	3	0,2	1,235	429
1986	5	0,7	971	185
1987	6	0,7	2,257	369
1988	4	0,3	1,431	371
1989	1	0,1	586	436
1990	3	0,3	1,296	372
1991	4	0,5	1,466	366
1992	1	0,1	389	359
1993	7	1,0	2,680	407
1994	1	0,1	231	244
1995	1	0,0	437	405
1996	8	2,3	6,073	768
1997	3	0,7	1,734	579
1998	6	2,0	3,481	544
1999	19	14,7	13,998	724
2000	8	3,7	5,849	709
2001	6	0,7	2,859	442
2002	1	0,1	510	464
2003	5	1,3	1,971	408
2004	4	1,7	2,015	547

(♦) From the census of official catches (Rodríguez-Marín, pers. comm.).
(●) Cort, 1990.

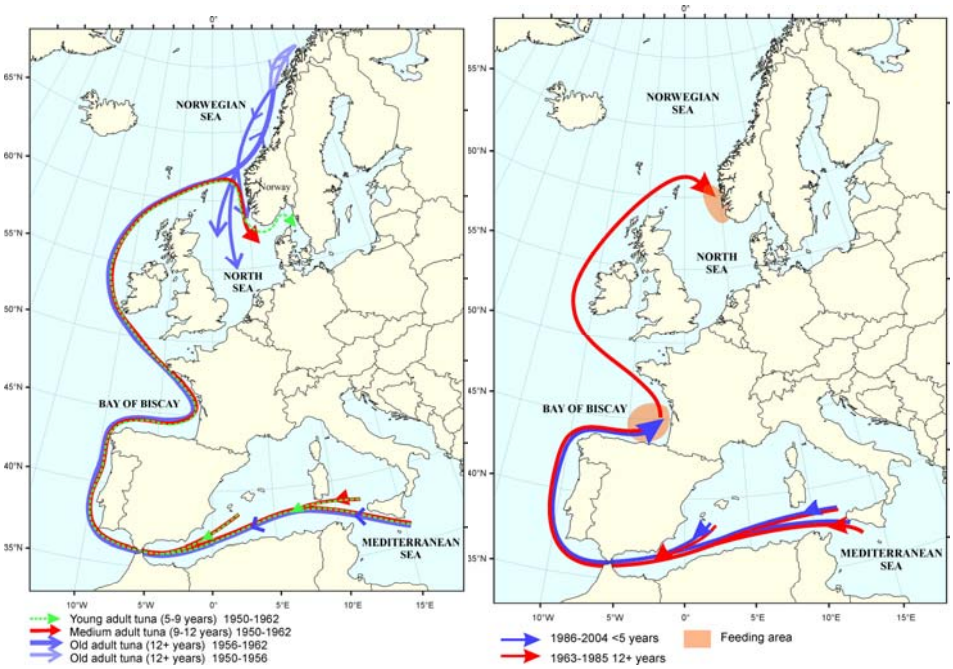

Figure 1a. Northern feeding migration pattern of North Atlantic tuna in the period 1950 to 1962. © IMR
Figure 1b. Northern feeding migration of Atlantic bluefin post 1963. © IMR

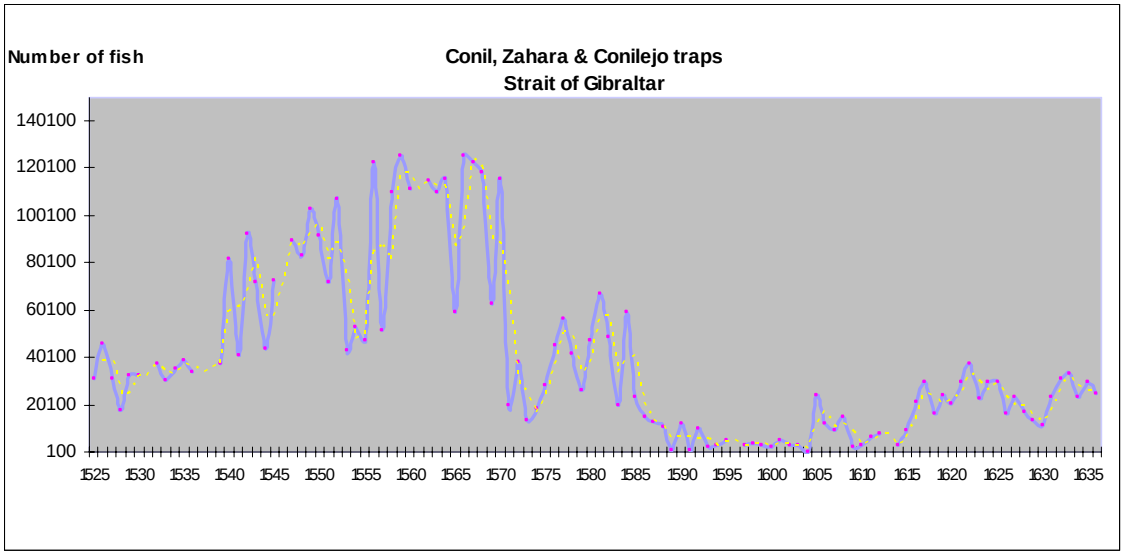

Figure 2. Statistical series of bluefin catches from the Strait of Gibraltar and Ibero-Moroccan Bay traps over 110 years (1525-1635). © IEO

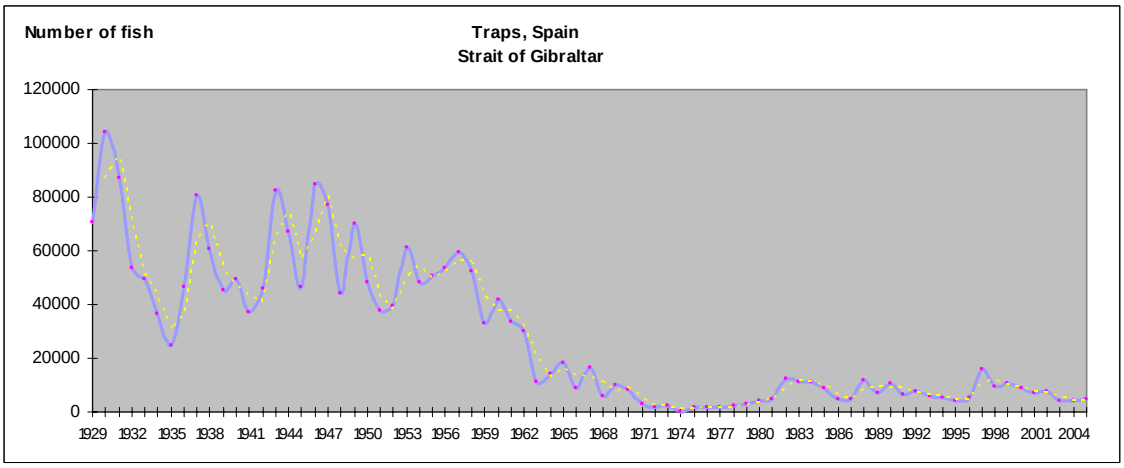

Figure 3. Bluefin trap catches in the Strait of Gibraltar area from 1929 to 2004. The number of traps during the period has been: 5-7 (1929-1962) (Lozano, 1958; R. Roda, 1964), 1-3 (1962-1974) (R. Roda, 1978) and 4-6 (1980 and 2004) (ICCAT; Rey *et al.*, 1987). © IEO

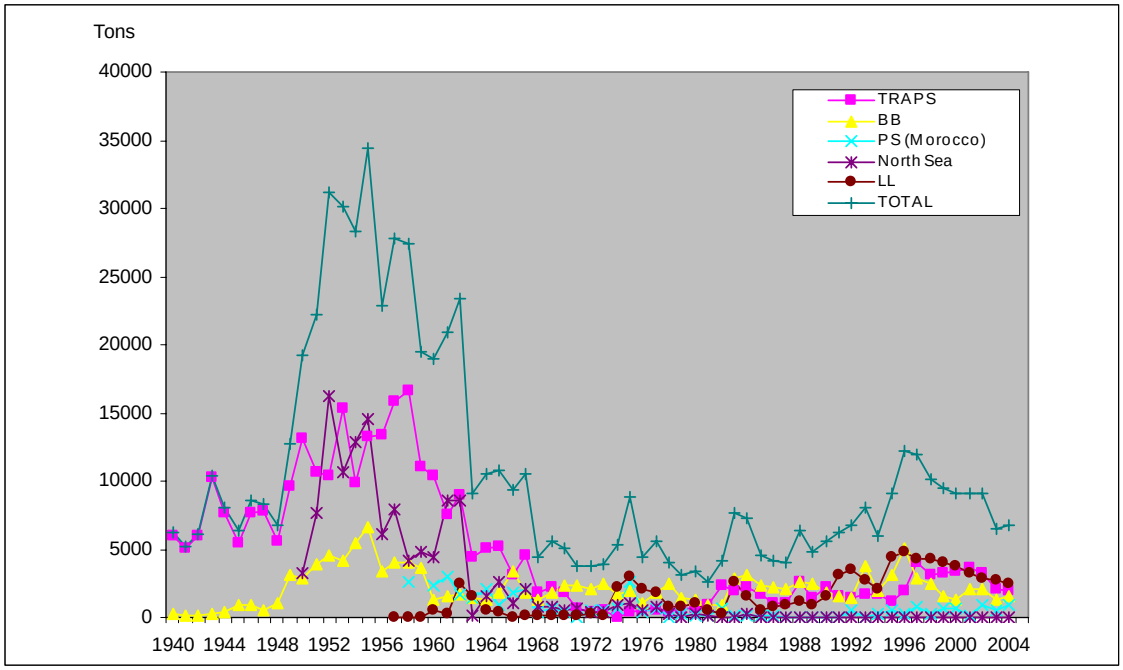

Figure 4. Eastern Atlantic bluefin catches, by gear **(**Source: ICCAT Db; Lozano, 1958; ICES, 1966; Rodríguez-Roda, 1964; Cort, 1990**).**

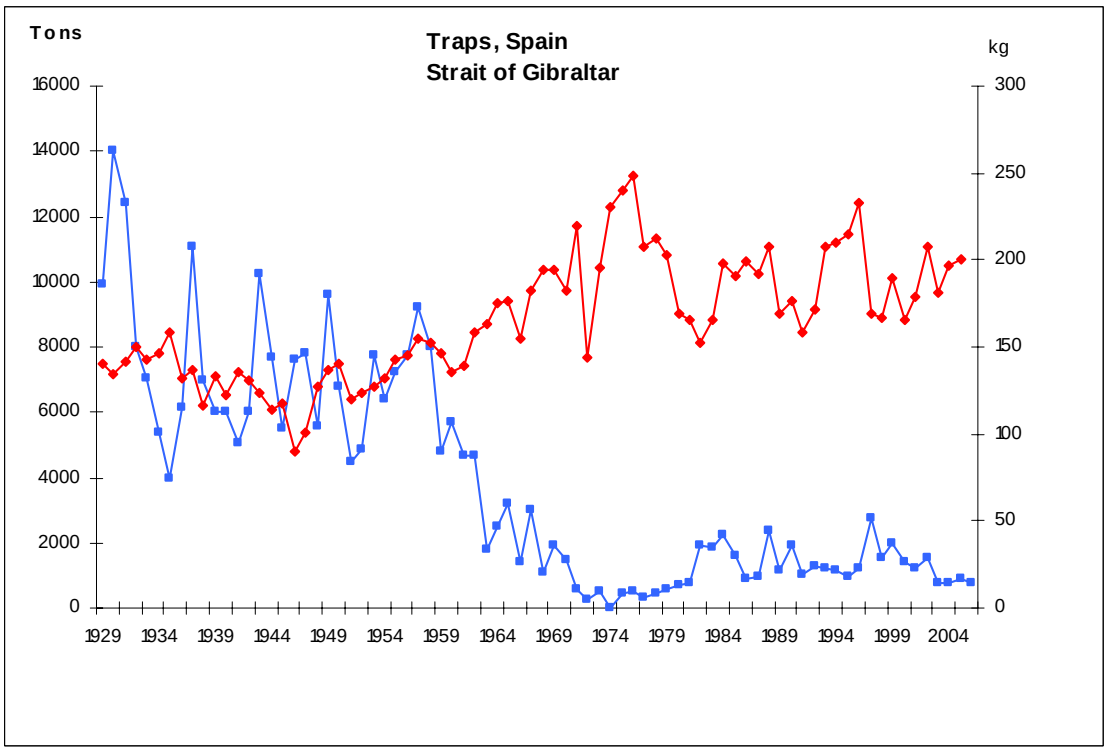

Figure 5. Mean weight and catch trends of bluefin from the Spanish traps in the Strait of Gibraltar area. © IEO

Figure 6 © IEO

Figure 7. ©IEO

Figure 8. ©IEO

Figure 9. ©IEO

Figures 6-9. Bluefin tuna fishing in the Bay of Biscay.

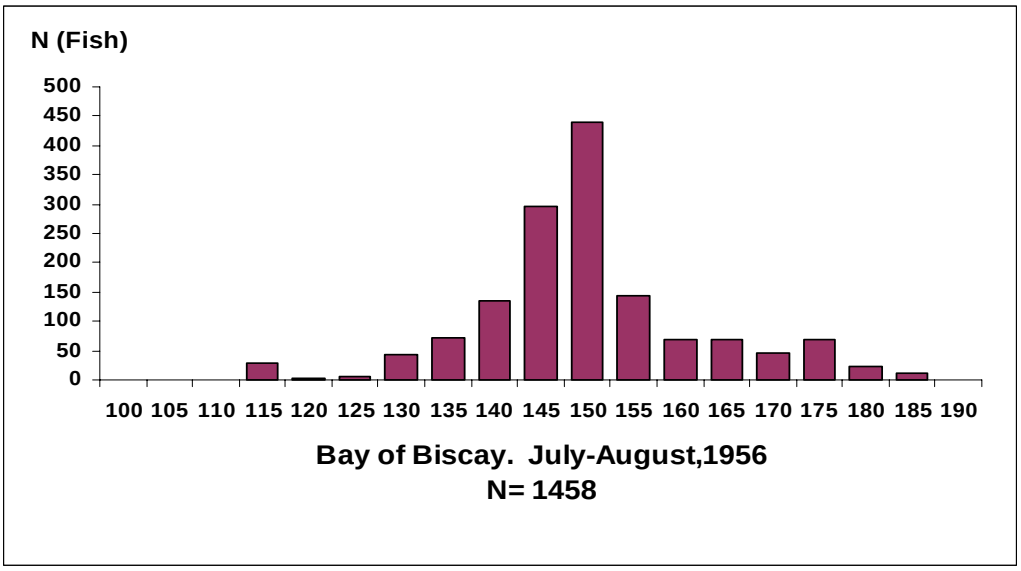

Figure 10. Size distribution of bluefin catch in the Bay of Biscay during the 1956 season. © IEO

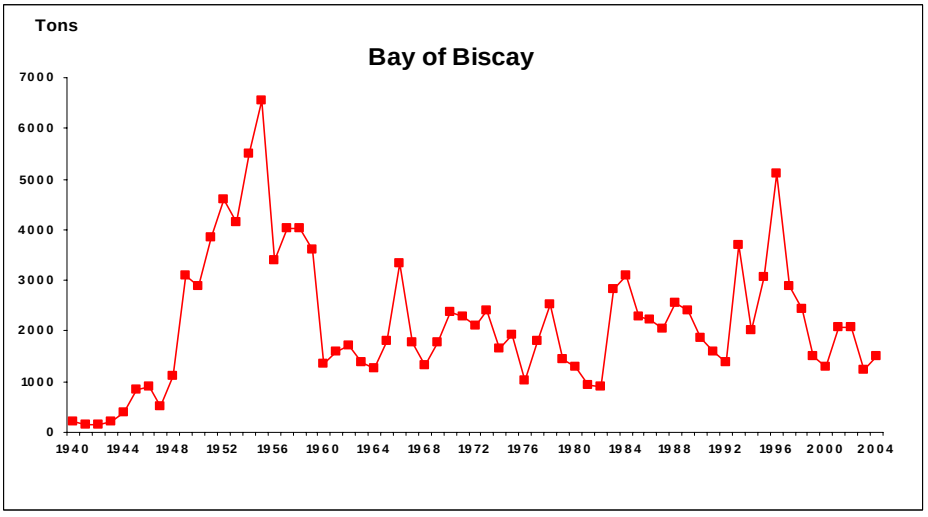

Figure 11. Bluefin tuna catches in the Bay of Biscay, 1940-2004. © IEO

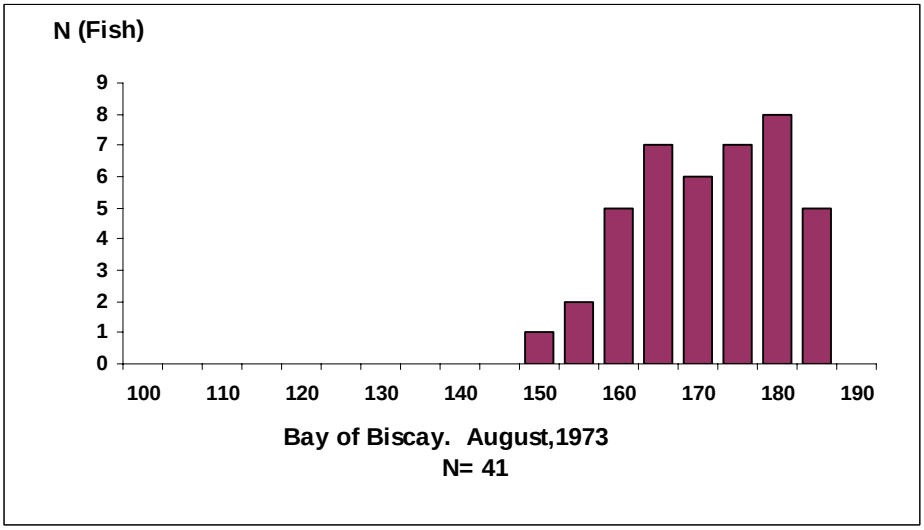

Figure 12. Length composition of bluefin tuna from the Bay of Biscay in August, 1973. © IEO

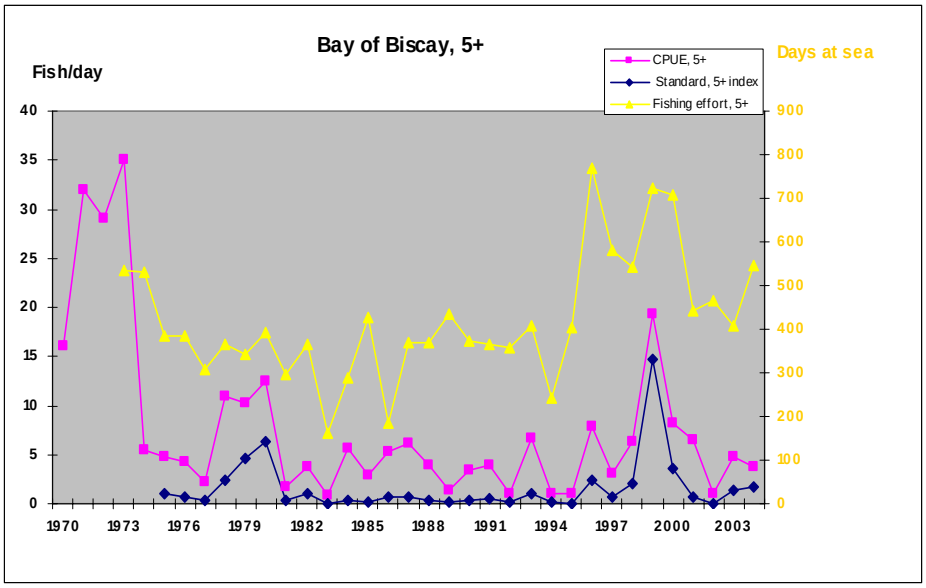

Figure 13. Catch, effort and standardized CPUEs of bluefin 5+ group in the Bay of Biscay. © IEO

Appendix Table 1. Review of Spanish catches in the Bay of Biscay (1950-1974).

					ICCAT (A)	*Cort, 1990 (B)*	*B - A*
1950	EC.Spain	NE	Bait boat	BB	996	1010	14
1951	EC.Spain	NE	Bait boat	BB	1086	950	-136
1952	EC.Spain	NE	Bait boat	BB	1424	2240	816
1953	EC.Spain	NE	Bait boat	BB	1192	1770	578
1954	EC.Spain	NE	Bait boat	BB	979	2050	1071
1955	EC.Spain	NE	Bait boat	BB	1417	3530	2113
1956	EC.Spain	NE	Bait boat	BB	1338	1950	612
1957	EC.Spain	NE	Bait boat	BB	1604	2490	886
1958	EC.Spain	NE	Bait boat	BB	1526	2670	1144
1959	EC.Spain	NE	Bait boat	BB	1021	1570	549
1960	EC.Spain	NE	Bait boat	BB	645	799	154
1961	EC.Spain	NE	Bait boat	BB	546	691	145
1962	EC.Spain	NE	Bait boat	BB	572	740	168
1963	EC.Spain	NE	Bait boat	BB	635	837	202
1964	EC.Spain	NE	Bait boat	BB	676	858	182
1965	EC.Spain	NE	Bait boat	BB	1002	1167	165
1966	EC.Spain	NE	Bait boat	BB	1501	1711	210
1967	EC.Spain	NE	Bait boat	BB	698	911	213
1968	EC.Spain	NE	Bait boat	BB	813	924	111
1969	EC.Spain	NE	Bait boat	BB	996	1227	231
1970	EC.Spain	NE	Bait boat	BB	1635	1635	0
1971	EC.Spain	NE	Bait boat	BB	1575	1575	0
1972	EC.Spain	NE	Bait boat	BB	1362	1363	1
1973	EC.Spain	NE	Bait boat	BB	1696	1870	174
1974	EC.Spain	NE	Bait boat	BB	1089	1126	37