

SUMMARY OF SWORDFISH (*Xiphias gladius*) RECAPTURES CARRIED OUT BY THE SPANISH SURFACE LONGLINE FLEET IN THE ATLANTIC OCEAN: 1984-2002.

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ABSTRACT

A total of 66 swordfish (*Xiphias gladius*) specimens were recovered during the 1984-2002 period from the fishing areas of the Atlantic Ocean. These recaptures were reported to the Instituto Español de Oceanografía. Almost all of the recaptures were submitted by the commercial Spanish surface longline fleet, with the exception of one tag, which was reported by the U.S. fleet. The origin of the recaptures may be broken down as follows: 11 came from swordfishes tagged by the Spanish surface longline fleet (a recapture rate of 0.33%), 8 from swordfishes tagged by the scientific staff of the IEO during tagging surveys (a recapture rate of 6.11%) and 47 recaptures pertained to swordfishes tagged by other countries. A total of 7 tags came from fishes tagged and recaptured in the South Atlantic (South of 10° South). In spite of the small increase seen in the number of fishes tagged and recaptured in the North East Atlantic, complex exchanges are already being inferred between areas at the level of the North Atlantic. Moreover, the data available do not suggest any trans-equatorial movements.

RÉSUMÉ

Un total de 66 spécimens d'espadon (*Xiphias gladius*) ont été récupérés au cours de la période 1984-2002 dans des zones de pêche de l'océan Atlantique. Ces récupérations ont été signalées à l'Institut espagnol d'océanographie (IEO). La quasi totalité des récupérations ont été soumises par la flottille commerciale espagnole de palangriers de surface, à l'exception d'une marque qui a été déclarée par la flottille des Etats-Unis. L'origine des récupérations peut être ventilée comme suit : 11 marques provenaient d'espadons marqués par la flottille palangrière espagnole de surface (taux de récupération de 0,33%), 8 provenaient d'espadons marqués par le personnel scientifique de l'IEO au cours de campagnes de marquage (taux de récupération de 6,11%) et 47 récupérations concernaient des espadons marqués par d'autres pays. Un total de 7 marques provenaient de poissons marqués et récupérés dans l'Atlantique sud (sud de 10° sud). Malgré la légère augmentation du nombre de poissons marqués et récupérés dans l'Atlantique nord-est, des échanges complexes peuvent déjà être observés entre les zones de l'Atlantique nord. Néanmoins, les données disponibles ne suggèrent pas de déplacements trans-équatoriaux.

RESUMEN

Un total de 66 ejemplares de pez espada (*Xiphias gladius*) fueron recapturados durante el periodo 1984-2002 procedentes de áreas del Océano Atlántico. Estas recapturas fueron comunicadas al Instituto Español de Oceanografía. Casi todas las recapturas fueron remitidas por la flota española de palangre de superficie, con la excepción de una sola marca que fue comunicada por la flota de EEUU. La procedencia de las recapturas puede ser dividida de la siguiente forma: 11 marcas proceden de peces espada marcados por la flota española de palangre de superficie (tasa de recaptura 0,33%), 8 de peces espada marcados por personal científico del IEO durante campañas de marcado (tasa de recaptura 6,11%) y 47 recapturas pertenecen a peces espada marcados por otros países. Un total de 7 peces espada proceden de peces marcados y recapturados en el Atlántico Sur (al Sur de 10° S). Pese al pequeño incremento observado en el número de peces marcados y recapturados en el Atlántico NE, ya se

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puede observar un complejo intercambio entre áreas del Atlántico Norte. Sin embargo, los datos disponibles no sugieren por el momento movimientos trans-ecuatoriales.

KEYWORDS

Swordfish, tagging

1. INTRODUCTION.

The aim of this document is to summarise the available information (May, 2002) on the swordfish recaptures reported by the Spanish surface longline fleet from 1984 to the present. These data include the recapture of fishes that had been tagged by scientific personnel on specific tagging surveys, during opportunistic tagging performed by scientific observers on board commercial vessels and by the voluntary tagging carried out by Spanish surface longline fleet which began collaborating with our Tagging Program in 1981. This voluntary tagging program carried out by the fleet is still underway at the present time, with an increase in the number of target species to be tagged such as billfishes and sharks. This collaboration activity takes place in the Atlantic Ocean (North and South) as well as in the Mediterranean Sea and in the Pacific and Indian Oceans.

Despite the fact that the program maintains continuous contact with the skippers, who have manifested a keen interest in understanding the migratory habits of this species, in addition to the increasing number of recaptures reported, the recapture rate obtained as a result of tagging by the fleet has traditionally been considered low in comparison with the tagging carried out by scientists (Mejuto, 1991; García-Cortés *et al.*, 2000). This document presents comparative values on the resulting recapture rates and discusses the possible reasons for these results.

2. METHODS.

Opportunistic swordfish tagging carried out by both the Spanish surface longline fleet and by observers on board commercial vessels took place in the North and South Atlantic, Mediterranean Sea, and the Pacific and Indian Oceans. Scientific tagging surveys were also carried out in the North Atlantic in 1981, 1997 and 1998, between 20°-40° N (except for 3 specimens tagged between 0°-2° N).

The recapture data were based on information provided by the commercial fleets. Almost all of the recaptures came from the Spanish surface longline fleet, whose crew members were given thorough instruction and information from the outset of the tagging program. Frequent contacts have been made with skippers, shipowners, seamen, guilds, etc., to explain and publicise the program. Additionally, posters have been put up and specific rewards have been made available to this fleet for many years. The methods of collecting and communicating the recaptures have been established in an easy-to-follow protocol, in order to make it easier for the fleet carrying out the recapture, to return the information effectively.

The types of tags used in tagging tasks (Mather *et al.*, 1974) have varied over the years in which the I.E.O. swordfish tagging program has been in operation. Changes in the type of tag have had an impact on the scientific surveys, also affecting both the opportunistic tagging carried out by the observers and the opportunistic tagging done by the Spanish surface longline fleet. During the first decade of the tagging program the most commonly used tags were the D type (spaghetti) tags, probably because they caused the least harm to the fish. Later the H type tags were introduced. Only three M type tags have been used.

3. RESULTS AND DISCUSSION.

The percentage of D type tags used was 67.7%, while type H accounted for 32.3%. The preferential use of type H tags at the present time is due to the fact that they are easier to handle and are sturdier when applied. Nonetheless, new tags that have less of an impact on the fish should be tested in the future. The D type tags used originally probably inflicted less injury on the fish, but the plastic head (harpoon) of the tag broke easily at the time of application because the steel applicator would often cut into the plastic, thus affecting its position in the muscle, reducing the possibilities of identifying the fish when recaptured.

Out of the total number of swordfishes tagged by the Spanish fleet since 1981, nearly 90% have been tagged in the Atlantic Ocean, approximately 5% in the Mediterranean Sea, around 3% in the Indian Ocean and around 2% in the Pacific. Within the Atlantic Ocean, most of these fishes were tagged in the South Atlantic (74.5%) while a smaller number (14.5%) were tagged in the North Atlantic.

Figure 1 shows the number of individuals released per year in the Atlantic Ocean over the course of all the tagging activities carried out under this program. The size range fluctuated from 30-190 cm LJFL (**Figure 2**). The mean size of the individuals tagged opportunistically was 80 cm LJFL. However, the mean size of the fishes tagged during scientific tagging surveys was 121 cm LJFL and the size range varied between 60-190 cm LJFL (**Figure 3**). The aim of these surveys was the preferential tagging of fishes weighing over 20-25 kg.

A total of 66 swordfishes were recaptured during the above period (**Table 1**), 47 were swordfishes that had been tagged by other countries and 19 of the recaptures pertained to fishes that had been tagged under the tagging program carried out in Spain by the IEO, one of which was reported by a U.S. vessel. The slight increase in the number of fishes tagged and recaptured in the NE Atlantic would suggest that the mixture is more complex than what had been assumed in earlier decades when tagging was done almost exclusively in the NW Atlantic with fairly repetitive geographic and temporal tagging designs.

Most of the recaptures pointed to a tendency towards movements between subtropical and temperate waters, but no trans-equatorial movements have been detected to date (**Figure 4**). 89.9% of the recaptures reported were from the North Atlantic between 13°-46° N and 5°-62° W and they pertained to individuals that had been tagged North of 10° N. 10.1% (7 fishes) were recaptured in the South Atlantic between 14°-30° S and 0°-49° W corresponding to specimens that had been tagged South of 17° S (**Figure 4**).

Of the 19 fishes that were tagged-recaptured by the Spanish fleet, 11 pertained to specimens tagged during commercial activity, either by the fleet or by the scientific observers (a recapture rate of 0.33%), while 8 had been tagged during the scientific tagging surveys carried out in 1997 and 1998. During these surveys the tagging protocols were substantially improved (García-Cortes et al., 2000) giving rise to a recapture rate of 6.11%. The recapture rate achieved during scientific tagging surveys would suggest that there may be a higher survival rate in tagged fishes, which would confirm the theory that the recapture rates are closely linked to the method of tag used (Beckett, 1972), to the size of the fish selected and to the handling of the fish during the tagging process. While this assertion may be generalised to include any type of fish, it would appear to be especially important in the case of swordfish owing to their extreme fragility.

These 19 swordfish specimens, recaptured in the Atlantic (**Figure 5**) and tagged during tagging surveys as well as opportunistically, account for a recapture rate of 0.55% with regard to the total number of fishes tagged in the Atlantic Ocean under our program and a rate of 0.53% in relation to the total number tagged between the Atlantic Ocean and the Mediterranean Sea (**Table 2**). The surprising lack of feedback from fleets other than Spain's could be due to a number of causes that should be looked into.

As discussed earlier, the size of the tagged specimens is a highly influential factor on the resulting recapture rate. The mean size of the tagged specimens that were later recaptured by the Spanish surface longline fleet was 103.8 cm LJFL. The mean size at the time of recapture was 138.8 cm LJFL. The size distribution of the tagged-recaptured individuals is given in **Figure 6**. The average number of days the fishes were at large was 813, with a maximum of 2723 and a minimum of 57.

An analysis of the recapture rates resulting from the voluntary tagging program carried out by the commercial fleet might lead us to believe that such activity is not 'scientifically profitable' owing to the low recapture rate obtained and the high cost in time and effort required to keep the program going. Clearly, scientific tagging is the most appropriate tagging method for this species, as handling and fish size are decisive factors in the recapture rates obtained (García-Cortés *et al.*, 2000). Nonetheless, we must remember that the voluntary tagging tasks carried out by the fleet present other related advantages that should also be taken into account. The training and involvement of the fleet in this scientific tag-recapture process helps crews to understand the utility of these scientific methods. This leads to a considerable improvement not only in the number of recaptures reported to the research labs (an increase in the report rates on this species and others) but it also substantially improves the quality of the information reported on each recapture (sizes, weight, sex, position, gonads stage, etc.). Moreover, the fleet becomes involved in tagging and releasing juvenile specimens, grasping the need for their protection. Therefore, these tagging activities may have an extremely positive collateral effect on this species or others, which should also be evaluated in each case, depending on the specific characteristics of each fleet, in addition to simply considering the quantitative assessments of the recapture rates obtained.

Also, the results suggest that caution must be used when evaluating the recapture rates obtained among fleets, especially in the case of this species, since the methodological protocols used, the selection of the size classes, the tagging areas and seasons and the activity of the fleets, etc. (in addition to the different report rates of the respective fleets) may all have a major impact on the resulting recapture rates and mixing rates.

The data collected during scientific tagging surveys suggest that the conditions are also appropriate for performing electronic tagging experiments on this species. However, it has not been possible to find financial backing for these experiments to date.

Additional note: A new recapture of swordfish was reported to our IEO laboratory by a Spanish vessel fishing in the South Atlantic when this document was nearly completed. Tag code: HM 02008, species: SWO, sex: female, size LJFL: 180 cm, date of recapture: 14/May/2002, position: 16° 05'S-30° 50' W, tagging laboratory: 75 Virginia Beach Drive, FL 33149 Miami, USA. Unfortunately the tagging data were not available upon the completion of this document. This recapture could be very important if the tagging area of this tag is the North Atlantic, as is initially suspected. In this case, a trans-equatorial movement would be established and some of conclusions in this document should be changed.

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Table 1. Tag-recapture information on 66 fishes tagged by different countries; recapture data reported to the IEO. (Date= day-month-year; q= quadrant; Lat.g and Lat.m=latitude in degrees and minutes; Lon.g and Lon.m=longitude in degrees and minutes).

Tag number	Lab. Count.	Rel. Date	Rec. Date	RELEASE LOCATION					RECAPTURE LOCATION					Days at-Large
				q	Lat.g	Lat.m	Lon.g	Lon.m	q	Lat.g	Lat.m	Lon.g	Lon.m	
HM 00291	Miami (USA)	07-10-94	01-11-95	4	38	20	73	30	4	37	0	15	0	390
HM 01776	Miami (USA)	24-06-95	01-12-98	4	17	7	64	49	4	20	0	30	32	1256
HM 02033	Miami (USA)	02-08-00	28-09-00	4	49	24	42	26	4	37	10	40	35	57
HM 32919	Miami (USA)	16-12-97	01-05-99	4	21	42	55	57	4	39	0	40	0	501
R 095849	Miami (USA)	15-10-87	18-06-88	4	47	0	42	0	4	43	50	42	0	247
R 195837	Miami (USA)	09-09-90	10-07-94	4	45	10	44	50	4	42	18	40	0	1400
R 195862	Miami (USA)	11-08-91	07-07-95	4	43	35	44	45	4	43	7	42	19	1426
R 263394	Miami (USA)	13-11-91	28-04-99	4	43	28	45	5	4	37	8	48	42	2723
R 278462	Miami (USA)	24-06-92	19-09-93	4	43	30	43	0	4	40	25	38	30	452
R 279214	Miami (USA)	15-05-92	09-08-93	4	38	30	68	20	4	43	56	41	20	451
R 279909	Miami (USA)	15-09-92	25-05-93	4	46	41	41	39	4	42	30	38	0	252
R 279948	Miami (USA)	06-11-92	22-05-94	4	42	15	51	56	4	44	0	39	0	562
R 288142	Miami (USA)	no info.	20/07/93		no information				4	43	20	34	20	no info.
R 292511	Miami (USA)	14-10-93	no date	4	43	34	47	11		no data available				no info.
R 293695	Miami (USA)	20-07-93	06-04-95	4	44	20	44	35	4	37	30	37	20	625
R 297464	Miami (USA)	21-02-93	06-07-95	4	21	41	86	4	4	44	50	41	51	865
R 306544	Miami (USA)	02-08-94	24-06-98	4	43	48	45	15	4	46	10	40	53	1422
R 320288	Miami (USA)	04-01-95	28-09-97	4	19	14	56	9	4	42	50	37	27	998
R 322112	Miami (USA)	21-09-94	18-03-95	4	47	18	41	12	4	36	42	37	27	178
R 345768	Miami (USA)	08-07-95	11-07-99	4	42	3	54	5	4	43	0	42	0	1464
R 346738	Miami (USA)	05-08-95	01-07-00	4	45	34	41	14	4	35	0	49	0	1792
R 346847	Miami (USA)	13-03-95	29-08-95	4	14	2	48	43	4	45	33	40	45	169
R 347653	Miami (USA)	11-10-95	30-06-96	4	37	25	74	30	4	42	9	41	42	263
I16248	Narrag (USA)	23-06-86	25-06-88	4	47	28	39	42	4	45	0	44	0	733
188561	Narrag (USA)	no info.	01-04-97		no information				4	13	42	10	32	no info.
198710	Narrag (USA)	30-03-94	18-07-94	4	14	45	47	53	4	43	27	40	15	110
199555	Narrag (USA)	09-12-95	02-04-00	3	35	10	52	18	3	30	30	12	20	1576
199570	Narrag (USA)	15-05-95	11-11-00	3	37	0	54	0	3	27	41	43	45	2007
199628	Narrag (USA)	14-06-94	14-06-00	3	36	40	52	17	3	18	49	28	40	2192
199636	Narrag (USA)	16-09-94	19-01-96	3	35	14	52	4	3	24	0	17	33	490
199637	Narrag (USA)	30-07-94	27-08-96	3	36	19	52	38	3	27	30	42	5	759
199648	Narrag (USA)	23-10-94	07-02-97	3	34	45	51	56	3	24	44	16	23	838
200133	Narrag (USA)	23-07-94	23-02-97	4	44	0	37	50	4	21	0	17	50	946
209133	Narrag (USA)	22-01-95	23-07-99	4	19	25	54	0	4	42	37	43	4	1643
211359	Narrag (USA)	miss. card	05-04-96		missing tag card				4	39	47	37	39	no info.
233611	Narrag (USA)	22-07-97	23-02-01	4	43	30	40	30	4	37	6	51	42	1312
233620	Narrag (USA)	25-07-97	25-02-98	4	43	30	38	45	4	32	49	40	58	215
245658	Narrag (USA)	02-09-98	08-07-99	4	45	35	41	10	4	43	32	26	20	309
255314	Narrag (USA)	03-12-00	10-08-01	4	15	23	44	50	4	29	50	24	15	250
302065	Narrag (USA)	26-07-94	28-08-95	4	43	34	43	29	4	46	5	41	50	398
JP 07366	St.And. (Canada)	23-07-96	05-08-98	4	42	22	58	45	4	44	50	40	40	743
JP 07059	St.And. (Canada)	30-09-93	11-07-94	4	43	18	60	48	4	42	45	40	20	284
BF 198716	Billf.Foun(USA)	19-07-00	11-04-01	4	33	0	72	0	4	36	25	37	15	266
BF 60525	Billf.Foun(USA)	29-05-94	29-07-95	4	16	22	64	15	4	43	59	40	57	426
BF 40729	Billf.Foun(USA)	23-12-93	05-05-99		no information				4	41	47	40	26	1959
A 26417	La Jolla (USA)	14-11-94	22-05-95	4	40	38	48	12	4	38	40	41	42	189
A 26414	La Jolla (USA)	14-11-94	22-06-99	4	43	3	27	14	4	43	3	27	14	1681
CR 000283	IEO (Spain)	25-05-97	15-10-00	4	26	1	19	6	4	25	10	21	29	1239
CR 000286	IEO (Spain)	25-05-97	23-08-97	4	26	19	18	42	4	36	40	7	18	90
CR 000435	IEO (Spain)	01-06-97	05-03-98	4	22	35	19	23	4	22	17	18	35	277
CR 000502	IEO (Spain)	07-06-97	07-03-98	4	24	53	17	42	4	22	18	18	38	273
CR 001285	IEO (Spain)	29-07-98	19-05-01	3	17	5	32	21	3	14	20	28	10	1025
CR 001741	IEO (Spain)	16-08-98	14-01-02	4	41	27	19	9	4	43	10	17	35	1247
CR 001931	IEO (Spain)	30-08-98	24-09-00	4	22	54	19	45	4	22	0	21	0	756
CR 002039	IEO (Spain)	06-09-98	03-11-00	4	25	55	18	58	4	37	37	15	41	789
CR 002052	IEO (Spain)	08-09-98	25-10-99	4	28	58	16	14	4	37	14	14	35	412
CR 002157	IEO (Spain)	29-11-98	04-05-01	4	41	0	19	0	4	37	52	38	44	887
CR 002173	IEO (Spain)	08-02-99	25-01-00	4	39	0	16	0	4	38	57	18	16	351
CR 003807	IEO (Spain)	07-11-00	06-09-01	4	38	8	16	30	4	43	56	5	37	303
PE 000080-8	IEO (Spain)	01-11-81	19-10-84	4	21	56	17	46	4	43	29	23	57	1083
KA 008117	IEO (Spain)	03-05-85	24-01-90	4	41	0	37	0	4	20	10	62	48	1727
ES 010205	IEO (Spain)	06-02-96	19-02-00	4	33	31	19	55	4	39	23	19	20	1474
ES 004444	IEO (Spain)	19-05-95	07-04-96	4	39	0	42	28	4	40	57	37	30	324
CT 001266	IEO (Spain)	19-10-96	09-02-98	4	37	57	12	0	4	39	4	10	44	478
CT 001120	IEO (Spain)	22-08-96	06-10-97	4	47	45	8	10	4	39	20	12	50	410
AT 000341	IEO (Spain)	16-08-89	16-11-91	4	20	47	17	45	4	36	30	15	39	822

Table 2. Different swordfish recapture rates obtained by the Spanish surface longline fleet by geographic tag survey area.(TOT.ATLANT.=TAG.SURVEY+ATLANT.O.;ATL+MED= TOT.ATLANT+MEDITERR.)

	REC.RATE
TAG.SURVEY	6,11
ATLANT. O.	0,33
TOT.ATLANT.	0,55
MEDITERR.	0,00
ATL+MED	0,53
PACIFIC O.	0,00
INDIAN O.	0,00
TOTAL	0,49

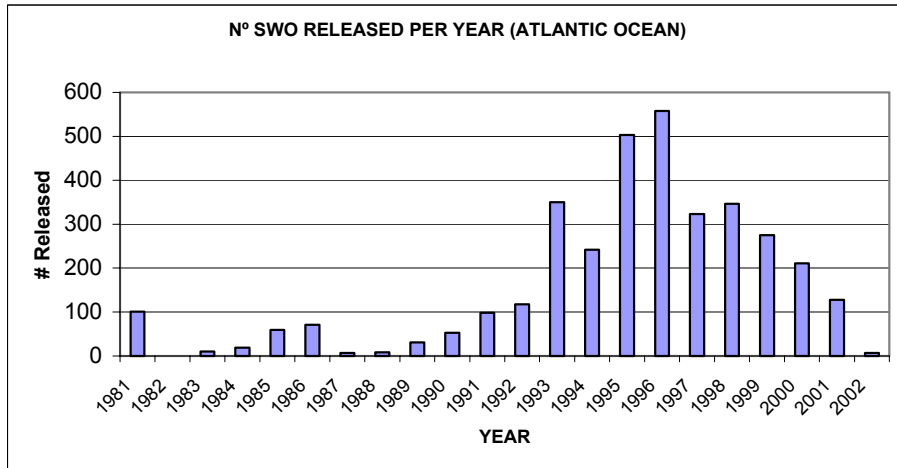


Figure 1. Total number of swordfishes tagged and released in the Atlantic Ocean by year during the scientific tag surveys and opportunistic tagging , (1981-2002).

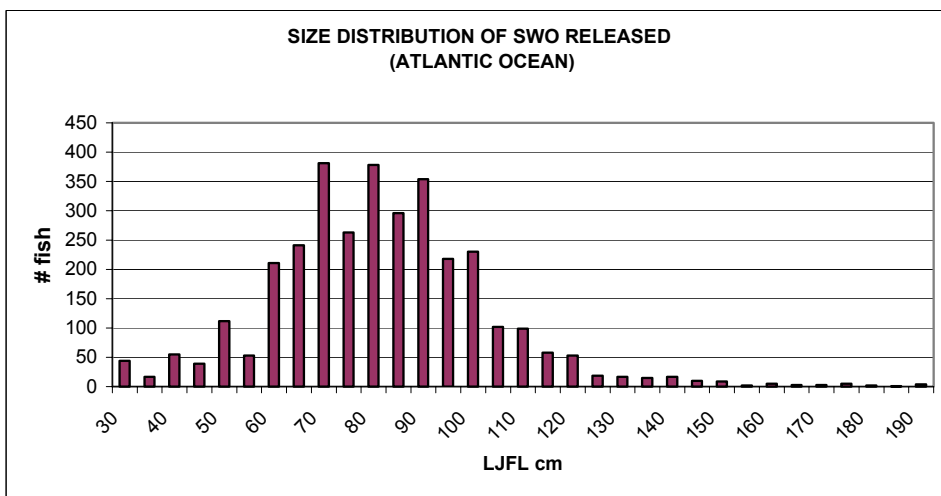


Figure 2. Number of swordfishes tagged and released by size class (LJFL) in the Atlantic Ocean during the scientific tagging surveys and opportunistic tagging, (1981-2001).

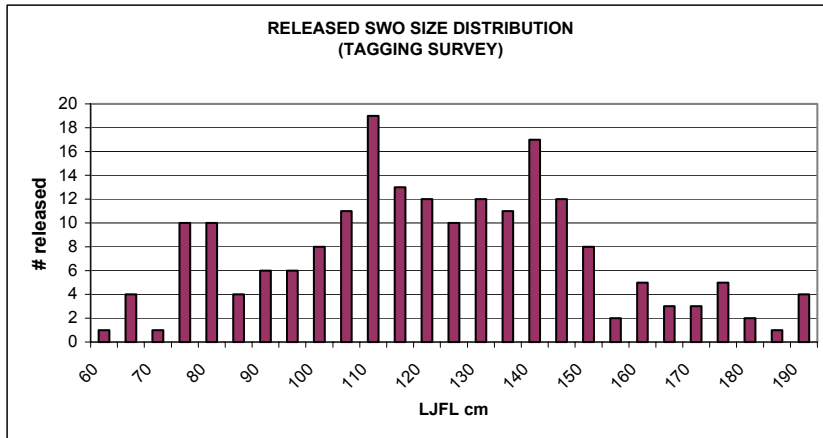


Figure 3. Size distribution of swordfish tagged and released in the North Atlantic during the scientific tagging surveys.

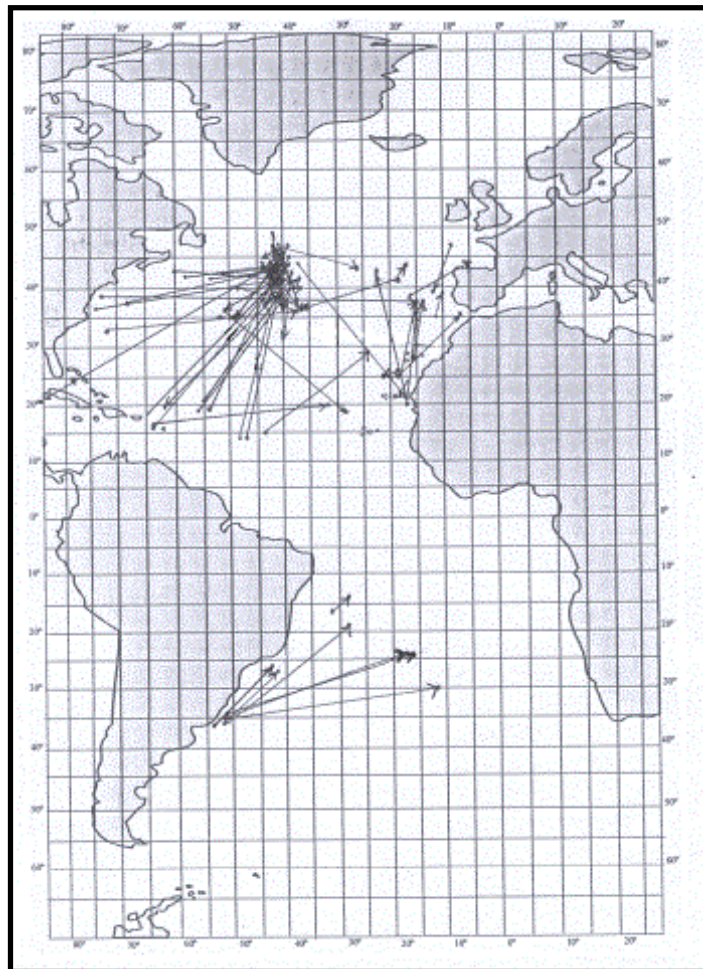


Figure 4. Rectilinear diagram of hypothetical movements of tagging-recapture of the swordfish reported to the IEO (1984-2002).

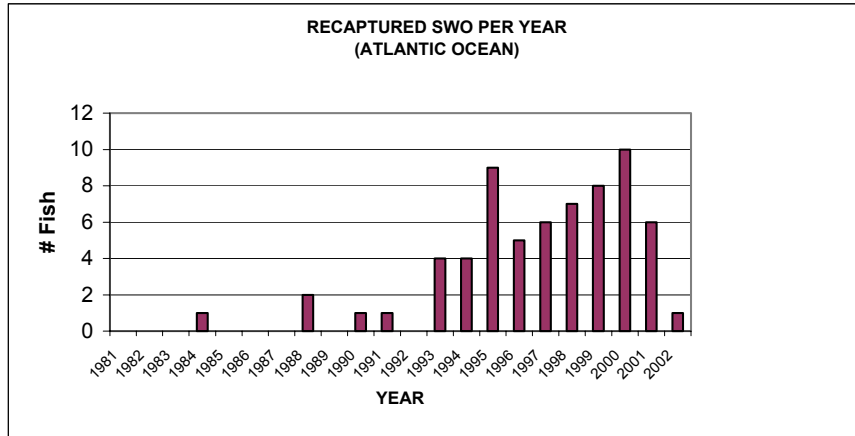


Figure 5. Number of swordfish specimens recaptured by year (1984-2002). Data for year 2002 is incomplete.

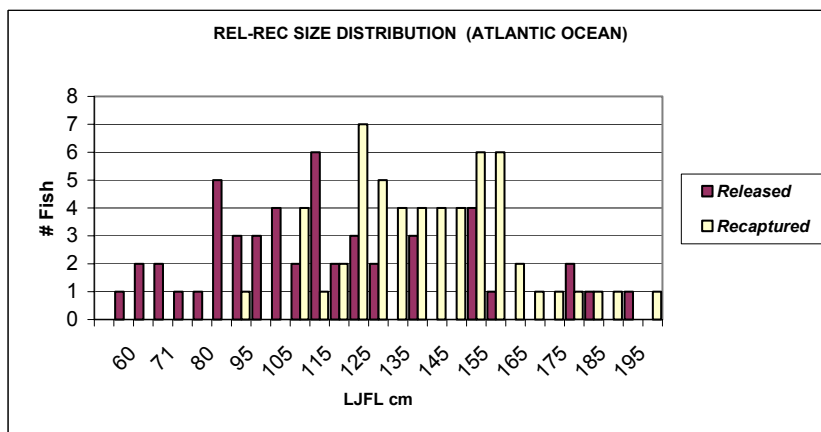


Figure 6. Swordfish size distribution (LJFL) at the time of tagging and recapture under the tag program carried out in the Atlantic Ocean (1981-2002).