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THE TUNA FISHERY IN THE EASTERN ADRIATIC

Verónica Alegría Hernández
Institute of Oceanography and Fisheries, Split

SUMMARY

The development of tuna fishery in the eastern Adriatic between 1947 and 1989 is presented. Bluefin tuna makes up the largest proportion of the total tuna catch whereas small tuna species (bonito, frigate tuna and little tunny) are caught in small quantities. Between 1947 and 1964 fishing was made by passive (traps) and active techniques (purse seines) and catches showed a decrease trend. From 1965 to date, only purse seines have been used and the catch has significantly increased. Data on the weight of tuna specimens are also given.

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INTRODUCTION

Even though of great significance in commercial fishing, tunas are still poorly studied fish species in the Adriatic Sea. Tuna fishing along the eastern Adriatic coast by traps and fixed nets can be traced back to the sixteenth century. These techniques were applied until about 1964. Modern tuna fishing techniques began to develop in 1929, when the first tuna boat with a purse seine was used (Basioli, 1962).

IDENTIFICATION OF THE FISHERY

Of the tunas, the bluefin tuna (Thunnus thynnus L.) is the most important as to catch quantities; that is, they make up, on the average, 77.3% of the total tuna catch for the 43-year period (Table 1). Small tunas, such as bonito (Sarda sarda Bloch), frigate tuna (Auxis rochei, Risso) and little tunny (Euthynnus (euthynnus) quadripunctatus Geoffrey Saint Hilaire) are caught in smaller quantities.

In the postwar period, tuna fishing developed intensively so that, with great annual variations, it amounted, on the average (43-year series), to the 2.9% of the total national catch. Two periods of this development may be distinguished: The first interval from 1947 to 1964 is characterized by the use of passive techniques (traps and fixed nets) and active fishing by tuna purse seiners with an annual average percentage of 3.4% of the total national catch. During the second interval, from 1965 to date, only purse seiners (active method) has been used. These boats also fish for small pelagic fishes. The proportion of tuna catch in the total marine catch dropped to 1.5%. Tuna purse seiners use nets approximatively 1000 m in length and 120 m in depth.

FISHING GROUNDS

Traditional tuna fishing grounds, particularly those for bluefin tuna, are in the northern part of the eastern Adriatic. Very big catches are taken from the vicinities of Kvarner and Kvarnerić. However, recently, best catches have been made off the islands of Lošinj and Dugi-otok. Bluefin are also caught in

significant quantities around the islands of Jabuka, Vis and Palagruža, as well as in the area of Blitvenica. They are rarely caught from the Pelješac channel (Fig. 1).

Bluefin tuna come from the eastern Mediterranean, moving in a south-north direction. A part of the population entering the Adriatic moves along the eastern coast to the north of the northern Adriatic descending in the opposite direction along the Italian coast. The other part of the population enters the middle of the Adriatic up to the Jabuka Pit moving along the Italian coast southwardly (Sccacini, 1961; Viličić, 1985). Younger fish mainly keep in the open middle Adriatic, prevalently around Jabuka, or the northeastern part of the Jabuka Pit (Basioli, 1962; Morović, 1968; Viličić, 1985; Alegría, 1984).

TUNA FISHING FLEET

The Yugoslav fleet developed considerably in the post-war period; 32 boats were operating in 1958. Owing to a period of poor productivity, this number was reduced so that, in the corresponding period of adaptation, only 14 (± 1) purse seiners remained, fishing alternately for tuna and small pelagic fish. These purse seiners are characterized by a hull length of 18.2 - 26.8 m and a gross registered tonnage (GRT) of 70 - 122 tons, and are equipped with engines of 200 - 400 HP. Half these boats have freezing facilities on board. Boats mainly belong to two principal fishing companies in Split and Zadar. They take about 95% of the total bluefin tuna catch. Catches of small tunas species are made by individual fishermen.

METHODS OF TUNA FISHING WITH PURSE SEINE

Most Yugoslav tuna fishing boats fish at night when over 90% of the catch is taken. Vessels may fish singly, in pairs, or in groups.

According to Viličić (1985) bluefin tuna schools may be detected by purse seiners in a variety of ways: when the fish are "jumping" for food or swimming at the sea surface, or disturb the sundance (by day), or generate phosphorescence (by night); by direct observation from spotter, by the inferred association with schools of dolphins and with floating objects.

When bluefin tuna are in pursuit of good at the sea surface they first force small pelagic fish schools to the surface where they chase them, even jumping out of the sea to catch their prey. If fish find enough food they will keep at the same site for a long time, so that a purse seiner may easily encircle the school and catch it.

The second method of bluefin tuna fishing is used for fish swimming at the sea surface. If the fish are small, from 5 to 10 kilogrammes, they generate small waves, whereas bigger fish of 30 or more kilogrammes generate bigger waves and their fins are easily visible.

Fishing for bluefin tuna at night, when the tuna may generate intense phosphorescence in the sea water that is visible when there is not moonlight, requires particular experiences and skill.

BLUEFIN TUNA CATCH

Bluefin tuna catch statistics expressed as total fish weight (in kg) at landing includes the data of all boats engaged in tuna fishing. It is a common practice that whole fish are landed immediately after catch. Rarely, gutted fish are also landed.

The trend in the proportion of bluefin in the total tuna catch is upwards and was 94.8% in 1988. The lowest percentage was obtained in 1955 (38.4 %) and lowest catch was made in 1962. Variations in bluefin tuna catch are presented in Figure 2 (annual) and Figure 3 (seasonal).

During the period of mixed (passive and active) fishing methods, 1947-1964, the bluefin tuna catch, with normal fluctuations, dropped from 897 t in 1948 to 271 t in 1964. This period was followed by a period of variable and low catches by 1974, with a mean annual catch of 236 tons.

The 1975-1988 period is characterized by an increase in the catch to the maximum value of 1523 t in 1988. Mean catch was 822 t per year in this period. In 1989, catch dropped to 560 t.

SMALL TUNA SPECIES

The statistics for these catches are not quite reliable. Most of small--tuna catch is realized by individual fisherman, who are not obliged to submit the data to the authorities.

In any case, the catch of small tunas shows a significant decrease throughout the period of observations. Bonito make up, on the average, 11.6% of the total tuna catch, with particularly low catches for the last few years, whereas, in 1955, the catch was 311 t; that is, 35% of the total tuna catch that year. However, a sudden increase in the catch of this species was recorded in 1989.

The catch of frigate tuna varies around 12% of the total tuna catch, with a decreasing trend being particularly pronounced since 1972.

Little tunny is a relatively unimportant species in the catch of small tunas, constituting not more than 2% of the total tuna catch.

Skipjack (Euthynnus (Katsuwonus) pelamis L.) occurs very rarely and for these fish no statistics are accummulated.

TUNA FISHING SEASON

Tuna fishing is seasonal, although the bluefin tuna are caught all year round (Fig. 3). The catch is considerably lower in winter down to quite insignificant amounts, very likely due to tuna migrations and climatic factors, as well as to the fact that purse seiners are engaged in small--pelagic fishing.

The statistics for the 1963-1989 period (Table 2) show that most of the bluefin tuna catch is made during summer. On the average, 52.7% of the total annual catch is obtained in July, August and September and 28.5% during the spring months. However, in the 1974-1976 period, almost the total annual catch was made during the first four months of the year.

WEIGHT STRUCTURE OF BLUEFIN TUNA CATCHES

The analyses of landings in the 1978-1988 period showed weight of specimens to vary from 6 to 200 kg, even though smaller specimens of 3-4 kg were also recorded. It is a common practice that bigger specimens are delivered directly to fish factories where total weight of landed catches is recorded. In the case of younger fish, the number of individuals and their total weight are recorded during transportation.

The number of younger specimens caught during individual fishing trips in 1978-1988 is given in Table 3 and 4. The recorded number of bluefin tuna caught comprises specimens of 3-30 kg weight. The rest of the caught fish are specimens of 10 to 200 kg weight.

Specimens of 6-14 kg prevail in observed catches, making up 52%, while individuals of 3-5 kg make up 33.5%. This means that these catches include specimens 2-3 years old and to a lesser extent 1-year-olds. These are juveniles or fish in the pre-adult stage of development or fish just reaching first maturity (Scaccini, 1965; Morović, 1971; Farrugio, 1978).

It still seems that the specimens of 4-10 years of age make up the major part of the catches.

Morović (1971), on the basis of measurements of 426 bluefin tuna specimens caught by purse seine in 1957-1961, reported the values for fork length and weight, shown in Table 6.

This author stated that all these individuals were immature.

The length-weight relation derived from these data is:

$$W = 1.66 \times 10^{-5} FL^{2.98} \qquad (r^2 = 0.97)$$

On the basis of practical experience and analysis of successive catches from the middle Adriatic over a longer time interval, Viličić (1985) concluded that young bluefin tuna grow rapidly. This author suggested that younger bluefin tuna showed a daily weight gain of 300-350 g. He also reported that young bluefin tuna weighed 2.8 - 5.8 kg during the second year of age, 10-16 kg during the third, 20-27 kg during the fourth and 30-37 kg during the fifth year of age.

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Table 1. Total catch of large pelagic fish from the eastern Adriatic in 1947-1989 (%T is percent of national catch)

Year	No.of vessels	BFT	%	BON	%	FRI	%	LT	%	TOTAL	%T
1947	-	459	46.5	295	30.5	185	19.1	22	2.3	968	5.8
1948	-	897	64.6	342	24.6	127	9.5	10	0.7	1388	5.7
1949	14	802	80.1	68	6.8	79	7.9	33	3.3	1001	4.1
1950	14	657	87.5	47	6.3	29	3.9	18	2.4	751	3.0
1951	14	531	81.2	48	7.3	52	8.0	23	3.5	654	3.9
1952	16	279	77.1	36	9.9	36	9.9	11	3.0	362	2.3
1953	21	588	92.3	21	3.3	22	3.5	6	1.7	637	3.7
1954	27	654	72.9	40	4.5	77	8.6	126	9.9	897	6.0
1955	30	346	38.4	311	34.6	195	21.7	47	5.2	898	6.6
1956	27	253	49.2	180	35.0	68	13.2	13	2.5	514	2.8
1957	29	382	84.5	27	6.0	32	7.1	22	4.9	453	2.2
1958	32	388	72.6	13	2.4	86	19.0	47	8.8	534	2.3
1959	27	224	66.4	30	8.9	72	21.4	11	3.3	337	1.8
1960	18	109	59.2	20	10.9	43	23.4	12	3.6	184	0.9
1961	15	123	46.6	82	31.1	35	13.3	24	9.1	264	1.0
1962	9	87	50.6	42	24.4	41	23.8	2	1.2	172	0.9
1963	16	277	70.3	34	8.6	75	19.0	8	2.0	394	1.8
1964	20	271	74.7	22	6.1	68	18.7	2	0.6	363	1.4
1965	14	134	61.5	30	13.8	52	23.9	2	0.9	218	0.8
1966	21	246	56.7	138	31.8	47	10.8	3	0.7	434	1.6
1967	16	331	73.2	56	12.4	58	12.8	7	1.5	452	1.5
1968	13	150	64.4	28	12.0	50	21.5	5	2.1	233	0.8
1969	17	301	78.8	17	4.5	56	14.7	8	2.9	382	1.4
1970	12	90	69.8	10	7.8	24	18.6	5	1.3	129	0.5
1971	16	326	87.6	13	3.5	29	7.8	4	1.1	372	1.2
1972	16	200	81.3	13	5.3	21	8.5	12	4.9	246	0.8
1973	14	224	90.0	4	1.6	12	4.8	9	3.6	249	0.8
1974	16	317	90.3	10	2.8	22	6.3	4	1.1	351	1.2
1975	13	155	77.5	9	4.5	16	8.0	20	9.9	200	0.6
1976	16	562	92.9	23	3.8	18	3.0	2	0.3	605	1.7
1977	14	932	94.5	26	2.7	24	2.6	4	0.4	986	2.8
1978	15	1049	94.2	39	3.5	23	2.1	0	-	1111	3.0
1979	16	756	94.1	29	3.6	17	2.2	0	-	802	2.4
1980	13	573	86.5	72	10.8	19	2.9	0	-	664	1.9
1981	12	376	87.6	39	9.1	14	3.3	0	-	429	1.0
1982	14	486	86.6	61	10.8	14	2.6	0	-	561	1.4
1983	13	1222	96.1	31	2.4	18	1.4	1	0.1	1272	2.4
1984	14	755	92.9	37	4.5	16	1.9	6	0.7	814	1.7
1985	14	1084	95.6	34	3.0	14	1.3	1	0.1	1133	2.3
1986	13	796	91.8	38	4.3	32	3.7	1	0.1	867	1.7
1987	14	648	89.3	62	8.5	14	1.9	2	0.3	726	1.4
1988	15	1523	94.8	36	2.2	41	2.6	5	0.4	1605	3.5
1989	14	560	79.5	98	13.9	42	7.0	4	0.6	704	1.5

Table 2. Monthly bluefin tuna catch frequency distribution for the eastern Adriatic, 1963-1989

Year	Months											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1963	-	-	17.8	3.5	1.1	58.8	163.7	24.0	5.4	2.6	0.1	-
1964	-	0.1	0.1	5.5	74.1	21.5	34.3	48.8	59.7	10.2	13.3	1.0
1965	-	1.2	4.1	4.6	0.9	18.3	3.2	36.4	41.5	17.5	3.8	0.3
1966	0.1	-	-	0.4	0.9	0.7	55.7	60.2	67.4	30.3	11.9	16.7
1967	0.5	0.3	0.3	5.0	11.1	0.2	0.1	157.9	86.4	46.7	22.2	0.3
1968	0.2	0.3	3.3	1.1	1.8	11.9	9.4	15.3	61.1	27.2	15.8	0.9
1969	0.5	0.6	0.4	0.5	44.1	2.4	10.7	94.1	134.2	10.2	1.9	1.0
1970	0.8	0.6	0.3	4.3	49.6	9.4	3.4	0.4	14.9	5.7	0.6	0.4
1971	0.6	0.3	0.7	36.8	14.9	14.2	134.5	55.2	40.2	8.6	1.0	18.6
1972	0.7	0.5	39.0	32.2	18.1	0.7	13.4	5.7	27.4	54.4	1.2	6.1
1973	0.6	0.4	0.1	10.5	40.1	5.6	0.3	47.9	57.3	4.5	55.9	0.6
1974	105.6	29.2	47.4	19.2	4.8	7.8	34.7	19.4	23.5	0.3	17.4	7.4
1975	0.8	0.2	30.8	61.0	20.3	5.4	0.2	5.4	14.4	14.6	0.3	1.0
1976	0.6	23.6	134.6	60.7	48.6	103.3	79.2	57.8	50.5	1.2	1.8	0.5
1977	3.6	0.1	129.7	19.9	76.1	142.4	259.9	124.8	61.9	89.6	20.6	3.1
1978	0.5	0.2	23.4	13.6	240.4	136.3	26.1	188.4	391.2	20.5	1.7	6.7
1979	0.6	0.2	0.3	24.8	138.9	162.8	297.4	199.1	37.8	2.6	1.1	21.4
1980	1.0	39.0	21.0	78.0	98.0	95.0	21.0	163.0	32.0	1.0	1.0	11.0
1981	2.0	1.0	16.0	6.0	18.0	6.0	150.0	13.0	99.0	64.0	2.0	1.0
1982	16.0	85.0	48.0	103.0	13.0	46.0	23.0	142.0	7.0	1.0	1.0	-
1983	0.3	4.0	148.0	106.8	61.2	156.0	237.0	252.0	223.0	1.9	28.0	0.2
1984	-	-	2.0	4.0	2.0	127.0	50.1	255.5	176.1	126.4	10.1	0.3
1985	0.4	0.2	1.8	15.8	406.8	188.0	121.0	188.2	73.0	55.0	1.0	0.2
1986	-	0.3	10.0	20.0	11.0	72.0	244.0	302.0	115.0	2.0	1.0	-
1987	1.0	0.2	1.0	176.0	6.0	2.0	-	2.0	216.0	236.0	0.5	-
1988	1.0	92.0	51.0	59.0	255.0	149.0	65.0	404.0	239.0	197.0	7.0	4.0
1989	4.0	12.0	7.0	2.0	20.0	0.5	4.0	240.0	238.0	239.2	2.2	1.3
%	1.0	2.0	5.3	5.3	12.2	10.7	13.8	21.2	17.7	8.7	1.5	0.7

Table 3. Structure of the catches of younger bluefin tuna as percentages of the total number of individuals (A) and their total weight (B) 1978-1988.

Individual weight range (kg)	A	B	Individual mean weight (kg)
3 - 5	33.5	11.8	3.98
6 - 8	18.4	14.5	6.93
9 - 11	15.5	16.5	10.08
12 - 14	18.0	24.4	12.94
15 - 17	3.8	6.4	16.00
18 - 20	4.1	8.4	19.04
21 - 23	1.0	2.4	21.73
24 - 26	4.0	10.7	25.11
27 - 29	1.4	4.1	28.07
30 - 32	0.1	0.3	31.11
33 - 35	0.1	0.2	34.18

Table 4. Annual weight distribution frequency of catches of younger bluefin tuna for the eastern Adriatic in 1978-1988.

W(kg)	Years									
	1978	1979	1981	1982	1983	1984	1985	1986	1987	1988
3	897	1358	244	2944	1531	182	800	9044	-	19326
6	-	36	1399	-	5377	479	472	1907	-	6995
9	6166	1391	230	3208	455	197	845	3848	2593	6719
12	1361	1556	743	117	3703	4688	859	4177	-	4728
15	802	-	123	-	210	-	408	243	1361	1040
18	681	-	-	-	-	-	384	192	100	2516
21	-	-	-	-	-	-	429	-	-	1795
24	-	-	-	-	80	-	-	634	-	3447
27	-	-	-	-	-	-	-	-	-	1148
30	-	-	-	-	-	-	-	81	-	-

Table 5. Length-weight data for bluefin tuna. (Morović, 1971)

FL(cm)	W(kg)	FL(cm)	W (kg)	FL(cm)	W(kg)
50	2.5	90	10.0	120	25.5
60	3.0	100	13.0	128	30.0
70	4.5	102	14.0	129	35.0 - 40.0
80	8.5	108	17.0	130	40.0 - 50.0

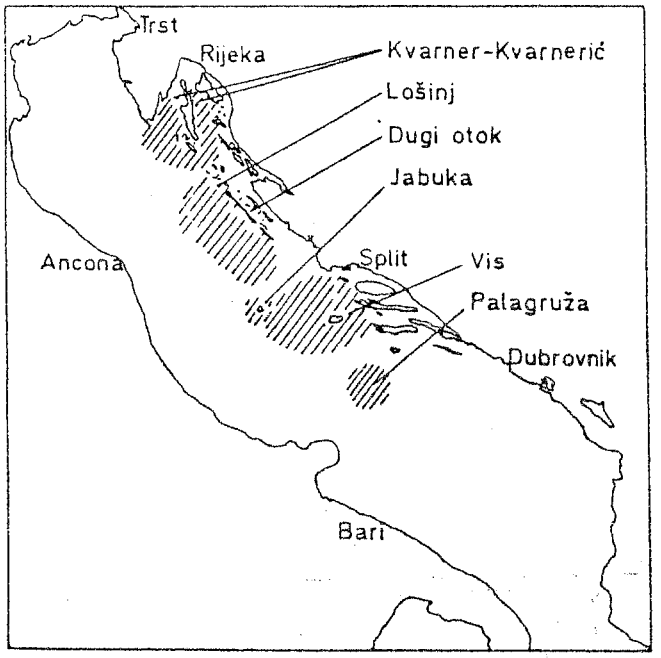

Fig. 1. Bluefin tuna fishing areas in the eastern Adriatic

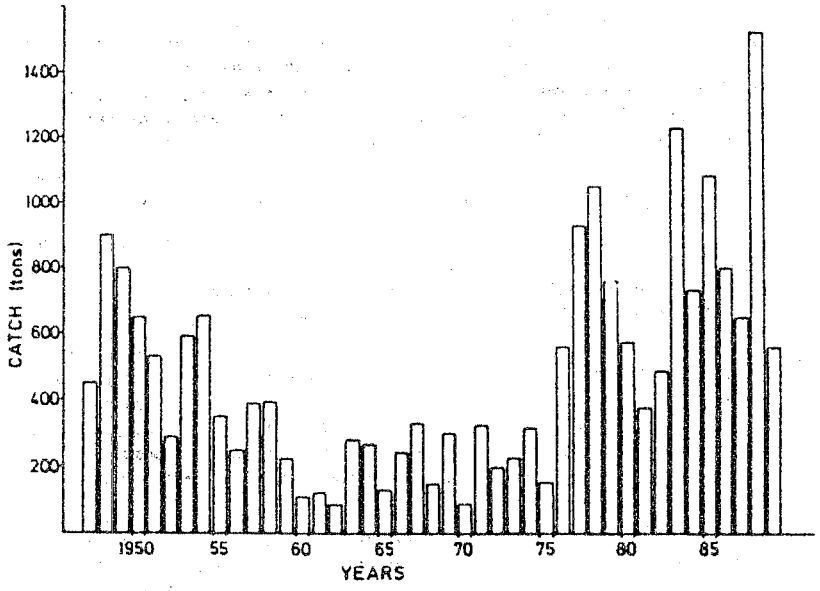

Fig. 2. Annual catch of bluefin tuna in the eastern Adriatic, 1947-1989

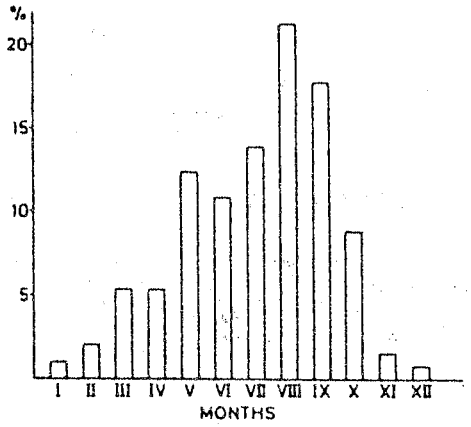

Fig. 3. Seasonal variations of bluefin tuna catch in the eastern Adriatic