DESCRIPTION OF THE JAPANESE LONGLINE FISHERY FOR BLUEFIN TUNA IN THE ATLANTIC

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1. HISTORY OF THE FISHERY

The Japanese longline fleet has largely changed the location of its fishing grounds in the course of the fishery development (Shingu and Hisada, 1977). The longline fishery, which started in western equatorial waters in 1956, expanded into the whole tropical waters, in the mid-1960's and then into higher latitudinal waters both in the northern and southern hemispheres (Fig. 1). Fishing effort, in terms of hook number, was about 100 million in the peak year, 1965, and afterwards decreased rapidly. In the early 1970's longline fishing effort tended to concentrate in temperate waters and this trend became more clear up to 1977.

The change in the longline fishing grounds was due to the fact that the target species of Japanese longliners changed from yellowfin, albacore and bigeye in the tropical waters to southern bluefin, bluefin and bigeye tunas distributed in temperate waters. From the beginning of the fishery to 1965, the peak year of fishing effort, most of the Japanese yellowfin and albacore catches from the Atlantic were landed at Las Palmas, Freetown, Dakar, Recife, Santos, Port of Spain and Venice, etc. for raw materials of canning for foreign consumption. However, in the early 1970's domestic consumption of southern bluefin, bluefin and bigeye for "sashimi" and "sushi", typical Japanese foods served raw, increased remarkably with the economic growth of Japan, so that longline fishing has been directed mainly at such tunas and most of the catches have been landed at Japanese ports. It seems that the catch of bluefin tuna off Brazil and eastern Florida in the 1960's was by-products while aiming at yellowfin and albacore catches and exported mainly to Italy and other Mediterranean countries for canning. Since the early 1970's the Japanese fishery has operated selectively in those areas and seasons, especially before spawning, in which bluefin tuna have a high fat content and are of higher commercial value. However, as will be mentioned later, due to the multi-specific nature of the longline fishery, the fishing grounds where only bluefin tuna dominate were few throughout the Atlantic Ocean.

2. FISHING GROUNDS AND SEASONS

Figure 1 suggests that most of the bluefin catch has been made recently in coastal areas rather than in oceanic waters. In this report the fishing season of bluefin is described by

Original report in English.

ICCAT (International Commission for the Conservation of Atlantic Tunas) Statistical Areas (Fig. 2). Annual catches of bluefin tuna by these areas are summarized in Table 1. Figure 3 shows the annual catch and effort (hook number) for the areas where bluefin catches are relatively high. This figure well reflects the historical changes in bluefin fishing grounds mentioned in the previous section. Longline operations in Areas 61 and 64 virtually ceased several years ago. The fishing seasons by area, based on the monthly species composition of the catches, are described as follows:

2.1 Past fishing grounds

Area 64 (off Brazil): Shingu and Hisada (1977) showed the monthly species composition of the longline catches from nearly the same area as Area 64. In this fishing ground bluefin were caught, mixed with target species, yellowfin, albacore and bigeye, from 1962 to 1965. After 1965 no significant catches of bluefin were made. Two fishing seasons, from March to April and from September to November, were observed in the period 1962 to 1965. Recently, the Japanese fishery in this area was replaced by the Korean and Cuban longline fisheries but no significant catch of bluefin is made.

Area 61 (northeast of Cuba): In this fishing ground bluefin tuna were caught during 1964 through 1967 when fishing effort was concentrated in the temperate waters and directed at adult albacore (Fig. 3). The fishing season was from May to June (Shingu and Hisada, 1977). However, recent bluefin catches by the Japanese and other longline fisheries are negligible. This type of large historical changes in the catch is one of the characteristics of the Atlantic and Pacific bluefin (Nakamura, 1965).

2.2 Present fishing grounds

The monthly species composition of the catches in these fishing grounds is shown in Fig. 4.

Area 51 (off Boston and New York): This fishing ground was exploited first aiming at bigeye and albacore in 1972 and secondly at bluefin tuna as well as bigeye. The fishing season runs from December to February.

Area 52 (off Newfoundland): Since 1970 the bluefin catch has been made during the season which runs from July to August or from November to December.

Area 55 (off Cape Hatteras): The fishing season and area are different between the early years (1964-66) and recent years. In the early period bluefin were caught with albacore from May to July. In recent years, however, the bluefin catch is made from December to February in the northern part of the area along the southern border of Area 51.

Area 60 (Gulf of Mexico): The Japanese longline fishery in this area started in 1964. Up to the early 1970's the bluefin catch was quite low because fishing effort was expended mostly in the fishing ground south of 25°N aimed at yellowfin during the summer season (Shingu and Hisada, 1977). Since 1975, the longline fishing has been directed at adult bluefin in the fishing ground north of 25°N from March to June.

Area 54 (Bay of Biscay): Small and medium-sized bluefin were caught from July to September during 1974 and 1975 in a relatively large number. However, fishing effort in this area declined rapidly after 1975 because the size of the fish caught was small and the meat of the fish was not suitable for raw consumption.

Area 58 (off Strait of Gibraltar): Bluefin have been caught with bigeye from 1974. The major part of the total bluefin catch is made from March to June and the remainder from October to February.

Area 59 (Mediterranean Sea): The longline fishery for bluefin tuna began in 1974. Except for the sporadic catch of swordfish and albacore, bluefin tuna is the only species caught by the longline fishery in this area. The fishing season was originally from May to July. Since 1975, the Japanese Government has prohibited Japanese longliners from fishing in this area from May 21 to June 30. Accordingly, no Japanese fishing takes place during this period.

3. FISHING GEAR, BOATS AND EQUIPMENT FOR THE LONGLINING METHOD

The basic gear construction of the longline consists of the mainline, branch lines, floats, float lines and hooks (Fig. 5). Wire lines of 2 to 4 m are used for the connecting parts with the hooks. The section between the two floats is called a "basket" and this unit normally includes 4 to 6 branch lines, attached to the mainline with snaps about 50 m apart from each other. The total straight distance of the mainline set in a normal operation with about 2,000 hooks reaches some 80-100 kms.

Although the gear structure of the longlining method, such as length of the float lines, number of branch lines in a basket and the sizes of hooks are sometimes changed depending on the species pursued (Suzuki et al, 1977), they remain more or less the same without major modifications regardless of the species or fishing grounds. Since the fishing operation is conducted from early morning to late night, automatic light buoys are attached to the parts of the mainline hauled at night. One or two radio buoys are also attached to secure the location of the gear.

The depths of the hooks set varies considerably according to such factors as sagging rate (ratio of horizontal distance between the two floats to the stretched length of the mainline per unit basket), length of the mainline in the unit basket and the currents. However, theoretical calculations with a common gear construction (branch line 30 m, float line 20 m, length of the mainline between the neighboring branch lines 50 m and sagging rate of 0.6) assuming the mainline hanging in a catenary, give the following estimation:

Serial number of branch counted either end of a basket (assuming symetrical shape in a catenary one half of the serial numbers are shown)	Number of the branch lines in unit basket			Depth in meters
	4	5	6	
1	96	96	97	
2	134	138	140	
3		159	172	

Longline fishermen use a 4-branchline-gear with larger hooks (14-16 cm in curved length measured along the hooks from base to the tip) than those employed on normal occasions (12-13 cm) in Areas 59 (Mediterranean) and 60 (Gulf of Mexico) where giant bluefin are usually caught. In the rest of the Atlantic, 5- or 6-branchline-gears are commonly used. The use of the 4-branchline-gear when catching large bluefin individuals is to set the hooks slightly shallower than in the usual case and by reducing the number of hooks in a basket to prevent capturing too many fish in a basket which sinks the gears to the depth, resulting in loss of fish and gears.

Table 2 shows the number of Japanese LL boats operating in the Atlantic. Homeland-based boats are now predominant and there are virtually no deck-loaded motherboats and foreign-based boats operating any more. These were once the main components of the Atlantic Japanese longline boats. All the presently-operating homeland-based boats are included in the 201-500 gross ton class, more specifically in a 300-400 ton class. While the majority of the boats shown in Table 2 operate only in the southern hemisphere, mainly off Cape Town for the purpose of capturing southern bluefin tuna, about one half to one-third of the boats categorized in the 201-500 ton class operate in the northern hemisphere pursuing bigeye and bluefin (personal communication with the Federation of Japan Tuna Fishermen's Co-operative Association). Only a small number of the boats operate both in the northern and southern Atlantic in one trip.

The carrying capacity of the boats from 300 to 500 gross tons ranges from about 250 to 400 tons and normally have about 20 crewmen on board. These longline boats are equipped with such nautical instruments as direction finder, fish finder, loran and radars as well as quick deep freezers (-50°C--60°C). Some of the work, from casting to holding of the various line parts of the longline gear, is now semi-automated.

4. RELATIONSHIP WITH OTHER FISHERIES AND SPECIES

The Japanese longline boats operating in the Atlantic engage exclusively in the longline fishery for capturing only tunas, with the very rare exception in that some boats use handlining gear in a particular area to catch bigeye. As mentioned previously, the longline fishery is a typical multi-specific fishery. Therefore, although bluefin as well as bigeye are pursued, they are usually caught mixed with a considerable amount of other tuna species, except in the Mediterranean Sea (Fig. 4).

5. TYPE OF BAIT

Like in other areas, in the Atlantic saury (Cololabis saira) and squid (Tridarodes pacificus) are most commonly used as bait for longlining. Although a specific bait could be used aimed at specific species, it is surmised that there may be little bait preference, if any, among tunas and success in fishing may depend instead on how well the bait is retained on the hooks rather than on the kind of bait. However, there are no systematic studies on the relationship between the kinds of bait and fishing efficiency for various tunas.

In areas where large bluefin are caught, larger squid (about 250-300 g) are used, with some supplementary amount of mackerel (Scomber japonicus) around 250 to 300 g. In other areas, normal longline-sized saury about 100 g or squid about 150-200 g are used. Mackerel are recently being used to some extent as a substitute for squid, due to the increase in price on the domestic markets of Japan. The bait fishes all used to be loaded in Japan but due to the increased squid price a considerable amount of squid (Illex illecebrousus) caught along the eastern coastal areas of Canada and the U. S. is now loaded at Canadian and U. S. ports by the longline boats operating in the northern Atlantic (personal communication with J. Ogawa).

6. LONGLINE OPERATION

The operation is conducted once a day and takes about 15 working hours to complete. Casting the gear begins from about 4 a.m. at the stern and takes 4 hours or so at a boat speed of about 10 knots. Then the longline set is left intact for 3 to 4 hours to await the tunas hooked. Hauling of the gear starts in the afternoon from the basket set last in the reverse order of the casting. The hauling takes about 10 hours at a boat speed of about 6 knots. At casting, the branch lines and buoys are attached to the mainline by snaps at a constant interval. The hauling is done on the starboard deck at the bow (Fig. 6). After detaching the branch lines and buoys, the mainline is held in store at the stern by way of the guide at the port. The detached branch lines and buoys are also stored at the stern in a similar way.

The longline boats are being built to endure rough weather by the installation of forecastle deck and high sides and are capable of maintaining the operations up to scale 6 on Beauford's Wind Scale. It takes a long period to complete one trip for the longline boats operating in the northern Atlantic because of remoteness from Japan and the low catch rate per operation, normally one to two tons.

Generally the number of operations per trip and the number of days per trip ranges from 200 to 300 sets and 300 to 400 days, respectively. Since the fishing season for bluefin tuna in each fishing ground is distinct, the longline boats usually shift their fishing grounds pursuing the best fishing grounds succesively in the course of the year, entering the ports for fuel and food supplies once every 3 or 4 months.

There seem to be no specific critical indices for finding good fishing grounds, except for the continental slope with a range of depth from 200-800 m, on which the longline operations are usually carried out. The longline boats form a fleet and search for good fishing spots on the basis of experience accumulated in the past.

7. PROCESSING OF THE CATCH ON-BOARD

Special attention is given to the processing and storage of the catches on-board by the Japanese tuna fishermen, as the catches are solely consumed raw. The fish hauled on-board (if alive, they are killed by a wooden-hammer beating on the head) are removed of their gills, guts and fins. Before this process, bleeding by cutting the surface blood vessel system particular to the tunas (retia mirabilia) at the base of the pectoral fins and caudal peduncle has recently been practiced to prevent deterioration of the meat quality.

The gilled-and-gutted and bled fish are submerged in cool sea water (2-5°C) and kept in the container for about one half to one hour to improve freezing efficiency and for cleaning of the bodies. After this, to complete the bleeding, the fish are hung upside-down in the pre-freezing chamber. It takes two whole days to complete deep freezing of the fish on the shelves with cooling tubes and the frozen fish are glazed for protection from drying and then stored in the fish wells at -50°C-60°C room temperature. The fish less than 150 kg are stored in a gilled and gutted condition, whereas larger fish are further filleted into four pieces.

8. TRENDS OF FISHING EFFORT AND CATCH AND SIZES OF THE FISH TAKEN

Due to the typical multi-specific nature of the longline fishery, it is difficult to separate the fishing effort directed at bluefin tuna from the total exerted effort. One way to ease this problem is to stratify the catch and effort data by a smaller spatio-temporal stratum (Shingu and Hisada, 1977, 1978). Therefore, the annual fishing effort shown in Figure 3 does not necessarily represent that directed to bluefin only, but it is still considered a reflection of gross trends of effort exerted on bluefin tuna in each fishing ground. The sizes of the bluefin in the catches from various fishing grounds have been reported in detail by Shingu and Hisada, (1977, 1978).

In Areas 51 and 52, both the fishing effort and the catch have increased after 1970 with considerable annual fluctuations. The fish taken from these areas are comprised mainly of individuals from 80 to 160 cm in fork length, mostly immature, and the fish from Area 52 tend to be larger than those in Area 51. Large bluefin, probably spawning fish, over 180 cm were caught during the years 1964-1966 in the southern parts of Area 55 but the fishing ground of this area in recent years has shifted to the northern parts contiguous to Area 51 and the catch shows a size range similar to that of Area 51.

In Area 60, spawning bluefin tuna mostly larger than 200 cm have been caught in substancial numbers after 1974 with the corresponding increased fishing effort. Large-sized fish similar to those in Area 60 were caught in Areas 61 and 64 in the early or mid-1960's but both fishing effort and catch in recent years are very low in these areas.

The operations in Areas 54, 58 and 59 started in the early 1970's and a high level of fishing effort and catch were shown in 1974 and 1975. However, after 1975, fishing effort and catch decreased remarkably, especially in Area 54. The sizes of the catch in Area 54 range from 80 to 160 cm and in Areas 58 and 59, large fish contributing to spawning, mainly over 180 cm, are caught.

9. MARKETING, FORMS OF CONSUMPTION AND AVERAGE PRICE

The bluefin caught in the Atlantic by the Japanese longline boats are all unloaded at major Japanese fishing ports. They are marketed by either bid or auction in a deep frozen condition. A new type of trading has become popular in recent years in which buyers, usually large trading

companies, make contracts at the fish markets with ship owners for whole catches of a boat without bid or auction.

Due to improvement in freezing techniques, it is not unusual that the same fish are sold several times in different or the same fish markets for speculative purposes. Frozen bluefin tuna are consumed exclusively raw as "sashimi" or "sushi" . The wholesale price of the frozen bluefin sold at Yaizu Fish Market, one of the biggest fish markets for tunas in Japan, is shown in Figure 7. Bluefin is of secondary highest commercial value after southern bluefin tuna. The low value of bluefin in 1975 probably reflected the low meat quality of post-spawning fish.

10. FISHING REGULATIONS

Conservation measures taken by the ICCAT for the Atlantic bluefin tuna have become effective from 1975 and following these regulations, the Government of Japan set a ceiling on the total catch at the 1975 level taken by the Japanese longline boats. In the Mediterranean Sea bluefin fishing by Japanese longliners has been banned during the period May 21 and June 30 since 1975. Presently, the number of Japanese boats entering the coastal areas of the U. S. and Canada or the amount of catches in those areas is limited to a certain level, by agreement among the countries concerned.

Finally, the authors wish to express their appreciation to Mr. Jiro Ogawa, Chief of the Fishing Department of Sumiyoshi Gyogyo Company, who provided us with valuable information on this fishery.

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Table 1. Annual catches (in number) of Atlantic bluefin tuna by the ICCAT Statistical Areas caught by the Japanese tuna longline boats.

Area No.	51	52	53	54	55	56	57	58	59	60	61	67	62	63	64	65	66
Year																	
1956															1		
1957															242	1	
1958															493	6	
1959												2			3313	116	2
1960															5507	1312	
1961													38		3976	117	
1962							7				91		59	19	50695	3051	52
1963					17					10	1591	90	12	65	64390	672	75
1964	5				12762	4	29			175	3554	918	378	489	44304	97	281
1965	300	597	10	3	29762	1187	429	73			10349	238	46	139	15433	284	1153*
1966	82	392	3		12295	166	51	2		27	7399	9	39	116	1392	9	457
1967			8		323	33	19				2805	30	1		667	2	54
1968	6	257			651	17	10			208	211	17		12	71	2	84
1969					67	2				1	550	2		1	97	2	11
1970	1	279			33	8	23			7	3		86		82	1	38
1971	1549	4536		4	486	30	682	109			523	3	8		7	1	30
1972	291	843		19	69	1	322	474	697	134					1	2	26
1973	1431	4368	63		67	125	72	149	1175	297			10			1	6
1974	5441	3096	20	11216	1791	13	259	8710	12894	1249	4		2		1	3	14
1975	117	1168	15	2857	125		562	20928	7620	6445	26		11		21	4	5
1976	5504	1776	4	348	6749		975	9576	5047	10236	3		36	8	4	1	2
1977	2334	931		220	18561		51	9271	3052	8749			1				1

*Provisional figure (may include southern bluefin tuna).

Table 2. Number of Japanese tuna longline boats which operated in the Atlantic Ocean and Mediterranean Sea, 1971-1977.

Type of boat	Size class (Gross tons)	1971	1972	1973	1974	1975	1976	1977
Deckloaded motherboat	Total	11	8	1	-	1	-	1
	201 - 500	-	2	1	-	1	-	1
	501 - 1000	7	5	-	-	-	-	-
	1001 -	4	1	-	-	-	-	-
Homeland-based boat	Total	142	186	199	221	228	146	179
	51 - 200		1	-	-	-	-	-
	201 - 500	142 (*)	181 (*)	199 (*)	221 (80)	228 (100)	146 (70)	179 (50)
	501 - 1000	-	4	-	-	-	-	-
Foreign-based boat	Total	36	11	2	-	-	-	-
	51 - 200	6	2	-	-	-	-	-
	201 - 500	30	9	2	-	-	-	-

Note: Figures in parentheses are the estimated number of boats which operated in the North Atlantic (personal communication with the Federation of Japan Tuna Fishermen's Co-operative Associations); * denotes that no information were available at hand for those years.

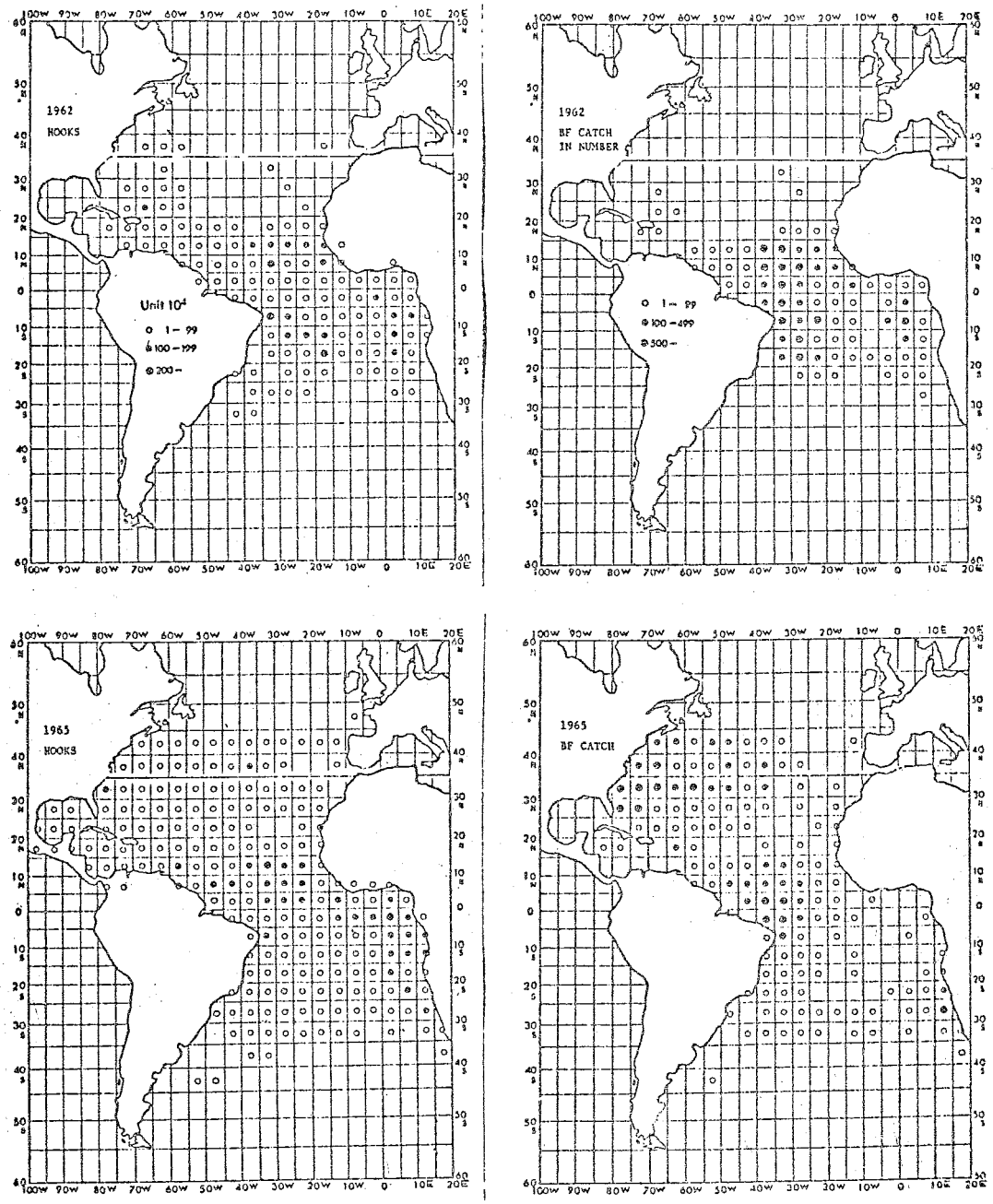


Fig. 1. Distribution of fishing effort and bluefin catch by the Japanese tuna longline fleets in the Atlantic for four years.

The catch of bluefin tuna off South Africa in 1965 may include southern bluefin tuna.

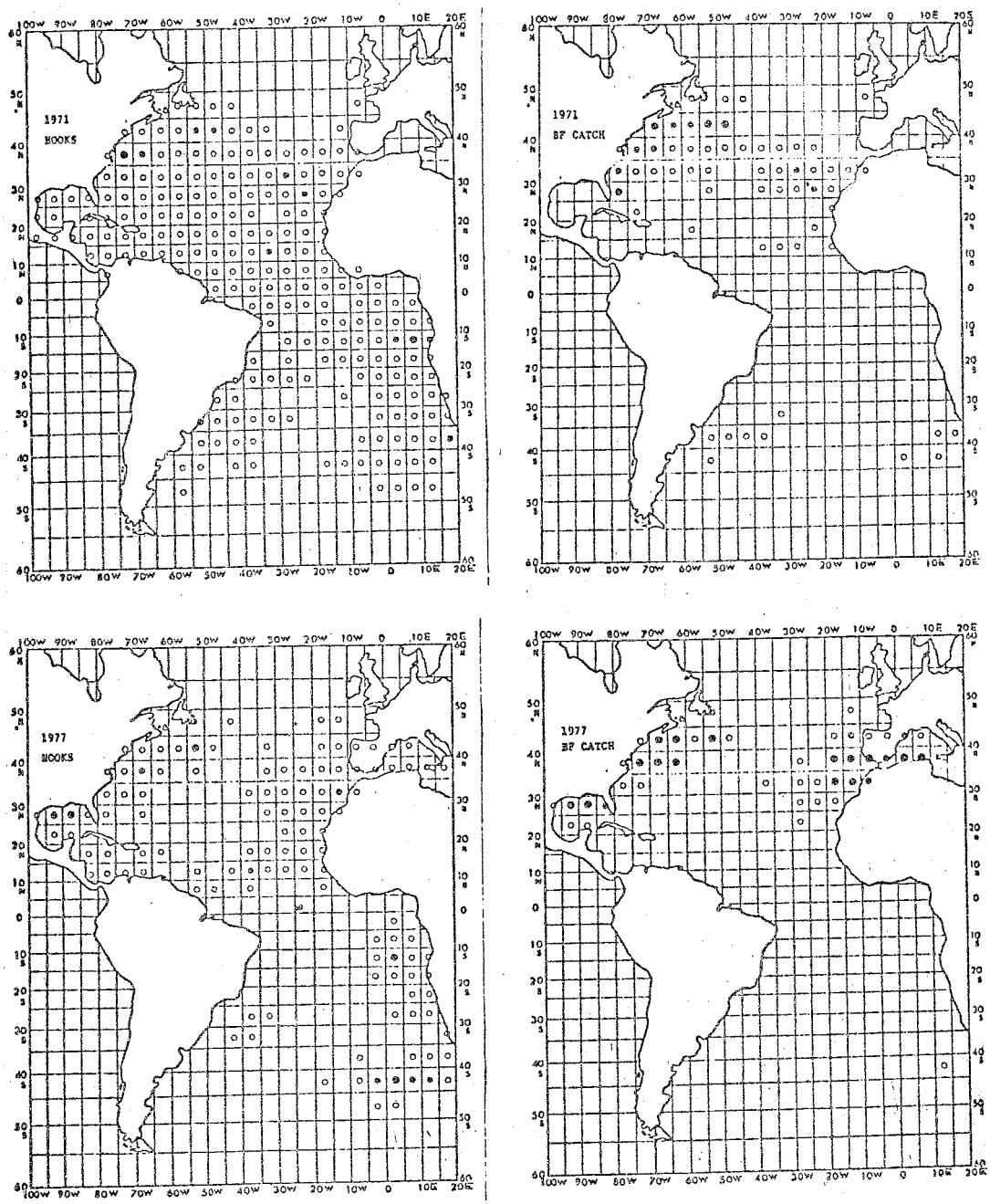


Fig. 1 (continued).

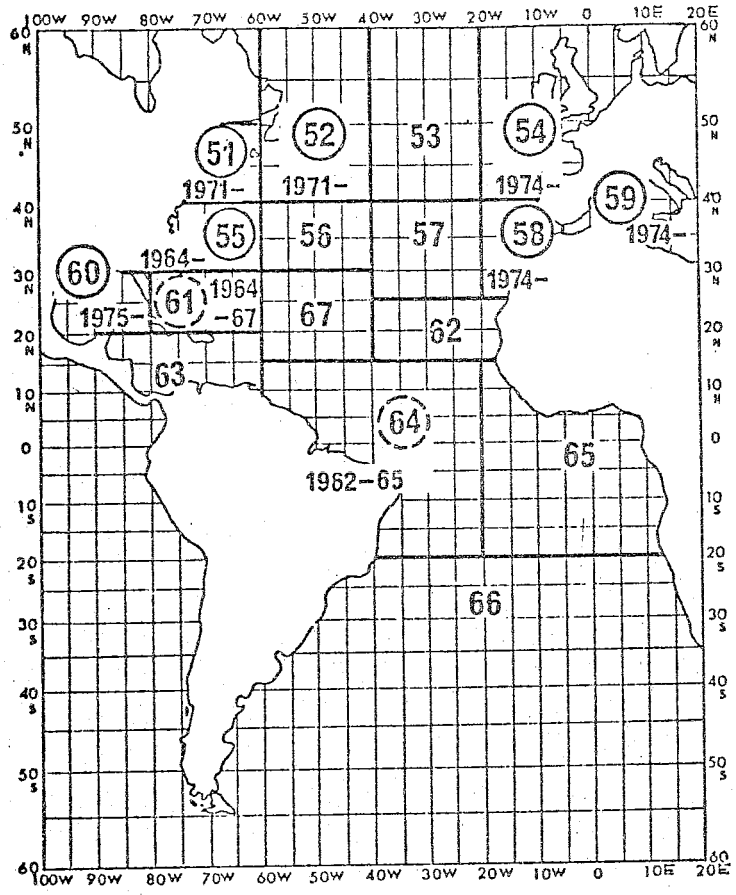


Fig. 2. Division of the Atlantic according to ICCAT Statistical Areas.

Large numbers denote the area numbers and those with broken and solid circles indicate the areas where relatively large numbers of bluefin were caught in the past or at present, respectively. Smaller numbers denote the period of years during which a significant number of bluefin were caught.

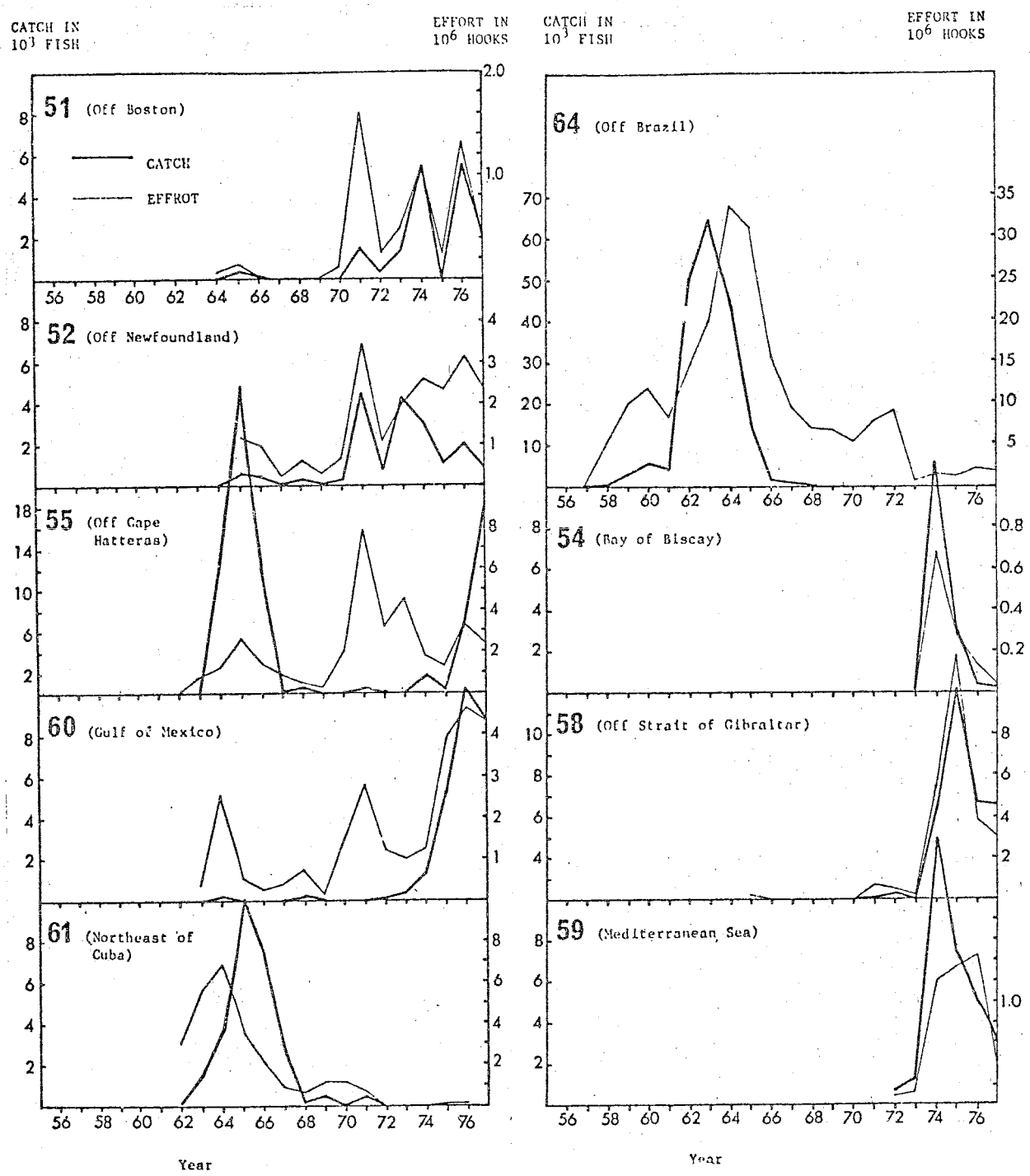


Fig. 3. Annual trends of fishing effort and bluefin tuna catch in the major bluefin fishing grounds by the Japanese longline boats.

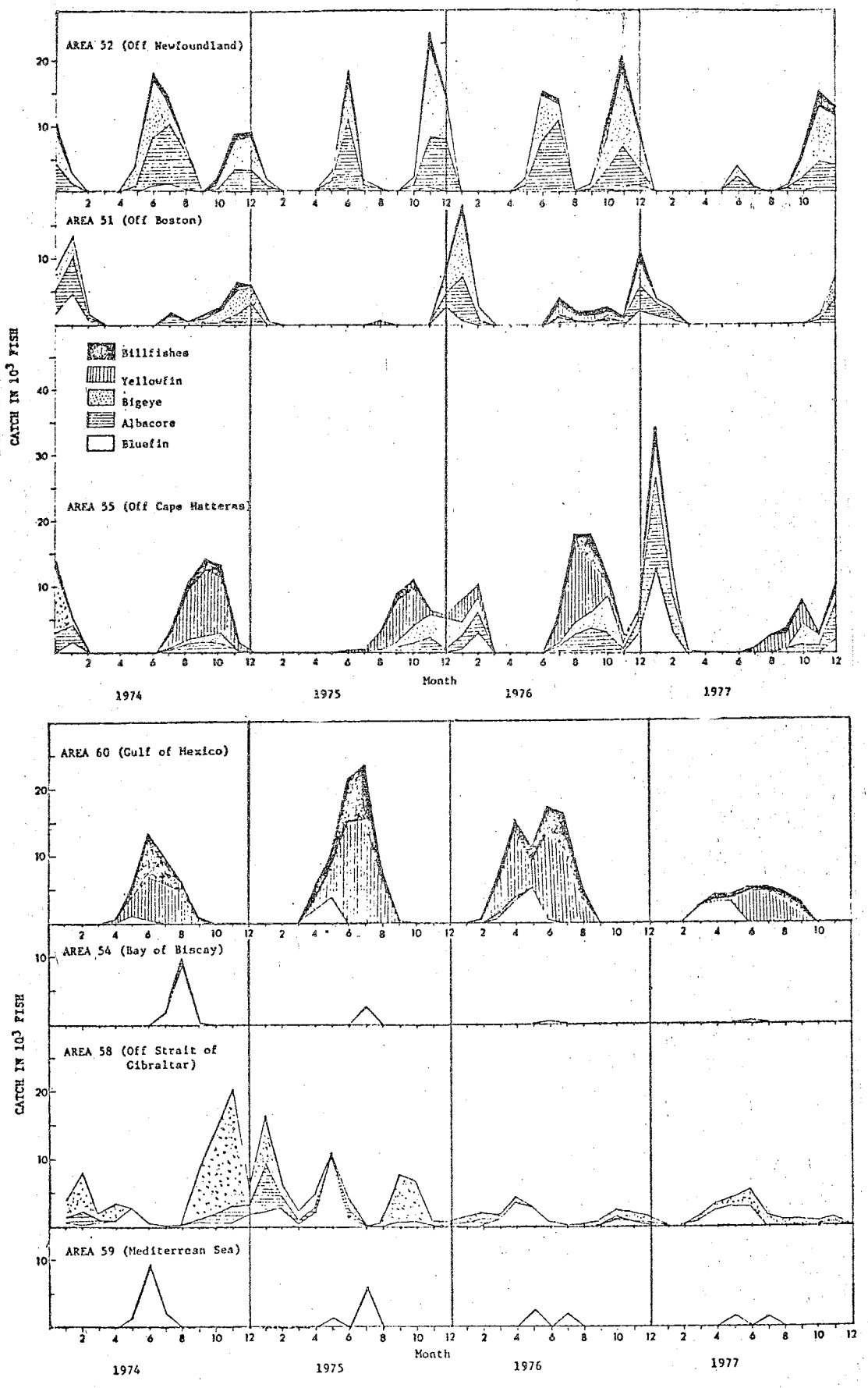


Fig. 4. Monthly species composition of the catches by the Japanese longline boats in the presently exploited bluefin fishing grounds, 1974-1977.

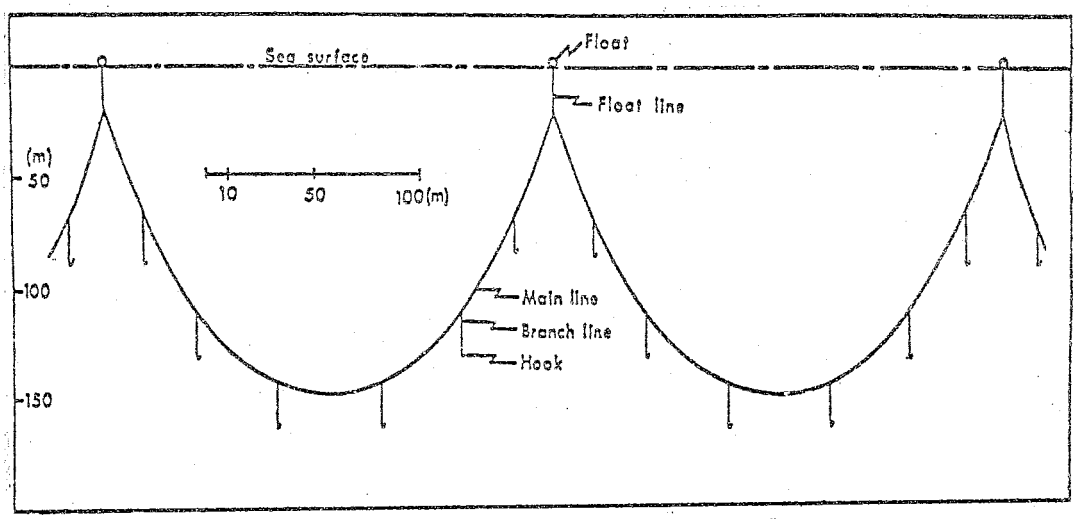


Fig. 5. Basic gear construction with 6-branchline-gear of the longlining method (modified from Suzuki, et al, 1977).

The figure was drawn assuming the mainline hanging in a catenary with float lines 20 m, branch lines 30 m, distance between branch lines 50 m and sagging rate (see text) 0.6.

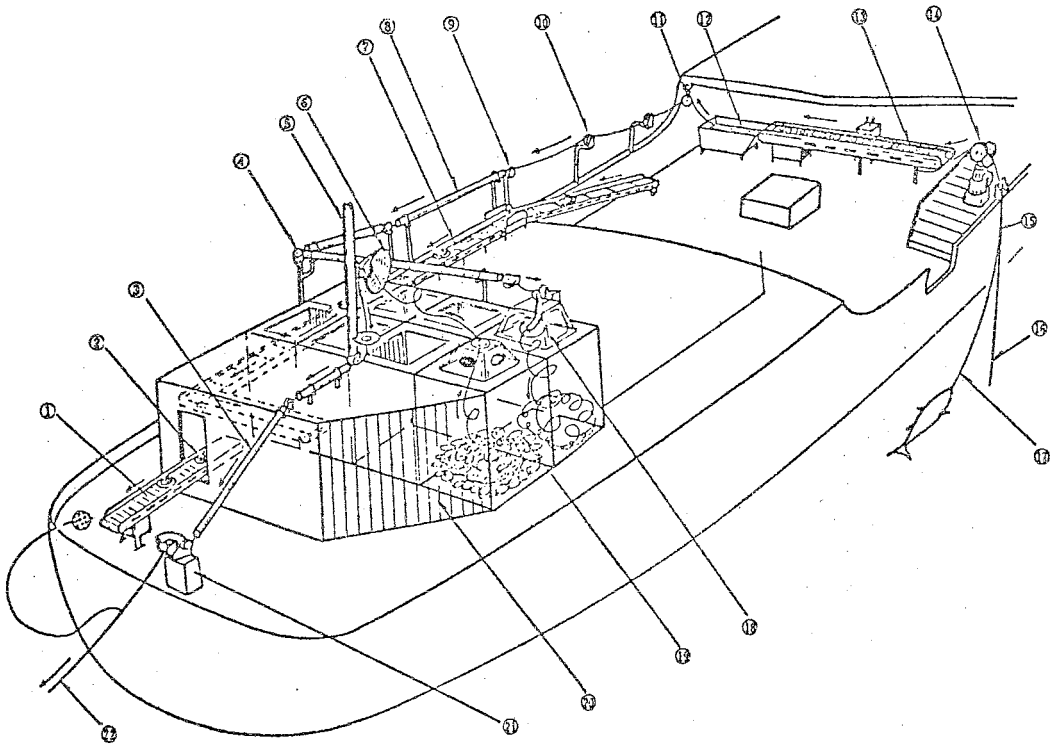
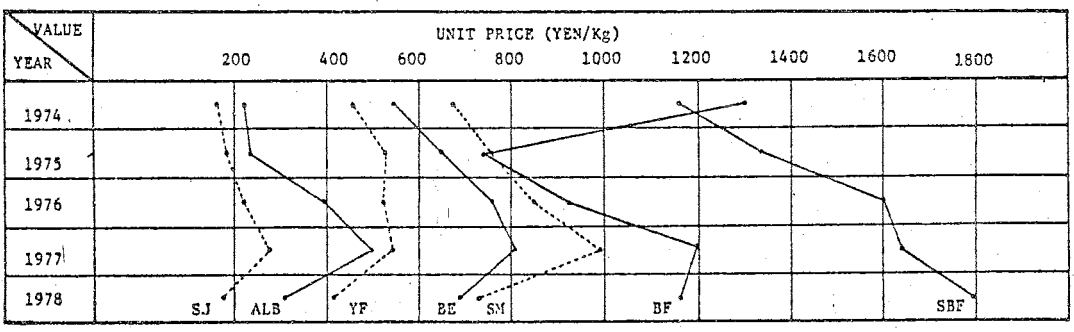


Fig. 6. Schematic representation of fishing equipment and flow of the mainline and branch lines (cited through the courtesy of the author and publisher from Tsudani (1977) in Illustrations of Japanese Fishing Boats published by Seizando-Shoten, Tokyo, Japan).

1 Slow conveyer
2 Branchline
3 Guide pipe
4 Guide roller
5 After mast
6 Unravel roller
7 Branchline conveyor
8 Guide pipe
9 Guide roller
10 Guide ring
11 Mainline guide block
12 Unravel water tank
13 Slow conveyor
14 Line hauler
15 Line hauling
16 Mainline
17 Branchline
18 Line winder
19 Mainline store
20 Branchline store
21 Line casting machine (casting speed: 0-660m/min.)
22 Mainline



SJ...Skipjack ALB...Albacore YF...Yellowfin BE...Bigeye
SM...Striped marlin BF...Bluefin SBF...Southern bluefin

Fig. 7. Wholesale price of tunas sold at Yaizu Fish Market.

Unit price shown is for frozen fish in the case of bluefin, and for unfrozen and frozen fish combined for other fishes.