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Review of Fishing Capacity Deployed on Tuna and Tuna-like Fish Fisheries, Particularly for Tuna Longline Fishery

Ziro SUZUKI*

Widespread and lingering problem of overcapacity in fishing power has been a big obstacle for sustainable and rational use of fish resources. This paper tries to estimate very briefly amount of overall overcapacity to be reduced in world tuna fishery, especially for distant water tuna longline fishery through reviewing trend of the fishing capacity of major tuna fisheries and comparing it to status of major tuna stocks. The result indicates that overall reduction of some 20-30% of all distant water longline fleet is necessary as soon as possible, simultaneously bycatch of juvenile bigeye tuna by tropical purse seiners should at least be capped immediately until more reliable stock assessment become available for bigeye stocks, eradication of increasing number of the boats flying flag of convenience is urgently needed, and finally it is important to quantify improvement of fishing power in the wake of technical innovation and to take it account of in the estimation of trend of the fishing capacity. Draft of this paper was submitted to the FAO Technical Working Group on the Management of Fishing Capacity held in La Jolla, U.S.A., during 15-18 April, 1998.

Key words: overcapacity, tuna, longline, purse seine, bigeye, fishing capacity

Introduction

There is a global concern about trend of the landing of world captive fisheries which shows sign of approaching a limit in recent years or within the near future (FAO, 1997a) as marine products covers a significant amount of important protein supply. Decline of stock size of the marine fisheries resources due to overfishing, often associated with overcapacity of fishing fleet, is one of the major causes of this trend. The purpose of this paper is to provide specific information that may be useful for better understanding of overcapacity problem by comparing the stock status of resources and the fishing capacity for major tuna and tuna-like fishes (hereafter referred to as "TTF") of the world in the context of major changes occurred in their history of fishing. The TTF was chosen as an example because of its economic importance in marine fisheries, worldwide existence and high concerns due to participation of many countries in the fishery. Particular emphasis was placed on longline fishery since it takes many TTS and larger fish in general which is most sensitive to overfishing.

Data Sources

Status of Stock Information

Information of the stock status for the TTF was basically referred from scientific reports of the regional management bodies such as IATTC (Inter-American Tropical Tuna Commission) and ICCAT (International Commission for the Conservation of Atlantic Tunas) as well as FAO publications. In reviewing the stock status in various areas or oceans, classification of the status used in FAO Fisheries Circular No. 920 was followed (FAO, 1997a). However, it should be noted, as stated in the FAO Circular, that the accuracy and precision of information concerning to the stock status for individual stock has a wide range. Therefore, it is difficult to apply a common standard for categorizing the stock status across the stocks in the world. In this regard, the classification, in some cases, may be somewhat subjective.

Most of the information about stock status from Pacific and Indian Ocean remains the same as FAO Circular either due to the reasons that no new stock assessments were attempted or that the stock status remains unchanged. Some new information is available for the Atlantic TTF and was included in this paper. It should be also born in mind that although the best available information was used, there is considerable uncertainty about stock structure for the TTF, even for major commercially important ones.

Fishing Capacity Information

Number of boats by type of fishing gear, country and size of boats are used in this paper as an index of fishing capacity. Most of information used here covers only large scale commercial fisheries. No analysis was attempted to recreational and coastal fisheries despite of their large potential impact to some stocks in terms of fishing capacity. This is largely because of lack of more detailed information available at hand. However, aside from appropriateness of using number of boats as a measure of fishing capacity, there are several technical difficulties in this approach. First of all, the data are incomplete, especially for the Western and Central Pacific and Indian Oceans. For example, they do not necessary cover 100% for all fleet, some fleet lacks information of size of the boats and unit of boat size is different among the countries even in the same fisheries. Nevertheless, number of boats approach is good one as a starting point to this kind of study. In addition, boat is a basic unit which integrates not only several factors affecting fishing capacity but also socio-economic entity. In the TTF, there are three major gear types in most cases, i.e., longline, purse seine and

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*National Research Institute of Far Seas Fisheries; 7-1, Orido 5 chome, Shimizu-shi, Shizuoka 424-8633, Japan.

baitboat. Therefore, unless otherwise specified, those three gears were used for the analysis. Size of boat is expressed either in gross tonnage (GRT) or carrying capacity (CC) in many cases.

Overall total fishing capacity in the GRT was calculated applying average GRT by fishing gears, countries and size categories. In estimating the average GRT, it was somewhat subjectively done not only using simple average of available data but also using additional information on specific fleet since detailed composition of the GRT or CC for a specific category often was not available. Therefore, the average values could be different even among the same boat class if oceans are different.

Fishing boat statistics are available in the reports of ICCAT, IATTC and IPTP (Indo-Pacific Tuna Development and Management Programme) and those published data were referred in this paper. In addition, unpublished data from SPC (South Pacific Commission) and industry information such as The Tuna Longline Fishing Nations Conference were referred to in cross checking several statistics available.

Results

I. Pacific Ocean

No single management body which covers the entire Pacific exists, because the Pacific Ocean is too big in size and too complicated in fisheries as well as socio-economic features. There are various TTF throughout the Pacific but two major fishing grounds are identifiable, one in the Eastern Pacific operated mainly by purse seine fishery participated in North, Central and South American countries and to much lesser degree by the Asian longliners, particularly Japanese longline fleet and the other in the Western and Central Pacific where purse seine and longline fisheries from various countries, mostly Asian fleet dominate in the catches. The IATTC has oldest history in management of the TTF, with its mandatory area in the Eastern Pacific approximately east of 150° W. For the Western and Central Pacific (refers to areas west of 150° W in this report), there is no effective management organization of the TTF. However, the SPC has been actively conducting stock assessment of some of the major TTF with cooperation of various regional countries.

I-1a. Western and Central Pacific

I-1a-1. Major Fleet and Their Target Species

Purse Seine Fleet

For SPC area which covers an extensive area of the tropical and subtropical Western and Central Pacific, currently purse seine catches of the TTF in the total TTF catch is largest, about 80%, followed by longline and baitboat, 10% each (SPC 1997a). Industrial purse seine fleet accounts almost all purse seine catch and Taiwan, Korea, USA and Japan are major purse seine countries. In the coastal waters around Japan, there exists coastal purse seine fishery of Japan targeting skipjack, yellowfin and bluefin with its relatively stable catch and fleet size for a long time.

Longline Fleet

The vessel number statistics are incomplete for the longline boats. Various size of longline boats operates in the Western and Central Pacific. They can be classified into small coastal boats and large distant water boats. For small boats, Japan and Taiwan have many boats in the order of thousands targeting various TTF. Since the statistics for those sector of the small longline fleet are compiled poorly, and bulk of catches is made by large distant water boats, only large fleet above 50 GRT (only distant water boats were selected for the Japanese longline boats based on the files compiled by the National Research Institute of Far Seas Fisheries, Japan) was used to see the overall trend of fishing capacity of the longline fleet. However, it should be noted that China increased substantially the number of small sized longline boats in the 1990s although the increase appears to be stabilized or somewhat decreased from the peak of about 450 boats. Large longline boats, mostly operated by Japan and Korea targeting bigeye and yellowfin and Taiwan targeting albacore.

Baitboat Fleet

Currently, only Japan has distant water fleet and it aims at skipjack and albacore mostly in the north Pacific. Their fleet size and catch declined substantially in the 1990s. Japan also has a sizable amount of coastal baitboat fishery around the northwest Pacific aiming at skipjack and albacore. Solomon Islands is an active leading baitboat fishing country in the coastal areas with stable catches and fleet size.

I-1a-2. Trend of Fleet Capacity

Purse Seine Fleet

The purse seine fishery in the tropical Western and Central Pacific was started in the late 1970s by Japanese fleet and later joined by Korea, U.S.A. and Taiwan. Although four major countries mentioned are predominant in the purse seine catches, there are several countries with much smaller fleet sizes such as Vanuat and the Philippines. Table 1 shows number of purse seine boats by those major countries by boat size classes. Figures shown in Table 1 were excerpted from the unpublished data provided by the SPC for the present study. Overall total fishing capacity in the GRT

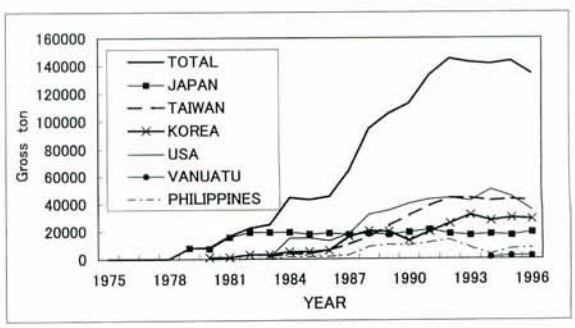

Fig. 1. Trend of fishing capacity in gross ton for major purse seine fleet with the large boats operated in the SPC area (Western and Central tropical and subtropical Pacific). Source from unpublished SPC data.

Table 1. Number of purse seine boats by country and by gross ton for major purse seine fleet with large sized boats operated in the SPC area.

	Japan					Taiwan					Korea					USA					Vanuatu					Philippimes					Grand
	0-50	51-149	150-499	500-	Total	0-50	51-149	150-499	500-	Total	0-50	51-149	150-499	500-	Total	0-50	51-149	150-499	500-	Total	0-50	51-149	150-499	500-	Total	0-50	51-149	150-499	500-	Total	Total
1975																														
1976																														
1977																														
1978																														
1979			10	4	14																									14
1980	1	4	9	3	17									1	1															18
1981	1	7	19	7	34									1	1															35
1982	1	7	25	8	41									3	3										1				1	45
1983	1	7	25	8	41		1	1	1	3				3	3			1	1										0	48
1984	1	7	25	8	41	1	1	1	3	6				5	5			15	15								3		3	70
1985		7	25	6	38	1	1	3	2	7				5	5			15	15								3		3	68
1986		5	27	6	38	1	1	2	5	9				6	6			13	13								3		3	69
1987		5	25	6	36	1	1	2	9	13				16	16			18	18								5		5	88
1988		7	26	6	39	1	1	3	14	19		2	19	21				32	32						1		7	5	13	124
1989		3	27	5	35		1	1	23	25		1	19	20				35	35								8	6	14	129
1990		7	29	5	41		1		31	32			13	13				40	40								7	6	13	139
1991		6	33	5	44		1		38	39		1	19	20				43	43								7	8	15	161
1992		3	31	3	37				44	44		1	25	26				44	44								5	11	16	167
1993		3	33	0	36				44	44		1	31	32				42	42								4	6	10	164
1994		1	34	1	36				42	42		1	27	28				50	50					1	1		2	2	4	161
1995			31	2	33				43	43		1	29	30				45	45					2	2	1	4	5	10	163
1996			34	3	37				42	42		1	28	29		3		35	38					2	2	1	3	6	10	158

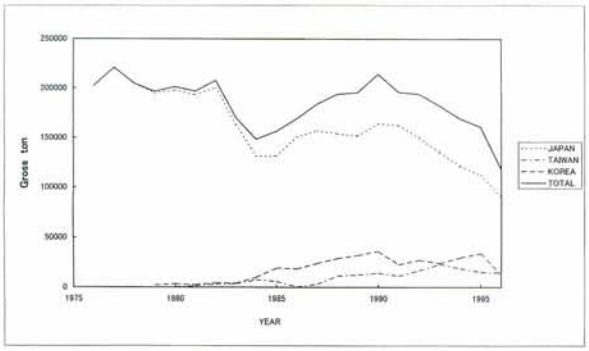

Fig. 2. Trend of fishing capacity in gross ton for major distant water longline fleet in the SPC area except Japanese fleet which operated in the whole Pacific. Source from unpublished SPC data except Japanese fleet.

was calculated applying average GRT by size categories and countries, there are: 50, 150, 500, 1000 (700 for Japan) tons for 0-50, 51-149, 150-499 and 500- categories, respectively. Fig. 1 shows a steep increase of fishing capacity of the total fleet up to 1992 and leveled off afterward. As is mentioned later, most of the US fleet moved to the Western and Central Pacific from the Eastern Pacific since 1993. The level off of the recent fishing capacity is partly due to FFA (Forum Fishery Agency) management policy to limit the purse seine fleet size in this area.

Longline Fleet

The Pacific is different from other Oceans in the fact of the dominance of the Japanese distant water longline fleet among the Asian fleet composed of boats from three major longline countries, i.e., Japan, Taiwan and Korea. Since fleet size information of the Japanese longline boats in the Eastern Pacific is not readily avaitable for this study, the longline fishing capacity here shown is for the whole Pacific for Japanese fleet while the rest of the fleet is those operated in the SPC areas. Overall fleet capacity was calculated applying 150, 300, 500 tons for 51-149, 150-499 and 500- classes, respectively. Here again, it should be born in mind that the trend refers only to the large size boats above 50 GRT (Table 2). The Japanese fleet shows a declining trend, first after 1982 reflecting 20% unilateral effort cut in terms of number of distant water longline boats, second after 1990 (Fig. 2). The second decline probably reflects leave of substantial numbers of boats from the Eastern Pacific due to decline in the catch rate of bigeye to other areas including the Atlantic. Taiwanese and Korean fleets show a slight increasing trend in the fishing capacity. The trend of Japanese longline fishing capacity should be accounted for at least increase in number of hooks used per operation since it is noted that the increase started in the early 1980s from about 2,100 to 2,700 hooks per set by the early 1990s, approximately 30% increase for the distant water longline (Fig. 3). However, overall fleet capacity by the three Asian distant water longline boats seems to be declining in the recent years even if a 20 to

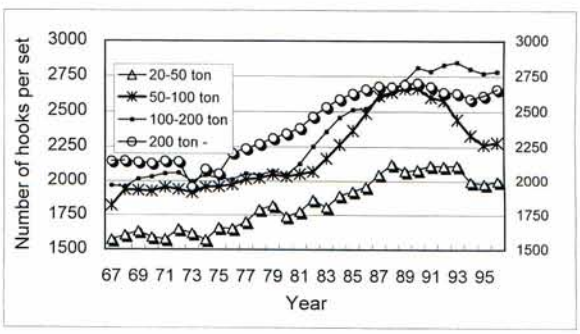

Fig. 3. Trend of number of hooks/set by four boat size classes for Japanese longline boats.

Table 2. Number of major distant water longline boats by country and by gross ton in the SPC area expect that of Japanese fleet operated in the whole Pacific compiled by the National Research Institute of Far Seas Fisheries.

	Japan			Taiwan				Korea				Ground
	51-149	150-449	Total	51-149	150-449	500-	Total	51-149	150-449	500-	Total	Total
1975												
1976		675	675									675
1977		736	736									736
1978	15	675	690									690
1979	179	560	739						6		6	745
1980	177	571	748	1	0		1		11		11	760
1981	175	556	731	0	5		5	3	6		9	745
1982	234	552	786	1	9		10	7	11		18	814
1983	158	464	622	4	9		13	0	13		13	648
1984	149	363	512	3	23		26	0	33		33	571
1985	136	370	506	8	15		23	0	64		64	593
1986	114	445	559	1	0		1	0	61		61	621
1987	155	446*	601*	16	2		18	1	79		80	699
1988	73	477	550	49	13		62	0	96		96	708
1989	64	474	538	68	7		75	0	104	1	105	718
1990	59	518	577	77	7	1	85	1	116	2	119	781
1991	35	524	559	62	6		68	2	74		76	703
1992	38	481*	519*	72	20		92	7	84	2	93	704
1993	25	438	463	77	38		115	6	73	2	81	659
1994	21	393	414	63	29	1	93		95	2	97	604
1995	15	366	381	55	23		78		110	1	111	570
1996	12	296	308	59	19		78		43		43	429

*Preliminary data.

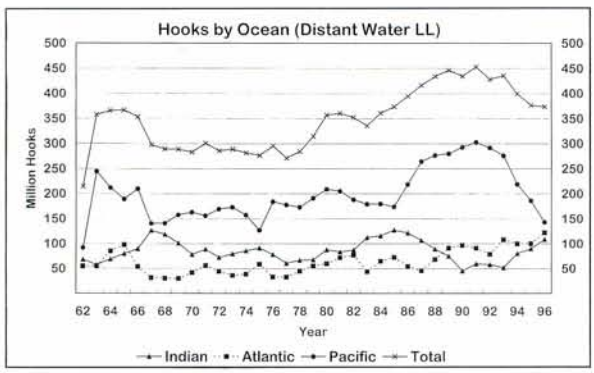

Fig. 4. Trend of number of hooks for Japanese distant water longline boats (120 GRT and over) by ocean.

30% increase of the number of hooks per set for the Japanese and the similar increase for Taiwanese fleet (Dr. S. K. Chang, personal comm.) is taken into account. For Japanese boats which has a dominant share in the longline fleet in the Pacific, Fig. 4 supports this inference.

I-1a-3. Stock Status and Fleet Capacity

The total catches of the TTF in the Pacific occupy a dominant share of about 60% in the world TTF catches (about 4.8 million tons in 1995). The catches from the Western and Central Pacific exceeded those from the Eastern Pacific since the 1980s and currently about three times bigger than those from the Eastern Pacific. The stock status of the Pacific TTF in general is healthy or fully exploited although there remains uncertainty for several important stocks. Table 3 summarizes the status of stocks in the Pacific TTF. Southern bluefin is referred to in the Indian Ocean section.

Yellowfin and skipjack are taken mostly by purse seiners both in the Eastern and Central Western Pacific. The catch of these two species dominates in the total TTF catches of the Pacific, about 90%. It is concluded that the stock status of these two species in the Pacific is moderately exploited. Purse seine fleet in the Pacific capacity remains stable in recent years.

Bigeye stock status is of high concern currently because of a long declining trend of longline CPUE, especially in the Eastern Pacific. In addition, as in other two Oceans, use of artificial FADs (fish aggregation devices) in the purse seine fishery has become serious issue in the Pacific too, especially in the Eastern Pacific where the bycatch of juvenile bigeye reached 52,000 tons in 1996, an increase of tenfold compared with those before the introduction of the FADs (IATTC, 1997a). To prevent possible adverse effect on longline fishery as well as stock caused by this increase, IATTC started to analyze several options to reduce the catch of juvenile bigeye tuna taken by purse seiners. Although the stock structure and stock status of the Pacific bigeye is not well known and future stock status largely depends on estimates of reliable value of natural mortality coefficient, equilibrium production model analysis based on single Pacific stock structure suggests that the stock is possibly exceed the estimated MSY, ranging from 100,000 to 170,000 tons with estimate of about 120,000 tons based on non-equilibrium production model which is more realistic in assumption than equilibrium model (SPC, 1997b). It should be noted that catch of juvenile bigeye is difficult to estimate due to mis-identification problem with juvenile yellowfin and probably bigeye catches are underestimated. Under these circumstances, it is alarming that the recent catch level of Pacific bigeye

Table 3. Stock status and management measures taken for the tuna and tuna-like fishes in the Pacific (top), Indian (middle) and Atlantic Ocean (bottom). Catch data from FAO (FAO, 1997b) for the Pacific, from IPTP (IPTP, 1997) for the Indian except southern bluefin tuna [catch from all Oseans provided by ICCAT (ICCAT, 1998)] and from ICCAT (ICCAT. 1998) for the Atlantic.

Pacific	Stock status	Current catch in MT(1995)	Major fisheries	Management measures TAC	Min. size	Time/Area closure	Remarks
Yellowfin	East:M,Central Weatern:U?	626728	PS,LL				
Skipjack	U?	1147703	PS,BB				
Bigeye	O?	127415	LL,PS				
Albacore	North:F?,South:M?	108574	LL,TROLL,BB				
Bluefin	F/M?	7232	PS,TROLL,LL,TRA				
Swordfish	?	31282	LL,GILL				
Total		2048934					

Indian	Stock status	Current catch in MT(1995)	Major fisheries	Management measures TAC	Min. size	Time/Area closure	Remarks
Yellowfin	F?	310522	PS,LL,GILL				
Skipjack	M?	276945	PS,BB				
Bigeye	O?	101100	LL,PS				
Albacore	F?	18838	LL				
Southern bluefin	O?	13183	LL,PS	X			range extends to other Oceans
Swordfish	?	21628	LL				
Longtail Tuna	O?	83508	GILL,PS				
Total		825046					

Atlantic	Stock status	Current catch in MT(1996)	Major fisheries	Management measures TAC	Min. size	Time/Area closure	Remarks
Yellowfin*	F	136900	PS,LL,BB		X	X	
Skipjack*	East:M,West:M	150500	PS,BB			X	
Bigeye*	O	107300	LL,PS,BB		X	X	
Albacore	North:F,South:O,Med:U	52859	LL,BB,TROLL	X			
Bluefin	West:O,East:O	42964	PS,LL,BB,TRA	X	X	X	TAC for South stock
Swordfish**	North:O,South:O/F?,Med:F	47684	LL	X	X		
Total		538207					

Abbreviation for stock status defined by FAO (1997):? = Not known or uncertain. No much information is available to make judgement, **U** =Underexploited or new fishery.Believed to have a signficant potential for expansion in total prodution, **M** =Moderetely exploited, exploited with a low lovel of fishing effort. Believed to have some limited potential for expansion in total production, **F** =Fully exploited. The fishery is operating at or close to an optimal yielid level, with no expected room for further expansion, **O** =Overexploited. Fishery is being exploited at an above level which is believed to be sustainable in the long term, with no potential room for further expansion and higher risk of stock depletion/collapse.

Abbreviation for major fisheries:**PS**=Purse seine, **LL** =lingline, **BB** =baitboat, **GILL** = gillet, **TRA** = trap net

*Voluntary time/area closure by purse seiners for FADs.

**Catch in 1995.

after 1990 is above the non-equilibrium estimates of the MSY, by some 20% higher on an average.

Albacore stocks, both south and north have been exploited by longline and surface fleets including baitboat and troll boats. For the north stock, the stock appears to be fully exploited by major albacore fishing fleet of Japanese longline and baitboat as well as U.S. troll boats. There is some suggestion that the stock size may be changed more by global change in environmental factor rather than the exploitation of the fisheries. After the withdrawal of gillnet fisheries in the high sea areas by the early 1990s, the fishing capacity for this stock seems to be reduced substantially. General situation is similar with the south stock for which the level of stock exploitation by major fleets of Taiwanese longline and US troll is relatively low.

Bluefin stock status is unknown. This stock has a long history of exploitation in two sides of the Pacific, around Japan by various fishing gears such as purse seine, troll and longline, and around California/Northern Mexico mainly by purse seine. Catch shows a wide fluctuation probably reflecting the strength of yearclass with relatively stable fishing capacity although the fishing capacity information is difficult to collect due to high diversity of coastal fisheries around Japan. Current level of fishing is probably sustainable judging from the fishing performance for a long time.

Swordfish is either targeted by major swordfish longliners of Japan and U.S. in addition to gillnet fishery mostly by Chili or taken as bycatch mainly by tuna longline fleet throughout the Pacific. Although recent increase of swordfish catch is remarkable, partly due to the increase of swordfish longline boats moved from the Atlantic, the stock status is unknown. It is noted that local depression may be occurring in some areas of the Pacific.

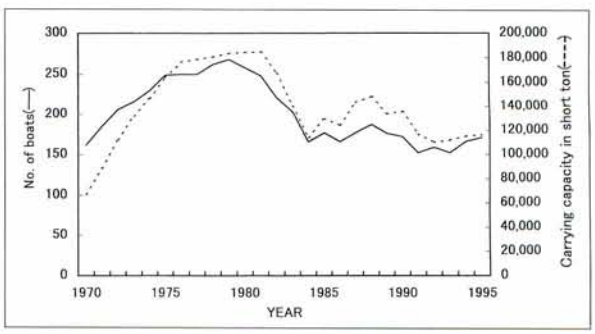

Fig. 5. Trend of fishing capacity in carrying capacity for purse seine fleet in the Eastern Pacific. Data from IATTC (1997b).

I-1b. Eastern Pacific

I-1b-1. Major Fleet and Their Target Species

Purse seine fishery dominates in the TTF in the Eastern Pacific and target yellowfin and skipjack as a major species. The purse seine fishery started in the early 1960s, replacing the baitboat fishery which had been a major fishery there. US boats were dominant in the purse seine fleet in the 1960s and 1970s but afterward, the Latin American countries lead by Mexico, Venezuela and Ecuador form a major part of the purse seine fleet. The catch by baitboat fishery is negligibly small compared to that by purse seine fishery. Longline fleet mainly from Japan operates aiming at bigeye in the Eastern Pacific which is the most important fishing ground for this species in terms of amount of catch.

I-1b-2. Trend of Fleet Capacity

Fig. 5 shows trends of number of purse seine and its carrying capacity in the Eastern Pacific compiled by the IATTC (IATTC, 1997b). Both measures of fleet capacity increased rapidly in the 1970s due to improvement of fishing techniques and expansion of fishing ground offshore. From 1982, total carrying capacity showed a sharp decline due to overfishing of yellowfin stock as well as exodus of a significant number of the purse seiners to the Western and Central Pacific due to devastating effect of El Niño in 1982-1983. Vessel number statistics of the longline fleet in this area, mostly the Japanese longliners, is not available but believed to have been decreasing significantly as roughly traced by change in number of distant water longline fleet in the whole Pacific which was shown in Section I-1a-2.

I-1b-3. Stock Status and Fleet Capacity

See Section I-1a-3.

II. Indian Ocean

The IOTC (Indian Ocean Tuna Commission), newly formed in 1996, is responsible to management of the TTF in the Indian Ocean. However, since the IOTC has not been operative yet, information of stock status and fishing capacity in this region comes from the IPTP publication. Those information is more uncertain compared with that in the ICCAT and IATTC areas due to delay of formulating the IOTC which has binding force both for data collection and management measures. One of the characteristics of the TTF in the Indian Ocean is importance of artisanal/coastal fisheries which forms about half of the total TTF catches (IPTP, 1997). They use a variety of fishing gears including active gillnet fishing that also cause difficulties in collecting basic statistics. Although catch by industrial purse seine is the largest in the total TTF catch, the catch by longline relative to the purse seine catch, is substantially large compared with the Atlantic and Pacific cases (Fig. 6). High catch of the TTF by gillnet is another unique point in the Indian Ocean.

II-1. Major Fleet and Their Target Species

Purse Seine Fleet

As is the case in other Oceans, catches of yellowfin and skipjack are biggest in the total TTF catches (about 60% in recent years) in the Indian Ocean. Modern purse seine fleet by France and Spain accounts for major part of the catches of those two species followed by much smaller Japanese and other purse seine catches. The purse seine fishery developed from the early 1980s. In recent years, the fleet has begun to deploy the artificial FADs extensively which increased bycatch of juvenile bigeye substantially. Small sized purse seiners account for important part of longtail tuna catch, especially in the Gulf of Thailand operated mainly by Thai boats.

Longline Fleet

Longline fleet can be classified into two groups, one, traditional Asian fleet composed of Japan, Taiwan and Korea and the other, relatively new fleet with much smaller boat size operated by coastal countries such as Indonesia and Oman. Major targets species of Japanese fleet is southern bluefin and to a much lesser extent bigeye. Korean fleet catches bigeye and yellowfin while Taiwan longliner has been changing target species recently from traditional albacore to bigeye.

Gillnet Fleet

Gillnet fishery has developed well and the total catch of the TTF by this gear is higher than that taken by baitboat in the Indian Ocean. Various countries operates this gear with major harvesting countries such as Iran, Sri Lanka and Pakistan mainly within their EEZ catching tropical species such as longtail tuna, sheerfishes, yellowfin and skipjack. Taiwan used to be a gillnet country for albacore but ceased the operation in 1993. Gillnet catch increased about threefold over the past 10 years (Fig. 6).

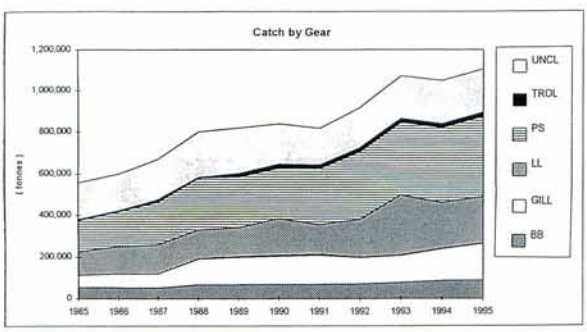

Fig. 6. Trend of catches for tuna and tuna-like fishes by major fishing gears in the Indian Ocean. Data from IPTP (1997).

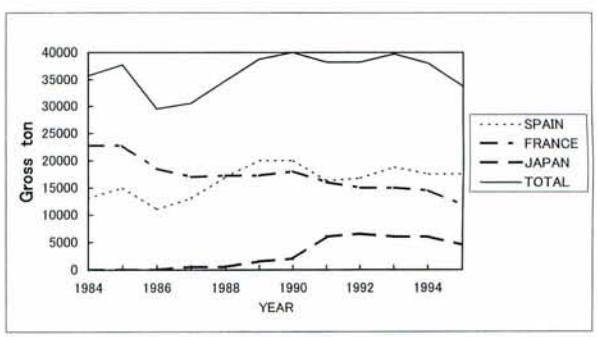

Fig. 7. Trend of fishing capacity in gross ton for major purse seine fleet in the Indian Ocean. Data from IPTP database.

Table 4. Number of purse seine boats by major fleet and by gross ton in the Indian Ocean.

	Spain					France					Japan					Grand
	0-100	101-500	501-1000	1001-	Total	0-100	101-500	501-1000	1001-	Total	0-100	101-500	501-1000	1001-	Total	Total
1975																
1976																
1977																
1978																
1979																
1980																
1981																
1982																
1983																
1984			4	10	14			17	10	27						41
1985			4	12	16			17	10	27						43
1986			4	8	12			14	8	22						34
1987			4	10	14			12	8	20		1			1	35
1988			4	14	18			11	9	20		1			1	39
1989			4	17	21			11	9	20		3			3	44
1990			4	17	21			12	9	21		4			4	46
1991			3	14	17			8	10	18		10	1		11	46
1992			1	16	17			4	12	16		11	1		12	45
1993			1	18	19			4	12	16		10	1		11	46
1994			2	16	18		7	12	2	21		10	1		11	50
1995			2	16	18		6	9	2	17		7	1		8	43

Data from IPTP database.

Baitboat Fleet

Maldives is an unique country which accounts almost all baitboat catch in the Indian Ocean. The baitboat catch, predominantly skipjack with some yellowfin, has been increasing steadily throughout the past two decades.

II-2. Trend of Fleet Capacity

Purse Seine Fleet

Overall fishing capacity in terms of GRT was calculated by summing products of number of boats and average GRT by boat size categories for Spanish, French and Japanese fleet which represents major purse seine component (Table 4). Average GRT applied were 500, 750 (500 for Japan) and 1,000 tons for 101-500, 501-1,000 and 1,000- classes, respectively. The Japanese data used in the Table 4 were compiled by the National Research Institute of Far Seas Fisheries while the IPTP database were used for other countries. Fig. 7 shows total purse seine capacity which reached a high level by 1984, only a few years after the start of the purse seining, by the French and Spanish boats migrated to the Western tropical Indian Ocean from the Atlantic and it remained relatively stable at around 35,000 tons in recent years. French capacity is slightly decreasing while Spanish fleet capacity shows a slight increasing trend.

Longline Fleet

Table 5 shows number of boats by country and boat size. Although the statistics are incomplete, it is suggested that boat size of the Taiwan fleet has becoming larger. Overall GRT was calculated as a product of number of boats and average GRT in a given size class, 100, 200, 300 and 500 tons for 0-100, 101-200, 201-500 and 500- classes, respectively. Total gross tonnage by three Asian fleet shows a slight increasing trend (Fig. 8). Both Japanese and Korean fleet tend to decrease in the fleet capacity whereas opposite trend is

Table 5. Number of distant water and coastal longline boats by major fleet and by gross ton in the Indian Ocean.

	Japan					Taiwan					Korea					Grand	Indonesia					Oman				
	0-100	101-200	201-500	501-	Total	0-100	101-200	201-500	501-	Total	0-100	101-200	201-500	501-	Total	Total	0-100	101-200	201-500	501-	Total	0-100	101-200	201-500	501-	Total
1971						5	68	166		239						239										
1972						6	102	60	2	170						170										
1973						6	54	63	3	126						126										
1974						8	99	69	1	177						177										
1975							28	31		59						59										
1976			292		292		29	29		58					127	477										
1977			249		249		34	32		66					165	480										
1978		1	258		259	1	35	49	1	86					151	496										
1979		10	289		299		39	63	1	103					174	576										
1980		12	303		315		39	72	1	112					173	600										
1981		12	314		326		39	70		109					142	577										
1982		17	305		322		52	75		127					146	595										
1983		24	309		333		61	138		199					115	647										
1984		44	255		299		37	113		150					75	524										
1985		39	275		314		26	100	1	127					62	503										
1986		26	253		279		27	120	6	153					66	498										
1987		26	232*		258*		21	128	19	168					81	507										
1988		12	211		223		19	129	39	187					112	522										
1989		21	207		228		17	146	100	263					87	578	8	48	23		79					
1990		9	189		198		15	140	117	272					77	547		162	132		294				20	20
1991		7	171		178		12*	130*	111*	253*					19	450		288	240		528				8	8
1992		7	220		227		12*	130*	111*	253*					40	520				988	988				29	29
1993		7	166		173		12*	130*	111*	253*					47	473									100	100
1994		5	198		203		12*	130*	111*	253*					45**	501										
1995		8	197		205		2	157	130	289*					52	546										
1996										314**																

Data from IPTP database except 1) those of Japanese fleet which were compiled by the National Research Institute of Far Seas Fisheries, and 2) Taiwanese data(*) from 1991 to 1994 which are not available in the IPTP database , and the 1990 value was repeated.

**Data from the Tuna Longline Fishing Nations Conference.

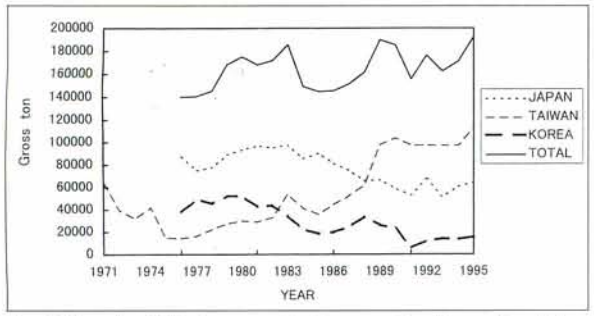

Fig. 8. Trend of fishing capacity in gross ton for major distant water longline fleet in the Indian Ocean. Data from IPTP database except Japanese fleet which was compiled by the National Research Institute of Far Seas Fisheries.

true for the Taiwanese fleet. It is noted that the number of small sized longline boats in Indonesia and to a lesser degree Oman, appears to be increasing substantially in the 1990s (Table 5).

Baitboat and Gillnet Fleet

IPTP statistics indicates the fleet capacity of baitboat (in the order of several thousand boats mainly by Maldives) and gillnet (in the order of several ten thousands operated mostly by Iran, Pakistan and Sri Lanka) fisheries have been increasing substantially (IPTP, 1997).

II-3. Stock Status and Fleet Capacity

No management measures are currently taken in the Indian Ocean except southern bluefin tuna for which the CCSBT (Commission for Conservation of Southern Bluefin Tuna) manages its whole stock range circularly distributing around the Antarctic. Summary of the stock status was made based on the latest scientific report of the IPTP (IPTP, 1997). Status of stock is unknown for most of the Indian TTF with serious concern about southern bluefin tuna and possibly about bigeye tuna and longtail tuna.

Increase of the total TTF catch in the Indian Ocean is remarkable, especially in the recent years, far exceeding that of the Atlantic. Fishing capacity for major fleet shows a slight increasing trend for the Asian longline fleet with a decreasing trend of Japanese and Korean boats contrasted by an increasing trend of Taiwanese boats, more or less stable but stays at high level for purse seine fleet composed mainly of French and Spanish boats and an increasing trend for baitboat and gillnet fisheries, although the statistics for gillnet fleet are incomplete. It should be noted that the fishing capacity for industrial purse seine as well as industrial longline fleet here shown is nominal one, not accounted by improvement of fishing efficiency and increase of number of hooks per operation.

Stock status of the Indian TTF is summarized in Table 3. Southern bluefin stock has been overfished first by longline and later by additional impact from the surface fishing. Although quota for this stock set about 12,000 tons to member countries, the catch by non-member countries amounts 4,200 tons (CCSBT, in press) which accounts for approximately 30% of the total catch. It is noted that the CCSBT has not been able to set an agreed TAC (Total Allowable Catch) in recent years due to conflicting stock assessments in the Scientific Committee, one opinion indicating stock recovery, the other the opposite with respect to spawning stock in the future. Yellowfin and skipjack mostly taken by the modern purse seiners are either fully or moderately exploited. Bigeye stock, always targeted by longline fleet due to their deep dwelling habit in most of their life except in juvenile stage, seems to be in trouble, especially in recent years. The catch jumped to more than 100,000 tons in 1995 due to the increase of catch both by longline and purse seine fleet. Use of the artificial FADs by the purse seine fleet is responsible for increase of juvenile bycatch of bigeye. Report of the IPTP (IPTP, 1995) suggests the MSY for bigeye around 50,000 to 60,000 tons while the catches in the recent three years range from 70,000 to 100,000 tons, substantially higher than the MSY.

III. Atlantic Ocean

The ICCAT has been in charge of management of the TTF in the Atlantic since its creation in 1968. Standing Committee on Research and Statistics (SCRS) is a subsidiary body of the ICCAT which assesses the stock status and gives scientific management advises to the Commission. Increase of yellowfin catch in the late 1960s urged the formation of the ICCAT. The mandatory area of the ICCAT includes the Mediterranean Sea where substantial fisheries for bluefin and swordfish exist for a long time. Vessel number statistics used for the Atlantic TTF fisheries in this paper were cited from the ICCAT Statistical Bulletins (ICCAT, 1986, 1996).

III-1. Major Fleet and Their Target Species

Purse Seine Fleet

There are two types of purse seine fleet, tropical and temperate fleet. They are different in fishing grounds, size of boats, flag countries and target species. Catches of tropical tuna such as yellowfin and skipjack dominate in the total TTF catch of the Atlantic (about 60%) and purse seine catch accounts for major part of the tropical species, except for bigeye for which longline catch is the biggest. In the tropical waters, the purse seiners aim at skipjack and yellowfin with juvenile bigeye as bycatch. Purse seiners in the tropical waters are highly mechanized and large mostly consist of super-seiners operated by so called FIS (French, Ivorian and Senegalian boats combined) and Spanish boats. They are quiet mobile, sometime across other Oceans but adapted only to the tropical waters rarely operates in the temperate waters. The temperate tuna purse seine fleet targets bluefin especially in the Mediterranean Sea. Their boat size is much smaller than the tropical fleet. Compared with the tropical fleet, available vessel statistics for the temperate purse seiners are partial, especially for many non-member countries.

Longline Fleet

Longline fleet could be classified into tuna longline

Table 6. Number of purse seine boats by major fleet and by carrying capacity in gross ton in the Eastern Atlantic.

	FIS(mostly French boats)							Spain							Total
	0-50	51-100	101-200	201-300	301-400	401-	Total	0-50	51-100	101-200	201-300	301-400	401-	Total	
1975				17	14	25	56			2	2	9	15	28	84
1976					19	26	45			1	2	9	21	33	78
1977				8	10	30	48				2	9	24	35	83
1978				3	10	30	43				2	9	28	39	82
1979				1	3	30	34				1	9	30	40	74
1980					1	32	33				1	10	32	43	76
1981					4	32	36				1	9	33	43	79
1982					3	35	38				0	1	45	46	84
1983					2	34	36					1	51	52	88
1984					1	25	26					1	47	48	74
1985					1	11	12					1	44	45	57
1986					2	12	14					1	37	38	52
1987					2	9	11						35	35	46
1988					2	12	14						37	37	51
1989					2	11	13						35	35	48
1990					1	19	20				1		34	35	55
1991						22	22						37	37	59
1992						20	20					2	37	39	59
1993						20	20					2	30	32	52
1994						21	21					2	28	30	51
1995						22	22					1	23	24	46
1996						19	19					1	23	24	43

Data from ICCAT (1986,1996).

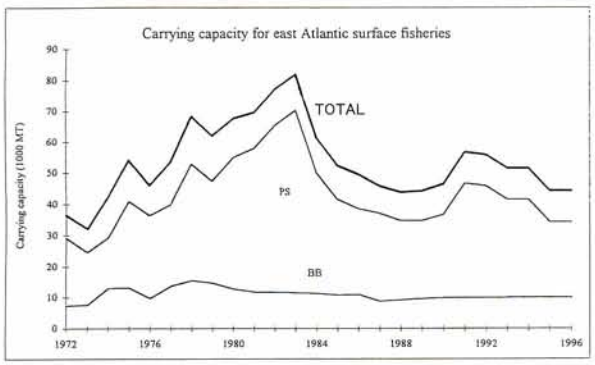

Fig. 9. Trend of carrying capacity for Eastern Atlantic surface fisheries. Data from ICCAT (1997).

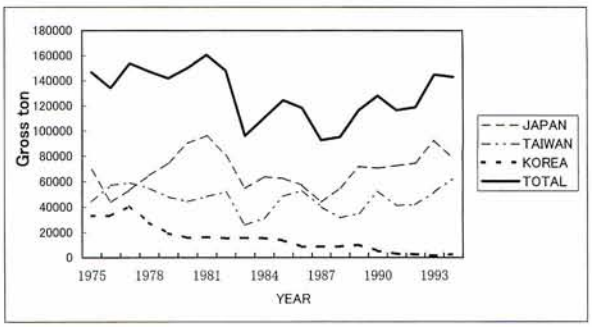

Fig. 10. Trend of fishing capacity in gross ton for major distant water longline fleet in the Atlantic. Data from ICCAT (1986, 1996).

fleet and swordfish longline fleet. Major tuna longline fleet in the tropical waters as well as in the temperate waters are operated by three Asian countries already mentioned. In addition, many longline boats flying flag of convenience suspected to be Asian origin have been witnessed operating. They are most mobile fleet among any other types of fishing boats not only trans-Oceanic like tropical purse seiners but also able to shift their fishing ground from temperate to tropical waters vice versa by changing targets. Their catch is mostly bigeye with yellowfin, swordfish and billfishes as secondary important species. Those boats are bigger than temperate longliners which is later explained and equipped with modern facilities for navigation, operation and storage of the harvested tunas. The swordfish longline fleet targets swordfish with much shallower gears than the tuna longline fleet and operated mostly at night. Spain, U.S.A., and Canada are major countries of swordfish longline.

Baitoboat Fleet

Like purse seine fleet, there are tropical and temperate fleets. Baitboat fleet, in general, is smaller in boat size, less mobile and less equipped with modern facilities compared with the purse seine and longline fleet. Tropical fleet target skipjack and yellowfin with bigeye as bycatch in the tropical waters. Ghana and the FIS are major tropical fleet and the catch is mostly juveniles. Major countries for temperate species are Spain for bigeye, skipjack, albacore and bluefin, Portugal for bigeye, skipjack and albacore, and South Africa for albacore.

III-2. Trend of Fleet Size

Purse Seine Fleet

Skipjack and yellowfin is taken mostly in the Eastern tropical Atlantic by purse seiners, about 80% of total catch of these two species. Spain and FIS fleets are primarily dominant among the purse seine fleet in the tropical Eastern Atlantic. Trend of carrying capacity for

Table 7. Number of distant water longline boats by major fleet by gross ton in the Atlantic.

	Japan					Taiwan					Korea					Grand
	0-50	51-200	201-500	501-	Total	0-50	51-200	201-500	501-	Total	0-50	51-200	201-500	501-	Total	Total
1975			229	1	230		20	141	4	165		8	110		118	513
1976			146		146		41	187	2	230		7	110		117	493
1977			179		179		44	192	3	239		5	136		141	559
1978			216		216		45	181	1	227		5	92		97	540
1979			249		249		35	158	1	194		2	64		66	509
1980			300		300		21	1464	1	1486		2	52		54	1840
1981			320		320		29	161		190		2	54		56	566
1982			269		269		40	173		213		1	51		52	534
1983			182		182		13	86		99			52		52	333
1984			212		212		12	104		116			51		51	379
1985			208		208		21	155	4	180			45		45	433
1986			190		190		17	168	5	190			28		28	408
1987			146		146		9	127	4	140			29		29	315
1988			183		183		9	98	4	111			29		29	323
1989			239		239		9	88	17	114			33		33	386
1990			235		235		8	91	50	149			17		17	401
1991			242		242		14	97	24	135			9		9	386
1992			248		248		13	98	25	136			8		8	392
1993			307		307		10	98	44	152			4		4	463
1994			261		261		10	94	68	172			8		8	441

Data from ICCAT (1986, 1996).

Table 8. Number of swordfish longline boats by major fleet by gross ton in the Atlantic.

	Spain					U.S.A					Canada				
	0-50	51-200	201-500	501	Total	0-50	51-200	201-500	501	Total	0-50	51-200	201-500	501	Total
1975															
1976															
1977															
1978												17			17
1979	8	127	6		141						5	22			27
1980	2	132	6		140						15	28			43
1981	0	136	5		141						18	21			39
1982	32	147	9		188						20	15			35
1983	32	147	9	1	189						12	20			32
1984	30	145	9	1	185						14	18			32
1985						252	106			358		20			20
1986						209	97			306		31			31
1987		390			390					0		70			70
1988						158	120			278	20	19			39
1989						197	160			357	21	28	3		52
1990						133	86		1	220	139	25		1	165
1991						92	45			137	281	55	3		339
1992						99	30			129	84	68	2		154
1993						138	40			178	372	45	5		422
1994						106	59			165	305	44	3		352

Data from ICCAT (1968, 1996).

Eastern Atlantic surface fisheries including other countries than the Spain and FIS shows an increasing trend up to 1983 and a steep decline until the end of the 1990s followed by moderate increase in the early 1990s (Fig. 9). The increase up to 1983 and decrease afterward with moderate increase are mainly due to increase in number of boats as well as shift of boats to large sized classes and exit and return of the boats (change in number of boats) from the Atlantic to Indian Ocean, respectively (Table 6).

As stated before, vessel statistics of the temperate purse seiners are poor but this fleet is most responsible for increase of bluefin catch in the Mediterranean Sea. Long term trend of the number of tuna purse seine in the Mediterranean is only available for French purse seiner. Both number of boats and the size class of the fleet remain stable fluctuating 20 and 40 for the past two decades. However, the catch of bluefin by the French fleet increased substantially in recent years with improvement of fishing techniques and changes in hunting strategy.

Longline Fleet

Table 7 shows trend of fleet size by major tuna longline fleets by Japan, Taiwan and Korea. As previously stated, those three countries account most of the tuna catches by longline. Japan and Taiwan show fluctuation without overall upward or downward trend whereas the number of Korean boats decreased to a very low number by 1994. Taiwanese fleet tend to shift from smaller boat to larger boat classes during the period. Overall gross tonnage was calculated multiplying average tonnage by number of boats. This was done by vessel class regardless of country,

applying average tonnage 200, 300, and 500 for 51-200 class, 201-500 class and 501- class, respectively. Fig. 10 shows the trend in terms of gross tonnage. Overall trend by three countries peaked in 1981 and showed a drop in the 1980s then increased again and attained about the same level in the later 1970s (Fig. 10). The drop after 1981 can partly be attributable to 20% cut of number of distant water longline boats of Japan. If the increase of number of hooks per operation, about 30% by the early 1990s, is adjusted, trend of the total number of Japanese longline hooks used in the Atlantic should be higher in the recent years compared to peak 1981 as shown already in Fig. 3.

For swordfish fleet, vessel statistics are less complete (Table 8). Spain, U.S.A. and Canada are major swordfish harvesting countries using directed swordfish longline boats. Before middle of the 1980s, there are no reliable catch records for swordfish in the USA and Canada due to mercury problem. However, it is well documented that the Atlantic swordfish catch rapidly increased after easing of the mercury safety standard.

Baitboat Fleet

Fig. 9 also shows trend of carrying capacity for tropical baitboats in the Eastern Atlantic. Their capacity is much smaller and the trend is more stable than those of the purse seine fleet in the Eastern Atlantic. Baitboat fishery in the Western tropical waters dominated by Brazil and the fleet capacity appears to be stable.

III-3. Stock Status and Fleet Capacity

Table 3 shows the latest status of the stock and relevant stock specific management measures (ICCAT, 1998). Most of the commercially important stocks of the TTF are either fully exploited or overfished in the Atlantic Ocean except skipjack. Current fishing capacity are about the same level of the peak year in 1981 for longline fleet and substantially lower than the peak 1983 for tropical purse seine fleet. Baitboat fleet has been minor in catch and the fleet size is stable. However, it is obvious the trend of tropical purse seine capacity and to some extent with longline fleet as well does not necessary represent the real overall fishing power. The SCRS tentatively assumes annual 3% increase of fishing efficiency for tropical purse seiners after 1981 due to installation of modern equipment including sonar and bird radar and concluded that yellowfin stock is fully exploited. While skipjack stock seems to be moderately exploited, there is serious concern about overfishing for bigeye due to increase of longline catch as well as tropical purse seine with use of artificial FADs. Management advice of the SCRS for bigeye is to reduce the catch at least to 1991-1992 level from current level, a reduction of approximately 20%. The Commission at the 1997 meeting addressed the issue of overharvest of bigeye tuna by contemplating the reduction of the number of fishing boats taking bigeye tuna. Major part of the purse seine fleet also started voluntary time area closure to reduce juvenile bigeye catch.

Although various fisheries target bluefin tuna, largest catch of bluefin tuna is attributable to temperate purse seiners, specifically in the Mediterranean. Several regulatory measures imposed on this species, a progressive 25% catch reduction by 1998 is adopted by the Commission for the eastern stock which includes the Mediterranean.

Albacore in the south Atlantic and marlins, to which TAC was imposed recently, are taken mostly by tuna longline fleet. They are bycatch of the tuna longliners except albacore aimed by Taiwanese fleet and their stock status are either fully exploited or overfished. The Commission decided to reduce catches of blue and white marlin by 25% by 1999 and the current catch of the south Atlantic stock is about 10% higher than recommended catch limit.

Table 9. Number of distant water tuna longline vessels with super low freezer (after Kagawa et al., 1998). Number of vessels of Indonesia and FOC (flag of convenience) nations were estimated based on total amount of sashimi-grade tuna imported to Japan divided by 250 tons per vessel.

	Japan	Republic of Korea	Taiwan	Total	Indonesia	FOC	Total
1981	964	208	72	1,244	NA	NA	—
1982	854	185	69	1,108	NA	NA	—
1983	770	169	71	1,010	NA	NA	—
1984	761	157	63	981	NA	NA	—
1985	773	156	75	1,004	NA	NA	—
1986	771	167	81	1,019	NA	NA	—
1987	770	189	103	1,062	37	83	1,182
1988	759	199	107	1,065	43	102	1,210
1989	764	196	143	1,103	60	106	1,269
1990	758	203	196	1,157	62	137	1,356
1991	743	194	290	1,227	31	156	1,414
1992	724	185	313	1,222	34	142	1,398
1993	722	174	314	1,210	36	122	1,368
1994	701	184	443*	1,328	29	147	1,504
1995	703	201	451*	1,355	35	163	1,553
1996	674	206	456*	1,336	29	152	1,517
1997	661	(206)	465*	1,332	24	170	1,526

*Since 1994, these numbers include fishing vessels based on ports with super freezer. The number of such vessels is estimated to be 109 in 1995, 122 in 1996 and 13 in 1997, by analyzing the trade statistics of Japan.

For swordfish stocks, they are overfished (south and north Atlantic stocks) or probably fully exploited (Mediterranean stock). Current catch for the south and north Atlantic stocks combined is about 25% higher than the ICCAT recommendation.

Summary and Conclusion

Brief overview of the stock status and trends of the fishing capacity for the world TTF reveals that yellowfin and skipjack stocks mainly caught by the tropical purse seine fleet is in healthy or fully exploited condition. However, it should be noted that the recent increase of bycatch of juvenile bigeye by the tropical purse seine fleet may give adverse effect to the status of bigeye stocks and longline fishery targeting bigeye as well. On the other hand, there are concerns about stock status of several tuna stocks targeted or mostly taken by distant water longliners, e.g., bigeye, bluefin and southern bluefin tunas. While the fishing capacity of the tropical purse seine fleet tends to be stabilized in recent years, the overall longline fishing capacity seems to be increasing in the Atlantic and Indian Oceans. The decline of the longline fishing activity in the Pacific reflects a lower catch rate of bigeye tuna as a resultant move of the dominant Japanese fleet to other areas and stocks which might aggravate resources conditions of less depleted stocks. In this section, problems with respect to the longline fishing capacity are reviewed in some details keeping in mind similar problems persist in purse seine case.

Japanese sashimi market is a key driving force in determining longline fleet dynamics since longline caught tunas with high meat quality are exported to Japan. Retrospectively, it was the invention of deep freezer by Japanese in the 1960s that made development of distant water longline fleet worldwide possible. After Japan, Taiwan and Korea joined the longlining. As freezing technology improves, total number of super-freezing longline boats capable of keeping processed tuna as low as minus 60 degree C started to increase, with an increase of sizable number of boats flying flag of convenience, FOC (Table 9). With these super-freezer boats, Taiwan, Korea and Indonesia have begun to change target species from yellowfin and albacore to more valuable bigeye, bluefin and southern bluefin tunas, the stocks already being overfished. As a result, catches by non-member countries of the relevant management bodies and by boats with flag of convenience have been increasing substantially in the longline fisheries. The purse seine fishery also suffers from the similar problems. The catches of those valuable tunas for sashimi market have reached a alarming level. In the early 1980s, Japan unilaterally reduced number of distant water longline fleet by 20%. However, due to increase of the longline fleet of other countries, this attempt failed to control the fishing capacity. Therefore, reduction of the fishing capacity can not be done effectively without including all fleets involved. The review indicates in very rough estimates from various stocks, mainly bigeye and temperate species that overall reduction of some 20-30% of all distant water longline fleet is necessary as soon as possible. In the same time, the bycatch of juvenile bigeye by tropical purse seiners should at least be capped immediately until more reliable stock assessment become available for bigeye stock. It should be reiterated that increase of flag of convenience boats both for longline and purse seine fisheries threatens the sustainable utilization of tuna resources because these boats continue to operate outside of the international conservation schemes. Since the fishing efficiency increases due to technological improvement of fishing gears and associated equipment, quantitative record of such improvement should be collected routinely so that the real increase of fishing capacity by such factors are taken into account to better monitoring of the overall trend of the fishing capacity.

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まぐろおよびまぐろ類似種を対象とする漁業，特にまぐろ延縄漁業に関する漁獲能力のレビュー

鈴木治郎*

摘　要

漁業における過剰漁獲努力量の恒常的な存在は，資源の持続的利用や合理的利用にとって大きな障害となっている．この論文では，過剰漁獲努力量問題をかかえているまぐろ漁業，特に遠洋まぐろ延縄漁業に焦点を当て，世界的規模で，主要まぐろ漁業の漁獲努力量の推移と主要資源の資源状態をレビューすることによって，削減されるべき漁獲努力量を極めて概略的に遠洋延縄漁業について見積もった．その結果は次のような主要点を指摘している．すなわち，遠洋まぐろ延縄の漁船隻数を20～30%程度直ちに削減する必要があること，同時に熱帯海域で操業する巻き網による小型メバチの混獲量を，より信頼できるメバチの資源評価が得られるまでは少なくともこれ以上増加させないこと，便宜置籍船の排除が急務であること，さらに総漁獲能力の変動傾向のより正確な把握のためには，技術革新による漁獲効率の向上を定量化して漁獲能力の推定の際に勘案することが肝要であることである．この論文の原稿は，1998年4月15～18日の間，米国ラホヤで開催されたFAO主催の漁獲能力の管理に関する専門家会議に提出されたものである．

*遠洋水産研究所（〒424-8633 静岡県清水市折戸5丁目7番1号）