A Review of Indian Ocean Fisheries for Skipjack Tuna, *Katsuwonus pelamis*, and Yellowfin Tuna, *Thunnus albacares*

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Introduction

Skipjack tuna, *Katsuwonus pelamis*, and yellowfin tuna, *Thunnus albacares*, together comprise the most important component of Indian Ocean tuna catches. Catches of these species by Indian Ocean fisheries have been increasing over the last decade and totaled 262,300 metric tons (t) in 1986 (Fig. 1; Table 1). Skipjack tuna was the most important species at 32 percent of the total tuna catch in 1986; yellowfin tuna was the second most important at 25 percent. Skipjack tuna are found throughout the Indian Ocean from the Gulf of Arabia in the north to lat. 40°S (Fig. 2)[1]. Yellowfin tuna are also distributed throughout the ocean to about lat. 50°S.

This paper reviews information on fisheries for skipjack and yellowfin tuna in the Indian Ocean. The report is based almost exclusively on working papers presented at the Expert Consultation on the Stock Assessment of Tunas in the Indian Ocean held in December 1986 (Anonymous, 1987c). Additional information was taken from statistical publications of the United Nations Food and Agriculture Organization's Indo-Pacific Tuna Development and Management Programme (IPTP) (Anonymous, 1988a; Anonymous, 1988b).

The Fisheries

Skipjack and yellowfin tuna have become increasingly important in Indian Ocean tuna fisheries; their proportion in the total Indian Ocean tuna catch increased from 35 percent in 1974 to 56 percent in 1986 (Fig. 1). The catch of these species in 1986, 262,300 t, was three times the 1981 catch. Although some of this increase is attributable to increased catches by traditional small-scale fisheries, the major part is due to catches by the large-scale purse seine fleet which began to take a significant part of Indian Ocean tuna catches in 1983. The purse seine catch increased from near zero in 1981 to 132,000 t in 1986 and accounted for 50 percent of the total Indian Ocean catch of skipjack and yellowfin tuna in 1986.

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Increases in catches of skipjack and yellowfin tuna in the Indian Ocean have been particularly great since 1982. Total skipjack catches increased gradually (33 percent) over a period of 8 years from 39,500 t in 1974 to 52,600 t in 1982 (Fig. 1). Over the same period, yellowfin catches increased 65 percent (from 28,300 t to 46,800 t), and catches of all tunas increased 45 percent. Then, during the 4-year period between 1982 and 1986, skipjack catches increased 181 percent to 148,100 t as the large-scale purse seine fishery was established and then expanded. Catches of yellowfin, the other principal species taken in the purse seine fishery, increased 144 percent during the period, while catches of all tunas increased 64 percent.

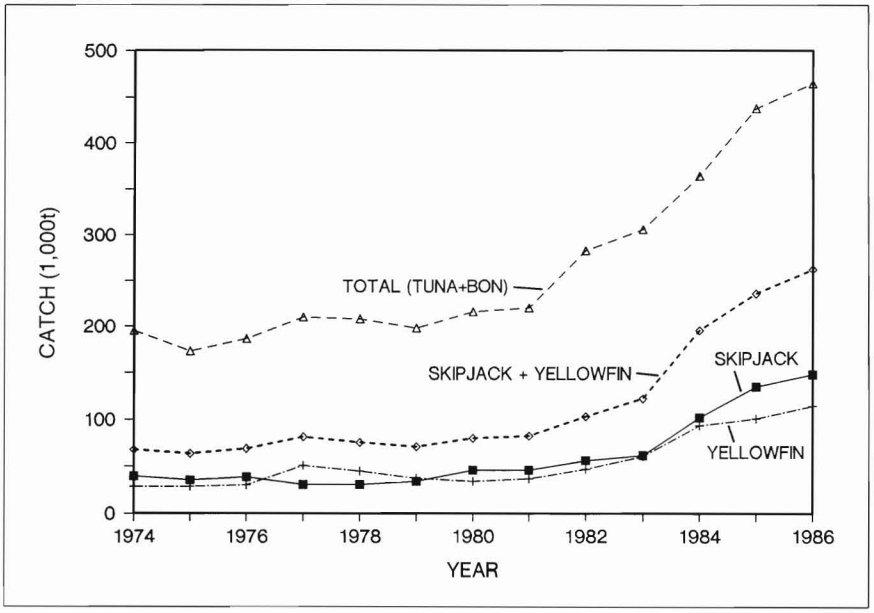

Figure 1.—Catches of skipjack and yellowfin tuna and of all tunas and bonitos in the Indian Ocean, 1974-1986 (Anonymous, 1988b).

[1]Figure 2 shows areas of skipjack tuna catches by the large-scale purse-seine fishery between lat. 20°S and 20°N. Catches by Indian Ocean small-scale fisheries, for which comparably detailed area data are not available, suggests availability from the Gulf of Arabia to lat. 40°S.

Table 1.—Catches (t) of tuna in the Indian Ocean, by species, 1974-1986 (Anonymous, 1988b).

Species	Catch (t)												
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Yellowfin	28,297	28,390	30,090	50,898	44,683	36,982	34,064	36,435	46,828	60,663	93,503	100,768	114,243
Bigeye	21,183	30,959	23,659	31,511	47,379	31,027	31,303	32,378	39,144	44,168	35,604	41,949	42,904
Albacore	14,964	5,361	6,170	9,713	16,653	16,211	11,637	13,233	23,205	17,180	15,119	9,628	25,358
Southern bluefin	30,543	21,273	26,866	26,395	17,122	16,944	24,205	26,065	29,136	36,741	30,163	28,002	21,908
Skipjack	39,502	35,165	38,612	30,294	30,461	33,916	45,835	45,792	52,620	61,594	101,922	134,994	148,110
Longtail	2,126	2,421	3,046	3,305	1,936	4,589	3,215	5,710	15,337	15,957	16,329	28,962	21,570
Kawakawa	15,832	16,756	16,529	15,019	9,660	14,480	8,282	23,113	25,507	21,322	29,080	25,978	28,369
Frigate	0	0	0	0	0	0	0	0	0	0	0	2,466	1,626
Bullet	0	0	0	0	0	0	0	0	0	0	0	617	67
Frigate/bullet	6,006	4,057	2,708	3,086	1,661	1,701	1,595	2,908	4,967	5,675	9,337	3,418	10,942
Bonita Indo-Pacific	0	0	0	0	0	0	0	0	0	0	0	2,762	0
Tunas	36,476	28,616	38,578	39,738	38,431	41,965	55,558	34,369	46,048	42,810	33,232	58,876	49,337
Total	194,929	172,998	186,258	209,923	207,986	197,815	215,694	220,003	282,792	306,110	364,289	438,420	464,434

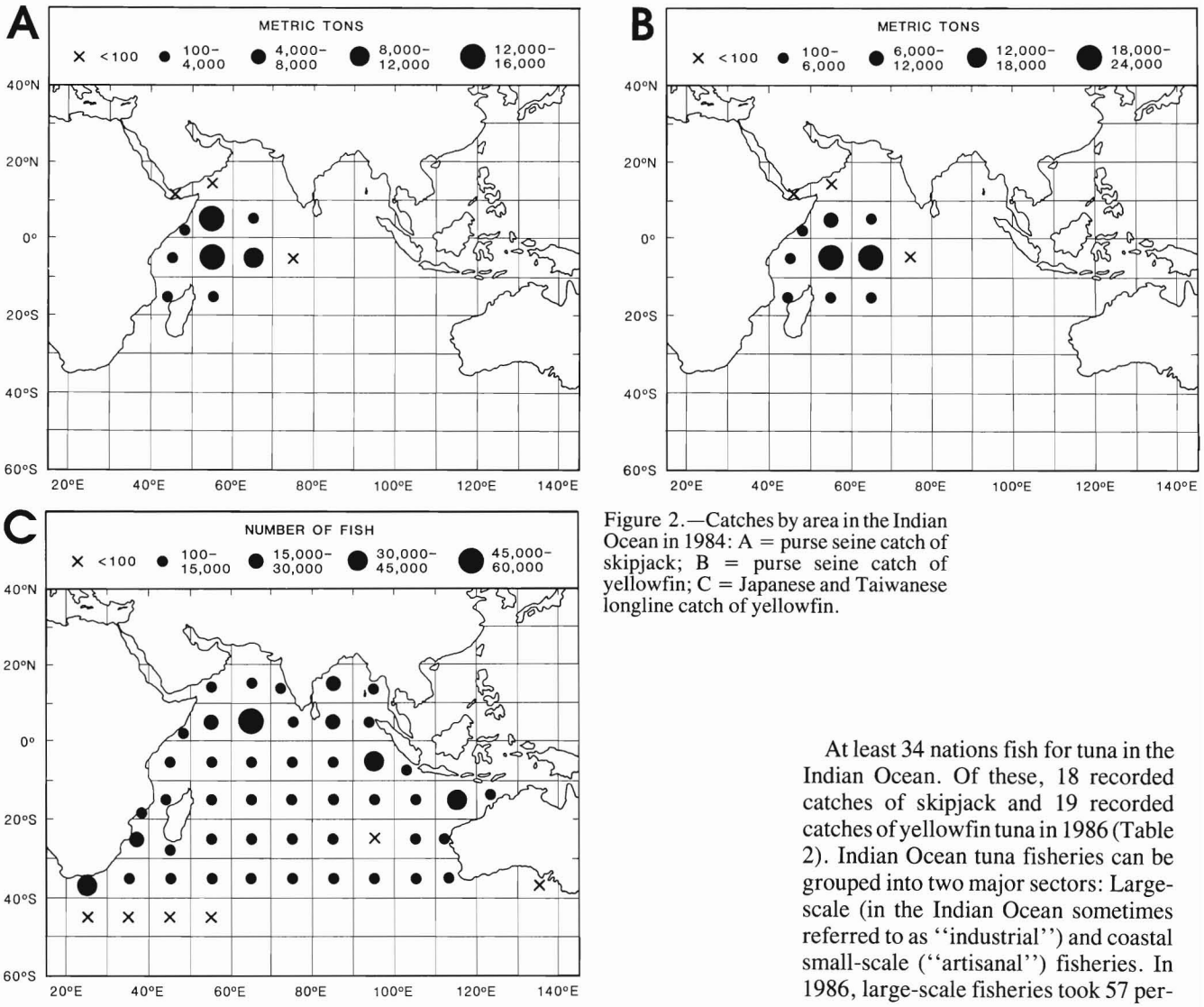

Figure 2.—Catches by area in the Indian Ocean in 1984: A = purse seine catch of skipjack; B = purse seine catch of yellowfin; C = Japanese and Taiwanese longline catch of yellowfin.

At least 34 nations fish for tuna in the Indian Ocean. Of these, 18 recorded catches of skipjack and 19 recorded catches of yellowfin tuna in 1986 (Table 2). Indian Ocean tuna fisheries can be grouped into two major sectors: Large-scale (in the Indian Ocean sometimes referred to as "industrial") and coastal small-scale ("artisanal") fisheries. In 1986, large-scale fisheries took 57 per-

Table 2.—Catches (t) of skipjack and yellowfin tuna, and total catches in the Indian Ocean by flag of fishing vessel, 1974-1986 (Anonymous, 1988b).

Species and country	Catch (t)												
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	19?	1985	1986
Skipjack tuna													
Australia	133	523	404	26	49	58	37	0	0	0	0	550	550
China (Taiwan)	39	83	42	18	5	11	9	20	11	9	22	36	29
Comoros	250	300	250	300	300	300	300	300	330	340	350	360	360
France	0	0	0	0	0	0	0	210	771	10,075	25,517	33,084	40,363
India	0	0	0	0	0	0	0	1,803	2,399	1,801	3,488	3,276	3,195
Indonesia	447	3,925	5,513	4,034	4,093	6,524	7,573	6,579	11,832	12,458	10,447	9,602	10,954
Ivory Coast	0	0	0	0	0	0	0	0	0	0	5,112	3,197	175
Japan	31	23	16	4	919	3	484	30	5	595	2	556	567
Kenya	0	0	0	0	0	0	0	71	97	33	45	63	49
Korea	72	200	63	151	253	65	43	48	57	8	0	0	0
Maldives	22,159	14,858	20,092	14,342	13,824	18,136	23,561	20,617	15,881	19,701	32,049	42,602	45,445
Mauritius	0	0	0	0	14	51	994	1,731	2,417	1,396	2,850	2,026	1,853
Mozambique	0	0	0	0	0	0	0	0	0	60	154	80	80
Pakistan	0	0	0	0	0	449	134	446	5,156	733	694	0	105
Panama	0	0	0	0	0	0	0	0	0	0	1,462	2,990	4,606
Seychelles	50	10	10	20	10	10	0	0	0	0	0	0	0
South Africa	0	0	0	0	0	0	0	0	0	13	0	4	0
Spain	0	0	0	0	0	0	0	179	14	0	8,079	22,854	24,877
Sri Lanka	12,321	15,243	12,222	11,399	10,994	8,309	12,700	13,758	13,250	13,972	11,619	12,118	13,737
United Kingdom	0	0	0	0	0	0	0	0	0	0	20	1,589	1,155
Yemen Dem.	0	0	0	0	0	0	0	0	400	400	12	7	10
Subtotal	35,502	35,165	38,612	30,294	30,461	33,916	45,835	45,792	52,620	61,594	101,922	134,994	148,110
Yellowfin tuna													
Australia	0	0	0	3	15	28	34	0	8	18	41	43	42
China (Taiwan)	800	523	425	4,733	3,261	2,878	2,723	1817	3,526	4,211	1,369	5,099	9,313
Comoros	100	100	100	100	100	100	100	100	110	120	130	140	140
France	0	0	0	0	0	0	0	260	1,224	10,773	33,611	32,231	35,519
Indonesia	1,071	869	1,317	2,345	2,811	3,236	3,348	3,350	3,740	5,888	4,247	4,543	3,270
Iran	0	0	800	0	0	341	322	0	0	0	0	0	0
Ivory Coast	0	0	0	0	0	0	0	0	0	0	5,107	3,046	562
Japan	4,415	4,719	2,744	2,061	4,263	2,023	3,440	4,701	6,355	7,232	7,467	9,372	11,115
Kenya	0	0	0	0	0	0	67	171	204	322	0	0	0
Korea	11,563	11,694	12,840	31,383	25,165	17,788	12,537	11,777	18,654	15,337	9,895	12,017	14,891
Maldives	4,128	3,774	4,891	4,473	3,584	4,289	4,229	5,284	4,004	6,241	7,123	6,066	5,321
Mauritius	0	0	0	0	15	5	1	1	0	1,057	1,284	914	851
Mozambique	0	0	0	0	0	0	0	0	0	15	188	15	15
Pakistan	0	0	0	0	0	0	0	0	0	0	0	0	2,093
Panama	0	0	0	0	0	0	0	0	0	0	2,441	3,236	3,432
Seychelles	150	100	50	80	100	128	357	949	518	157	198	147	10
Spain	0	0	0	0	0	0	0	363	55	0	13,796	15,411	17,532
Sri Lanka	6,070	6,611	6,915	5,720	5,369	6,166	6,906	7,662	8,350	9,046	6,439	6,716	7,977
Tanzania	0	0	0	0	0	0	0	0	0	0	0	0	600
United Kingdom	0	0	0	0	0	0	0	0	0	0	155	1,177	1,050
Yemen Dem.	0	0	0	0	0	0	0	0	80	80	12	511	510
Subtotal	28,297	28,390	30,090	50,898	44,683	36,982	34,064	36,435	46,028	60,663	93,503	100,768	114,243
Group total YF + SJ	63,799	63,555	68,702	81,192	75,144	70,898	79,899	82,227	98,648	122,257	195,425	235,672	262,353

Table 3.—Catches (t) of tuna by small-scale and large-scale fisheries in the Indian Ocean by species in 1986 (Anonymous, 1988b).

Fishery	Catch (t) by species[1]												
	YFT	BET	ALB	SBF	SKJ	LOT	KAW	FRI	BLT	FRZ	BIP	TUN	Total
Small-scale	20,126	179	0	0	73,935	21,435	28,369	0	0	12,635	0	43,300	199,979
Large-scale	94,117	42,725	25,358	21,908	74,175	135	0	0	0	0	0	6,404	264,822
Total	114,243	42,904	25,358	21,908	148,110	21,570	28,369			12,635		49,704	464,801

[1]Abbreviations: YFT = yellowfin; BET = bigeye; ALB = albacore; SBF = southern bluefin; SKJ = skipjack; LOT = longtail; KAW = kawakawa; FRI = frigate; BLT = bullet; FRZ = frigate/bullet; BIP = Indo-Pacific bonito; TUN = not identified to species.

cent of the total catch of tunas, 50 percent of the skipjack, and 82 percent of the yellowfin catch (Table 3). Small-scale fisheries took 43 percent of the total tuna catch, 50 percent of the skipjack, and 18 percent of the yellowfin catch.

No Indian Ocean tuna fishery catches skipjack or yellowfin tuna exclusively, but rather a mix of pelagic species that

may change both within and between seasons is harvested. While yellowfin typically comprises no more than 50 percent of the annual tuna catch of any single Indian Ocean fishery, skipjack is the most important of the tunas in catches of many fisheries, particularly the small-scale fisheries. In 1986, 90 percent of the total catch of tunas, tuna-like fishes, and billfishes was comprised of, in decreasing order of catch, skipjack tuna, yellowfin tuna, king mackerel, *Scomberomorus cavalla*; bigeye tuna, *Thunnus obesus*; kawakawa, *Euthynnus affinis*; albacore, *T. alalunga*; southern bluefin tuna, *T. maccoyii*; longtail tuna, *T. tonggol*; and tunas of unrecorded species.

The principal yellowfin-catching fisheries are the large-scale longline and purse seine fisheries which, in 1986, took 32 percent and 51 percent, respectively, of the total yellowfin catch. The principal skipjack fisheries are the large-scale purse seine fishery and the small-scale fisheries which each took 50 percent of the 1986 skipjack catch. Longline catches of skipjack are negligible.

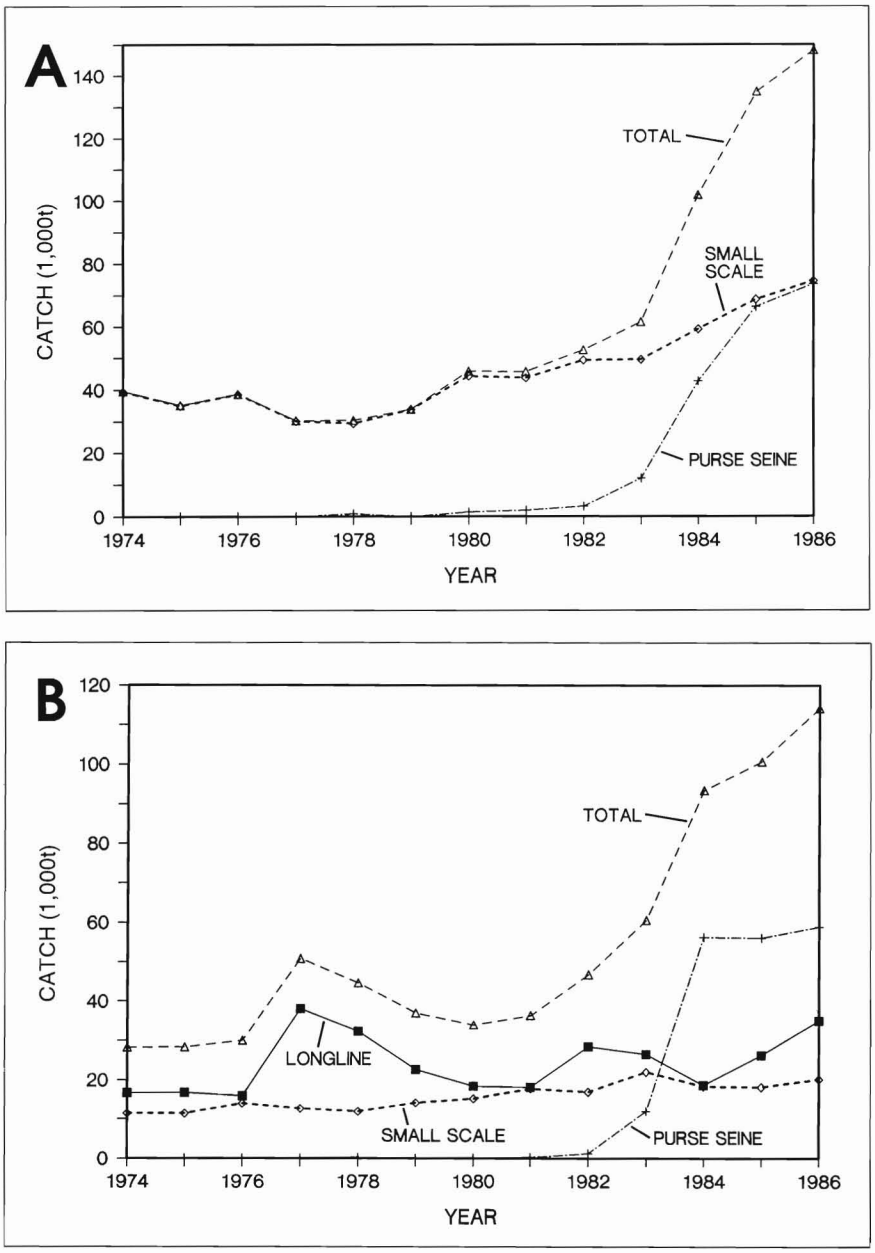

Figure 3.—Catches by fishery in the Indian Ocean 1974-1986: A = skipjack; B = yellowfin.

Large-scale Fisheries

Vessels in large-scale Indian Ocean tuna fisheries are typically long-range vessels primarily of distant-water fishing nations (DWFN). There are two major large-scale components: One is the longline fleets of Japan, Korea, and Taiwan; the other is the purse seine fleets primarily of France and Spain.

The large-scale longline fishery took 32 percent of the 1986 catch of yellowfin. Following the beginning of the fishery in the early 1950's, annual catches varied between 25,000 t and 70,000 t until 1973, when catches declined to around 15,000 t (Anonymous, 1987a). Between 1974 and 1986, yellowfin catches varied between 15,000 t and 40,000 t, reaching 36,000 t in 1986 (Fig. 3B).

Japanese longline vessels began fishing for tunas in the Indian Ocean in the early 1950's, followed by vessels from Taiwan and Korea in the 1960's (Amarasiri and Joseph, 1987). These large (200-500 GRT) longliners target yellowfin and other large tunas. In 1984, the longline fleet operated in virtually the entire Indian Ocean from lat. 45°S north to the Gulf of Arabia and between the coast of East Africa to Indonesia (Fig. 4). In 1985, 250 Japanese, 62 Korean, and 127 Taiwanese longliners operated in the Indian Ocean (Anonymous, 1987b; Indian Ocean Fishery Commission, 1985).

The longline fishery catches other large pelagic species besides yellowfin tuna—albacore, bigeye tuna, southern bluefin tuna, and billfishes. In 1986, yellowfin tuna composed 34 percent of the total longline catch. The Japanese longline fleet in recent years has targeted bigeye and southern bluefin tuna. In 1986 the catch of yellowfin tuna was 11,000 t, 26 percent of the total Japanese catch of

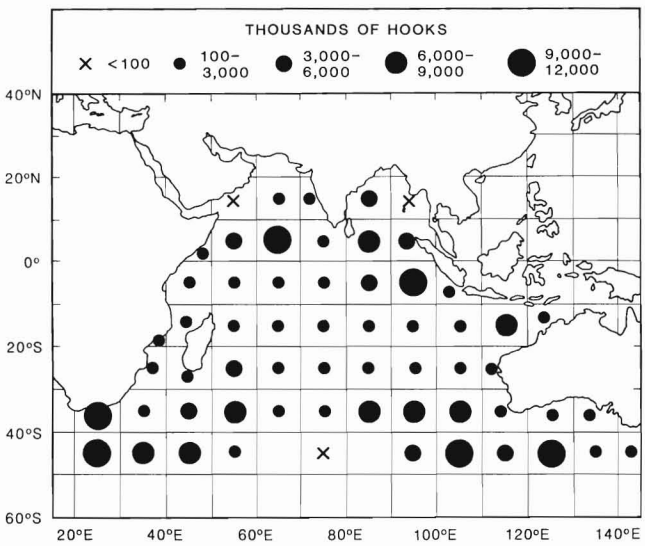

Figure 4.—Effort by the large-scale longline fishery by area in the Indian Ocean in 1984 (Anonymous, 1988a).

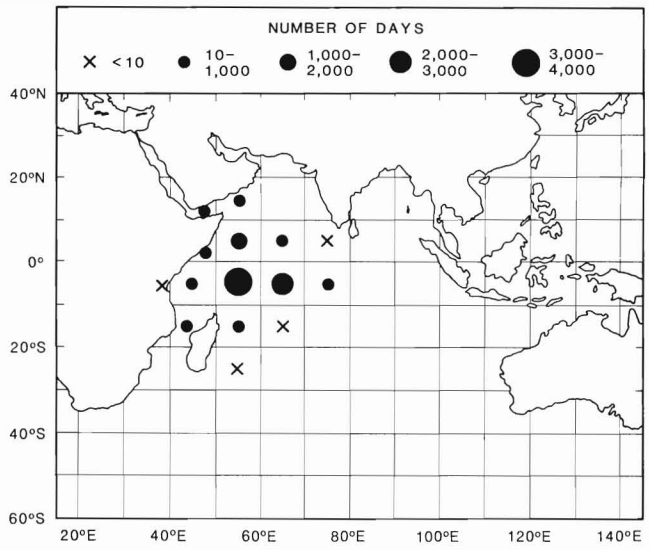

Figure 5.—Effort by the large-scale purse seine fishery by area in the Indian Ocean in 1984 (Anonymous, 1988a).

tunas and billfishes (Table 2). Korean longliners target yellowfin tuna, which in 1986, at 14,900 t, comprised 47 percent of the Korean catch. The Taiwanese fleet targets albacore and, in 1986, caught 9,300 t of yellowfin tuna, 20 percent of the total.

The large-scale purse seine fishery took 50 percent of the total 1986 catch of skipjack and 52 percent of the catch of yellowfin tuna. Catches of skipjack and yellowfin tuna were first recorded for this fishery in 1978 (1,147 t) and remained at low level through 1982 (4,400 t; Fig. 3). Beginning in 1983, catches increased rapidly to 132,000 t in 1986 (73,000 t skipjack, 59,000 t yellowfin).

The purse seine fishery became a significant presence in the Indian Ocean in the early 1980's when French and Spanish interests relocated large purse seiners from fishing grounds off the west coast of Africa to the western Indian Ocean. Exploratory purse seining in 1981 and 1982 suggested that commercial operations in the Indian Ocean would be successful (Steguert and Marsac, 1986). Subsequently, the French purse seine fleet in the western Indian Ocean grew to 27 vessels by 1985. The Spanish followed the French into the western Indian Ocean fishery in 1984 with 16 vessels. In the early years of the fishery the fleet operated near the Seychelles Islands. The fishery developed rapidly, and by 1985 the fishery, composed primarily of French and Spanish vessels plus some from Ivory Coast, Mauritius, Panama, and the United Kingdom, had expanded to cover the whole of the western part of the Indian Ocean, moving seasonally from the southern Arabian Sea to the Mozambique channel (Indian Ocean Fishery Commission, 1985). In 1984, purse-seine effort was concentrated between Madagascar in the south and the mouth of the Red Sea in the north and between the coast of East Africa and long. 70°E (Fig. 5).

The purse seine fishery catches a variable mixture of skipjack and yellowfin tuna and minor quantities of other tunas. In 1986, catches by the fleet were 53 percent skipjack, 43 percent yellowfin, and 4 percent other species, primarily bigeye tuna. In 1986, French catches of skipjack and yellowfin tuna were 40,300 t and 35,500 t, 50 and 44 percent, respectively, of the French total (Table 2). Spanish catches were 24,800 t skipjack and 17,500 t yellowfin, 58 and 41 percent, respectively, of the Spanish total.

Activities of the principal European participants in the purse seine fishery, France and Spain, are governed by fishing agreements between the Seychelles Government and the European Economic Community (EEC) to fish in the EEZ (Anonymous, 1987b). Seychelles-based vessels operate both in and outside the Seychelles EEZ. They transship catches at the port of Victoria where they also provision and resupply. The number of purse seiners operating out of the Seychelles reached a maximum of 49 at the end of 1984 (Anonymous, 1987b). In 1986, some of the vessels also fished in the Atlantic Ocean, leaving an average of 35 vessels fishing in the western Indian Ocean at any given time.

The EEC has also arranged access for member nations with other Indian Ocean nations (e.g., Madagascar and Mozambique; Anonymous, 1987b). Victoria, Seychelles, and Antananarivo, Madagascar, are the two major ports used by the fishing fleet. Vessels shift ports with season depending on fishing conditions in adjacent areas.

Small-scale Fisheries

The small-scale sector of the Indian Ocean tuna fisheries is composed primarily of coastal fishing vessels of Indian Ocean coastal nations. Traditional small-scale fisheries for tunas have operated in

Table 4.—Catches (t) of tunas by countries having small-scale fisheries in the Indian Ocean by species in 1986 (Anonymous, 1988b).

Country	Catch by species[1]												
	YFT	BET	ALB	SBF	SKJ	LOT	KAW	FRI	BLT	FRZ	BIP	TUN	Total
Bangaladesh	0	0	0	0	0	0	0	0	0	0	0	67	67
Comoros	140	0	0	0	360	0	1,300	0	0	0	0	140	1,940
Djbouti	0	0	0	0	0	0	0	0	0	0	0	30	30
Egypt	0	0	0	0	0	0	0	0	0	0	0	300	300
India	0	0	0	0	3,195	185	18,116	0	0	8,485	0	2,780	32,761
Indonesia	3,270	0	0	0	10,954	0	0	0	0	0	0	21,600	35,824
Iran	0	0	0	0	0	11,710	1,870	0	0	326	0	0	13,906
Israel	0	0	0	0	0	0	0	0	0	100	0	0	100
Kenya	0	0	0	0	49	0	0	0	0	0	0	0	49
Maldives	5,321	0	0	0	45,445	0	1,071	0	0	1,779	0	415	54,031
Mauritius	190	179	0	0	0	0	0	0	0	0	0	400	769
Mozambique	15	0	0	0	80	0	0	0	0	0	0	280	375
Oman	0	0	0	0	0	0	0	0	0	0	0	11,728	11,728
Pakistan	2,093	0	0	0	105	3,275	1,225	0	0	18	0	3,535	10,251
Reunion	0	0	0	0	0	0	0	0	0	0	0	190	190
Saudia Arabia	0	0	0	0	0	0	0	0	0	0	0	264	264
Seychelles	10	0	0	0	0	0	323	0	0	0	0	0	333
Sri Lanka	7,977	0	0	0	13,737	0	1360	0	0	1367	0	4	24,445
Tanzania	600	0	0	0	0	0	0	0	0	0	0	70	670
Thailand	0	0	0	0	0	1,895	0	0	0	0	0	1,497	3,392
U.A.E.	0	0	0	0	0	3,973	1,396	0	0	540	0	0	5,909
Yemen A.R.	0	0	0	0	0	307	438	0	0	0	0	0	745
Yemen Dem.	510	0	0	0	10	90	1,270	0	0	20	0	0	1,900
Total	20,126	179			73,935	21,435	28,369			12,635		43,300	199,979

[1]Abbreviations: Same as in Table 3.

coastal areas for over 100 years and, in some instances (e.g. the Maldives), perhaps for 1,000 years[2]. These fisheries land the entire Indian Ocean catch of small tunas and, in recent years, about half the catch of skipjack and 20 percent of the catch of yellowfin (Yesaki, 1987; Sivasubramanian, 1987).

Catches by these small-scale fisheries were first estimated for 1972 and have increased from 80,000 t in 1972 to 200,000 t in 1986 (Yesaki, 1987). Between 1974 and 1986, catches of skipjack and yellowfin increased from 50,000 t to 94,000 t (Fig. 3). Skipjack are taken more often in coastal fishing areas used by small-scale fisheries, and catches of skipjack increased more than catches of yellowfin. Skipjack continue to be the more important component of catches of these fisheries.

The principal small-scale tuna fishery nations in the Indian Ocean are India, Indonesia, the Maldives, and Sri Lanka. The principal nations catching skipjack and yellowfin—Indonesia, the Maldives, and Sri Lanka—took 92 percent of all small-scale fishery landings of these species in 1986. Skipjack made up 30 percent (11,000 t) of the total Indonesian catch of tuna in the Indian Ocean in 1986; yellowfin made up 9 percent (3,270 t, Table 2). The tuna catch of the Maldives was 84 percent (45,400 t) skipjack and 10 percent (5,300 t) yellowfin; the catch of Sri Lanka was 56 percent (13,700 t) skipjack and 33 percent (8,000 t) yellowfin.

The quality of data on the activities of small-scale Indian Ocean fisheries is improving, due in large part to the IPTP efforts, but problems still exist. Data for these fisheries are probably not as complete or accurate as data for large-scale fisheries, especially for years before 1982 when IPTP began. Catches recorded by IPTP for India seem low considering the great number of vessels estimated for India. However, most of the vessels are nonmechanized and even primitive (e.g. little more than logs tied together) and take very few tuna.

Also misleading are statistics showing small-scale fisheries that seem to develop or disappear "overnight." This is probably not real and most likely reflects improvement in statistics-gathering arrangements, which are often coordinated by IPTP (e.g. Pakistan, Table 2).

Of the 23 nations whose small-scale fisheries caught tuna in 1986, 9 reported catches of skipjack and 10 reported catches of yellowfin (Table 4). Five nations—India, Indonesia, the Maldives, Pakistan, and Sri Lanka—had skipjack or yellowfin catches greater than 1,000 t. In 1986, fisheries of these nations took 79 percent of the total small-scale fishing landings of tuna, 95 percent of small-scale landings of skipjack, and 96 percent of all small-scale landings of yellowfin. While skipjack is important in the tuna catches of India, Indonesia, the Maldives, and Sri Lanka, yellowfin is important only in Sri Lanka where it composed 25 percent of the total tuna catch in 1986 (Table 4; Maldeniya and Joseph, 1987).

Compared to the large-scale fisheries, small-scale Indian Ocean fisheries are very heterogeneous and even less directed at any particular species (for a detailed description see Steguert and Marsac, 1986). Most catch a mixture of small yellowfin, skipjack, and other small tunas. In 1986, catches were 37 percent skipjack, 14 percent kawakawa, 11 percent longtail tuna, 10 percent yellowfin, and 22 percent unclassified. Indian Ocean small-scale fisheries vary considerably in all aspects from vessel size and sophistication to target market. In some, vessels are small, unpowered,

[2]Joel Nageon de Lestang, Director, Resource Management, Seychelles Fishing Authority, P.O. Box 449, Fishing Port, Mahe, Seychelles. Personal commun., August 1989.

Table 5.—Estimated numbers of tuna fishing vessels by gear type[1] for various countries in the Indian Ocean in 1984 (Yesaki, 1986).

	Mechanized				Nonmechanized			
Country	GN	PL	T	PS	PL	T	Unclass.	Total
India	2,362	263		221			133,019	135,865
Indonesia	1,188		2,237	260				3,685
Iran	1,464							1,464
Maldives					561	3,115		5,003
Oman								
Pakistan	274							274
Somalia								
Sri Lanka	2,541							2,541
Thailand	30			153				183
U.A.E.								
Yemen Dem.								
Total	7,859	1,590	2,237	634	561	3,115	133,019	149,015

[1]Abbreviations: GN = gillnet; PL = pole and line; T = troll; PS = purse-seine.

Table 6.—Estimated tuna catch (t) by gear type[1] for various countries in the Indian Ocean in 1984 (Yesaki, 1986).

	Mechanized				Nonmechanized			
Country	GN	PL	T	PS	PL	T	Unclass.	Total
India		3,037						3,037
Indonesia			8,009	7,004				15,013
Iran	13,615							13,615
Maldives		50,602			416	2,495		53,513
Oman								
Pakistan	3,951							3,951
Somalia								
Sri Lanka	24,980							29,490
Thailand	52			7,317				7,369
U.A.E.								
Yemen Dem.								
Total	42,598	53,639	8,009	14,321	416	2,495		121,478

[1]Abbreviations: Same as in Table 5.

and constructed of wood, and the fishermen use hand gear. Catches are sold informally at beach landing sites. In others, vessels are larger, more sophisticated in design, and made of fiberglass. Operators of these vessels fish with mechanized gear and deliver to ports where catches are processed in modern facilities, and the product is exported. Most vessels are between 7 and 25 m in length; major fishing gears include gill net, pole and line, troll, purse seine, and longline. Gillnet is the most commonly used gear. According to a 1984 survey, gill nets were used by an estimated 50 percent of small-scale fishing vessels for which gear was recorded (Yesaki, 1987; Table 5). The same survey found that 44 percent of the tuna catches for which gear could be determined in 1984 was taken by pole-and-line gear (Table 6).

Discussion

Economic Considerations

In recent years, skipjack and yellowfin tuna have comprised about 50 percent of the total catch of tunas in the Indian Ocean. Since Indian Ocean tuna fisheries are virtually all mixed-species fisheries, it is impossible to discuss economic considerations for skipjack and yellowfin fisheries separately. Consequently, the following relates to all Indian Ocean tuna fisheries.

Each of the two major sectors of the Indian Ocean tuna fishery, the large-scale and the small-scale, operates under a different set of economic considerations. In addition, a third entity, the coastal, resource-adjacent nation, operates under a third set of considerations.

Vessels of the large-scale sector are part of the mobile, world-wide, DWFN tuna fleet. These long-range vessels change operating areas rapidly in response to catch rates, demand for raw tuna, market prices and area-specific operating costs (Indian Ocean Fishery Commission, 1985). Their major economic consideration is maximum return for minimum cost.

Vessels of the small-scale sector, not being able to easily change fishing areas, are more closely tied to local economies and in certain instances play a major role in the economies of developing Indian Ocean nations. Hafiz (1987) notes that "... [the] tuna fishery in the Maldives is one of the 'pillars' of the national economy. It provides the major source of export earnings, employment, and is directly linked with the livelihood of most island communities. [The] fisheries sector employs about 1/3 of the total labor force." The fishery also indirectly employs large numbers of workers in related occupations such as fish-curing and boat building (Anderson and Hafiz, 1987).

While a large proportion of catches by small-scale fisheries is consumed locally, in some cases a significant proportion is exported. About half of the 1985 catch of the small-scale tuna fishery in the Maldive Islands, the largest Indian Ocean small-scale tuna fishery, was exported (Hafiz, 1987).

The advent of coastal states' rights to fishery resources in their EEZ's and the development of large-scale fisheries have provided an opportunity for Indian Ocean coastal states to benefit economically from expanding tuna fisheries. An obvious way for a resource-adjacent nation to benefit from foreign fishing is to charge a fee for access to its EEZ. However, the Seychelles, the base of the major part of the large-scale purse seine fishery (the French and Spanish fleets) found that <20 percent of the foreign exchange benefits are from access fees[3]. The major part of the benefits to the Seychelles are from payment of port fees, and payment for stevedoring, food purchases, fuel, and supplies. Another way used by the Seychelles to capture some of the value of the fishery was to construct and operate a joint-venture tuna cannery with French partners. The project benefits the Seychelles by creating 250 jobs in the local economy.

A coastal nation can also benefit from resources in its EEZ by developing its own fishery. Besides benefits of fishermen's income and supply of tuna to local markets, the principal argument for developing at least some domestic capacity is to protect against the ever-present risk

[3]Michaud, P. Seychelles' response to rapid development in industrial tuna fishing. Presented to the Ninth Meeting of the IOFC Committee on the Management of Indian Ocean Tuna, Colombo, Sri Lanka, December 1986, 14 p.

of the foreign fleet's leaving the coastal state's zone for a more profitable situation. Arguments against developing catching capacity in the Seychelles in 1986 included the depressed world market for tuna, the high cost of tuna vessels and gear, and the long time needed to learn to use the technologically advanced gear[3].

Two issues will dominate the near-term future of Indian Ocean fisheries for skipjack and yellowfin tuna: 1) The degree to which tuna fisheries will develop and 2) the growing awareness that some kind of cooperative management of fisheries on commonly exploited tuna resources will probably be necessary.

Fisheries Development

Further development of the large-scale longline fishery is considered unlikely (Indian Ocean Fishery Commission, 1985). The fishery is not primarily a yellowfin fishery, but shifts its target among the various sashimi-quality fish, primarily yellowfin, bigeye, and southern bluefin tunas and billfishes. This, plus the great mobility of the fleet, suggests that future catches of yellowfin tuna will be related to resource availability as well as species-specific market demand and the economic efficacy of operating in the Indian Ocean relative to that of operating in other areas.

The large-scale purse seine fishery should continue to expand its area of operations, particularly if fishing effort increases (Indian Ocean Fishery Commission, 1985). Prospects for increased effort by the Seychelles-based fleet, and others already operating in the Indian Ocean and South Atlantic fisheries, will be related to future trends in yellowfin and skipjack tuna catch rates relative to rates in the Atlantic[3]. If exploitable resources are found in new areas in the eastern Indian Ocean, some of the current Indian Ocean-South Atlantic fleet may relocate to this area. If South Atlantic resources show greater promise, the combined fleet may favor that area. On a broader scale, the highly-mobile purse seine fleet operates in all oceans, and decisions by vessels in this fleet to fish in the Indian Ocean or elsewhere, will depend on the relative profitability of operating in the various areas. Profitability is related to catch rates, vessel support, and (at least partly) area-specific prices. Less tangible aspects, such as the desire to establish a presence in a given area, may also influence fleets' presence in the Indian Ocean. Since the target of the purse seine fleet shifts between yellowfin and skipjack tuna, future trends in catches of these species will depend on their relative abundance, market demand, and the relative economics of operating in the Indian Ocean.

Small-scale Indian Ocean tuna fisheries should continue to develop. At least one small-scale fishing nation, the Maldives, exports a significant proportion of its tuna catch, a situation likely to be repeated by other Indian Ocean nations. The Maldives and other small-scale fishing nations are increasing catches by improving existing gear or by introducing new and more efficient gear types. Post-harvest processing and marketing infrastructure is gradually improving; however, significant developments in this area will probably require foreign investment and expertise. These trends will continue as many fleets modernize and expand to take advantage of the improving world market for tuna (James and Jayaprakash, 1987).

Close proximity to the resource may also provide an opportunity for coastal nations to economically enter yellowfin fisheries—such as longline fisheries in and near their EEZ's—that might be less economical for DWFN's (Indian Ocean Fishery Commission, 1984). This development is heavily dependent on developing domestic or export markets and the ability to follow the strict quality standards demanded in the sashimi market.

Prospects for a resource-adjacent Indian Ocean coastal nation wishing to benefit economically from the tuna resource without developing a fishery but by selling access rights to its EEZ, depend on how DWFN fleets perceive the economic benefit of purchasing fishing rights relative to the benefit of operating elsewhere. The key component of this economic benefit is the state of the international tuna industry and its effect on the continued operation of far-seas fisheries[3].

Fisheries Management

The need for international management of Indian Ocean tuna fisheries is increasingly discussed in area fishery management forums (Anonymous, 1987b). Coastal nations are concerned that continued expansion of both small-scale and large-scale tuna fisheries both inside and outside Indian Ocean EEZ's could reduce catches. Most often mentioned is their concern that the rapidly growing purse seine fishery will expand to areas adjacent to those used by the small-scale fisheries. They fear that this may adversely affect the availability of fish in the fishing grounds traditionally exploited by their fishermen and ultimately lead to decreased catches in small-scale fisheries (Anonymous, 1987a, 1987b).

Fishery managers' concern about possible interaction between small-scale and large-scale fisheries is only now being addressed scientifically, and little information is available on the effects of interaction among Indian Ocean fisheries. Preliminary analyses of trends in longline catches before and after the large-scale purse seine surface fishery was established suggest little interaction between fisheries on an ocean-wide basis (Suzuki, 1987). However, theoretical studies of interaction between surface and longline gears fishing on the same stock of yellowfin tuna suggest a possible advantage to total yield-per-recruit of at least yellowfin tuna from increasing longline effort while holding effort constant in small-scale and large-scale surface fisheries (Marsac and Hallier, 1987). These results cannot be applied to management at this time due to the lack of definitive stock structure information and basic population parameters.

Without formal stock-wide management of Indian Ocean tuna fisheries, the likelihood of surface fisheries limiting their activities in favor of longline fisheries is small. Current access agreements, under which more efficient (in the sense of contributing to a greater total yield-per-recruit) large-scale purse seine fisheries in effect pay rent (access fees) to less efficient local small-scale harvesters, are effectively an informal manage-

ment system that benefits longliners.

Insight into the probability of interaction between Indian Ocean tuna fisheries is provided by investigations of interaction among skipjack fisheries in the South Pacific (Kleiber et al., 1984). While the authors did not actually estimate degrees of interaction between fisheries, they did identify situations in which interaction was more likely. Applying their results to the Indian Ocean, given the current degree of fishery development, significant interaction is more likely between close-neighbor fisheries (e.g. small-scale coastal fisheries and large-scale purse seine fishery operating in an EEZ). Interaction is less likely where fisheries are widely separated.

Events directed at developing cooperative international management of Indian Ocean tuna fisheries began with the establishment of IPTP in 1982 following recommendations made by the Indo-Pacific Fisheries Commission in 1979. This was followed in 1985 by the Consultative Phase of the first Indian Ocean Marine Affairs Cooperation Conference, in which 35 states and 22 international organizations discussed formal international management (Anonymous, 1987b). The IOFC Committee for Management of Indian Ocean Tunas met in June 1988 to discuss possible long-term institutional arrangements. The Committee agreed that a new body should be established under Article XIV of the FAO constitution. In late 1988, FAO circulated a draft agreement to establish an Indian Ocean Tuna Commission. The draft was discussed at a conference in April 1989 convened to prepare a final agreement. Results of this meeting were inconclusive. However, should a final agreement be agreed on, it will then be presented to the FAO Conference for approval.

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