

The Baitboat Fishery for Skipjack in the Gulf of Guinea, 1969-82

J. P. WISE

International Commission for the Conservation of Atlantic Tunas, Príncipe de Vergara 17, 28001 Madrid, Spain

The baitboat fishery in the Gulf of Guinea was one of the first of the modern Atlantic tuna fisheries. The fleets based at Tema (Ghana) are the principal component of this fishery, and are important contributors to Atlantic skipjack catches. In recent years their skipjack catch per day has averaged higher than that of the large purse seiners, and the baitboat catch per unit effort has tended to increase, while that of the large purse seiners has not. These differences are at least partially attributable to the targeting of skipjack by the baitboats as their principal species, and their concentration of fishing in a relatively small area closer to shore than most of the areas fished by purse seiners.

A production model for Eastern Atlantic skipjack, standardizing effort to Japanese baitboats, indicates an MSY of 104,000 tons, not much different from previous estimates. Analysis of the model and the data suggests that traditional production models may not give useful results when applied to this fishery.

La pêche à la canne du golfe de Guinée a été l'une des premières des pêcheries thonières modernes de l'Atlantique. Les flottilles basées à Tema (Ghana) en forment le principal élément, et contribuent de façon importante aux prises de listao dans l'Atlantique. Ces dernières années, la capture journalière de cette espèce par ces flottilles a dépassé celle des grands senneurs; la capture par unité d'effort des canneurs tend par ailleurs à augmenter, ce qui n'est pas le cas pour les grands senneurs. Ces différences sont attribuables, du moins en partie, au fait que les canneurs visent le listao en tant qu'espèce-cible, et à la concentration de leurs activités de pêche dans une zone relativement réduite et plus proche des côtes que la plupart des secteurs exploités par les senneurs.

Un modèle de production destiné au listao de l'Atlantique est, et prenant les canneurs japonais comme indice d'effort standard, donne une PME de 104.000 TM, ce qui diffère peu des estimations antérieures. L'analyse du modèle et des données permet de penser que les modèles de production traditionnels pourraient ne pas s'avérer des plus utiles en ce qui concerne cette pêcherie.

La pesquería del cebo de Golfo de Guinea ha sido una de las primeras pesquerías atuneras modernas del Atlántico. Está compuesta principalmente por las flotas con base en Tema (Ghana), que representan una importante contribución a las capturas atlánticas de listado; en los años recientes, sus capturas por día de esta especie han sido superiores a las conseguidas por los grandes cerqueros, y la captura por unidad de esfuerzo de los barcos de cebo ha mostrado tendencia hacia el aumento, en contraste con la de los grandes cerqueros. Estas diferencias son imputables, al menos parcialmente, a la concentración de barcos de cebo que persiguen al listado en una zona relativamente reducida, más próxima a la costa que la mayor parte de las zonas explotadas por cerqueros.

Un modelo de producción para el listado del Atlántico Este, normalizando el esfuerzo en base a los datos de cebo japoneses, indica un RMS de 104.000 TM, cifra no muy distinta de las estimaciones anteriores. Los análisis de este modelo y de los datos sugieren que los modelos de producción tradicionales no darían resultados prácticos aplicados a esta pesquería.

1. History of the Fishery

The baitboat fishery in the Gulf of Guinea was one of the first of the modern Atlantic tuna fisheries. Le Guen et al. (1965) describe catch and effort for French and Japanese baitboats based at Pointe-Noire fishing north of Cape Lopez in early 1964. The early fishery was directed at yellowfin tuna (*Thunnus albacares*) almost exclusively — landings at Pointe-Noire in 1964 were ninety eight percent yellowfin.

The fishery has changed its character since that time. Pointe-Noire is no longer an active tuna port. Abidjan in the Ivory Coast and Tema in Ghana are now the principal ports in the area, and most fishing is now conducted by purse seiners flying various flags, from as far away as Japan, Mexico, and the United States. Skipjack (*Katsuwonus pelamis*), a minor part of the catch in the early years because of market considerations, now contributes about as much to Atlantic tuna landings as does yellowfin. Catches of skipjack by baitboats in the eastern Atlantic have been

remarkably constant since 1977 at about 41,000 tons per year, plus or minus less than ten percent (Table 1).

Table 1. Atlantic skipjack catches (metric tons), 1969-82.

Year	Eastern Atlantic		Other ^a	Total Atlantic
	Baitboats	Purse seine		
1969	11437	14803	1956	28196
1970	16733	31107	2570	50410
1971	26529	50250	2761	79540
1972	23941	50717	2067	76725
1973	23700	51259	3631	78590
1974	37744	76541	4527	118812
1975	15318	37575	9125	62018
1976	28289	35163	13744	77196
1977	42581	63915	11602	118098
1978	40319	59424	8194	107937
1979	44564	38554	7826	90944
1980	37808	60689	17070	115567
1981	38668	75402	26145	140215
1982	43723	84845	37147	165715

^a "Other" includes Western Atlantic catches by Brazil and Venezuela which increased sharply in the 1980's.

Sources: ICCAT Statistical Bulletin, Vols. 10-13.

The Japanese had baitboats based in Tema in the 1960's. In the mid-1970's they were joined by Korean baitboats (some flying Panamanian and other flags of convenience) and baitboats with Ghanaian registry. The number of baitboats based in Tema has varied. In most years since 1973 it has been twenty five or more; it was forty or more in 1977-79. In recent years, the number of Japanese and Korean boats has been decreasing (Table 2). Most if not all of the Ghanaian baitboats have been bought from Japanese or Korean interests and have changed registry without leaving Tema. The Japanese boats have remained the most important component of the Tema fleets in terms of number of boats (Table 2) and of total catch, taking half or more of the skipjack in nearly all of the last fourteen years (Table 3).

Table 2. Number of Tema-based baitboats by tonnage class, 1969-81.

Year	Ghana	Japan	Korea	Other ^a	Total
1969	0+ 0 ^b	-6-	0+ 0	0+ 0	-6-
1970	0+ 0	0+ 6	0+ 0	0+ 0	0+ 6
1971	0+ 0	0+ 8	0+ 0	0+ 0	0+ 8
1972	0+ 0	0+13	0+ 0	0+ 3	0+16
1973	0+ 0 ^c	0+21	0+ 1	3+ 6	3+28
1974	0+ 0 ^c	0+23	0+ 5	0+ 0	0+28
1975	0+ 1	0+20	0+ 6	0+ 4	0+31
1976	0+ 4	0+16	0+ 7	0+ 3	0+30
1977	0+ 5	0+18	0+ 5	0+12	0+40
1978	0+ 4	0+20	0+10	0+12	0+46
1979	0+ 8	0+18	0+ 8	0+12	0+46
1980	0+10	0+12	0+ 7	0+10	0+39
1981	0+14	0+12	0+ 6	0+ 6	0+38

^a "Other" includes Honduras, Netherlands, Panama, USA

^b First number in each column is number of baitboats of <151 gross tons; second number is number of baitboats of >151 gross tons

^c Ghanaian catches for 1973-74 shown in Table 3 were made by one baitboat whose registration was uncertain

Sources: Data for 1969-71: "Fishing Power" tables, ICCAT Statistical Bulletin; for 1972-81: Martin A. Mensah, Fishery Research Unit, Tema Ghana, personal communication.

Table 3. Catches of skipjack (metric tons) by eastern Atlantic baitboats, 1969-1982

Year	Ghana	Japan	Korea	Panama ^a	FISM ^b	Other ^c	Total
1969	0	4926	0	0	3740	2771	11437
1970	0	7481	0	0	4393	4859	16733
1971	0	11730	0	0	5839	8960	26529
1972	0	10149	0	676	3828	9288	23941
1973	128	12980	922	159	3286	6225	23700
1974	701	18672	2123	979	4548	10721	37744
1975	1252	3664	4469	1854	1829	2250	15318
1976	2103	15042	1948	2467	2210	4519	28289
1977	3492	16845	3600	3970	2658	12016	42581
1978	2636	14614	8132	2890	3307	8740	40319
1979	3905	14686	12017	1750	3304	8902	44564
1980	4545	12304	6718	1735	3050	9456	37808
1981	4773	12935	7538	144	2530	10748	38668
1982	13649	8520	2827	2541	4320	11866	43723

^a "Panama" includes Korean-owned and crewed vessels fishing under Panamanian and other flags

^b FISM = France, Ivory Coast, Senegal, Morocco

^c "Other" includes Angola, Cape Verde, Portugal (Azores, Madeira), Spain (Canaries), etc.

Sources: ICCAT Statistical Bulletin, Vols. 10-13.

The Tema fleets have been important contributors to Atlantic skipjack catches. Since 1969 they have taken almost a quarter of the eastern Atlantic skipjack catch, and over twenty percent of all skipjack caught in the Atlantic (Tables 1 and 3).

2. Fishing Areas

Most fishing by baitboats based in Tema has been carried out in the waters east of 5°W, and nearly all of it has been confined to waters east of 10°W. The major exception occurred in the last half of 1973 and the first part of 1974 when some Japanese baitboats fished farther to the west and north, up to 10°N, but catches per unit effort (CPUE) were in general below average.

The Ghanaian, Japanese and Korean fleets based at Tema have somewhat different fishing patterns. The Ghanaian fleet has concentrated its effort north of 2°N and between 3°E and 5°W. Japanese effort has been concentrated north of the equator and on or close to the 0° meridian. In 1977 and 1978 there was some Japanese effort as far south as 8°S, probably reflecting an attempt to find new grounds after the very low catches and CPUE in 1975. Korean baitboats have fished farther south and east than the Ghanaian and Japanese fleets. They made a major movement southward, along and close to the 0° meridian, beginning in 1976, principally in the first and second quarters of the year. This tendency appears to have reached its apogee in 1979 and 1980 when some Korean-registered boats fished south of 15°S, including in the vicinity of Saint Helena Island. CPUE was average or better, but the pattern did not persist into 1981.

3. Catch Per Unit Effort

There are unresolved problems concerning lack of agreement between CPUE estimates for skipjack derived from various components of the data base (Wise 1983). Some of the differences are evident in Table 4. A major difference is that the Japanese government data for most years are for successful days fishing, while the others are for days fishing or days at sea. Kume (1980) estimated fishing days for the Japanese baitboats based at Tema for 1969-78. I calculated from his Table 1 that the relation between the two types of effort is

$$Y = -45.05 + 1.148 X$$

where X is successful days fishing and Y is fishing days. This relationship suggests reducing the Japanese government CPUE shown in Table 4 for 1969-78 by fifteen percent to make it comparable to the other sources. It appears that the Japanese effort data for 1979 and later years are for days fishing or days at sea, since they agree much more closely with the other data sets — see Table 4 and Figure 1.

Table 4. Skipjack CPUE (tons/day)¹ for Tema-based baitboats for each year, 1969–82, and each quarter of those years.

Year	Source of Data					
	a	b	c	d	e	f
1969	—	4.2	—	—	—	—
Q-1	—	5.1	—	—	—	—
Q-2	—	3.2	—	—	—	—
Q-3	—	6.7	—	—	—	—
Q-4	—	2.4	—	—	—	—
1970	—	6.0	—	—	—	—
Q-1	—	4.0	—	—	—	—
Q-2	—	4.7	—	—	—	—
Q-3	—	9.0	—	—	—	—
Q-4	—	5.4	—	—	—	—
1971	—	6.9	—	—	—	—
Q-1	—	6.2	—	—	—	—
Q-2	—	7.5	—	—	—	—
Q-3	—	6.6	—	—	—	—
Q-4	—	7.2	—	—	—	—
1972	—	5.9	—	—	—	—
Q-1	—	8.2	—	—	—	—
Q-2	—	5.7	—	—	—	—
Q-3	—	6.3	—	—	—	—
Q-4	—	4.5	—	—	—	—
1973	—	4.2	—	3.1	—	—
Q-1	—	3.9	—	—	—	—
Q-2	—	3.2	—	—	—	—
Q-3	—	4.8	—	—	—	—
Q-4	—	4.6	—	3.1	—	—
1974	2.5	4.9	—	3.9	2.4	—
Q-1	4.9*	5.5	—	4.0	2.7	—
Q-2	3.4*	5.8	—	4.3	2.9	—
Q-3	.8*	3.2	—	2.8	2.3*	—
Q-4	1.8	5.4	—	4.1	1.9	—
1975	2.3	4.8	—	2.1	2.9	—
Q-1	2.3*	5.5	—	1.7	2.2	—
Q-2	2.7*	—	—	2.4	3.1	—
Q-3	1.8	3.5	—	2.2	3.1	—
Q-4	3.8	3.6	—	2.3	3.7	—
1976	3.2	5.3	—	2.9	2.8	2.9
Q-1	2.2	4.5	—	2.6	1.7	2.0
Q-2	2.7*	4.5	—	2.7	1.6	2.4
Q-3	4.3	6.1	—	5.3	4.4	3.9*
Q-4	3.6	5.6	—	2.9	—	3.6
1977	4.3	5.5	—	3.8	2.7	3.8
Q-1	4.2	5.4	—	4.0	1.8	3.3
Q-2	5.0	5.2	—	3.7	2.3	4.4
Q-3	4.3	5.9	—	4.0	2.3	4.0
Q-4	3.5	5.5	—	3.7	3.5	3.3
1978	3.5	6.4	3.6	4.1	3.4	2.7
Q-1	2.9	4.9	3.7	2.6	2.2	1.8
Q-2	4.5	8.7	3.7	5.3	4.4	4.4*
Q-3	4.3	7.3	4.5	4.9	3.4	3.7*
Q-4	2.3	5.1	2.5	3.2	3.1	2.2*
1979	4.2	7.1	6.7	7.3	5.3	—
Q-1	6.7	8.3	8.5	6.3	5.5	—
Q-2	5.1	7.4	7.3	10.5	6.5	—
Q-3	2.8	7.4	5.8	7.3	5.1	—
Q-4	2.2	5.2	5.0	4.5	4.6	—
1980	3.4	6.3	4.0	5.6	3.7	—
Q-1	3.4	4.9	3.9	4.7	4.3	—
Q-2	3.3	6.6	4.3	5.7	4.0	—
Q-3	2.3	7.6	3.4	5.8	3.0	—
Q-4	3.7	6.8	4.7	5.7	3.8	—
1981	5.1	6.9	7.0	7.4	6.7	—
Q-1	5.5	5.7	5.8	4.9*	8.6*	—
Q-2	6.5	8.5	7.2	8.5	6.6	—
Q-3	4.4	7.5	6.7	6.9	5.4	—
Q-4	4.2	5.5	8.7	6.0	7.6	—

Year	Source of Data					
	a	b	c	d	e	f
1982 ²	—	6.5	6.3	—	—	—
Q-1	—	4.9	4.9	—	—	—
Q-2	—	7.6	3.8	—	—	—
Q-3	—	5.8	5.8	—	—	—
Q-4	—	8.9	11.8	—	—	—

- a — Ghana government
- b — Japanese government
- c — Korean government
- d — Ghanaian sampling of Japanese boats
- e — Ghanaian sampling of Korean-owned and crewed boats fishing under other flags
- f — ICCAT-calculated from Ghanaian size sampling data

Notes: 1. Total catch/total effort in modified ICCAT data base as described in Appendix.

2. Data for 1982 for columns a, d, e, f not available.

* 30 or less days effort in quarter.

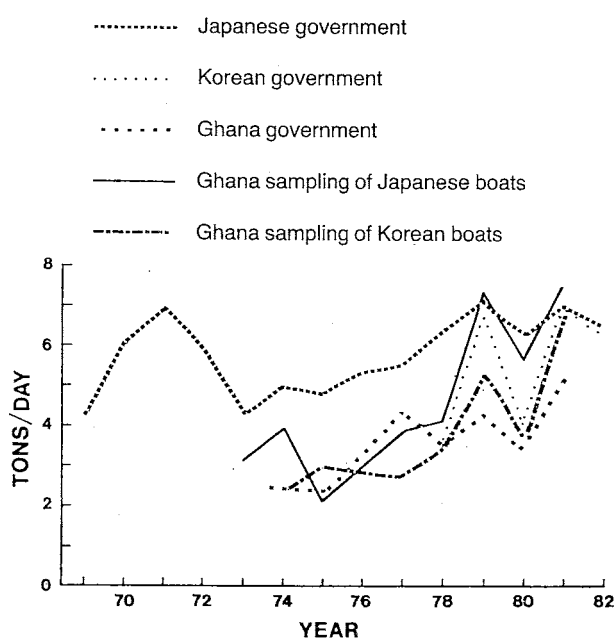


Figure 1. Skipjack catches per day, Tema-based baitboats, 1969–82 (data from Table 5).

These differences were ignored in Table 5, and mean catch per unit effort was calculated for each year and quarter by summing the total catch in the data base and dividing it by the total effort. This method weights the CPUE toward those areas in which the effort and catch were greatest. It also weights the CPUE heavily by the Japanese and Korean government data. Japanese government data constitute more than eighty percent of all the records through 1977 and nearly forty percent in 1978–81. Korean government data make up nearly forty percent of the data in 1978–81. Only Japanese and Korean government data for 1982 are available at the time of writing. (See description of the data base in the Appendix).

Table 5. Mean CPUE (tons/day)^a for yellowfin (YFT), skipjack (SKJ), and bigeye (BET), by year, quarter, and species for Tema-based baitboats, 1969–82.

YEAR	Species		
	YFT	SKJ	BET
1969	.8	4.2	.26
Q-1	.7	5.1	.06
Q-2	1.8	3.2	.16
Q-3	.4	6.7	.80
Q-4	.4	2.4	.05
1970	.8	6.0	.02
Q-1	.4	4.0	.05
Q-2	.2	4.7	.03
Q-3	.2	9.0	.02
Q-4	2.3	5.4	.01
1971	1.8	6.9	.01
Q-1	.5	6.2	.02
Q-2	.7	7.5	.00
Q-3	2.3	6.6	-0-
Q-4	3.1	7.2	-0-
1972	2.6	5.9	.03
Q-1	2.0	8.2	.04
Q-2	1.5	5.7	.01
Q-3	3.1	6.3	.07
Q-4	3.0	4.5	-0-
1973	2.5	4.2	.07
Q-1	2.0	3.9	.01
Q-2	1.9	3.2	.05
Q-3	3.7	4.8	.13
Q-4	2.3	4.5	.06
1974	1.9	4.4	.05
Q-1	1.6	4.8	.09
Q-2	.4	8.4	.02
Q-3	2.2	3.0	.03
Q-4	2.9	4.5	.04
1975	1.0	3.2	.50
Q-1	1.1	3.6	.03
Q-2	.6	3.1	-0-
Q-3	1.1	2.8	1.04
Q-4	1.1	3.5	1.23
1976	.6	4.5	1.11
Q-1	.5	3.4	1.28
Q-2	.2	3.7	.43
Q-3	.8	5.8	.99
Q-4	1.2	5.1	1.80
1977	.8	4.3	.35
Q-1	.4	4.3	.30
Q-2	.3	4.1	.15
Q-3	1.1	4.5	.48
Q-4	1.2	4.3	.39
1978	.5	4.3	.54
Q-1	.5	3.2	.45
Q-2	.2	5.3	.36
Q-3	.7	4.9	.66
Q-4	.6	3.6	.61
1979	.6	6.3	.71
Q-1	.6	7.1	.61
Q-2	.6	7.3	.77
Q-3	.6	6.1	.67
Q-4	.8	4.7	.80
1980	.8	4.8	.43
Q-1	.5	4.5	.59
Q-2	.5	5.0	.42
Q-3	.9	4.7	.40
Q-4	1.2	5.0	.36
1981	1.2	6.8	.10
Q-1	.7	5.8	.19
Q-2	.6	7.8	.07

YEAR	Species		
	YFT	SKJ	BET
Q-3	1.6	6.7	.14
Q-4	2.1	6.3	.02
1982	1.1	6.5	.00
Q-1	1.2	4.9	.00
Q-2	.9	6.6	.00
Q-3	.9	5.8	-0-
Q-4	1.4	9.6	-0-

^a Total catch/total effort in modified ICCAT data base as described in Appendix

There is a striking difference between the skipjack CPUE of the Tema-based fleets and those of the other fleets fishing for skipjack in the Eastern Atlantic (Table 6). The figures for the Tema baitboats average from five to nearly ten times as high as those for the French, Ivoirian, Senegalese, and Moroccan (FISM) baitboats, and in recent years fifty percent or more higher than the large purse seiners. Only a small part of these differences can be accounted for by the CPUE figures based on Japanese government data.

Table 6. Skipjack CPUE (tons/day) for various eastern Atlantic fishing gears, 1969–81.

YEAR	Type of Gear										
	a	b	c	d	e	f	g	h	j	k	l
1969	4.2	.3	.5	.4	.9	.8	.5	(1.6)	—	2.4	—
1970	6.0	.7	.5	.5	1.1	1.6	1.5	(4.9)	—	5.1	—
1971	6.9	1.0	.7	.7	1.5	1.9	2.8	(.4)	—	10.0	—
1972	5.9	.7	.5	.4	1.4	1.9	3.4	2.8	(2.1)	3.7	—
1973	4.2	.8	.4	.3	.7	1.0	1.3	1.8	1.6	17.0	1.6
1974	4.4	1.1	.6	.3	1.3	2.3	2.9	4.6	4.0	8.7	1.2
1975	3.2	.5	.6	(.1)	1.1	1.4	1.4	1.5	2.2	2.7	2.2
1976	4.5	.6	.7	(.5)	.7	1.2	1.7	2.5	2.2	5.1	4.7
1977	4.3	.9	1.1	(1.1)	2.4	2.4	3.5	4.4	3.2	3.8	6.4
1978	4.3	1.1	1.0	(.9)	(1.4)	2.3	2.1	3.4	2.8	2.4	3.1
1979	6.3	.9	.8	(.6)	—	1.8	2.0	2.1	2.1	2.2	1.8
1980	4.8	1.1	1.5	(.8)	—	2.1	2.6	3.0	3.0	3.9	2.3
1981	6.8	—	1.1	—	—	2.5	—	1.0	—	5.0	3.0

Gear: a — Tema-based baitboats, from Table 5

b — FISM baitboats (ice)¹

c — FISM baitboats (40 tons)¹

d — FISM baitboats (90 tons)¹

e — FISM purse seiners (90 tons)¹

f — FISM purse seiners (200 tons)¹

g — FISM purse seiners (400 tons)¹

h — FISM purse seiners (700 tons)¹

j — FISM purse seiners (1000+ tons)¹

k — "American" purse seiners²

l — Spanish purse seiners³ (SKJ Areas 71+72+73), see Fig. 6, The International Skipjack Year Program, Origins... (this volume).

¹ Sources: 1969–80 FISM (France, Ivory Coast, Senegal, Morocco) data from Fonteneau and Cayré (1982). Numbers in parentheses probably represent data of less confidence. 1981 FISM data from Pianet (1983), Figure 3.6.

² Source: American data from "Review of United States fisheries and research activities on tunas and tuna-like fishes of the Atlantic Ocean for 1981–1982", ICCAT Biennial Report, 1983

³ Source: Data from ICCAT Data Record and ICCAT Statistical Series.

The Tema baitboats are much larger than the FISM baitboats, and operate in a better fishing area for skipjack, so the differences in CPUE between the baitboats are easily accounted for. Differences in target species and fishing grounds probably account for the higher skipjack CPUE of the Tema baitboats over the larger purse seiners. Herrick (1983) shows that nearly all of the high catches of eastern Atlantic skipjack by the FISM and "American" purse seine fleets in 1975 were made east of 10°W, as were half or more in 1980. There was a similar pattern for the French-Ivoirian-Senegalese (FIS) and Spanish purse seine fleets in 1979 and 1980 (Pianet 1983).

The trend of increasing skipjack CPUE for the Tema-based baitboats since 1975 is clear (Tables 4 and 5, Figure 1). The trend is apparent to a greater or lesser degree in five series of data collected by three governments (Table 4, columns a-e; Figure 1). This tendency differs markedly from that of the large purse seiners, whose skipjack CPUE's have not shown a tendency to increase since 1975 (Table 6).

There is little if any within-year pattern in the Tema-based baitboat CPUE data for skipjack, except that the CPUE in the third quarter is higher than that in the fourth quarter in nine of the fourteen years (Table 5). (The seasonality of yellowfin abundance can be seen in Table 5, the yellowfin CPUE being highest in the last quarter in nine of the fourteen years and almost always higher in the latter half of the year.) There seems to be no clear pattern of fishing being concentrated in certain areas in certain seasons, as is common in many other fisheries.

4. Production Models

The Dakar Working Group (ORSTOM 1976) standardized skipjack fishing effort in terms of a medium FIS (France, Ivory Coast, Senegal) purse seiner fishing in the Annobon (Pagalu) Island area, using catch and effort data for 1969-75, and calculated maximum sustainable yield (MSY) under various assumptions. MSY was estimated from 90,000 to 125,000 tons.

Sakagawa and Coan (1977) also did production model analysis, using Annobon as the index area and 1969-75 data, and calculated MSY under various assumptions. MSY was estimated at between 89,300 and 118,400 tons. They noted that the models did not fit the data very well.

Pianet (1980) analyzed the Eastern Atlantic skipjack fishery and the status of the stocks through 1978, using 1969-78 data for the FIS and USA purse

seiners and the Tema-based Japanese baitboats. He also standardized CPUE in terms of medium FIS seiners fishing in the Annobon area and constructed a production model, using total adjusted effort and total Eastern Atlantic skipjack catch. He estimated that the equilibrium catch would be 92,500 tons (with a probable error on the order of plus or minus fifty percent) at an effort equivalent to 68,000 standard days. He noted that this estimate of MSY was comparable to the estimates made by the Dakar Working Group. Pianet warned that these results should be accepted with some caution, since catches had fluctuated widely since 1971, due largely to differences in recruitment and large variations in availability from year to year.

I standardized effort on the basis of Tema-based Japanese baitboats (Table 7) and constructed a simple production model, using 1969-81 data (Figure 2). The rationale for using baitboats is their increasing concentration on skipjack in recent years (Table 5), versus the decreasing concentration by purse seiners. The fishing power of the purse seiners (as estimated from carrying capacity) has increased by a factor of five or six since 1969, but skipjack catches by purse seiners have only roughly doubled in the same period.

Table 7. Eastern Atlantic skipjack catch, standardized effort and catch per unit effort, 1969-82.

Year	Total Eastern Atlantic catch (metric tons)	Japanese Baitboat CPUE (tons/day)	Standardized Effort (Baitboat days)
1969	26240	3.6	7289
1970	47840	5.1	9380
1971	76779	5.9	13013
1972	74658	5.0	14932
1973	74959	3.6	20822
1974	114285	3.9	29304
1975	52893	2.1	25187
1976	63452	2.9	21880
1977	106496	3.8	28025
1978	99743	4.1	24328
1979	83118	7.3	11386
1980	98497	5.6	17589
1981	114070	7.4	15415
1982	128568	6.5	19780

Sources: 1. Catch from Table 1.

2. CPUE for 1969-73 and 1982 from Table 4, Column b. Values for 1969-73 adjusted from successful days to fishing days, as described in text.

3. CPUE for 1974-81 from Table 4, Column d.

Such a radical departure from the previous practice of standardizing on purse seine CPUE was approached with trepidation. It turns out however, that the Japanese baitboat CPUE shown in Table 7 is

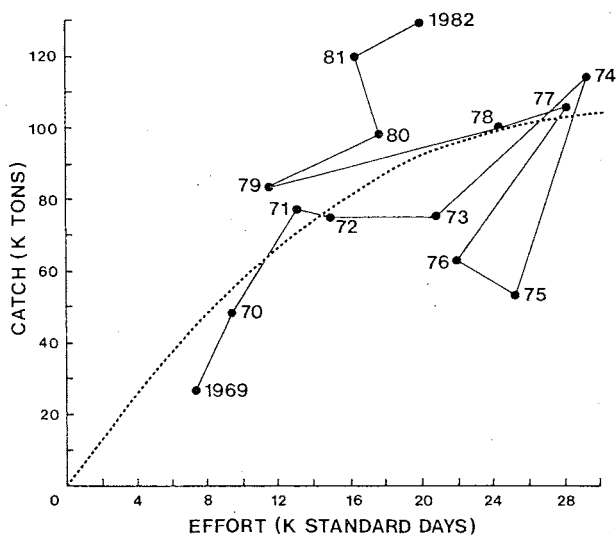


Figure 2. Schaefer model of Eastern Atlantic skipjack fishing effort standardized to Japanese baitboat days (data from Table 7).

highly correlated with the Annobon purse seine CPUE used by the Dakar Working Group (ORSTOM 1976) and by Pianet (1980). The calculated MSY for Eastern Atlantic skipjack is on the order of 104,000 tons, well within the range of those previously estimated, with an effort level equivalent to some 30,000 baitboat days.

As in the case of Sakagawa and Coan's work, the model does not fit the data very well. The obvious reason is the extreme variability in the catch and effort data. Low catches (<80,000 tons) occur at effort levels of about 7,000 to 25,000 days, and high catches (>80,000 tons) occur at effort levels of about 11,000 to 29,000 days. The picture is one of catches fluctuating randomly with respect to effort, particularly at effort levels above about 15,000 days, making the traditional production model essentially meaningless.

The conclusion from examining the data independently of the model agrees in general nonetheless with Pianet's (1980) observation based on his model — the Eastern Atlantic skipjack catch has remained around 90,000 tons, plus or minus about forty percent, throughout the last twelve years, 1971–82.

Appendix

THE DATA BASE

The total ICCAT file for Ghana-based baitboat catch and effort includes about 8,000 monthly records

covering the years 1969–82. These records were combined by quarters of the year into a new base for this study. This new base contains 4,913 records. (The file for 1982 is not complete at the time of writing.)

Each record consists of fifteen coded elements:

1. Year
2. Country
3. Fishing gear
4. Quarter of year
5. Size of square
6. Quadrant
7. Latitude
8. Longitude
9. Port
10. Kind of catch
11. Kind of effort
12. Amount of effort
13. Catch of yellowfin
14. Catch of skipjack
15. Catch of bigeye

Elements 5–8 are explained on page 18 of Miyake and Hayasi (1978). Element 5 is normally in $1^{\circ} \times 1^{\circ}$ squares for baitboats. Element 12 is in days fishing or days at sea (defined in Element 11.) Elements 13–15 are in metric tons (defined in Element 10).

Some records were eliminated from further consideration because:

1. Size of square was not $1^{\circ} \times 1^{\circ}$
2. Quadrant was not given
3. Longitude was greater than 25°W
4. Latitude was greater than 11°N
5. Effort was not expressed in days
6. Effort was not stated

Of the 162 records not used, 93 are for Japanese baitboats fishing in the eastern Caribbean from late 1973 to early 1975, 31 are data reported by Korea for $5^{\circ} \times 5^{\circ}$ squares and/or effort other than days in 1976–77, and 24 are for days spent baiting rather than fishing in 1981. The few remaining records contain apparently random errors. Records that indicated fishing on land or in such unusual places as Lake Chad were not eliminated. The distribution of useable records by year and source of data is shown in Table A1.

Table A1. Usable records by year and source of data.

Year	Number of Records						Total
	Ghana	Japan	Korea	Japan (G)	Panama (G)	Gha- ICAT	
1969	0	196	0	0	0	0	196
1970	0	121	0	0	0	0	121
1971	0	118	0	0	0	0	118
1972	0	159	0	0	0	0	159
1973	0	301	0	4	0	0	305
1974	13	319	0	68	17	0	417
1975	11	97	0	12	39	0	159
1976	9	257	0	25	10	10	311
1977	35	274	0	62	41	22	434
1978	14	207	247	32	52	5	557
1979	16	210	170	37	70	0	503
1980	22	222	234	52	55	0	585
1981	61	170	173	90	102	0	596
1982	0	175	115	0	0	0	290
Total	181	2826	939	382	386	37	4751

Notes: 1. (G) = collected by Ghana government

2. Panama (G) is principally Korean-owned boats with Panamanian registry

3. Data available for 1982 only from Japanese and Korean government sources

The Japanese government reports account for ninety percent or more of the Japanese catch in most years. The Ghanaian government reports account for twenty to eighty percent of the Ghanaian catch each year since 1974, usually thirty percent or more since 1977. Korean government reports cover forty percent or more of the Korean and "Panamanian" catches since 1978.