APPENDIX 3

ABUNDANCE ESTIMATES FOR SKIPJACK TUNA

1. Introduction

With the larger tunas (yellowfin, albacore, bluefin, and bigeye) already being harvested at the maximum level, the tuna fisheries of the Pacific are now turning to skipjack tuna as the resource with potentials for further development. With the closure of the season for yellowfin tuna in about March in the eastern Pacific, it is desirable to find alternate fishing grounds where the highly mobile U.S. purse seine fleet can profitably operate. With this goal in mind, the following factors will be discussed:

(1) Skipjack tuna school sightings.

(2) Abundance estimates derived from these sightings.

(3) Catch per day statistics from selected baitboat fisheries for selected years.

(4) Purse seine operations in the Pacific.

(5) Oceanographic conditions in various areas of the Pacific as they relate to purse seine fishing.

Following these discussions, recommendations will be made regarding expansion of the U.S. purse seine operations.

2. Estimates of skipjack tuna abundance

The annual catches of skipjack tuna given in Table 1 show the magnitude of the principal fisheries in the Pacific Ocean. The Japanese fishery off the home islands is the largest in the world with a maximum catch of 207,000 short tons (ST) in 1966. The fishery in the eastern tropical Pacific ranks second after the Japanese home islands fishery; however, the yellowfin tuna is the primary species sought here, mainly by the highly efficient fleet of purse seine vessels, with skipjack tuna being secondary. Another major fishery, which began around 1964, is the Japanese southern water fishery (Tohoku Regional Fisheries Research Laboratory, n.d.) in tropical waters of the western Pacific. All other fisheries, including that in Hawaii, are relatively much smaller.

Table 1.--Annual skipjack tuna catches in short tons for various areas in the Pacific Ocean.

Year	Eastern Pacific[1]	Hawaii[2]	Japan, southern sea areas[3]	Palau, Caroline Islands[4]	Japan[5]	Ryukyu Islands[6]
1900	--	211	--	--	--	--
1903	--	380	--	--	--	--
1917	209	--	--	--	91,284	--
1918	1,513	--	--	--	77,278	--
1919	3,449	--	--	--	70,998	--
1920	3,979	--	--	--	97,238	--
1921	570	--	--	--	89,958	--
1922	5,933	--	--	--	71,974	--
1923	5,733	--	--	--	74,734	--
1924	1,891	--	--	2	75,276	--
1925	7,119	--	--	10	76,660	--
1926	10,499	--	--	46	75,818	--
1927	16,907	--	--	17	94,488	--
1928	7,910	2,213	--	144	84,881	--
1929	13,502	1,669	--	252	79,531	--
1930	10,245	3,119	--	173	75,842	--
1931	8,256	3,062	--	604	88,581	--
1932	10,820	1,581	--	1,755	74,028	--
1933	8,345	2,781	--	2,364	85,232	--
1934	7,417	3,963	--	4,166	93,622	--
1935	8,601	2,437	--	5,944	80,354	--
1936	13,506	2,782	--	4,229	111,391	--
1937	23,557	6,395	--	15,187	116,766	--
1938	11,330	4,862	--	3,771	133,201	--
1939	15,064	4,303	--	3,913	110,825	--
1940	28,796	6,711	--	6,667	128,276	--
1941	12,891	1,826	--	3,639	101,022	--
1942	19,498	4	--	--	87,886	--
1943	14,718	--	--	--	56,990	--
1944	15,576	--	--	--	53,363	--
1945	17,021	1,954	--	--	19,625	--
1946	21,230	2,816	--	--	40,819	--
1947	26,746	2,796	--	--	53,693	--
1948	30,744	4,193	--	--	44,873	--
1949	40,517	4,948	--	--	51,268	--

Table 1.--Continued.

Year	Eastern Pacific[1]	Hawaii[2]	Japan, southern sea areas[3]	Palau, Caroline Islands[4]	Japan[5]	Ryukyu Islands[6]
1950	64,646	4,756	--	--	93,275	--
1951	60,582	6,464	--	--	114,994	--
1952	45,401	3,647	--	--	94,818	--
1953	66,842	6,031	--	--	80,154	--
1954	86,885	7,012	--	--	110,033	--
1955	64,014	4,848	--	--	109,922	--
1956	75,166	5,568	--	--	108,049	--
1957	64,164	3,066	--	--	107,497	5,464
1958	82,469	3,418	--	--	[7]154,796	7,788
1959	88,819	6,208	--	--	183,793	12,082
1960	55,262	3,680	--	--	86,659	4,857
1961	71,566	5,449	--	--	159,096	6,529
1962	80,718	4,709	--	--	187,762	8,030
1963	102,572	4,051	--	--	124,476	6,078
1964	62,614	4,513	9,724	3,405	184,123	5,560
1965	92,970	8,080	17,118	--	142,227	4,166
1966	66,115	6,493	21,023	--	207,387	3,859
1967	134,928	4,021	28,151	3,233	164,498	5,513
1968	77,658	4,660	29,831	5,972	132,194	6,615
1969	64,614	2,982	25,367	2,981	149,283	3,749
1970	55,212	3,676	33,173	9,364	156,119	10,695
1971	115,675	6,671	53,913	6,943	181,257	--
1972	36,903	5,460	19,353	--	--	--

[1]Data for 1917-33 from Power (1959, p. 383); data for 1934-54 from Shimada and Schaefer (1956); data for 1955-66 from Inter-American Tropical Tuna Commission (1967); data for 1967-71 from Inter-American Tropical Tuna Commission (1972); and preliminary data for 1972 from U.S. Department of Commerce (1973).

[2]Data for 1900, 1903, 1928-36 (fiscal years), 1937-42 and 1945-53 from Yamashita (1958); data for 1954-72 from catch records of the Hawaii Division of Fish and Game.

[3]Data for 1964 through 1972 from Tohoku Regional Fisheries Research Laboratory (n.d.).

[4]Data for 1922-40 from Shapiro (1948); data for 1941 from Smith (1947); data for 1964 from U.S. Department of State (1965); and data for 1967-71 from White (1972).

[5]Data for 1917-46 from Espenshade (1948) and data for 1947-64 and 1965-70 from Food and Agriculture Organization (1966, 1972).

[6]Data for 1957-65 from J. Isa, Economic Affairs Department, U.S. Civil Administration, Ryukyu Islands, pers. comm.; and data for 1965-70 from Food and Agriculture Organization (1972).

[7]Estimated.

2.1 Baitboat operations

The rates of sighting skipjack tuna schools in various island areas of the Pacific by quarters of the year (Table 2) were extracted from a recent review of the Honolulu Laboratory's cruise records in the central Pacific Ocean (Naughton, MS.[1]). Data on skipjack tuna school sightings off the east coast of Japan were obtained from Kimura (1954). These data were tabulated as 10-day summaries with corresponding charts showing the distribution of the schools. The two sets of data were not readily comparable so estimates of abundance were calculated to facilitate comparison. The data were processed as described below to result in estimated weight (short tons) per unit area per day. The unit area chosen was 450 square nautical miles (1,400 km^2) as this was estimated to be the approximate area scouted in 1 day from a research ship.

Table 2.--Rate of sightings of skipjack tuna schools for various island areas in the Pacific Ocean. Tabulated are the average numbers of skipjack schools sighted per day and, in parentheses, the number of days of scouting effort

	Quarter of year			
	1	2	3	4
Marshall Islands	.57(10.3)	0(2)	.31(3.2)	.78(3.8)
Line Islands	.53(104.2)	.24(111.4)	.79(34.0)	1.05(93.2)
Marquesas	2.6(69.2)	1.85(72.0)	1.61(19.8)	1.38(53.6)
Hawaiian	.15(171.7)	.58(163.6)	.78(141.1)	.30(185.2)
Fiji	.50(6)	--	--	0(4.2)
Tuamotu	.84(15.3)	.63(18.8)	.41(2.4)	.89(17.8)
Samoa	.50(7.9)	.64(17.2)	--	--

[1] Naughton, J.J. Bird flock and surface tuna school sightings in the central Pacific Ocean, 1950-72. National Marine Fisheries Service, Southwest Fisheries Center, NOAA, Honolulu, HI. 96812

[2] Narrative report, M/V Anela, charter cruise. Mimeogr. Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Honolulu, HI. 96812

The catch records of the American purse seiner Kerri M in the area of the Marquesas Islands (October 1971 and October 1972), were used to estimate the size of skipjack tuna schools in that area. It was assumed that the entire school was caught by the purse seine. An average of 16.2 short tons per school resulted. On several occasions the R/V Charles H. Gilbert simulated commercial live-bait operations in the Marquesas area. Catches ranged from 1 to 1.7 short tons per school. From this it was estimated that live-bait boats catch one-tenth the number of individuals in a school. Catch per school data (Uchida and Sumida, 1971), and narrative report, M/V Anela, charter cruise[2]) were then used to estimate the average weight of skipjack schools in various areas. The average school size from various areas fell into two categories, 10 ST per school or 5 ST per school. A size of 5 ST per school was assigned to the Line Islands area where we do not have adequate catch data. The Marquesas data appeared to be obviously skewed so 10 ST per school was used for this area.

For the Japanese data the area over which the sightings occurred was obtained from the distribution charts and adjusted to 450 square nautical miles. Because of extensive areas reported on the distributional charts we assumed that the 10-day tabulated totals did not truly represent a full 10-day coverage over the entire area. Instead of dividing the 10-day total by 10 to get the daily number of sightings, we therefore used a divisor of 2.

The estimates of abundance for the various areas are tabulated by quarters of the year in Table 3. The numbers in parentheses represent the average school size in short tons used in the calculations.

Data were scarce from the Marshall Islands, Fiji, and Samoa so that the estimates for these areas are less reliable than the others. An outstanding feature of the results (Table 3) is the great abundance of skipjack tuna in the Marquesas Islands compared to the other island areas. The abundance estimates for the Marshall Islands and Samoa are relatively low but, as pointed out earlier, data for these areas are scarce and additional data may show otherwise. In between the high and low estimates are those for the Hawaiian Islands, Line Islands, Tuamotu Islands, Japan, and Fiji.

Data from the Caroline Islands and the Mariana Islands were not in a form that was convertible to the same scale and therefore not included in Table 3. Catch per boat day values reported from these areas (Kasahara, 1971), however, suggest that the amount of skipjack tuna there in the second half of the year may approximate the amounts estimated for the Marquesas Islands.

Table 3.--Estimates of abundance of skipjack tuna in various island areas of the Pacific Ocean. Values tabulated are tons of skipjack tuna per 450 square nautical miles (1,400 km^2) per day. In parentheses is the average school size in tons.

Area	Quarters of the year			
	1	2	3	4
Marshall (5)	3.1	--	1.6	4.3
Line (5)	3.0	1.3	4.3	5.7
Hawaiian (10)	1.6	6.4	8.6	3.3
Marquesas (10)	28.6	20.3	17.7	15.2
Tuamotu (10)	9.2	6.9	4.5	9.8
Fiji (10)	5.5	--	--	--
Samoa (5)	2.7	3.5	--	--
Japan (10)	--	--	6.0	6.0

Estimates of catch rates in terms of catch per day of fishing by baitboats in the eastern tropical Pacific, derived from Alverson (1960), are presented in Figure 1. Considering catches of both skipjack tuna and yellowfin tuna, the baitboats generally caught over 5 ST per day but never, at least in those early years, exceeded 9 ST per day. The catch rates for each species separately in the fishery were relatively low and never exceeded 5 ST per day.

Comparable estimates of catch rates for the Hawaiian Islands area are presented in Figure 2. Since the catch rates generally fall under 5 ST per day, the catch rates for skipjack tuna in Hawaii are less than that for the combined catches of skipjack and yellowfin tunas in the eastern Pacific; but they are greater than the catch rate for skipjack tuna separately in the eastern Pacific. These data are standardized to a size-class of vessels which ranges from 45 to 77 gross tons.

The catch rates for skipjack tuna in the Mariana Islands (with some effort extending to the Caroline Islands) by Japanese baitboats are presented in Figure 3. These data represent catches for the entire year, but most of the effort was expended from July to December with effort reaching a minimum in late spring and summer (Kasahara and Tanaka, 1968). All the catch rates fall within the 5 and 9 ST per day isopleths and indicate good fishing conditions for baitboats. This "southern waters area" is the third largest skipjack fishery in the Pacific. The Japanese baitboats carry anchovy bait from Japan to the Mariana and Caroline Islands (and recently to the Marshall and Gilbert and Ellice Islands).

Catch rates for the largest skipjack fishery in the world, the Japanese coastal fishery, are presented in Figure 4. These data are presented by ports of landing (the northern and a middle region being on the main island of Honshu and the southern region with one port on the southern tip of Honshu and the other ports on Shikoku and Kyushu Islands) and represent catch and effort data for vessels in excess of 50 gross tons (Japan Ministry of Agriculture and Forestry, 1958-64) for the years 1957-63. All of the catch rates fall well below the 5 ST per day isopleth. Either the Japanese boats are not particularly efficient, or else there is competition between gear (vessels) to severely limit the catches. The total fleet is large, and the vessels below 50 gross tons comprise a significant part of the fleet.

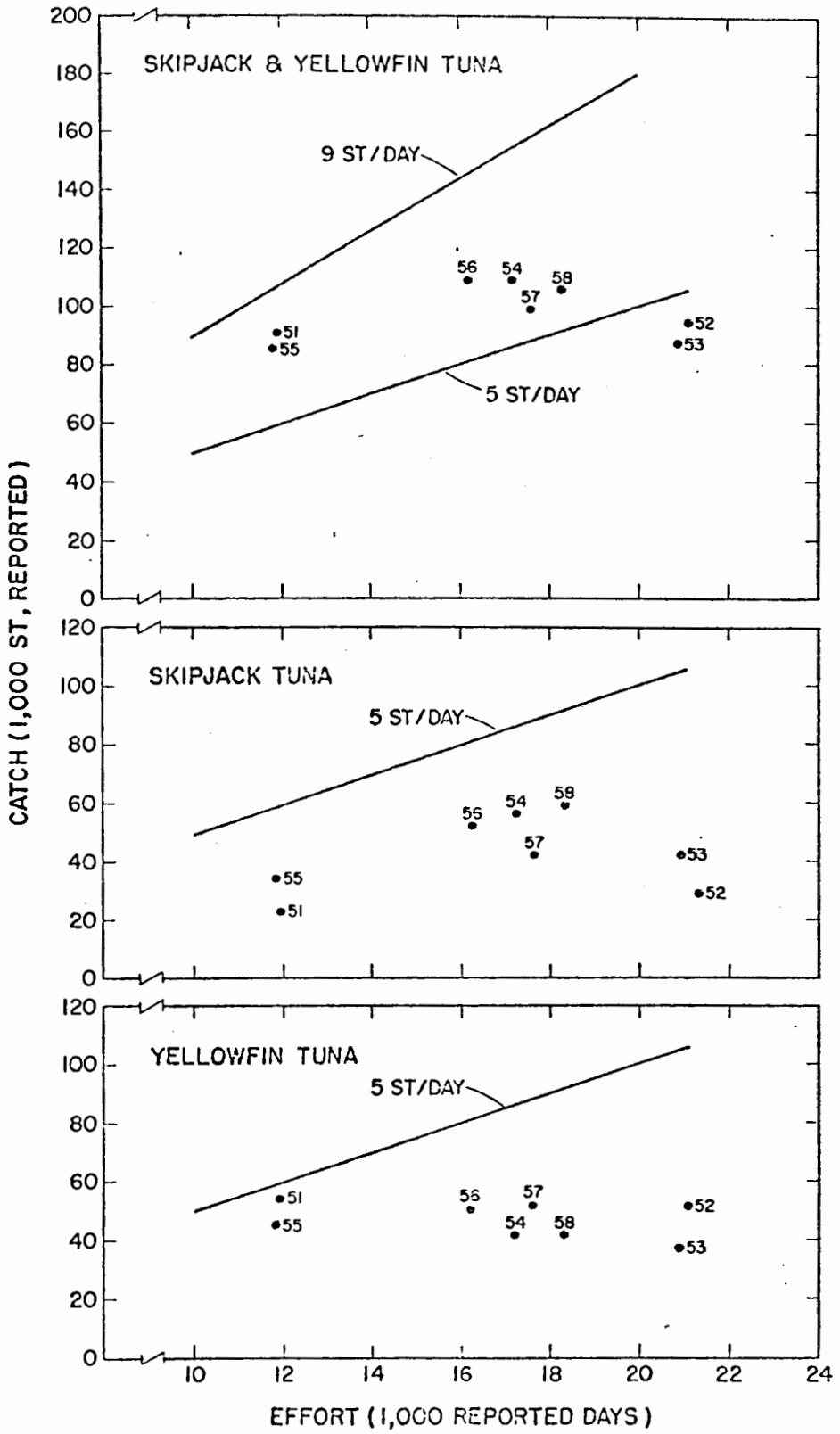

Figure 1.--Catch and effort data for bait boats in the eastern tropical Pacific, 1951-53 (Alverson, 1960)

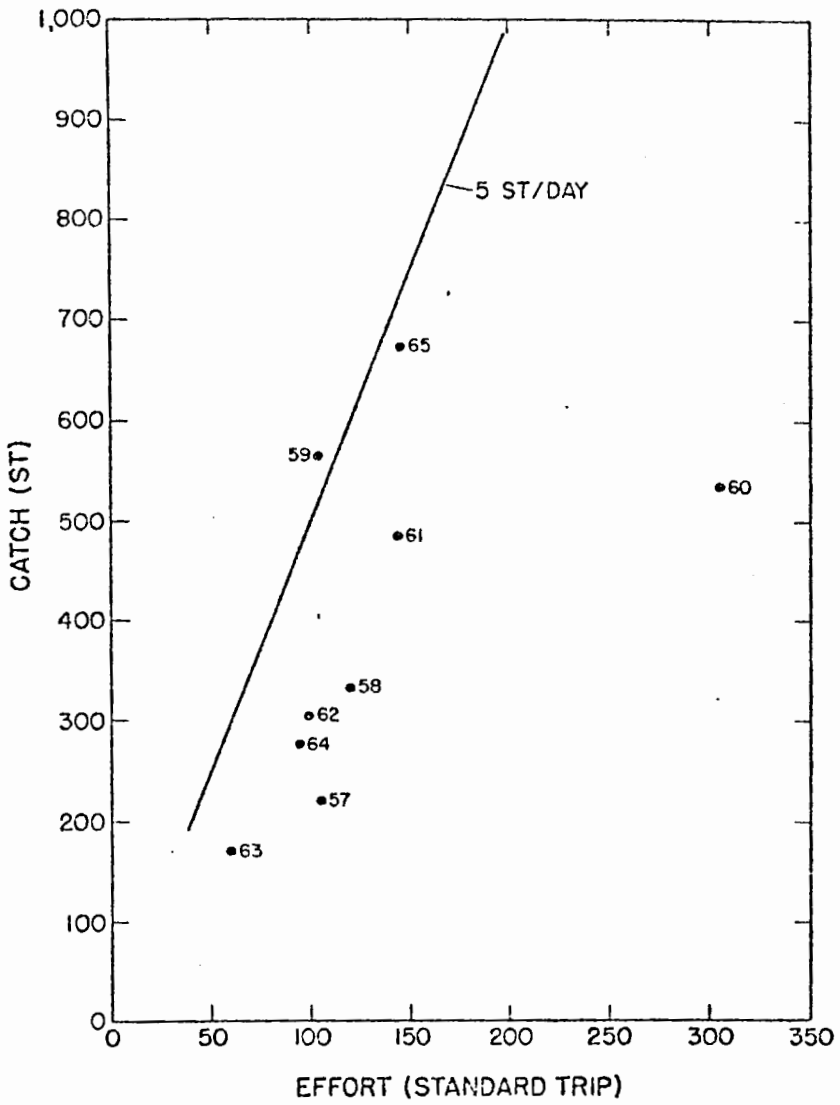

Figure 2.--Catch and effort data for bait boats in the Hawaiian skipjack fishery, 1957-65. These data were calculated from four selected areas (two on the leeward and two on the windward side of the island chain) from data presented by Uchida (1970)

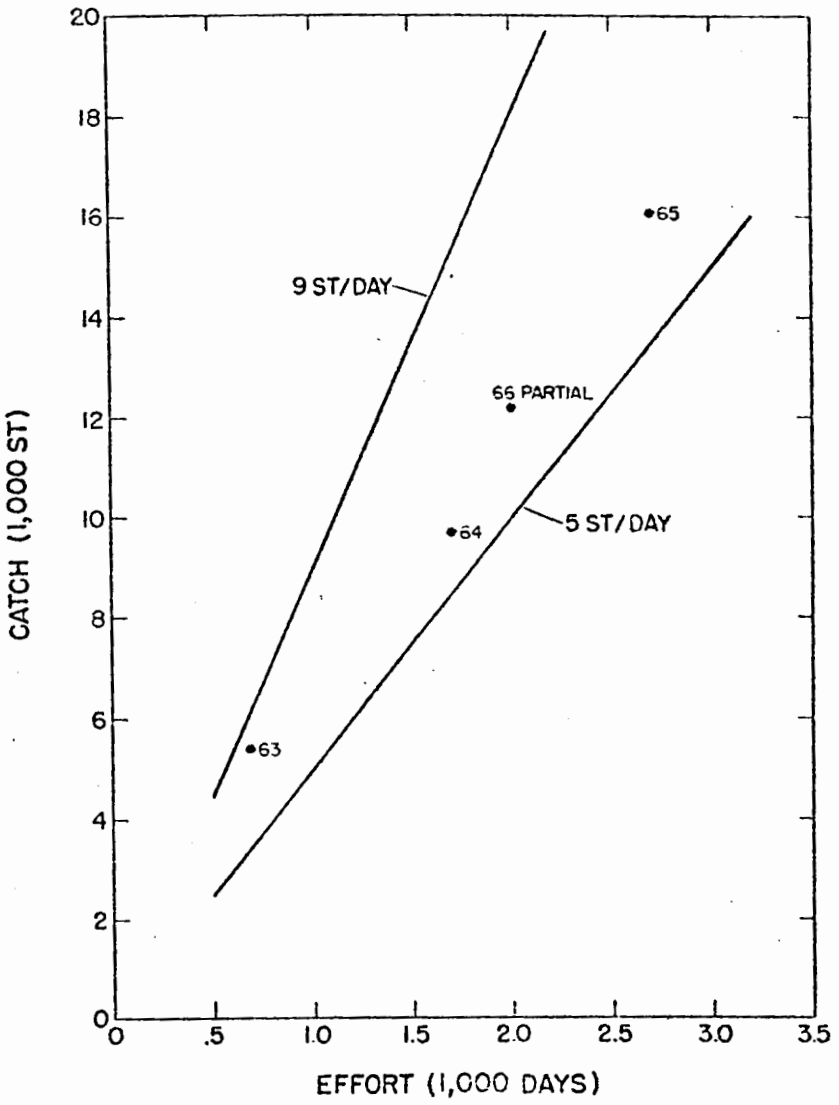

Figure 3. --Catch and effort data for Japanese bait boats fishing primarily in the area of the Marianas, 1963-66. Calculated from data given by Kasahara and Tanaka (1968)

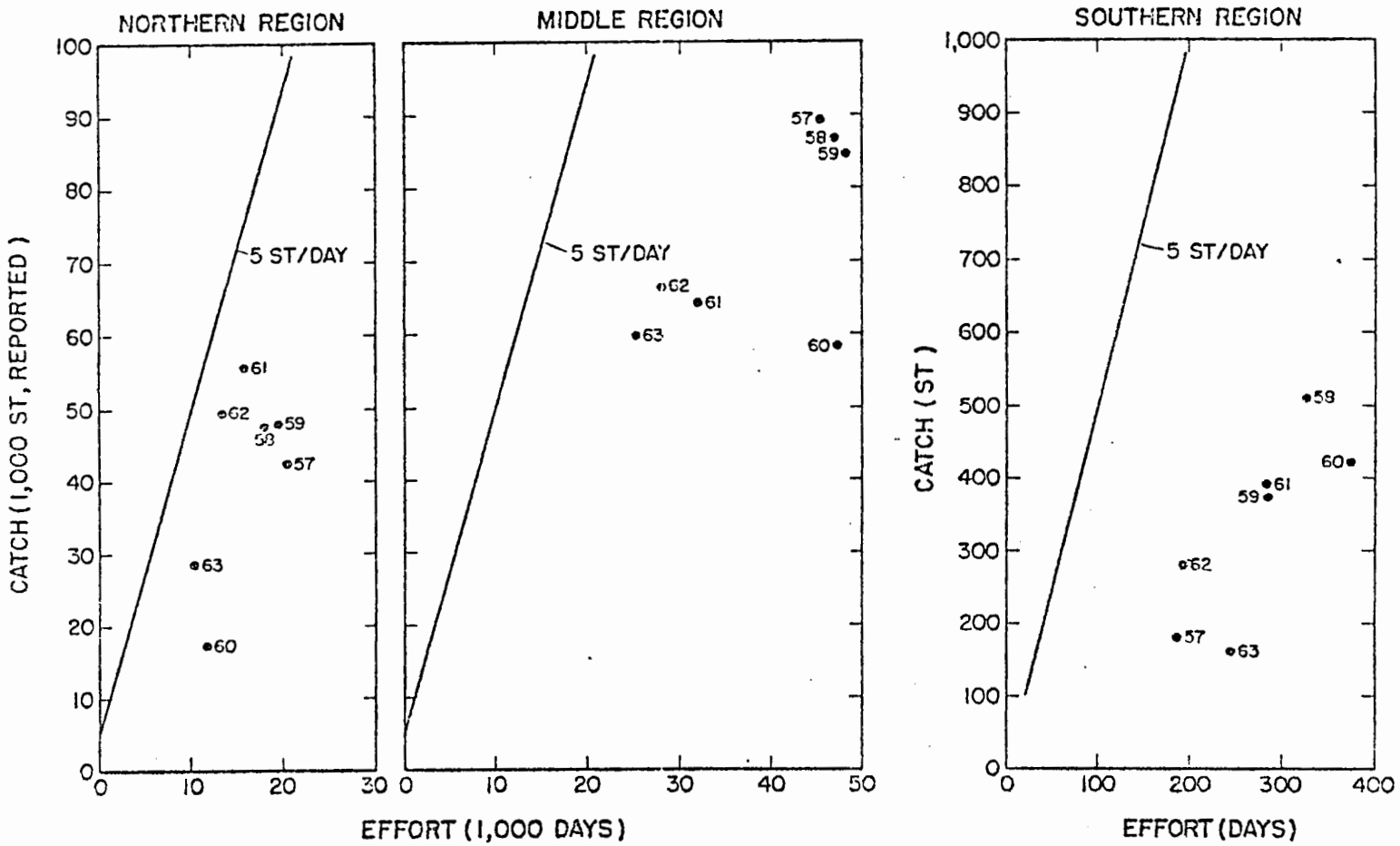

Figure 4.--Catch and effort data for Japanese bait boats fishing in waters adjacent to Japan, 1957-63. The data were obtained from the raw data given by [Japan] Statistics and Survey, Division, Ministry of Agriculture and Forestry (1958-64)