Comparisons of areas fished by the Japanese and U.S. purse seine fleets in the central-western Pacific

Atilio L. Coan Jr.
National Marine Fisheries Service
Southwest Fisheries Science Center
La Jolla, CA 92038

Naozumi Miyabe
National Research Institute of Far Seas Fisheries
Shimizu, Japan

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INTRODUCTION

Skipjack, (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*) and bigeye (*T. obesus*) tuna are caught throughout the central-western Pacific by distant-water purse seiners from Japan, Korea, Taiwan and the U.S. Most of this catch is sold to canneries and canned as light meat tuna. The canneries usually pay a different price for purse seine landings of skipjack and yellowfin tuna; however, yellowfin and bigeye tuna usually command the same price, except for large fish in the Japanese market. Therefore, because of this pricing differential and because yellowfin and bigeye tuna are difficult to distinguish, especially at smaller sizes, yellowfin and bigeye tunas are usually unloaded together and recorded as yellowfin tuna landings. Vessel captains also seldom differentiate between the two species in logbook records. The combination of bigeye tuna and yellowfin tuna landings has led to an underestimate of the bigeye tuna catch, an overestimate of the yellowfin tuna catch and a difficult situation for scientists who are trying to assess the status of these stocks.

In order to estimate the quantities of bigeye tuna that have been recorded as yellowfin tuna in the U.S. purse seine landings, scientists from the National Marine Fisheries Service (NMFS) developed a species composition sampling program. The program was started in 1988, when a South Pacific Regional Tuna Treaty (SPTT) was negotiated between 16 island nations and the U.S. As part of the Treaty, port sampling was established in Pago Pago, American Samoa to collect logbook and landing information, measure catches and determine species composition of the catch. Japan started collecting species composition samples in 1994. However, the program is relatively new and sample sizes are low.

In 1997, at the 10th meeting of the Standing Committee of Tunas and Billfish of the Secretariat of the Pacific Community, scientists decided that estimates of the bigeye tuna catch from all purse seine fleets were necessary. Procedures were developed to separate the bigeye tuna from yellowfin tuna landings based on the NMFS species composition sampling. For the period before and including 1988, NMFS species composition samples from 1989-1995 would be combined and used. For the period, 1989-1995, the NMFS species composition sample for each year would be used and, for the post 1995 period, NMFS species composition from 1989-1995 would again be used to correct catches of other fleets. Concerns related to biases of this procedure was expressed at the 11th SCTB and scientists from Japan and the U.S. were asked to investigate differences between the two fisheries, especially in regards to biases introduced if different areas are fished by the fleets.

The purpose of this paper is to investigate differences in areas fished by the U.S. and Japanese purse seine fleets in the central-western Pacific. Differences in areas fished by the two fleets are shown and the related appropriateness of using NMFS species composition samples to separate bigeye tuna from yellowfin tuna catches of the Japanese purse seine fleet is discussed. Catch and effort data from both fleets for the period 1981 to 1998, and NMFS species composition samples for 1989 to 1998, were used. Data for 1998 were still considered preliminary.

DATA AND METHODS

NMFS species composition samples were summarized by area strata (1°, 5°, 10°, 20°). Species composition samples were analyzed with an analysis of variance model to determine if the proportion of bigeye tuna in the reported yellowfin catch was significantly different between area strata. Area strata with NMFS species composition samples were compared to areas fished by the Japanese fleet to assess sampling coverage. Logbook data from both the U.S. and Japanese purse seine fisheries were summarized by number of sets and area strata. Comparisons between areas fished were done graphically and in tables by observing the percentages of area strata fished individually and by both fleets.

U.S. Purse Seine Fishery

The U.S. purse seine fleet in the central-western Pacific, during the period 1980 to 1998, varied between 14 and 62 vessels (SPC 1998). Maximum vessel participation occurred in 1983. Since the SPTT, the number of vessels has been limited at 50 to 55 and the actual number of vessels fishing has varied between 31 and 49. The vessels were large purse seiners between 900 t and 1,800 t carrying capacity. The vessels were home ported in Tinian, Northern Marianas or in Pago Pago, American Samoa. However, as of 1996, most of the vessels home ported in American Samoa (Coan et. al. 1997). Nearly 90% of the catch was delivered to canneries in American Samoa. The rest was sent to other canneries in the Pacific region, Puerto Rico, or Europe. Logbook data were collected from 100% of the fleet for the period 1989 to 1998.

Logbook data, for 1981 to 1998, indicate that the U.S. fleet concentrated mainly on free-swimming school fish sets until 1995. Starting in 1996 and continuing through 1998, the fleet switched to approximately 60% floating object sets (log and FADs) and 40% free-swimming school sets (Figure 1). Log sets dominated floating object sets until 1996 and 1997 when FAD sets were more dominant. The U.S. fleet fishes throughout the year. However, sets usually peak in June and September (Figure 2).

NMFS port sampling for species composition occurred in 1988 to 1998. Species composition sampling is accomplished during size measurements. While drawing 50 fish for a length-frequency sample, if a species other than the targeted species for measurement is encountered, a 100 fish species composition sample is drawn. If no other species is encountered after drawing 50 fish for the length-frequency measurement, then the species composition is considered pure. Each fish in the 100 fish species composition sample is identified to species and measured for fork length. The number of samples, both mixed (samples containing yellowfin and bigeye tunas) and pure (samples of pure yellowfin or bigeye tuna), varied between 369 in 1998 and 621 in 1992 (Table 1). Samples were mainly from log and free-swimming school sets until 1996 when a large number of samples were also taken from FAD sets. Sampling coverage, the number of 1° squares with at least 1 species composition sample as a percent of the number of 1° squares fished for yellowfin tuna, ranged from 32% in 1997 to 51% in 1989. As expected, sampling coverage increases with increases in area size. For 20° squares, sampling coverage was 100% for most years.

Japanese Purse Seine Fishery

The Japanese purse seine fleet in the central-western Pacific consists of a coastal element and a distant-water/offshore element. The distant-water/offshore element during the period 1980 to 1998 varied between 16 and 39 vessels (SCTB 1998). Maximum vessel participation occurred in 1988, 1994 and 1995. The coastal element varied between 59 vessels in 1983 and 20 vessels in 1995. The vessels were large purse seiners between 135 t and 350 t gross registered tons and approximately 900 t carrying capacity. The vessels unloaded their catch in one of three major ports, Yaizu, Makurazaki or Yamagawa, Japan. About 30% of the catch was delivered to canneries in recent years. The rest was sent to the Sashimi market and for skipjack tuna to the Katsuobushi market. Logbook data were collected from nearly 100% of the distant-water/offshore fleet since the late 1970s.

Logbook data, for 1981 to 1998, indicated that the Japanese fleet concentrated approximately 60% of its sets on log sets and 40 percent on school sets during the period 1983 to 1988 and from 1989 to 1998 the percentages were almost equal between log and school sets (Figure 1). The percentage of sets made on FADs was very low until 1997 and 1998 when the occurrence of these sets was approximately 5%. The Japanese fleet fishes throughout the year. However, sets usually peak in March, April and October (Figure 2).

During the period 1994 to 1998, the Japanese fleet was sampled for species composition through two programs, on-board sampling by fishermen and port sampling. On-board sampling may not have accurately reflected the species composition as it was difficult to obtain a random sample of the catch. The annual number of samples was moderate, around 200 to 300 for on-board sampling and less than 50 for port sampling.

COMPARISONS

Species Composition

The proportion of bigeye tuna in NMFS species composition samples, between area strata, were significantly different (Table 2). The analysis of variance model showed the most significant effect was between 1° and 5° area strata. As the size of the area strata increased to 10° and 20°, the effect of area on the difference in bigeye tuna proportions decreased. Latitude effects were more significant than longitude effects for 1° and 5° area strata. Longitude effects became more significant than latitude effects for 10° and 20° area strata.

The percentages of area strata fished by the Japanese fleet that were sampled for species composition by NMFS varied between 8% and 63%, for 1° area strata (Table 3). As expected, the percentages improved (54% to 100%) with increased area strata size. The lowest percentage (1° area strata) was in 1993 and the highest in 1982. Higher percentages were obtained for the 1981 to 1988 and 1996 to 1997 periods, when species composition samples for 1989 to 1995 were used and thus more areas sampled. Many of the 1° area strata with NMFS species composition samples were not fished by the Japanese fleet (Figure 3). This is especially true if the composite of all species composition samples taken during 1989 to 1995 were compared to any year fished by the Japanese before 1989.

Areas Fished

When 1° area strata with sets were compared, very few of the strata fished by the U.S. fleet were also fished by the Japanese fleet (Table 4). The percent of strata fished by both fleets varied from 13% in 1983 to 40% in 1981. The number of strata fished by the U.S. varied between 179 and 555, for Japan between 169 and 417 and the number of strata fished by both fleets between 85 and 207. A closer look at the area strata fished by each country showed that the U.S. fleet fished area strata further to the east and Japanese fleet area strata further west and north (Figure 4). This was especially true during the early 1980s.

If 5° area strata with sets were compared, the percent of strata fished by both fleets varied from 21% in 1983 to 63% in 1981 (Table 4). The number of strata fished by the U.S. varied between 27 and 63, for Japan between 17 and 47 and the number of strata fished by both fleets between 14 and 33.

If 10° area strata with sets were compared, the percent of strata fished by both fleets varied from 26% in 1983 to 79% in 1997 (Table 4). The number of strata fished by the U.S. varied between 12 and 24, for Japan between 7 and 20 and the number of strata fished by both fleets between 6 and 15.

If 20° area strata with sets were compared, the percent of strata fished by both fleets varied from 38% in 1983 to 90% in 1997 (Table 4). The number of strata fished by the U.S. varied between 6 and 11, for Japan between 3 and 11 and the number of strata fished by both fleets between 3 and 9.

CONCLUSIONS AND RECOMMENDATIONS

Statistically significant differences in the proportion of bigeye tuna in yellowfin tuna catches exist between area strata sampled by NMFS. While the significance of this difference decreases with increased area strata size, the decrease is not enough to warrant safe substitution of composition samples between area strata. The Japanese fleet fished many 1° area strata that were not sampled for species composition by the NMFS. Also, many NMFS composition samples were taken in areas not fished by the Japanese fleet. Therefore any substitution of samples may lead to biases.

In general, the U.S. and Japanese purse seine fleets fished different area strata during the period 1981 to 1998. The differences between area strata fished by the two fleets was quite evident when considering 1° strata, and as expected, became less evident as area size increased to 20° strata. However, the percent of strata fished by both fleets topped 70% only in two years, 1997 and 1998, and was less than 65% for all other years and area strata. A closer look at the 1° area strata fished by the two fleets showed that, in general, the U.S. fleet fished areas farther east, the Japanese fleet areas farther west and north and both fleets fished areas between 5°N and 10°S and 160°E and 175°W (Figure 4).

Based on these results, it appears that substitution of species composition samples between fleets could lead to inaccurate estimates of the actual bigeye tuna catch and, in turn, the actual yellowfin tuna catch.

However, since the NMFS species composition samples are the only data available for estimating the bigeye tuna catch from the purse seine fleets and removing this catch from the yellowfin tuna catch, the authors recommend the following.

1) Continue to maintain two sets of tables, one for adjusted yellowfin and bigeye tuna purse seine catch and one for reported unadjusted yellowfin and bigeye tuna purse seine catch. These two sets of data will allow for corrections in the future, if a better procedure is found. The adjusted bigeye and yellowfin tuna catch should be used in analyses to place a range around the results based on the uncertainty of the yellowfin or bigeye tuna catch.

2) Use only NMFS species composition samples from areas fished by both fleets. For this example, species composition samples taken from the eastern areas would not be used to obtain the Japanese purse seine bigeye tuna catch and to adjust the yellowfin tuna catch.

3) Encourage species composition sampling of all purse seine catches. Special emphasis could be targeted at areas not sampled by NMFS. Analyze these samples for consistent differences in proportions of bigeye tuna in areas and adjust, if necessary, previous estimates of bigeye and yellowfin tuna catch.

LITERATURE CITED

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Table 1. Number of National Marine Fisheries Services species composition samples taken in different types of sets and area strata (1E, 5E, 10E, 20E) from catches of U.S. purse seiners in the central-western Pacific 1989 to 1998. Species composition samples include mixed (both yellowfin and bigeye tuna) and pure (yellowfin or bigeye tuna only) samples. FADs are fish aggregating devices, mainly floating rafts. Number of squares fished are number of squares with sets on yellowfin tuna.

YEAR	NUMBER OF SPECIES COMPOSITION SAMPLES (MIXED AND PURE)					NUMBER OF 1° AREAS		NUMBER OF 5° AREAS		NUMBER OF 10° AREAS		NUMBER OF 20° AREAS	
	ALL	LOG	FAD	SCH	OTH	SAMPLED	FISHED	SAMPLED	FISHED	SAMPLED	FISHED	SAMPLED	FISHED
1989	576	245	14	258	59	116	227	29	34	10	12	6	6
1990	487	206	1	267	13	145	317	27	34	12	13	7	7
1991	508	172	0	319	17	132	263	29	33	10	11	6	6
1992	621	403	2	191	25	159	319	24	33	9	12	6	6
1993	560	336	1	186	37	131	300	23	31	11	12	6	6
1994	462	191	1	265	5	147	393	28	40	11	16	7	8
1995	489	253	5	218	13	121	318	29	38	12	14	6	7
1996	440	85	278	67	10	137	402	33	51	14	16	7	8
1997	534	163	196	129	46	159	497	31	46	14	16	8	9
1998	369	154	107	85	23	129	338	21	34	9	15	7	7

Table 2. Results of an analysis of variance model to assess the differences between proportions of bigeye tuna from National Marine Fisheries Service species composition samples taken of U.S. central-western Pacific purse seine catches in 1989 to 1998, by area strata (1E, 5E, 10E, 20E). Probability close to zero indicates significant differences in effects.

EFFECTS	PROBABILITY			
	1°	5°	10°	20°
LATITUDE	0.00057	0.00285	0.26773	0.91723
LONGITUDE	0.09320	0.10104	0.13530	0.00003
AREA	0.03499	0.02288	0.50823	0.71874

Table 3. Number of area strata (1E, 5E, 10E, 20E) sampled for species composition by the National Marine Fisheries Service (NMFS sampled), number of area strata fished by the Japanese purse seine fleet (Japan fished) and number of NMFS sampled area strata that were fished by the Japanese fleet (Japan sampled). Species composition samples for the period 1989 to 1995 were used for 1981 to 1988 and for the Japanese fleet in 1996 to 1998.

YEAR	1 DEGREE				5 DEGREE				10 DEGREE				20 DEGREE			
	U.S.	JAPAN			U.S.	JAPAN			U.S.	JAPAN			U.S.	JAPAN		
	SAMPLED	FISHED	SAMPLED	PERCENT	SAMPLED	FISHED	SAMPLED	PERCENT	SAMPLED	FISHED	SAMPLED	PERCENT	SAMPLED	FISHED	SAMPLED	PERCENT
1981	540	186	99	53.23	58	22	21	95.45	19	8	7	87.50	10	6	5	83.33
1982	540	187	118	63.10	58	17	14	82.35	19	10	7	70.00	10	7	6	85.71
1983	540	169	87	51.48	58	17	13	76.47	19	10	6	60.00	10	7	4	57.14
1984	540	194	76	39.18	58	17	14	82.35	19	7	5	71.43	10	3	3	100.00
1985	540	240	113	47.08	58	25	21	84.00	19	9	6	66.67	10	5	4	80.00
1986	540	286	124	43.36	58	26	19	73.08	19	9	6	66.67	10	5	4	80.00
1987	540	304	142	46.71	58	32	24	75.00	19	12	8	66.67	10	6	5	83.33
1988	540	282	98	34.75	58	26	17	65.38	19	11	6	54.55	10	6	5	83.33
1989	116	260	22	8.46	28	23	12	52.17	10	10	6	60.00	6	7	5	71.43
1990	145	252	22	8.73	26	29	12	41.38	12	13	8	61.54	7	8	5	62.50
1991	132	288	43	14.93	29	31	16	51.61	10	14	6	42.86	6	11	6	54.55
1992	159	276	43	15.58	24	38	14	36.84	9	18	8	44.44	6	10	6	60.00
1993	131	315	25	7.94	23	47	14	29.79	11	20	9	45.00	6	10	6	60.00
1994	147	356	41	11.52	28	35	15	42.86	11	13	7	53.85	7	7	5	71.43
1995	121	311	37	11.90	28	35	16	45.71	12	15	8	53.33	6	8	5	62.50
1996	540	333	133	39.94	58	37	26	70.27	19	14	9	64.29	10	8	6	75.00
1997	540	417	236	56.59	58	45	38	84.44	19	17	14	82.35	10	10	9	90.00
1998	540	396	219	55.30	58	42	33	78.57	19	16	12	75.00	10	7	7	100.00

Table 4. Number of area strata (1E, 5E, 10E, 20E) fished by the U.S. and Japanese purse seine fleet in the central-western Pacific, 1981 to 1998. "BOTH" indicates the number of area strata fished by both fleets.

YEAR	1 DEGREE			5 DEGREE			10 DEGREE			20 DEGREE		
	US	JAPAN	BOTH	US	JAPAN	BOTH	US	JAPAN	BOTH	US	JAPAN	BOTH
1981	179	186	104	27	22	19	12	8	7	8	6	5
1982	411	187	125	48	17	14	18	10	7	9	7	6
1983	549	169	85	63	17	14	24	10	7	11	7	5
1984	477	194	128	45	17	17	21	7	7	8	3	3
1985	452	240	145	47	25	20	19	9	7	9	5	5
1986	365	286	163	42	26	17	17	9	7	8	5	4
1987	358	304	95	34	32	15	14	12	7	6	6	4
1988	270	282	139	35	26	17	13	11	7	7	6	5
1989	284	260	108	37	23	16	12	10	6	6	7	5
1990	437	252	89	42	29	17	15	13	8	7	8	5
1991	415	288	148	40	31	16	14	14	8	7	11	7
1992	443	276	120	36	38	20	12	18	10	6	10	6
1993	395	315	92	36	47	22	14	20	11	6	10	6
1994	550	356	177	46	35	21	19	13	9	9	7	5
1995	406	311	146	51	35	23	17	15	9	8	8	6
1996	507	333	133	55	37	22	17	14	8	8	8	5
1997	555	417	207	49	45	33	17	17	15	9	10	9
1998	422	396	206	43	42	27	17	16	10	7	7	6

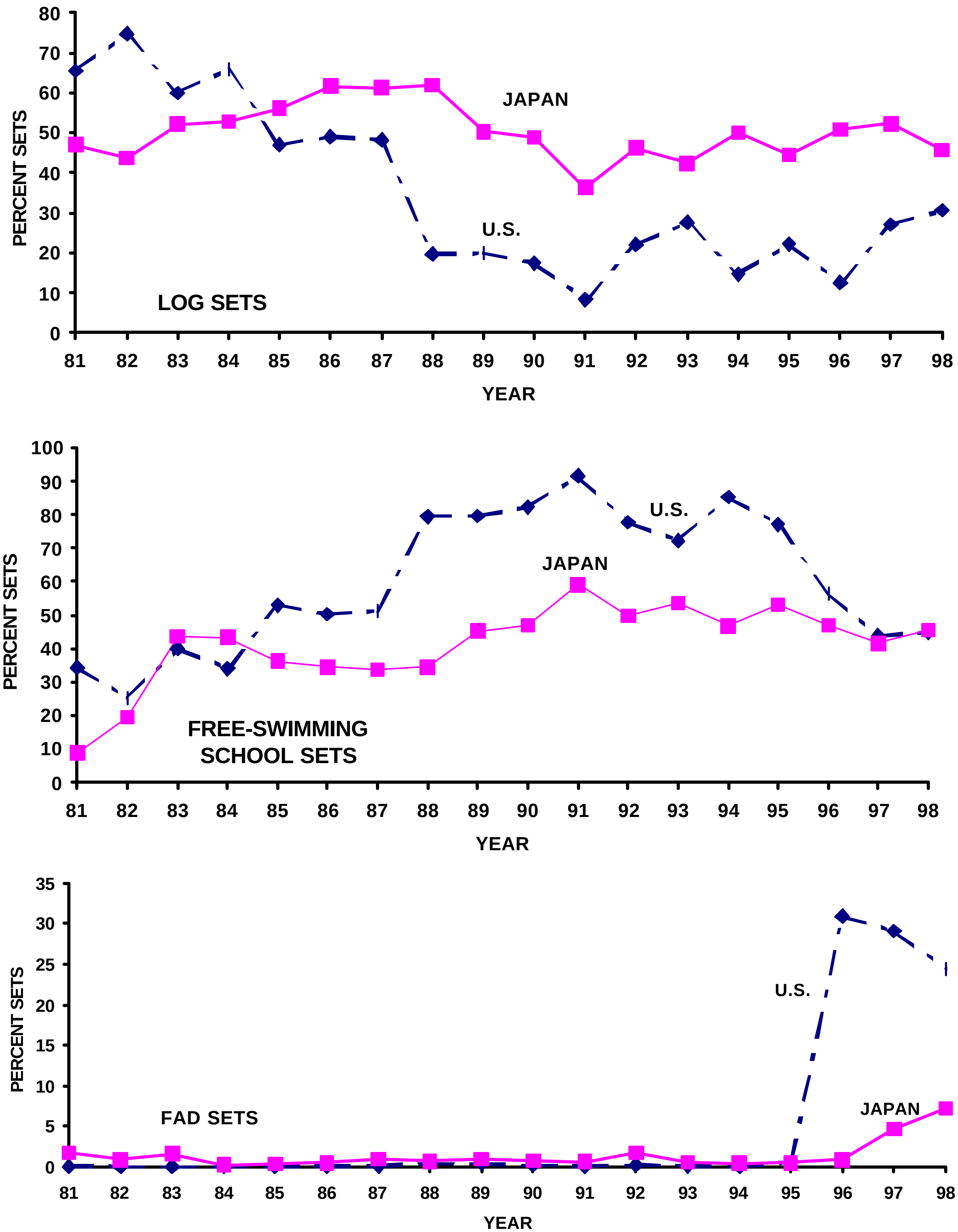

Figure 1. Percent of sets by set type for U.S. and Japanese purse seine fishery in the central-western Pacific 1981-1998. FAD (fish aggregating device) sets are drifting rafts.

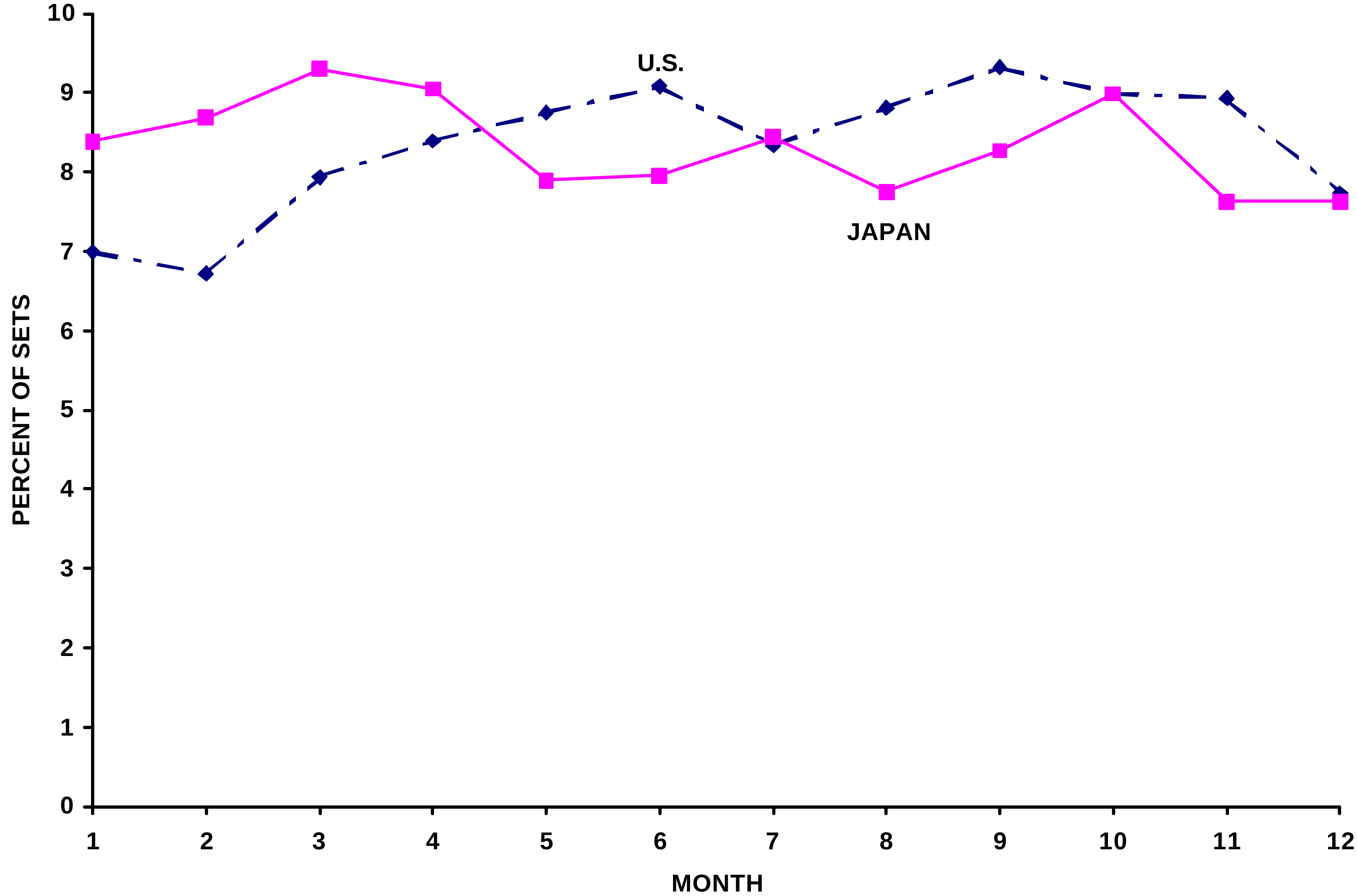

Figure 2. Average monthly percent of sets fished by U.S. and Japanese purse seiners fishing in the central-western Pacific in 1981-1998.

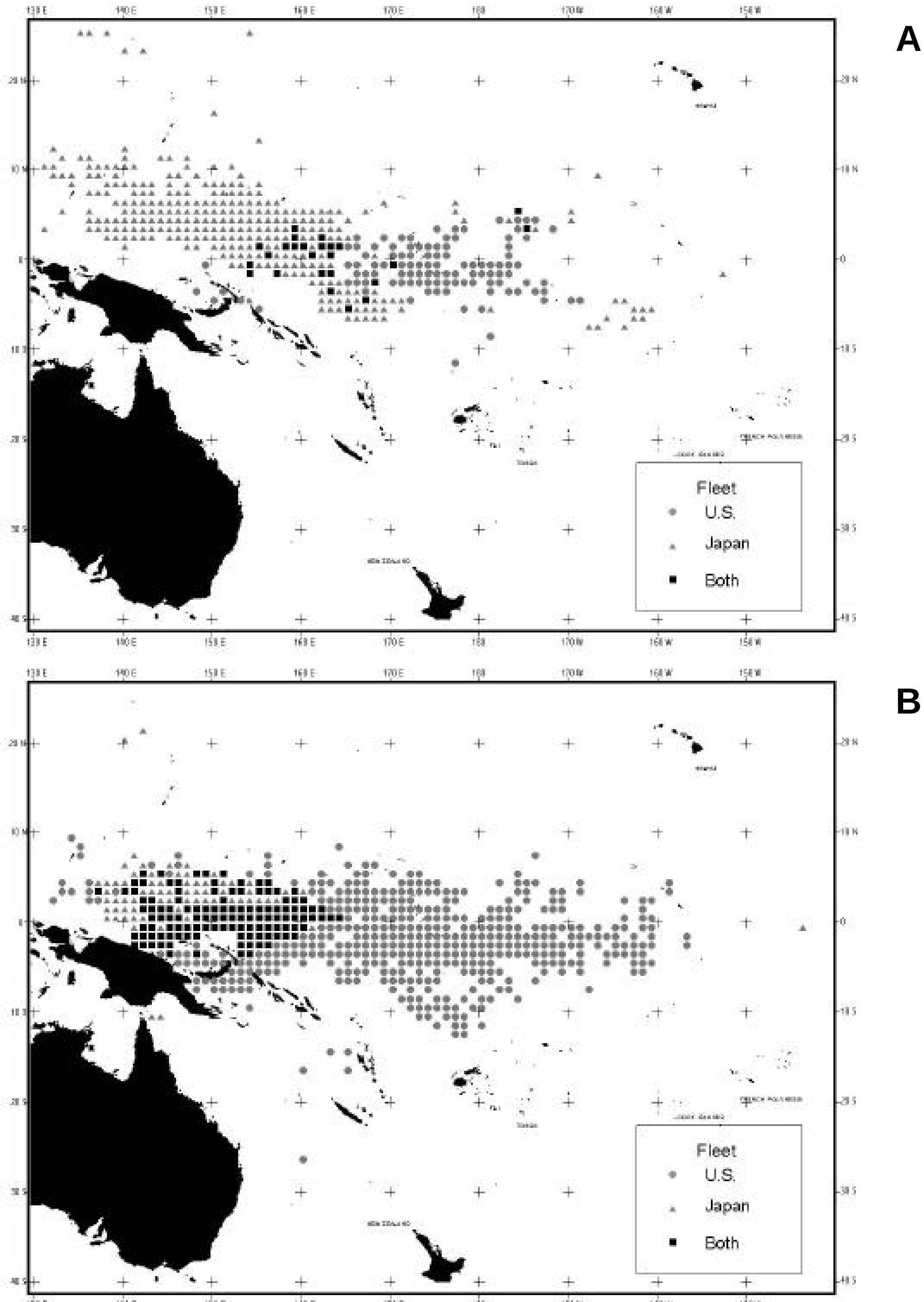

Figure 3. 1E area strata fished by the Japanese purse seine fleet (triangles) in 1993 (A) and 1982 (B) and 1E strata fished by the U.S. purse seine fleet and sampled for species composition by the National Marine Fisheries Service (circles), 1993 (A) and 1989 to 1995 (B). Squares indicate area strata where both Japanese fishing and U.S. species composition samples occurred.

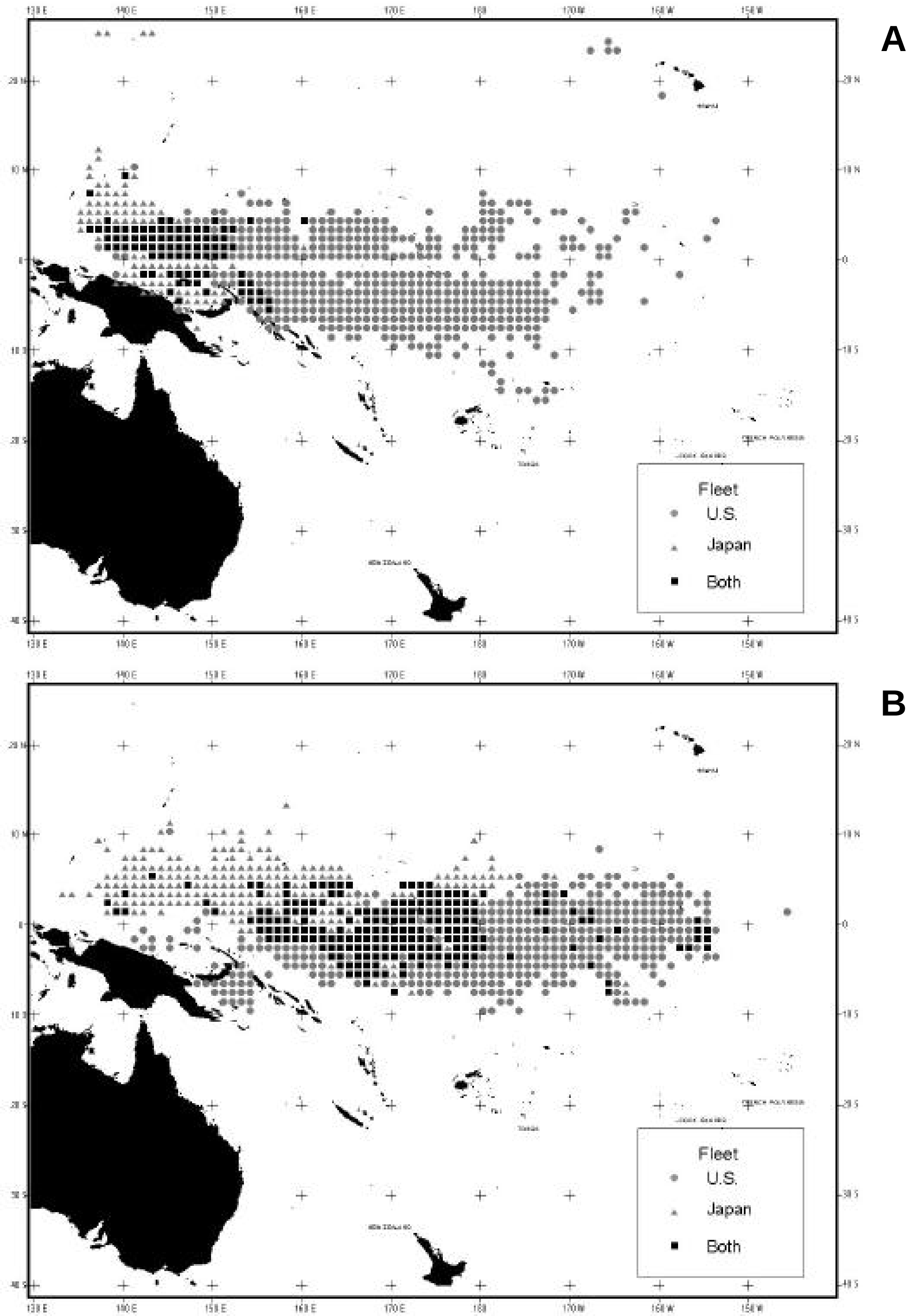

Figure 4. 1E area strata fished by the Japanese purse seine fleet (triangles) and the U.S. purse seine fleet (circles) in 1983 (A) and 1997 (B). Squares indicate area strata fished by both fleets.