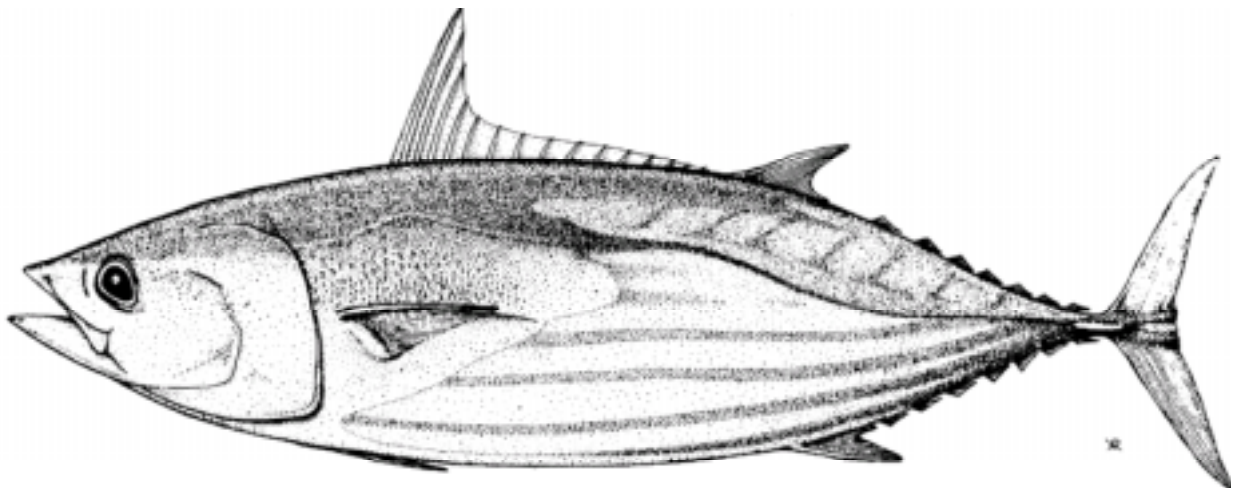# Classification of purse-seine effort by school association

Colin Millar
Peter Williams

Oceanic Fisheries Programme,
Secretariat of the Pacific Community,
Noumea

1 INTRODUCTION

This paper looks at the heterogeneity of purse seine set types (school association) within time/area strata. The purpose is to:
(i)   Describe the extent of missing data by time/area strata.
(ii)   Describe current procedures used to apportion set types to missing data.
(iii)   Review the homogeneity of set types by time/area strata.

Table 1 - Percentage of annual purse seine effort (sets) by fleet where set type has not been provided. Shaded columns represent the major purse seine fleets.

Year	AU	ES	FM	ID	JP	KI	KR	MH	PG	PH	SB	SU	TW	US	VU
1980					0%		0%								
1981					0%		0%							0%	
1982					0%		0%			100%				0%	
1983					0%		0%						0%	0%	
1984					0%		0%			0%	11%		0%	0%	
1985					0%		0%			2%	0%	4%	0%	0%	
1986				23%	0%		0%			13%	0%	8%	11%	1%	
1987				18%	0%		0%			0%	2%		14%	1%	
1988	0%			5%	0%		0%			0%	47%		4%	13%	
1989	0%			6%	0%		0%			5%	43%		5%	2%	
1990	23%			4%	0%		0%			6%	47%		5%	2%	
1991	24%		92%		0%		0%			8%	49%		9%	1%	
1992	15%		5%		0%		0%			19%	69%		17%	1%	
1993	3%		3%		0%		0%			15%	64%	100%	5%	1%	
1994			2%		0%	0%	0%		85%	7%	67%	100%	9%	0%	0%
1995			13%		0%	11%	0%		62%	14%	43%		17%	1%	8%
1996			2%		0%	4%	2%		52%	8%	40%		8%	1%	42%
1997			7%		0%	0%	1%		12%	2%	44%		4%	1%	41%
1998		0%	6%		0%	1%	2%		5%	0%	1%		2%	1%	27%
1999		19%	0%		0%	6%	4%		6%	1%	2%		1%	0%	36%
2000		2%	0%		1%	0%	1%	1%	0%	0%	1%		3%	1%	26%
2001		0%	0%		6%	0%	1%	0%		0%			0%		

2 EXTENT OF MISSING DATA.

Set type data are incomplete for various years and fleets (see Table 1) and are currently estimated prior to use in various research conducted by the OFP. The procedure used by SPC to estimate set types is as follows:

Purse seine catch and effort used for analyses exists in an aggregated form by flag, 1°x1° square, month, and set type. For each instance (i.e. catch and effort record by flag / 1°x1° / month / set type) where catch and effort data does not have school association information, the following methodology has been used.

1.   Effort (sets) and species catch, where school association has been reported, is determined for matching **vessel nationality, month, 1°x1°grid** strata. The proportion of effort and individual species catch by set type is then applied to the catch and effort data with missing school association information to produce estimates of catch and effort by school type, which are updated in the database.

2.   Where there is insufficient information available at the level described in **1**, the proportion of catch and effort are determined and applied for strata aggregated by **vessel nationality, month, 2°x2°grid** strata.

3. Where there is insufficient information available at the level described in **2**, the proportion of catch and effort are determined and applied for strata aggregated by **vessel nationality, month, 5°x5°grid** strata.

4. Where there is insufficient information available at the level described in **3**, the proportion of catch and effort are determined and applied for strata aggregated by **vessel nationality, month, 10°x10°grid** strata.

5. Where there is insufficient information available at the level described in **4**, the proportion of catch and effort are determined and applied for strata aggregated by **vessel nationality, year, 10°x10°grid** strata.

6. Where there is insufficient information available at the level described in **5**, the proportion of catch and effort are determined and applied for strata aggregated by **month, 10°x10°grid** strata (that is, aggregated over all vessel nationalities).

7. Where there is insufficient information available at the level described in **6**, the proportion of catch and effort are determined and applied for strata aggregated by **vessel nationality, month** strata (that is, aggregated over all areas).

8. Where there is insufficient information available at the level described in **7**, the proportion of catch and effort are determined and applied for strata aggregated by **month** strata only (that is, for aggregated over all areas and vessel nationalities).

The extent to which each of these methods is used to apportion catch/effort to set type is shown in the table below.

Table 2 – Number of records where set type was estimated for each method.

Method	Amount of data where the method was able to estimate set type	
	Number of records	**Percentage**
1	144	0.76
2	265	1.39
3	615	3.24
4	290	1.53
5	0	0.00
6	4444	23.39
7	4846	25.50
8	8398	44.20

3   REVIEW OF HOMOGENEITY BY TIME/AREA

3.1   Methodology

The data used were logsheet data provided to SPC member countries by the 4 major purse seine fleets – Taiwan, Korea, United States, and Japan.

For the analyses, variations on 3 elements were applied:

Replicates were defined using the criteria for the eight estimation methods listed in Section 2, with variations in stratification by flag, year, month, and area (1°x1°, 2°x2°, 5°x5°, or 10°x10°).

Strata:
- Flag and year.
- Flag and longitude.

Homogeneity cut-off percentage – arbitrarily selected percentage of sets of one type that a stratum had to equal or better to be considered homogeneous.
- 90% of sets
- 95% of sets
- 100% of sets

For each stratum a percentage was obtained that indicates the proportion of replicates that satisfied the homogeneity cut-off percentage. For example, if the stratum used was flag and year, the replicates were 1°x1° squares, and the cut-off percentage was 95, then a single stratum would be 100% homogeneous if all 1°x1° squares for that flag and year had 95% or more sets of one type.

Set Types:
The set information was grouped into 5 groups:
- Unassociated
- Log
- Anchored FAD
- Drifting FAD
- Other

For the homogeneity calculations, sets allocated to 'other' were excluded. Sets that did not belong to one of the five groups above were not included in the data set at all, but these data generally represent less than 0.1% of the total number of sets. Table 1 shows the percentage of sets with no set type information by flag and year, and Table 2 shows how many of these sets were estimated by each of the estimation methods described in Section 2.

3.2 Results

Figures 2 to 5 are graphs of homogeneity by flag and year, showing homogeneity plots for the three cut-off percentages and for the two types of replicates. For each of the plots, it is interesting to note that for the 1°x1° square replicates the cut-off percentage makes very little difference. The graphs only show those years for which there were more than 1000 sets (see Figure 1).

Table 3 shows the average homogeneity by flag (where available), weighted by the number of sets for each year, for the eight estimation methodologies with a cut-off percentage of 90%. This shows that the homogeneity is reasonable for the finest resolution replicates (1°x1° squares by flag and month), but continually decreases as the resolution of the replicates become coarser. This is further illustrated in Figure 8 where homogeneity is plotted for each of the methods by year.

Table 3 – Weighted average percentage homogeneity over all years for the 8 set type estimation methodologies, using a cut-off percentage of 90%.

Estimation method	Replicate	Flag				All flags combined
		JP	KR	TW	US	
1	Flag, year, month, 1°x1°	71	62	62	78	69
2	Flag, year, month, 2°x2°	61	55	55	72	62
3	Flag, year, month, 5°x5°	49	44	46	62	52
4	Flag, year, month, 10°x10°	40	34	36	54	43
5	Flag, year, 10°x10°	23	15	29	39	28
6	Year, month, 10°x10°	-	-	-	-	34
7	Flag, year, month	8	6	17	29	16
8	Year, month	-	-	-	-	1

Figure 6 shows homogeneity for all flags by year, 1°x1° square replicates and a cut-off percentage of 95%. This graphs only shows those years for which there were more than 1000 sets (see Figure 1). Homogeneity is relatively constant over time for each flag. In general, the years with the highest percentages are those years with the fewest number of sets, and the years with the lowest percentages are those with the highest number of sets.

Figure 7 plots homogeneity for all flags by longitude, 1°x1° square replicates and a cut-off percentage of 90%. There are no striking trends apparent in this plot with homogeneity similar at different longitudes for each flag.

Figures 9 to 32 are pie plots showing the set types for 5°x5° squares by flag and year for the years 1995 to 2000. These plots show that, by year, the sets within 5°x5° areas are mostly mixed. They also show the increasing use of drifting FADs in recent years, although the use of drifting FADs in the year 2000 seems to have declined a little from 1999.

4   CONCLUSIONS

The results show that there is always a certain degree of heterogeneity in set types for the 1°x1° squares by month replicates, which are the finest strata size available. As expected, the heterogeneity steadily increases as the strata estimates become coarser, until by the coarsest replicate (year and month) there is basically no homogeneity at all.
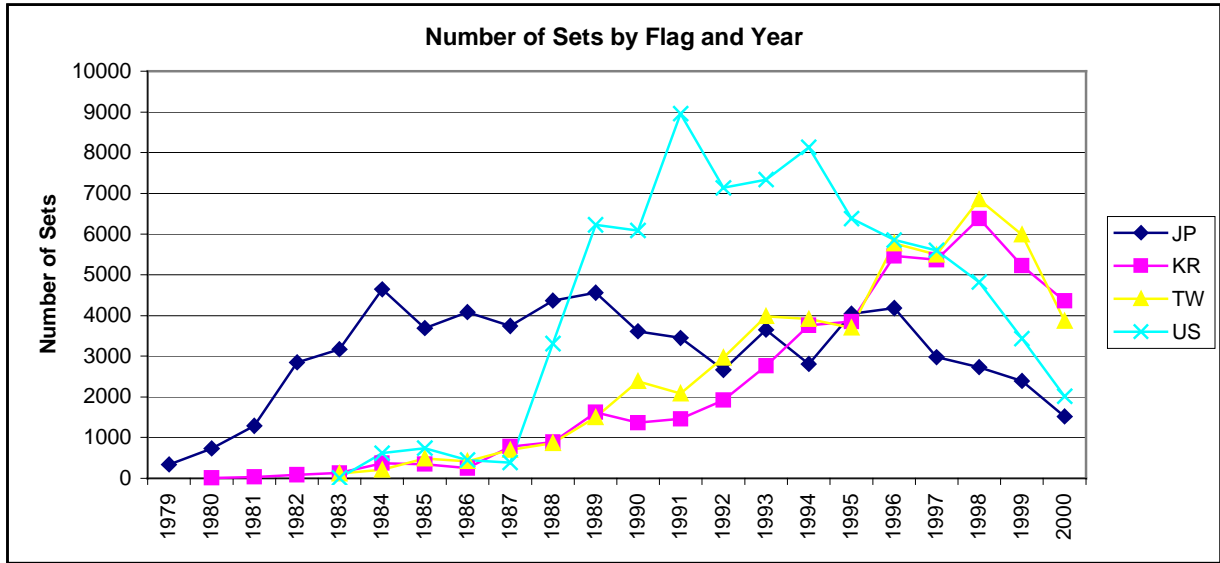
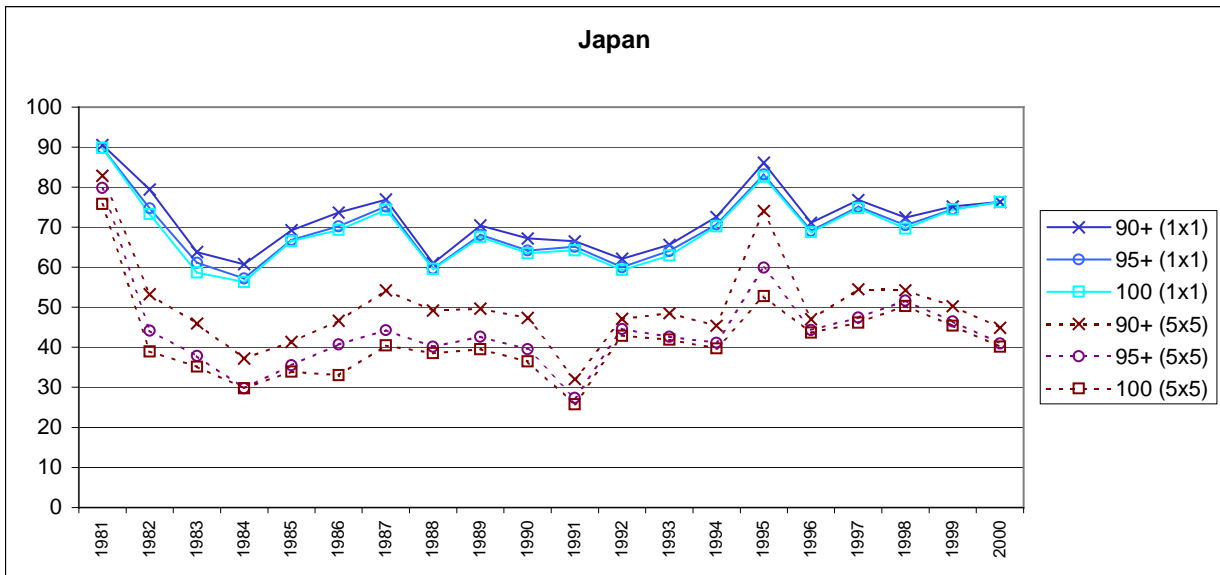**Figure 1** – Number of sets by flag and year (excluding 'other').

Figure 2 – Homogeneity of set types for Japanese vessels by year.
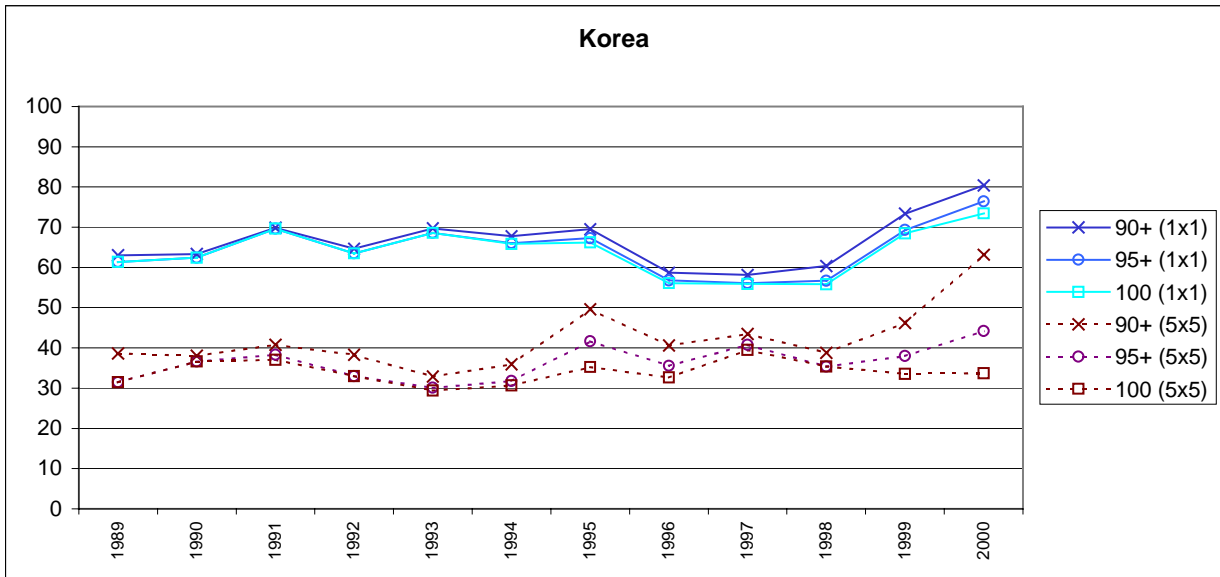
Figure 3 - Homogeneity of set types for Korean vessels by year
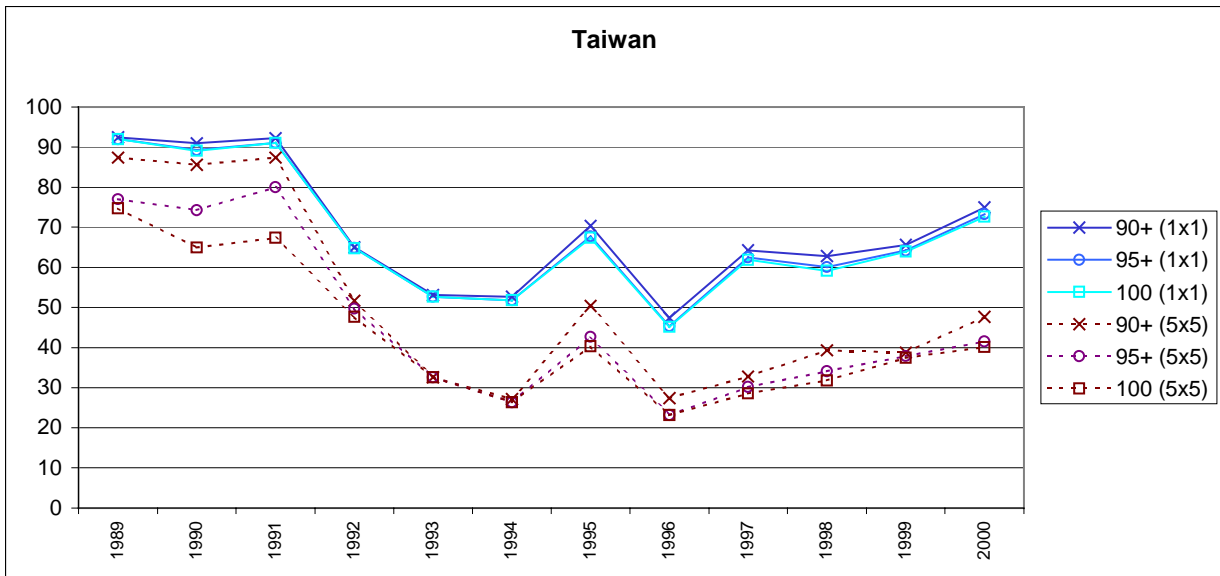

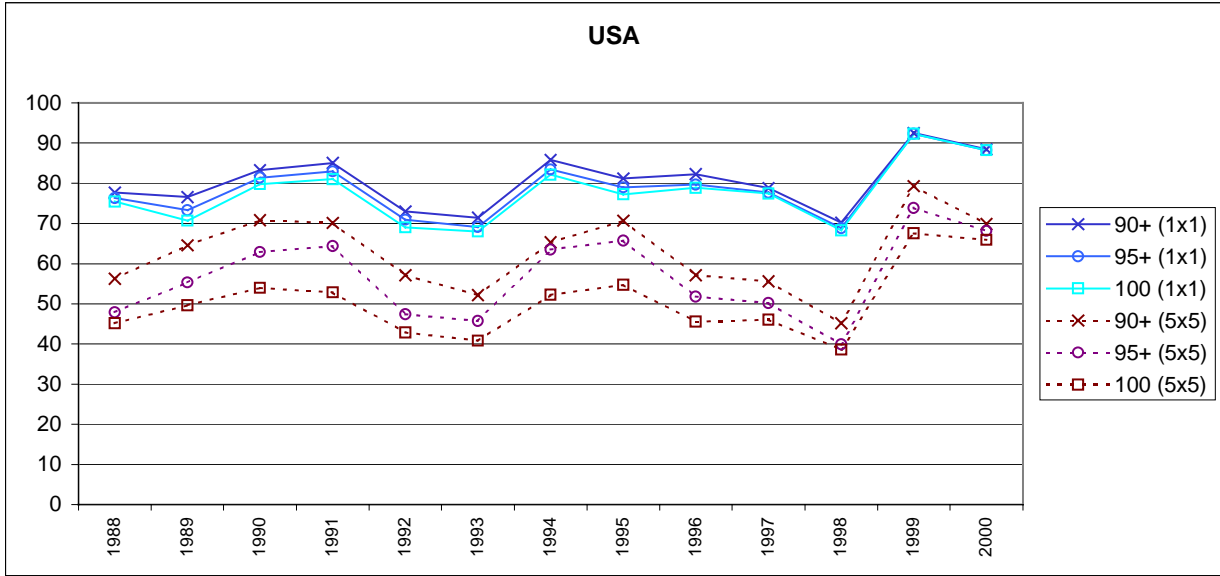**Figure 4** - Homogeneity of set types for Taiwanese vessels by year

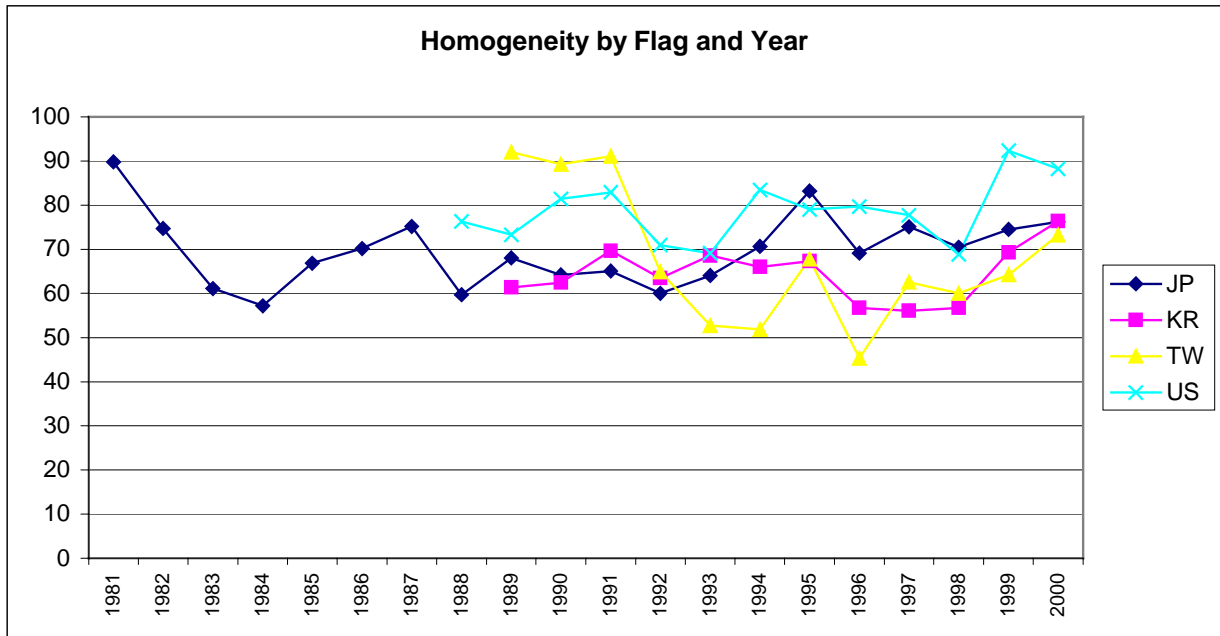**Figure 5** - Homogeneity of set types for U.S. vessels by year

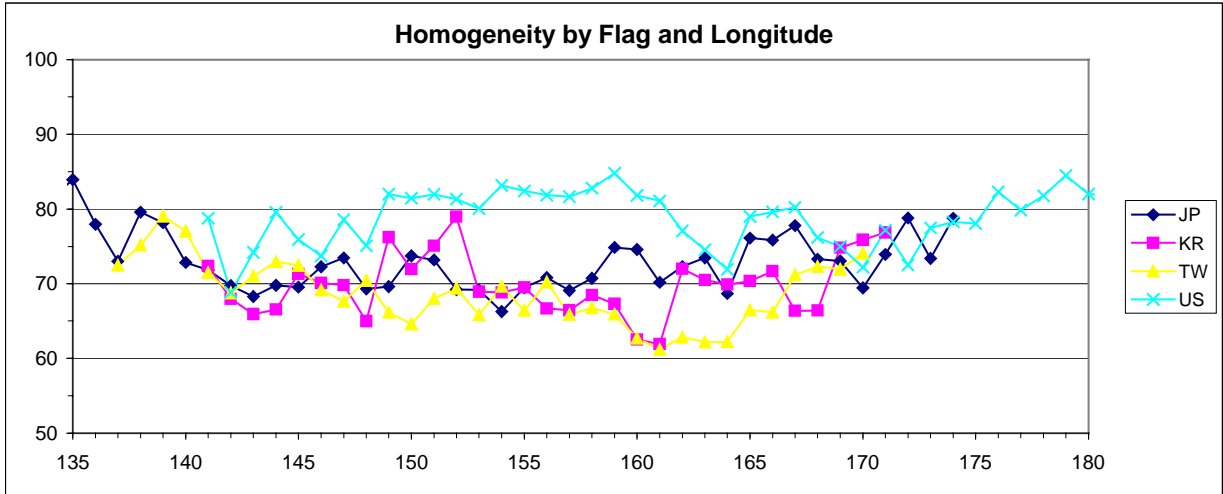**Figure 6 -** Homogeneity of set types by flag and year for 1°x1° squares by month and a cut-off percentage of 95%

Figure 7 - Homogeneity of set types by flag and longitude for 1°x1° squares by month and a cut-off percentage of 95%
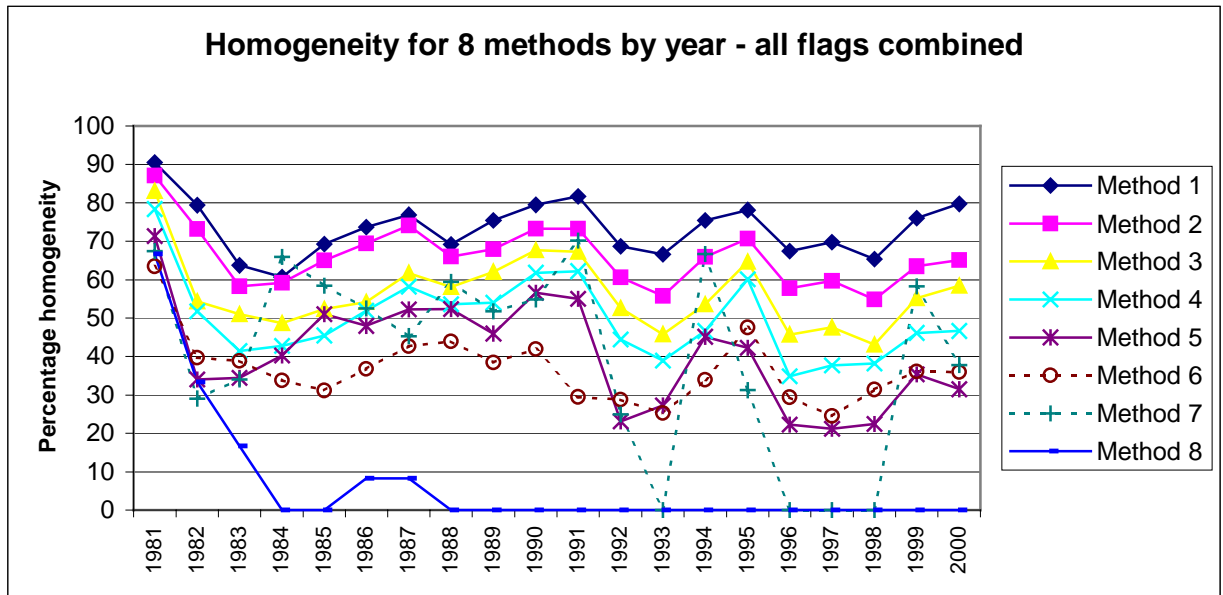
Figure 8 - Homogeneity for all 8 estimation methods by year - all flags combined
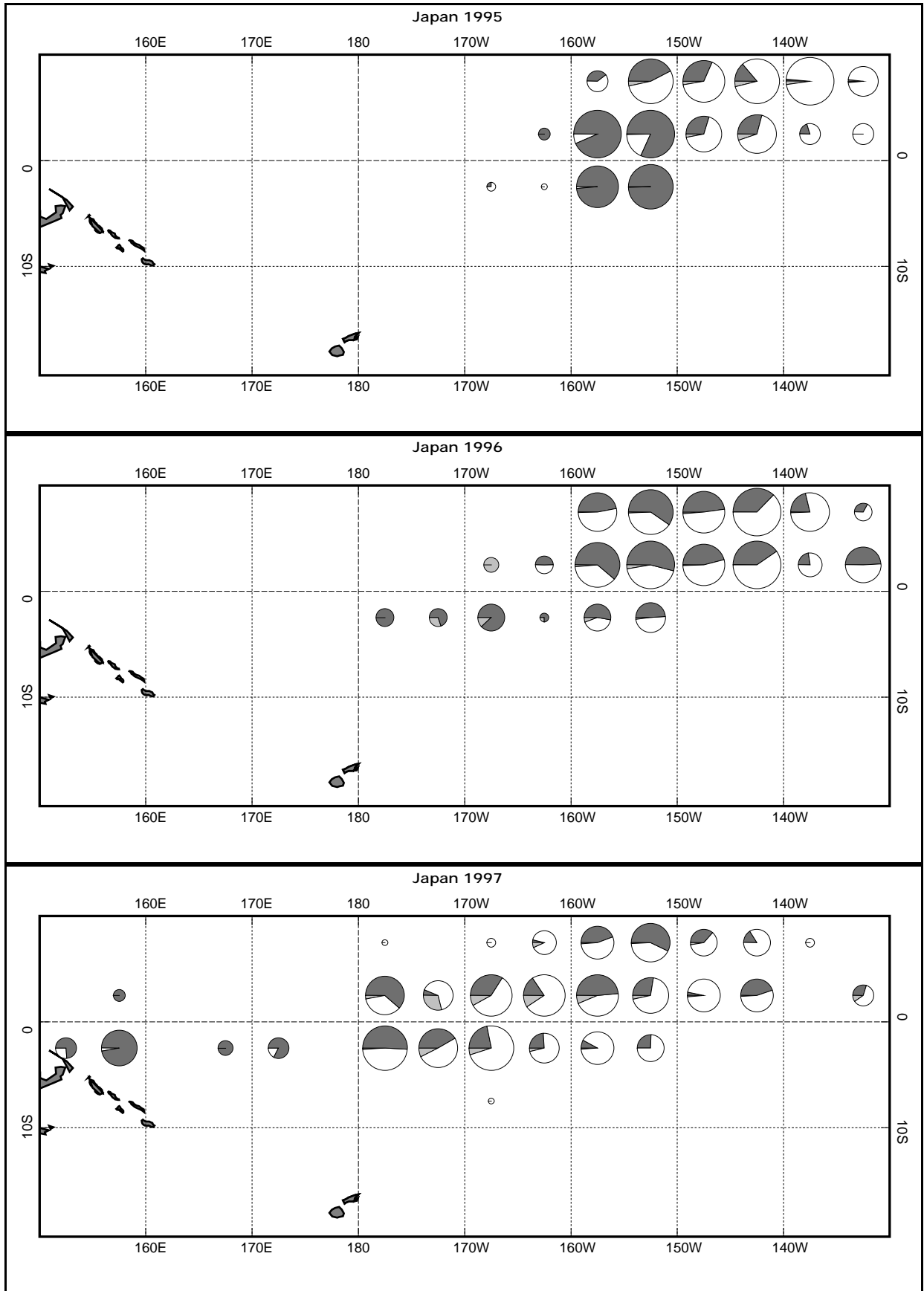
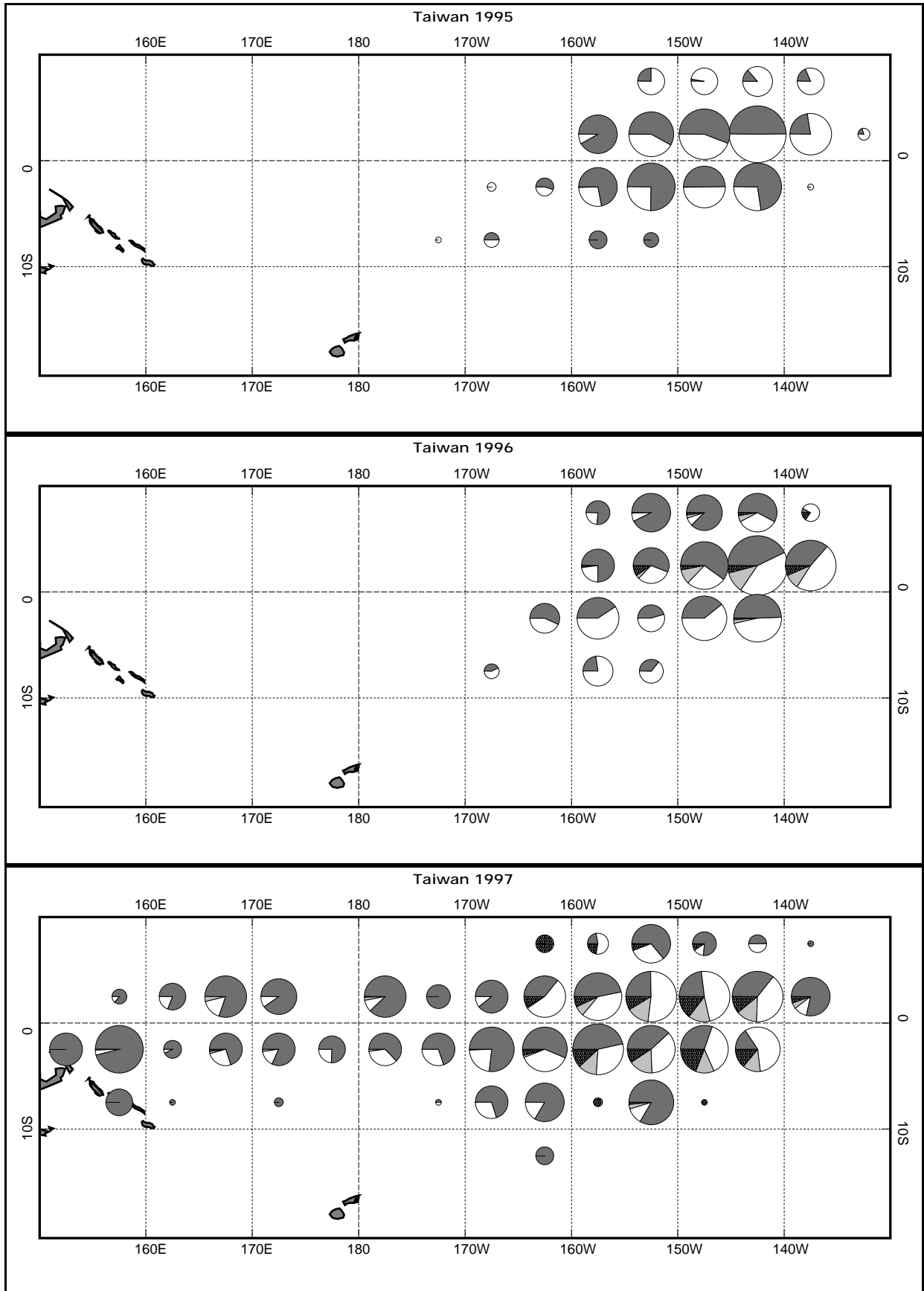**Figures 9, 10, 11** – Distribution of purse seine set types for Japanese vessels 1995-1997.
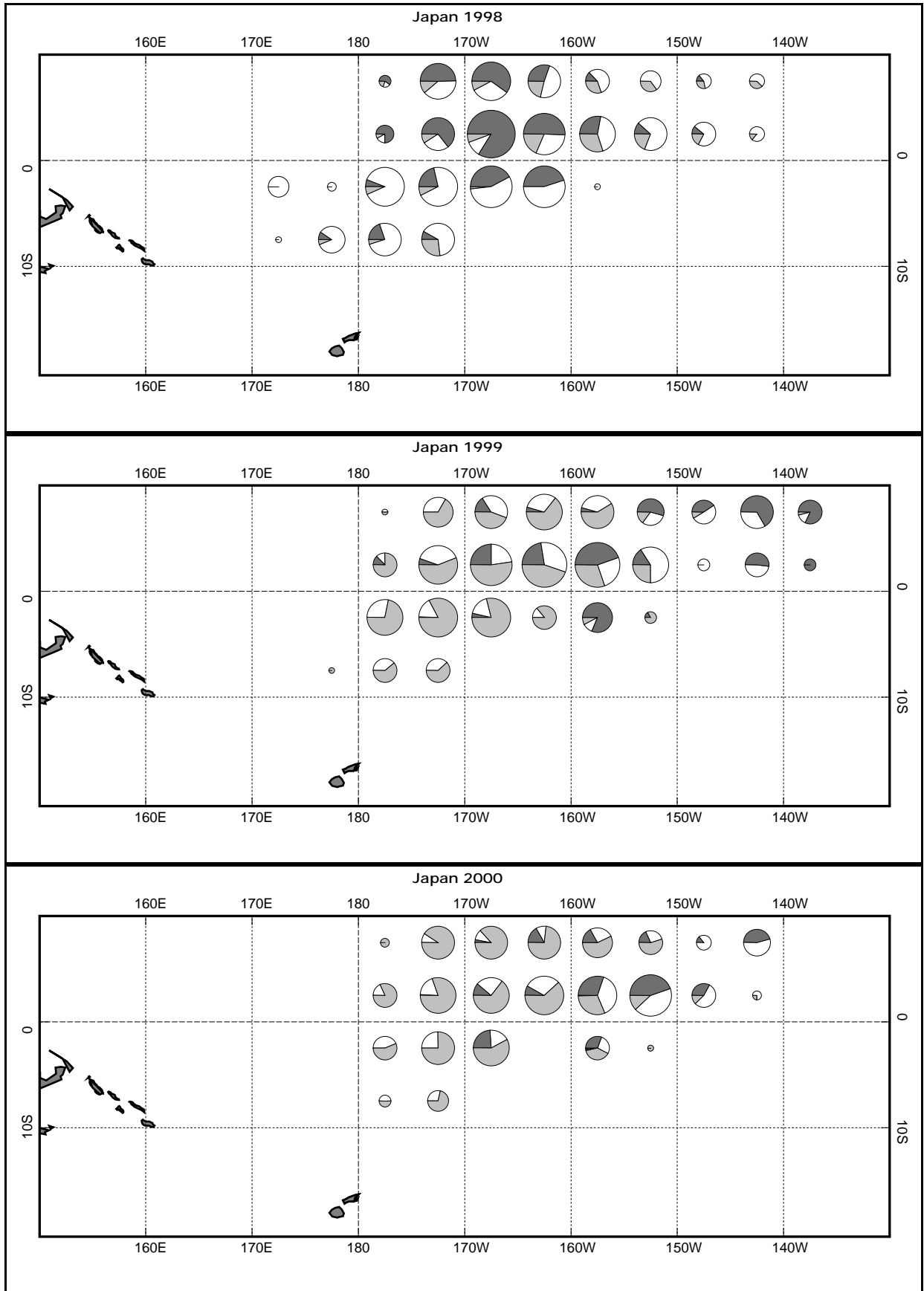
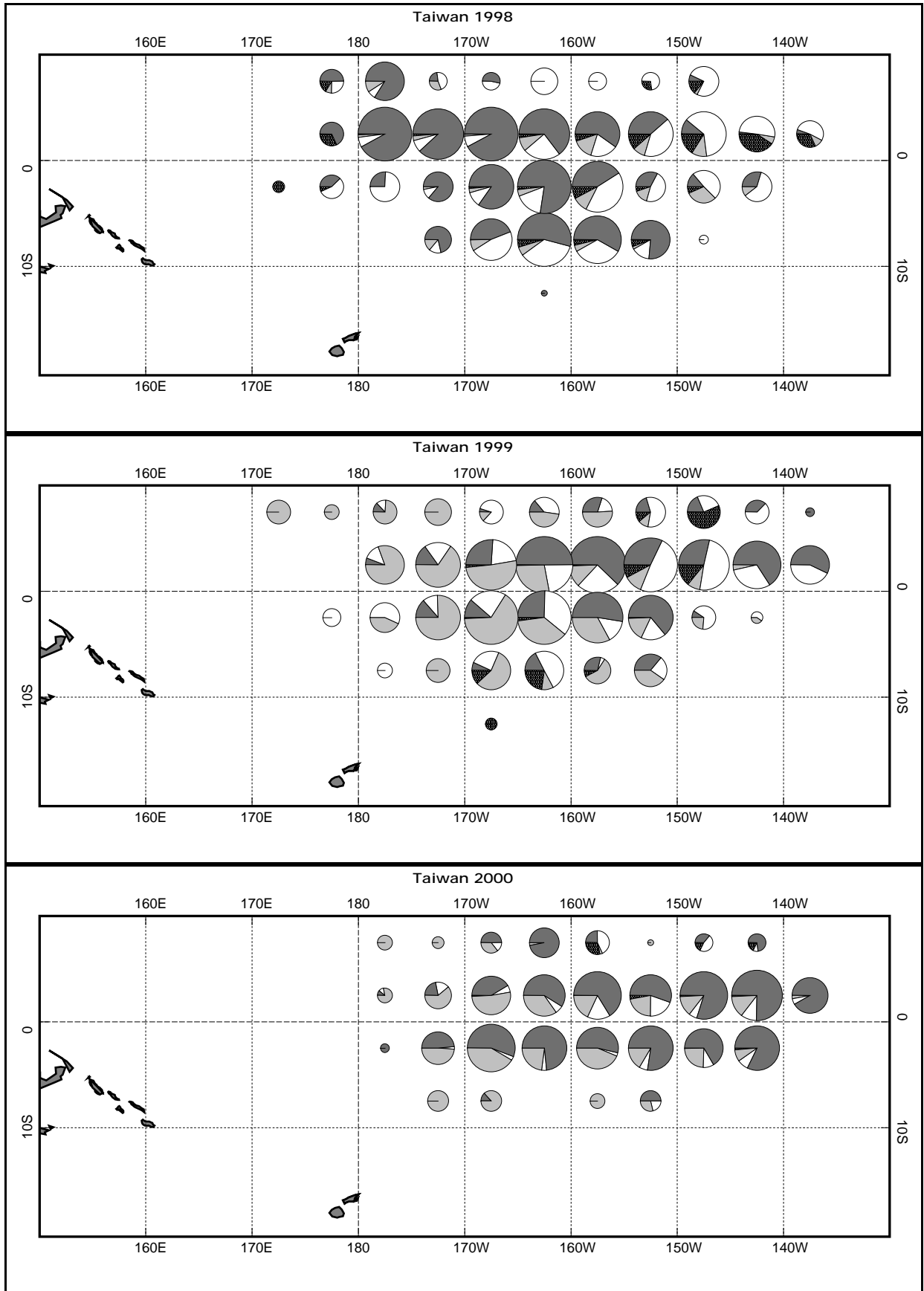**Figures 12, 13, 14** - Distribution of purse seine set types for Japanese vessels 1998-2000.
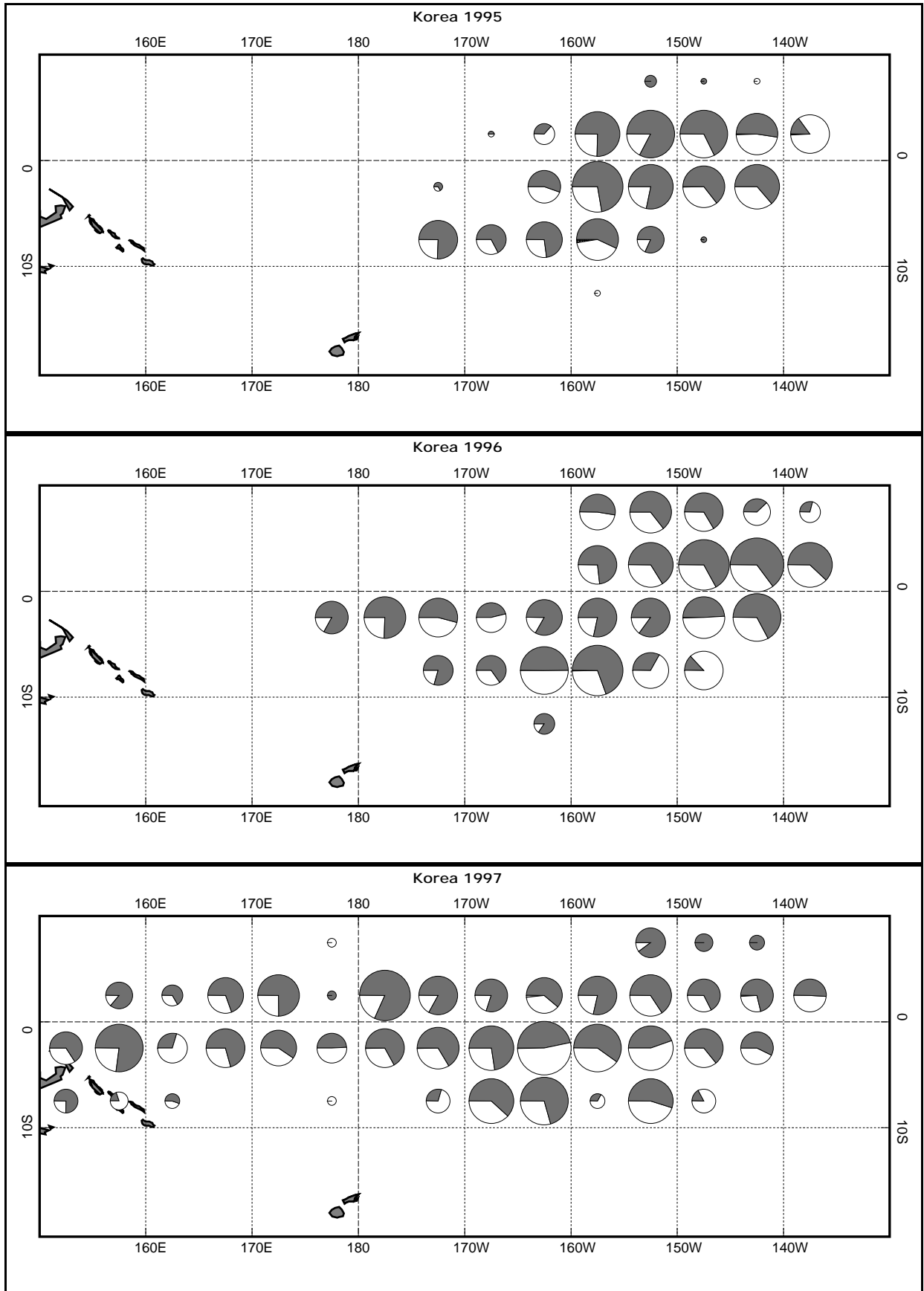
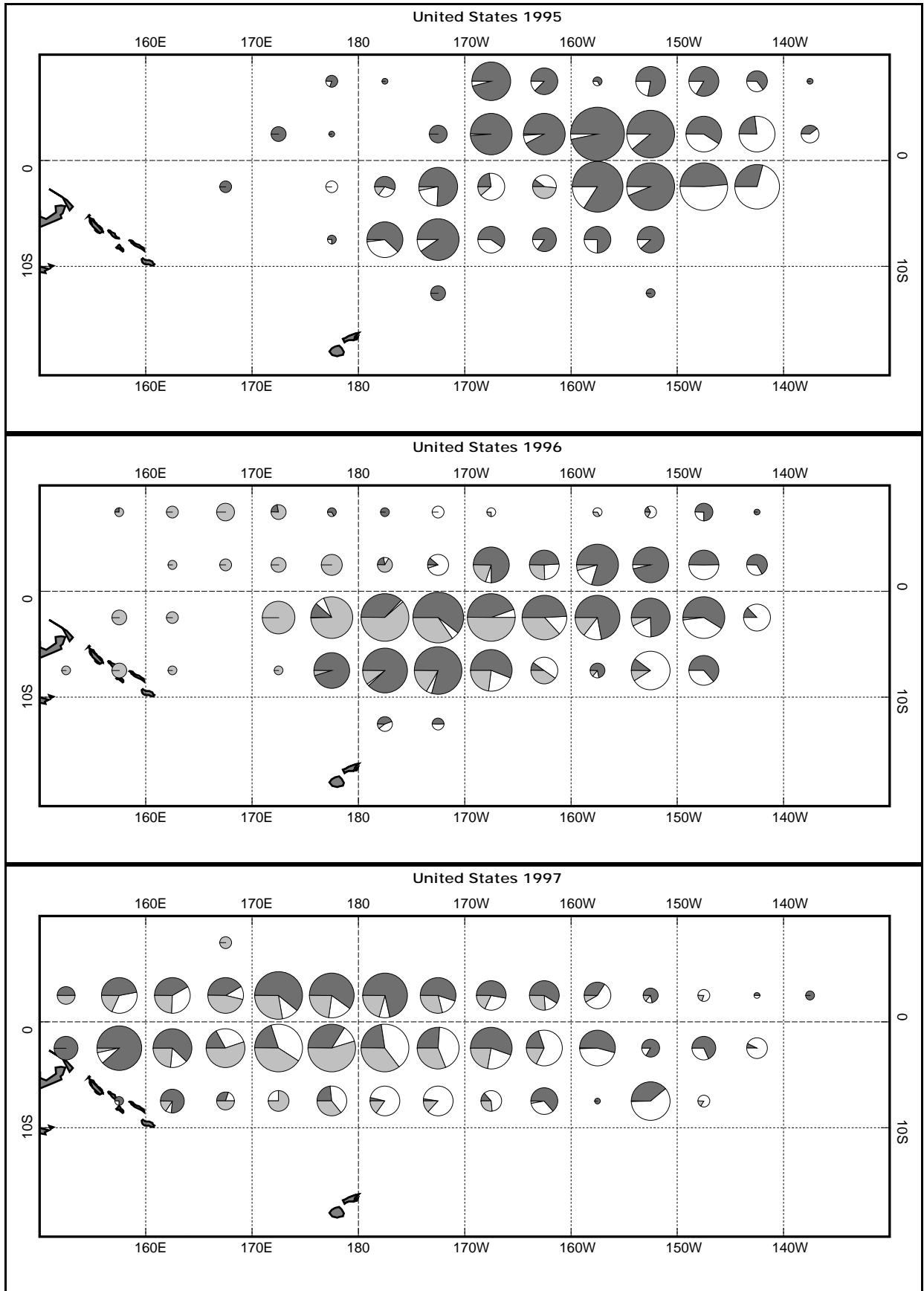**Figures 15, 16, 17 -** Distribution of purse seine set types for Korean vessels 1995-1997.
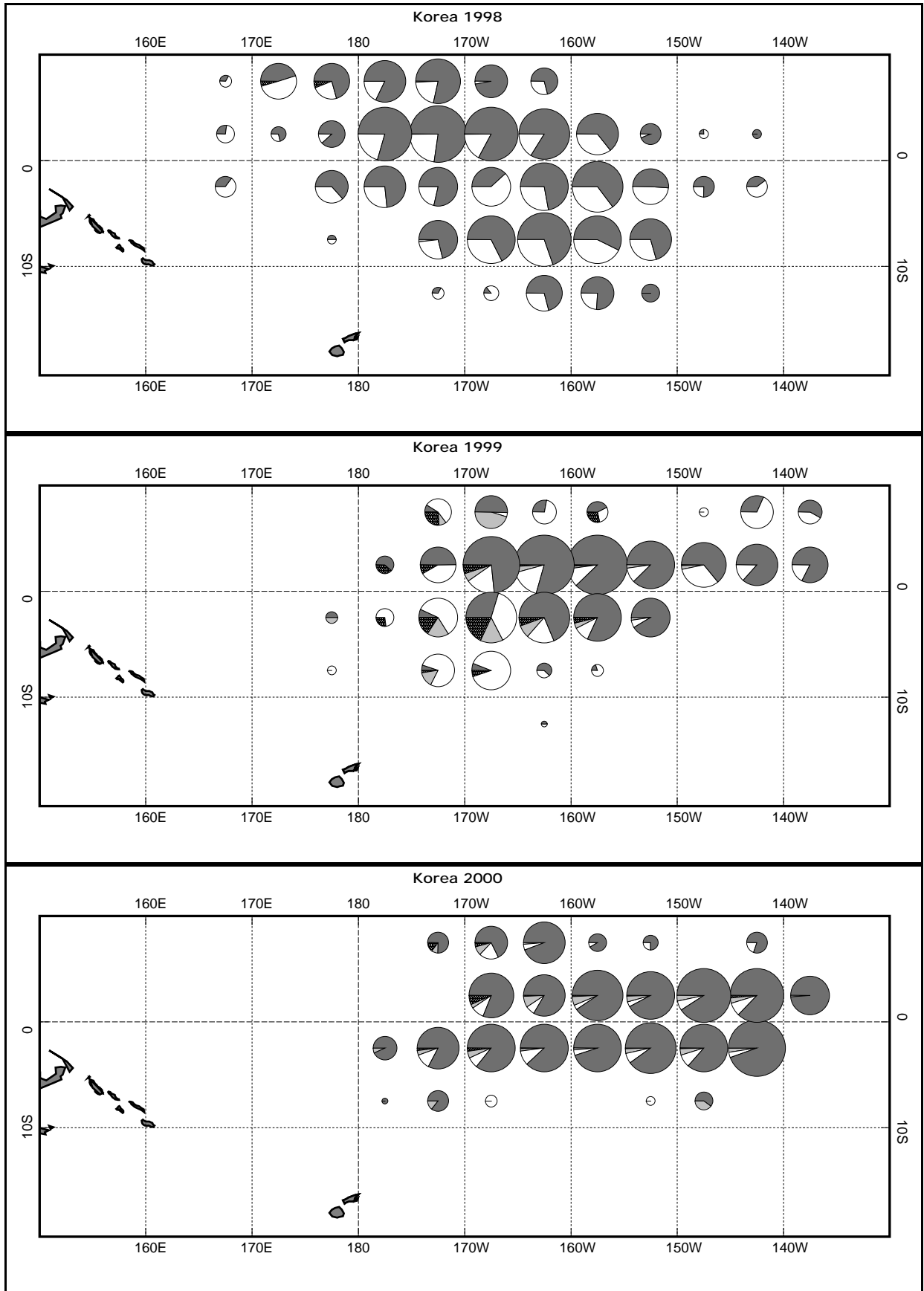
Figures 18, 19, 20 - Distribution of purse seine set types for Korean vessels 1998-2000.
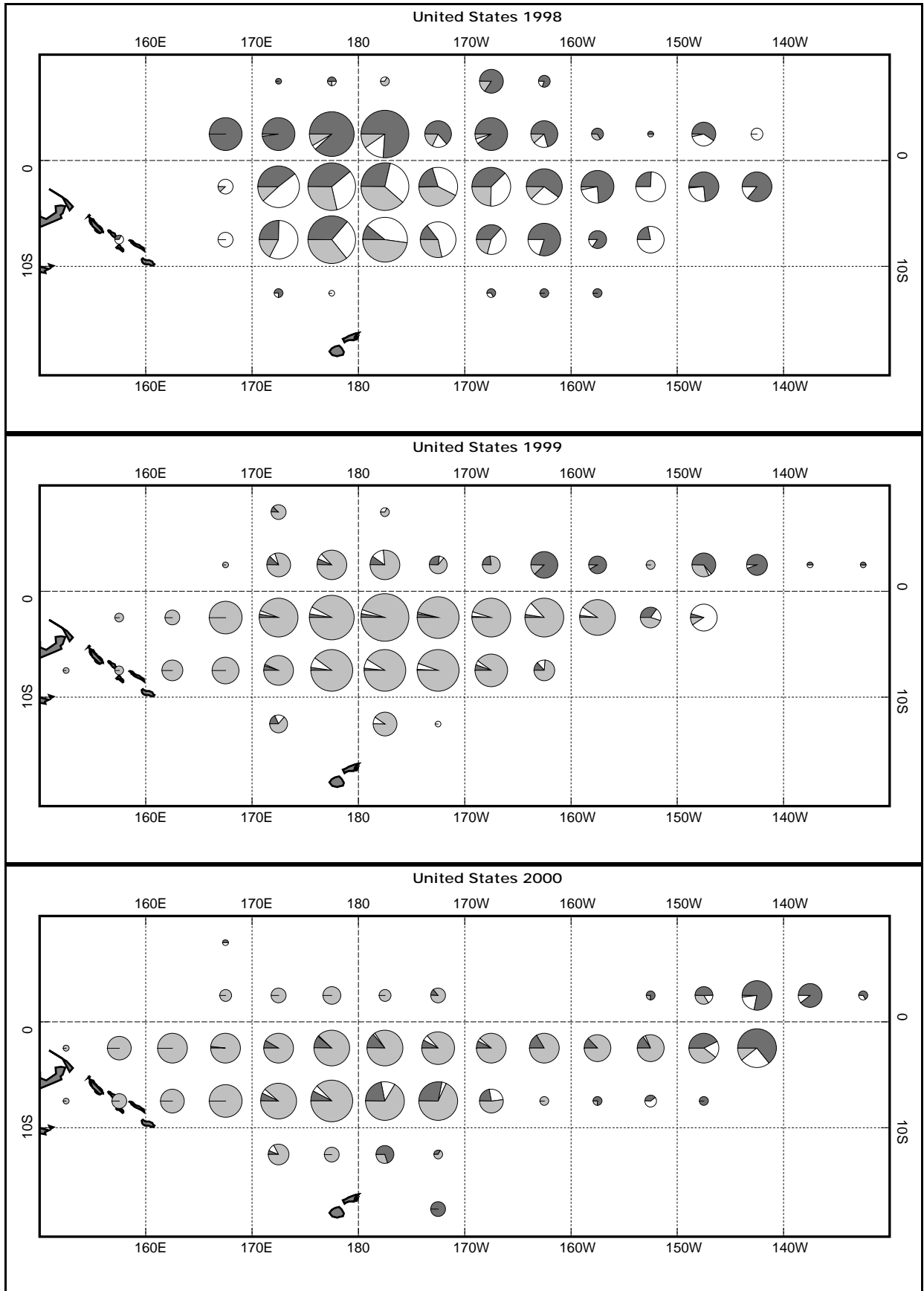
Figures 21, 22, 23 - Distribution of purse seine set types for Taiwanese vessels 1995-1997.

Figures 24, 25, 26 - Distribution of purse seine set types for Taiwanese vessels 1998-2000.

Figures 27, 28, 29 - Distribution of purse seine set types for U.S. vessels 1995-1997.

Figures 30, 31, 32 - Distribution of purse seine set types for U.S. vessels 1998-2000.