Yearly Trend in Population Density of Large Baleen Whales in the Antarctic Areas IV and V in Recent Years

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ABSTRACT

By use of whale sightings data which were collected by the JARPA survey, yearly trends of blue, fin and humpback whale populations in Areas IV, V and IV+V was examined by eight kinds of time series in combination of months, types of research vessels and schools and school sizes. The instantaneous increasing rate (IR) , per year and its coefficient of variation (CV) were calculated for each kinds of time series. Although IRs are not always statistically significant, IRs of the blue whale are -1.5 and 3.8 % in Areas IV and V, respectively. In the case of the fin whale, they are 22.4 and 24.7 % in Areas IV and V, respectively. The IRs of the humpback whales are 8.9 in Area IV, and 56.6 % in Area V. Several matters related to the estimation of yearly trend in population density by the JARPA are discussed.

INTRODUCTION

Much concern has been put into the current situation and trend of large baleen whale populations which had been exploited heavily in the Antarctic in the past, related to the effect of moratorium of commercial whaling and to the establishment of the sanctuary of whales in the Antarctic as the conservation measure of them. Accepting this concern, the IWC passed two resolutions in 1993 and 1994 on the promotion of research related to the conservation of large baleen whales in the Southern Oceans (IWC, 1994; 1995), and the Scientific Committee (SC) is now preparing the research for this purpose (Anon., 1995).

The IWC has been conducting the whale sightings in the Antarctic under the International Decade of Cetacean Research (IDCR) since 1978, and Japan has been conducting a long term whale research in the Antarctic Areas IV and V (JARPA) under the Article 8 of the Convention since 1987 (Kato *et al.*, 1989, 1990; Fujise *et al.*, 1990; Kasamatsu *et al.*, 1993, Fujise *et al.*,1993a, 1993b, Nishiwaki *et al.*, 1994, 1995). Both researches have engaged in estimation and monitoring of the cetacean populations. Although the IDCR surveys is designed to investigate whole the Management Areas I-VI of the Antarctic, each Area has been surveyed every six years in average. On the other hand the JARPA surveys in limited areas of Areas IV and V every two years, although only one third of the whole Antarctic are covered by the JARPA. The JARPA seems to be more efficient for the monitoring of the population trend in the Antarctic than the IDCR, if it will be continued for long years.

At the Steering Committee Meeting for Research related to Conservation of Large Baleen Whales in the Southern Oceans which was held in Tokyo on 7-10 March, 1995 (Anon., 1995), Japan submitted a document on the trend of some baleen whales by use of JARPA whale sightings data (ICR, 1995MS), and it indicated the apparent increase of blue whales in Area V. The Steering Group noted that it would be necessary to test this apparent increase for statistical significance. Then, we analyzed the data in further detail in this paper, although this study is still preliminary, because only four times of research have been carried out in each Area yet.

MATERIAL AND METHODS

Materials

The JARPA engages in research by the combination of the whale sightings and random sampling of minke whales systematically in the Management Areas IV (70°E-130°E) and V (130°E-170°W), but in the Ross Sea the eastern range is more east than 170°W related to the ice line of the eastern margin of the Ross Sea) under the long term programme. After the feasibility studies in a part of Area of IV (105°E-115°E) and V (168°E-178°E) in the first two years of 1987/88 and 1988/89, the full-scale research has been conducting in whole Areas of IV or V, alternately in each year. The present study uses the whale sightings data by the JARPA for eight years from 1987/88 to 1994/95, although data in 1994/95 are preliminary. Then, four times of surveys have been carried out in each Area, including one time of feasibility study.

The research area also covers in the waters north of 60°S in every year (cf. Fujise *et al.*, 1993a), but for the statistical analysis in this study the data are limited to those in the main research areas south of 60°S, except distribution maps of whales in Figs. 2a-e. The research in areas of north of 60°S are carried out on the way to and from the main research areas usually, and they are different by years. This study aims to the large baleen whale species which are densely distributed in the south of the 60°S such as blue, fin and humpback whales in summer. The sei whale which is distributed mainly in the waters of north of 60°S as shown Fig. 2c and the right whale which concentrates in a part of research areas as shown in Fig. 2e are excluded from the present analysis.

Research areas are designed to be exchanged every year between Areas IV and V in the JARPA survey. There is a possibility that the distribution density may be different by locality within an Area. Hence, each Area is divided into four sub-areas, but when the pack ice opens in the Prydz Bay, research is carried out in the bay, and then the bay (PB) is separated from Sub-area West- south (WS) of Area IV, as shown in Fig. 1. Southern sub-areas are limited within the waters 45 n. miles apart from the pack ice line which moves seasonally and yearly north- and south-ward. Statistical tables were made by Sub-areas as shown in Appendices . Furthermore, as the density distribution of whales may change by months in a year because of seasonal migration, the data are tabulated by months.

The whale sightings were carried out by two or three sighting/sampling vessels till 1990/91, and from 1991/92 onward one of three research vessels (SV) alternately engaged in whale sightings dedicately in each sub-area exchanging among three research vessels. On the other hand, other f

retwo vessels (SSV) engaged in sighting and sampling. Then, data of both types osearch vessels are separated in the analysis, because the whale sighting manners and efficiency may be different each other as examined later.

The same catcher boat type research vessels have been used for the JARPA (*Kyomaru* No.1 *Toshimaru* No. 18 and *Toshimaru* No. 25) so that it is assumed that the correction of sightings efficiency by the type of vessels will not be needed.

The total research distance is used as the indicator of whale sightings effort, considering the sightings pattern of each vessel is the same. The types of whales sighted are separated into the primary and secondary sightings in the JARPA as same as the case of the IDCR, and only the data of primary sightings are used in this study, because they will be the most suitable as the data for estimation of population density.

The sightings distance, number of schools and total number of whales counted for each whale species (blue, fin and humpback whales) primarily sighted are summed up by sub-area, by year, by month, and by types of research vessels. Appendix 1-3 show the results of the tabulation from 1987/88 to 1994/95.

Methods

The density index (DI)of whale distribution in the research sub- area is calculated as the number of schools (DIS) or number of whales (DIW) sighted per 100 n. miles of whale sightings distances.

On each whale species in Areas IV and V, the yearly trend of the population density was examined by applying the simple least squares estimation to the log-linear model of the following formula:

$$Y = a\, e^{bx}$$

where, Y is density index, x is year, a is density at year 0 , and b is instantaneous increasing rate (per year) in the density index. In this formula, the b indicates the increasing rate (IR) of populations which are distributed in the given research area. Statistical examination of the IR was examined by calculation of b and its coefficient of variation (CV).

SUB-AREAS IN WHICH WHALE SIGHTINGS WERE CONDUCTED

As shown in Appendix 1, whale sightings survey was not conducted in all of sub-area in each month of every year. Especially in the feasibility study periods of 1987/88 and 1988/89, the research areas were set in longitudinally narrow waters (105E°-115°E in 1987/88 and 168°E-178°E in 1988/89). The sub-areas and months in which whale sightings survey was conducted in every four successive years are the Sub-area East-south of Area IV (IVES) in January, Sub-area ES of Area V (VES) in February and Sub-area East-north of Area V (VEN) in January. As a secondary time series, Sub-area West-north of Area IV (IVWN) in February, Sub-area ES of Area IV (VES) in March, Sub-area East-north of Area IV (VEN) in January, Sub-area Prydz Bay (PB) in February, and Sub-area WN of Area V (VWN) in January have every three successive

years.

Research was conducted from December to March every year, but some Sub-areas such as IVWN, IVWS, IVEN, PB and VES lack the data in some months.

DISTRIBUTION PATTERNS OF LARGE BALEEN WHALES IN THE ANTARCTIC

Spatial pattern

Figs. 2a-e show positions of blue, fin, sei, humpback, and right whale schools, respectively, primary sighted in the waters south of 40°S during the sighting survey by research vessels of the JARPA.

The distribution patterns are different latitudinally and longitudinally among whale species. All the blue whale schools were found in the waters south of 60°S, and they are distributed more in southernmost waters. They were found in the Ross Sea. Blue whales were distributed longitudinally even (Fig. 2a). In the case of the fin whale many schools were found in the waters north of 60°S (Fig. 2b). They were distributed longitudinally wide as same as the blue whale, but the distribution pattern is more north than that of the blue whale. Only one school of the fin whale was found in the Ross Sea. Sei whale schools were rarely found in the waters south of 60°S, while they were found more in the waters north of 60°S (Fig. 2c).

Humpback whales were distributed densely in the waters south of 60°S (Fig. 2d). Their distribution pattern is different between Areas IV and V. In Area IV the values of DI are high in both southern and northern Sub-areas except Sub-area PB. On the other hand, the DIs in Area V are lower than those in Area IV, and those in southern Sub-areas are higher than those in northern Sub-areas in Area V. But, only one school was found in the Ross Sea.

According to Ohsumi and Kasamatsu (1986), the right whale is rarely distributed in the Antarctic in summer. However, as shown in Fig. 2e, many right whale schools were found in the waters south of 60°S by the JARPA. But they were limited longitudinally in the waters of 92°E-143°E, with a concentration in the waters around 100°E -110°E.

Temporal pattern

Temporal pattern of density distributions is also different by whale species. In the case of the blue whale there is no clear seasonal change in densities, although they are relatively low in March.

There is no clear seasonal change in density in the case of the fin whale within four months from December to March.

The DIs of the humpback whale in Area IV are higher in later part of research season than earlier part, although the values are not so different each other. On the other hand, there is a tendency to decrease of DI with the season goes in Area V.

SELECTION AND COMBINATION OF DATA USED FOR ANALYSIS

Selection of research vessel type

The JARPA has been using a research vessel which engages in whale sightings dedicately (SV) since 1991/92 season. If the sighting efficiency and the research grounds are the same between the dedicated vessel and sighting/sampling vessels (SSV), data of both types of vessels can be combined to use for the analysis. However, if not so, it will be better to separate them for the analysis.

Table 1 shows the comparisons of the density index (DI) of three baleen whale species between SV and SSV in the years when both types of vessels were conducted to whale sightings. There is no constant tendency of difference of DIs between both types of vessels in both areas. The same tendency was observed between DIS and DIW by species and by Areas. In the case of blue and fin whales the DIs of SV are half of those of SSV in Area IV, but the tendency is different in Area V, although those in Area V are two to ten timed more than those in Area IV which will be represented the difference of density between both Areas. In the case of humpback whales similar tendency was also observed, although they were little larger in Area IV than in Area V.

The SV engaged in whale sightings only in southern Sub-areas of Area IV in 1991/92, although after the season both types of research vessels have engaged in the same Sub-areas in the same month. Furthermore, only the data for four years (two times in each Area) have been collected by the SV.

From above examinations we chose the data of SSVs which engaged in past eight years (four times in each Area) mainly for the present study, and the case of combination of both SV and SSV was also employed in part. The data of SVs will be used separately in future with those of SSV for the examination of yearly trend of whale populations, when the enough data will be accumulated.

Selection and combination of research months

There is a possibility that there is seasonal change in DI caused by migration patterns. If there are seasonal differences of amount of whale sighting efforts by year, we must choose the months in which the efforts have been expended most constantly in different years.

Table 2 shows the ratios of sightings efforts in each month in each year. In January and February the ratios are close in each year, but in December and March the ratios fluctuate largely by year (0.0-42.4 %).

Therefore, the combined data in January and February are used as a case of time series for the present study. This procedure is also convenient for the comparison of results of the IDCR in future which whale sighting cruises carried out in January and February .

The present study employs also the combined data of all months from December to March to increase the amount of data, because seasonal change was not clear in density distribution.

Selection of school sizes or school number

The sighting efficiency depends on the school size, and a school of large school size is more easily found than smaller school size. If yearly change in school size sighted is observed, we must consider this factor for the examination. However, as shown in Table 3, there is no trend in school sizes on every whale species in both Areas, although there are large differences in school sizes by year and area.

Then, we use both the numbers of schools and the numbers of whales sighted per unit of sighting distance (schools or whales per 100 n. miles) as the DIS and DIW independently in the present analysis.

YEARLY CHANGE IN POPULATION DENSITIES

From the data which are shown in Appendix 1-3, several time series of density indices were made as shown in Tables 4-6, and increase rates and their CV were calculated. They are also shown in each Table on each time series.

Blue whale

Table 4 shows the results of calculation of increase rates (IR) and their coefficients of variation (CV) on the blue whales in Areas IV, V and IV+V for 24 kinds of combinations of months, vessel types and numbers of schools or whales.

There is no statistically significant trend of population change in Area IV, but the average of eight cases was -0.015. In Area V, if the data in all months were used, statistically significant trend of population density increase were observed in four cases. The increasing rates are 0.176-0.355 with the average of 0.277. The average of total eight cases was 0.038 in Area V.

Fin whale

Table 5 shows the results of calculation of increase rates on the fin whales . Statistically significant trends of population increase were observed in Area IV on the time series of all months based on number of schools. The increasing rates of the SSV and the SV+SSV are 0.180 and 0.172. The average of eight cases was 0.224.

In the case of Area V statistically significant trends were observed on the time series using data of January and February in the case of SSV, and they were 0.422 and 0.486. The average of eight cases was 0.247.

Humpback whale

Table 6 shows the results of calculation of increase rates by combinations of various factors on the humpback whales. The statistically significant increasing trends of population were observed in Area V on all the time series, and they are 0.497-0.633 with the average of 0.566.

On the other side, on only one time series, statistically significant increasing trend was observed in Area IV. This series was the combination of northern Sub-areas on all months based on

number of schools. The increasing rate was 0.503 in this case. However, the average rate of increase in Areas IV were 0.089.

DISCUSSION

In the cases in which statistically significant increasing trend of populations were observed, the rates were higher than we expected from the biological common sense, especially in the case of the humpback whale in Area V (0.586). It will be needed to examine the reason of this phenomenon in future.

Although on some whale species in some Areas statistically significant trends of population increase were observed, they were not so clear in many other cases, and there are large fluctuations in apparent values of DI year by year. There might be some factors as the reasons which brought these phenomena. One is the yearly fluctuation in the migration of whales in temporal and spatial aspects, and the second is that the amount of whale sighting effort is not enough to catch real yearly trend. As the third reason density index will be better to include the size of area as examined by Ohsumi (1983) on the North Pacific Bryde's whales, especially in combination of data of areas or subareas where density and size of areas are different. Anyway, the numbers of survey times are still too short to detect yearly trend.

Related to this matter, two times of feasibility studies were conducted in 1987/88 and 1988/89 seasons in the earliest period. These surveys were carried out in billiards manner which was different from zigzag manner in later surveys, in a part of the Areas IV and V, respectively, and the amounts of data are fewer than those of full-scale surveys. Then, they may be different in quality from those the data of the full-scale surveys after 1989/90. Although these data were used in this study, they should be taken off in future study, when many data will be accumulated. Among three whale species, the statistically significant increasing trends were observed in Area V in most cases, but these trends were not so clear in Area IV. This phenomenon may indicate that the stocks are different in Area IV from Area V, and it is reflected by the difference of increasing rates of the stocks in both Areas.

In the case of the humpback whale, statistically significant trend of population was not detected in Area IV with exception of a case in Northern Sub-areas in all months by sighting/sampling vessels (Table 6). The average increasing rate was 0.089 in eight kinds of time series, although most of them are not statistically significant. On the other hand, Bannister (1994) reported that continuing significant increase in number of humpback whales with the rate of 10.9 % was observed by aerial survey off western Australia. By means of whale marking it is known that the humpbacks which are distributed in Area IV in summer are closely related to those migrate to the western Australia in winter (Dawbin, 1966). At least the apparent figures of the present study are not so far from that by Bannister (1994). However, we must consider that the western Australian stock intermingles with the western Australian stock in Area V in summer as shown by Dawbin (1966). Another consideration may be the difficulty of whale sightings in wide feeding ground in the Antarctic more than those in narrow area of the breeding ground for estimation of yearly trend of a population.

Further continuation of survey and more detailed analysis by use of accumulated data will be needed to detect the population trends which are distributed in the Antarctic, additionally further analysis method should be examined. And, the continuation of the JARPA survey will contribute largely for monitoring of various whale species in the Antarctic in future.

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Table 1: Comparison of density indices of baleen whales between dedicated sighting vessels (SV) and sighting/sampling vessels (SSV) in all months.

Species	Area IV*		Area V**		Areas IV+V	
	SV	SSV	SV	SSV	SV	SSV
a. DIS						
Blue whale	0.02	0.03	0.09	0.06	0.05	0.04
Fin whale	0.03	0.06	0.37	0.21	0.20	0.12
Humpback w.	0.60	1.03	0.56	0.53	0.58	0.82
b. DIW						
Blue whale	0.03	0.04	0.15	0.07	0.09	0.05
Fin whale	0.13	0.29	1.25	0.62	0.68	0.42
Humpback w.	1.12	1.77	1.02	0.92	1.07	1.42

DIS : no. schools / 100 n.miles
DIW: no. whales / 100 n.miles
*: 1991/92 and 1993/94
**: 1992/93 and 1994/95

Table 2: Comparison of monthly ratios of sightings efforts of SSV.

	Ratios of efforts (%)			
Year	Dec.	Jan.	Feb.	Mar.
1987/88	0.0	29.2	28.4	42.4
1988/89	0.0	42.3	30.5	24.6
1989/90	24.8	37.9	27.6	9.7
1990/91	10.4	42.8	28.1	18.6
1991/92	11.9	33.7	29.5	24.9
1992/93	23.5	31.5	22.6	22.5
1993/94	30.0	32.6	29.8	7.5
1994/95	37.8	43.2	6.0	12.9

Table 3: Average school size of baleen whales which were sighted by SSVs in all months.

	Area IV			Area V		
Year	Blue	Fin	Hump.	Blue	Fin	Hump.
1987/88	-	1.00	2.15			
1988/89				2.00	2.28	2.00
1989/90	1.80	4.00	1.73			
1990/91				1.50	2.03	1.53
1991/92	1.00	6.00	1.80			
1992/93				1.00	1.89	1.57
1993/94	1.67	2.00	1.61			
1994/95				1.33	3.28	1.74

Table 4: Comparisons of results in estimation of increasing rates (IR) on blue whales and their CV by combinations of sub-areas and month.

Area	Month	Vessel	Number	IR	CV
IV	Jan.+Feb.	SSV	S	0.056	2.066
"	"	"	W	0.033	7.905
"	All	"	S	0.000	-
"	"	"	W	-0.046	6.381
"	"	SV+SSV	S	0.000	-
"	"	"	W	-0.046	6.381
"(SO)	"	SSV	S	-1.101	0.577
" "	"	"	W	-0.056	4.164
V	J.+F.	SSV	S	1.101	2.032
"	"	"	W	-0.173	0.949
"	All	"	S	0.317	0.195
"	"	"	W	0.176	0.160
"	"	SV+SSV	S	0.355	0.132
"	"	"	W	0.259	0.125
"(SO)	"	SSV	S	0.208	1.538
" "	"	"	W	0.225	1.802
IV+V	J.+F.	SSV	S	-0.041	2.286
"	"	"	W	-0.105	1.233
"	All	"	S	0.237	0.478
"	"	"	W	0.089	1.284
"	"	SV+SSV	S	0.254	0.503
"	"	"	W	0.421	0.463
"(SO)	"	SSV	S	-0.171	0.419
"	"	"	W	0.131	1.433

Remarks:
SO:Southern Sub-areas, J.:January, F.:February, All:All months,
SV:Sighting vessel, SSV:sighting/sampling vessels, S:Schools,
W:Whales.

Table 5: Comparisons of results in estimation of increasing rates (IR) on fin whales and their CV by combinations of Sub-areas and months.

Area	Month	Vessel	Number	IR	CV
IV	Jan.+Feb.	SSV	S	0.114	1.429
"	"	"	W	0.257	1.113
"	All	"	S	0.180	0.457
"	"	"	W	0.316	0.838
"	"	SV+SSV	S	0.172	0.361
"	"	"	W	0.339	0.644
" (NO)	"	SSV	S	0.118	0.615
" "	"	"	W	0.284	0.720
V	J.+F.	SSV	S	0.422	0.129
"	"	"	W	0.486	0.108
"	All	"	S	0.143	0.773
"	"	"	W	0.193	0.709
"	"	SV+SSV	S	0.203	0.755
"	"	"	W	0.253	0.797
" (NO)	"	SSV	S	0.099	0.615
" "	"	"	W	0.178	0.720
IV+V	J.+F.	SSV	S	0.306	0.375
"	"	"	W	0.395	0.333
"	All	"	S	0.223	0.563
"	"	"	W	0.304	0.497
"	"	SV+SSV	S	0.255	0.531
"	"	"	W	0.346	0.436
" (NO)	"	SSV	S	0.163	0.655
" "	"	"	W	0.270	0.521

Remarks:
NO:Northern Sub-areas, J.:January, F.:February, All:All months,
SV:Sighting vessel, SSV:sighting/sampling vessels, S:Schools,
W:Whales.

Table 6: Comparisons of results in estimation of increasing rates (IR) on humpback whales and their CV by combinations of Sub-areas and months.

Area	Month	Vessel	Number	IR	CV
IV	Jan.+Feb.	SSV	S	0.055	1.301
"	"	"	W	0.017	4.996
"	All	"	S	0.043	0.739
"	"	"	W	0.000	121.432
"	"	SV+SSV	S	0.006	7.144
"	"	"	W	-0.034	1.397
" (NO)	"	SSV	S	0.503	0.295
" "	"	"	W	0.120	1.272
V	J.+F.	SSV	S	0.497	0.426
"	"	"	W	0.549	0.364
"	All	"	S	0.626	0.469
"	"	"	W	0.551	0.427
"	"	SV+SSV	S	0.633	0.467
"	"	"	W	0.564	0.413
" (NO)	"	SSV	S	0.570	0.061
" "	"	"	W	0.555	0.023
IV+V	J.+F.	SSV	S	0.188	1.080
"	"	"	W	0.395	1.135
"	All	"	S	0.249	0.972
"	"	"	W	0.184	1.199
"	"	SV+SSV	S	0.226	1.072
"	"	"	W	0.179	1.226
" (NO)	"	SSV	S	0.392	0.691
" "	"	"	W	0.233	0.937

Remarks:
NO:Northern Sub-areas, J.:January, F.:February, All:All months,
SV:Sighting vessel, SSV:sighting/sampling vessels, S:Schools,
W:Whales.

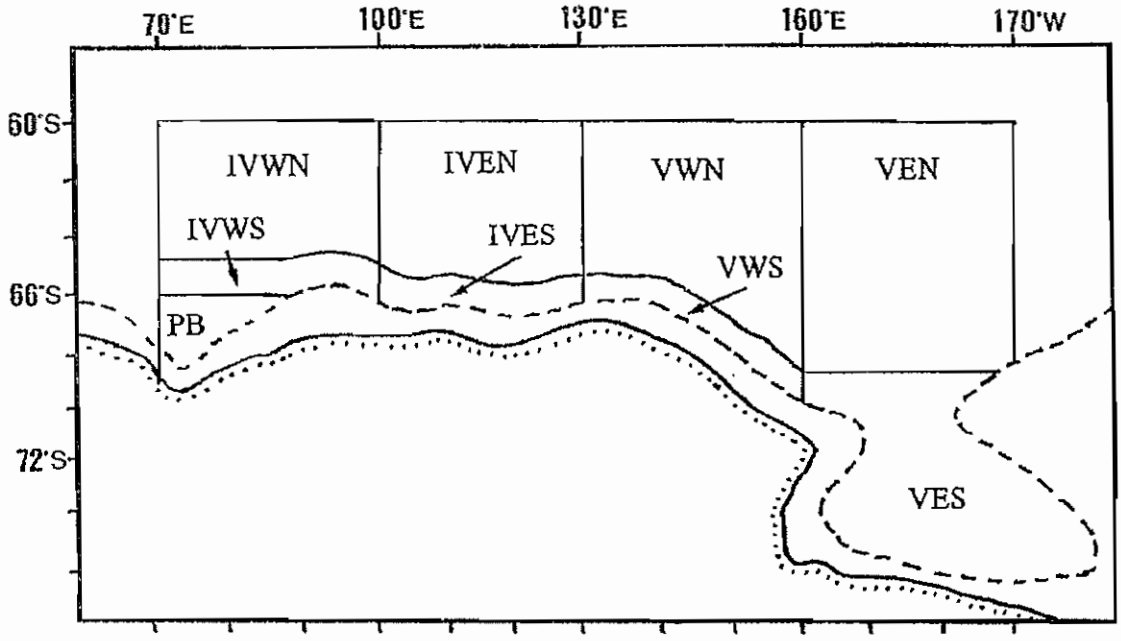


Fig. 1. Separation of sub-areas in research area of JARPA. Solid line with dot : Continental line, broken line : Pack ice line.

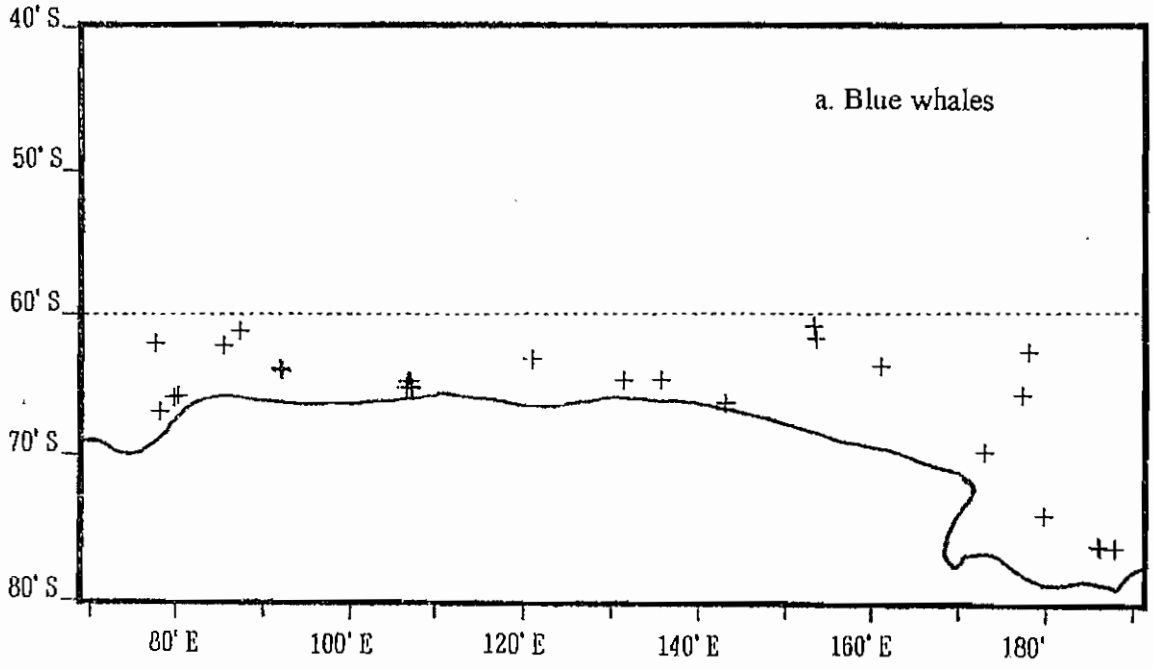


Fig. 2. Geographical positions of primary sighting of large baleen whale schools during JARPA for the period 1987/88-1993/94.

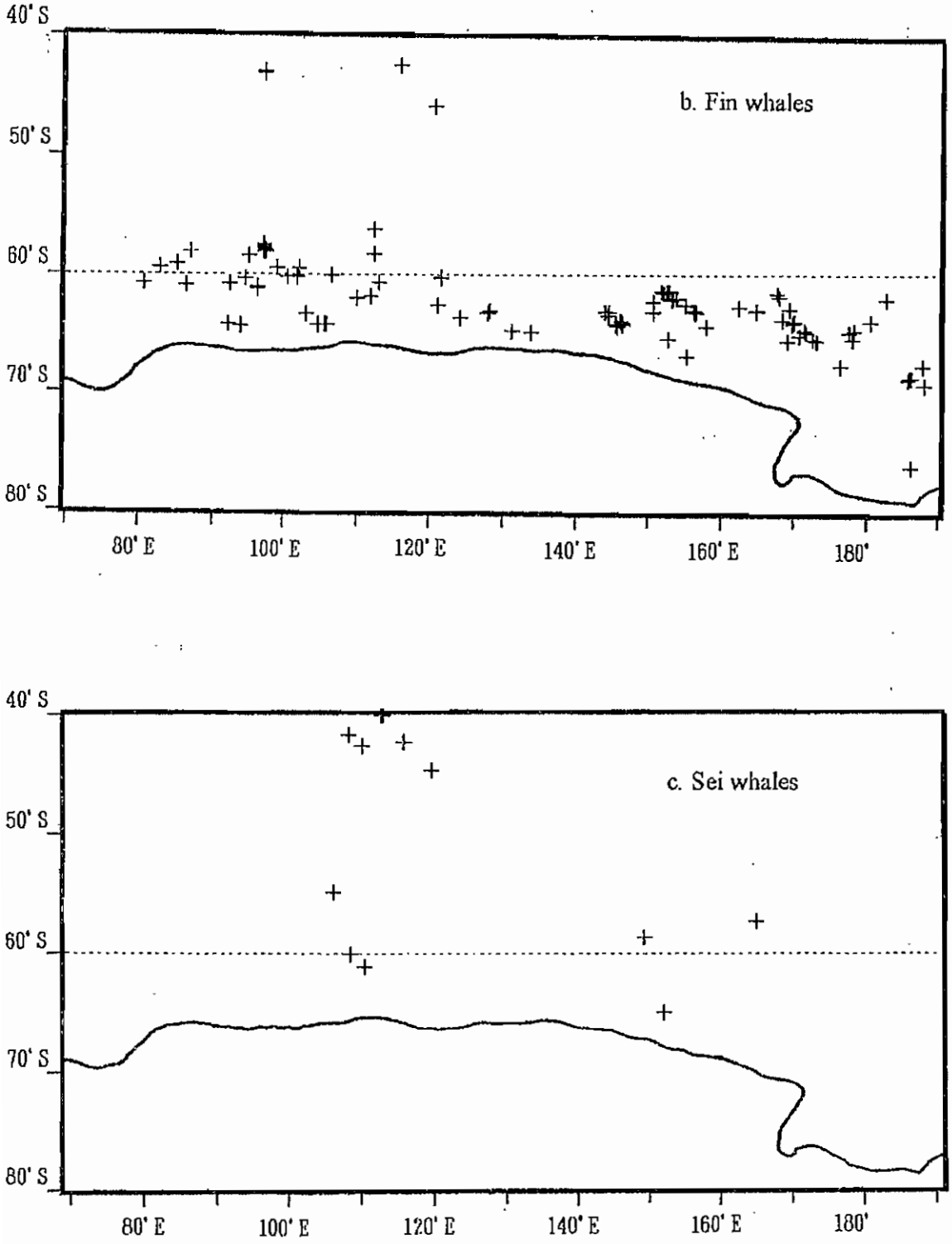
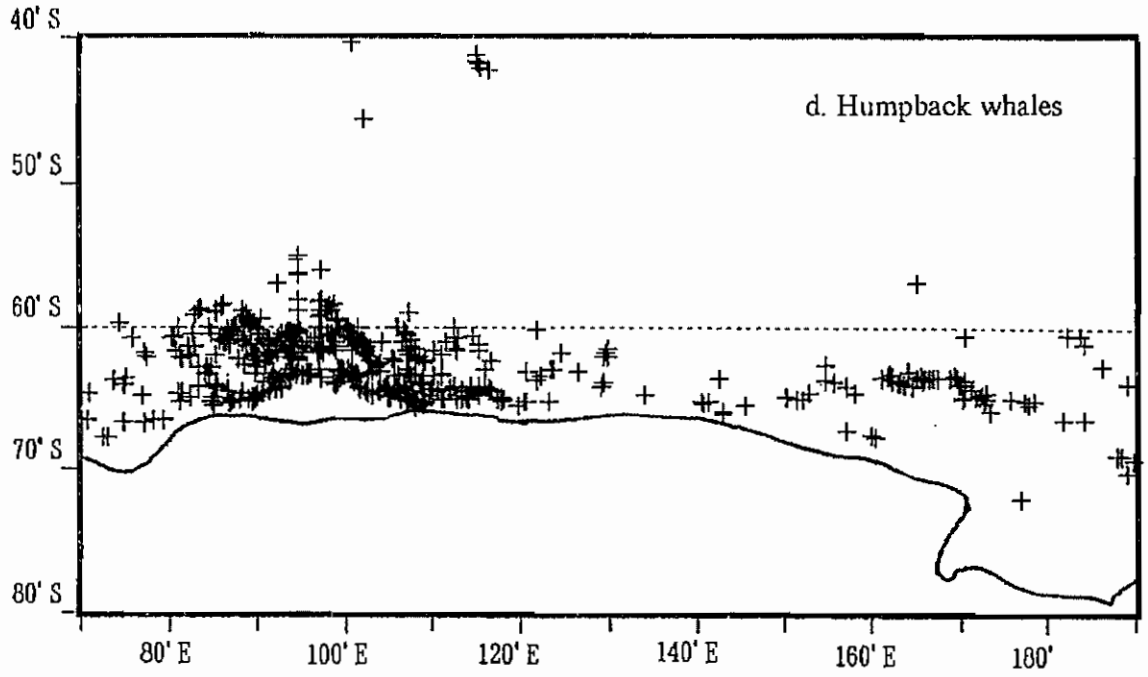


Fig. 2. (continued)



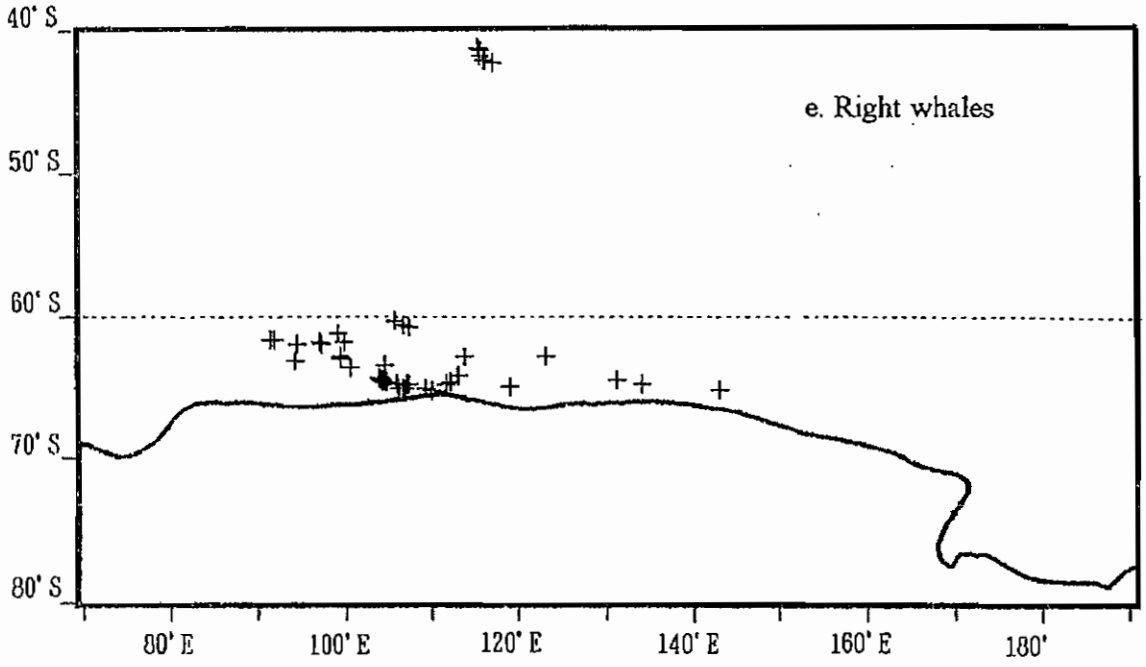


Fig. 2. (continued)

Appendix 1: Whale sighting distance in n.miles by JARPA.

a.Area-IV

Year	Vessel	Month	WN	WS	EN	ES	PB	TOTAL
1987/88 (105E-115E)	SSVs	Jan.			797.4	415.7		1213.1
		Feb.			859.0	321.0		1180.0
		Mar.			1251.3	511.5		1762.8
		Total			2907.7	1248.2		4155.9
1989/90	SSVs	Dec.	885.0	2921.0				3806.0
		Jan.		2518.7	1960.6	1345.5		5824.8
		Feb.	1967.4			1420.2	843.6	4231.2
		Mar.			1495.1			1495.1
		Total	2852.4	5439.7	3455.7	2765.7	843.6	15357.1
1991/92	SV	Dec.		887.0				887.0
		Jan.		559.1		926.6		1485.7
		Feb.		450.4		236.9	212.2	899.5
		Mar.				600.3		600.3
		Total		1896.5		1763.8	212.2	3872.5
	SSVs	Dec.	1023.3	464.4				1487.7
		Jan.		682.4	2160.2	1364.4		4207.0
		Feb.	2472.3	452.8		401.0	364.1	3690.2
		Mar.			2262.0	842.0		3104.0
		Total	3495.6	1599.6	4422.2	2607.4	364.1	12488.9
1993/94	SV	Dec.			635.5	1201.1		1836.6
		Jan.		1023.4	1250.2	203.3		2476.9
		Feb.	1412.8				477.6	1890.4
		Mar.	251.0		707.0	623.9		1581.9
		Total	1663.8	1023.4	2592.7	2028.3	477.6	7785.8
	SSVs	Dec.			979.9	2067.8		3047.7
		Jan.		986.8	1912.1	407.9		3306.8
		Feb.	2065.3	366.0			597.1	3028.4
		Mar.	427.0			336.4		763.4
		Total	2492.3	1352.8	2892.0	2812.1	597.1	10146.3
TOTAL	SV	Dec.		887.0	635.5	1201.1		2723.6
		Jan.		1582.5	1250.2	1129.9		3962.6
		Feb.	1412.8	450.4		236.9	689.8	2789.9
		Mar.	251.0		707.0	1224.2		2182.2
		Total	1663.8	2919.9	2592.7	3792.1	689.8	11658.3
TOTAL	SSVs	Dec.	1908.3	3385.4	979.9	2067.8		8341.4
		Jan.		4187.9	6830.3	3533.5		14551.7
		Feb.	6505.0	818.8	859.0	2142.2	1804.8	12129.8
		Mar.	427.0		5008.4	1689.9		7125.3
		Total	8840.3	8392.1	13677.6	9433.4	1804.8	42148.2

TOTAL	SV+ SSVs	Dec.	1908.3	4272.4	1615.4	3268.9		11065.0
		Jan.		5770.4	8080.5	4663.4		18514.3
		Feb.	7917.8	1269.2	859.0	2379.1	2494.6	14919.7
		Mar.	678.0		5715.4	2914.1		9307.5
		Total	10504.1	11312.0	16270.3	13225.5	2494.6	53806.5

b. Area-V

Year	Vessel	Month	WN	WS	EN	ES	TOTAL
1988/89 (160E-180)	SSVs	Jan.			3493.0		3493.0
		Feb.				2376.2	2376.2
		Mar.			1917.0		1917.0
		Total			5410.0	2376.2	7786.2
1990/91	SSVs	Dec.				1516.4	1516.4
		Jan.	2720.7	1631.6	1868.5		6220.8
		Feb.			2467.0	1613.6	4080.6
		Mar.	1657.9	1050.2			2708.1
		Total	4378.6	2681.8	4335.5	3130.0	14525.9
1992/93	SV	Dec.	682.3	638.9			1321.2
		Jan.	482.6	562.1	717.3		1762.0
		Feb.	440.6	443.2		663.1	1546.9
		Mar.	255.4	713.8		361.7	1330.9
		Total	1860.9	2358.0	717.3	1024.8	5961.0
	SSVs	Dec.	976.9	789.8			1766.7
		Jan.	784.4	640.3	944.4		2369.1
		Feb.	592.6	262.6		845.4	1700.6
		Mar.	460.5	952.8		281.6	1694.9
		Total	2814.4	2645.5	944.4	1127.0	7531.3
1994/95	SV	Dec.		800.2	863.3		1663.5
		Jan.	1166.8	86.3	869.3		2122.4
		Feb.			322.8	305.8	628.6
		Mar.			725.6	379.8	1105.4
		Total	1166.8	886.5	2781.0	685.6	5519.9
	SSVs	Dec.		1303.7	1920.0		3223.7
		Jan.	2060.1	280.2	1343.9		3684.2
		Feb.			223.1	286.9	510.0
		Mar.			783.4	317.4	1100.8
		Total	2060.1	1583.9	4270.4	604.3	8518.7
TOTAL	SV	Dec.	682.3	1439.1	863.3		2984.7
		Jan.	1649.4	648.4	1586.6		3884.4
		Feb.	440.6	443.2	322.8	968.9	2175.5
		Mar.	255.4	713.8	725.6	741.5	2436.3
		Total	3027.7	3244.5	3498.3	1710.4	11480.9
TOTAL	SSVs	Dec.	976.9	2093.5	1920.0	1516.4	6506.8
		Jan.	5565.2	2552.1	7649.8		15767.1
		Feb.	592.6	262.6	2690.1	5122.1	8667.4
		Mar.	2118.4	2003.0	2700.4	599.0	7420.8
		Total	9253.1	6911.2	14960.3	7237.5	38362.1

TOTAL	SV+ SSVs	Dec.	1659.2	3532.6	2783.3	1516.4	9491.5
		Jan.	7214.6	3200.5	9236.4		19651.5
		Feb.	1033.2	705.8	3012.9	6091.0	10842.9
		Mar.	2373.8	2716.8	3426.0	1340.5	9857.1
		Total	12280.8	10155.7	18458.6	8947.9	49843.0

Appendix 2: Whale schools and individuals which were primary sighted in area IV.

a. Blue whales

Year	Vessel	Month	School						Individual					
			WN	WS	EN	ES	PB	TOTAL	WN	WS	EN	ES	PB	TOTAL
1987/88 (105E-115E)	SSVs	Jan.			0	0		0			0	0		0
		Feb.			0	0		0			0	0		0
		Mar.			0	0		0			0	0		0
		Total	0	0	0	0	0	0	0	0	0	0	0	0
1989/90	SSVs	Dec.	0	1				1	0	2				2
		Jan.		0	0	4		4		0	0	7		7
		Feb.	0			0	0	0	0			0	0	0
		Mar.			0			0			0			0
		Total	0	1	0	4	0	5	0	2	0	7	0	9
1991/92	SV	Dec.		0				0		0				0
		Jan.		0		0		0		0		0		0
		Feb.		0		0	0	0		0		0	0	0
		Mar.				0		0				0		0
		Total	0	0	0	0	0	0	0	0	0	0	0	0
	SSVs	Dec.	1	0				1	1	0				1
		Jan.		0	0	0		0		0	0	0		0
		Feb.	0	2		0	0	2	0	2		0	0	2
		Mar.			0	0		0			0	0		0
		Total	1	2	0	0	0	3	1	2	0	0	0	3
1993/94	SV	Dec.			0	1		1			0	3		3
		Jan.		0	0	0		0		0	0	0		0
		Feb.	0				1	1	0				1	1
		Mar.	0		0	0		0	0		0	0		0
		Total	0	0	0	1	1	2	0	0	0	3	1	4
	SSVs	Dec.			0	0		0			0	0		0
		Jan.		2	0	0		2		4	0	0		4
		Feb.	1	0			0	1	1	0			0	1
		Mar.	0			0		0	0			0		0
		Total	1	2	0	0	0	3	1	4	0	0	0	5
TOTAL	SV	Dec.		0	0	1		1		0	0	3		3
		Jan.		0	0	0		0		0	0	0		0
		Feb.	0	0		0	1	1	0	0		0	1	1
		Mar.	0		0	0		0	0		0	0		0
		Total	0	0	0	1	1	2	0	0	0	3	1	4
TOTAL	SSVs	Dec.	1	1	0	0		2	1	2	0	0		3
		Jan.		2	0	4		6		4	0	7		11
		Feb.	1	2	0	0	0	3	1	2	0	0	0	3
		Mar.	0		0	0		0	0		0	0		0
		Total	2	5	0	4	0	11	2	8	0	7	0	17
TOTAL	SV+ SSVs	Dec.	1	1	0	1		3	1	2	0	3		6
		Jan.		2	0	4		6		4	0	7		11
		Feb.	1	2	0	0	1	4	1	2	0	0	1	4
		Mar.	0		0	0		0	0		0	0		0
		Total	2	5	0	5	1	13	2	8	0	10	1	21

b. Fin whales

Year	Vessel	Month	School						Individual					
			WN	WS	EN	ES	PB	TOTAL	WN	WS	EN	ES	PB	TOTAL
1987/88 (105E-115E)	SSVs	Jan.			0	0		0			0	0		0
		Feb.			1	0		1			1	0		1
		Mar.			0	0		0			0	0		0
		Total	0	0	1	0	0	1	0	0	1	0	0	1
1989/90	SSVs	Dec.	2	0				2	2	0				2
		Jan.		1	1	0		2		5	1	0		6
		Feb.	0			0	0	0	0			0	0	0
		Mar.			1			1			12			12
		Total	2	1	2	0	0	5	2	5	13	0	0	20
1991/92	SV	Dec.		0				0		0				0
		Jan.		0		0		0		0		0		0
		Feb.		0		0	0	0		0		0	0	0
		Mar.				0		0				0		0
		Total	0	0	0	0	0	0	0	0	0	0	0	0
	SSVs	Dec.	0	0				0	0	0				0
		Jan.		0	1	3		4		0	1	9		10
		Feb.	4	0		0	0	4	42	0		0	0	42
		Mar.			1	0		1			2	0		2
		Total	4	0	2	3	0	9	42	0	3	9	0	54
1993/94	SV	Dec.			2	0		2			11	0		11
		Jan.		0	1	0		1		0	2	0		2
		Feb.	1				0	1	2				0	2
		Mar.	0		0	0		0	0		0	0		0
		Total	1	0	3	0	0	4	2	0	13	0	0	15
	SSVs	Dec.			1	1		2			3	2		5
		Jan.		1	2	0		3		1	5	0		6
		Feb.	0	0			0	0	0	0			0	0
		Mar.	0			0		0	0			0		0
		Total	0	1	3	1	0	5	0	1	8	2	0	11
TOTAL	SV	Dec.		0	2	0		2		0	11	0		11
		Jan.		0	1	0		1		0	2	0		2
		Feb.	1	0		0	0	1	2	0		0	0	2
		Mar.	0		0	0		0	0		0	0		0
		Total	1	0	3	0	0	4	2	0	13	0	0	15
TOTAL	SSVs	Dec.	2	0	1	1		4	2	0	3	2		7
		Jan.		2	4	3		9		6	7	9		22
		Feb.	4	0	1	0	0	5	42	0	1	0	0	43
		Mar.	0		2	0		2	0		14	0		14
		Total	6	2	8	4	0	20	44	6	25	11	0	86

TOTAL	SV+ SSVs	Dec.	2	0	3	1		6	2	0	14	2		18
		Jan.		2	5	3		10		6	9	9		24
		Feb.	5	0	1	0	0	6	44	0	1	0	0	45
		Mar.	0		2	0		2	0		14	0		14
		Total	7	2	11	4	0	24	46	6	38	11	0	101

c. Humpback whales

Year	Vessel	Month	School						Individual					
			WN	WS	EN	ES	PB	TOTAL	WN	WS	EN	ES	PB	TOTAL
1987/88 (105E-115E)	SSVs	Jan.			6	0		6			11	0		11
		Feb.			4	11		15			6	28		34
		Mar.			0	12		12			0	26		26
		Total	0	0	10	23	0	33	0	0	17	54	0	71
1989/90	SSVs	Dec.	25	23				48	44	35				79
		Jan.		11	20	1		32		18	35	1		54
		Feb.	22			2	2	26	43			3	3	49
		Mar.			15			15			27			27
		Total	47	34	35	3	2	121	87	53	62	4	3	209
1991/92	SV	Dec.		2				2		4				4
		Jan.		6		7		13		11		14		25
		Feb.		0		5	1	6		0		11	2	13
		Mar.				10		10				20		20
		Total	0	8	0	22	1	31	0	15	0	45	2	62
	SSVs	Dec.	15	2				17	26	3				29
		Jan.		13	15	10		38		21	26	19		66
		Feb.	42	1		10	0	53	81	1		17	0	99
		Mar.			19	11		30			34	20		54
		Total	57	16	34	31	0	138	107	25	60	56	0	248
1993/94	SV	Dec.			3	2		5			4	3		7
		Jan.		7	11	0		18		12	21	0		33
		Feb.	11				1	12	19				2	21
		Mar.	0		2	2		4	0		3	4		7
		Total	11	7	16	4	1	39	19	12	28	7	2	68
	SSVs	Dec.			3	11		14			4	19		23
		Jan.		19	21	0		40		25	41	0		66
		Feb.	21	0			3	24	34	0			5	39
		Mar.	14			3		17	20			5		25
		Total	35	19	24	14	3	95	54	25	45	24	5	153
TOTAL	SV	Dec.		2	3	2		7		4	4	3		11
		Jan.		13	11	7		31		23	21	14		58
		Feb.	11	0		5	2	18	19	0		11	4	34
		Mar.	0		2	12		14	0		3	24		27
		Total	11	15	16	26	2	70	19	27	28	52	4	130
TOTAL	SSVs	Dec.	40	25	3	11		79	70	38	4	19		131
		Jan.		43	62	11		116		64	113	20		197
		Feb.	85	1	4	23	5	118	158	1	6	48	8	221
		Mar.	14		34	26		74	20		61	51		132
		Total	139	69	103	71	5	387	248	103	184	138	8	681

TOTAL	SV+ SSVs	Dec.	40	27	6	13		86	70	42	8	22		142
		Jan.		56	73	18		147		87	134	34		255
		Feb.	96	1	4	28	7	136	177	1	6	59	12	255
		Mar.	14		36	38		88	20		64	75		159
		Total	150	84	119	97	7	457	267	130	212	190	12	811

Appendix 3: Whale schools and individuals which were primary sighted in area V.

a. Blue whales

Year	Vessel	Month	School					Individual				
			WN	WS	EN	ES	TOTAL	WN	WS	EN	ES	TOTAL
1988/89 (160E-180)	SSVs	Jan.			0		0			0		0
		Feb.				0	0				0	0
		Mar.			1		1			2		2
		Total			1	0	1			2	0	2
1990/91	SSVs	Dec.				0	0					0
		Jan.	0	0	0		0	0	0	0		0
		Feb.			0	3	3				4	4
		Mar.	1	0			1	2	0	0		2
		Total	1	0	0	3	4	2	0	0	4	6
1992/93	SV	Dec.	0	1			1	0	2			2
		Jan.	0	0	1		1	0	0	1		1
		Feb.	0	0		1	1	0	0		2	2
		Mar.	0	0		0	0	0	0		0	0
		Total	0	1	1	1	3	0	2	1	2	5
	SSVs	Dec.	1	0			1	1	0			1
		Jan.	0	1	0		1	0	1	0		1
		Feb.	1	0		0	1	1	0		0	1
		Mar.	0	1		0	1	0	1		0	1
		Total	2	2	0	0	4	2	2	0	0	4
1994/95	SV	Dec.		5	0		5		9	0		9
		Jan.	0	0	0		0	0	0	0		0
		Feb.			0	1	1			0	2	2
		Mar.			0	1	1			0	1	1
		Total	0	5	0	2	7	0	9	0	3	12
	SSVs	Dec.		3	1		4		5	1		6
		Jan.	0	1	0		1	0	1	0		1
		Feb.			0	0	0			0	0	0
		Mar.			0	1	1			0	1	1
		Total	0	4	1	1	6	0	6	1	1	8
TOTAL	SV	Dec.	0	6	0		6	0	11	0		11
		Jan.	0	0	1		1	0	0	1		1
		Feb.	0	0	0	2	2	0	0	0	4	4
		Mar.	0	0	0	1	1	0	0	0	1	1
		Total	0	6	1	3	10	0	11	1	5	17
TOTAL	SSVs	Dec.	1	3	1	0	5	1	5	1	0	7
		Jan.	0	2	0		2	0	2	0		2
		Feb.	1	0	0	3	4	1	0	0	4	5
		Mar.	1	1	1	1	4	2	1	2	1	6
		Total	3	6	2	4	15	4	8	3	5	20
TOTAL	SV+ SSVs	Dec.	1	9	1	0	11	1	16	1	0	18
		Jan.	0	2	1		3	0	2	1		3
		Feb.	1	0	0	5	6	1	0	0	8	9
		Mar.	1	1	1	2	5	2	1	2	2	7
		Total	3	12	3	7	25	4	19	4	10	37

b. Fin whales

Year	Vessel	Month	School					Individual				
			WN	WS	EN	ES	TOTAL	WN	WS	EN	ES	TOTAL
1988/89 (160E-180)	SSVs	Jan.			2		2			4		4
		Feb.				0	0				0	0
		Mar.			5		5			12		12
		Total			7	0	7			16	0	16
1990/91	SSVs	Dec.				2	2				7	7
		Jan.	2	1	0		3	5	2	0		7
		Feb.			7	1	8			8	1	9
		Mar.	16	4			20	35	9			44
		Total	18	5	7	3	33	40	11	8	8	67
1992/93	SV	Dec.	0	0			0	0	0			0
		Jan.	0	0	2		2	0	0	5		5
		Feb.	0	1		0	1	0	1		0	1
		Mar.	0	1		0	1	0	2		0	2
		Total	0	2	2	0	4	0	3	5	0	8
	SSVs	Dec.	0	1			1	0	3			3
		Jan.	1	1	4		6	2	2	7		11
		Feb.	1	0		1	2	1	0		2	3
		Mar.	0	0		0	0	0	0		0	0
		Total	2	2	4	1	9	3	5	7	2	17
1994/95	SV	Dec.		3	2		5		9	3		12
		Jan.	4	1	14		19	11	9	38		58
		Feb.			1	1	2			2	1	3
		Mar.			5	8	13			18	45	63
		Total	4	4	22	9	39	11	18	61	46	136
	SSVs	Dec.		5	3		8		21	4		25
		Jan.	4	2	3		9	12	14	5		31
		Feb.			8	0	8			26	0	26
		Mar.			0	0	0			0	0	0
		Total	4	7	14	0	25	12	35	35	0	82
TOTAL	SV	Dec.	0	3	2		5	0	9	3		12
		Jan.	4	1	16		21	11	9	43		63
		Feb.	0	1	1	1	3	0	1	2	1	4
		Mar.	0	1	5	8	14	0	2	18	45	65
		Total	4	6	24	9	43	11	21	66	46	144
TOTAL	SSVs	Dec.	0	6	3	2	11	0	24	4	7	35
		Jan.	7	4	9		20	19	18	16		53
		Feb.	1	0	15	2	18	1	0	34	3	38
		Mar.	16	4	5	0	25	35	9	12	0	56
		Total	24	14	32	4	74	55	51	66	10	182

TOTAL	SV+ SSVs	Dec.	0	9	5	2	16	0	33	7	7	47
		Jan.	11	5	25		41	30	27	59		116
		Feb.	1	1	16	3	21	1	1	36	4	42
		Mar.	16	5	10	8	39	35	11	30	45	121
		Total	28	20	56	13	117	66	72	132	56	326

c. Humpback whales

Year	Vessel	Month	School					Individual				
			WN	WS	EN	ES	TOTAL	WN	WS	EN	ES	TOTAL
1988/89 (160E-180)	SSVs	Jan.			1		1			2		2
		Feb.				0	0				0	0
		Mar.			0		0			0		0
		Total			1	0	1			2	0	2
1990/91	SSVs	Dec.				26	26				41	41
		Jan.	1	24	6		31	2	35	8		45
		Feb.			1	1	2			3	1	4
		Mar.	1	0			1	2	0			2
		Total	2	24	7	27	60	4	35	11	42	92
1992/93	SV	Dec.	0	1			1	0	3			3
		Jan.	1	0	4		5	1	0	8		9
		Feb.	0	3		0	3	0	9		0	9
		Mar.	0	0		1	1	0	0		2	2
		Total	1	4	4	1	10	1	12	8	2	23
	SSVs	Dec.	1	0			1	1	0			1
		Jan.	0	1	3		4	0	1	5		6
		Feb.	5	0		4	9	9	0		8	17
		Mar.	0	2		0	2	0	4		0	4
		Total	6	3	3	4	16	10	5	5	8	28
1994/95	SV	Dec.		14	10		24		25	14		39
		Jan.	8	1	16		25	15	2	30		47
		Feb.			2	0	2			3	0	3
		Mar.			1	2	3			2	3	5
		Total	8	15	29	2	54	15	27	49	3	94
	SSVs	Dec.		21	22		43		33	35		68
		Jan.	6	6	8		20	10	11	20		41
		Feb.			3	0	3			5	0	5
		Mar.			0	3	3			0	6	6
		Total	6	27	33	3	69	10	44	60	6	120
TOTAL	SV	Dec.	0	15	10		25	0	28	14		42
		Jan.	9	1	20		30	16	2	38		56
		Feb.	0	3	2	0	5	0	9	3	0	12
		Mar.	0	0	1	3	4	0	0	2	5	7
		Total	9	19	33	3	64	16	39	57	5	117
TOTAL	SSVs	Dec.	1	21	22	26	70	1	33	35	41	110
		Jan.	7	31	18		56	12	47	35		94
		Feb.	5	0	4	5	14	9	0	8	9	26
		Mar.	1	2	0	3	6	2	4	0	6	12
		Total	14	54	44	34	146	24	84	78	56	242
TOTAL	SV+ SSVs	Dec.	1	36	32	26	95	1	61	49	41	152
		Jan.	16	32	38		86	28	49	73		150
		Feb.	5	3	6	5	19	9	9	11	9	38
		Mar.	1	2	1	6	10	2	4	2	11	19
		Total	23	73	77	37	210	40	123	135	61	359