Abundance trend of Southern Hemisphere minke whales in Areas IV and V obtained from JARPA data

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Abstract

To estimate the abundance trend of the Southern Hemisphere minke whales, we used JARPA sighting data obtained in Areas IV and V (1989/90-2000/01 for Sighting and Sampling Vessels (SSV) and 1991/92-2000/01 for dedicated Sighting Vessel (SV)). At the 52nd IWC/SC meeting, there was agreement that the estimates from closing mode on IDCR/SOWER surveys and JARPA SV could be used in the same way (IWC, 2001). Therefore, we estimated abundance estimates obtained from sighting data of SV as an index of relative abundance. Because there were longer time series for SSV data than SV data, we also estimated a ratio of school density for SSV to that for SV to convert abundance from SSV to SV ('pseudo' SV). We calculated inverse-variance weighted average of the abundance obtained form SV and 'pseudo' SV as a relative abundance index. Estimated abundance trends are –0.04% per year in Area IV and 0.83% per year in Area V. Results of regression analyses showed that neither significant increase nor decrease was observed in Areas IV and V respectively.

Key Words ANTARCTIC MINKE WHALE, TRENDS, ABUNDANCE ESTIMATE, INDEX OF ABUNDABCE

Introduction

IWC/IDCR-SOWER program for minke whale assessment have been conducted since 1978/79 in the whole Antarctic baleen whale management Areas. Abundance estimates of Southern Hemisphere minke whales in the 3rd circumpolar series (still continued) is less than in the 1st and 2nd circumpolar series, and therefore it is questioned whether the abundance is decreasing or not. JARPA survey is conducted in Areas IV and V every two year. As the JARPA surveys have been conducted consistently in the same area, its sighting data must be suitable for estimation of abundance trend. At the JARPA review meeting in 1997, it was pointed out that bias of abundance estimate results from the higher-density-under-surveying feature of the JARPA survey design. Since then, some analyses to examine appropriate methods of adjusting the abundance estimates was conducted (Tanaka, 1999, Clarke *et al.*, 1999, 2000). Clarke *et al.*

(1999, 2000) investigated the performance of GAM-based estimator by simulation. At the 52nd IWC/SC meeting, in the light of their simulation results and the similarity of closing mode on IWC/IDCR-SOWER surveys and JARPA SV mode, there was agreement that estimates from these two modes could be used in the same way (IWC, 2001). Therefore, in order to estimate the abundance trend of minke whales, we estimated abundance estimates obtained from JARPA SV data as relative indices of abundance.

Unlike SV, SSVs have conducted sighting survey since JARPA commenced, so there are longer time series of sighting data of SSVs than SV. If we could adjust abundance estimates using SSVs appropriately to the SV, they would be more useful to estimate the trend than SV. In order to conduct preliminary study to correct abundance obtained from SSVs, a ratio of school density for SSV to that for SV was estimated as a correction factor R and was used to convert SSV to SV. We used the method described in Haw (1991). Furthermore, inverse-variance-weighted averages of converted SSV and SV abundance for all year were calculated to estimate abundance trend.

MATERIALS AND METHODS

Survey area

Area IV are divided into 5 strata; North-East (NE), North-West (NW), South-East (SE), South-West (SW) and Prydz Bay. Area V are divided into 4 strata; North-East (NE), North-West (NW), South-East (SE) and South-West (SW). SE in Area V includes Ross Sea. More details in stratification are given by Nishiwaki *et al.* (2001). Abundance was estimated for each stratum. Fig. 1 shows track line on effort and position of primary sighting of school of minke whale. This figure shows that the searching effort uniformly covered Areas IV and V every year.

Sighting Vessel (SV) and Sighting and Sampling Vessel (SSV)

From 1991/92 season, one sighting vessel was devoted to sighting only for the purpose of investigating the effect of sampling activity on abundance estimates. Until 1994/95 season, one vessel out of three had acted as a SV and the rest had acted as SSVs. Since 1995/96 season, one vessel have acted as a SV and three vessels have acted as SSVs. Because SV does not conduct sampling whereas SSVs do, searching distance per one vessel is likely to be longer than that of SSV. On the one hand, because SSVs takes one or two hours to take one sample including closing, the more school is detected, the much time is allocated to sampling activity. On the other hand, SV only closes when a school is detected and it takes at most half an hour until the survey is resumed. For this reason, searching effort per one vessel of SV is much longer than that of SSV in high-density area.

Predetermined distance per day

To conduct the survey in all strata in the schedule, predetermined distance per day is set. If vessels cannot achieve the predetermined distance in a day, they proceed the rest of the distance without surveying to the starting point of the next day survey. As explained in the previous paragraph, SSVs sometimes spend so much time on sampling activity that they need go along track line during night without surveying. Contrary, SV spends time on only closing therefore it rarely move forward during night. For example, in 1992/93 season, proceed distance during night is 351.0 n.miles out of 5509.0 n.miles for SV, 4276.9 n.miles out of 10948.6 n.miles for SSV. Such distance probably became shorter than 1992/93 season because predetermined daily distance was shorten since 1993/94. This means that the JARPA sighting survey engaged by SV is very similar to closing mode on the IWC IDCR/SOWER, which is one of the basis for regarding SV abundance as a relative abundance index.

The detail of the survey methodology is described in Nishiwaki *et al.* (2001).

Abundance estimation

Methodology of abundance estimation used in this study was described Burt and Stahl (2000) which is the standard methodology adopted by IWC. The program DISTANCE (Buckland et al., 1993) was used for abundance estimation. Following formula was used for abundance estimation.

$$P = \frac{AE(s)n}{2wL} \qquad (1)$$

Where

P = abundance estimate

A = area of stratum

$E(s)$ = estimated mean school size

N = numbers of schools primary sightings

W = effective search half-width for schools

L = search effort

The CV of P is calculated as follows

$$\mathrm{CV}(P) = \sqrt{\{\mathrm{CV}(\frac{n}{L})\}^2 + \{\mathrm{CV}(E(s))\}^2 + \{\mathrm{CV}(w)\}^2} \qquad (2)$$

Assuming abundance is log-normally distributed, 95% confidential interval of the abundance estimate was calculated as $(P/C, CP)$ where

$$C = \exp(Z_{0.025}\sqrt{\log_e[1 + \{\mathrm{CV}(P)\}^2]}) \qquad (3)$$

$Z_{0.025}$ represents 2.5-percentage point of standard normal distribution. To see more detail, please refer to, for example, Buckland et al. (1993) or Branch and Butterworth (2001).

Distance and angle estimation experiment

To correct biases of distance and angle estimation, distance and angle estimation experiment was conducted on each vessel. Bias was estimated for each platform (Table 1). Linear regression models with standard error proportional to true (radar) distance were conducted to detect significant bias of estimated distance at 5% level. In order to correct significant biases, estimated distance was divided by the estimated slope through the origin. Linear regression models with constant variance were conducted to detect significant bias of estimated angle at 5% level. In order to correct significant biases, estimated angle was divided by the estimated slope through the origin.

Smearing and truncation

The radial distance and angle data for each sighting are smeared using the method II of Buckland and Anganuzzi (1988). Smearing parameter was shown in Table 2. After smearing, the perpendicular distance distribution is truncated at 1.5 n.miles. The smeared and truncated number of detection was substitute to formula (1).

Effective search half-width

Hazard rate model with no adjustment terms was used as a detection function model. It was assumed that *g(0)* is 1 (i.e. Probability of detection of whale on the track line is 1.). Effective search half-width was estimated for each stratum.

Mean school size

Only the sightings for which school size is confirmed are used for estimation. We used the method of estimation of mean school size described Buckland *et al.* (1993). Regression of log of school size on $g(x)$ was conducted to estimate mean school size. If the regression coefficient was not significant at 15% level, mean of observed school size was substituted to formula (1). If estimated school size is less than 1, mean of observed school size was substituted to formula (1) even if the regression coefficient was significant.

Stratification

SV abundance was estimated for each stratum and SSV abundance was estimated for each track line. SSV abundance for each stratum was estimated by effort-weighted average of that for each track line.

Estimation correction factor *R*

A ratio of school density D_s for SSV to that for SV was estimated by using the method of Haw (1991). R was estimated for each stratum by calculating inverse-variance-weighted average of R-values for all years:

$$\overline{\ln R} = \sum_i \frac{\mathrm{Var}(\ln R_i)}{\sum_j \mathrm{Var}(R_j)} \ln R_i \qquad (4\text{-}1)$$

$$\mathrm{Var}(\overline{\ln R}) = \left\{\sum_i \mathrm{Var}(R_i)\right\}^{-1} \quad (4\text{-}2)$$

$$R = \exp(\overline{\ln R} + \mathrm{Var}(\overline{\ln R})/2) \quad (4\text{-}3)$$

$$\mathrm{se}(R) = \sqrt{R\{\exp(\mathrm{Var}(\overline{\ln R})) - 1\}} \quad (4\text{-}4)$$

where $$R_i = \frac{D_{s,i,\mathrm{SSV}}}{D_{s,i,\mathrm{SV}}} \quad (4\text{-}5)$$

$$\mathrm{CV}(R_i) = \sqrt{\{\mathrm{CV}(D_{s,i,\mathrm{SSV}})\}^2 + \{\mathrm{CV}(D_{s,i,\mathrm{SV}})\}^2} \quad (4\text{-}6)$$

$$\mathrm{Var}(\ln R_i) = \ln[\{CV(R_i)\}^2 - 1] \quad (4\text{-}7)$$

R for whole Area IV and whole Area V also estimated by 'super-strata' method described by Haw (1991). To conduct this method, D_s for 'super-strata' (weighted by Area of each stratum) is estimated by

$$W_i = \frac{A_i}{\sum_i A_i} \quad (5\text{-}1)$$

$$\overline{D} = \frac{1}{2w}\sum_i W_i\left(\frac{n}{L}\right)_i \quad (5\text{-}2)$$

$$\mathrm{CV}(\overline{D}) = \sqrt{\{\mathrm{CV}(\hat{w})\}^2 + \frac{\sum_i W_i^2\left(\frac{n}{L}\right)_i^2\left[\mathrm{CV}\left\{\left(\frac{n}{L}\right)_i\right\}\right]^2}{\left\{\sum_i W_i\left(\frac{n}{L}\right)_i\right\}^2}} \quad (5\text{-}3)$$

where w is pooled estimate of effective search half- width. R for 'super-strata' is estimated similarly.

Abundance estimate for 'Pseudo SV' and combined abundance

For the purpose of adjusting SSV abundance that might be affected by sampling activity, SSV abundance was divided by estimated R. CV of 'Pseudo SV' abundance was calculated by

$$\mathrm{CV}(P_{Pseudo}) = \sqrt{\{\mathrm{CV}(P_{SSV})\}^2 + \{\mathrm{CV}(R)\}^2} \quad (6\text{-}1)$$

Next, inverse-variance-weighted average of P_{Pseudo} and P_{SSV} and its CV was calculated by following formula,

$$P_{combined} = \frac{\mathrm{Var}(P_{Pseudo})P_{SV} + \mathrm{Var}(P_{SV})P_{Pseudo}}{\mathrm{Var}(P_{SV}) + \mathrm{Var}(P_{Pseudo})} \quad (6\text{-}2)$$

$$\mathrm{CV}(P_{combined}) = \frac{\sqrt{\{\mathrm{Var}(P_{Psedo})\}^2 \mathrm{Var}(P_{SV}) + \{\mathrm{Var}(P_{SV})\}^2 \mathrm{Var}(P_{Pseudo})}}{\{\mathrm{Var}(P_{SV}) + \mathrm{Var}(P_{Pseudo})\}P_{combined}} \quad (6\text{-}3)$$

Estimation of trend

At first, abundance trend was estimated using the time series of SV abundance estimate in Areas IV and V respectively. Linear regression log of abundance on year was conducted to estimate simultaneous increasing rate and its 95% confidential interval. The result suggests that trend estimates using SV abundance is not precious enough, therefore, similarly, abundance trend was estimated from time series of combined abundance. It should be taken into consideration that combined abundance estimates are not independent because they were calculated using common *R* estimated from abundance estimate for all year. To overcome this difficulty, Monte Carlo Simulation was conducted.

Monte Carlo simulation

We denote SSV abundance estimate in year *y* as $P_{1,y}$ and SV abundance in year *y* as $P_{2,y}$. Superscript *p* indicate that it was Pseudo data. Pseudo data set was produced according to equations (7-1) – (7-6).

$$(\sigma_{1,y})^2 = \ln(1 + \{\mathrm{CV}(P_{1,y})\}^2 \quad (7\text{-}1)$$

$$(\sigma_{2,y})^2 = \ln(1 + \{\mathrm{CV}(P_{2,y})\}^2 \quad (7\text{-}2)$$

$P_{1,y}^p = P_{1,y}\exp(\varepsilon_{1,y}^p)$ where $\varepsilon_{1,y}^p$ is a random number from N (0, $(\sigma_{1,y})^2$) (7-3)

$P_{2,y}^p = P_{1,y}\exp(\varepsilon_{2,y}^p)$ where $\varepsilon_{2,y}^p$ is a random number from N (0, $(\sigma_{2,y})^2$) (7-4)

and for the simplicity, it was assumed that CV of $P_{i,y}^p$ (i = 1,2) is constant. Standard errors of $P_{i,y}^p$ (i = 1,2) are calculated by

$$\mathrm{se}(P_{1,y}^p) = P_{1,y}^p \mathrm{CV}(P_{1,y}) \quad (7\text{-}5)$$

$$\mathrm{se}(P_{2,y}^p) = P_{2,y}^p \mathrm{CV}(P_{2,y}) \quad (7\text{-}6)$$

Combined abundance estimate calculated from the Pseudo data set and estimated trend similarly.

This procedure was repeated 99 times. 95% confidential interval of estimated slope was estimated by (a_5, a_{95}) where a_i is the *i* th slope estimated from produced data set arranging increasing order.

RESULTS

Table 3 and 4 show the SSV abundance estimates for each stratum in Areas IV and V respectively. Table 5 and 6 show the SV abundance estimates for each stratum in Areas IV and V respectively. Fig. 2 shows yearly change of the abundance for SSV and SV. The tendency to increase or decrease is not observed. Total of abundance estimates in Area IV and Area V were summarized in Table 11. Yearly change of these estimates is shown in Fig. 2. In Area IV, SV abundance is higher than SSV abundance in some of the seasons but SV abundance is almost same as SSV abundance in the other seasons. In Area V, SV abundance is higher than SSV abundance in first 3 seasons but SV abundance is almost same as SSV abundance in the last 2 seasons.

Values of *R* for each stratum in Area IV are shown Table 7. They used for estimation of average *R* in Area IV. Estimate of *R* in Area IV for 'super-stratum' and each stratum is listed in Table 8. Values of *R* for each stratum in Area V are shown Table 9. Estimate of *R* in Area V for 'super-stratum' and each stratum is listed in Table 10. Most of the estimated *R* is close to 1 except in SW in Area V. It suggests that effect of sampling activity on abundance estimate is smaller than we had expected. Estimated *R* using *R* for 'super-strata' in Areas IV and V is 0.926 (CV=0.109). It was used for calculate 'Pseudo SV' abundance and combined abundance. These abundance estimates are shown in Table 11. Combined abundance seems to be close to SSV abundance because *R* estimate is close to 1 and CV of SSV abundance is smaller than that of SV abundance.

Estimated abundance trend using SV abundance and combined abundance with their 95% confidential interval are shown in Table 12 respectively. The former is 2.71% in Area IV and is –4.21% in Area V and the latter is –0.04% in Area IV and is 0.83% in Area V. In all case, 95% confidential interval includes 0 (i.e. Estimated trend is not significantly different from 0.). The results indicate that significant increase or decrease was not observed since 1989/90 season.

DISCUSSIONS

Relation between the abundance estimate and ice-edge

,Most of Prydz Bay in 1997/98 season and most of Ross Sea (part of SE stratum in Area V) in 1998/99 season were not able to survey due to hard pack ice. Therefore, abundance estimate in northern strata is more than usual. This suggests that whales that could not migrate Prydz bay or Ross Sea due to hard pack ice were distributed in the Northern strata. The reason why abundance estimate in 1997/98 were less than usual is that whales might migrate to Area III because they could not moved into Prydz Bay or that they might be distributed in polynia (Shimada *et al.*, 2001).

It should be noted that poor body fat condition of minke whales due to food shortage would be linked with shape of sea ice extent (Ichii et. al, 1998). Sea ice area and extent showed yearly fluctuations in each Area in Antarctic (Shimada et. al, 2001). Minke whale movement pattern in feeding area would be associated with shape of sea ice extent as well as other environmental factors. If minke whales react to that kind of environmental change, the distribution patter may be different by year. This kind of change must be taken account in the future analysis.

Dependence of R on density of minke whale school

Fig. 4a suggest that R is decreasing as school density is increasing. Linear regression of log of $D_{s/SV}$ to log of $D_{s,SSV}$ was conducted (Fig. 4b). Regression equation is

$$\log_e(D_{s,SSV}) = 0.622\log_e(D_{s,SV}) - 1.258 \qquad (10).$$

And slope is significantly different from 1.Taking exponential of left hand side and right hand side of (10), Equation (10) can be expressed following

$$D_{s,SSV} = 0.284(D_{s,SV})^{0.622} \qquad (10)'.$$

Substituting (10)' to (4-5), R is expressed as a function of $D_{s,SV}$ following

$$R = 0.284(D_{s,SV})^{-0.378} \qquad (11).$$

(11) indicates that R is a strictly decreasing function of $D_{s,SV}$. This fact suggests that the effect of sampling activity on abundance estimate obtained from SSV depends on minke whale school density. In order to examine the effect of sampling activity on SSV abundance, it would be important to investigate the relation between this effect of sampling activity and the school density further. Due to the dependence of R on density, it became more difficult to adjust SSV abundance in seasons when SV was not engaged in the survey. It is necessary to investigate the estimation of R to correct SSV abundance from 1989/90 to 1991/92. We can correct SSV abundance to 'pseudo SV' abundance if R can be estimated appropriately. It is also necessary to investigate method of correcting SSV or SV abundance to 'pseudo passing mode' abundance if we would like to use SV abundance as an absolute abundance.

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Table 1. Estimated observer bias in distance and angle estimation.

1989/90

Vessel	platform	distance	angle
K01	barrel	n.s.	0.938
	upper bridge	n.s.	n.s.
T18	barrel	n.s.	1.041
	upper bridge	n.s.	n.s.
T25	barrel	1.083	n.s.
	upper bridge	1.051	n.s.

1990/91

Vessel	platform	distance	angle
K01	barrel	n.s.	1.051
	upper bridge	0.953	1.064
T18	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.
T25	barrel	0.890	n.s.
	upper bridge	n.s.	n.s.

1991/92

Vessel	platform	distance	angle
K01	barrel	0.935	n.s.
	upper bridge	n.s.	n.s.
T18	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.
T25	barrel	1.063	n.s.
	upper bridge	1.055	n.s.

1992/93

Vessel	platform	distance	angle
K01	barrel	n.s.	n.s.
	upper bridge	1.083	0.958
T18	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.
T25	barrel	n.s.	n.s.
	upper bridge	n.s.	1.130

1993/94

Vessel	platform	distance	angle
K01	barrel	0.846	n.s.
	upper bridge	n.s.	n.s.
T18	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.
T25	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.

1994/95

Vessel	platform	distance	angle
K01	barrel	n.s.	n.s.
	upper bridge	n.s.	0.960
T18	barrel	n.s.	n.s.
	upper bridge	0.946	n.s.
T25	barrel	n.s.	n.s.
	upper bridge	0.923	n.s.

1995/96

Vessel	platform	distance	angle
K01	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.
T18	barrel	n.s.	n.s.
	upper bridge	1.079	n.s.
T25	barrel	n.s.	n.s.
	upper bridge	0.948	1.035
KS2	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.

1996/97

Vessel	platform	distance	angle
K01	bridge	n.s.	n.s.
	upper bridge	n.s.	n.s.
T18	bridge	0.950	n.s.
	upper bridge	n.s.	n.s.
T25	bridge	n.s.	n.s.
	upper bridge	n.s.	n.s.
KS2	bridge	1.120	0.942
	upper bridge	1.155	1.053

1997/98

Vessel	platform	distance	angle
K01	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.
T18	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.
T25	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.
KS2	barrel	1.055	n.s.
	upper bridge	n.s.	n.s.

1998/99

Vessel	platform	distance	angle
K01	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.
T25	barrel	n.s.	1.050
	upper bridge	1.054	1.065
YS1	barrel	0.931	n.s.
	upper bridge	n.s.	n.s.
KS2	barrel	0.939	0.960
	upper bridge	n.s.	n.s.

1999/2000

Vessel	platform	distance	angle
K01	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.
T25	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.
YS1	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.
KS2	barrel	n.s.	0.934
	upper bridge	n.s.	n.s.

2000/2001

Vessel	platform	distance	angle
K01	barrel	n.s.	1.038
	upper bridge	n.s.	n.s.
T25	barrel	n.s.	n.s.
	upper bridge	n.s.	n.s.
YS1	barrel	n.s.	1.036
	upper bridge	1.057	n.s.
KS2	barrel	n.s.	n.s.
	upper bridge	n.s.	0.882

*n.s. indicates no significant at 5% level.

Table 2. Smearing Parameters used in this analysis.

Area IV

	SSV		SV	
	angle	distance	angle	distance
1989/90	6.591	0.297		
1991/92	5.335	0.249	6.460	0.250
1993/94	6.191	0.239	5.046	0.298
1995/96	6.806	0.242	4.412	0.215
1997/98	6.733	0.238	5.739	0.169
1999/2000	7.023	0.254	6.484	0.219

Area V

	SSV		SV	
	angle	distance	angle	distance
1990/91	6.000	0.250		
1992/93	6.000	0.296	5.410	0.200
1994/95	7.490	0.211	6.593	0.25
1996/97	7.022	0.254	5.524	0.254
1998/99	7.764	0.237	6.360	0.279
2000/01	6.393	0.239	3.216	0.172

Table 3. Abundance estimates of minke whales in the Antaractic Area IV using SSV data from 1989/90 to 1999/2000.
Data are truncated at 1.5 n.miles. esw was calculated for each srtatum. E(s)'s are estimated from confirmed school size data

Year	Stratum	area	period	TL	n	L	n/L*100	CV	esw	CV	E(s)	CV	D*100	P	CV	95% CI LL	95% CI UL
1989/90	NW	218,378	2/8-16	TL1	14.3	646.9	2.208	0.325	0.452	0.397	1.133	0.080	2.765	6,038	0.520	2,316	15,739
				TL2	17.6	656.8	2.679	0.360	0.452	0.397	1.529	0.139	4.527	9,887	0.554	3,587	27,253
				TL3	18.0	683.9	2.632	0.323	0.452	0.397	1.389	0.085	4.040	8,822	0.519	3,388	22,974
				combined	49.9	1987.6	2.509	0.196	0.452	0.397	1.360	0.066	3.786	**8,268**	**0.315**	4,521	15,118
	NE	213,661	1/11-19	TL1	15.0	684.2	2.192	0.519	0.576	0.124	1.676	0.182	3.190	6,816	0.564	2,435	19,080
				TL2	17.0	710.0	2.394	0.455	0.576	0.124	3.188	0.197	6.627	14,159	0.511	5,510	36,387
				TL3	17.0	570.2	2.981	0.158	0.576	0.124	1.647	0.137	4.264	9,111	0.243	5,694	14,578
				combined	49.0	1964.4	2.494	0.230	0.576	0.124	2.250	0.119	4.744	**10,136**	**0.297**	5,737	17,908
	SW	41,683	1/21-2/1	TL1	30.0	877.1	3.420	0.278	0.463	0.236	1.889	0.111	6.977	2,908	0.381	1,413	5,986
				TL2	22.0	823.5	2.670	0.277	0.463	0.236	1.864	0.113	5.373	2,240	0.381	1,089	4,608
				TL3	32.3	817.7	3.945	0.158	0.463	0.236	2.094	0.129	8.921	3,718	0.312	2,046	6,757
				combined	84.2	2518.3	3.345	0.137	0.463	0.236	1.963	0.071	7.084	**2,953**	**0.206**	1,981	4,400
	SE	40,371	12/31-1/10	TL1	49.6	495.7	10.010	0.275	0.657	0.124	1.959	0.094	14.924	6,025	0.315	3,295	11,019
				TL2	49.3	431.3	11.421	0.257	0.657	0.124	2.231	0.098	19.392	7,829	0.301	4,394	13,948
				TL3	50.1	435.2	11.507	0.377	0.657	0.124	2.200	0.112	19.265	7,778	0.412	3,580	16,896
				combined	149.0	1362.2	10.935	0.178	0.657	0.124	2.096	0.057	17.726	**7,156**	**0.202**	4,838	10,584
	PB	34,628	2/3-6	TL1	14.0	308.6	4.521	0.557	0.709	0.194	1.846	0.172	5.883	2,037	0.615	672	6,178
				TL2	12.0	308.4	3.885	0.631	0.709	0.194	1.667	0.171	4.563	1,580	0.682	470	5,308
				TL3	15.6	214.9	7.281	0.519	0.709	0.194	1.750	0.152	8.979	3,109	0.574	1,092	8,855
				combined	41.6	831.9	4.998	0.326	0.709	0.194	1.756	0.093	6.194	**2,145**	**0.358**	1,087	4,233
	Total	548,721			373.7	8664.4							5.587	**30,657**	**0.142**	23,254	40,418
1991/92	NW	219,773	2/15-25	TL1	23.7	748.8	3.168	0.205	0.432	0.195	1.550	0.099	5.682	12,488	0.300	7,029	22,189
				TL2	25.8	845.8	3.047	0.294	0.432	0.195	1.583	0.107	5.582	12,268	0.369	6,091	24,709
				TL3	25.8	888.1	2.906	0.277	0.432	0.195	1.960	0.240	6.591	14,485	0.415	6,628	31,656
				combined	75.3	2482.7	3.033	0.153	0.432	0.195	1.710	0.108	5.973	**13,127**	**0.219**	8,585	20,072
	NE	217,764	1/1-9	TL1	13.0	632.5	2.053	0.962	0.530	0.540	1.308	0.134	2.532	5,514	1.111	951	31,960
				TL2	6.6	684.7	0.959	0.863	0.530	0.540	1.429	0.208	1.292	2,814	1.039	526	15,052
				TL3	4.0	856.7	0.467	0.446	0.530	0.540	1.000	0.000	0.440	959	0.700	278	3,305
				combined	23.6	2173.9	1.083	0.587	0.530	0.540	1.304	0.102	1.317	**2,869**	**0.705**	826	9,967
	SW	34,259	1/27-2/6	TL1	23.9	606.8	3.941	0.298	0.649	0.230	2.046	0.122	6.212	2,128	0.396	1,008	4,494
				TL3	32.6	592.6	5.507	0.626	0.649	0.230	2.424	0.108	10.288	3,525	0.676	1,060	11,724
				combined	56.6	1199.4	4.715	0.383	0.649	0.230	2.028	0.088	8.226	**2,818**	**0.444**	1,227	6,472
	SE	34,871	1/16-26	TL1	19.8	641.6	3.087	0.385	0.486	0.248	3.000	0.151	9.532	3,324	0.482	1,357	8,140
				TL3	19.0	716.1	2.653	0.244	0.486	0.248	2.146	0.192	5.861	2,044	0.397	965	4,329
				combined	38.8	1357.7	2.858	0.230	0.486	0.248	3.100	0.117	7.596	**2,649**	**0.328**	1,415	4,959
	PB	27,733	2/9-14	TL1	32.2	209.0	15.390	0.491	0.562	0.324	2.839	0.155	38.849	10,774	0.608	3,590	32,332
				TL3	30.5	161.4	18.874	0.380	0.562	0.324	1.652	0.107	27.731	7,691	0.510	2,995	19,750
				combined	62.6	370.4	16.908	0.313	0.562	0.324	2.426	0.105	34.005	**9,430**	**0.432**	4,194	21,206
	Total	534,400			256.8	7584.1								**30,893**	**0.181**	21,728	43,926

Year	Stratum	area	period	TL	n	L	n/L*100	CV	esw	CV	E(s)	CV	D*100	P	CV	95% CI LL	95% CI UL
1993/94	NW	230,748	2/15-3/3	TL1	28.2	1191.5	2.366	0.381	0.582	0.148	1.292	0.087	2.624	6,056	0.418	2,760	13,288
				TL3	25.0	1338.8	1.867	0.361	0.582	0.148	1.500	0.114	2.405	5,550	0.407	2,578	11,949
				combined	53.2	2530.3	2.102	0.264	0.582	0.148	1.391	0.072	2.508	**5,788**	**0.291**	3,308	10,128
	NE	161,376	1/5-20	TL1	30.5	965.2	3.158	0.350	0.466	0.240	1.552	0.122	5.257	8,484	0.442	3,708	19,412
				TL3	28.2	916.4	3.081	0.315	0.466	0.240	1.679	0.111	5.548	8,953	0.411	4,128	19,419
				combined	58.7	1881.6	3.120	0.236	0.466	0.240	1.614	0.082	5.399	**8,712**	**0.427**	3,908	19,425
	SW	35,428	1/22-2/4	TL1	58.3	650.4	8.969	0.322	0.751	0.178	2.121	0.077	12.663	4,486	0.376	2,201	9,145
				TL3	43.9	702.5	6.255	0.559	0.751	0.178	1.506	0.085	6.272	2,222	0.592	759	6,509
				combined	102.3	1352.9	7.560	0.302	0.751	0.178	1.846	0.059	9.344	**3,310**	**0.320**	1,795	6,107
	SE	40,813	12/21-1/4	TL1	39.3	627.2	6.263	1.019	0.660	0.218	2.410	0.091	11.432	4,666	1.046	865	25,154
				TL3	24.0	791.9	3.031	0.466	0.660	0.218	2.696	0.196	6.187	2,525	0.550	921	6,921
				combined	63.3	1419.1	4.459	0.657	0.660	0.218	2.285	0.089	8.505	**3,471**	**0.660**	1,068	11,284
	PB	35,196	2/6-14	TL1	22.7	283.0	8.013	0.258	0.521	0.143	1.857	0.077	14.281	5,026	0.305	2,803	9,012
				TL3	21.8	279.3	7.789	0.356	0.521	0.143	2.353	0.109	17.588	6,190	0.399	2,916	13,140
				combined	44.4	562.3	7.902	0.218	0.521	0.143	2.079	0.069	15.924	**5,605**	**0.258**	3,406	9,223
	Total	503,561			321.9	7746.2								**26,887**	**0.187**	18,713	38,631
1995/96	NW	217,044	1/10-26	TL1	17.7	893.0	1.980	0.690	0.890	0.120	1.708	0.133	1.898	4,121	0.713	1,173	14,472
				TL2	21.0	921.1	2.280	0.612	0.890	0.120	2.294	0.184	2.937	6,375	0.650	1,991	20,413
				TL3	19.3	922.8	2.092	0.459	0.890	0.120	1.891	0.140	2.222	4,822	0.495	1,927	12,067
				combined	58.0	2736.9	2.119	0.342	0.890	0.120	1.922	0.085	2.357	**5,116**	**0.366**	2,552	10,255
	NE	231,845	2/10-19	TL1	19.0	715.1	2.654	0.349	0.481	0.344	1.125	0.114	3.102	7,192	0.503	2,835	18,242
				TL2	23.0	697.4	3.295	0.310	0.481	0.344	1.667	0.162	5.707	13,232	0.490	5,330	32,852
				TL3	21.1	711	2.967	0.376	0.481	0.344	1.207	0.134	3.719	8,623	0.527	3,268	22,750
				combined	63.1	2123.5	2.969	0.199	0.481	0.344	1.420	0.074	4.164	**9,655**	**0.299**	5,441	17,133
	SW	29,610	12/22-1/9	TL1	55.3	827.5	6.684	0.393	0.957	0.083	1.880	0.075	6.562	1,943	0.408	900	4,195
				TL2	49.8	623.2	7.994	0.296	0.957	0.083	2.152	0.099	8.985	2,660	0.323	1,435	4,932
				TL3	37.4	686.3	5.445	0.616	0.957	0.083	1.593	0.099	4.529	1,341	0.629	433	4,159
				combined	142.5	2137	6.668	0.245	0.957	0.083	1.885	0.052	6.616	**1,959**	**0.245**	1,220	3,145
	SE	30,123	2/20-29	TL1	39.6	469.2	8.438	0.139	0.765	0.112	1.900	0.119	10.479	3,157	0.215	2,083	4,784
				TL2	45.5	502.9	9.042	0.166	0.765	0.112	2.696	0.166	15.932	4,799	0.260	2,907	7,923
				TL3	32.3	489.4	6.592	0.293	0.765	0.112	1.977	0.114	8.519	2,566	0.334	1,358	4,851
				combined	117.3	1461.5	8.028	0.113	0.765	0.112	2.121	0.067	11.699	**3,524**	**0.159**	2,586	4,803
	PB	27,929	1/27-2/6	TL1	27.6	341.5	8.075	0.352	0.795	0.208	1.321	0.078	6.710	1,874	0.417	856	4,105
				TL2	34.3	247.3	13.854	0.663	0.795	0.208	1.500	0.077	13.067	3,650	0.700	1,059	12,574
				TL3	27.4	257.8	10.638	0.329	0.795	0.208	1.357	0.097	9.081	2,536	0.401	1,189	5,410
				combined	89.3	846.6	10.544	0.295	0.795	0.208	1.336	0.045	9.289	**2,594**	**0.334**	1,371	4,908
	Total	536,551			470.1	9305.5								**22,848**	**0.159**	16,774	31,122

(Table 3 continued)

Year	Stratum	area	period	TL	n	L	n/L*100	CV	esw	CV	E(s)	CV	D*100	P	CV	95% CI LL	95% CI UL
1997/98	NW	224,230	1/1-15	TL1	25.3	845.2	2.989	0.415	0.891	0.224	1.588	0.156	2.665	5,975	0.497	2,380	15,002
				TL2	20.7	909.7	2.272	0.568	0.891	0.224	2.591	0.222	3.304	7,409	0.650	2,316	23,698
				TL3	25.0	861.4	2.903	0.384	0.891	0.224	3.185	0.353	5.190	11,637	0.568	4,130	32,788
				combined	70.9	2616.3	2.711	0.260	0.891	0.224	1.880	0.105	3.718	**8,338**	**0.349**	4,293	16,193
	NE	224,567	1/31-2/13	TL1	20.3	812.1	2.497	0.531	0.645	0.325	1.300	0.113	2.515	5,649	0.633	1,811	17,620
				TL2	19.9	894.7	2.223	0.378	0.645	0.325	1.254	0.118	2.160	4,850	0.512	1,884	12,490
				TL3	16.1	936.5	1.724	0.492	0.645	0.325	2.563	0.367	3.424	7,689	0.694	2,250	26,279
				combined	56.3	2643.3	2.131	0.273	0.645	0.325	1.732	0.166	2.717	**6,101**	**0.384**	2,950	12,621
	SW	31,505	2/14-3/1	TL1	27.6	738.2	3.737	0.537	0.766	0.182	1.586	0.152	3.866	1,218	0.587	419	3,537
				TL2	28.8	864.6	3.334	0.565	0.766	0.182	1.828	0.165	3.975	1,252	0.617	412	3,810
				TL3	23.9	965.2	2.478	0.662	0.766	0.182	1.290	0.088	2.085	657	0.692	193	2,238
				combined	80.3	2568	3.128	0.338	0.766	0.182	1.523	0.069	3.233	**1,019**	**0.366**	508	2,041
	SE	41,450	1/16-30	TL1	27.4	814.4	3.369	0.128	0.554	0.287	1.038	0.089	3.155	1,308	0.326	701	2,439
				TL2	23.0	822.3	2.802	0.253	0.554	0.287	1.565	0.138	3.956	1,640	0.407	762	3,530
				TL3	30.2	733.7	4.110	0.189	0.554	0.287	1.936	0.155	7.175	2,974	0.377	1,456	6,074
				combined	80.6	2370.4	3.402	0.110	0.554	0.287	1.187	0.058	4.677	**1,939**	**0.228**	1,247	3,014
	PB	2,481	2/2-9	TL1	35.6	217.6	16.352	0.734	0.377	0.209	3.206	0.151	69.521	1,725	0.778	448	6,639
				TL2	20.0	136.1	14.695	0.790	0.377	0.209	1.613	0.176	31.442	780	0.836	187	3,248
				TL3	14.9	78.6	19.013	1.423	0.377	0.209	2.202	0.266	55.518	1,377	1.463	169	11,212
				combined	70.5	432.3	16.314	0.527	0.377	0.209	2.568	0.100	54.987	**1,364**	**0.583**	473	3,937
	Total	524,233			358.7	10630								**18,761**	**0.206**	12,586	27,964
1990/00	NW	236,307	12/28-1/13	TL1	14.0	522.0	2.682	0.550	0.895	0.192	1.077	0.071	1.614	3,815	0.587	1,313	11,082
				TL2	16.6	679.1	2.439	0.777	0.895	0.192	1.235	0.110	1.684	3,980	0.808	992	15,965
				TL3	15.9	625.1	2.542	0.455	0.895	0.192	1.188	0.158	1.687	3,987	0.518	1,533	10,369
				combined	46.5	1826.2	2.544	0.358	0.895	0.192	1.174	0.072	1.665	**3,935**	**0.389**	1,887	8,208
	NE	229,576	1/14-27	TL1	31.8	843.0	3.771	1.542	0.809	0.116	1.355	0.088	3.157	7,249	1.549	829	63,357
				TL2	31.7	850.4	3.726	0.982	0.809	0.116	1.095	0.062	2.521	5,788	0.991	1,144	29,286
				TL3	32.9	813.7	4.040	1.100	0.809	0.116	1.210	0.064	3.020	6,934	1.107	1,201	40,042
				combined	96.4	2507.1	3.843	0.710	0.809	0.116	1.217	0.038	2.897	**6,651**	**0.740**	1,820	24,302
	SW	34,825	2/19-3/1	TL1	72.1	556.2	12.971	0.486	0.861	0.084	2.951	0.106	22.240	7,745	0.504	3,047	19,689
			3/7-9	TL2	92.8	515.6	18.005	0.361	0.861	0.084	3.479	0.130	36.386	12,671	0.393	6,033	26,613
				TL3	61.6	594.1	10.372	0.299	0.861	0.084	3.361	0.171	20.250	7,052	0.354	3,595	13,834
				combined	226.6	1665.9	13.602	0.229	0.861	0.084	3.009	0.062	25.909	**9,023**	**0.244**	5,627	14,468
	SE	33,129	1/28-2/18	TL1	101.4	575.2	17.636	0.383	0.837	0.113	6.510	0.167	68.621	22,734	0.432	10,102	51,161
				TL2	102.8	696.7	14.757	0.435	0.837	0.113	5.870	0.130	51.769	17,150	0.467	7,176	40,986
				TL3	76.9	612.9	12.548	0.421	0.837	0.113	2.336	0.115	17.522	5,805	0.451	2,498	13,488
				combined	281.2	1884.8	14.917	0.240	0.837	0.113	4.986	0.084	45.775	**15,165**	**0.284**	8,792	26,157
	PB	27,000	3/2-6	TL1	40.2	240.6	16.716	0.280	0.813	0.111	1.610	0.125	16.546	4,468	0.326	2,396	8,332
				TL2	59.2	379	15.625	0.239	0.813	0.111	3.148	0.158	30.238	8,164	0.307	4,535	14,698
				TL3	30.4	233.3	13.041	0.238	0.813	0.111	2.194	0.133	17.588	4,749	0.294	2,700	8,353
				combined	129.9	852.9	15.226	0.150	0.813	0.111	2.677	0.115	22.916	**6,187**	**0.202**	4,185	9,148
	Total	560,837			780.4	8736.9								**40,961**	**0.175**	29,131	57,594

(Table 3 continued)

Table 4. Abundance estimates of minke whales in the Antar c Area V using SSV data from 1990/91 to 2000/01.
Data are truncated at 1.5 n.miles. esw was calculated for each srtatum. E(s)'s are estimated from confirmed school size data

Year	Stratum	area	period	TL	n	L	n/L*100	CV	esw	CV	E(s)	CV	D*100	P	CV	95% CI LL	95% CI UL
1990/91	FNW	232,898	1/21-31	TL1	42.0	887	4.735	0.327	0.328	0.186	1.38	0.116	0.099	23,133	0.394	10,991	48,690
				TL2	56.4	951.4	5.930	0.299	0.328	0.186	1.59	0.092	0.143	33,383	0.364	16,729	66,618
				TL3	50.0	888.4	5.628	0.371	0.328	0.186	1.71	0.141	0.147	34,204	0.438	15,039	77,792
				combined	148.4	2726.8	5.443	0.193	0.328	0.186	1.55	0.065	0.130	**30,316**	**0.235**	19,259	47,723
	SNE	347,440	2/16-26	TL1	25.3	681.1	3.710	0.237	0.260	0.477	1.37	0.155	0.098	33,914	0.554	12,297	93,531
				TL2	20.0	893.2	2.239	0.274	0.260	0.477	1.48	0.163	0.064	22,143	0.574	7,784	62,985
				TL3	16.8	924.6	1.814	0.531	0.260	0.477	2.17	0.159	0.076	26,290	0.731	7,291	94,793
				combined	62.0	2498.9	2.483	0.194	0.260	0.477	1.57	0.091	0.077	**26,885**	**0.367**	13,391	53,977
	FSW	62,355	1/11-20	TL1	32.4	556.1	5.824	0.214	0.564	0.204	1.96	0.155	0.101	6,326	0.334	3,346	11,960
				TL2	37.7	470.3	8.016	0.276	0.564	0.204	1.99	0.128	0.141	8,823	0.366	4,403	17,678
				TL3	38.7	608.6	6.352	0.371	0.564	0.204	1.63	0.107	0.092	5,710	0.437	2,518	12,946
				combined	108.7	1635	6.651	0.175	0.564	0.204	1.83	0.071	0.109	**6,815**	**0.220**	4,454	10,427
	SSE	208,511	2/5-14	TL1	55.5	589	9.423	0.164	0.549	0.149	1.84	0.113	0.158	32,972	0.247	20,473	53,104
				TL2	76.0	576.3	13.185	0.288	0.549	0.149	1.83	0.099	0.220	45,890	0.341	23,938	87,973
				TL3	80.6	504.7	15.960	0.222	0.549	0.149	2.03	0.101	0.294	61,375	0.283	35,610	105,784
				combined	212.0	1670	12.697	0.140	0.549	0.149	1.82	0.055	0.221	**46,014**	**0.175**	32,719	64,710
	Total	851,204			531.2	8530.7								**110,031**	0.133	84,819	142,736
1992/93	NW	332,682	1/25-2/5	TL1	22.0	712.3	3.089	0.585	0.447	0.147	1.31	0.085	0.045	15,043	0.610	4,998	45,271
				TL3	18.0	512.3	3.514	0.449	0.447	0.147	1.63	0.124	0.064	21,252	0.489	8,581	52,633
				combined	40.0	1224.6	3.266	0.380	0.447	0.147	1.50	0.074	0.053	**17,640**	**0.390**	8,438	36,878
	NE	290,526	12/30-1/11	TL1	14.6	481.2	3.028	0.553	0.681	0.221	1.53	0.190	0.034	9,908	0.625	3,214	30,549
				TL3	19.7	463.0	4.254	0.353	0.681	0.221	1.31	0.099	0.041	11,918	0.428	5,332	26,641
				combined	34.3	944.2	3.629	0.311	0.681	0.221	1.53	0.100	0.037	**10,894**	**0.370**	5,400	21,978
	SW	43,572	1/15-24	TL1	36.3	468.2	7.758	0.452	0.959	0.138	3.15	0.142	0.128	5,557	0.494	2,224	13,883
			2/8-13	TL3	36.2	434.5	8.339	0.586	0.959	0.138	2.44	0.153	0.106	4,623	0.621	1,509	14,166
				combined	72.6	902.7	8.038	0.370	0.959	0.138	2.76	0.103	0.117	**5,107**	**0.389**	2,449	10,650
	SE	180,745	2/14-3/6	TL1	60.8	640.8	9.493	0.689	0.647	0.227	1.84	0.098	0.135	24,393	0.732	6,753	88,109
				TL3	54.0	564.8	9.558	0.406	0.647	0.227	2.11	0.091	0.156	28,196	0.474	11,673	68,104
				combined	57.4	1205.6	4.762	0.824	0.647	0.227	2.01	0.066	0.145	**26,175**	**0.434**	11,587	59,130
	Total	847,525			204.2	4277.1								**59,816**	**0.235**	38,006	94,141

Year	Stratum	area		TL	n	L	n/L*100	CV	esw	CV	E(s)	CV	D*100	P	CV	95% CI LL	95% CI UL
1994/95	NW	194,879	1/4-19	TL1	24.0	1003.4	2.387	0.670	0.748	0.157	2.56	0.176	0.041	7,966	0.710	2,276	27,879
				TL3	30.6	1059.1	2.892	0.473	0.748	0.157	2.19	0.139	0.042	8,268	0.517	3,184	21,469
				combined	54.6	2062.5	2.646	0.396	0.748	0.157	2.36	0.111	0.042	**8,121**	**0.434**	3,600	18,319
	NE	303,617	1/20-2/5	TL1	41.5	1228.9	3.378	0.373	0.595	0.153	1.34	0.076	0.038	11,578	0.410	5,348	25,065
			2/13-18	TL3	33.9	720.9	4.708	0.579	0.595	0.153	1.51	0.093	0.060	18,097	0.606	6,044	54,180
				combined	75.5	1949.8	3.870	0.332	0.595	0.153	1.41	0.058	0.046	**13,988**	**0.360**	7,053	27,742
	SW	40,116	12/18-1/3	TL1	45.8	801.7	5.707	0.411	0.817	0.208	1.92	0.097	0.067	2,697	0.471	1,121	6,485
				TL3	38.7	782.6	4.949	0.457	0.817	0.208	3.13	0.160	0.095	3,796	0.527	1,439	10,015
				combined	84.5	1584.3	5.333	0.306	0.817	0.208	2.26	0.082	0.081	**3,240**	**0.364**	1,623	6,466
	SE	175,421	2/8-9	TL1	72.4	263	27.515	0.524	0.874	0.101	2.40	0.095	0.377	66,204	0.542	24,476	179,076
			2/23-3/11	TL3	71.8	343.6	20.901	0.654	0.874	0.101	2.30	0.091	0.275	48,221	0.668	14,671	158,491
				combined	144.2	606.6	23.769	0.419	0.874	0.101	2.28	0.065	0.319	**56,018**	**0.428**	25,075	125,144
	Total	714,033			358.7	6203.2								**81,367**	**0.305**	45,391	145,858
1996/97	NW	305,819	2/5-20	TL1	15.0	731.0	2.052	0.774	0.552	0.314	1.71	0.143	0.032	9,744	0.847	2,305	41,180
				TL2	13.8	773.4	1.779	0.610	0.552	0.314	1.42	0.142	0.023	6,986	0.700	2,025	24,102
				TL3	23.5	568.6	4.135	0.573	0.552	0.314	1.68	0.127	0.063	19,239	0.665	5,873	63,028
				combined	52.3	2073	2.521	0.376	0.552	0.314	1.52	0.074	0.037	**11,319**	**0.434**	5,015	25,551
	NE	363,668	1/5-20	TL1	35.3	735.0	4.800	0.309	0.654	0.230	1.28	0.092	0.047	17,107	0.396	8,103	36,116
				TL2	34.1	773.8	4.412	0.342	0.654	0.230	1.58	0.103	0.053	19,342	0.425	8,709	42,956
				TL3	32.1	818.5	3.917	0.513	0.654	0.230	2.03	0.106	0.061	22,126	0.572	7,796	62,791
				combined	101.5	2327.3	4.361	0.226	0.654	0.230	1.58	0.057	0.054	**19,615**	**0.288**	11,286	34,090
	SW	40,130	1/21-2/4	TL1	36.9	846.1	4.356	0.611	0.646	0.232	2.44	0.125	0.082	3,299	0.666	1,006	10,813
				TL2	33.5	784.2	4.273	0.814	0.646	0.232	1.55	0.121	0.051	2,054	0.855	481	8,776
				TL3	39.6	801.7	4.936	0.472	0.646	0.232	2.18	0.146	0.083	3,342	0.546	1,229	9,091
				combined	109.9	2432	4.520	0.364	0.646	0.232	2.10	0.075	0.073	**2,912**	**0.386**	1,401	6,050
	SE	208,224	2/21-3/12	TL1	45.9	495.1	9.277	0.552	0.613	0.205	2.80	0.095	0.212	44,144	0.596	14,979	130,100
				TL2	48.3	411.2	11.741	0.583	0.613	0.205	4.46	0.288	0.427	88,953	0.682	26,483	298,778
				TL3	52.6	415.5	12.656	0.189	0.613	0.205	2.51	0.156	0.259	53,970	0.319	29,296	99,425
				combined	146.8	1321.8	11.105	0.267	0.613	0.205	3.24	0.141	0.294	**61,172**	**0.359**	30,903	121,092
	Total	917,841			286.7	8154.1								**95,019**	**0.245**	59,241	152,405

Year	Stratum	area		TL	n	L	n/L*100	CV	esw	CV	E(s)	CV	D*100	P	CV	95% CI LL	95% CI UL
1998/99	NW	321,375	1/30-2/3	TL1	14.0	268.1	5.222	0.469	0.424	0.249	2.14	0.161	0.132	42,369	0.555	15,335	117,061
				TL2	17.9	311.1	5.747	0.472	0.424	0.249	1.94	0.135	0.132	42,313	0.550	15,443	115,935
				TL3	19.0	254.4	7.469	0.369	0.424	0.249	1.47	0.109	0.130	41,674	0.458	17,715	98,036
				combined	50.9	833.6	6.104	0.251	0.424	0.249	1.82	0.081	0.131	**42,136**	**0.306**	23,423	75,798
	NE	311,050	1/24-29	TL1	12.0	194.9	6.157	0.375	0.489	0.206	1.92	0.261	0.121	37,504	0.501	14,826	94,869
				TL2	16.0	204.9	7.804	0.460	0.489	0.206	2.17	0.180	0.173	53,876	0.536	20,132	144,181
				TL3	18.0	174.3	10.327	0.253	0.489	0.206	2.56	0.133	0.271	84,148	0.353	43,021	164,589
				combined	46.0	574.1	8.011	0.212	0.489	0.206	2.23	0.104	0.185	**57,509**	**0.263**	34,671	95,388
	SW	45,455	2/4-25	TL1	85.2	583.2	14.607	0.384	0.518	0.137	2.28	0.109	0.321	14,613	0.422	6,614	32,286
				TL2	80.9	579.9	13.954	0.234	0.518	0.137	3.05	0.118	0.411	18,679	0.296	10,587	32,958
				TL3	60.7	522.9	11.605	0.335	0.518	0.137	2.05	0.123	0.230	10,441	0.382	5,062	21,535
				combined	226.8	1686	13.451	0.189	0.518	0.137	2.47	0.066	0.324	**14,718**	**0.211**	9,768	22,176
	SE	52,553	2/26-3/15	TL1	35.0	425.2	8.231	0.746	0.527	0.144	2.49	0.105	0.194	10,205	0.767	2,690	38,705
				TL2	45.0	370.9	12.131	1.053	0.527	0.144	1.94	0.096	0.224	11,746	1.067	2,127	64,869
				TL3	36.0	387.6	9.288	0.737	0.527	0.144	1.67	0.113	0.147	7,733	0.759	2,061	29,014
				combined	116.0	1183.7	9.799	0.519	0.527	0.144	1.98	0.061	0.188	**9,878**	**0.526**	3,748	26,034
	Total	730,433			341.2	3306.3								**124,240**	**0.167**	89,731	172,021
2000/01	NW	249,712	2/11-25	TL1	28.0	899.8	3.110	0.729	0.609	0.233	1.73	0.212	0.044	11,033	0.794	2,803	43,437
				TL2	19.0	952.8	1.999	0.751	0.609	0.233	1.94	0.226	0.032	7,965	0.818	1,959	32,380
				TL3	18.0	992.5	1.814	0.751	0.609	0.233	2.00	0.213	0.030	7,434	0.815	1,835	30,111
				combined	65.0	2845.1	2.286	0.436	0.609	0.233	1.85	0.128	0.035	**8,750**	**0.470**	3,646	20,998
	NE	334,377	1/2-23	TL1	69.3	888.1	7.807	0.394	0.626	0.164	1.74	0.080	0.108	36,245	0.434	16,049	81,857
				TL2	75.8	898.0	8.437	0.354	0.626	0.164	1.92	0.138	0.130	43,323	0.414	19,871	94,453
				TL3	81.5	918.7	8.869	0.416	0.626	0.164	1.82	0.086	0.129	43,106	0.455	18,415	100,903
				combined	226.6	2704.8	8.377	0.226	0.626	0.164	1.70	0.043	0.122	**40,925**	**0.252**	25,152	66,589
	SW	64,854	2/27-3/19	TL1	64.2	769.7	8.336	0.408	0.741	0.165	1.38	0.064	0.078	5,027	0.445	2,186	11,560
				TL2	64.5	770.9	8.362	0.344	0.741	0.165	1.48	0.070	0.083	5,408	0.388	2,596	11,265
				TL3	68.8	727.1	9.463	0.276	0.741	0.165	1.72	0.080	0.110	7,128	0.332	3,784	13,429
				combined	197.4	2267.7	8.706	0.199	0.741	0.165	1.43	0.036	0.090	**5,830**	**0.221**	3,800	8,944
	SE	105,458	1/24-2/9	TL1	159.5	764.9	20.846	0.210	0.682	0.106	2.52	0.106	0.385	40,587	0.258	24,656	66,810
				TL2	182.2	857.9	21.236	0.283	0.682	0.106	2.55	0.117	0.397	41,837	0.324	22,513	77,748
				TL3	163.4	751.1	21.757	0.212	0.682	0.106	2.42	0.113	0.387	40,789	0.262	24,595	67,647
				combined	505.1	2373.9	21.275	0.140	0.682	0.106	2.42	0.055	0.390	**41,102**	**0.167**	29,714	56,855
	Total	754,401			994.1	8200.1								96,608	0.136	74,125	125,910

(Table 4 continued)

Table 5. Abundance estimates of minke whales in the Antaractic Area IV using SV data from 1991/92 to 1999/2000.
Data are truncated at 1.5 n.miles. esw was calculated for each srtatum. E(s)'s are estimated from confirmed school size data.
NE and NW strata were not surveyd by SV in 1991/92 season.

Year	Stratum	area	period	n	L	n/L*100	CV	esw	CV	E(s)	CV	D*100	P	CV	95% CI LL	95% CI UL
1991/92	SW	34,259	1/26-2/6	48.9	1038.1	4.713	0.271	0.378	0.339	2.258	0.122	14.088	4,826	0.450	2,079	11,206
	SE	34,871	1/16-24	28.5	924.0	3.082	0.142	0.969	0.132	2.181	0.167	3.470	1,210	0.259	735	1,993
	PB	27,733	2/9-14	79.1	237.1	33.380	0.485	0.762	0.203	4.466	0.495	97.832	27,132	0.690	7,982	92,225
1993/94	NW	232,782	2/15-3/3	26.0	1667.4	1.559	0.317	0.295	0.255	1.280	0.106	3.378	7,863	0.416	3,597	17,190
	NE	171,281	1/5-20	22.4	1250.4	1.788	0.224	0.408	0.534	1.650	0.166	3.614	6,190	0.598	2,095	18,290
	SW	33,394	1/22-30	40.2	1024.8	3.926	0.262	0.643	0.281	1.760	0.132	5.373	1,794	0.404	837	3,845
	SE	30,908	12/21-1/4	60.0	839.8	7.145	0.717	0.479	0.353	2.214	0.111	16.516	5,105	0.807	1,274	20,446
	PB	35,196	2/6-14	27.0	477.7	5.652	0.415	0.350	0.300	1.369	0.096	11.060	3,893	0.518	1,497	10,120
	total	503,561		175.6	5260.1	3.338							**24,845**	**0.273**	14,697	41,999
1995/96	NW	217,044	1/10-26	15.0	793.6	1.890	0.437	0.251	0.829	2.267	0.169	8.526	18,505	0.940	3,888	88,074
	NE	228,383	2/10-18	17.6	856.2	2.055	0.594	0.183	0.489	2.222	0.220	12.498	28,542	0.800	7,189	113,321
	SW	33,433	12/22-1/9	41.0	714.2	5.741	0.410	0.460	0.224	2.737	0.121	17.066	5,706	0.482	2,331	13,966
	SE	29,932	2/19-29	53.9	578.4	9.316	0.206	0.475	0.176	2.362	0.127	23.152	6,930	0.300	3,901	12,311
	PB	27,929	1/27-2/5	25.0	475.2	5.261	0.144	0.351	0.347	1.379	0.134	10.339	2,887	0.399	1,359	6,133
	total	536,721		152.5	3417.6	4.461							**62,570**	**0.463**	26,397	148,315
1997/98	NW	224,230	12/31-1/14	26.0	750.9	3.463	1.083	0.928	0.181	2.293	0.149	4.275	9,586	1.108	1,660	55,369
	NE	224,567	1/30-2/12	10.0	979.4	1.021	0.339	0.966	0.094	1.556	0.156	0.822	1,846	0.382	895	3,807
	SW	31,505	2/13-28	19.7	787.1	2.508	0.447	0.723	0.309	1.625	0.147	2.821	889	0.553	323	2,446
	SE	41,450	1/15-29	24.0	825.5	2.907	0.258	0.681	0.181	1.524	0.086	3.251	1,347	0.326	722	2,514
	PB	2,481	3/1-4	24.7	135.1	18.250	0.603	0.493	0.544	2.167	0.185	40.105	995	0.819	244	4,050
	total	524,233		104.4	3478	3.002							**14,663**	**0.729**	4,077	52,733
1999/2000	NW	236,307	12/27-1/11	6.0	997.4	0.602	0.437	0.497	0.344	1.500	0.333	0.909	2,147	0.574	754	6,115
	NE	229,576	1/11-26	56.5	1045.4	5.404	0.317	0.433	0.167	1.432	0.088	8.948	20,541	0.364	10,284	41,032
	SW	34,825	2/18-3/1,3/6-9	107.7	637.3	16.901	0.340	0.950	0.094	2.755	0.112	24.515	8,537	0.361	4,298	16,959
	SE	33,129	1/28-2/18	144.2	819.5	17.599	0.243	0.756	0.122	3.642	0.136	42.368	14,036	0.286	8,096	24,336
	PB	27,000	3/1-6	43.5	425.3	10.239	0.560	0.896	0.326	1.875	0.209	10.705	2,890	0.659	891	9,378
	total	560,837		358.0	3924.9	9.120							**48,151**	**0.194**	33,067	70,115

Table 6. Abundance estimates of minke whales in the Antaractic Area V using SV data from 1992/93 to 2000/01. Data are truncated at 1.5 n.miles. esw was calculated for each srtatum. E(s)'s are estimated from confirmed school

Year	Stratum	area	period	n	L	n/L*100	CV	esw	CV	E(s)	CV	D*100	P	CV	95% CI LL	95% CI UL
1992/93	NW	332,682	1/25-2/5	47.0	923.0	5.092	0.464	0.451	0.170	1.565	0.076	8.834	29,388	0.500	11,634	74,235
	NE	290,526	12/30-1/11	15.0	717.3	2.091	0.638	0.460	0.194	2.581	0.317	5.867	17,045	0.738	4,680	62,080
	SW	43,572	1/15-24,2/8-13	106.0	1004.7	10.546	0.241	0.484	0.264	2.914	0.102	31.766	13,841	0.372	6,835	28,027
	SE	180,745	2/14-3/6	173.7	1050.7	16.530	0.332	0.478	0.144	1.913	0.071	33.087	59,803	0.369	29,715	120,359
	Total	847,525		341.6	3695.7	9.244							**120,077**	**0.248**	74,387	193,829
1994/95	NW	194,879	1/4-19	48.3	1166.9	4.137	0.756	0.464	0.399	1.423	0.144	6.350	12,375	0.867	2,853	53,681
	NE	303,617	1/20-2/14	29.8	1194.7	2.497	0.272	0.565	0.270	1.759	0.127	3.890	11,812	0.404	5,514	25,305
	SW	40,116	12/18-1/3	88.4	884.7	9.996	0.328	0.776	0.146	3.918	0.109	25.235	10,123	0.375	4,971	20,615
	SE	175,421	2/15-3/13	193.6	686.4	28.209	0.368	0.823	0.098	4.091	0.102	70.089	122,950	0.394	58,394	258,874
	Total	714,033		360.2	3932.7								**157,260**	**0.318**	85,609	288,881
1996/97	NW	305,819	2-4/20	14.8	711.6	2.082	0.279	0.542	0.257	4.077	0.538	7.833	23,956	0.658	7,392	77,636
	NE	363,668	1-3/20	16.0	806.1	1.985	0.426	0.243	0.277	1.568	0.180	6.413	23,321	0.539	8,668	62,745
	SW	40,130	1/21-2/3	20.4	692.4	2.942	0.655	0.766	0.395	2.739	0.325	5.257	2,110	0.831	510	8,735
	SE	208,224	2/20-3/12	107.1	790.1	13.550	0.642	0.709	0.151	3.700	0.106	35.337	73,581	0.668	22,377	241,954
	Total	917,841		158.2	3000.2								**122,968**	**0.432**	54,642	276,733
1998/99	NW	321,375	1/13-2/4	52.2	961.8	5.432	0.359	0.648	0.199	2.739	0.229	11.477	36,884	0.470	15,366	88,534
	NE	311,050	1/12-23	16.4	652.8	2.517	0.365	0.329	0.555	1.938	0.242	7.421	23,083	0.707	6,630	80,362
	SW	45,455	2/3-24	100.6	652.5	15.418	0.327	0.427	0.286	4.035	0.199	72.811	33,096	0.477	13,619	80,432
	SE	52,553	2/24-3/12	32.0	372.3	8.600	0.545	0.495	0.226	1.609	0.212	13.970	7,341	0.627	2,374	22,708
	Total	730,433		201.3	2639.4								**100,404**	**0.288**	57,716	174,664
2000/01	NW	249,712	2/11-24	20.0	906.8	2.206	0.385	0.453	0.217	1.625	0.231	3.954	9,875	0.498	3,922	24,859
	NE	334,377	1/1-22	45.4	1236.3	3.669	0.259	0.258	0.583	2.436	0.302	17.293	57,824	0.706	16,628	201,085
	SW	64,854	2/25-3/18	44.0	885.2	4.971	0.533	0.268	0.333	1.692	0.236	15.702	10,183	0.671	3,082	33,648
	SE	105,458	1/23-2/6	171.4	946.3	18.107	0.294	0.899	0.123	1.872	0.115	18.852	19,881	0.338	10,429	37,903
	Total	754,401		280.7	3974.6								**97,763**	**0.432**	43,469	219,871

Table 7. R (=Ds (SSV)/Ds (SV)) for each stratum in Area IV for each year.

year	stratum	*Ds* (SSV)	CV	*Ds* (SV)	CV	*R*	ln *R*	SE(ln*R*)
1991/92	SW	0.0363	0.446	0.0624	0.434	0.582	- 0.541	0.572
	SE	0.0294	0.338	0.0159	0.194	1.849	0.615	0.376
	PB	0.1504	0.450	0.2191	0.526	0.686	- 0.376	0.626
	All	0.0628	0.264	0.1028	0.411	0.611	- 0.493	0.462
1993/94	NW	0.0181	0.302	0.0264	0.407	0.684	- 0.380	0.478
	NE	0.0335	0.337	0.0219	0.579	1.528	0.424	0.609
	SW	0.0503	0.351	0.0305	0.384	1.649	0.500	0.489
	SE	0.0338	0.692	0.0746	0.799	0.658	- 0.418	0.866
	PB	0.0758	0.261	0.0808	0.512	0.939	- 0.063	0.534
	All	0.0280	0.164	0.0282	0.245	0.994	- 0.006	0.289
1995/96	NW	0.0119	0.362	0.0375	0.931	0.317	- 1.149	0.832
	NE	0.0309	0.397	0.0562	0.769	0.549	- 0.600	0.748
	SW	0.0348	0.259	0.0623	0.467	0.559	- 0.582	0.501
	SE	0.0525	0.159	0.0980	0.271	0.535	- 0.625	0.307
	PB	0.0663	0.361	0.0750	0.376	0.884	- 0.123	0.490
	All	0.0289	0.167	0.0385	0.269	0.751	- 0.286	0.309
1997/98	NW	0.0152	0.343	0.0186	1.098	0.816	- 0.203	0.918
	NE	0.0165	0.424	0.0053	0.352	3.125	1.139	0.515
	SW	0.0204	0.384	0.0174	0.543	1.176	0.162	0.605
	SE	0.0307	0.307	0.0213	0.315	1.438	0.363	0.420
	PB	0.2164	0.567	0.1851	0.812	1.169	0.156	0.827
	All	0.0212	0.191	0.0155	0.687	1.369	0.314	0.641
1999/2000	NW	0.0142	0.407	0.0061	0.556	2.347	0.853	0.623
	NE	0.0237	0.719	0.0625	0.358	0.380	- 0.967	0.706
	SW	0.0790	0.244	0.0890	0.353	0.888	- 0.119	0.411
	SE	0.0892	0.265	0.1163	0.272	0.766	- 0.266	0.367
	PB	0.0961	0.349	0.0571	0.647	1.683	0.520	0.658
	All	0.0298	0.244	0.0346	0.191	0.862	-0.149	0.303

Table 8. Estimate of R for each stratum in Area IV

	All strata	NE	NW	SE	SW	PB
ln*R*	- 0.154	0.237	- 0.143	- 0.086	- 0.108	- 0.019
var(ln*R*)	0.025	0.097	0.104	0.031	0.050	0.071
se(ln*R*)	0.157	0.312	0.323	0.177	0.224	0.267
z	0.978	- 0.758	0.441	0.486	0.480	0.071
p	0.328	0.449	0.659	0.627	0.632	0.943
R	0.868	1.330	0.914	0.932	0.921	1.017
se(*R*)	0.137	0.425	0.303	0.166	0.209	0.277

Table 9. *R* (=*Ds* (SSV)/*Ds* (SV)) for each stratum in Area V for each year.

year	stratum	*Ds* (SSV)	CV	*Ds* (SV)	CV	*R*	ln *R*	SE(ln*R*)
1992/93	NW	0.0365	0.408	0.0564	0.495	0.648	- 0.435	0.587
	NE	0.0267	0.381	0.0227	0.667	1.173	0.159	0.681
	SW	0.0419	0.395	0.1090	0.358	0.384	- 0.956	0.500
	SE	0.0368	0.855	0.1730	0.362	0.213	- 1.548	0.788
	All	0.0294	0.288	0.0717	0.253	0.410	- 0.892	0.370
1994/95	NW	0.0177	0.426	0.0446	0.855	0.397	- 0.924	0.805
	NE	0.0325	0.365	0.0221	0.383	1.471	0.386	0.497
	SW	0.0326	0.370	0.0644	0.359	0.507	- 0.680	0.485
	SE	0.1360	0.431	0.1713	0.381	0.794	- 0.231	0.534
	All	0.0516	0.300	0.0655	0.291	0.788	- 0.238	0.401
1996/97	NW	0.0228	0.490	0.0192	0.379	1.189	0.173	0.570
	NE	0.0334	0.322	0.0409	0.508	0.816	- 0.204	0.556
	SW	0.0350	0.432	0.0192	0.765	1.824	0.601	0.756
	SE	0.0906	0.336	0.0955	0.659	0.949	- 0.052	0.661
	All	0.0429	0.201	0.0382	0.448	1.125	0.118	0.465
1998/99	NW	0.0719	0.354	0.0419	0.411	1.716	0.540	0.508
	NE	0.0819	0.296	0.0383	0.664	2.138	0.760	0.651
	SW	0.1298	0.233	0.1805	0.434	0.719	- 0.330	0.466
	SE	0.0930	0.539	0.0868	0.590	1.071	0.069	0.703
	All	0.0713	0.160	0.0510	0.250	1.397	0.334	0.291
2000/01	NW	0.0188	0.494	0.0243	0.442	0.771	- 0.260	0.603
	NE	0.0669	0.279	0.0710	0.638	0.943	- 0.059	0.629
	SW	0.0587	0.258	0.0928	0.628	0.633	- 0.458	0.616
	SE	0.1560	0.176	0.1007	0.318	1.549	0.437	0.352
	All	0.0613	0.144	0.0504	0.230	1.215	0.195	0.267

Table 10. Estimate of *R* for each stratum in Area V

	All strata	NE	NW	SE	SW
ln*R*	- 0.017	0.202	- 0.055	0.014	- 0.487
var(ln*R*)	0.023	0.070	0.071	0.057	0.058
se(ln*R*)	0.151	0.264	0.266	0.239	0.241
z	0.112	- 0.763	0.206	- 0.059	2.019
p	0.911	0.446	0.837	0.953	0.043
R	0.994	1.267	0.981	1.044	0.633
se(*R*)	0.151	0.341	0.265	0.253	0.155

Table 11. Combined abundance estimate in Areas IV and V
R =0.926 (CV=0.109) is used to estimate abundance for 'Pseudo SV'

Area IV

year	SSV	CV	SV	CV	Pseudo SV	CV	Combined	CV
1989/90	30,657	0.142			33,096	0.179	33,096	0.179
1991/92	30,893	0.181			33,351	0.211	33,351	0.211
1993/94	26,887	0.187	24,845	0.273	29,026	0.216	27,097	0.170
1995/96	22,848	0.159	62,523	0.463	24,666	0.193	25,660	0.183
1997/98	18,761	0.206	14,663	0.729	20,253	0.233	19,342	0.223
1999/00	40,961	0.175	48,151	0.194	44,220	0.206	46,145	0.141

Area V

year	SSV	CV	SV	CV	Pseudo SV	CV	Combined	CV
1990/91	110,031	0.133			118,785	0.172	118,785	0.172
1992/93	59,816	0.235	120,077	0.248	64,575	0.259	77,858	0.187
1994/95	81,367	0.305	157,260	0.318	87,841	0.323	104,792	0.236
1996/97	95,019	0.245	122,968	0.432	102,578	0.268	106,878	0.228
1998/99	124,240	0.167	100,404	0.288	134,125	0.200	118,570	0.166
2000/01	96,608	0.136	97,763	0.432	104,294	0.174	103,274	0.162

Table 12. Estimated trend in Areas IV and V. Confidential interval of trend obtained from combined abundance estimate was estimated by using Monte Carlo method.

Area		trend	confidence interval	
Area IV	SV	2.71%	- 52.34%	121.35%
	SSV	- 0.30%	- 9.80%	10.20%
	combined	- 0.04%	- 4.32%	2.90%
Area V	SV	- 4.21%	- 11.39%	3.56%
	SSV	2.45%	- 6.23%	11.94%
	combined	0.83%	-2.44%	4.19%

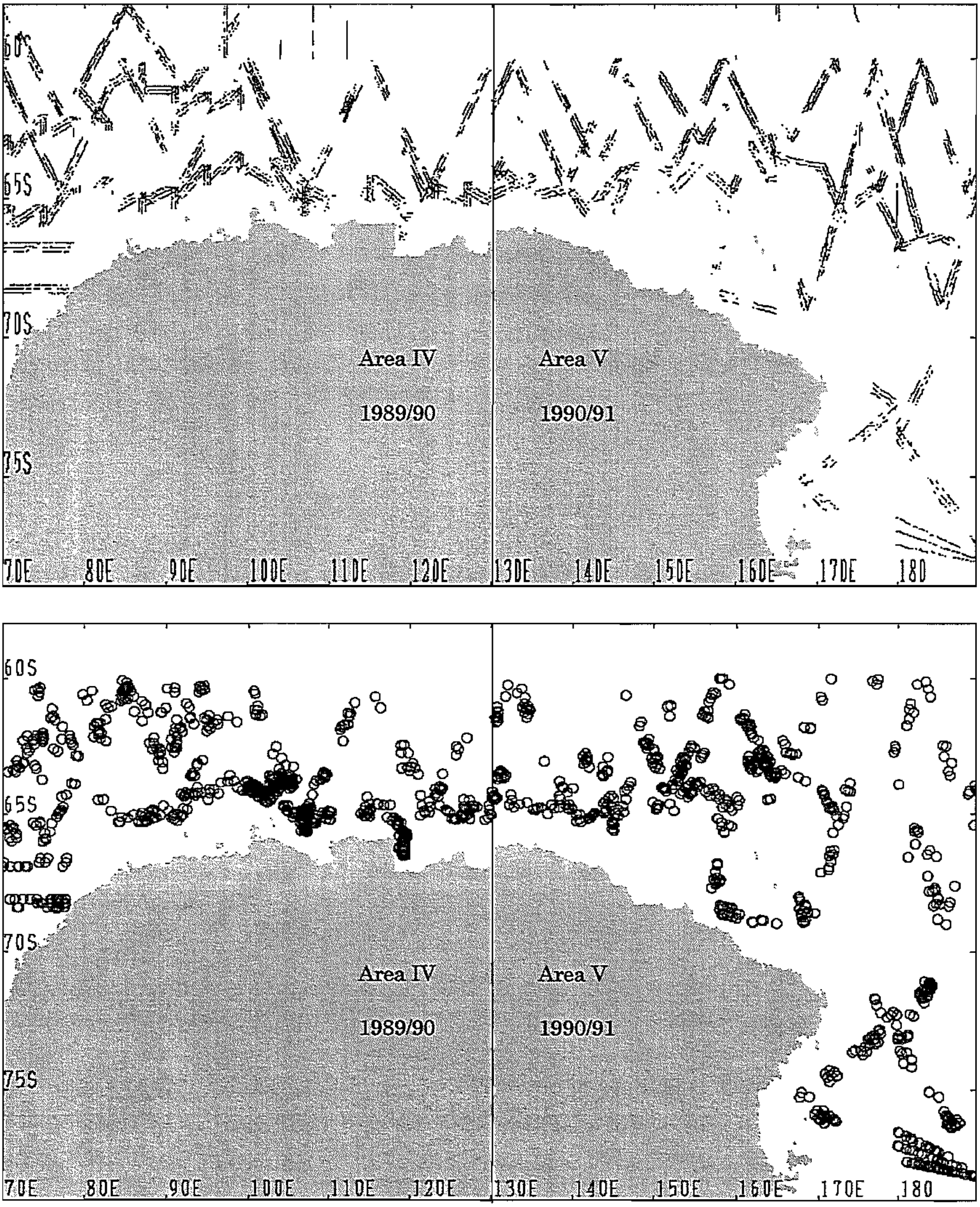
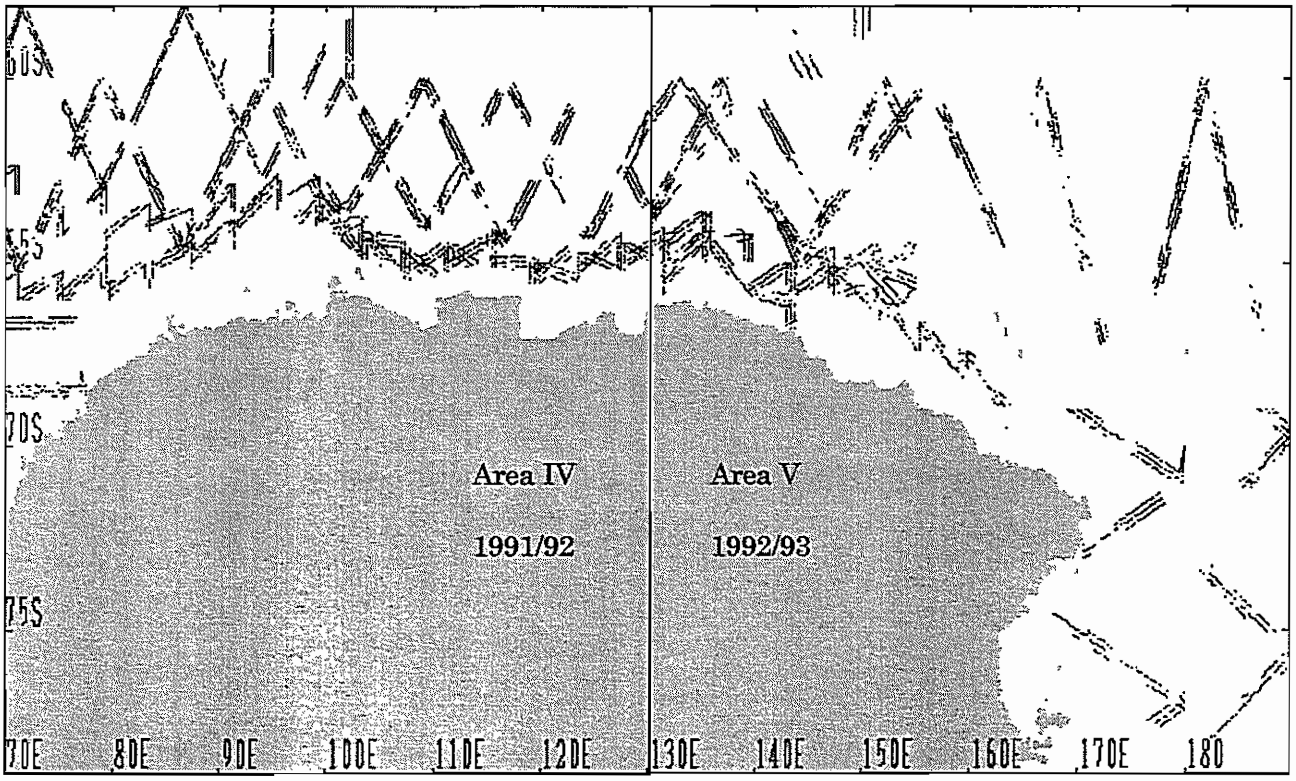


Fig. 1-a. Distribution of searching effort and primary sightings of minke whales in 1989/90 and 1990/91 JARPA survey. Gray zone is Antarctic continent.



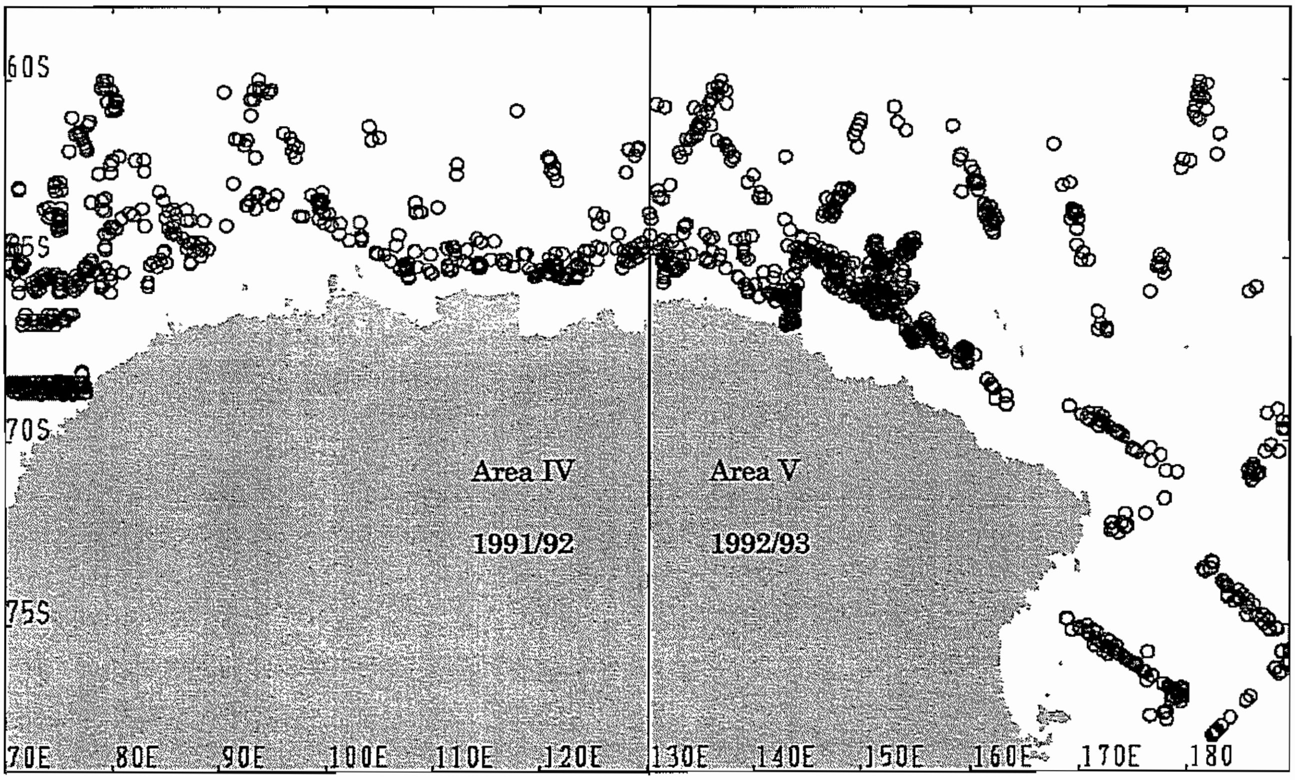


Fig. 1-b. Distribution of searching effort and primary sightings of minke whales in 1991/92 and 1992/93 JARPA survey. Gray zone is Antarctic continent.

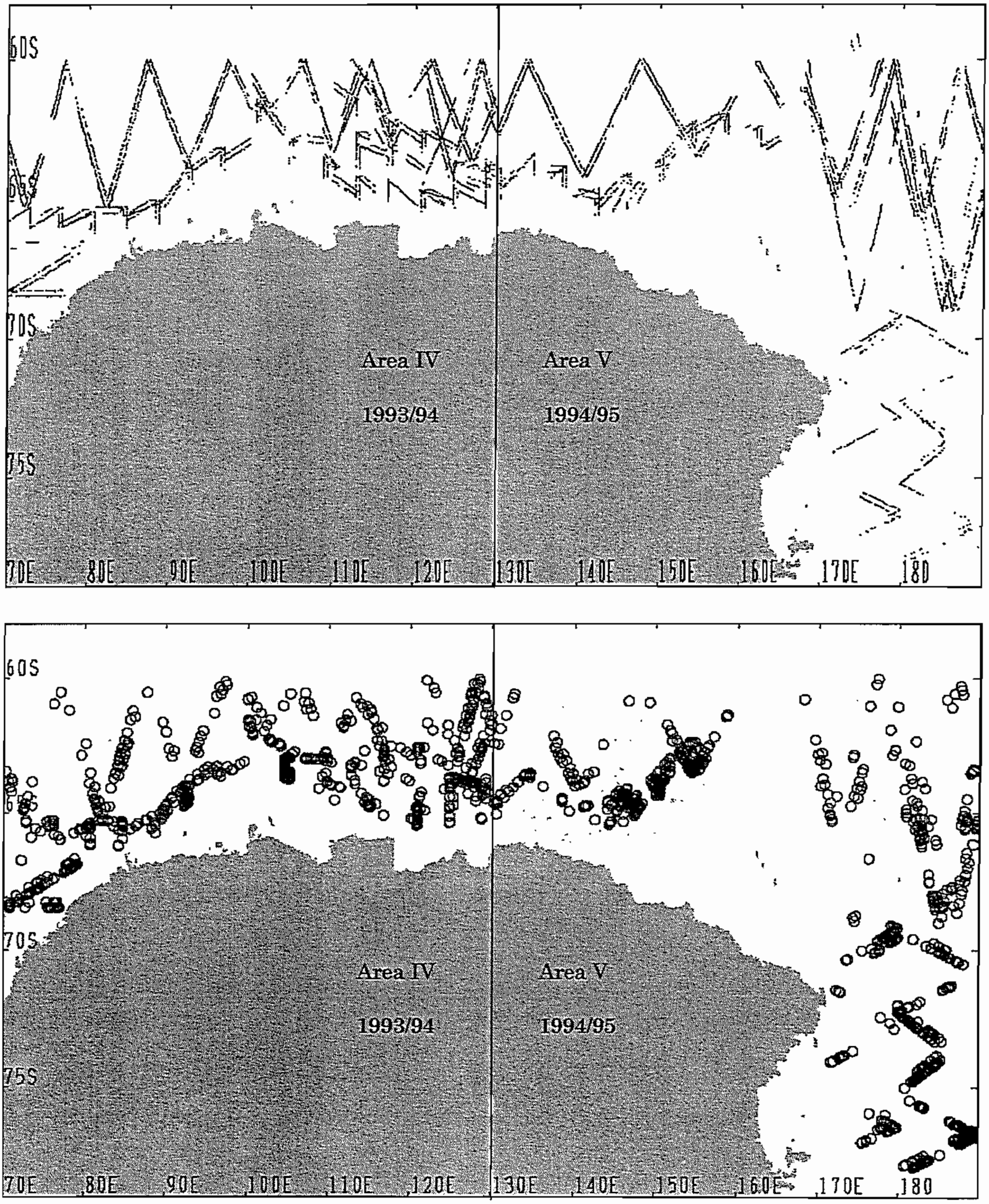


Fig. 1-c. Distribution of searching effort and primary sightings of minke whales in 1993/94 and 1994/95 JARPA survey. Gray zone is Antarctic continent.

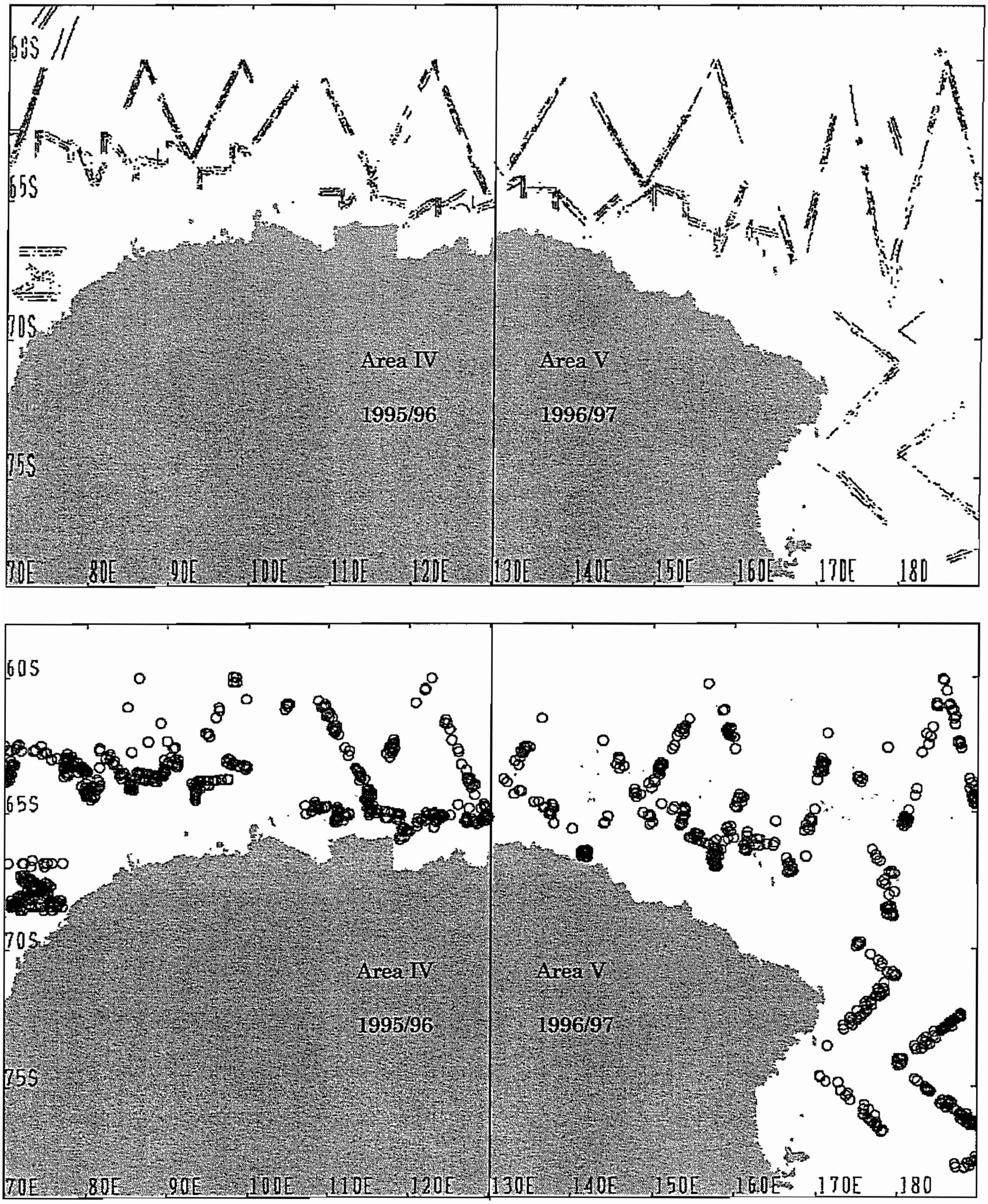


Fig. 1-d. Distribution of searching effort and primary sightings of minke whales in 1995/96 and 1996/97 JARPA survey. Gray zone is Antarctic continent.

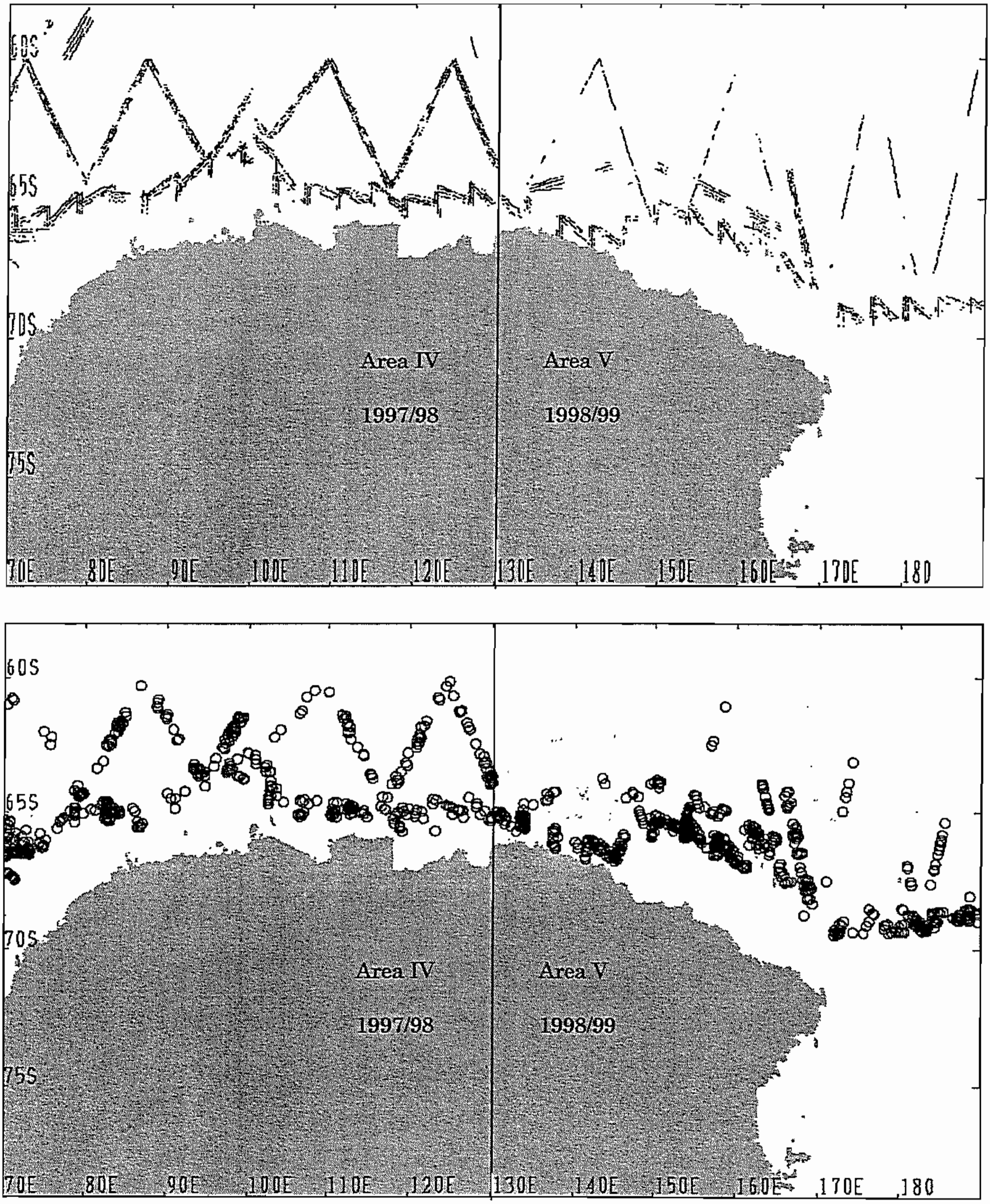


Fig. 1-e. Distribution of searching effort and primary sightings of minke whales in 1997/98 and 1998/99 JARPA survey. Gray zone is Antarctic continent.

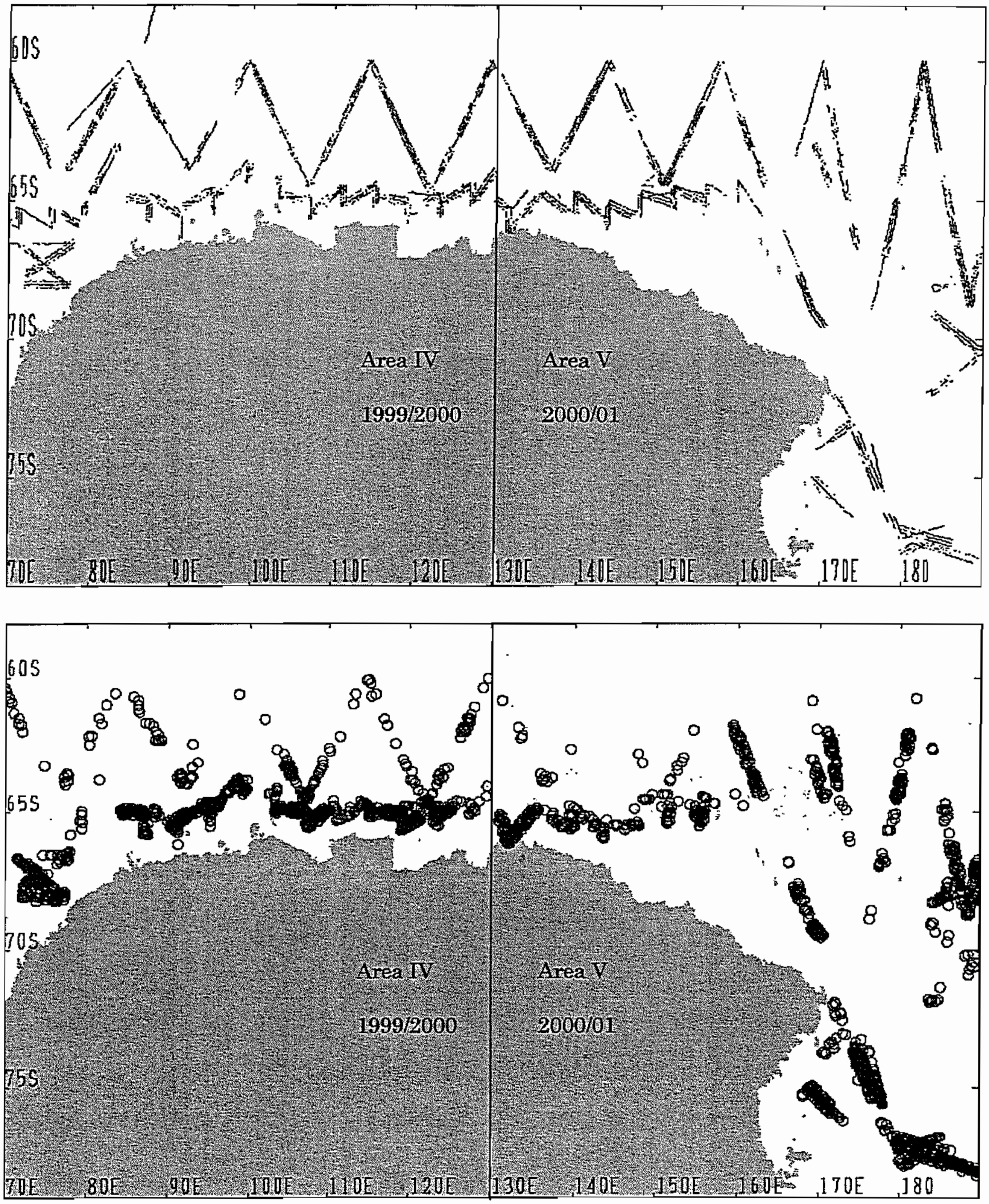


Fig. 1-f. Distribution of searching effort and primary sightings of minke whales in 1999/00 and 2000/01 JARPA survey. Gray zone is Antarctic continent.

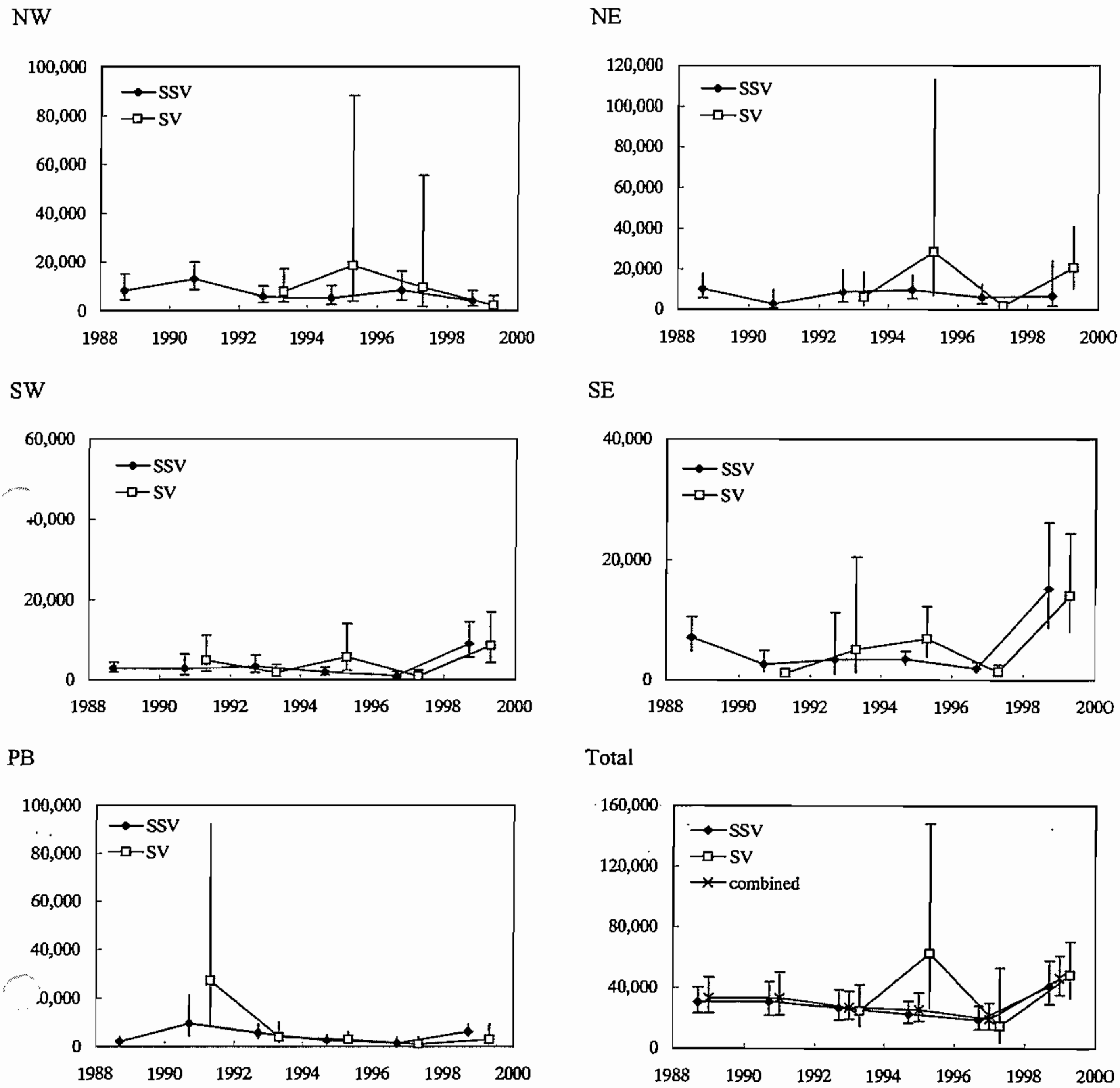


Fig. 2a. Comparison of abundance estimates of minke whales using SSV data with that using SV data in Area IV (south of 60° S) from 1989/90 to 1999/2000 seasons. Vertical lines represent 95% confidential interval.

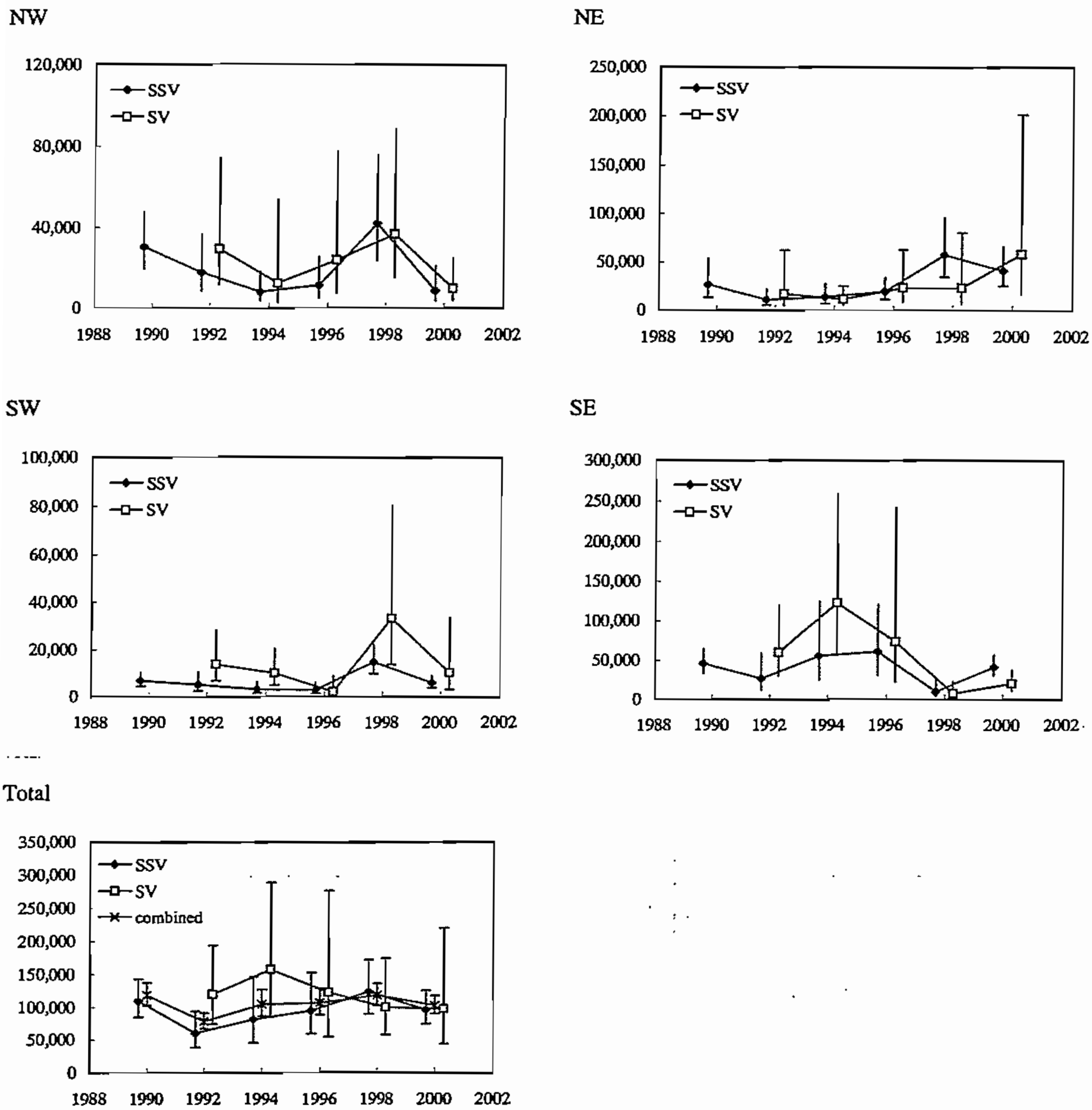


Fig. 2b. Comparison of abundance estimates of minke whales using SSV data with that using SV data in Area V (south of 60° S) from 1990/91 to 2000/01 seasons. Vertical lines represent 95% confidential interval.

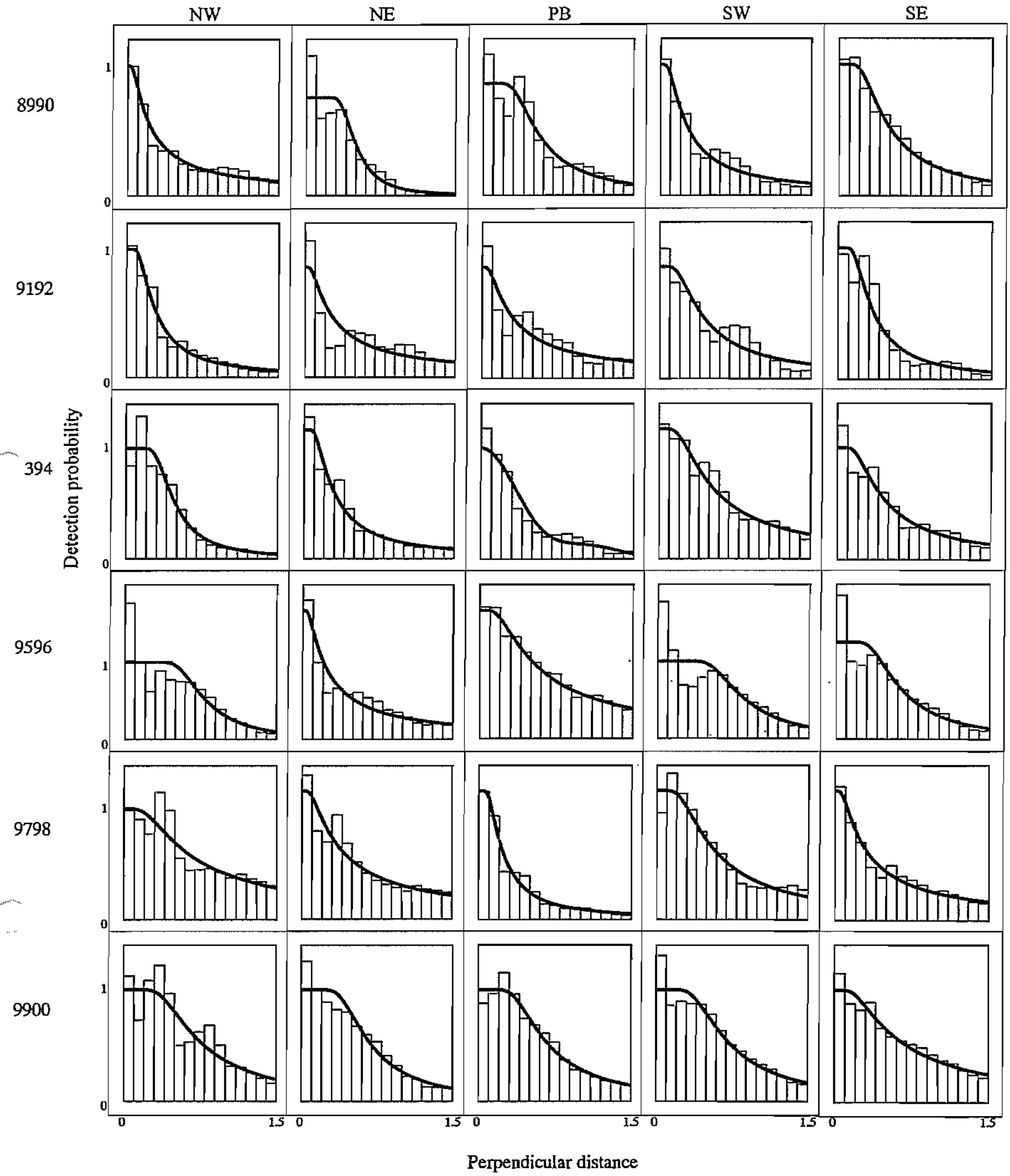


Fig. 3a. Detection probability function of minke whale for each stratum in Area IV surveyed by SSVs from 1989/90 to 1999/2000 seasons.

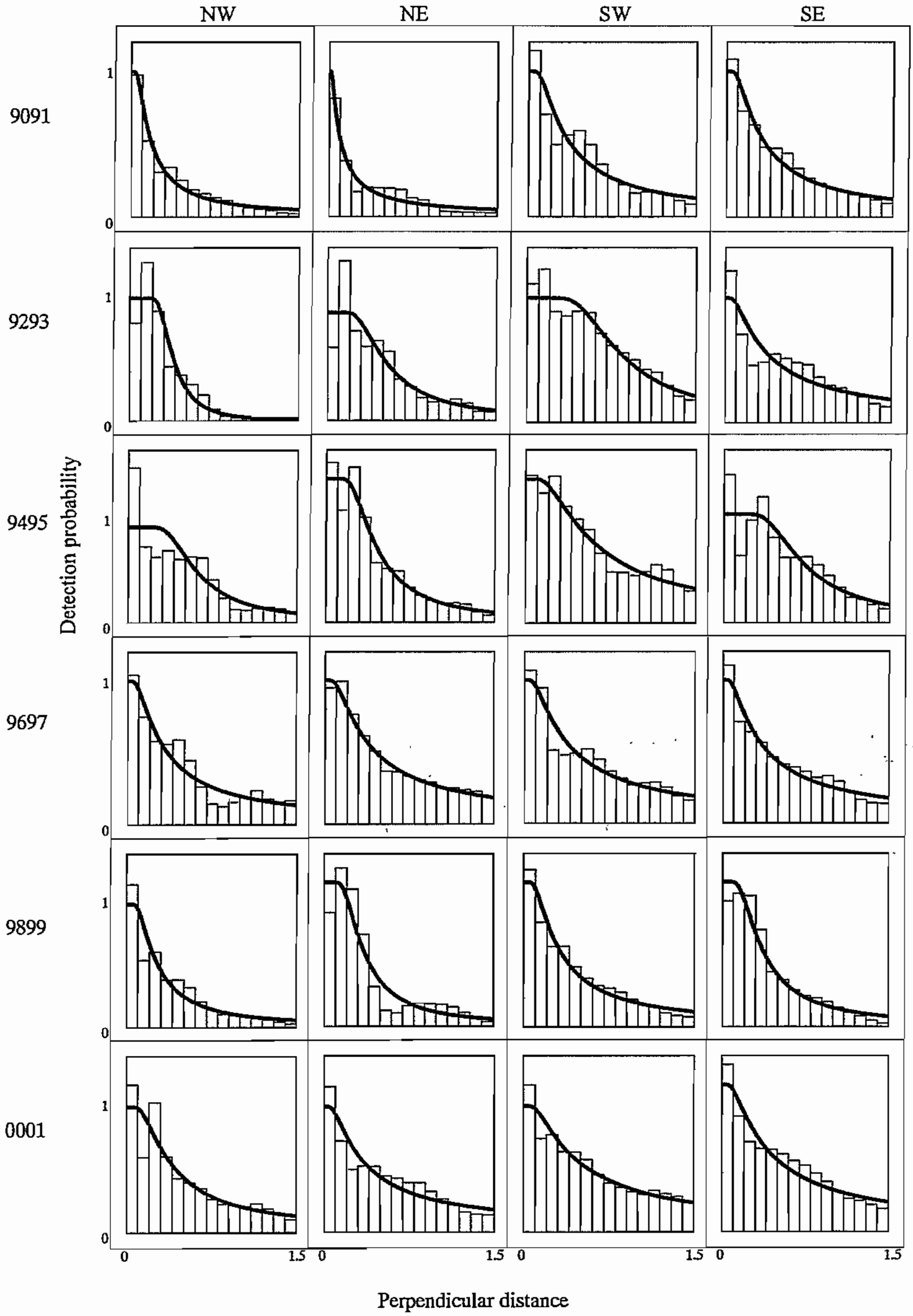


Fig. 3b. Detection probability function of minke whale for each stratum in Area V surveyed by SSVs from 1990/90 to 2000/01 seasons.

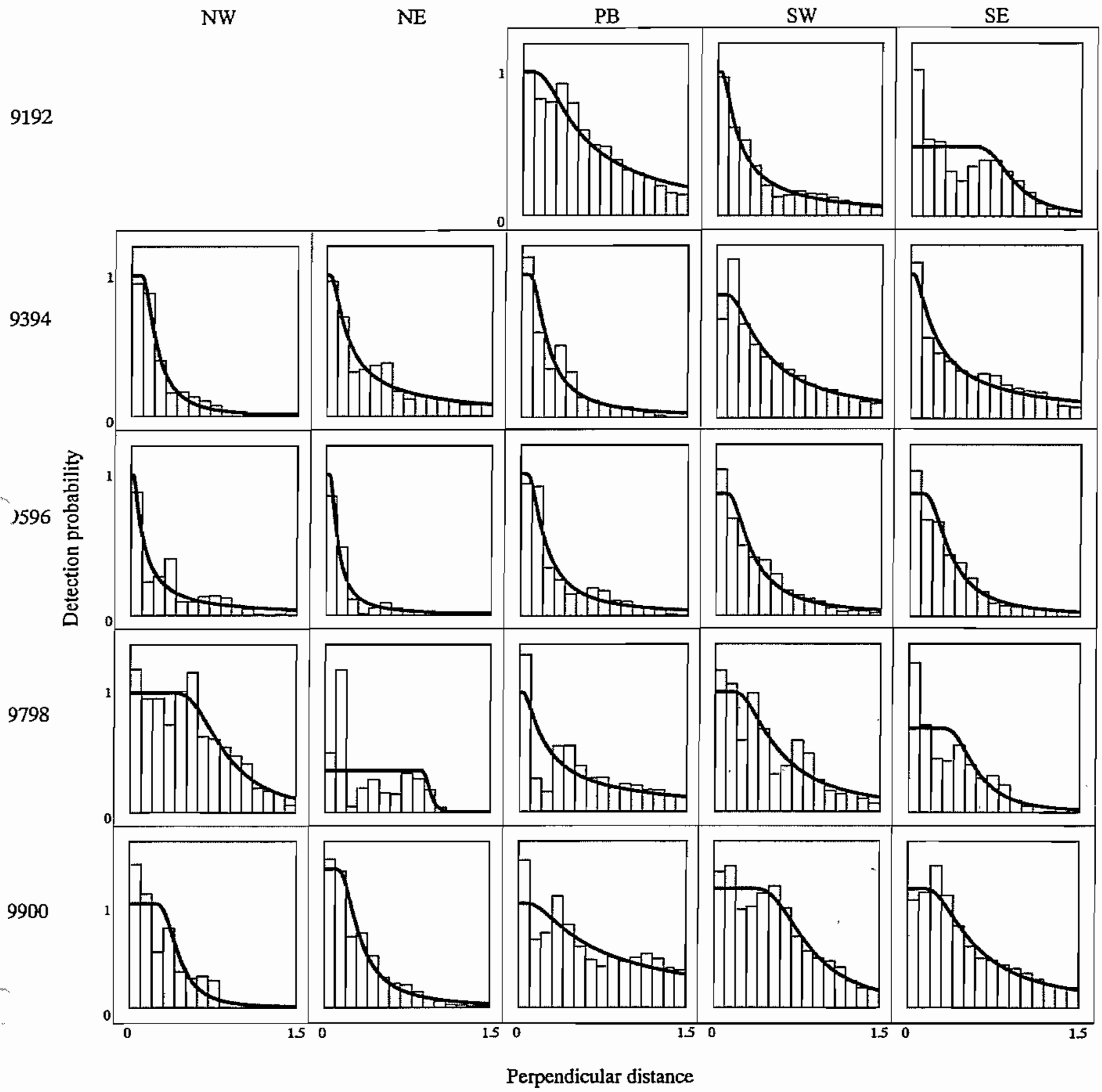


Fig. 3c. Detection probability function of minke whale for each stratum in Area IV surveyed by SV from 1989/90 to 1999/2000 seasons. In 1991/92 season, NW and NE srata was not surveyed by SV.

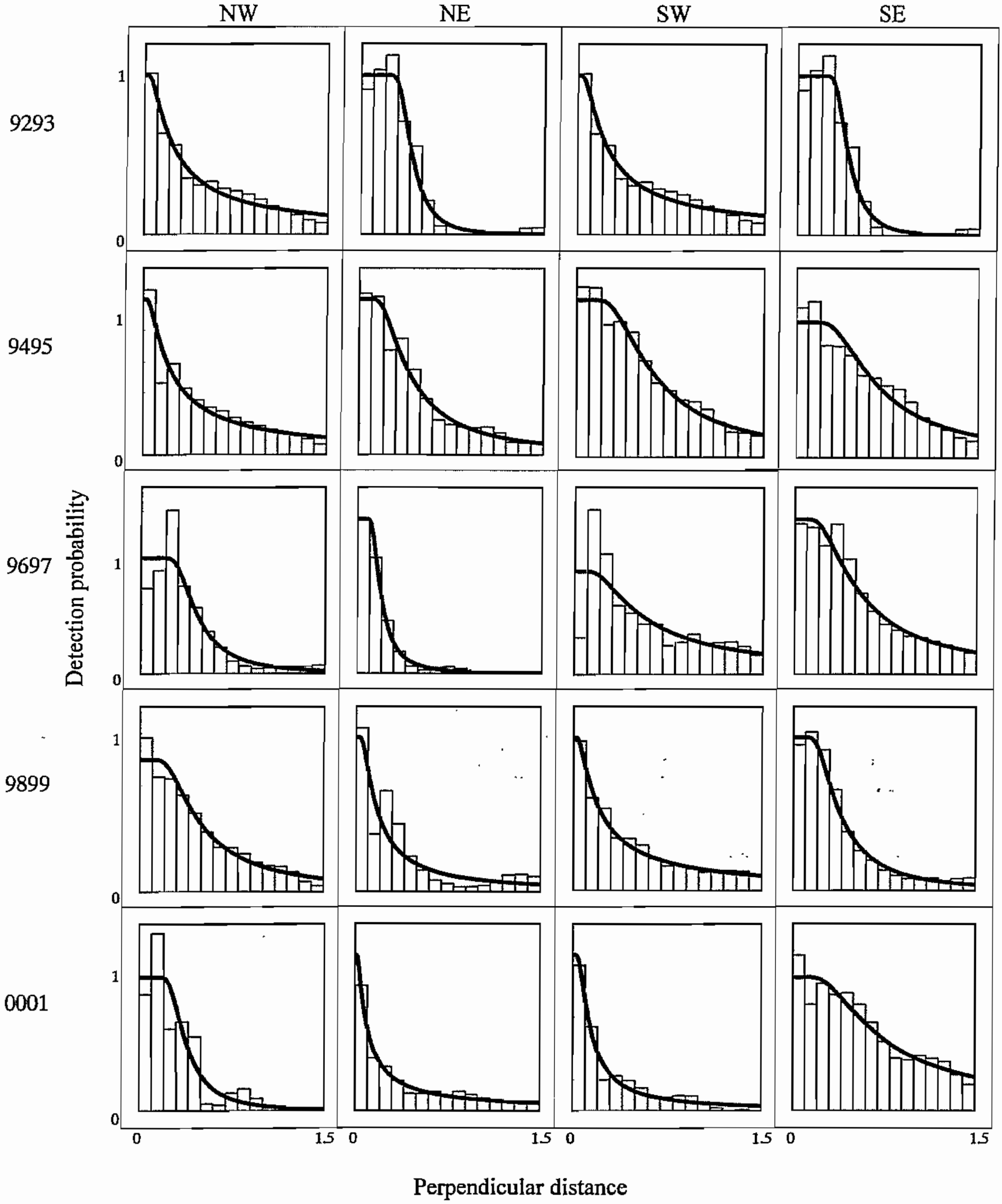


Fig. 3d. Detection probability function of minke whale for each stratum in Area V surveyed by SV from 1990/90 to 2000/01 seasons.

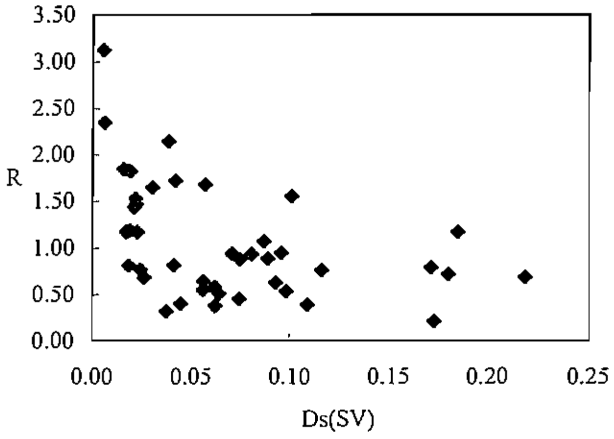


Fig. 4a.Relation between R and Ds (SSV)

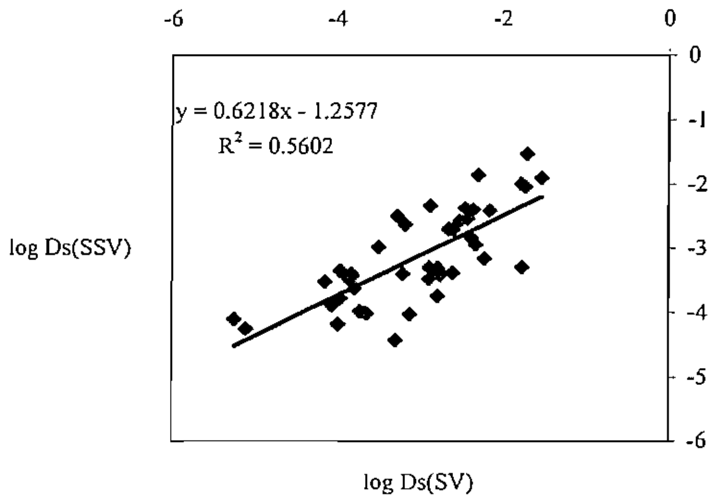


Fig. 4b.Relation between log Ds (*SV*) and log Ds (SSV).

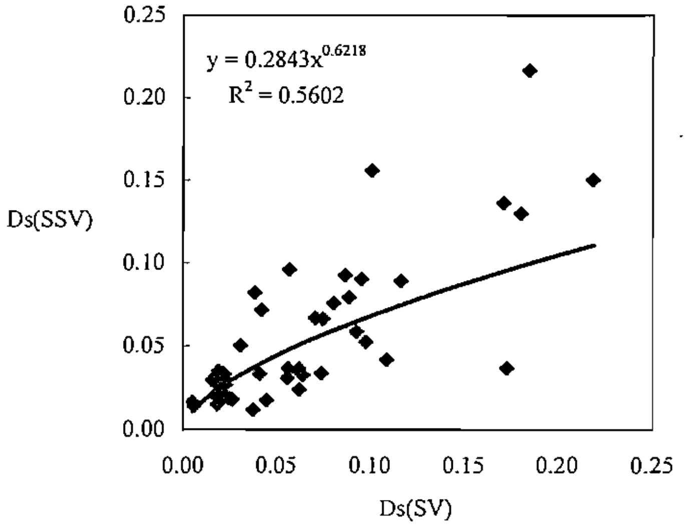


Fig. 4c.Relation between Ds (SV) and Ds (SSV).