Applying alternative approach to Antarctic minke whale abundance estimation with an example for the part of Area IV using IWC/SOWER-1998/99 data

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ABSTRACT

We report revised Antarctic minke abundance estimation by alternative approach to compare with the IWC standard method for SOWER-1998/99 survey. In the last SC meeting, abundance estimate 7,140 (CV=0.345) for 1998/99 cruise was reported (Burt and Stahl 2001). In this analysis, data from all strata were pooled for estimating effective search width (*Ws)* and mean school size (*E(s))* because sample size was too small. It was pointed out that sea state conditions and the distribution pattern of the Antarctic minke whales were different between the northern strata (*N)* and southern strata (*S*), because sea state conditions generally better in the *S* than the *N* and thus wider strip widths might be expected in the *S*. And latitudinally as larger school size were mainly observed in the *S*. Solitary animal which difficult to make sightings distributed in the *N*, (Matsuoka *et al.*, 2001).

In a recent analysis, it was suggested that sighting cues (blow or body), *Ws* and *E(s)* clearly changed by latitudes (Murase *et al.* 2002). Further, as a result of ANOVA, there is significant difference in average of the perpendicular distance and the mean school size between *N* and *S*, whereas there is no significant difference among vessels (Hakamada and Matsuoka 2002). It was confirmed that taking into account characteristics of *N* or *S* the pooling within *N* or within *S* was appropriate when sample size was small. Revised parameters was estimated by DESS using 1998/99 data following the same manner as Branch and Butterworth (2001) except pooling options. Revised abundance of Antarctic minke whale in the part of Area IV (between 80-130E) was estimated 10,470 (CV=0.350) individuals although it was not include other factors which could affect the estimate (e.g. Effect of g (0) and abundance in the pack ice etc.). It is 47 % increasing compare with Burt and Stahl (2001) estimation which was pooled all strata together. A view point of environmental and biological reasons, abundance estimates which taking into account characteristics of *N* or *S* was plausible than previous estimation, while the pooling combined *N* and *S* was not recommendable.

INTRODUCTION

IWC/SOWER-1998/99 cruise was conducted in the part of Area IV between 80-130E (Ensor *et al* 1999). Figure 1 show the distribution of primary sightings of Antarctic minke whale which used in

this analysis with searching effort. Because of a logical constraint, a part of western sector (between 70E-80E; including the Prydz bay) was not covered. Abundance of 7,140 (CV=0.345) individuals was reported in the last SC meting (Burt and Stahl 2001). In the analysis, data from all strata were pooled for estimating effective search width (*Ws*) and mean school size (*E(s)*) because sample size was too small.

In the meeting, it was pointed out that sea state conditions and distribution pattern of Antarctic minke whales were different between the northern strata (*N*) and southern strata (*S*), because sea state conditions generally better in the *S* than the *N* and thus wider strip widths might be expected in the *S*. And latitudinally as larger school size were mainly observed in the *S*. Solitary animal which difficult to make sightings distributed in the *N*, (Matsuoka *et al.* 2001). This was also supported by the fact that small body size immature male Antarctic minke whales were prevailed in the *N* strata based on JARPA data (Fujise *et al.* 1999).

In discussion at the SC meeting, it was noted that the analysis had been conducted using DESS with pooling options that have become standard for analyses of these surveys (notwithstanding the fact that the analysis methods are currently under review). It was also noted that the standard options might not necessarily be the best options for this particular survey. Alternative stratification options, for example, might lead to quite different mean school size estimates, although small sample sizes limit the options available. While it was agreed that the analyses of these data might be particularly sensitive to changes in the options used, the results did not suggest that the standard estimate was inadequate (IWC 2002. Annex G, 6.1).

In this paper, we analyzed revised estimates of parameters and abundance for Antarctic minke whales considering the effect of different pooling option.

MATERIAL AND METHOD

The 1998/99 data used were extracted from the DESS. The bias for distance and angle estimation were corrected in the DESS data. For abundance estimation of Antarctic minke whales, species codes were used for (04 (Antarctic minke) + 92 (Like Antarctic) + 91 (Undetermined minke)) in this analysis. However, there were no sightings with code 92 (Like Antarctic) in this cruise. These codes already corrected as suggested by Branch and Ensor (2001).

After SC meeting, Hakamada and Matsuoka (2002) conducted an Analysis of Variance (ANOVA) in order to compare average of school size and perpendicular distance among groups stratified by survey mode, survey vessels, period and southern or northern strata. They suggested that there was larger difference in average school size and perpendicular distance between *N* and *S* than between vessels. Therefore, strata should be pooled into two *N* together (Eastern North stratum + Western North stratum) and likewise for two *S* (Eastern South stratum + Western South stratum) when the sample size was small.

Abundance was estimated by the same manner as Branch and Butterworth (2001) except for pooling method. Truncation was set at 1.5 n.miles. The g (0) was assumed to be one. As a mean school size less than unity (one animal) was not plausible, this has been replaced by the actual mean school size for that stratum. The Pseudo-passing estimates were calculated by dividing the closing mode estimates by R= 0.751 (CV=0.152) to compare with the previous abundance.

Hazard-rate model was fitted.

RESULT

Table 1 show revised estimates of parameters for Antarctic minke whales by each survey mode using the IWC/SOWER-1998/99 cruise in the part of Area IV (between 80E-130E). In the Closing mode, though sample size in the northern strata was not sufficient (n= 6.0 in the EN, n=5.0 in the WN), *Ws* and *E(s)* were estimated to be 0.490 (CV=0.321) n.miles and 1.25 (CV=0.200) individuals, respectively by pooling EN + WN. For southern strata, *Ws* and *E(s)* (n= 19.4 in the ES, n=4.0 in the WS) were 0.998 (CV=0.196) n.miles and 1.27 (CV=0.088) individuals, respectively by pooling ES + WS. In IO mode, in the northern strata (n= 18.2 in the EN, n=17.7 in the WN), *Ws* was estimated 0.686 (CV=0.278) n.miles by pooling EN + WN. For southern strata, *Ws* (n= 23.5 in the ES, n=14.8 in the WS) was 0.730 (CV=0.323) n.miles by pooling ES + WS. The *E(s)* by Closing mode were applied for IO mode. Figure 2. show the detection probability plots of each pooling strata by each survey mode. Hazard-rate model was fitted in each survey mode in northern and southern strata.

Table 2. show that revised abundance estimate in each survey mode, the Pseudo-passing estimate and Inverse-variance weighted abundance estimate with CV. Revised total abundance estimate in the part of Area IV were 10,470 (CV=0.350) individuals by pooled the two northern strata together and likewise for the southern strata as shown in Table 1.

DISCUSSION

Consideration of a characteristic of each stratum for pooling option

It is known that sighting conditions (e.g. sea state) and distribution pattern of Antarctic minke whale were different between the northern stratum (*N*) and southern stratum (*S*). The sea state conditions are generally better in the *S* than the *N* and thus wider strip widths are expected. The mean school size was expected to be different latitudinally because larger schools distributed in the *S* than the *N*. On the contrary, solitary animal schools distributed in the *N* than the *S* (Matsuoka *et al.* 2001). These were also supported by the fact that small body size immature male Antarctic minke whales with small school size were prevailed in the *N* strata based on JARPA data (Fujise *et al.* 1999).

According to recent analyses, it was clear that sighting cues (blow or body), *Ws* and *E(s)* changed by latitudes (Murase *et al.* 2002). Further, as a result of ANOVA, there was significant difference in average of perpendicular distance and in mean school size between *N* and *S*, whereas there is no significant difference among vessels (Hakamada and Matsuoka 2002). It was confirmed that taking into account characteristics of *N* or *S* the pooling within *N* or *S* should be applied when sample size was small.

Revised abundance of Antarctic minke whale in the part of Area IV (between 80-130E) was estimated 10,470 (CV=0.350) individuals although it is not include other factors for their abundance (e.g. Effect of g (0) and abundance in the pack ice etc.). The previous abundance estimation was 7,140 (CV=0.345) by pooling all strata together to estimate *Ws* and *E(s)* (Burt and Stahl 2001). Revised abundance estimation is 47 % increasing compare with pooled all strata together. A view point of environmental and biological reasons, abundance estimates which taking into account characteristics of *N* or *S* was plausible than previous estimation.

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Table 1. Revised estimates of parameters for Antarctic minke whales (04: Antarctic minke + 92: Like Antarctic + 91:undetermined minke) by each mode in the IWC/ SOWER 1998/99 cruise in the part of Area IV (80-130E). Truncate is at 1.5 n.miles. The g (0) is assumed to be one. Eastern and western strata were pooled (the two northern strata together (EN+WN) and likewise for the southern strata (ES+WS))for *W(s)* and *E(s)* in this analysis.

Closing: Closing mode, **IO:** Independent observer mode, **A:** area size, **L:** Searching distance n.miles), **n:** Number of schools sighted, after smearing and truncation at a perpendicular distance of 1.5 n.miles. ***Ws*:** effective search half-width for schools (n.miles), ***E(s)***: estimated mean school size (based on schools with confirmed school size in closing mode only), **P:** uncorrected abundance estimates.

mode	stratum	A	L	n	n/L	CV	Ws	CV	E(s)	CV	P	CV
Closing	EN	169,387	557.43	6.0	0.011	0.282	0.490	0.321	1.25	0.200	2,323	0.472
	WN	105,396	259.36	5.0	0.019	1.213					2,589	0.869
	ES	70,193	608.14	19.4	0.032	0.344	0.998	0.196	1.27	0.088	1,430	0.406
	WS	42,605	377.62	4.0	0.011	0.641					287	0.676
IO	EN	169,387	578.69	18.2	0.031	0.234	0.686	0.278	1.25	0.200	4,856	0.414
	WN	105,396	377.80	17.7	0.047	1.079					4,495	1.132
	ES	70,193	685.92	23.5	0.034	0.204	0.730	0.323	1.27	0.088	2,098	0.392
	WS	42,605	472.33	14.8	0.031	0.387					1,161	0.512

WN: West-North stratum (but a part of it was not covered).

WS: West-South stratum (but a part of it was not covered).

EN: East-North stratum, **ES:** East-South stratum.

Table2. Abundance estimates of Antarctic minke whales by each mode in the IWC/ SOWER 1998/99 cruise in the part of Area IV (80-130E). Pseudo-passing estimates are calculated by dividing the closing mode estimates by R= 0.751 (CV=0.152). Truncate is at 1.5 n.miles. The g (0) is assumed to be 1.

Year	Area	Closing mode		IO mode		Pseudo-passing		Inverse-var weighted	
		Total	CV	Total	CV	Total	CV	Total	CV
1998/99	part of Area IV (80-130E)	6,630	0.531	12,610	0.441	8,828	0.552	10,470	0.350

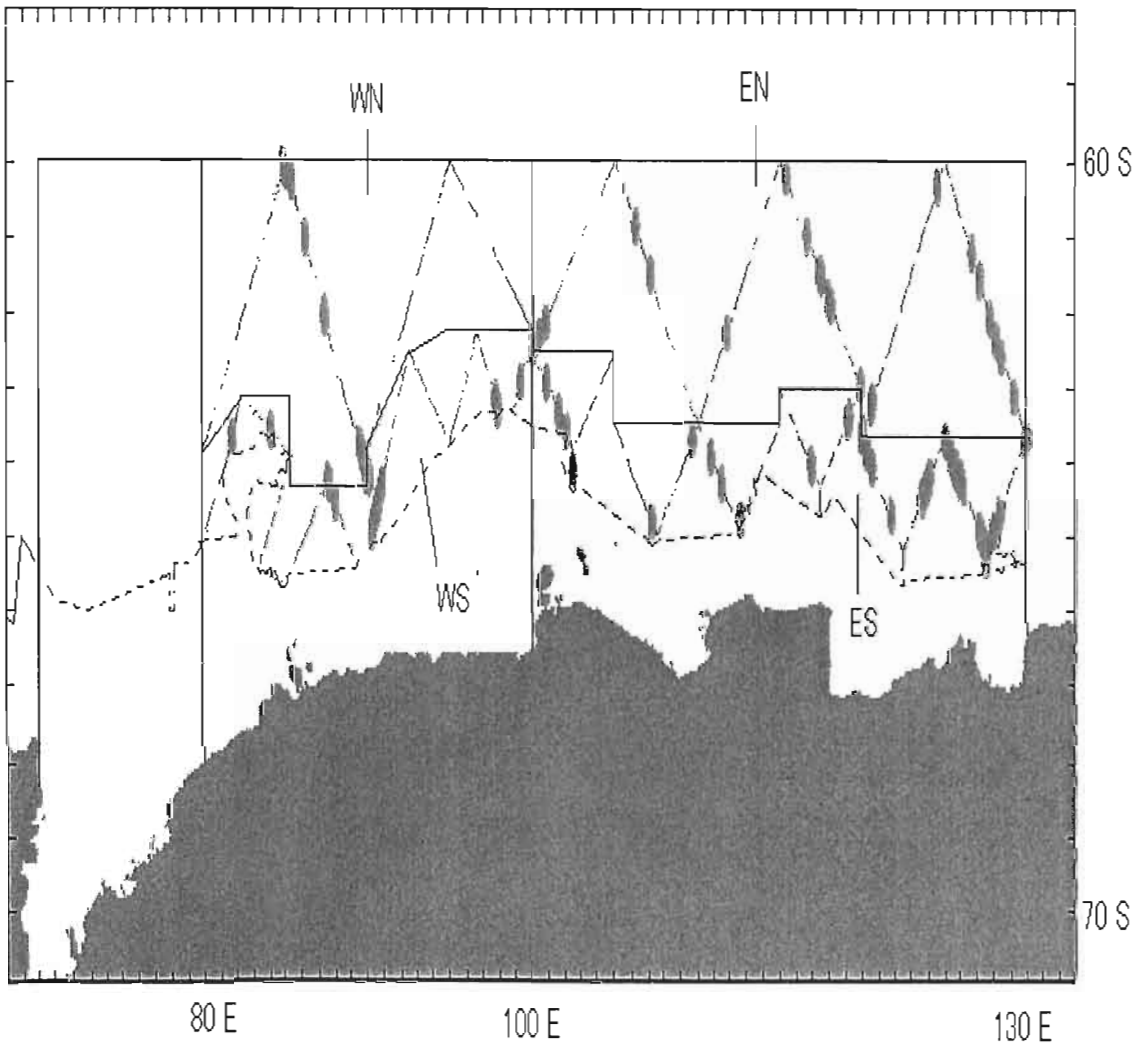

Figure1. Distribution of primary Antarctic minke whale schools sighted (gray ellipse) during IWC/SOWER-1998/99 cruise in the part of Area IV (80E-130E). Black zone is the Antarctic continent.

A dotted line shows the estimated ice-edge line.

A solid line shows the boundary between southern and northern strata.

WN: West-North stratum (but a part of it was not covered).

WS: West-South stratum (but a part of it was not covered).

EN: East-North stratum.

ES: East-South stratum.

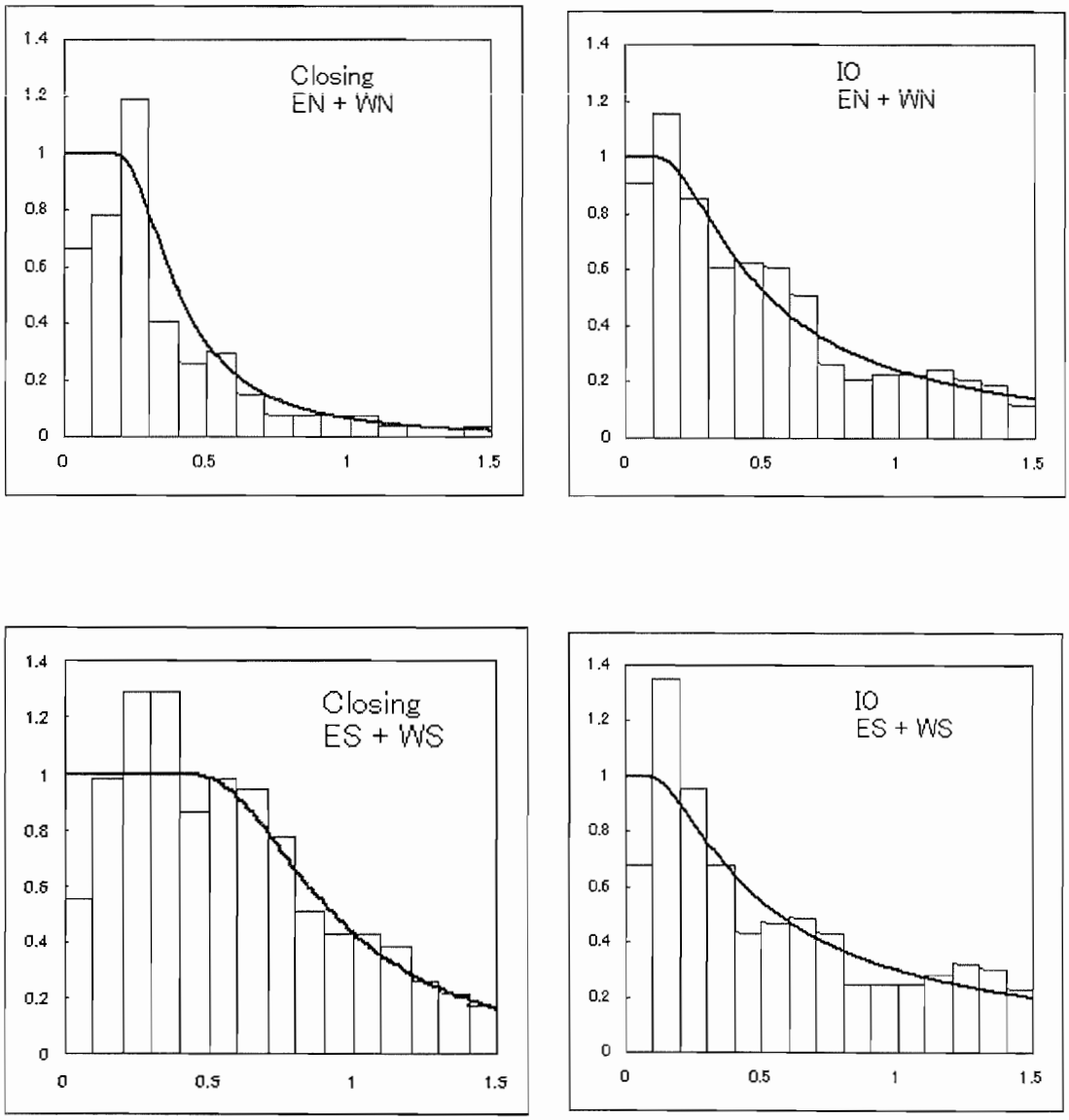

Figure2. Detection probability plots of each pooling strata by each survey mode as shown in Table1.

The left: Closing mode,

The right: IO mode.

WN: West-North stratum (but a part of it was not covered).

WS: West-South stratum (but a part of it was not covered).

EN: East-North stratum.

ES: East-South stratum.