Abundance trend of Antarctic minke whales in Areas IV and V based on JARPA data

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ABSTRACT

Abundance trends for Antarctic minke whales (*Balaenoptera bonaerensis*) in Areas IV and V based on JARPA (1989/90-2003/04 in Area IV and 1990/91-2004/05 in Area V) were estimated. Those were estimated to be 1.2% and -1.3% in Areas IV and V, respectively. As their 95% confidential intervals are (-2.8%, 3.9%) and (-4.3%, 1.1%) in Areas IV and V, respectively, there is no significant trend in Areas IV and V from JARPA abundance data. However, the change in Area V may be negatively biased because of possible underestimate of abundance in 2004/05. Change in abundance estimates is different between IWC- IDCR/SOWER and JARPA in Areas IV and V. JARPA surveyed in Areas IV and V every two years for 16 years, respectively whereas IDCR/SOWER surveyed three times in these Areas in 26 years. It is suggested that JARPA provide more reliable trend of abundance estimate.

KEY WORDS: ANTARCTIC MINKE WHALES, ABUNDANCE ESTIMATE, TREND

INTRODUCTIONS

Hakamada *et al*., (2005) estimated abundance trend based on JARPA taking into account for correction of biases pointed out at JARPA review meeting in 1997 (IWC, 1998) by using correction method in Haw (1991). Adding to abundance estimates in Hakamada *et al*. (2005), an abundance estimate for the minke whales in Area V of 94,000 (CV=0.173) in 2004/05 was used to re-estimate the trend. This paper briefly introduce whether the abundance trend would change adding recent abundance estimate in Area V.

MATERIALS AND METHODS

Abundance estimates
Table 1 shows abundance estimate based on JARPA in Hakamada *et al*. (2005) and new abundance estimate in 2004/05 in Area V. 'Combined estimates' of Sampling and Sighting Vessel (SSV), dedicated Sighting Vessel (SV) closing and SV passing, which are eliminated the bias due to closing and sampling, are used to estimate instantaneous increasing rate.

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 of logarithm of abundance on year weighted by inverse of square of their CV was applied in order to estimate instantaneous increasing rate and their 95% confidential intervals. Because the result suggested that trend estimates using SV abundance is not precious enough, 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 correction factors *R*1 and *R*2 estimated from abundance estimate for all year. To overcome this difficulty, Monte Carlo Simulation was conducted.

Monte Carlo simulation
We denote abundance estimated from SSV in year *y* as $P_{1,y}$, abundance estimated from SV in closing mode in year *y* as $P_{2,y}$ and abundance estimated from SV in passing mode in year *y* as $P_{3,y}$. Superscript *p* indicate that it was Pseudo data. Pseudo data set was produced according to equations (1) – (3).

$$(\sigma_{i,y})^2 = \ln\left[1+\{\mathrm{CV}(P_{i,y})\}^2\right] \qquad (i=1,2,3) \qquad (1)$$

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

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

$$\mathrm{se}(P_{i,y}^p) = P_{i,y}^p\mathrm{CV}(P_{i,y}) \qquad (i=1,2,3) \qquad (3)$$

Combined abundance estimate was calculated from the Pseudo data set and estimated trend similarly as described in previous section. This procedure was repeated 999 times to estimate 95% confidential interval of the slope, which was estimated by

$$(a_{25}, a_{976}),$$

where a_i is the *i* th slope estimated from produced data set arranging increasing order.

RESULTS

Table 2 shows the abundance trend estimates in Areas IV and V. Those were estimated to be 1.2% and -1.3% in Areas IV and V, respectively. Their 95% confidential intervals are (-2.8%, 3.9%) and (-4.3%, 1.1%) in Areas IV and V, respectively. From the 95% confidential intervals, there is no significant increase/decrease trend from 1989/90 to 2004/05 in both Areas.

DISCUSSIONS

Estimated abundance trend in Area V is different between in this study and in Hakamada *et al*. (2005). This difference is due to the abundance estimate of 94,000 in 2004/05, which may be possibly underestimated. This estimate is less than usual in Area V. Because of this abundance estimate, the change of abundance estimate in Area V may be negatively biased. The reason why this abundance estimate was obtained is not identified at this stage. In 2004/05, warm surface water was distributed widely in survey area. (Nishiwaki *et al*., 2005) and Ross Sea connected widely with Area VI. These could be one of the possible reasons of lower density than usual in northern stratum. Further sighting surveys in Area V by JARPA II will make clear if the abundance estimate in 2004/05 is reliable or not.

The estimated abundance trend in this study inconsistent with abundance estimate ratio of CPIII to CPII of 0.12 in Area IV and 0.56 in Area V (Branch, 2005). These apparent drops in estimated abundance cannot be explained by the estimated abundance trend based on JARPA. JARPA surveyed in Areas IV and V every two years for 16 years, respectively whereas IDCR/SOWER surveyed three times in these Areas in 26 years. It is suggested that JARPA provide more reliable trend of abundance estimate.

In this study, it is assumed that *g*(0)=1. From the estimate of mean school size and effective half strip width in Hakamada *et al*. (2005), there seems no significant trend in those estimates. It can be considered that assumption that *g*(0)=1 would not bias abundance trend.

The estimated upper and lower bound of 95% CI might be underestimated because median of estimated increasing rate from resamples is lower by 0.6% in Area IV and by 0.3% in Area V than point estimate in Table 1.

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Table 1. Abundance estimate in Areas IV and V used to estimate abundance trend in this study.

Area IV

year	SSV	CV	SV-closing	CV	SV-passing	CV	Combined	CV	95% CI LL	95% CI UL
1989/90	30,788	0.164					54,772	0.231	35,061	85,564
1991/92	31,913	0.201					56,774	0.258	34,507	93,407
1993/94	26,438	0.176	24,845	0.273			41,895	0.211	27,816	63,098
1995/96	22,890	0.201	62,523	0.463			42,882	0.245	26,694	68,886
1997/98	16,969	0.227	18,490	0.650			29,683	0.266	17,780	49,554
1999/00	40,352	0.170	66,611	0.320	40,548	0.241	49,922	0.168	35,997	69,233
2001/02	51,830	0.197	31,352	0.334	75,631	0.240	67,954	0.169	48,900	94,434
2003/04	54,040	0.493	29,081	0.680	41,123	0.556	47,818	0.358	24,204	94,468

Area V

year	SSV	CV	SV-closing	CV	SV-passing	CV	Combined	CV	95% CI LL	95% CI UL
1990/91	106,739	0.174					189,887	0.238	119,936	300,635
1992/93	59,770	0.251	120,077	0.248			126,590	0.232	80,885	198,122
1994/95	78,613	0.307	157,260	0.318			164,121	0.269	97,709	275,674
1996/97	93,904	0.251	122,968	0.432			169,878	0.265	102,035	282,829
1998/99	120,655	0.197	83,983	0.755			195,991	0.251	120,689	318,278
2000/01	97,891	0.176	265,198	0.971	168,708	0.618	174,904	0.222	113,877	268,635
2002/03	166,016	0.179	114,702	0.434	212,558	0.227	225,796	0.162	164,576	309,790
2004/05	73,902	0.260	84,095	0.442	84,114	0.221	93,989	0.174	66,952	131,945

Table 2. Point estimate of increasing rates in Areas IV and V and their 95% confidential interval

Area	trend	confidence interval	
Area IV	1.2%	-2.8%	3.9%
Area V	-1.3%	-4.3%	1.1%