The relationships between sea ice extension and trends in sighting parameters of Antarctic minke whales based on IDCR-SOWER data from CPII to CPIII

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ABSTRACT
The relationship between sea ice extensions and the trends in sighting parameters (Area size (A), effort (L), number of school sightings (ns), effective search half width (Ws), mean school size (E(s)), abundance estimates (P)) from CPII to CPIII, used in the estimations of abundance of Antarctic minke whale by Branch (2005), was investigated. According to recent information, sea ice extensions were observed in most management Areas from CPII to CPIII, except Area VI. Especially, large sea ice extensions were observed in Areas III and IV. On the other hand, sea ice reduction was observed in Area VI. The present analysis was focused on Areas III-W, IV-E and VI-W where survey area changed clearly due to the sea ice extension from CPII to CPIII. The sighting rate and mean school size decreased in the case of Areas III-W and IV-E, but they increased in the case of Area VI-W. It is possible that sea ice extension has caused the under estimation of Antarctic minke whale abundance for CPIII in Areas III and IV.

KEY WORDS: ANTARCTIC, SURVEY VESSEL, DISTRIBUTION, ABUNDANCE ESTIMATE, ANTARCTIC MINKE WHALE

INTRODUCTION

It is clear that relationship between sea ice coverage and abundance estimates of Antarctic minke whales is relevant, based on the following studies in recent SC meeting;

1) Sea ice was more extensive in CPIII than CPII in Area I, II, III, IV and V based on the satellite data. It is suggested that estimates of Antarctic minke whales in these Areas were underestimated due to some unsurveyed area where vessels could not survey within the sea ice (Shimada and Murase, 2005).
2) According to the sea ice analysis in each Area between CPII and CPIII, an unusually extensive sea ice free area, polynia, adjacent to the southeastern side of the Antarctic Peninsula was observed in the CPIII in Area II. Such large polynia were not observed via satellite during the rest of the observation period (1979-2002). The vessels could not survey within the polynia because the sea ice prevented access to the polynia (Murase *et al*, 2005).
3) By the ice breaker observations, it was confirmed that there were some Antarctic minke whales in the sea ice area where the normal vessels could not enter the area (Shimada and Kato, 2005).

This paper reports relationship between sea ice extensions and the trends in sighting parameters of Antarctic minke whales from CPII to CPIII, based on IDCR-SOWER abundance estimation.

MATERIAL AND METHODS

Sea ice data

Fig. 1 show that January sea ice extent anomaly (million km^2) trend in each Area from 1979 to 2002. Bootstrap sea ice concentrations are from Nimbus-7 SMMR and DMSP SSM/1. The triangles and circles indicate survey years in CPII and CPIII, respectively. Sea ice extensions were observed in almost management Areas from CPII to CPIII except Area VI (Shimada and Murase, 2005).

Index of the sea ice extent and abundance estimates

Shimada and Murase (2006) investigated the Index of the estimated abundance and sea ice extent compared to CPIII and CPII (Fig. 2).

Sea ice information and cruise track lines

We extracted these information from IWC/DESS. A database package called DESS 3.5 (Strindberg and Burt 2004) has been developed to automate the process of extracting survey data and to invoke the Distance software program to provide estimates of abundance. Fig. 3a-3c compared the stratification and cruise track lines from CPII and CPIII in Areas III, IV and V. Fig.5 compared the cruise track line and sighting positions of the Antarctic minke whale in CP I, II and III.

Sighting parameters

We used the sighting parameters (Area size (A), effort (L), number of school sightings (ns), effective search half width (Ws), mean school size (E(s)), abundance estimates (P)) between CPII and CPIII, based on IDCR-SOWER abundance estimation (Table 4a- 4e, Branch, 2005).

RESULT AND DISCUSSION

Each Area was divided into two classes by Fig.2. Large abundance declines were observed in Areas III and IV. On the other hand, sea ice reduction was observed in Area VI (Shimada and Murase, 2005). Fig. 3a-3c also indicated the status of sea ice extensions and reduction. We found that west half of Area III, east half of Area IV and west half of Area VI showed larger difference between CPII and CPIII. Therefore, we focus on Areas III-W, IV-E and VI-W where survey area changed clearly due to the sea ice extension from CPII to CPIII. However, we excluded Area II, because large polynia was not surveyed in CPIII and abundance estimate could be underestimated greatly (Murase *et al*., 2005).

As a result, the sighting rate (ns/L) and mean school size (E(s)) were decreased in the case of larger sea ice extension (Areas III-W and IV-E), but they increased in the case of sea ice reduction (Area VI-W) (Fig. 4a and 4b). Present results suggested that sea ice extension caused to decrease of the sighting rate (ns/L) and mean school size (E(s)) of Antarctic minke whales, and this caused the under bias of the abundance estimates in most Areas in CPIII.

Based on this conclusion, we should adopt the abundance estimates during normal sea ice condition years, and would emphasize the necessity of appropriate corrections for estimates during sea ice extension years in the CPIII. Present data support this conclusion.

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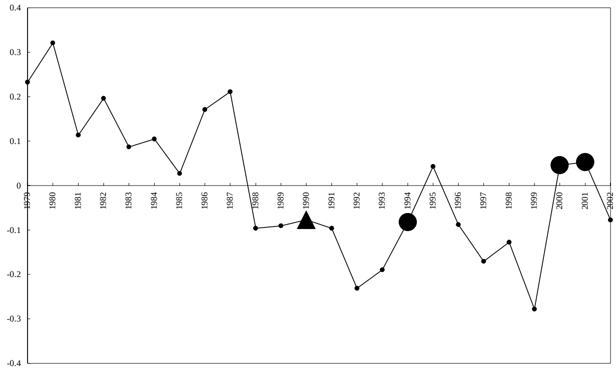
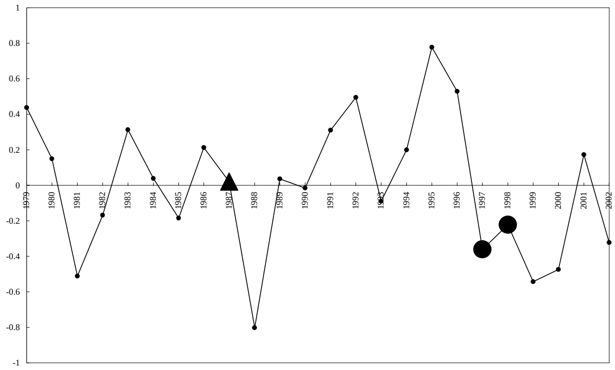
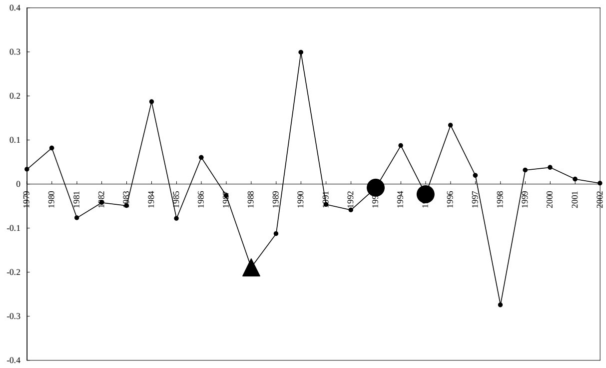


Area I



Area II



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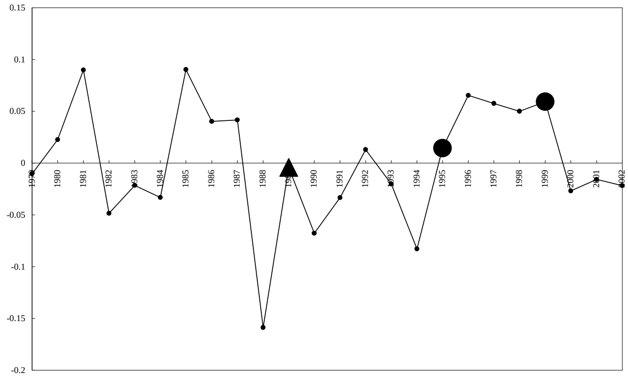
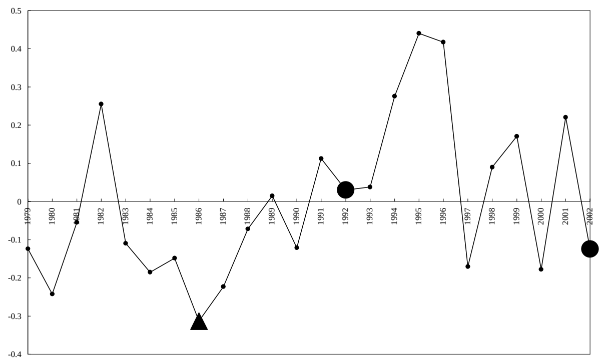
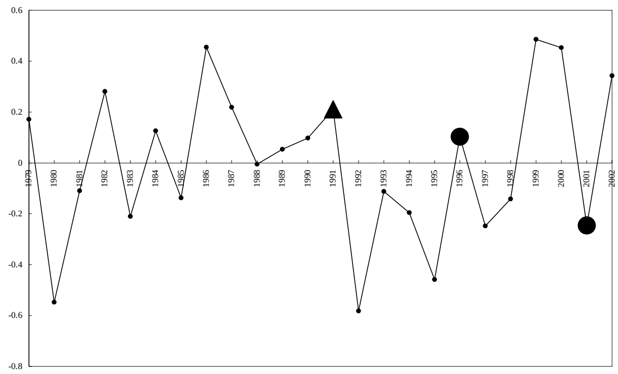


Area IV



Area V



Area VI

Fig.1. January sea ice extent anomaly (million km^2) trend in each Area from 1979 to 2002. Bootstrap sea ice concentrations are from Nimbus-7 SMMR and DMSP SSM/1. The triangles and circles indicate survey years in CPII and CPIII, respectively. sea ice extensions were observed in almost management Areas between CPII and CPIII except Area VI (Shimada and Murase, 2005）.

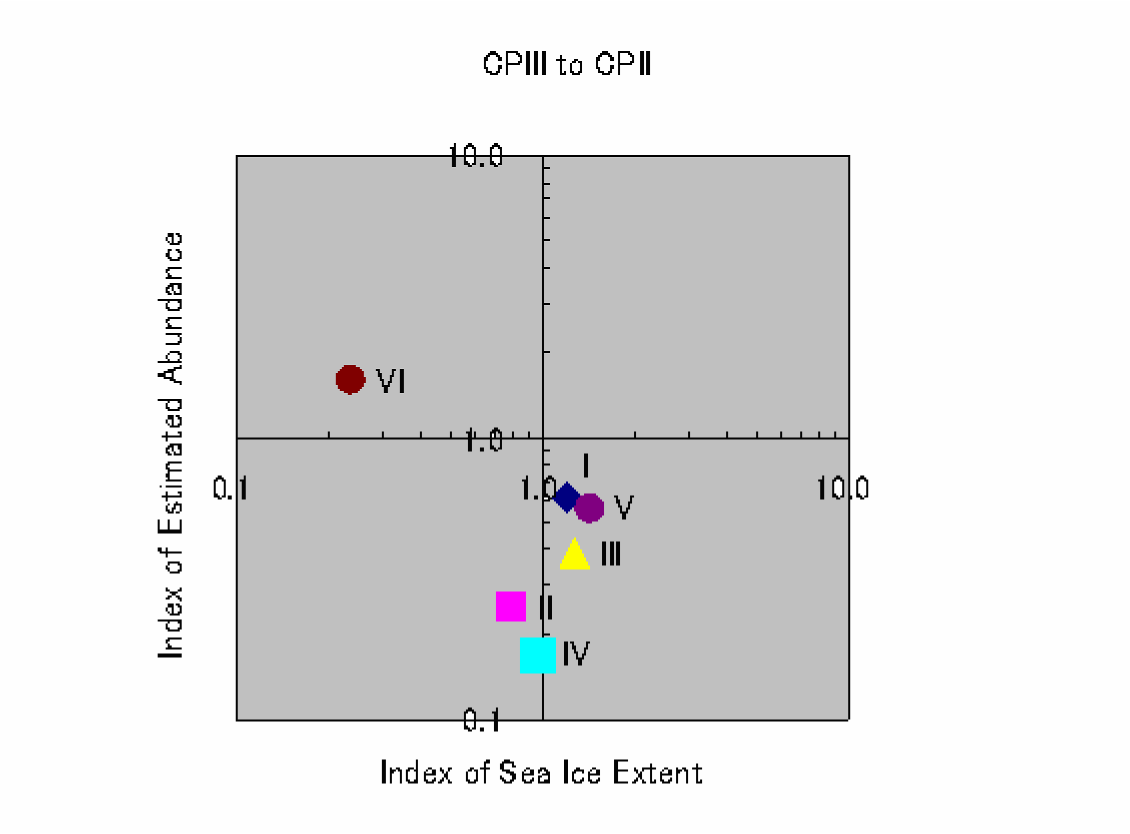


Fig.2. Relationship between Index of estimated abundance and sea ice extent compare to CPIII and CPII (Shimada and Murase, 2006).

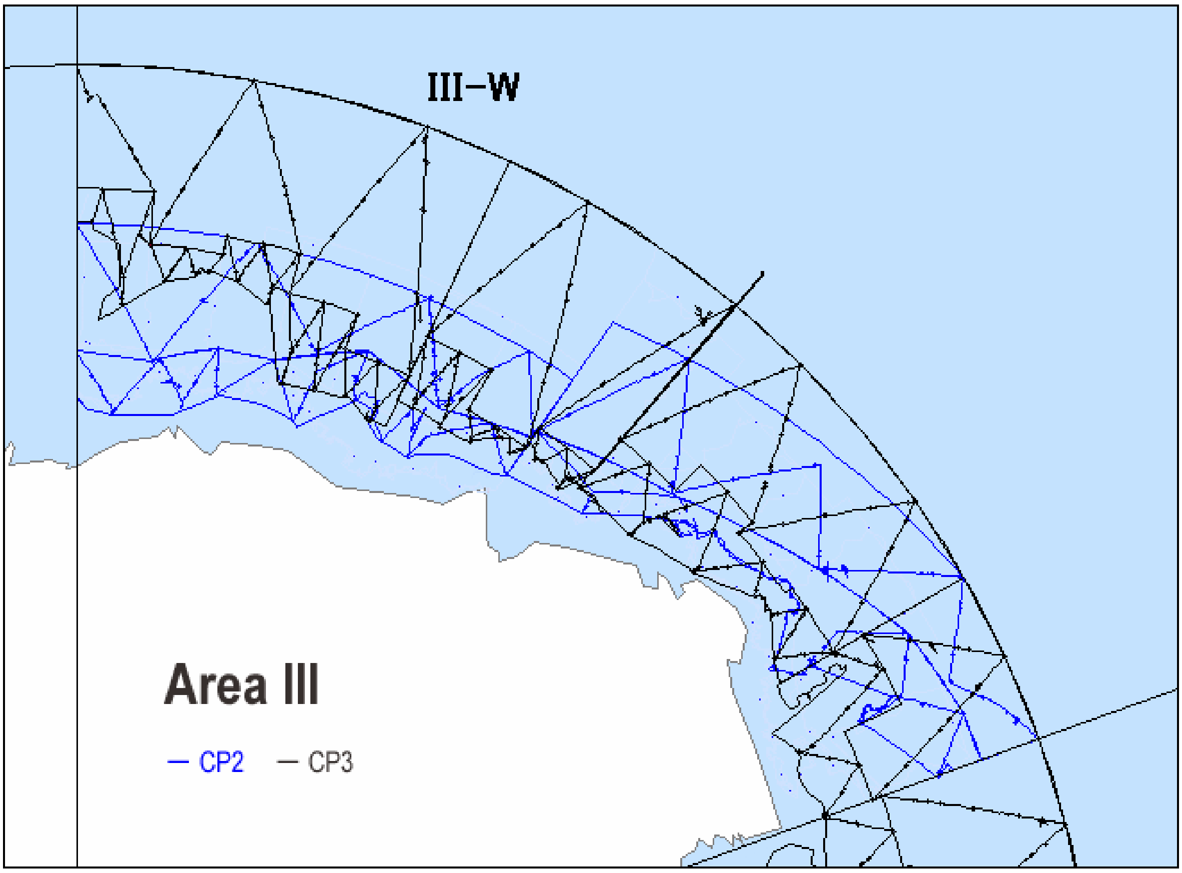


Fig. 3a. Comparison of the stratification and cruise track between CPII and CPIII in Area III.

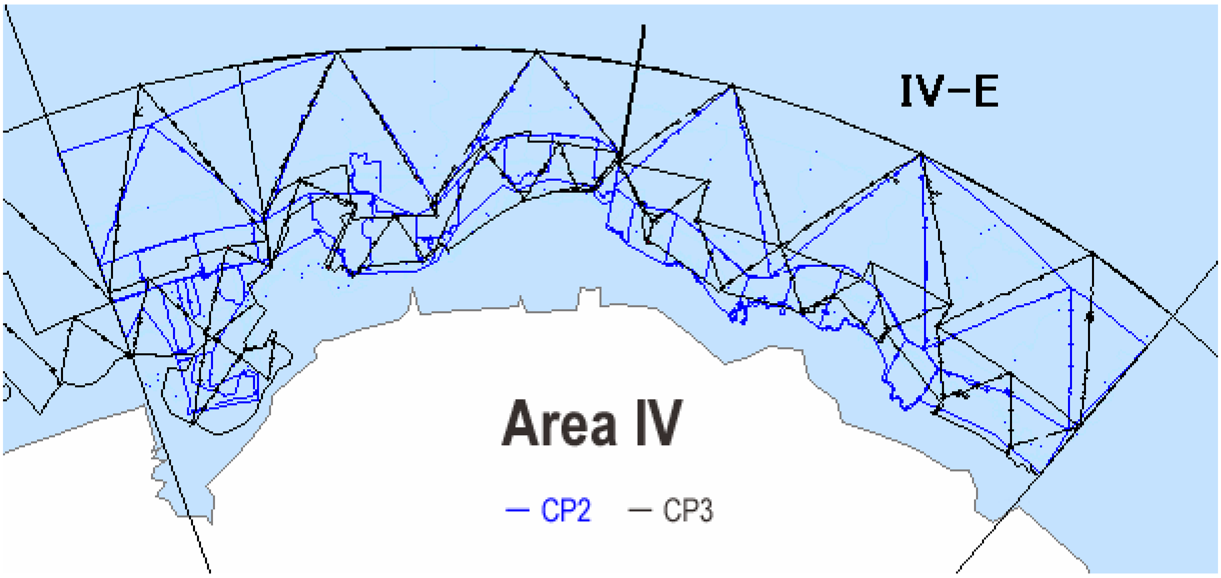


Fig. 3b. Comparison of the stratification and cruise track between CPII and CPIII in Area IV.

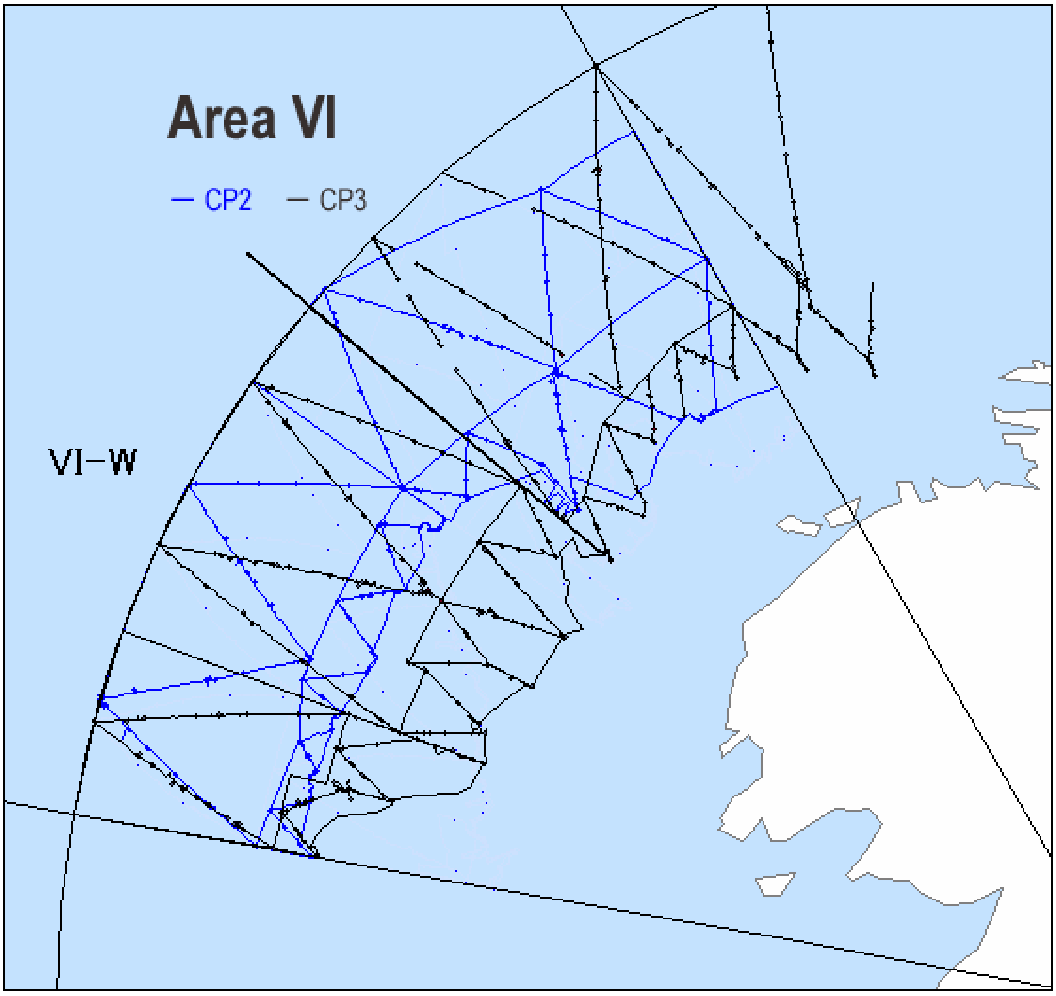


Fig. 3c. Comparison of the stratification and cruise track between CPII and CPIII in Area VI. Survey area changed clearly due to the sea ice coverage between CPII and CPIII.

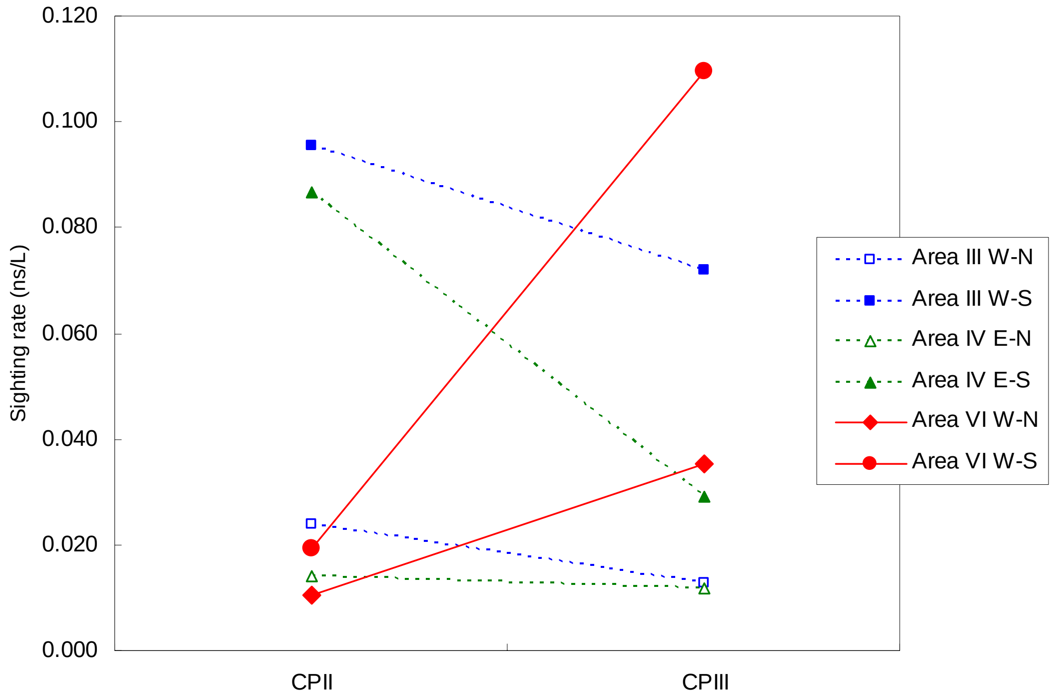


Fig. 4a. Trends in the sighting rates (number of whales / n.mile) of Antarctic minke whales in Closing mode (NSC) between CPII and CPIII.

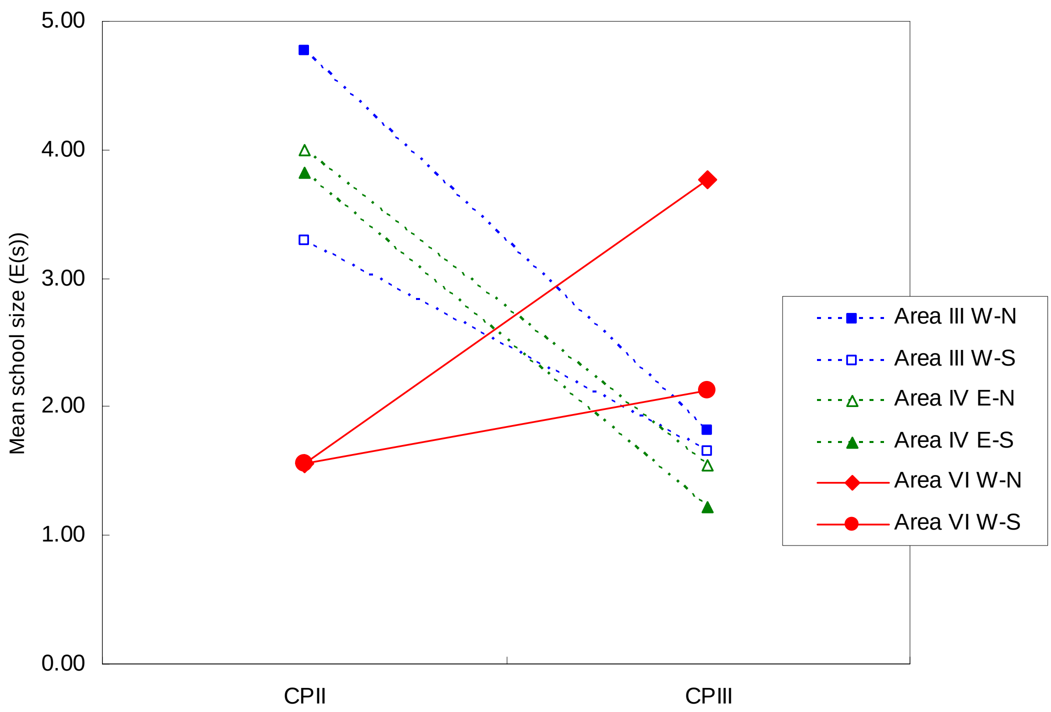


Fig. 4b. . Trends in the mean school size of Antarctic minke whales in Closing mode (NSC) between CPII and CPIII.

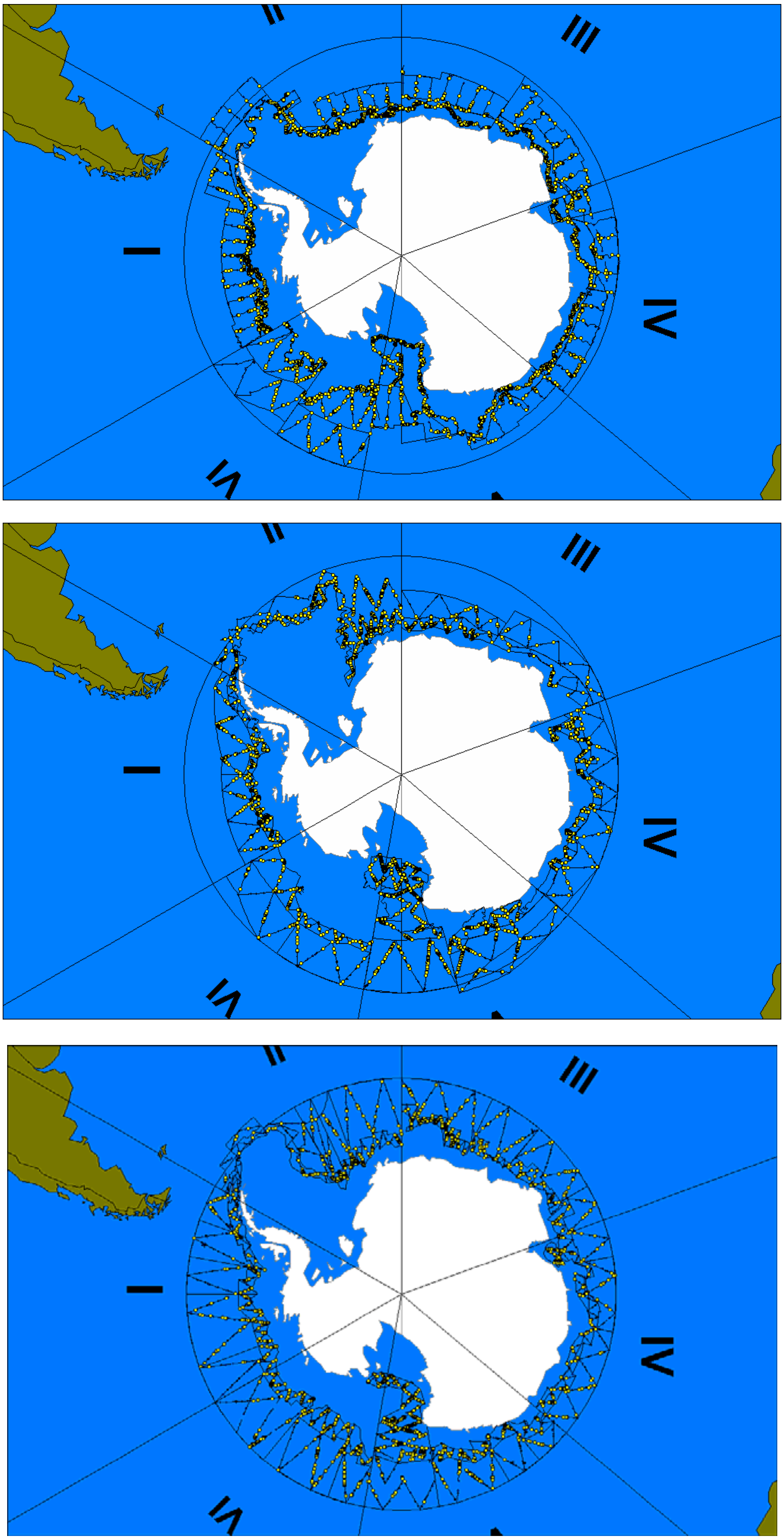


Fig. 5. Comparison of the cruise track and sighting position of Antarctic minke whales in each Area (Upper: CPI, middle: CPII, Lower: CPIII).