Re-consideration of the sub-areas for the RMP *Implementation* of western North Pacific common minke whales

Tomio Miyashita[1] and Hiroshi Hatanaka[2]

[1] *National Research Institute of Far Seas Fisheries, Fukuura 2-12-4, Kanazawa-ku, Yokohama, Kanagawa 236-8648, Japan*
[2] *The Institute of Cetacean Research, Toyomi-cho 4-5, Chuo-ku, Tokyo 104-0055, Japan*

Abstract
This paper proposes a new designation for sub-areas based on the available information on migration patterns and stock structure of J and O stocks, and a procedure to ensure a satisfactory and sustainable harvesting in their migration corridors.

Introduction
Sub-areas and *Small Areas* which were a combination of sub-areas in the western North Pacific were designed during the *Implementation Simulation Trials* (*IST*) of common minke whales which was completed by the International Whaling Commission Scientific Committee (IWC SC) in 2003. Figure 1 shows the sub-areas used in 2003. However, some of those sub-areas were not designed based on the best biological information available for this species in the western North Pacific at that time, in particular the migration pattern and segregation by sex and maturity of the O-stock minke whales (Hatanaka and Miyashita, 1997). The specifications of the RMP in 2003 did not take into account that the harvest occurs on the migration corridor of the stock, and consequently abundance estimates and calculated catch limits were not satisfactory for sub-areas 7, 8 and 9, which are on the migration corridor of this stock. On the other hand the migration pattern of the J-stock was not available in 2003, but some relevant information have become available in recent years and has been summarized to some extent in (Hatanaka *et al*., 2009, Goto *et al.,* 2010).

This paper propose a new designation for sub-areas based on the available information on migration patterns of J and O stocks, and a procedure to ensure a satisfactory and sustainable harvesting in their migration corridors.

1. Sub-areas in the Okhotsk Sea

1) Problems with current sub-areas 11 and 12

The boundary between sub-areas 11 and 12 at 46ºN was not based on any biological ground, but it was just based on the political boundary between Russia and Japan. Sub-areas 12SW and 12NE were designed based on flipper color patterns of 169 minke whales caught by the test whaling of *Miwa-maru* (Kato *et al*., 1992).

It is known that differences exist in breeding periods between the J and O stocks, of about three months (Kato, 1992). Therefore the timing of migration to and from the Okhotsk Sea have to be different for these stocks. However this was not taken into account in the 2003 *ISTs*.

2) Suggestions to improve the designation of sub-areas

Available information and suggestions are shown separately by two feeding migration seasons, one is April-June whoch is the assumed season for J-stock and the other is July-September which is the assumed season for O-stock.

a. April-June

- Limited information on flipper color pattern exist (most of the whaling operations by *Miwa-maru* were done in July-September) (Kato *et al*., 1992).
- Allozyme (Wada, 1991) and mtDNA (Pastene and Goto, 1998) data were available for sub-area 11. Data on mixing proportion of O and J stocks based on data in April and May are considered more reliable due to larger sample sizes in those months (see IWC, 2004).
- J-stock whales are assumed to come from the Sea of Japan through La Pérous Strait (Soya Strait), and therefore their occurrence and distribution have to depend largely on the sea ice conditions in March and April (Figure 2).
- In March the sea is open only along the coast of Hokkaido and east coast of southern Sakhalin. In April a passage through La Perous Strait to main Okhotsk Sea is formed. The distribution of J-stock in these months shall be limited to the south western part of Okhotsk Sea (Goto *et al.*, 2010).
- Based on the considerations above it is suggested to divide the Okhotsk Sea into two sub-areas by lines at 50ºN and 150ºE as shown in Figure 3.
- Based on the genetic data in the new sub-area 11 a considerable number of J-stock is

assumed to be mixed in this season.

- Based on the observation of cookie-cutter shark scars in the new sub-area 12 only O-stock animals are assumed to occur in this season.
- Further collection of data on stock structure in this season and sub-areas is necessary.

b. July-September

- Data on flipper color pattern was available in the northern part and south-west part of sub-area 12 (Kato *et al*., 1992).
- Information from allozyme (Wada, 1991) and mtDNA (Pastene and Goto, 1998) is available for sub-area 11, however sample sizes are small and data on mixing proportion of O and J stocks in those months are not considered reliable (see IWC, 2004).
- The breeding season (conception date) of J-stock is assumed to be September to November (Kato, 1992), and therefore most of the J animals should have left this area by July-September.
- An analysis of cookie-cutter shark scars showed that the proportion of J-stock animals in the Okhotsk Sea in August and September was zero (Miyashita *et al*., 2010).
- Same as in the April-June season it is proposed to divide the Okhotsk Sea into two sub-areas by lines at 50ºN and 150ºE as shown in Figure 3.
- It is assumed that few J-stock animals occur in sub-area 11 in this season..
- It is assumed that only O-stock animals occur in sub-area 12 in this season.
- Further collection of data on stock structure in this season and sub-areas is necessary.

2. Sub-areas 7, 8 and 9

1) Problems with current sub-areas 7, 8 and 9

These three sub-areas were divided into eastern and western, respectively based on some stock structure scenarios, particularly Baseline stock scenarios C and D, which proposed three and two O stocks in the Pacific side of Japan, respectively.. Consequently, abundance estimates became small with large CV. For example 585 animals with CV=1.07 in the case of sub-area 8W (IWC 2003).

2) Suggestions to improve the designation of sub-areas

As noted above specifications of stock structure hypotheses C and D were the reasons for further sub-division in sub-areas 7, 8 and 9. For example line at 147ºE (dividing sub-area 7 into west and east) and 153ºE (dividing sub-area 8 into west ad east)are associated with Scenario C while lines at 147ºE and 162ºE (dividing sub-area 9 into

west and east) are associated to scenario D. All the new information on stock structure accumulated after the 2003 *ISTs* should be considered to evaluate the plausibility of these stock structure scenarios. Hypothesis C was based on the application of a single technique (Boundary Rank-BR) and the same technique was used on an updated set of genetic data (Gaggiotti and Durand, 2010). It will be important to discuss results of this study and whether or not they continue supporting stock structure scenario C.

- If the updated Boundary rank analysis does not support the baseline C, then we should abandon the divisions at 147ºE and 153ºE (variant of scenario C).
- Recent genetic analyses based on updated data sets and hypothesis testing (some of which included analysis of statistical power) do not support stock scenarios C and D (Goto *et al*., 2009a,b; Kanda *et al*., 2009a,b; IWC, 2009). Based on those results divisions at 147ºE, 153ºE and 162ºE are questioned.
- It is assumed that the sub-areas contain the animals from the following stocks:

  Sub-area 7: some J-stock animals are mixed with O stock (Kanda *et al*., 2009c; d);

  Sub-area 8: only O-stock animals;

  Sub-area 9: only O-stock animals but some W-stock animals because genetic data still showing some support to Baseline A (Kanda *et al*., 2009a; b).

3. Reconsideration of sub-areas in the Sea of Japan

After the new information on stock structure is discussed and stock structure hypotheses are agreed, reconsideration of sub-areas in the Sea of Japan might be necessary.

4. Intrusion of sub-area 12 into the Pacific Ocean

At the start of the *ISTs* for western North Pacific minke whales detailed geographical configuration of the Kuril Islands, which are the border between Okhotsk Sea and Pacific Ocean, was not considered. As a consequence the current sub-area 12 included a part the Pacific Ocean. This has been corrected in the new definition for sub-area 12 (Figure 3).

5. Division of sub-area 2

This sub-area is assumed to be the breeding areas of O-stock. However, most of animals (80%) incidentally caught in the coastal part of sub-area 2 were identified as J-stock (Kanda *et al*., 2009c;d), though animals in the offshore waters in this area are assumed

to be O-stock. Based on the genetic information this sub-area should be divided into coastal and offshore ones. The Kuroshio Current can be used as a natural boundary between O and J stocks in this sub-area. A line between two points, 35ºN 141ºE and 30º30'N 131ºE, will represent the axis of Kuroshio Current in this area (Figure 4).

Sub-area 2W: Breeding area of both J and O-stocks

Sub-area 2E: Breeding area of O-stock

6. Sub-area 13

Sub-area 13 (east of 170E) was classified as a residual area for which abundance was not estimated. .However sighting surveys might be conducted in the near future. Then this residual-area shall be changed to a sub-area (or *Small Area*). New information on stock structure could suggest other changes for both sub-areas 9 and 13 in the future.

7. Harvesting in the migration corridor

1) Problems with the current treatment

Coastal areas around Japan are basically considered the migration corridors of minke whales, though some of the areas were feeding areas of young animals (Hatanaka and Miyashita, 1997). Therefore it is true that past Japanese coastal whaling was made exclusively in the migration corridor. Future whaling will be held in the same manner. However in the *Small Areas* defined on the basis of sub-areas 7, 8 and 9 in the migration corridor, abundance was estimated in summer when most of animals had already passed through. Consequently small catch limits were calculated for these sub-areas.

The RMP/ISTs procedure should be adapted to take into account this situation.

This problem have been discussed as "Spatio-temporal consideration" in the IWC SC from 2003 to 2005 meetings (IWC, 2004; 2006), and the IWC SC agreed with a modification to the Annotation 2 of the RMP during the 2005 meeting (IWC, 2006). Some *Small Areas* are defined to be a combination of feeding and migratory areas, and temporal and/or spatial restrictions on whaling are charged to avoid unfair harvesting of one stock. However this treatment is not satisfactorybecause the problem is not resolved at all in the case of small areas formed only from migratory corridors sub-areas.

2) Suggestion

Given the current knowledge on stock structure and migration pattern, from the

biological
point of view there is no problem that the catch limit calculated in a feeding area is taken in the migration corridor on which animals pass through toward the feeding area. A modification to the RMP Specification is suggested that the catch limits for the *Small Area* in feeding area can be taken in the migratory corridor.

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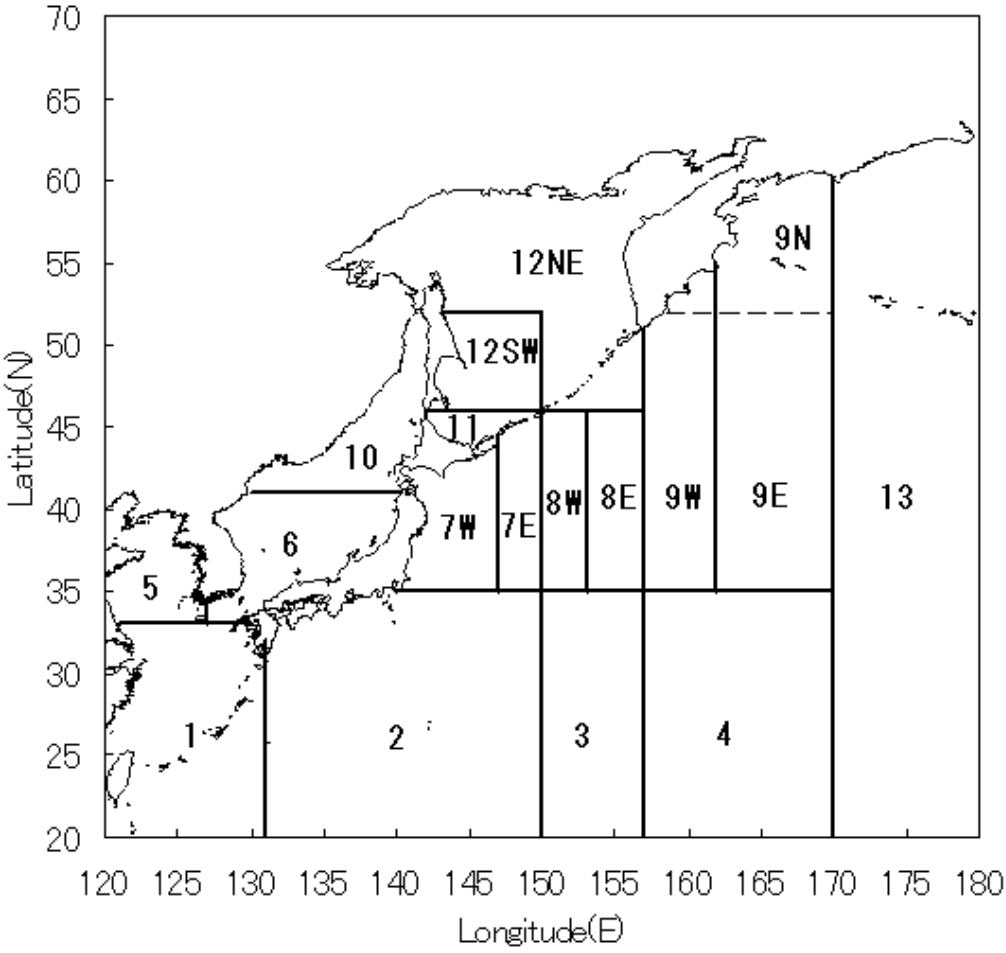
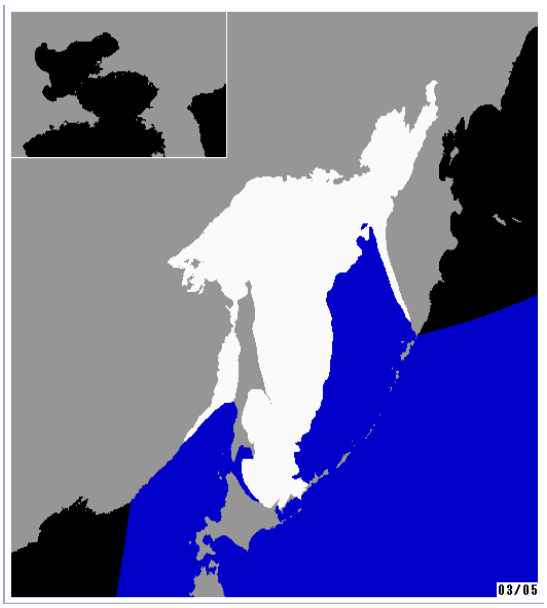


Fig. 1. Definition of sub-areas for the RMP/IST of the western North Pacific minke whales.



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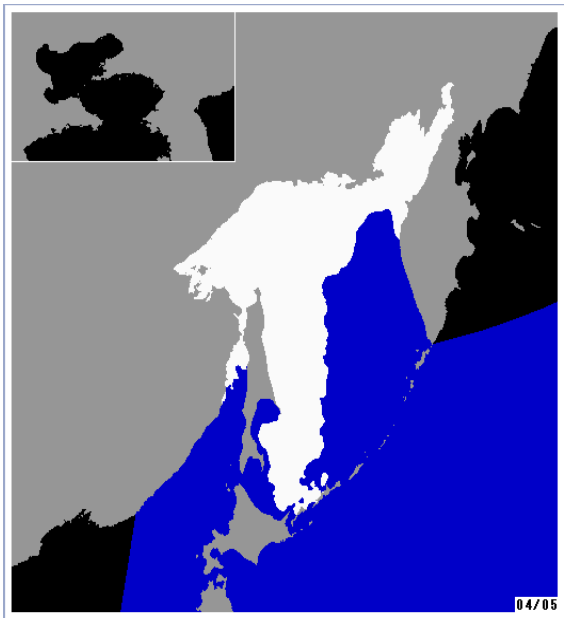

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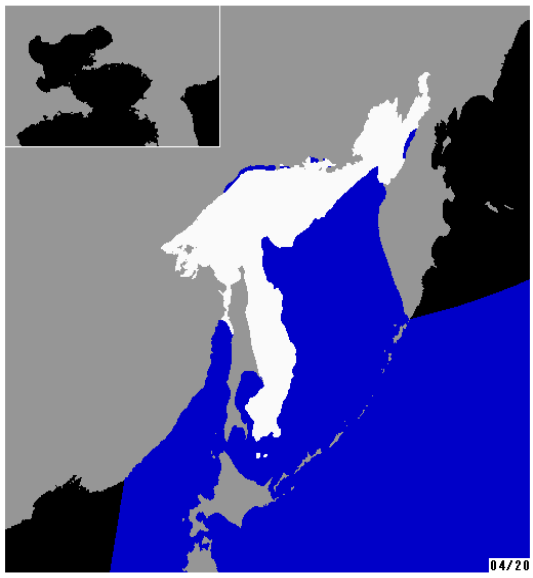

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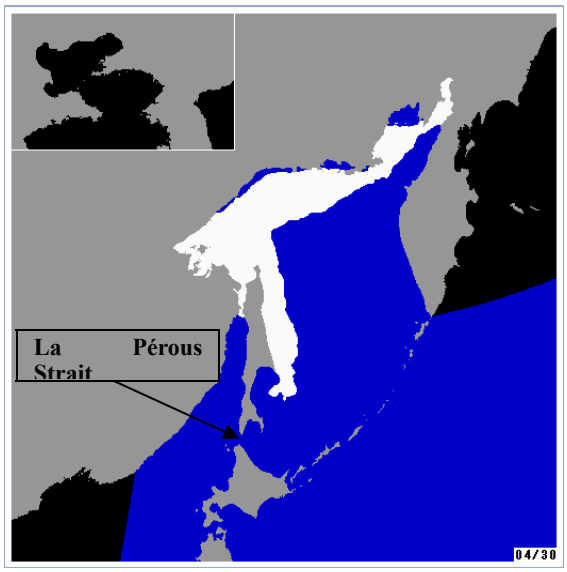

30 April

Fig.2. Average occupation of sea ice in the Sea of Okhotsk during 1971 to 2000.
From the website of the Japan Meteorological Agency
(http://www.data.kishou.go.jp/kaiyou/db/seaice/okhotsk/okhotsk_normal.html).

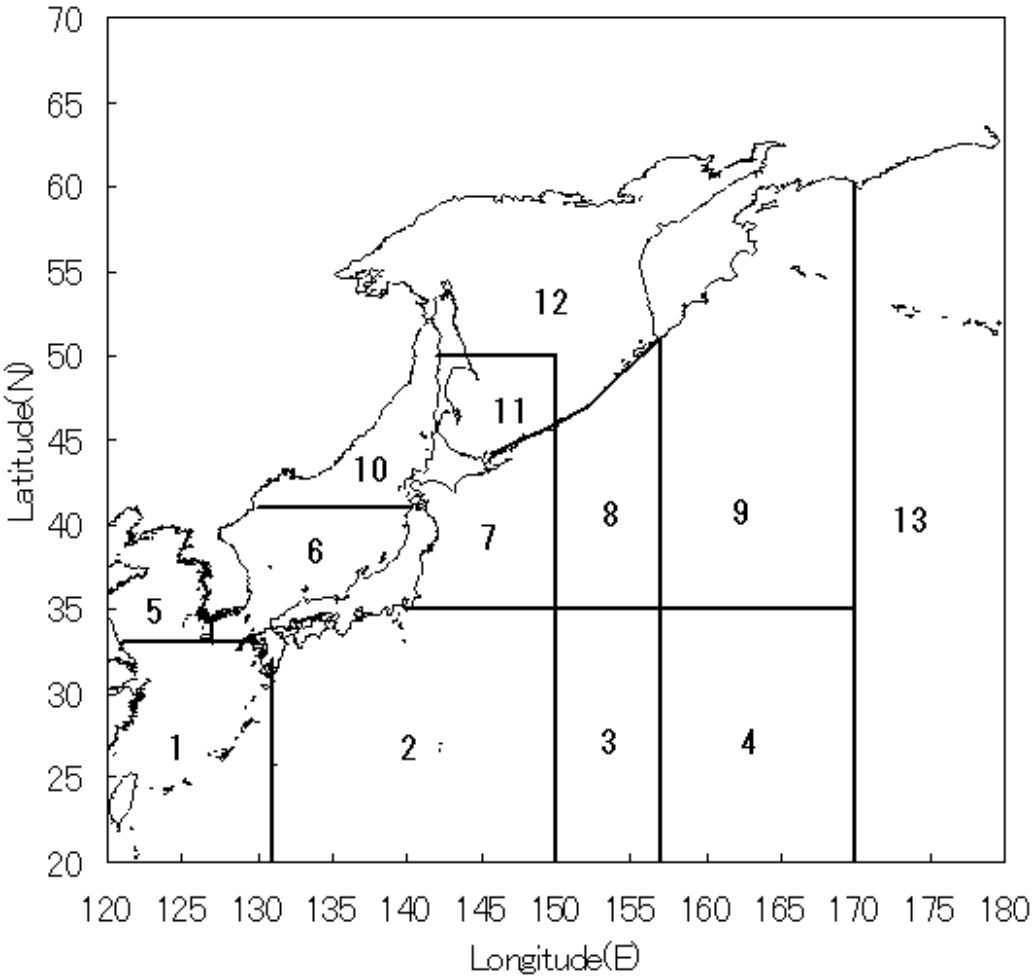

Fig. 3. Suggested new sub-areas 11, 12 and 8.

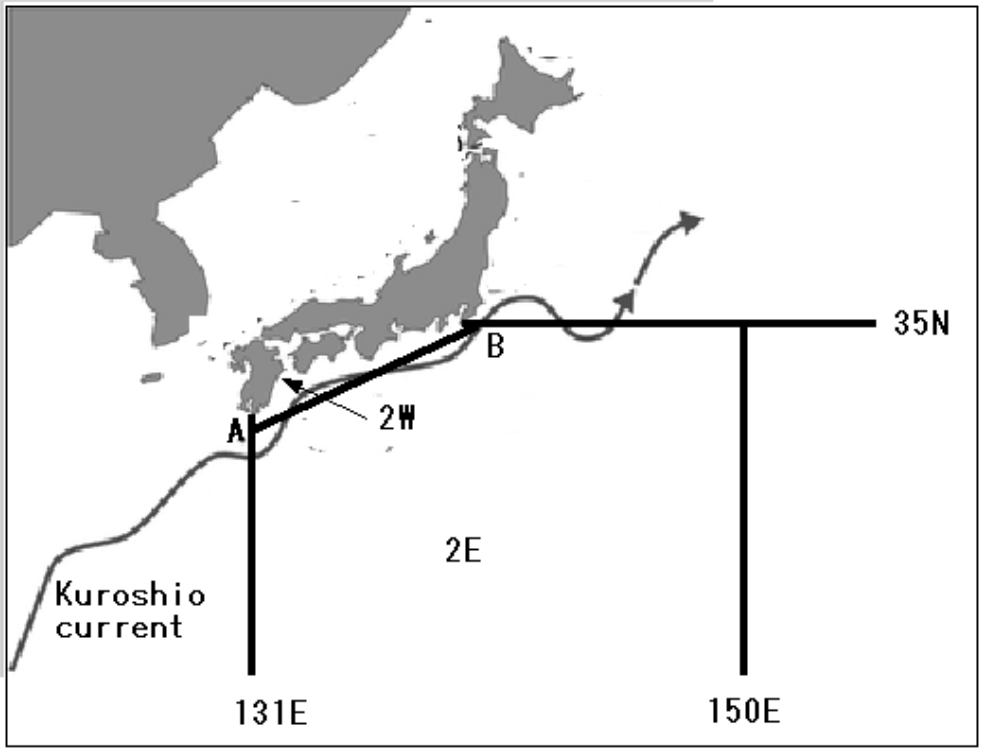

Fig. 4. Average root of the Kuroshio current and the suggested division of the sub-area 2.
A: 30°30'N, 131°E B: 35°N, 141°E.