Non-genetic data provide little support for additional structure in the J and O stocks common minke whales

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ABSTRACT

Wade *et al.* (2010) reviewed non-genetic biological information relevant to the stock structure of common minke whales in the Yellow Sea, Sea of Japan and western North Pacific. Results of their review were considered by Wade and Baker (2010) in the context of structure hypotheses of the J and O stocks. This exercise derived in the proposal of an hypothesis on stock structure (stock structure Hypothesis 5) which includes the following components: i) different stocks in the Yellow Sea and Sea of Japan; ii) different J stocks in the western and eastern side of Japan; and iii) different O stocks in coastal and offshore areas of the Pacific side of Japan. Non-genetic information was re-examined in the context of stock structure Hypothesis 5. Our re-examination took into account a) the relative value of different non-genetic information for determining stock structure; b) the interpretation of the authors of the original studies reviewed; and c) the known biological characteristics of minke whales such as temporal and geographical segregation by sex and maturity stage. On the basis of this re-examination we concluded that the available non-genetic data provide little support for the three components of Hypothesis 5 indicated above.

KEYWORDS: COMMON MINKE WHALE, WESTERN NORTH PACIFIC, STOCK STRUCTURE, NON-GENETIC DATA, RMP *IMPLEMENTATION*

INTRODUCTION

Wade *et al.* (2010) reviewed non-genetic biological information relevant to the stock structure of common minke whales in the Yellow Sea, Sea of Japan and western North Pacific. They structured the review to examine four questions:

Q1) Are whales in the Yellow Sea part of a population that migrates into the Sea of Japan?
Q2) Are whales along the Korean coast part of the same population as whales that migrate along the Japanese west coast?
Q3) Are whales on the east coast of Japan the same population as on the west coast of Japan?
Q4) Is there a coastal population in sub-area 7 that is different from offshore minke whales in the Pacific Ocean?

Questions 1 and 2 are less complicated to respond than questions 3 and 4 because it has been assumed that only J stock minke whales distributed in the Yellow Sea and Sea of Japan. Questions 3 and 4 are more complicated because of the known occurrence and mixing of both O and J stocks in the coastal areas of the Pacific side of Japan. For this reason the IWC SC has repeatedly recommended the exclusion of any animals that are likely to be from the J stock in the analysis of O stock (IWC, 2003).

Results of the review by Wade *et al.* (2010) were considered (in conjunction with genetic information) by Wade and Baker (2010) in the context of structure hypotheses of the J and O stocks. This derived in the proposal of an hypothesis on stock structure (stock structure Hypothesis 5) which involves the following components: i) different stocks in the Yellow Sea and Sea of Japan (Question 1 above); ii) different J stocks in the western and eastern side of Japan (Question 3 above); and iii) different O stocks in coastal and offshore areas of the Pacific side of Japan (Question 4 above).

In the context of Q3 and Q4 these authors interpreted the results of non-genetic information under two scenarios: two stocks (J and O) which mix to each other in the Pacific side of Japan; and two J stocks in case of Q3 and two O stocks in case of Q4. They considered the latter interpretation as the most plausible, which derived in the proposal of Hypothesis 5 with the three components mentioned above.

A common practice to investigate stock structure questions is the examination of several lines of evidences. However different lines of evidences have different values or utility for investigating stock structure (IWC, 2002) which should be recognized in any review of information. Furthermore it is very important to carry out a correct interpretation of the data and results in the context of what is known on the biology of the species investigated. The relevance of this is that hypotheses that are derived from a wrong interpretation and not supported by hard data could make the RMP *Implementation* a useless tool for management. For example the consequences of keeping some elements of Hypothesis 5 such as the occurrence of a coastal O stock, which to our opinion is not supported by strong evidences, is that the catch limits by the RMP in sub-area 7 will be virtually zero.

The objective of his paper was to re-examine the non-genetic information with the aim to evaluate the consistency of Hypothesis 5 with scientific data, specially the consistency of the components of this hypothesis mentioned above: i) different stocks in the Yellow Sea and Sea of Japan (Ql above); ii) different J stocks in the western and eastern side of Japan (Q3 above); and iii) different O stocks in coastal and offshore areas of the Pacific side of Japan (Q4 above).

Our re-examination took into account a) the relative value of different non-genetic information for determining stock structure; b) the interpretation of the authors of the original studies reviewed; and c) the known biological characteristics of minke whales such as temporal and geographical segregation by sex and maturity stage.

We focused on the same information examined by Wade *et al.* (2010): feeding grounds, whale density, migration pattern, immature/mature ratio, sex ratio, conception date, age at maturity, morphometrics, flipper color, baleen color, cookie cutter shark-induced scars, contaminants and stable isotopes.

RESULTS

The examination follows the information listed above.

Feeding grounds

Wade *et al.* (2010) reviewed the information on feeding grounds of minke whales around the Korean Peninsula reported by Wang (1985) and Gong (1982). On the basis of this review they concluded that differences in feeding grounds support the occurrence of different J stocks in the Yellow Sea and Sea of Japan (Q1), consistency with one or two stocks on both sides of Japan (Q3) and different O stocks in coastal and offshore Pacific of Japan (Q4) (Table 3 of Wade *et al.*, 2010 and Table 1 of Wade and Baker, 2010). It should be noted that no data was reviewed by those authors regarding the O stock in the Pacific side of Japan.

The occurrence of whales in different feeding grounds is not a strong argument to support stock differentiation as whales from a single stock can occupy different feeding grounds and perhaps the best example of this is the North Atlantic humpback whale.

The observation by Gong (1982) on mature females caught in the Yellow Sea in summer could be interpreted in the context of stock structure. It has been suggested that the feeding ground of adult J stock females might be the northern part of Sea of Japan and Southern Okhotsk Sea (Hatanaka *et al.*, 2010). Therefore one interpretation of this observation is that a different stock (Y stock), which migrates less extensively than the J stock, occurs in the Yellow Sea. The alternative interpretation is that adult females in the Yellow Sea correspond to non-migratory whales of the J stock. In the case of the Antarctic minke whales it has been reported that not all whales migrate to the Antarctic feeding grounds in spring/summer with some whales remaining in low latitude waters in those seasons.

As mentioned above Wade *et al.* (2010) provided no evidence or rational to their suggestion of two O stocks in the Pacific side of Japan (Q4). In the past the IWC SC had proposed several O sub-stocks based on possible site fidelity of the animals (IWC, 1994). However during its 2006 meeting the IWC SC, based on new results from JARPN, concluded that the sub-stock scenario proposed in 1993 was not plausible (IWC, 1997). Animals from a single stock can occupy different feeding grounds depending on sex and maturity. In the case of O stock for example most of adult females use the Sea of Okhotsk, while adult males spread widely from coastal to offshore waters in the Pacific Ocean and Sea of Okhotsk (Hatanaka and Miyashita, 1997). In the case of J stock, juveniles live mostly in coastal area, while adults make migration from warm breeding area to cold feeding area through offshore waters (Hatanaka *et al.*,2010;

Goto *et al.*, 2010). Pastene *et al.* (2003) conducted a genetic analysis based on mtDNA and microsatellite and found no significant differences among the sexual classes of minke whales in the Pacific side of Japan. Segregation by sex and maturity stage is well documented for Antarctic minke whales with mature females feeding further south than other components.

Segregation by sexual classes in the J stock (Hatanak et al., 2010) could also explain different feeding grounds on both sides of Japan.

In summary there is no ground from the review of feeding grounds to support the occurrence of different J stocks on both sides of Japan (Q3), different O stocks in the Pacific side of Japan (Q4). Considering maturity stage and the season in which minke whales have been observed in the Yellow Sea there is the possibility of additional stock structure there but other interpretations are also possible (Q1).

Whale density

Wade *et al.* (2010) reviewed the information on minke whales density in the Pacific side of Japan reported by the JARPN review workshop (relative density by longitude across the JARPN sub-areas) and Konishi *et al.* (2009) (NPMR model in the JARPN II sub-areas). On the basis of this review they concluded that differences in whale density support the occurrence of different O stocks in coastal and offshore areas in the Pacific of Japan (Q4) (Table 3 of Wade *et al.*, 2010 and Table 1 of Wade and Baker, 2010).

Differences in whale density index is not a strong argument to support stock differentiation as density of whales within a single stock can change spatially and temporally according to oceanographic conditions, which in turn determine the occurrence of prey species. Therefore whale density might depend on food availability. In the case of North Pacific minke whales, density also depends on the segregation pattern e.g. adult males distribute widely from coastal to offshore waters while juveniles tend to distribute in the coastal waters in sub-area 7, in addition to adult males (Hatanaka and Miyashita, 1997).

In any case the hiatus found by the JARPN review workshop and Konishi *et al.* (2009) at 147°E (which is referred by Wade *et al.*, 2010) can be explained by incomplete survey as this longitude relates to the boundary of the Russian EEZ, where Japanese vessels can not conduct surveys. Furthermore Okamura *et al.* (2001) investigated the spatial and temporal structure of the minke whale distribution based on JARPN sightings data and GAM. The authors concluded that the monthly transition of the density distribution suggested the northward seasonal feeding migration of the minke whale as suggested by Hatanaka and Miyashita (1997). This published paper was not consulted by Wade *et al.* (2010).

In summary there is no ground from whale density index to support the occurrence of different O stocks in the Pacific side of Japan (Q4).

Migration pattern

Wade *et al.* (2010) reviewed the information on migration pattern of minke whales reported in Omura and Sakiura (1956), Pastene *et al.* (2000), Kato *et al.* (1992), Zenitani *et al.* (2002) and Wang (1985). Based on their review they concluded differences between whales in the Yellow Sea and Sea of Japan (Q1), consistency with 1 or 2 stocks on both sides of Japan (Q3) and in the Pacific side of Japan (Q4) (Table 3 of Wade *et al.*, 2010 and Table 1 of Wade and Baker, 2010).

Information on migratory pattern could provide valuable information on the stock structure but such information should be appropriately interpreted, especially in the context of the known biological characteristic of the species e.g. differential pattern of movement and segregation by sex and maturity stage.

Regarding Q1 Wade *et al.* (2010) just said 'Wang (1985) describes a movement of whales into the northern Yellow Sea during spring and summer'. This is the only piece of evidence for their statement of differences in migratory pattern between Yellow Sea and Sea of Japan whales. Movement of whales into the Yellow Sea in spring summer do not necessarily mean stock differentiation, and other interpretations are possible as indicated above.

Regarding Q3, Wade et al. (2010) reviewed Omura and Sakiura (1956) and interpreted the catch pattern as northward movements of whales. Their interpretation is not correct as they confounded some geographical localities in Japan and they were not familiar with the technical aspects and complexities of whaling operations in the Sea of Japan. Clearly additional information on whaling operation and effort should be considered for an appropriate interpretation of catch data. These problems should be solved before a comparison of migration of J stocks animals on both sides of Japan is attempted (Q3). A detailed explanation of this was given during the discussions at the IWC SC 62 (Miyashita personal communication).

Regarding Q4 Wade *et al.* (2010) reviewed the information in Kato *et al.* (1992), Pastene *et al.* (2000) and Zenitani *et al.* 2002). However they did not mention the conclusion of these authors that their data were consistent with the occurrence of a single stock with marked segregation by sex and maturity stage.

Hatanaka and Miyashita (1997) drew a picture on the feeding migration of O stock and segregations with sex and maturity and concluded that it is likely that one stock is distributed widely from coastal sub-area 7 to offshore sub-area 9 with segregation depending on sex and reproductive status. Okamura *et al.* (2001) investigated the spatial and temporal structure of the minke whale distribution based on JARPN sightings data and GAM. The authors concluded that the monthly transition of the density distribution suggested the northward seasonal feeding migration of the minke whale as suggested by Hatanaka and Miyashita (1997). Unfortunately these two published papers were not consulted by Wade *et al.* (2010).

Information on migration pattern, if correctly described, could be very useful for determining stock structure. However the interpretation on migratory pattern made by Wade *et al.* (2010) has some problems as they did not take into consideration operational factors of whaling operations and the known characteristic of segregation by sex and maturity stage of this species.

Therefore the information on pattern of migratory movement reviewed by theses authors provide no basis to support different stocks in the Yellow Sea (Q1), different stocks on both sides of Japan (Q3) and different O stocks in the Pacific side of Japan (Q4).

Immature/mature ratio
Wade *et al.* (2010) reviewed the information on whale maturity stage of minke whales in the Pacific side of Japan and Okhotsk Sea reported in Kato (1992), Zenitani *et al.* (2002), Taylor and Martien (2003) and Wang (1985). Based on their review they concluded that the information on immature/mature ratio was consistent with two stocks in the Yellow Sea and Sea of Japan (Q1), differences on both side of Japan (Q3) and consistent with one or two stocks (Q4) (Table 3 of Wade *et al.*, 2010).

The immature/mature ratio is of limited value to elucidate stock structure especially for species where geographical and temporal segregation by sex and maturity stage has been documented, as in the case of minke whale.

In their review there were not analyses or discussion on this ratio in the Yellow Sea and Sea of Japan. Notwithstanding the authors concluded that the information is consistent with a different stock in the Yellow Sea (Q1) and that differences occur on both sides of Japan (Q3). As noted above this ratio is not useful for stock identification because the temporal and spatial segregation of minke whale in the Sea of Japan, i.e. adults and juveniles have different feeding areas in the case of J stock (Hatanaka *et al.*, 2010; Goto *et al.*, 2010).

In the Pacific side of Japan Hatanaka and Miyashita (1997) examined length composition data by sex and maturity stage of O stock minke whales (Figure 1). Segregation was clearly shown. Adult males appeared in all sub-areas, but adult females appeared mainly in the Sea of Okhotsk (sub-areas 11 and 12). Male and female juveniles appeared mainly in sub-area 7. Consequently, immature/mature ratio in each sub-area varied. This is caused by segregation and not related to stock differentiation.

Therefore the information on immature/mature ratio reviewed by these authors provide no basis to support different stocks in the Yellow Sea (Q1), different stocks on both sides of Japan (Q3) and different O stocks in the Pacific side of Japan (Q4).

Sex ratio
Wade *et al.* (2010) reviewed the information on sex ratio in the studies by Kato (1992), Zenitani *et al.* (2000;2002) and concluded that there differences for all four questions (Table 3 of Wade *et al.*, 2010).

Again sex ratio is not useful to elucidate stock structure questions especially in those species as minke whales where temporal and geographical segregation by sex and maturity stage has been documented (Hatanaka and Miyashita, 1997).

Differences in sex ratio among whales reported in Table 3 of Wade *et al.* (2010) are not useful for determining stock structure.

Conception date

Wade *et al.* (2010) reviewed the information on conception date of minke whales in the Sea of Japan, Okhotsk Sea and Pacific side of Japan in the studies of Kato (1992), Kato and Kasuya (1992) and Wang (1985), and concluded that the information reviewed was consistent with differences between Yellow Sea and Sea of Japan whales (Q1), differences between Sea of Japan and Pacific side of Japan whales (Q3) and no differences in O stock animals in the Pacific side of Japan (Q4) (Table 3 of Wade *et al.*, 2010 and Table 1 of Wade and Baker, 2010).

Conception date can be considered a useful indicator of stock structure as differences in this life history parameter have agreed well with genetic difference between North Pacific minke whale stocks. As noted by Wade *et al.* (2010) conception date between populations can be viewed as evidence the populations differ on an evolutionary time scale.

A summary of the information on conception date in minke whales is as follow. Wada (1984) showed gene frequency differences between whales from Korean and Japanese Pacific coastal areas. Wada (1991) found that pregnant females in sub-area 11 in April with large foetuses of 60 cm or more were very close to whales from Korean waters. Best and Kato (1992) examined foetal length data and suggested two groups that are effectively reproductively separated from each other by conception seasons six month apart. Kato (1992) found two groups of different conception dates, autumn and winter. Based on the foetal length reported by Matsura (1936) and Omura and Sakiura (1956) in the Sea of Japan and Wang (1985) in the Yellow Sea, Kato (1992) estimated that these animals were autumn conceptions. On the other hand, animals from sub-area 7 were winter conception. Kato (1992) reported that his foetal analysis agreed well with the Wada (1991)'s results in sub-area 11 where two groups were mixed. These results showed that minke whales in the Sea of Japan (J stock) were autumn conception while these in Pacific waters (O stock) were winter conception.

Given the comments on evolutionary time scale above it is likely that the differences suggested by Wade *et al.* (2010) between Sea of Japan and Pacific side whales (Q3) can be attributed to differences between J and O stocks, not to differences between J stock animals

Wade *et al.* (2010) noted that the Sea of Japan sample examined by Kato (1992) presented a bimodal distribution of conception dates. They therefore suggested two possibilities: animals in the Sea of Japan have two peaks of conception or the sample represents a mixture of two stocks. It should be noted that the sample from the Sea of Japan involved only 8 individuals caught in the west coast of Hokkaido. It is considered that the sample size was too small and too limited geographically to make speculation on stock structure as Wade *et al.* (2010) did.

Recently Bando *et al.* (2010) examined conception date of minke whales sampled by JARPN and JARPN II. They confirmed that minke whales genetically identified as J and O stocks have different conception dates although the span of the J stocks overlap with that of the O stock. Therefore an alternative explanation for the 'bimodal' pattern noted by Wade *et al.* (2010) for the Sea of Japan sample is that the span of conception dates in the J stock is larger than previously thought. In the sample of J stock from the Pacific side of Japan, Bando *et al.* (2010) found whales with both conception dates, a similar pattern as in the sample of 8 individual examined by Kato (1992). Then this result does not support the view of differences in conception dates on both sides of Japan (Q3). Furthermore Bando *et al.* (2010) found no differences in conception dates among O stocks in the Pacific side of Japan (Q4) coinciding with the evaluation of Wade *et al.* (2010). However the sample sizes is still small for final conclusions.

Regarding differences between Yellow Sea and Sea of Japan (Q1) suggested by Wade *et al.* (2010), such suggestion depends on the assumption made on the Sea of Japan sample. As explained earlier sample size in the Sea of Japan is too small to make speculations on stock structure.

Age of maturity
As noted by Wade *et al.* (2010) age of maturity provide little or no information on stock structure in North Pacific common minke whale.

Body size and morphometrics
Wade *et al.* (2010) reviewed the morphological and morphometric information in the studies of Omura and Sakiura (1956), Ohsumi (1983), Kato *et al.* (1992), Zenitani *et al.* (2000) and Hakamada and Bando (2009). On the basis of their review they concluded that the information was consistent with differences between whales on both side of Japan (Q3) and mixed results in the case of the Pacific side of Japan (Q4) (Table 3 of Wade *et al.*, 2010 and Table 1 of Wade and Baker, 2010).

Morphometric information can be considered a useful indicator of stock structure as differences in this character have agreed well with genetic difference between North Pacific minke whale stocks. As noted by Wade *et al.* (2010) differences in body length and morphometrics between populations can be viewed as evidence the populations differ on an evolutionary time scale.

Regarding Q3 several authors had found morphological and morphometric differences in minke whales from both sides of Japan. Contrary to the inference made by Wade *et al.* (2010), the original authors had attributed such differences to J and O stocks, not to differentiation within the J stock. This is much more plausible given the above comment on evolutionary time scale.

Regarding Q4 Wade *et al.* (2010) noted a significant p value ($p=0.05$) found in the comparison of body length distribution between sub-areas 7 and 8 in Zenitani *et al.* (2000). This was the only 'significant' p value in many pairwise comparisons made by these authors. As explained by these authors the low p-value could be due to sexual and reproductive segregation e.g. juveniles distribute mainly in coastal waters and adult males in offshore waters.

There were other morphometric studies not reviewed by Wade *et al.* (2010). For example Hakamada and Fujise (2000) conducted a morphometric analysis based on ANCOV and Hakamada and Fujise (2001) extended that work in response to some IWC SC recommendations. These studies and that of Hakamada and Bando (2009) concluded that there are differences in morphometric between O and J stocks animals (identified genetically) but that no differences were found among O stock animals in sub-areas 7, 8 and 9.

In summary morphometric studies suggest differences between Sea of Japan and Pacific side of Japan (Q3) but these differences are attributed to O and J stocks. No differences occur in the Pacific side of Japan among animals assigned genetically to the O stock (Q4).

Flipper color
Wade *et al.* (2010) reviewed the information on flipper color in the study of Kato *et al.* (1992). On the basis of their review they concluded that the information was consistent with differences between whales on both side of Japan (Q3) and no differences in the case of the Pacific side of Japan (Q4) (Table 3 of Wade *et al.*, 2010 and Table 1 of Wade and Baker, 2010).

Flipper color can be considered a useful indicator of stock structure as differences in this character have agreed well with genetic difference between North Pacific minke whale stocks.

Regarding Q3 Kato *et al.* (1992) found differences in this character in minke whales from both sides of Japan (Sea of Japan and Sanriku). Contrary to the inference made by Wade *et al.* (2010), the original author had attributed such differences to J and O stocks, not to differences within J stock animals.

In summary the information on flipper color provides no supporting evidence to separate the J stock into Sea of Japan and Pacific side of Japan.

Kanda *et al.* (2010a) conducted a new analysis on flipper color and tail color patterns. Samples from sub-area 7W were classified into J and O stocks based on microsatellite analyses (Kanda *et al.*, 2009). The study showed that the color type composition was different between the J and O stocks for both flipper and tail. No heterogeneity was found within the sample of O and J stocks.

Baleen color type
Wade *et al.* (2010) reviewed the study of Kato *et al.* (1992) and agreed with the opinion of the original authors that the color of baleen plate may simply be a function of age rather than difference between stocks.

Cookie cutter shark-induced body scars
Wade *et al.* (2010) reviewed the information on cookie cutter scars in the study of Goto *et al.* (2009). On the basis of their review they concluded that the information was consistent with differences in the case of the Pacific side of Japan (Q4) (Table 3 of Wade *et al.*, 2010 and Table 1 of Wade and Baker, 2010).

Cookie cutter shark-induced body scars can be considered a useful indicator of stock structure as differences in prevalence have agreed well with genetic difference between North Pacific minke whale stocks.

Wade *et al.* (2010) conducted some additional analyses based on Goto *et al.* (2009) data and sought that the degree of scarring increased moving east in sub-areas 7 to 9. But later they quoted decrease in the number of body scars in whales moving offshore. In any case it is known that this shark might not be distributed in the Sea of Japan while it is widely distributed in the Pacific Ocean. This means that scars might be useful for distinguishing whales from these two oceans basins. However we have no information on the distribution and abundance of cookie cutter sharks in the Pacific Ocean. Goto *et al.* (2009) also noted that the number of scars depend on age and latitudes.

Wade *et al.* (2010) concluded that the information on cookie cutter shark (prevalence of scar increase, decrease? to the east) is supportive of differences within O stock in the Pacific side (Q4). However the simple comparison of the number of scars is not a strong evidence to support such hypothesis. Comparisons among Pacific Ocean whales should take into consideration information on distribution and abundance of the cookie cutter shark in both coastal and offshore areas, which is not available yet.

Contaminant
Wade *et al.* (2010) reviewed the information on contaminants in the studies of Fujise (1996), Yasunaga *et al.* (1999), Nakata *et al.* (2000), Fujise *et al.* (2000), Yasunaga and Fujise (2009a;b). On the basis of their review they concluded that the information was consistent with differences in the case of the Pacific side of Japan (Q4) (Table 3 of Wade *et al.*, 2010 and Table 1 of Wade and Baker, 2010).

Level of contaminant accumulation could be a useful tool to examine stock structure, but for a correct interpretation, information of the behavior of the particular contaminant in the environment and accumulation pattern according to body length and age of the animals should be investigated.

Wade *et al.* (2010) examined several publications and noted some differences between sub-areas in the Pacific side of Japan. They considered that differences in Hg level between 7, 8 and 9 support the occurrence of different O stocks (Q4). Level of contaminants in whales depends exclusively on foods consumed and on the age and sex of the animals. Yasunaga and Fujise (2009a) whose data were used as an evidence for additional structure in the Pacific side of Japan, however, made a different interpretation. They considered that yearly changes in accumulation level of Hg in sub-area 9 reflect change in food habit rather than changes in accumulation levels of Hg in the environment. Again simple comparison of pollutant accumulation level between sub-areas is not useful for stock identification purposes.

Stable isotopes
Wade *et al.* (2010) reviewed the information on stable isotopes in the study of Mitani *et al.* (2000). They concluded that no useful information was available in that study for stock structure purposes.

DISCUSSION AND CONCLUSIONS

As noted earlier the examination of several lines of evidences is a common good practice for the investigation of stock structure. However before concluding on stock structure hypotheses, the relative utility of each piece of information for investigating stock structure should be evaluated. Furthermore a temporal and spatial segregation by sex and maturity stage is well documented for both North Pacific common and Antarctic minke whales. This characteristic of the species should be taken into account in the interpretation of non-genetic information in the context of the stock structure.

We focus here in those components of Hypothesis 5 that are still being a source of controversy and disagreement among IWC SC members: i) different stocks in the Yellow Sea and Sea of Japan (Q1); ii) different J stocks in the western and eastern side of Japan (Q3); and iii) different O stocks in coastal and offshore areas of the Pacific side of Japan (Q4).

Regarding Q1 the only observation possible to be interpreted in the context of stock structure is that reported by Gong (1982) on mature females caught in the Yellow Sea in summer. Because the feeding ground of adult females of J stock might be the northern part of Sea of Japan and Southern Okhotsk Sea (Hatanaka *et al.*, 2010) one of the interpretations of the Gong (1982)'s observation is that a different stock (Y stock), which migrates less extensively than the J stock, occurs in the Yellow Sea.

Therefore we consider that non-biological information is consistent with this component of Hypothesis 5 (Q1) (although other alternative interpretations are possible for this observation). It should be noted here that some evidences from the genetics are available to support the occurrence of a separated stock in the Yellow Sea (Kanda *et al.*, 2010b).

The information mentioned by Wade and Baker (2010) as supporting the hypothesis of different J stocks on both sides of Japan (Q3) are conception date, flipper color and morphometric. Furthermore these authors noted that feeding grounds and migration pattern information are consistent with 1 or 2 stocks on both sides of Japan.

As mentioned earlier migration pattern and feeding grounds are not particularly useful for determining stock structure. The occurrence of whales in different feeding grounds is not a strong argument to support stock differentiation as whales from a single stock can occupy different feeding grounds. Information on migratory pattern could provide valuable information on the stock structure but such information should be appropriately interpreted, especially in the context of the known biological characteristic of the species e.g. differential pattern of movement and segregation by sex and maturity stage. Perhaps for this reason the IWC SC did not consider these approaches in a review made on the utility of non-genetic approaches to examine stock structure in whales (IWC, 2002).

Different authors have demonstrated differences in conception date, flipper color and morphometric between whales from both sides of Japan. These authors attributed such differences to differentiation between J (Sea of Japan) and O (Pacific side of Japan) stocks. As noted by Wade *et al.* (2010) differentiation in these characters can be viewed as evidence the populations differ on an evolutionary time scale. Therefore differences in these characters can be attributed to differences between whales of the O and J stocks but not among whales within the J and O stocks. Indeed recent analyses in those characters have showed no differences among genetically identified J stock whales and no differences among genetically identified O stock whales.

Our conclusion is that non-genetic data provide no evidence to support different J stocks on both sides of Japan (Q3).

Wade and Baker (2010) concluded that the following information support the hypothesis of different O stocks in the Pacific side of Japan (Q4): cookie cutter shark-induced scars, contaminants, feeding grounds and whale density. They argued that information on migratory pattern is consistent with 1 or 2 O stocks in the Pacific side of Japan. As noted above information on feeding grounds and migratory corridors are not useful information for stock structure. Differences in whale density index is not a strong argument to support stock differentiation as density of whales within a single stock can change spatially and temporally according to oceanographic conditions, which in turn determine the occurrence of prey species. Therefore whale density might depend on food availability. In the case of North Pacific minke whales, density also depends on the segregation pattern e.g. adult males distribute widely from coastal to offshore waters while juveniles tend to distribute in the coastal waters in sub-area 7, in addition to adult males (Hatanaka and Miyashita, 1997; Okamura *et al.* 2001). In ay case the geographical 'gap' noted by Wade *et al.* (2010) at 147°E is due to incomplete survey. It is not a natural and persistent gap in distribution of the species.

The use of ecological markers (e.g. prevalence of cookie cutter shark-induced scars and contaminants) are very difficult to interpret without knowledge of the behavior and abundance of cookie cutter shark and particular contaminants in the environment. Differences in prevalence of the cutter shark-induced scars in the Pacific sub-areas are very difficult to interpret without more detailed biological information and abundance of the cookie cutter shark. On the other hand the original authors of the contaminant studies considered that yearly changes in accumulation level of Hg in sub-area 9 reflect change in food habit rather than changes in accumulation levels of Hg in the environment. Again simple comparison of pollutant accumulation level between sub-areas is not useful for stock identification purposes.

We concluded that the non-genetic information hardly support the existence of different O stocks in the Pacific side of Japan (Q4).

We considered that in their responses to Q3 and Q4 Wade *et al.* (2010) and Wade and Baker (2010) a) interpreted the phenomenon of segregation within a stock as differences between stocks; b) attributed evolutionary scale differences in some characters between J and O stocks to differences within J and O stocks, which is much less plausible; c) did not consider information of mixing of O and J stocks in the Pacific side of Japan; d) did not consider the interpretations given by the authors of the original papers consulted.

As mentioned earlier in the context of Q3 and Q4 Wade and Baker (2010) interpreted the results of non-genetic information under two scenarios: two stocks (J and O) which mix to each other in the Pacific side of Japan; and two J stocks in case of Q3 and two O stocks in case of Q4. They considered the latter interpretation as the most plausible, which derived in the proposal of Hypothesis 5 with the three components mentioned above. Our conclusion is that most of non-genetic data examined just confirm the differentiation between O and J stocks and mixing of these two stocks in the Pacific side of Japan and that those data are uninformative of sub-structures within O and J stocks.

We believe that two components of Hypothesis 5 (conclusions of Wade and Baker, 2010 regarding Q3 and Q4) are not supported by the non-genetic and genetic (Kanda *et al.*, 2010b; Park *et al.*, 2010) data. Therefore further consideration of these elements of Hypothesis 5 in the *Implementation* is not longer necessary.

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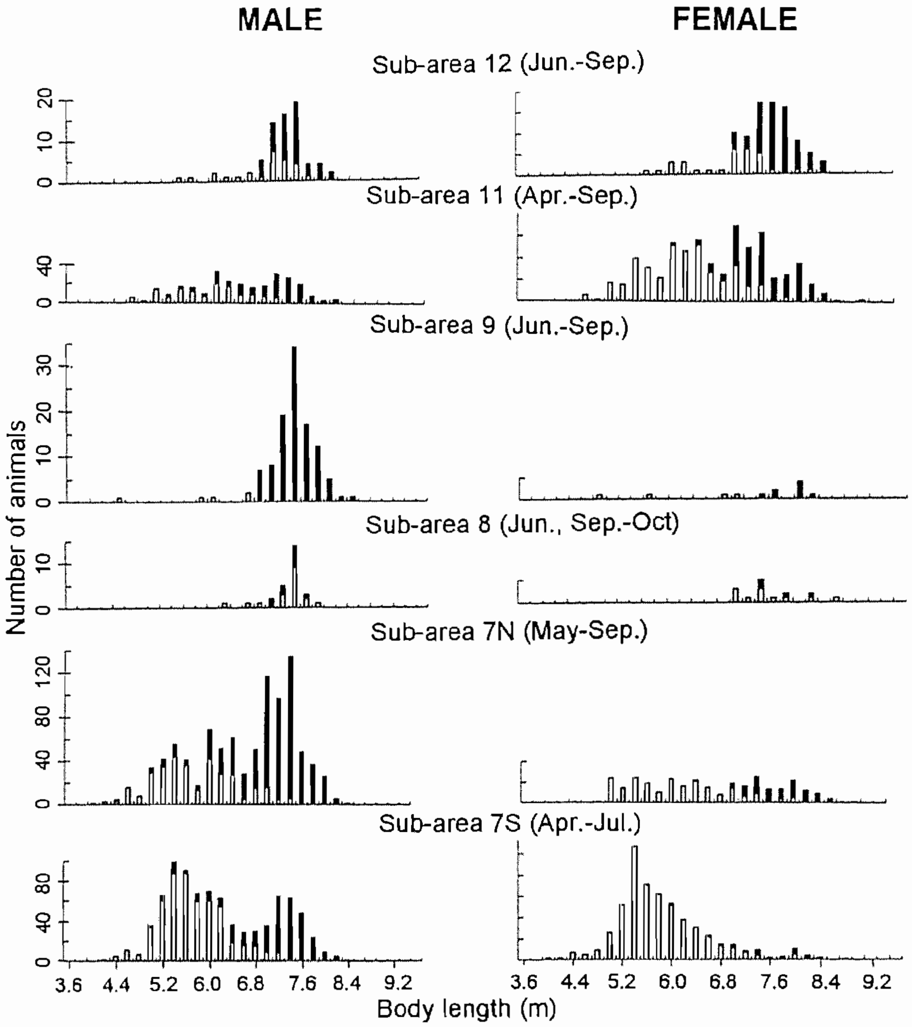

Figure 1. Length composition of common minke whales taken in the western North Pacific by sub-area. White areas indicate the immature and maturity unknown animals and black the mature (from Hatanaka and Miyashita, 1997).