On the different criteria used by the IWC/Scientific Committee for defining stocks in bowhead and western North Pacific minke whales

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ABSTRACT

This paper briefly reviews data, methodology and criteria considered by the Scientific Committee for defining stocks in two whale species subjected to management by the IWC: the western North Pacific minke whale under the Revised Management Procedure (RMP) and the Western Arctic stock or B-C-B stock of bowhead whale under the Aboriginal Whaling Management Procedure (AWMP). Based on such review it is concluded that the Committee has used different criteria for examining these cases: a) citing the lack of information on stock structure the Committee has repeatedly required additional information in the case of the minke whale; in the case of the bowhead whale, the lack of perfect information on stock structure has not been a reason for the Committee to reject the single stock scenario for B-C-B, b) on many occassions the Committee has recommended the attainment of data from putative breeding ground in the minke whale, (which is scientifically correct but logistically difficult to achieve); however it has not put similar emphasis to recommend the attainment of samples in the Chukchi Sea and Bering Sea islands in summer (which is scientifically correct but also logistically difficult to achieve), which could elucidate the hypothesis of sub-stocks, c) the possibility of more than one stock passing Point Barrow has been rejected by the Committee citing that segregation by sexual component during migration is consistent with a single stock scenario; the same argument has been rejected for minke whale, d) the possibility that animals from depleted stocks move into the distribution area of the B-C-B stock has not been a cause of concern by the Committee; the movement and mixing of animals from the J stock into the area of distribution of the O stock has been a cause of large concern by the Committee, e) a larger number of analytical methods have been used to examine DNA data in the case of the minke whale; the Committee seems to not be interested to use different analytical methods on the available DNA data from bowhead whale. The aim of this paper is not criticize previous management decisions on the bowhead whale, as such decisions have been as good as are practical to achieve. The attainment of perfect scientific data on stock structure in this case (as insisted for the case of the western North Pacific minke whale) is unrealistic. Neither is this paper an attempt to criticize the work of scientists that have collected and analyzed data. This paper is written to motivate the Committee to consider the two cases on a consistent basis, as a scientific approach demands and to urge that the same criteria used for defining stocks in the bowhead whale be used in the case of the minke whale.

INTRODUCTION

Several species and stocks of large whales have been identified by the IWC/Scientific Committee (Committee) as the targets of both aboriginal and commercial whaling. Two of these cases are the Western Arctic stock or B-C-B stock of bowhead whale and the western North Pacific minke whale. In applying management procedures, the aboriginal whaling management procedure (AWMP) in the former case and the revised management procedure (RMP) in the latter case, information on stock structure has been an important factor taken into consideration by the Scientific Committee.

After more than ten years since initiation of the *Implementation Simulation Trials* (*ISTs*) for western North Pacific minke whale, the Committee is still considering new scenarios on stock structure. As a consequence the number of *ISTs* for this species has increased dramatically (IWC, 2003) complicating the implementation of RMP for this species. In the case of the B-C-B stock of bowhead whale the Committee has consistently recommended the single stock scenario for the implementation of the aboriginal whaling

management procedure (AWMP). The most recent reference by the Committee on this issue was made during its 2002 meeting. The Committee noted that the 'SWG (Standing Working Group) on the AWMP has carried out a thorough review of the sub-stock question and the Committee believes that the single-stock hypothesis is most consistent with existing data' (IWC, 2003).

The objective of this paper is to briefly review the information on data, methodology and criteria considered by the Committee for defining stocks in the bowhead and western North Pacific minke whales. The objective of this paper is not to conduct a detailed review of the stock structure studies in these two cases. These reviews have already been done by DeMaster *et al.* (2000) and Pastene *et al.* (2000) for bowhead and North Pacific minke whales, respectively. This paper focuses on the discussions of stock structure conducted at the Committee meetings. Of particular interest is the examination of the information and criteria used by the Committee to conclude the B-C-B stock is a single stock and make a comparison with the information and criteria used for rejecting the single stock hypothesis in the case of the western North Pacific minke whale.

The aim of this paper is not criticize previous management decisions on the bowhead whale, as such decisions have been as good as are practical to achieve. The attainment of perfect scientific data on stock structure in this case (as insisted for the case of the western North Pacific minke whale) is unrealistic. This paper is written to motivate the Committee to consider the two cases on a consistent basis, as a scientific approach demands.

DISCUSSION ON STOCK STRUCTURE AT THE SCIENTIFIC COMMITTEE

Bowhead whale

The first major discussion on stock structure of the bowhead whale was conducted by the Committee in 1991 (IWC, 1992a). On that occasion the Committee had considered five stocks of bowhead whale: Spitsbergen, Davis Strait, Hudson Bay, Okhotsk and Western Arctic (Bering-Chukchi-Beaufort). Discussion on the identity of the B-C-B stock was based on data on distribution of sightings and historical catches but no comparative analyses using genetic or non-genetic data were available. The next time the Committee briefly mentioned stock identity of the B-C-B stock was in 1994. The Committee noted on that occassion that while there is much evidence for segregation by age and sex, with adults perhaps ranging more widely than sub-adults, there appears to be a single stock whose movements are governed by food aggregations and ice conditions (IWC, 1995 pp.72). The only other information provided was on satellite tagging. One animal moved from the Canadian Beaufort Sea to the Siberian coast within 34 days. No other information was presented that year.

During the assessment of the bowhead whale in 1998 (IWC, 1999 pp. 33-34) the Committee examined a document presenting shore-based observations of seasonal distribution and migrations of bowhead whales in waters adjacent to the Chukotka Peninsula in 1994-1996. The authors indicated that whales winter in leads and polynyas on the leeward shore and capes and points of the Asian coastline of the Bering Sea. Every spring some of the whales remain in the Gulf of Anadyr and the whales' northward migration along the eastern coast of the Chukotka Peninsula take place much later than along the shore of northwestern Alaska. Also during the 1998 assessment the first genetic paper on bowhead whale was discussed but that paper was not focused on comparisons among different localities within the range of distribution of the B-C-B stock, rather the paper was focused to investigate a possible genetic bottleneck in this population. The analysis involved mtDNA control region sequences from 93 whales from the northern coast of Alaska and six from St. Lawrence Island. The main results were that there was no genetic bottleneck in the Western Arctic stock and that genetic variability has remained relatively high in spite of severe depletion. DeMaster *et al.* (2000) reported that whales from northern coast of Alaska (93) were not statistically different in mtDNA composition from St. Lawrence Islands (6) and that no conclusion was obtained from this comparison due to the small sample size from St. Lawrence Island.

In 1999 (IWC, 2000 pp. 22) the Committee received a new genetic paper on B-C-B stock based on microsatellite analyses of 102 whales from the northern coast of Alaska and six from St. Lawrence Island. The main result was that there was no genetic bottleneck in the Western Arctic stock and that genetic variability has remained relatively high in spite of severe depletion. DeMaster *et al.* (2000) reported that

whales from the northern coast of Alaska (102) were not statistically different from St. Lawrence Islands (6) and that as in the case of mtDNA analysis, no conclusion is obtained from this comparison due to the small sample size from St. Lawrence Island (6). A review of the studies on stock structure in bowhead whale was conducted at the Working Group on Stock Definition in 2000. Although the original review presented by DeMaster *et al.* (2000) recognizes that there have been very few genetic studies aimed at investigating the relationships among bowhead whale stocks or putative sub-stocks and that almost no non-genetic comparative studies within the B-C-B stock had been conducted, the Committee in 2000 agreed with the concept of single management stock for B-C-B. It further noted that even if there is separation of sub-stocks after migration, for instance between the Chukchi and Beaufort Seas, there is little risk of differential local depletion, because harvesting occurs almost entirely during migration, and is spread in time across the duration of the migration (IWC, 2001a pp. 38).

The Committee has addressed the issue of stock identity of the B-C-B stock on several occasions as summarized above. However, it should be recognized that those discussions have been based on very limited data and almost no comparative analyses on stock identity within the B-C-B (genetic and non-genetic) have been presented. The few genetic samples available come mainly from a single locality (northern coast of Alaska). Despite the limited availability of data and comparative analyses on stock identity within the B-C-B stock, the Committee recommended again in 2002 the single B-C-B stock scenario for management (IWC, 2003). This is the only stock structure scenario being considered by the AWMP.

Western North Pacific minke whale

In the case of the western North Pacific minke whale studies on stock identification around Japan started in 1950's using catch distribution information as well some biological data such as differences in body length and conception date (Omura and Sakiura, 1956; Ohsumi, 1983). The IWC identified three stocks (Sea of Japan-Yellow Sea-East China Sea (J), Okhotsk Sea West Pacific (O) and remainder stocks) and established boundaries for management of these stocks following recommendations from the Committee (IWC, 1983 pp. 52). The next time the Committee addressed the issue of stock structure was during the comprehensive assessment of this species conducted in 1991 (IWC, 1992b). On that occasion the Committee agreed that the existing stock definition and boundaries did not provide an adequate basis for assessment (IWC, 1992b). Previous to the 1993 annual meeting the Committee established a Working Group to start the *Implementation Simulations Trials* (*ISTs*) for the application of the RMP for western North Pacific minke whale (IWC, 1994a). This Working Group felt that stock structure information was not sufficient for the trials and proposed a complicated stock scenario based on three stocks (J, O and W) and 7 sub-stocks (three in J and four in O). The Group established 13 sub-areas for the purpose of trials (IWC, 1994a).

The Committee had noted the desirability of obtaining improved data on stock identity and migration pattern in western North Pacific minke whale (IWC, 1994b pp. 50). In response Japan started a research program (JARPN) with three main objectives 1) Clarify whether W stock exists, 2) Clarify the mixing rate of W stock and 3) Clarify the validity of O sub-stock scenario. The program was conducted between 1994 and 1999 and a considerable amount of new information on stock structure was accumulated in that period. The most valuable aspects of the JARPN were that a) it explored regions from which data were not previously available, particularly from offshore sub-areas 8 and 9, b) samples were collected systematically on predefined track-lines and c) the new available samples allowed the comparison among IWC's sub-areas 7, 8 and 9 using both genetic and non-genetic approaches.

The Committee reviewed partial data obtained by JARPN in a workshop conducted in 1996 (IWC, 1997a). The Working Group agreed that the new data, in conjunction with those reported previously, a) confirmed the distinction between the J and O stocks, b) the data were compatible with a hypothesis of only one stock in sub-areas 7, 8, 9, 11 and 12 (with allowances for some J stock animals in sub-areas 7, 11 and 12 seasonally) and, c) the data were generally inconsistent with there being sub-stocks characterized by different levels of latitudinal migration (IWC, 1997a pp. 208-9). With regard the W stock, the Group agreed that no evidence was presented to support the hypothesis of a W stock. Some members, however, considered that the information did not exclude this possibility in particular because of concerns about the ability of the available data to detect genetic differences (IWC, 1997a pp. 209).

The Committee conducted a full review of JARPN during a workshop conducted in 2000 (IWC, 2001b). See also Tables 1 and 2 in Pastene *et al.*, (2000) for a summary of genetics and non-genetics works conducted. A total of 32 scientific papers were presented and discussed at the workshop. Comparative analyses among IWC's sub-areas 7, 8 and 9 involved genetic approaches (allozymes, mtDNA, microsatellites) as well non-genetic approaches (biological parameters, conception date, external measurements, pattern of sighting distribution, pollutant burden, parasite load) were presented and discussed. In general these approaches were consistent with the single stock scenario (O stock) in sub-areas 7, 8 and 9, allowing some occurrence of J stock animals in sub-area 7 seasonally. The only evidence for the occurrence of W stock came from an mtDNA analysis based on hypothesis testing, which showed low (but not significant) P values in the comparison involving sub-area 9. A post-stratification analysis showed that some degree of mtDNA heterogeneity was due to samples taken in the western part of sub-area 9 in 1995. Therefore the possibility of occurrence of W stock was not completely discarded and the Workshop recommended further studies and samples, especially from offshore regions (IWC, 2001b).

After the JARPN workshop several additional analyses on stock structure were conducted and presented to annual meetings of the Committee in 2000, 2001 and 2002 (following recommendations from the Workshop). In the most recent meetings the Committee has examined results of analysis on DNA data (produced by JARPN), based on different methods. In particular mtDNA data have been examined by Committee members using hypothesis testing-based methods (involving both sequence and haplotype statistics), ISOLDE, Bayesian-based methods and Boundary Rank technique (BR).

The frequent request within the Committee for additional samples and analyses and the successive re-considerations of stock structure scenarios have been some of the factors delaying the completion of the *ISTs* for western North Pacific minke whale. The more recent workshops on *ISTs* for this species have considered again some additional stock scenarios (IWC, 2003):

Scenario A: two main stocks (J and O) allowing the sporadic occurrence of a third stock (W) in part of sub-area 9 (based on the results of the JARPN review, particularly mtDNA results by Japanese scientists).
Scenario B: two stocks (J and O) (based on the results of the JARPN review).
Scenario C: four stocks (J, Ow, Oe, W) with three to the eastern side of Japan with hard boundaries at 147°E and 157°E (results of the application of BR by American scientists).
Scenario D: three stocks (J, O and W) with mixing gradient between O and W between 147°E and 162°E (based on the interpretation of the results of BR and assisted by some oceanographic data by American and Australian scientists).

This year and after more than ten years since the start of the RMP/*ISTs* process for western North Pacific minke whale, the Committee is still discussing the plausibility of these scenarios!

DIFFERENT CRITERIA TO DEFINE STOCKS IN THE COMMITTEE

From the brief review presented above, the following aspects can be considered as establishing different criteria by the Committee for defining stocks in the two cases examined:

1- The Committee has already noted that different standards appeared to have been used within the Committee to establish the minimum unit to be conserved for different stocks. It was recognized that discussions on stocks/sub-stocks for whales taken by aboriginal hunters were sometimes less risk-averse than those associated with preparations for implementation of the RMP (IWC, 1997b pp. 85). This observation is confirmed by the brief review presented above. For example the Committee cited the lack of data on stock structure when it started the *ISTs* for western North Pacific minke whale in 1993 and then defined a very complicated stock/sub-stock scenario. As we have seen above, information on stock structure in the case of the B-C-B stock is not particularly large or robust. However, in this case the Committee has not considered alternative hypotheses on stock structure to cover for the lack of data. Consistently the Committee has recommended the single stock scenario for the B-C-B stock.

2- In the case of the western North Pacific minke whale the Committee has recommended on several occasions the analysis of genetic data from putative breeding areas, which can assist the interpretation of

genetic variability in migratory corridors and feeding areas of the minke whale. Some scientists have argued that without such information it will not be possible to clarify the stock structure of the minke whale. While this recommendation makes scientific sense, it should be also recognized that the attainment of samples from putative breeding grounds is a very difficult task particularly as the location of such putative grounds is unknown. In the case of the B-C-B stock of bowhead whale the possibility of additional stock/sub-stock structure has been mentioned. For example Bogoslovskaya *et al.* (1982) suggested that some whales migrate west along the north coast of Chukotka in late spring resulting in two migration routes, one in the western Chukchi Sea, the second in the eastern Chukchi Sea. Melninov *et al.* (1998) also suggested the whales winter in leads and polynyas on the leeward shore and capes and points of the Asian coastline of the Bering Sea. Every spring some of the whales remain in the Gulf of Anadyr and the whales' northward migration along the eastern coast of the Chukotka Peninsula take place much later than along the shore of northwestern Alaska. This information could suggest the occurrence of two stocks or sub-stocks within the B-C-B stock but the Committee has discarded this possibility based on information on temporal distribution of sightings and historical distribution of catches. However the most adequate approach to investigate such possibility is the conduct of genetic analysis comparing whales summering along the Russian coast and Islands in the Bering Sea to whales summering in the Beaufort Sea (passing through Pt. Barrow). Such analyses have not been done because the collection of samples in such localities is difficult to achieve (similar to the case of getting samples of minke whales from low latitudes).

3- It also can be argued that in absence of comparative analyses (genetic or not genetic approaches) among whales passing Point Barrow, the possibility of more than one stock which mix together as they pass through the area close to Point Barrow, can not be discarded. Further, it can be also argued that one of these stocks could be depleted (a similar situation to the J and O stocks in the minke whale). The Committee has rejected such a possibility saying it is known that young whales generally migrate past Barrow before older whales and such fact is difficult to reconcile with a multiple stock hypothesis (IWC, 2001a pp. 418). A similar argument has been given to support the single stock scenario in the case of the minke whale where a large proportion of immature animals migrate close to the coast while mature animals migrate in more offshore areas. However, this argument has not been accepted by the Committee for supporting the single stock scenario in minke whales.

4- The movement of J stock animals to areas where O stock could be harvested has been a subject of substantive discussion within the Committee and the *ISTs* consider detailed information on stocks mixing between O and J stocks. In the case of the bowhead whale there is some evidence of possible interchange between the B-C-B stock and the Davis Strait stock. The evidence was based on two whaling irons taken from whales in the Chukchi Sea that apparently came from ships than only cruised in arctic waters of the western North Atlantic sector (Bockstoce and Burn, 1993). These authors noted that it is highly unlikely that these irons would have been carried to the Chukchi Sea aboard a ship. The Committee noted the possibility that as the B-C-B stock recovers, it might help to repopulate other depleted stocks of bowhead whales can not be ruled out (IWC, 2001a pp. 418). However it has not considered the reverse possibility; that whales from depleted stocks move to or occupy areas where B-C-B stock animals are harvested.

5- Genetic and non genetic data available for studies on stock structure in the minke whale are comprehensive. Results from the genetic approach are interpreted in the context of the results from other non-genetic approaches. However some members of the Committee seem to be interested in the analysis of a single marker (mtDNA). MtDNA data from the JARPN have been requested and used by several members of the Committee and several analytical methods have been used. However there is little interest by these members to use these methods for the available DNA data from the B-C-B stock of bowhead whale.

As emphasized in the introduction, the aim of this paper is not criticize previous management decisions by the Committee on the bowhead whale as these have been as good as is practical to achieve. Also this paper in no way attempts to criticize the work of scientists that with much effort have collected and analyzed samples from this stock. The information on stock structure in this case is not complete but it should be recognized that the attainment of perfect scientific data on stock structure in the bowhead whale (as is insisted on in the case of the western North Pacific minke whale) is unrealistic. This paper is written

to motivate the Committee to consider the two cases, the western North Pacific minke and the B-C-B stock bowhead whale on a consistent basis, as a scientific approach demands.

The Committee has considered that the 'unit to conserve' in the case of the bowhead whale is a breeding stock wintering in the central and western Bering Sea, which move north in spring. Some whales passing through Point Barrow summer in the Beaufort Sea, other summer in the Chukchi Sea. The Committee has not considered plausible a situation of matrilineal feeding site fidelity as it has been observed in the case of the North Atlantic humpback whale.

In the case of the western North Pacific minke whale there is even a better case (more data available) to support the single O stock scenario. The 'unit to conserve' in this case is a breeding stock with whales wintering in some unknown breeding ground and then migrating to higher latitudes in spring with a marked segregation by sex and age during the migration with juveniles migrating near the coast and adults in offshore waters. There is no genetic evidence of additional structure apart from that from mtDNA analysis that suggests the sporadic occurrence of W stock in part of sub-area 9. Also there is no evidence of feeding site fidelity. Furthermore commercial whaling was conducted in the coastal area for a long period however there is no evidence of depletion or loss of genetic diversity. This is also suggestive that whales from offshore sub-areas 8 and 9 belong to the same stock as whales in sub-area 7.

In conclusion if the criteria used by the Committee for defining a single stock in the case of the B-C-B stock is applied to western North Pacific minke whale, then we should recognize the single O stock scenario in sub-areas 7, 8 and 9 (allowing for some J stock in sub-area 7 seasonally and some few W stock in part of sub-area 9 sporadically).

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