An examination of the plausibility of different stock structure hypotheses of North Pacific Bryde's whale based on the available information

LUIS A. PASTENE

The Institute of Cetacean Research, Toyomi 4-5, Chuo-ku, Tokyo 104-0055, Japan

ABSTRACT

This paper examines the plausibility of the four stock structure hypotheses agreed during the 'First Intersessional Workshop' for North Pacific Bryde's whale *Implementation*, based on the information presented and discussed at that Workshop. The following kind of information was available to the Workshop: allozymes, mtDNA, microsatellites, sighting distribution, catch distribution, external body proportion, biological parameters, mark-recapture and age distribution. Evidence from this information in favour or against the hypotheses was summarized. Based on this evaluation it is proposed the following rank of plausibility: Hypothesis 1: High, Hypotheses 2 and 3: Low-no sufficient data, Hypothesis 4: Low.

KEYWORDS: BRYDE'S WHALES, *IMPLEMENTATION*, WESTERN NORTH PACIFIC, STOCK STRUCTURE HYPOTHESES, PLAUSIBILITY

INTRODUCTION

Following the schedule for an *Implementation* and subsequent *Implementation Review* recommended in 2004 (IWC, 2005a), the Scientific Committee (SC) completed the *pre-implementation assessment* of western North Pacific Bryde's whale during a Workshop carried out in early 2005 (IWC, 2005b). The Workshop considered all the aspects required under the 'Requirements and Guidelines' for *Implementations* to complete a *pre-implementation assessment* (IWC, 2005a), specifically a) abundance estimates; b) catches; c) stock structure hypotheses; d) dispersal rates; and e) data for conditioning. Based on the results of the examination, the Workshop recommended to the SC that it considered the *pre-implementation* process completed. The SC accepted the Workshop report and agreed that the *pre-implementation assessment* for western North Pacific Bryde's whales was completed and recommended that *Implementation* can commence (IWC, 2005c).

With regard to stock structure of western North Pacific Bryde's whales, the *pre-implementation assessment* Workshop had identified five alternative hypotheses, which considered sufficiently inclusive that collection of new data during the *Implementation* process is unlikely to suggest a new stock hypothesis (IWC, 2005b). The Workshop had agreed that the various stock hypotheses were not equally plausible, but did not assign plausibility weights to these hypotheses as this is scheduled for the 'First Annual Meeting'.

The 'First Intersessional Workshop' of North Pacific Bryde's whale was conducted in October 2005. The primary objective of this Workshop was to develop an appropriate *Implementation Simulation Trials* structure and to specify the associated conditioning so that it can be carried out before the 'First Annual Meeting'. A review of the hypotheses on stock structure was carried out during the Workshop with the aim to eliminate any hypotheses that are inconsistent with the data. Of the five hypotheses agreed in the *pre-implementation assessment*, four hypotheses were retained during the 'First Intersessional Workshop'.

The objective of this paper is to assign plausibility to the hypotheses on stock structure derived from the 'First Intersessional Workshop' taking into account all the available scientific information presented and discussed at that Workshop.

DESCRIPTION OF THE HYPOTHESES ON STOCK STRUCTURE

The four hypotheses on stock structure retained during the 'First Intersessional Workshop' are summarized in Figure 1.

Hypothesis 1: this is a single stock hypothesis under which only one stock of Bryde's whale is found in the area from 130°E-155°W (excluding the area in which East China Stock is found) and there are no sub-stocks.

Hypothesis 2: Different stocks in sub-areas 1 and 2 and there are no sub-stocks.

Hypothesis 3: Same as Hypothesis 2. This hypothesis differs from Hypothesis 2 in that the stock found in sub-area 1 is also found in sub-area 2.

Hypothesis 4: Same as Hypotheses 2 and 3, except that there are two sub-stocks which mix in sub-area 1.

EVALUATING PLAUSIBILITY OF THE STOCK STRUCTURE HYPOTHESES

No quantitative method has been agreed in the SC for evaluating plausibility. During the 2002 SC meeting Japanese scientists presented the results of an AIC (Akaike's Information Criterion)-based evaluation of the plausibility of baseline stock scenarios for North Pacific common minke whales. These were based exclusively on mtDNA data. However there was no agreement at the SC on the validity of using AIC for evaluating plausibility.

Here a qualitative analysis is conducted by listing up all the scientific evidences (genetics and non-genetics) pro and again different hypotheses and then assigning rank of low, medium and high (Table 1). The scientific evidences are the same as those discussed during the 'First Intersesional Workshop'. Notations at the bottom of Table 1 were extracted from the report of the 'First Intersessional Workshop' (IWC, 2005d). Original references can be found in that report. The final assignment of ranks is according the criterion of the author.

According to this evaluation Hypothesis 1 is assigned a high rank, Hypothesis 2 and 3, low rank (it should be emphasized that there is no sufficient data to evaluate this hypothesis) and Hypothesis 4 a low rank.

REFERENCES

International Whaling Commission. 2005a. Report of the Scientific Committee. *J Cetacean Res. Manage*. 7 (Suppl.): 1-391

International Whaling Commission. 2005b. Report of the Workshop on the *pre-implementation assessment* of western North Pacific Bryde's whales. Document SC/57/Rep3 (30pp).

International Whaling Commission. 2005c. Report of the Scientific Committee. J. *Cetacean Res. Manage*. (Suppl.00): 00-00.

International Whaling Commission. 2005d. Western North Pacific Bryde's Whale *Implementation*: Report of the First Intersessional Workshop. IWC Document SC/58/RepX (44pp).

Table 1: General summary of the information useful to assess plausibility of alternative stock-structure hypotheses. A '+' indicates evidence in favour of a hypothesis, '-' indicates evidence against a hypothesis, '(+)' indicates weak evidence in favour of a hypothesis, '(-)' indicate weak evidence against a hypothesis. A 'O' indicate no sufficient evidence (data). Notations at the bottom of this table were extracted from the report of the 'First Intersessional Workshop' (IWC, 2005d).

Evidence	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4
Allozymes	(+) [a]	(-) [a]	(-) [a]	(-) [a]
mtDNA	+ [b]	O [c]	O [c]	- [d]
Microsatellites	+ [b]	O [c]	O [c]	- [d]
Sighting distribution	+ [e]	- [e]	- [e]	- [e]
Catch distribution	+ [e]	- [e]	- [e]	- [e]
External body proportion	(+) [f]	(-) [f]	(-) [f]	(-) [f]
Biological parameters	(+) [f]	(-) [f]	(-) [f]	(-) [f]
Mark-recapture	+ [g]	O [h]	O [h]	- [g]
Age distribution	(-) [i]	(-) [i]	(-) [i]	(+) [i]
Rank	High	Low-insufficient data	Low-insufficient data	Low

[a] The Workshop agreed that while the power to detect genetic structure might be considered to be low as only a single locus was analysed, the fact that this had been sufficient to detect structure in the Pacific Ocean suggest that if there are multiple stocks differentiated at a level similar to that between the western North stock and other stocks, examination of this single locus should be sufficient to detect this.

[b] Clustering and hypothesis testing analyses of mtDNA and microsatellites were conducted, and as noted by the Committee, none of these analyses revealed any significant heterogeneity (and hence evidence for more than one stock).

[c] Analysis of mtDNA and microsatellites have been conducted only for samples available in sub-area 1. No DNA data are available for sub-area 2.

[d] *Mixing of two sub-stocks*: There are no genetic data for the breeding grounds so the possibility of multiple sub-stocks cannot be excluded. Furthermore if two breeding stocks mix almost completely, it will be difficult to detect differences using, for example, genetics tests based on comparisons between data for the west and east of sub-area 1. However while complete mixing may lead to all methods of detecting stock structure having low power, the plausibility of this was considered fairly low given the behaviour of most large whales. Hypothesis tests based on comparisons for approximately the same area in sub-area 1 found no significant differences among years which suggest that if two sub-stocks mix in sub-area 1, there is little difference in the distribution proportion among years. Although the data set encompasses only four years, such a lack of variation in distribution proportions among years seems unlikely given the known behaviour of whales. In principle evidence for hypotheses 4 could be obtained by testing for deviation from Hardy-Weinberg equilibrium within sub-areas 1W and 1E because such deviations provide evidence of non-random mating as well as selection or migration, i.e. when genetically two different populations are being sampled. Analyses of nuclear markers for Bryde's whales in sub-area 1 have been conducted and these analyses provide no evidence for the significant deviations in Hardy-Weinberg equilibrium within sub-areas 1W and 1E which would provide support for multiple sub-stocks.
Statistical power: The Workshop received a paper, which evaluated the power to detect population structure using the chi-square test and Fisher Exact test under an island model in which population differentiation is controlled using a single parameter, Fst. Statistical power of the genetic analysis in sub-area 1 was found to be high for moderate sample sizes and quite small values for Fst, while it was higher for microsatellite data than for mtDNA.

[e] The Workshop examined the sightings data and agreed that it revealed no evidence of a discontinuity in distribution within sub-areas 1 and 2. A similar conclusion was reached with respect to catch

distribution. Discontinuity in the commercial catches identified in earlier meetings merely reflected operational constraints.

[f]External body proportion data (three features) and several biological parameters (body length, pregnancy rate, length at sexual maturity, seasonality in breeding) had been examined using data from past commercial whaling. Although operational differences (e.g. different minimum length limits for coastal and pelagic whaling) meant that some comparisons could not be made, the authors of these analyses concluded that there were no differences that could not be attributed to operational factors.

[g]Mark-recapture analysis revealed movement of animals within sub-area 1. A very limited number of marks were placed in sub-area 2 and while none has been recovered in sub-area 1, the sample sizes for this sub-area are sufficiently small that even if there is mixing between sub-area 1 and 2, zero recaptures would not be highly unlikely.

[h]Mark-recapture data are available mainly for sub-area 1.

[i]One of the possible explanation for the differences observed in age distribution between sub-area 1W and 1E+2 is that these differences are real. Other possible explanations were also listed up by the Workshop.
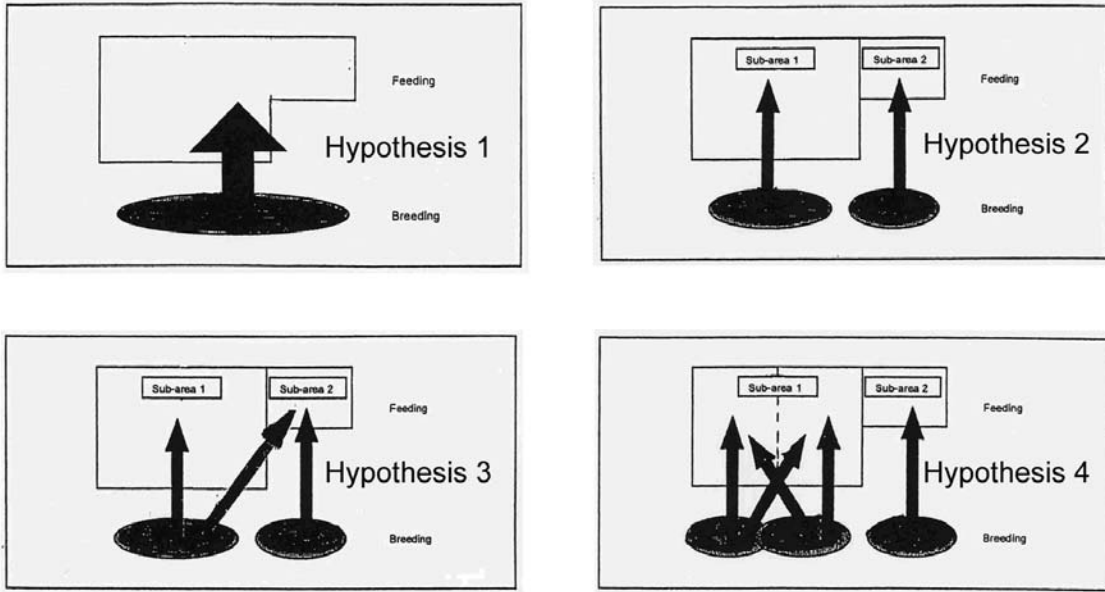
Figure 1: Stock structure hypotheses of North Pacific Bryde's whales retained at the 'First Intersessional Workshop'.