Annex I

Report of the Working Group on Stock Definition

Members: Bravington (Convenor), Amaral, Baba, Bachmann, Bamy, Brockington, Butterworth, Campbell, Carvalho, Castellote, Cipriano, de Moor, Donovan, Fleming, Gaggiotti, Hoelzel, Jackson, Jérémie, Kanda, Lang, López-Mirones, Luna, Lusseau, Lyrholm, Øien, Okada, Pampoulie, Pastene, Punt, Scordino, Skaug, Suydam, Uoya, Vázquez, Víkingsson, Waples, Weir, Werner, Wiig, Yamakage, Yasokawa, Yoshida, Young.

1. INTRODUCTORY ITEMS

1.1 Election of Chair and appointment of rapporteurs
Bravington was elected as Chair, and also acted as rapporteur.

1.2 Adoption of Agenda
The adopted Agenda is given as Appendix 1.

1.3 Review of documents
The documents considered were SC/62/SD1-2.

2. STATISTICAL AND GENETIC ISSUES RELATING TO STOCK DEFINITION

SC/62/SD2 presented information regarding the acoustic behaviour of fin whales in the western Mediterranean Sea and adjacent North Atlantic waters. Seafloor recorders were deployed during 2006-09 to further contribute to knowledge of movement patterns and population structure within and outside of the Mediterranean basin. Analysis of 24,280 recording hours revealed typical long, patterned sequences of 20Hz pulses, back beats, 135-140Hz notes and downsweeps. Acoustic parameters (inter pulse interval, pulse duration, pulse bandwidth, centre and peak frequency) were compared between signals from the Mediterranean Sea and northeast North Atlantic Ocean (NENA) using a hierarchical regression analysis to compare and characterise fin whale sounds. Pulse interval and pulse bandwidth showed the highest variability between study areas revealing two clearly differentiated acoustic patterns, one attributed to all North Atlantic study areas, Strait of Gibraltar and southwestern Mediterranean basin (Alborán Sea) and another to the northwestern Mediterranean basin (Balearic, Provenzal and Ligurian Seas). These acoustic patterns were related to two different fin whale populations. The first one, with a pulse interval of 15 seconds and a pulse bandwidth of 5Hz, corresponds to the resident Mediterranean population; the second one, with a pulse interval of 13 seconds and a pulse bandwidth of 6.5Hz, corresponds to a NENA population. In particular, 135-140Hz notes and the presence of songs composed exclusively of back-beats strongly suggests that the NENA population might be Icelandic (EI or F stocks) or Norwegian (N stock). Mediterranean fin whales were never detected in the Alborán basin or the Gibraltar Strait suggesting that their distribution range excludes this region of the southwestern Mediterranean basin. The presence of NENA fin whales in the Strait of Gibraltar area and Alborán Sea was seasonal, from early winter till early summer, and short detections also occurred during summer and further east, within the Balearic Sea. This reveals that male NENA fin whales enter the Mediterranean Sea primarily during breeding season and spatial and temporal overlap may exist between populations. The author of SC/62/SD2 discussed how these results match the current knowledge on fin whale use of the Strait of Gibraltar and could fit the genetic scenario of the Mediterranean fin whale subpopulation, where a low recurrent gene flow between NENA and Mediterranean whales has been proposed as the most plausible hypothesis. The author ended his presentation by recommending that current distribution ranges of these fin whale populations should be reviewed based on these acoustic results.

In discussion, the SDWG welcomed the work in SC/62/SD2, and encouraged the plans to follow up with biopsy sampling. SC/62/SD2 shows a case where acoustic data have been able to generate plausible yet previously-unsuspected hypotheses about stock structure. The SDWG also recalled its previous discussions about the benefits of, and difficulties associated with, the use of acoustic data in stock definition (e.g. IWC, 2005). Previous considerations have often focused on humpback whales, which are known to learn and imitate acoustic behaviour; this complicates the interpretation of acoustic signals in population-dynamics terms. By contrast, fin whales appear to have stable acoustic behaviour, at least after maturity. Other studies on fin whales have shown a negative correlation between acoustic and genetic distance, allowing discrimination between the songs of different populations in both the North Atlantic and North Pacific Oceans (see Hatch and Clark, 2004). This is a species for which acoustics is particularly useful in generating hypotheses and indeed subsequent sampling strategies.

2.1 DNA data quality
This item concerns guidelines for marker validation and systematic quality control in genetic studies to be used in stock structure discussions relevant to management (IWC, 2009b). The guidelines now form a 'living document', available on the IWC website. The Committee has identified the desirability of proposing numerical guidelines, where feasible, for some of the quality control measures. Last year, it was agreed to start a literature review on this subject through an intersessional email group, led by Tiedemann. Unfortunately, Tiedemann had to withdraw from this year's meeting at the last moment, and it has not been possible to progress on this item. It remains on the agenda for next year's meeting.

2.2 Guidelines for analysis methods
In parallel with the development of data quality guidelines, the Committee has asked the SDWG to provide guidelines for some of the more common types of statistical analysis of genetic data that are employed in IWC management contexts. The guidelines will cover two aspects: comments on general statistical usage; plus summaries of the appropriate domains of application of, and limitations of, different stock structure tools such as STRUCTURE, BayesAss, etc. The document

contains a motivating example (North Pacific Bryde's whales) that demonstrates the kind of management questions faced by the Committee.

An intersessional email group under Waples has been preparing sections of this document. SC/62/SD1 describes the overall structure of the document (as shown in IWC, 2009c), and shows the draft sections that have been prepared so far. The SDWG thanked Waples and the other authors for their past-and-future-efforts. This is a complex document, and much further work will be required to complete all sections. However, after one further iteration, the document should be ready to go onto the IWC website. In terms of the structure of the document, a number of suggestions were made.

- Descriptions of genetic methods in the main part of the document should be kept short, and focused on strengths and weaknesses in management contexts (including but not limited to *CLA*-like applications). More comprehensive descriptions may be provided in appendices.
- An 'FAQ' would be desirable. For example: 'I have some samples from the feeding grounds but not the breeding grounds. What should I do?'
- The theoretical population-dynamic example from IWC (2009c) should be incorporated as an illustration of the distinction between demographic (i.e. management-related) and genetic differentiation of stocks.
- The sections dealing with particular methods should be cross-referenced against results from TOSSM (see Item 3), which has taught us a great deal about the likely performance or otherwise of various commonly-applied stock identification methods in management contexts.
- Consideration could be given to using simulated datasets from TOSSM to illustrate the steps and pitfalls involved in analysing real data using a particular method.
- When this document is ready, it will have entailed a great deal of effort, but it should be of lasting importance. It deserves to be published, both online via IWC and in peer-reviewed literature.

The intention for this year's SD working group meeting was to devote most of the time available to working on this document. Progress was somewhat restricted since two Scientific Committee members with custody of substantial sections were unable to attend. The review and update of this document will likely be the main task of the SDWG at next year's meeting.

3. TOSSM (TESTING OF SPATIAL STRUCTURE MODELS)

3.1 Update on progress

The aim of TOSSM is to allow simulation-testing of the performance of population structure methods intended for use in conservation planning. Specifically, methods can be tested in terms of how successfully they set spatial boundaries for management. The TOSSM software is available as an R package on CRAN, with extensive documentation and supplementary materials. Simulated datasets are available for three of the five Archetypes identified by the Committee (IWC, 2009a, p.51); the exceptions are Type III (cline) and Type V (persistent feeding stocks). Interested parties can develop their own datasets for specific types of population structure, e.g. clines. Many other aspects of TOSSM can also be adapted to particular needs, e.g. different management regimes.

Table 1

Methods tested under TOSSM, and where to read about them (see reference list).

Always-one-stock	Martien *et al.* (2008)
Wombling	Martien and Gregovich (2008)
Monmonnier	Martien and Gregovich (2008)
Waples/Gaggiotti	Martien and Gregovich (2008)
Close-kin (Oyvind/Skaug)	Økland *et al.* (2008)
STRUCTURE	Martien *et al.* (2007)
BayesAss	Edwards and Butterworth (2007)
Seq hyp test	Poljak Grez *et al.* (2006)
MIXPROP	IWC (2007)
GENELAND	IWC (2007)

To date, the SDWG has reviewed TOSSM results from ten methods (Table 1). All tests relate to performance on Archetypes I (panmixia) and/or Archetypes II (breeding ground samples/harvest, with migration). No other Archetypes have been used in testing so far. Most test results relate to total population size 7,500, with sample sizes of 600 animals at 30 microsatellite loci, and a variety of migration rates. The papers listed below and the associated Scientific Committee reports should be consulted for full details. Briefly, though, the Oyvind/Skaug (close-kin) method was usually able to identify the appropriate number of demographically independent units for management regardless of migration rate, but all other methods eventually failed to detect demographically independent units when the migration rate became too high. Some methods were also prone to detecting stock structure when none was actually present. The Monmonnier and Waples/Gaggiotti methods performed much better than any of the other non-close-kin approaches, being able to cope with migration rates of at least 5*10-4 per capita *per annum* in the scenarios tested.

No papers were received this year on further method-tests using TOSSM. Just as last year, the Committee noted the relevance of Archetype IV to North Pacific minke whales, where STRUCTURE is receiving extensive use, and encouraged the submission of papers to next year's meeting on testing STRUCTURE's performance using Archetype IV. Tests need not be restricted to overall management performance; more detailed aspects, such as the reliability of individual assignments, can easily be investigated too.

Mark-recapture as well as genetic data is becoming widely used in the Scientific Committee's deliberations over stock structure. Bravington offered to investigate the feasibility of adding simulated mark-recapture data to TOSSM datasets. As yet, there are few if any formal methods for incorporating mark-recapture and genetic data into a single analysis of stock structure, but this is likely to change; TOSSM should be prepared.

3.2 Proposals for further work

So far, there have not been any tests of coalescent-based methods in TOSSM. Computational complexity has probably been the limiting factor. Jackson offered to investigate the feasibility of testing one type of coalescent model (MDIV) under TOSSM. The SDWG welcomed this offer.

4. OVERALL WORK PLAN BEFORE AND DURING NEXT YEAR'S MEETING

- Furtherance of guidelines for analysis.
- Receive updates on guidelines for DNA Data Quality.
- Statistical and genetic issues concerning stock definition.
- TOSSM.
- Unit-to-conserve.

5. ADOPTION OF REPORT

The report was adopted at 18:52 on Monday 7 June 2010.

REFERENCES

Edwards, C.T.T. and Butterworth, D.S. 2007. Development of a Boundary Setting Algorithm based on migration rates estimated using BayesAss and its preliminary application to TOSSM datasets. Paper SC/59/SD6 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 16pp. [Paper available from the Office of this Journal].

Hatch, L.T. and Clark, C.W. 2004. Acoustic differentiation between fin whales in both the North Atlantic and North Pacific Oceans, and integration with genetic estimates of divergence. Paper SC/56/SD6 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 37pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2005. Report of the Scientific Committee. Annex I. Report of the Working Group on Stock Definition. *J. Cetacean Res. Manage. (Suppl.)* 7:247-53.

International Whaling Commission. 2007. Report of the 2nd TOSSM (Testing of Spatial Structure Models) Workshop. *J. Cetacean Res. Manage. (Suppl.)* 9:489-98.

International Whaling Commission. 2009a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 11:1-74.

International Whaling Commission. 2009b. Report of the Scientific Committee. Annex I. Report of the working group on stock definition. *J. Cetacean Res. Manage. (Suppl.)* 11:248-57.

International Whaling Commission. 2009c. Report of the Scientific Committee. Annex I. Report of the working group on stock definition. Appendix 2. Guidelines for DNA data quality control for genetic studies relevant to IWC management advice. *J. Cetacean Res. Manage. (Suppl.)* 11:252-56.

Martien, K.K., Archer, E. and Taylor, B.L. 2007. Simulation-based performance testing of the Bayesian clustering program STRUCTURE. Paper SC/59/SD3 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 10pp. [Paper available from the Office of this Journal].

Martien, K.K. and Gregovich, D. 2008. Comparative performance testing of spatially explicit genetic analytical methods. Paper SC/60/SD4 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 10pp. [Paper available from the Office of this Journal].

Martien, K.K., Gregovich, D. and Punt, A.E. 2008. Evaluating the performance of the *CLA* when population structure is not correctly identified. Paper SC/60/SD3 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 10pp. [Paper available from the Office of this Journal].

Økland, J.M., Haaland, Ø.A. and Skaug, H.J. 2008. A boundary setting algorithm based on genetically determined close relatives. Paper SC/60/SD5 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 12pp. [Paper available from the Office of this Journal].

Poljak Grez, D., Punt, A.E., Cope, J.M. and Brandon, J.R. 2006. Application of a sequential hypotheses testing method to example TOSSM data sets. Paper SC/58/SD1 presented to the IWC Scientific Committee, May 2006, St. Kitts and Nevis, West Indies (unpublished). 8pp. [Paper available from the Office of this Journal].

Appendix 1

AGENDA

1. Introductory items
   - 1.1 Election of Chair and appointment of rapporteurs
   - 1.2 Adoption of Agenda
   - 1.3 Review of documents
2. Statistical and genetic issues relating to stock definition
   - 2.1 DNA data quality
   - 2.2 Guidelines for analysis methods
3. TOSSM (Testing of Spatial Structure Models)
   - 3.1 Update on progress
   - 3.2 Proposals for further work
4. Overall work plan
5. Adoption of Report