non-trivial bias becomes evident when sampling is preferentially to one side of the optimal dividing line. Furthermore the distribution of boundary placement about this optimum is quite wide and this width appears to decrease only rather slowly as sample size increases. These further analyses thus serve to support previous advocacy of the need for close inspection of results from application of the BR technique if a cline structure is suspected, rather than automatically accepting its outputs.

In discussion, the Working Group concurred that close scrutiny of automatic boundary-setting methods is always important. However, although SC/57/SD5 certainly does reveal an underlying bias independent of sample size, the implications for practical use of BR with whales are not clear. The extent of bias is not enormous (up to about 10% of population range for the scenarios in the paper), although the large random variability in boundary placement may be of more concern. The scenarios in SC/57/SD5 have very low haplotypic diversity; at higher and more realistic diversities, other effects may swamp this particular bias. It was also suggested that the centre may not in fact be the best place to put a management boundary in a cline, if harvesting (and sampling) is skewed towards one end.

Of course, it is desirable to keep simulations simple, and it would be a big task to address all such complications directly in a one-off simulation model. Fortunately, the TOSSM project provides exactly the framework needed for the most meaningful tests of Boundary Rank (and other algorithms). More complex simulations along the lines of SC/57/SD5 can be done fairly easily within the existing package RMETASIM; in simple exploratory cases, it will not even be necessary to use the harvesting and demographic extensions in Testing of Spatial Structure Models (TOSSM). The Working Group **recommended** that those thinking about doing simulation tests of boundary-setting should explore the possibility of using TOSSM/RMETASIM.

5. TESTING OF SPATIAL STRUCTURE MODELS (TOSSM)

5.1 Update on intersessional progress

At the 2003 IWC meeting, the Scientific Committee and the SD Working Group instigated the TOSSM project, following a Workshop in La Jolla, USA, January 2003. The main aim of TOSSM is to develop simulation tools that can be used to examine the performance of current and future genetic population structure techniques. The focus is on a management context, where the genetic techniques are used to suggest management boundaries, which in turn are used to set or subdivide catch limits according to some rule; the performance of different genetic methods is ultimately to be assessed in terms of how well a simulated management regime performs if the suggested boundaries are used. The Scientific Committee’s experience of studying population structure, e.g. in developing *Implementation Simulation Trials* (*ISTs*) for common minke whales (*Balaenoptera acurostrata*) in the North Pacific, has shown that genetic data does not usually provide unequivocal evidence for specific boundaries for use in management. Furthermore, few boundary-placement techniques have been subject to any form of simulation testing. Even those that have, cannot be considered to have undergone the level of extensive simulating testing to incorporate uncertainty that has been a feature of, for example, the IWC’s work on the RMP and AWMP. This is perhaps not surprising, given the scope and complexity of developing suitable genetically-specified simulation datasets.

The Report of the TOSSM Workshop (IWC, 2004) identified the following six work modules, each of which has to be completed before the simulation performance testing can actually begin.

(i) Genetic simulation.
(ii) Biology and population dynamics.
(iii) Sampling.
(iv) Catch strategy.
(v) Adaptation of boundary-settings methods for testing.
(vi) Integrating all the above to allow a complete test to be run.

Considerable progress on these was made before the 2004 IWC meeting. At that stage, the SD Working Group identified the following priority tasks for intersessional work before the 2005 meeting:

(a) working with the developer of RMETASIM to fix a bug uncovered during TOSSM testing;
(b) incorporation of coalescence into step (i) to speed up the simulations, which are currently very slow; and
(c) incorporation of whale-like density dependence into step (ii).

The TOSSM developers (Martien, Tallmon, Tiedemann) made good progress intersessionally. Tasks (a) and (b) are complete, and (c) should be complete by 1 July 2005. However, there were delays beyond the control of the developers, and it has not been possible to take the project through to generating the first simulated datasets, as was hoped last year.

The Working Group warmly thanked Martien, Tallmon, and Tiedemann for their efforts. Modules (i) and (ii) are now basically complete (at least for the simple population archetype proposed for the first round of tests). Modules (iii), (iv) and (vi) should be easier than (i) and (ii) were, because of the RMETASIM framework and the availability of code for the *Catch Limit Algorithm* (*CLA*). The hardest remaining work is in module (v). The WG noted that detailed documentation is vital in complex simulation models, and requested that the developers maintain a 'living document' describing *inter alia* the demographic model and parameters.

5.2 Directions for further work

The IWC has extensive experience of complex simulation exercises similar to TOSSM. To avoid costly back-tracking, it is important to do some 'full runs' early on - that is, to make sure that the entire set of steps can be completed together for a fairly simple scenario - before spending too much attention on polishing individual details. Although some background work is still needed, TOSSM has now reached the 'full run' stage. Once a few 'full run' results are in hand, it will be time to discuss preliminary results with non-IWC developers of population structure models, who form an essential part of the TOSSM process.

The most efficient way forward would be to hold an intersessional Workshop after completing the background work and some 'full runs'. Holding the Workshop in March 2006 would leave enough time to (i) complete the background work beforehand and (ii) implement some of the Workshop recommendations before IWC 2006, so that a more useful set of test results can be considered at that meeting. Tiedemann offered to host the meeting at University of Potsdam, including free meeting facilities and the provision of computing power for generating extra datasets during the meeting. The WG thanked Tiedemann for his offer and **strongly endorsed** the Workshop proposal, which is given in full in Appendix 2. The workshop objectives are:

(1) present results of preliminary runs using existing adapted methods;
(2) discuss adjustments to the first sets of simulated data;
(3) discuss how to better adapt existing boundary-setting methods, specifically via:
    (a) tunable 'back-end' rules for deciding how many boundaries;
    (b)'front-end' rules for preliminary sample grouping, etc;
(4) discuss other boundary-setting methods that might be tested in TOSSM; and
(5) decide on priorities for further simulated datasets, e.g. more complex population archetypes, more realistic genetics, simulation of physical tags.

The intersessional background work needed before the Workshop is listed in Table 1, together with timelines and lead personnel.

[Table 1 here]

6. UNIT-TO-CONSERVE

The point of this agenda item is to allow consideration of various possible definitions of unit-to-conserve, and their corresponding implications for management; see IWC (2003, p.49). No papers were received this year, but the Working Group discussed recent academic thinking on this point as summarised in Waples and Gaggiotti (In press). In Waples' summary, the term 'population' is used in a somewhat similar way to 'stock' in IWC pre-2002, the year when the Stock Definition WG decided not to use the term 'stock' except in its own name.

When faced with a case where two randomly-mating groups are linked by migration, two fundamental questions arise:

Question 1. Given that the magnitude of departure from panmixia occurs along a continuum, how does one define a point along that continuum at which subunits are differentiated enough to be considered 'populations'?

Question 2. Assuming one has defined a point along the continuum that corresponds to the concept 'population', how can one in practice determine whether units of interest are populations? This is a quantitative question that requires developing population metrics that can be evaluated for power and sensitivity.

Biological definitions of 'population' can be sorted into two different paradigms (Andrewartha and Birch, 1984): the ecological paradigm (which emphasises demographic cohesion) and the evolutionary paradigm (which emphasises reproductive cohesion). A suite of definitions is shown in Table 2.

Waples noted that none of the definitions in Table 2, with the possible exception of number 6 (McElhany *et al.*, 2000), is operational in the sense of being able to unambiguously answer Question 1. This lack emphasises the importance of a process such as TOSSM to bridge the gap between empirical data related to population structure

Table 1

Timetable for intersessional work.

	Population dynamics model	RMETASIM	RMP	Methods
1/7/05 1/11/05	Finish specification of movement and mutation rates for 'gray whale with stepping stones' RT/AP/PP	Finish density dependence KM/DT Add data generation for RMP + catch-setting via calling RMP MB/KM	Write RMP blackbox (AP/CA)	Adapt ~4 existing methods (SAMOVA, Spagedi, etc.); add rules for initial grouping and for deciding number of stocks RT/KM/NK/TK
1/1/06		Generate dataset(s) KM/HS		
1/2/06	Preliminary 'full run' test of methods (including harvesting under RMP) and feedback to non-IWC developers RT			

TK=Kitakado; NK=Kanda; MB=Bravington; KM=Martien; DT=Tallmon; HS=Skaug; PP=Palsbøll; CA=Allison; AP=Punt; RT=Tiedemann.

Table 2

Some suggested definitions of 'population' in the ecological literature.

Definition	Ref
Ecological paradigm	
A group of organisms of the same species occupying a particular space at a particular time.	1,2
A group of individuals of the same species that live together in an area of sufficient size that all requirements for reproduction, survival and migration can be met.	3
A group of organisms occupying a specific geographic area or biome.	4
A set of individuals that live in the same habitat patch and therefore interact with each other.	5
A group of individuals sufficiently isolated that immigration does not substantially affect the population dynamics or extinction risk over a 100-year time frame.	6
Evolutionary paradigm	
A community of individuals of a sexually reproducing species within which matings take place.	7
A major part of the environment in which selection takes place.	8
A group of interbreeding individuals that exist together in time and space.	9
A group of conspecific organisms that occupy a more or less well defined geographic region and exhibit reproductive continuity from generation to generation.	10
A group of individuals of the same species living close enough together than any member of the group can potentially mate with any other member.	11
Variations	
Stock: a species, group, or population of fish that maintains and sustains itself over time in a definable area.	12
Demographic units: those having separate demographic histories.	13
Demes: separate evolutionary units.	13
Interaction group – based on distance an individual might travel during the non-dispersive stage of its life.	14
Natural population: can only be bounded by natural ecological or genetic barriers.	15
Local population: (a) individuals have a chance to interact ecologically and reproductively with other members of the group; and (b) some members are likely to emigrate to or immigrate from other local groups.	15

References: [1]Krebs (1994); [2]Roughgarden *et al*. (1989); [3]Huffaker *et al*. (1984); [4]Lapedes (1978); [5]Hanski and Gilpin (1996); [6]McElhany *et al*. (2000); [7]Dobzhansky (1970); [8]Williams (1966); [9]Hedrick (2000); [10]Futuyma (1998); [11]Hartl and Clark (1988); [12]Booke (1981); [13]Brown and Ehrlich (1980); [14]den Boer (1977, 1979); [15]Andrewartha and Birch (1984).