

## Annex D

### Report of the Sub-Committee on the Revised Management Procedure

**Members:** Hammond (Chair), Allison, Baba, Baker, Berggren, Bjørge, Borodin, Bravington, Breiwick, Brown, Brownell, Butterworth, Cawthorn, Childerhouse, Cooke, Dalebout, Dizon, Donovan, Engel, Ensor, Fujise, Givens, Goto, Grønvik, Hakamada, Hatanaka, Hedley, Hester, Hovelsrud-Broda, Johnston, Kato, Kawahara, Kim, Kishiro, Komatsu, Lauriano, Lawrence, Leaper, Lens, Lento, Miyashita, Morishita, Murase, Ohsumi, Øien, Okamura, Palazzo, Palka, Pastene, Pérez-Cortés, Perrin, Perry, Phillips, Polacheck, Punt, Rojas-Bracho, Rose, Rosenbaum, Ryan, Sakamoto, Sayeg, Schweder, Senn, Skaug, Slooten, Smith, T., Tamura, Tanaka, Tanakura, Taylor, Thiele, Tomita, Urbán, Wada, Walløe, Witting, Yamamura, Yoshida, Wade, Walters, Zeh.

#### 1. CONVENOR'S OPENING REMARKS

Hammond welcomed the participants.

#### 2. ELECTION OF CHAIRMAN AND APPOINTMENT OF RAPORTEURS

Hammond was elected Chairman. Palka, Punt, Smith and Schweder were appointed rapporteurs.

#### 3. ADOPTION OF AGENDA

The adopted agenda is given as Appendix 1.

#### 4. REVIEW OF DOCUMENTS

Documents considered were SC/52/RMP1-22; SC/52/SD6, 7, 10; SC/52/O1, 25; SC/52/Rep2.

#### 5. EVALUATION OF CLA PROGRAM AND TUNING

At last year's meeting the Committee agreed that the new program implementing the *Catch Limit Algorithm (CLA)* written by the Norwegian Computing Centre (NCC) under contract to the IWC (with additional funding from Norway) should be fully evaluated by application to a set of selected combinations of input data (IWC, 2000a, pp.79-80).

SC/52/RMP1 reported comparisons of the accuracy of the new program (CATCHLIMIT) with the program that has been used by the International Whaling Commission's Scientific Committee to compute catch limits in simulation studies of the behaviour of its Revised Management Procedure (MANAGE). The program CATCHLIMIT incorporates more sophisticated and efficient numerical

integration procedures. The two programs allow adjustments in numerical integration details that trade off accuracy and execution time. Following the procedures agreed last year (IWC, 2000a, pp.78-80), catch limits calculated using both programs were compared for a set of hypothetical catch and abundance estimation histories. The catch limits from both programs were identical to within one whale when the numerical integration was made sufficiently precise in all cases where this was attempted, and it appears that this would be true for all other cases. However, computing time requirements limited this comparison for all cases.

The sub-committee agreed that the CATCHLIMIT program performed better in that it obtained more accurate answers more rapidly, and **recommends** its use by the Secretariat.

Several issues identified in SC/52/RMP1, however, require some additional attention. These include adjusting the convergence procedure to be robust when less precise integration is used, possibly optimising the two level convergence criteria, developing and implementing a convergence criterion that is relative to the magnitude of the catch limit or to the level of depletion, and incorporating the sub-program into the Secretariat suite of programs, including incorporating the diagnostic warnings into the simulation programs previously used. The sub-committee also agreed that the previously established approach to computing a more accurate tuning of the RMP to meet Commission specifications (IWC, 1999a, p.61) could now be followed for this new program. The sub-committee **recommends** that this work be undertaken by the Secretariat. An Intersessional Steering Group was established with membership Hammond (convenor), Cooke, Hakamada, Skaug, Smith, Walløe, to oversee this work.

SC/52/RMP1 also presented a comparison of the difference between catch limits computed using the CATCHLIMIT program and those from MANAGE with the level of numerical integration precision used in RMP simulation studies. The relative differences between the unrounded catch limits ranged from -14% to +50% over the cases considered. The MANAGE limits tended to exceed the CATCHLIMIT limits for cases where the limits were less than roughly 1,000 or greater than 6,000. At intermediate levels the MANAGE limits were slightly lower. The effect of these differences could be evaluated by re-running some of those simulations using the CATCHLIMIT program. However, Cooke pointed out that to compare such simulations it would be necessary to use the appropriate tuning values, which would differ for the two programs. The appropriate value for MANAGE would be that used in the simulations, while for CATCHLIMIT it would be the value

computed as described above. The sub-committee agreed that such a comparison should be made for a limited number of simulations, possibly the base-case trials, and referred this to the Intersessional Steering Group established above.

## 6. TOTAL CATCHES OVER TIME

The sub-committee established a Working Group (Butterworth, Cooke and Donovan) to consider the Commission's request from last year for the Scientific Committee to provide 'suitable wording for consideration by the Commission for inclusion in the RMS in time for next year's meeting'. The report of the Working Group is given in Appendix 2. The sub-committee agreed with the proposals of the Working Group and **recommends:** (a) that the text given below be forwarded to the Commission for its consideration; and (b) that the estimation of incidental catch and other human induced mortality of baleen whales should be placed on the Committee's agenda next year.

### 6.1 Wording in response to the request from the Commission:

Catch limits calculated under the Revised Management Procedure shall be adjusted downwards to account for human-induced mortalities due to sources other than commercial catches.

Each such adjustment shall be based on an estimate provided by the Scientific Committee of the size of adjustment required to ensure that total removals over time from each population and area do not exceed the limits set by the Revised Management Procedure. Total removals include commercial catches and other human-induced mortalities, to the extent that these are known or can reasonably be estimated.

## 7. COMPONENT OF POPULATION TO WHICH *MSYR*, *MSYL* AND DENSITY-DEPENDENCE SHOULD APPLY

The sub-committee met jointly with the AWMP sub-committee to discuss differences on the form of the density-dependence in the population models being used for the *Implementation Simulation Trials* in the Revised Management Procedure and the Aboriginal Whaling Management Procedure. The RMP has a non-age structured model at its core, but in the age structured model used in *Implementation Simulation Trials*, density-dependence had been assumed to be determined by the abundance of mature whales. In contrast, the AWMP was currently being developed using trials with population models that assumed that density-dependence was determined by the density of age one and older animals (1+). An earlier evaluation of the differences between these two approaches had identified a number of issues (IWC, 1998, pp.205-7).

One of these issues, the segregation of population components on the feeding ground, was addressed by SC/52/RMP20, which focused on the question of whether density-dependence is likely to apply to just the mature component of the population or the total (1+) population. The 1+ component of the population was defined as all animals that were independent of their mothers in the main feeding season. Even if competition for food can be assumed to be one of the primary mechanisms for density-dependence, the details of interactions between animals that determine competition for food are not well

understood. One factor that will affect competition is segregation on the feeding grounds and evidence for segregation by age and sex classes was reviewed for several baleen whale species. Although it was difficult to make any generalisations, it appeared that substantial segregation of population components on the feeding grounds was evident for the *Balaenoptera* populations where this issue had been investigated. The situation for *Megaptera* and *Eubalaena* suggested a lesser degree of segregation.

SC/52/RMP20 argued that for *Balaenoptera* populations at least, the balance of evidence tends to support the hypothesis that mature animals are subject to more direct competition with each other than with immature animals, thus implying that density-dependence in reproductive success would tend to be a function of the mature population size rather than the total 1+ population. A number of simulation trials, based on the MANTST program used in simulation trials of the RMP, were run to examine the sensitivity of trajectories of simulated exploited populations to different assumptions about density-dependence. The results showed that the choice of population component to which density-dependence applies had a relatively minor effect on the simulation results. The paper addressed only some aspects of the complex biological mechanisms underlying density-dependence in baleen whales but these issues may also be of importance for understanding the effects of environmental change on protected populations as well as considering the effects of exploitation.

The sub-committees agreed that there were likely differences in segregation between *Balaenoptera* and other species, and noted that the focus of the AWMP had so far been on bowhead whales, where such segregation was less apparent. Further, the sub-committee agreed that the results in SC/52/RMP20 suggested that the choice of the population component to which density-dependence applies in the simulation trial models may be of little import in the behaviour of the RMP as it exists.

It was noted that for both the RMP and AWMP some of the simulation trials were case-specific, and it was agreed that the form of the density-dependence should not be considered fixed for implementation trials for either management procedure but should be determined on a case-by-case basis.

Of particular concern, however, was the potential for the use of different population dynamics models in simulation trials for the RMP and the AWMP when applied to the same population, for example minke whales in the North Atlantic. In such a case, it was considered undesirable to have different definitions used, both conceptually (because the biological parameters of a population are independent of who harvests it) and, as noted previously, in terms of having a common currency to allow determination of comparability of risk. The sub-committees agreed that the Committee should aim for consistency in such cases, especially in the context of explaining the results of its work to the Commission and elsewhere.

In some cases both aboriginal whaling and commercial harvests (e.g. that by Norway) include large proportions of immature animals. Although there are complexities introduced in the models when the density-dependent component and the age composition of the harvest differ, such situations were not thought to have a dominant bearing on the modelling choice for density-dependence.

The sub-committees discussed the differing implications of defining *MSYL* in terms of the 1+ or the mature component of the population to set population parameter values in *Implementation Simulation Trials* for both the

RMP and the AWMP. This raised the question of whether the choice could lead to major differences in interpretation of the results.

Because previous work (e.g. Butterworth and Punt, 1992; Cooke and de la Mare, 1994) and discussions had not provided the information that the sub-committees needed, it was agreed that an evaluation of management procedure performance using simulation trials constructed using the different assumptions for the nature of density-dependence and definitions for *MSYL* would be useful.

A Working Group including individuals from both sub-committees was established comprising Punt (convenor), Bravington, Butterworth, Cooke, Givens, Polacheck, with terms of reference: to define modelling work that would assist the Committee in understanding the implications of the choices of modelling density-dependence and defining *MSYL* in the implementation process of management procedures.

The report of the Working Group is given as Appendix 3. The sub-committees agreed that the results of the trials described in Appendix 3 should facilitate an evaluation of the magnitude of differences in statistics caused by changing the component for *MSYL* and density-dependence and whether such differences are easily interpreted after translating the results to a scale appropriate for the component choices. The sub-committees **recommend** that the Secretariat run these trials, assisted by Punt. Allison noted that some of the work was planned to be undertaken as part of the development of the AWMP.

The sub-committees noted that the objective of *Implementation Simulation Trials* for populations potentially subject to commercial whaling is to compare variants of the RMP (including *catch capping* and *catch cascading*) in situations in which stock structure is uncertain. Some members believed that different specifications for *MSYL* and the density-dependence component would not have a significant impact on the relative performance of different RMP options.

## 8. ABUNDANCE ESTIMATION

### 8.1 Report of Intersessional Working Group

The objectives of this Working Group were to review proposed methods that estimate abundance from multi-year data and to evaluate abundance estimators that might be used to produce estimates used in the RMP when heterogeneities occur and assumptions are violated and, in particular, to evaluate the precision and bias of estimates when heterogeneities are present, when responsive movement is occurring, and when there are duplicate identification errors. No new methods to estimate abundance from multi-year data were presented to the Intersessional Working Group to review. To evaluate estimators when heterogeneities were present, simulated datasets were analysed with five methods and the results reported in SC/52/RMP18. To evaluate estimators when responsive movement is occurring, the computer code that created the above simulated data was modified to incorporate responsive movement. The next step will be to ensure that the resulting simulated data are reasonable and then to mass produce simulated data that can be analysed by methods that attempt to account for responsive movement. No attempt was made to incorporate errors due to duplicate identification into the simulated datasets.

SC/52/RMP18 presented a comparison of the precision and bias of five analytical methods that estimate whale

density from double-team line transect data where  $g(0) < 1$  and covariates affect the detection probability. The analytical methods included the logistic regression model of Borchers *et al.* (1998), the perpendicular distance discrete hazard model of Skaug and Schweder (1999), two variations of the radial distance hazard probability models of Cooke and Leaper (1998), and the modified direct duplicate model of Palka (1995). One hundred simulated datasets of 32 scenarios that had various degrees and combinations of heterogeneities due to weather, team, platform, group size and type of scanning mode were analysed. Results suggested that all the estimators are biased, though much less than if no effort was made to account for  $g(0) < 1$ . The radial distance hazard estimator performed best, having small bias in all cases. The performance of the direct duplicate and the logistic regression estimators was quite different with scanner mode surveys and non-scanner mode surveys. The direct duplicate method was negatively biased with non-scanner mode surveys and positively biased with scanner mode surveys. The logistic regression method, designed for scanner-type data, was substantially negatively biased with non-scanner mode surveys but much less negatively biased with scanner surveys. The perpendicular distance hazard model is not applicable to scanner mode surveys; in other cases the estimator was positively biased. Bias was greatest when there were large differences between the two teams.

The sub-committee agreed that the most appropriate analytical method to be used in the future depends on the desired performance, information collected and ease of implementation. For example, the modified direct duplicate method is easy to program, though the average results are biased. In contrast, the performance of the radial distance hazard estimator was superior; however, dive time information is required and the analysis methods are more complex. The sub-committee suggested that other potential issues to investigate included: why the perpendicular distance discrete hazard model was positively biased and the performance of methods when other sources of heterogeneity were incorporated. Other sources of heterogeneity include, in particular, those unknown to the analyser, when available sample sizes are small, when dive time information is unknown, when observer search patterns reflect those using binoculars, when animal dive patterns reflect longer divers, such as minke or Bryde's whales, when responsive movement was occurring, when there are errors in determining duplicates, and when measurement error is incorporated.

### 8.2 Estimates from multi-year surveys

Skaug presented a statistical method to incorporate additional variance into the analysis of data from the ongoing multi-year sighting surveys in the Northeast Atlantic (SC/52/RMP12). The method was a modification of the method in Skaug (1999). An application of the method to data from the 1989 and 1995 surveys in the EB *Small Area* yielded a four times increase in the CV of the abundance estimate, relative to the situation with synoptic coverage. However, it was pointed out that the estimate of the additional variance parameter was based on a small dataset, and hence was imprecise.

The sub-committee agreed that the method presented in SC/52/RMP12 was conceptually appropriate but there were a number of technical issues to be addressed. These included: avoiding use of improper priors for the parameters; investigating if normalised priors or likelihood methods

could be used; investigating if the covariance between areas can be derived from first principles instead of using the simple correlations; and, in the future when the time span between the time series of surveys is much longer, investigating if the assumption that the annual growth rate is constant is still valid.

The sub-committee revisited issues flagged last year for the Committee to consider when utilising abundance estimates derived from multi-year surveys with the RMP. A Working Group convened by Palka was established to consider: technical issues when estimating additional variance using methods described in SC/52/RMP12 and issues relating to the use of multi-year survey estimates in the RMP. The report of the Working Group is given in Appendix 4.

The sub-committee agreed that the outstanding technical and RMP implementation issues had been resolved as described in Appendix 4 and **recommends** that annotations to the RMP should now be drafted to reflect this (see Item 8.4).

### 8.3 Other

Bravington presented a new method of estimating abundance that incorporates the spatial structure of cetacean distribution (SC/52/RMP14 and SC/52/RMP15). SC/52/RMP14 described a statistical framework for fitting spatial models to sightings data. Sighting rates are described through linear or smooth functions of effort-related covariates such as position, sighting conditions, or indicator variables of platform. Either single- or dual-platform data can be used; the type of data available determines whether density estimates should be interpreted as relative or absolute abundance. Absolute abundance estimates require the pre-calculation of effective strip width as a function of covariates, using standard methods. As with all abundance estimators, size bias can be problematic. The appropriate remedy, if there is one, depends on the type of data and on what assumptions are deemed reasonable; several approaches are suggested in the paper.

The statistical model is that of a continuous-time Poisson process with varying rate, but estimates are consistent in the presence of non-Poisson clustering of sightings. Confidence limits are obtained by bootstrapping, which should mimic the pattern of clustering found in real data that cannot be explained by fitting a model. SC/52/RMP15 described a method to estimate clustering behaviour and simulate realistically-clustered datasets, based on the output of the models in SC/52/RMP14. In the sample dataset presented, ignoring clustering underestimates sampling variance by a factor of more than two.

Although these two papers have as yet only been used to estimate relative abundance, Bravington suggested several potential advantages for estimating absolute abundance. Spatial models, such as Hedley *et al.* (1999) or SC/52/RMP14, potentially allow more realistic confidence limits than stratified estimates, because systematic structure within a stratum is not treated as noise. Compared with GAM-based spatial models, the continuous-time approach allows realistic bootstrapping without a subjective choice of resampling unit. Also, smooth terms can be purpose-built, e.g. to behave well at boundaries, and multivariate responses (i.e. partial stratification by species or group size) can be accommodated easily.

The sub-committee welcomed these new methods to estimate abundance when assumptions are violated and encouraged Bravington to continue the development of this

method to estimate absolute abundance and to incorporate covariates. The sub-committee noted that methods described in SC/52/RMP15 may be used to compare simulated North Atlantic minke whale distributions used in previous estimates or the simulated distributions used in SC/52/RMP18 to determine if the simulated distributions match actual whale distributions.

Leaper presented SC/52/O25 on behalf of the authors. Minke whale surfacing rates off the west coast of Scotland were analysed from visual data collected over a three year period. Data were only considered for analysis if a single animal could be observed for a 30 minute period in good sighting conditions. The mean interval between surfacings of the 1,367 dive sequences that were analysed was 66.1 seconds. Significant differences in surfacing intervals were found between months with the shortest intervals in June and July and longest intervals in May and August. Surfacing intervals were also significantly longer in mid-morning and mid-afternoon than in the middle of the day.

The sub-committee noted that the results from this paper re-enforce previous Committee recommendations. In particular, surfacing information used in abundance estimates should be collected under the same general conditions as the abundance surveys themselves, as was done in the North Atlantic minke whale surveys, and representative surfacing data from a sufficient sample of whales should be obtained.

### 8.4 Future work

The sub-committee established an Intersessional Working Group to continue work on matters relating to abundance estimation under the RMP, with membership: Palka (convenor), Borchers, Bravington, Butterworth, Cooke, Hakamada, Hammond, Hedley, Kingsley, Okamura, Polacheck, Schweder, Skaug and Smith. The highest priority issue for the Intersessional Working Group is to develop and present to next year's meeting draft annotations to the RMP relating to abundance estimates from multi-year surveys that will be used in the RMP (as described in Appendix 4). The next highest priority issues are to continue work suggested in past years. This includes, in particular, conditioning simulated datasets on North Pacific sighting surveys for minke and/or Bryde's whales and evaluating abundance estimators that might be used to produce estimates used in the RMP when responsive movement is occurring.

## 9. NORTH PACIFIC MINKE WHALES

### 9.1 Results of Implementation Simulation Trials run intersessionally

The terms of references of the Intersessional Steering Group established last year included 'In the light of the results of the initial trials (1-42) in Appendix 5, decide upon four possible combinations of *Small Area* definitions and RMP variants for which to run the selected set of trials (i.e. NPM1, 3, 5, 7, 9, 37, 39, 41)' (IWC, 2000c, p.117). Butterworth (Chair of the Intersessional Steering Group) reported that RMP variants had not been examined intersessionally because it was evident from discussions during the JARPEN review (SC/52/Rep2) that re-specification of the trials was highly likely.

Appendix 5 lists results for six trials for the case in which the RMP *Small Areas* are assumed to be the sub-areas and the J(i) variant for incidental catches is assumed for Japan. These trials differ from those for which results were

presented last year because: (i) the CPUE data for the Korean past commercial fishery had been re-analysed interessionally; (ii) the approach used to model incidental catches had been changed; and (iii) the proportions of 'J' stock animals in the sub-areas around Japan had been updated.

The slope in the CPUE data for the Korean past commercial fishery is used in the conditioning of these *Implementation Simulation Trials*. It is the primary source of data in these trials used to determine the abundance of the 'J' stock; the survey estimates for sub-areas 6 and 10 are treated as minimum estimates. Butterworth indicated that questions were raised concerning the derivation of this slope by members of the Intersessional Steering Group at the stage that the trials were finalised last year. A review of the derivation of the previous specifications indicated that the model used in 1984 to obtain the slope differed from that underlying the trials and that more catch and effort data were available than in the original analysis. This led to a re-analysis of the catch and effort data based on the perceived intent of the Scientific Committee, and involved applying essentially the same GLM approach as had been used to analyse the original catch and effort data for the Korean fishery in 1984 to the total dataset (1973-86).

The re-analysis of the Korean CPUE data was communicated to the full Scientific Committee in September 1999 in the form of: (i) a report by Allison and Punt documenting their reconstruction of the 1984 analysis of the 1973-82 Korean CPUE data on which the previous conditioning had been based; (ii) a re-analysis by Brandão of the Korean CPUE data for the entire period 1973-86, including additional data for the period 1983-86 submitted to the IWC after the 1984 assessment; (iii) an alternative analysis of these same data by Cooke; and (iv) a covering note by Butterworth reflecting the agreed proposal of the Intersessional Steering Group to condition the trials given these new analyses. No objections to the proposal in this note were received so the trials were conditioned based on the results of the re-analysis by Brandão. Cooke stated that there were some errors in the report of the 1984 analysis, which he had pointed out to the authors but that had not appeared in the final version that was subsequently circulated and published. The Chairman ruled that this would not be discussed further.

The report by Punt and Allison and the analysis of the Korean CPUE data by Brandão have been published in IWC (2000c, pp.115-117). They were prepared subsequent to last year's meeting and, although circulated to members of the Committee interessionally, were not the subject of discussion last year. Donovan explained that the normal procedure was for sub-committee reports to be corrected and completed after the meeting and before publication. This was often the case for complex appendices such as those relating to trials in both the sub-committees on the RMP and the AWMP. However, in this particular instance the changes had been more substantial than this procedure allows for and were included in error. An erratum is to be published in the Introduction to this volume.

Several members commented that the Korean catch and effort data could have been analysed more fully. For example, the model fitted to the output from the GLM analysis to estimate the slope did not explain much of the variance, and the residuals had not been examined. These members noted that the estimate of trend was sensitive to the inclusion or otherwise of the last four points of the time series. In addition, although boats had fished both sides of Korea, the location of the catches was not included in the

data. They believed that it was necessary to use the survey data as the basis for conditioning the trials. The sub-committee recalled that the use of CPUE as an index of abundance for whales is seldom considered reliable and accepted as a basis for estimating abundance in the Committee. The Chairman then closed the discussion of this matter.

The sub-committee discussed the level of detail needed when modelling the 'J' stock in the *Implementation Simulation Trials*. Some members emphasised that the trials were originally designed to evaluate variants of the RMP (e.g. capping, cascading) when the fishery targets the 'O' stock. These members did not believe that the *Implementation Simulation Trials* constituted an 'assessment' although it was necessary to consider the impact of unintended harvests of 'J' stock whales. Other members emphasised the value of the results of *Implementation Simulation Trials* in the context of the status of the 'J' stock and therefore highlighted the importance of carefully considering the specifications that relate to this stock. Butterworth observed that the process of conditioning *Implementation Simulation Trials* was synonymous with 'assessment' as the term is conventionally used in fisheries, as such these *Trials* implicitly 'assessed' the 'J' stock. The procedure used to condition the trials would not necessarily constitute an adequate basis for a re-assessment of the 'J' stock when this is conducted because of uncertainties surrounding the Korean CPUE data and the limited coverage of the survey data. The sub-committee agreed that a future reassessment of this stock would need to be based on a comprehensive review of the available information.

The information (inferences from data on conception dates and flipper colour) used to determine the proportion of 'J' stock animals in sub-area 12 (the northern Sea of Okhotsk) is limited. The consequences for the number of 'J' stock animals of the manner in which this proportion is specified could be substantial because the trials indicate that the bulk of the catch will be taken from sub-area 12.

Taylor observed that in the results of trials in Appendix 5 catches appear to be allowed from the 'O' stock even when it is less than 54% of carrying capacity. It was noted that this was due to: (a) incidental catches being taken from waters in which 'O' stock animals are found; (b) the RMP allowing some catches for stocks below 0.54K even for single stock scenarios; and (c) the results presented are for the case in which the RMP is applied to each sub-area separately. It was noted that the purpose of *Implementation Simulation Trials* was to contrast the performances of different variants of the RMP and that different variants (e.g. capping) might give rise to behaviour different from that evident from the set of trials in Appendix 5. The sub-committee agreed that future trial results should distinguish between commercial and incidental catches when listing the catches for the 'J' and 'O' stocks.

SC/52/RMP2 used the Baleen II model to estimate status and examine trends in the abundance of 'J' stock minke whales in the western North Pacific as implied by the recently updated Korean commercial CPUE information, to help clarify these aspects in the context of the *Implementation Simulation Trials*. Point estimates of the updated CPUE trend suggest that the 'J' stock currently exceeds 10,000 whales and 50% of its pre-exploitation level. However, the lower five percentiles for these trend estimates give rather pessimistic results for the case where CPUE is assumed to have a square root rather than a linear dependence on abundance, although even in this case the 1992 depletion is still above 15%.

## 9.2 Incidental catches

Kim provided information about incidental catches off Korea in 1999 (Appendix 6). The sub-committee welcomed this information, noting that almost half of the animals had been sampled. It further encouraged continued sampling of bycatch and strandings. It was noted that the strandings were in too poor a condition for the cause of death to be determined so some of these animals may have died as a result of a fishery interaction. The sub-committee agreed to update the specifications for the trials to include the information on the size of the Korean bycatch (56 animals), including its seasonality and sex-structure.

The sub-committee noted that the reported bycatch off Japan for 1999 was 19 (SC/52/ProgRepJapan) and agreed to update the information on bycatch off Japan used in the appropriate trials to reflect this new information.

Baker *et al.* (2000) reported a two-tiered analysis of molecular genetic variation of whale products purchased from retail markets in Japan and the Republic of Korea from 1993-99. Phylogenetic analysis of mtDNA from 655 products identified eight species of baleen whales and numerous odontocetes. Of this total, 152 products were identified as North Pacific minke whales (Japan,  $n=98$ ; Korea,  $n=54$ ). The mtDNA haplotype frequencies were compared to those reported for whales taken under the JARPN programme ( $n=368$ , Goto and Pastene, 1999) to determine the likely stock origins of these products. Following the high-resolution analysis of mtDNA sequences presented in Congdon *et al.* (1999) and used in Goto *et al.* (2000), less than 5% of the JARPN samples were determined to have J-type mtDNA. This expected proportion differed significantly ( $p < 0.001$ ) from the J-type proportion of 32% found in the Japanese market products. A 'mixed-stock' analysis and maximum-likelihood methods (Pella and Milner, 1987) were used to estimate that 31% (95% bootstrap confidence intervals of 19-43%) of the Japanese market products originated from the 'J' stock, presumably as incidental takes. To calculate the 'true' size of the incidental take, Baker *et al.* (2000) solved for the value required to explain the market proportion of 'J' stock products, using the known catches taken under JARPN (94 whales per year) and the reported coastal distribution of incidental takes (60% west coast, assumed to be 'J' stock). The required total incidental take was found to be 100 whales per year. Baker *et al.* (2000) noted that the estimate is close to the independent estimate of undocumented incidental takes based on extrapolation of reported takes and the effort of coastal fisheries (Tobayama *et al.*, 1992) but substantially higher than the 25 per year average (bycatch and strandings) reported by the Fisheries Agency, Government of Japan, in its annual progress reports to the IWC.

SC/52/RMP19 described work on stock structure and individual identification of North Pacific minke whales by means of microsatellite profiling of whalemeat products from commercial markets in Japan and the Republic of Korea. The expected heterozygosity as well as the total number of alleles for tetramer loci was found to be lower for the Korean market than for the Japanese market, or for sub-area 9 (Abe *et al.*, 1997). However, more alleles were found at these loci for Korean 'J'-stock products than were found by Abe *et al.* (1997) for sub-area 6 using a sample of 26 animals taken during commercial whaling in 1982. Although pairwise tests of independence suggested a significant difference between the Korean market and sub-area 9, no significant differences were found between the Korean and Japanese market products. This finding appears to reflect the mixed composition of the Japanese

market, which includes a large proportion of products from 'J'-type animals, from an undocumented source. Matching of microsatellite profiles showed that the 101 products from the Japanese market were derived from 87 individuals. Of these, 33.3% were determined to be of likely 'J' stock origin based on mitochondrial DNA sequence analyses. SC/52/RMP19 concluded that this demonstrates that the estimate of 'J' stock products on the market reported in Baker *et al.* (2000), was not biased by duplicate sampling, and is consistent with an annual bycatch for Japan of approximately 100 animals. For the Korean market, matching of microsatellite profiles indicated that the 42 products were derived from at least 34 individuals. No matches were found between Korean products purchased in March and October of 1999. The 34 individuals are therefore a minimum census of the Korean bycatch in 1999. Using a frequency-of-capture model based on the number of duplicate and triplicate samples, SC/52/RMP19 estimated that 45 whales were available on the market in March, and 53 whales were available in October. Considering that no individuals were 'captured' in both periods, these totals were summed to provide a minimum estimate of about 98 whales for the Korean bycatch in these two months of 1999.

Pastene stated that he was extremely surprised to find some of his genetic data for North Pacific and southern dwarf minke whales in Baker *et al.* (2000). These data had been used in Baker *et al.* (2000) without his permission. In addition, he expressed his concern that a large amount of genetic data for the western North Pacific (sampled during JARPN) and from the Sea of Japan (taken during commercial operations in 1982 around Korea) had been used in the paper, also without his permission and was hence scientifically unethical. He made clear that Baker and his co-authors have the right to conduct forensic analysis of whale products in Korea, Japan and indeed anywhere they wish. It was in that spirit that he and Prof. Hori had supplied Baker with two reference sequences in the past. However, in this instance he believes that the way they extracted and used his data without consultation is completely unacceptable and infringes any basic principles among researchers. He indicated further that the publication of his data without authorisation was particularly disturbing because, in collaboration with Danish, Brazilian and other Japanese scientists, he is completing a worldwide phylogenetic analysis of the minke whale, using a large dataset from the various forms and geographical areas, that they will soon be planning to submit for publication. As recently as last year's meeting of the Scientific Committee, Baker was explicitly told not to use the minke whale genetic data for publication.

Baker replied that Pastene was mistaken concerning the publication of the North Pacific and dwarf form minke whale reference sequences (from Hori *et al.*, 1994). The sequences were not published in Baker *et al.* (2000). The position of the taxa is shown in the tree (and acknowledged) to assist in standardisation of the phylogenetic identification of species and oceanic origins, in keeping with the purpose of the original loan. Concerning the frequencies of the mtDNA haplotypes from the Japanese scientific whaling and the Korean commercial catch, Baker noted that these had been published, in part, by Goto and Pastene (1997; as haplotypes) and reported, in full, by Goto and Pastene (1999; as sequences). No conditions on citation were indicated on this report. Further, these data have been integrated into the *Implementation Simulation Trials* of the North Pacific minke whales, as well as analysed and referenced extensively in the reports to the Scientific Committee and the review of the

JARPN programme. As such, Baker assumed these data (in the limited form used to determine the expected frequency of products from the scientific hunt) were publicly available for scientific research related to management. Acknowledgement of the comprehensive genetic information from the scientific whaling programme, provided by Goto and Pastene, is indicated in the text and fully referenced in an electronic appendix on the authors internet home page.

Pastene was invited to respond to the summary of the sub-committee discussions. His comments are reflected in Appendix 7.

SC/52/SD7 presented the results of a molecular genetic analysis of whale products collected from the Japanese retail markets during surveys in 1996 and 1999/2000. The 1996 survey was conducted between March and June and covered 28 Japanese prefectures. The 1999/2000 survey was conducted between November 1999 and January 2000 and covered 22 prefectures. The method of sampling employed was not random. A total of 65 and 30 products was identified as North Pacific minke whale in the 1996 and 1999/2000 surveys respectively. Using the criterion of a G base in position 298, 9 (13.9%) and 13 (43.3%) products were identified as 'J' stock animals, respectively. SC/52/SD7 showed that the proportion of 'J' stock products seems to change across prefectures. The authors emphasised that the interpretation of these estimates is complicated for several reasons: (i) sampling has not been conducted based on a random design; (ii) the molecular criteria to identify 'J' stock products are not absolute; and (iii) analyses are based on the number of samples, not the number of individuals. Therefore, the authors recommended that these results should not be used in the *Implementation Simulation Trials* for North Pacific minke whales.

Brownell noted that 15 of 25 minke whale market samples collected in August 1999 in Korea (SC/52/SD6) had unique sequences.

The sub-committee considered whether the trials should be modified based on the information contained in Baker *et al.* (2000), SC/52/RMP19, SC/52/SD6 and SC/52/SD7.

Considerable discussion ensued regarding the representativeness of the sampling schemes used when sampling markets and the use of the resultant data to estimate incidental bycatch off Korea and Japan. Two of the views expressed are summarised in Appendices 8 and 9. Several members believed that the sampling designs on which the market surveys in SC/52/RMP19 and Baker *et al.* (2000) are based were inadequately described and hence it was not possible to evaluate the resultant estimates. Some of these members believed that the non-random nature of the sampling scheme meant that any inferences from the data collected during the market surveys were flawed. Pastene indicated that more information on the geographic and temporal details of the market surveys would assist in evaluating the value of the data and Kasuya commented that the value of the data would be enhanced if the spatial distribution of 'J'/'O' stock animals in the two types of studies (the market surveys conducted by Baker and colleagues and those conducted by the Government of Japan) agreed.

The sub-committee noted that some information on the sampling scheme was provided in other papers including SC/52/SD17 and Dizon *et al.* (2000). Baker commented that the sampling methodology differed between Korea and Japan. He noted that although the market surveys were not designed to be random, there is considerable consistency among the results of surveys conducted in different years and

that the problem identified in previous years that duplicates could be sampled had now been overcome. He believed that the split of the catch in the Japanese market was particularly relevant for the purposes of the sub-committee.

Baker requested information from Pastene and Goto on frequencies of 'J'-types in the JARPN samples for comparison to the samples collected from markets by the JFA surveys. Pastene responded that he was unable to accede to this request given Baker's misuse of data provided previously.

In relation to the level of bycatch off Japan, the sub-committee recalled that it had been unable to reach agreement last year on the value of data collected during market surveys, the implications of the data provided in Tobayama *et al.* (1992), and the re-analysis of those data in Inoue and Kawahara (1999). However, it agreed last year that 'an appropriate range for the purposes of *Implementation Simulation Trials* would be 25 to 75' even though use of these options for trial purposes did not constitute agreement by all members of the sub-committee that the entire range was plausible (IWC, 2000a, p.85). The sub-committee agreed to continue to use this range in future trials. It recalled the comment by Butterworth last year that the results for levels of incidental catch in the range 25 to 75 could be obtained by interpolation.

In relation to the level of Korean bycatch, concerns were raised about the estimate of 98 whales calculated in SC/52/RMP19 because, *inter alia*, no estimates of uncertainty were available for the estimate and a sampling design that attempted to minimise sampling duplicates would tend to overestimate incidental catch. Baker did not consider that this last point applied to the sampling strategy for the Korean market. The sub-committee agreed not to modify the approach agreed last year (IWC, 2000c, pp.110-111) to include incidental catches off Korea in the trials, and to use an incidental catch off Korea of 56 for 1999.

The sub-committee recalled the comment made by some members last year that no account is taken in trials of possible additional incidental catches in fisheries of countries other than Japan and Korea. The sub-committee again encouraged the collection and analysis of data for these fisheries/nations. The sub-committee noted that the catches used in RMP applications need to be based on the best estimates of all non-natural removals (IWC, 1999b, pp.251-8). It again encouraged collaborative work with the aim of determining the best estimates of incidental take off Japan and Korea.

Berggren noted that regarding bycatch of other cetaceans in other geographical areas, the Scientific Committee has recommended that reliable estimates of bycatch mortality be obtained using statistically-based observer programmes (IWC, 1996, p.90).

Several members believed that there is a need for the Committee to devote time to develop and test methods that could be applied to the information collected during market surveys to provide acceptable estimates of incidental catches, as this information is valuable and should be used, *inter alia*, in the specification of *Implementation Simulation Trials* (see also Item 6).

### 9.3 Sightings surveys

SC/52/RMP4 reported on a joint Japanese and Russian sightings survey conducted in 1999 in the Okhotsk Sea (sub-areas 11 and 12). This cruise was a second attempt to apply the Norwegian independent observer method in this area. During the survey 1,690 n.miles were surveyed, with

26 minke sightings made when searching during IO passing mode. The vocal recording system was used effectively to determine duplicate sightings in the field, with the result that seven sightings were made by both the top barrel and the IO platform, while seven and eight sightings were made only from the top barrel and only from the IO platform, respectively. The results of the survey are intended to be used for abundance estimates, although there were insufficient data to allow this to be done from this survey alone.

Miyashita had acted to oversee the survey for the Committee, and it was agreed that the conduct of the survey was appropriate for use in the RMP. The sub-committee noted with appreciation that the survey was conducted jointly with Russia, and appreciated the granting of permission to survey in Russian waters.

In reviewing the cruise report the sub-committee agreed that additional information should be routinely reported for such surveys to allow more complete monitoring of survey methodology. These included plots of the sighting angles and distances, as well as the perpendicular distances, and a fuller description of the angle and distance experiments conducted. The distribution of survey tracks was focused in the western portion of the area because of weather constraints, and the sightings suggested differences in density over the survey area that suggest the analysis may require post stratification of the data. The need for collecting dive time data was emphasised.

Miyashita introduced SC/52/RMP5, the research plan for a joint Japanese and Russian sightings survey to be conducted in the Okhotsk Sea from July to September 2000. The survey will be conducted using two vessels this year and will begin two weeks earlier than last year to attempt to obtain better weather and survey coverage. The survey design includes a spatial stratification by depth (and apparent minke whale density based on earlier surveys), with three primary strata each separated into a nearshore and an offshore component for a total of six strata. The design is to utilise the analysis method of Skaug (1997), and the results are intended for use in the RMP.

The sub-committee was pleased to see this joint Japanese and Russian sightings survey proposal.

The sub-committee discussed the survey design and some details of the survey plan. It noted that the offshore area may have too many strata for the likely numbers of sightings, and that this may need to be treated as a single stratum. The map presented did not allow for evaluation of the representativeness of the spatial coverage because the curvature of the earth was not considered. The importance of obtaining improved survey coverage in the northern portions of the Okhotsk Sea was emphasised.

The sub-committee noted the results of SC/52/RMP18, in terms of bias in the method of Skaug (1997) as was proposed to be used for data analysis. It was suggested that other methods that would be appropriate for such data are now being incorporated into the program DISTANCE, and that these could be considered.

The need for collection of additional dive time data was noted, both in the inshore area as planned, but also including the offshore area. It was noted that recent developments of pop-up archival tag methodology would allow an alternate method of collecting dive time data that would be easier to obtain and preferable to the visual method proposed for use.

The sub-committee **recommends** that the Commission request the relevant authorities of the Russian Federation to grant permission in a timely fashion for Japanese vessels to

survey in its EEZ, including both the southern and the northern portions of the entire Sea of Okhotsk and associated gulfs and bays, because of the apparent higher density in the immediate nearshore areas.

The sub-committee asked Miyashita and Nishiwaki to provide Committee oversight for this survey, suggesting that Nishiwaki participate in survey training with Miyashita because the two would not overlap during the survey.

The reports of a joint Korea-Japan minke whale pilot sightings survey in 1999 were presented in SC/52/RMP11 and SC/52/RMP22. The surveys were designed to provide additional information for use in the western North Pacific minke whale *Implementation Simulation Trials* under the RMP. The Japanese portion was conducted over the southwest portion of the Sea of Japan in June and July, and covered 560 n.miles of trackline. Of the sightings of cetaceans, none were of minke whales.

The Korean portion was conducted in the eastern waters of Korea in June and July, and covered 850 n.miles of trackline. Twenty-two sightings of minke whales were made on primary effort. It was noted that the survey area was selected from past commercial catch information, from the same time period and a little later in the year.

Kim presented SC/52/RMP21, reporting a whale sightings survey conducted in May 2000 in the eastern waters of Korea. This was also designed to provide information for the North Pacific minke whale *Implementation Simulation Trials* for the RMP. During the survey, 24 sightings of minke whales were made in primary survey mode in 772 n.miles of trackline. Sightings were made by naked eye.

It was noted that most sightings were made near the coasts and, if this is a migratory corridor, the data suggest that it is quite narrow, which may be useful in re-specifying the RMP *Implementation Simulation Trials*.

A corresponding Japanese survey was conducted, but no report was yet available. It was reported that some minke whales were sighted this year in nearshore waters.

Plans for whale sightings surveys, similar to previous surveys, to be conducted in September 2000 in the same area were presented by Kim. These surveys were also designed to provide information for the *Implementation Simulation Trials* under the RMP. It was noted that biopsy sampling had been intended in previous surveys but it is difficult for this species, and such sampling is not planned to be conducted in this survey. The need for collection of dive time data was noted. There was a suggestion that the survey design allocated too much effort toward the inshore area, and that this might be balanced better. Kim stated that abundance estimation of data from the two surveys conducted in June 1999 and May 2000 will be undertaken and presented to next year's meeting.

Finally, Kim presented plans for two additional whale sighting surveys to be conducted in April and September 2001 in western waters of Korea, in the Yellow Sea. The sub-committee welcomed this proposal and the intention noted by Kim that it is hoped these surveys would continue.

#### 9.4 Mixing and stock structure

The sub-committee first considered papers presenting analyses in response to recommendations from the JARPN review (SC/52/Rep2).

SC/52/RMP3 attempted to identify if there are any abrupt geographical changes in the density of western North Pacific minke whales. This was in response to comments in



SC/52/Rep2 that the pre-stratification of the western North Pacific minke whale distribution might be inappropriate and the recommendation that any new stratification should include consideration of the influence of covariates such as year, month and sea state using a generalised linear model. Only the sightings data collected from sub-areas 7, 8 and 9 during 1994-99 were examined. The effects of several covariates were included into a density index through GLM and GAM analyses. The process for estimating the density indices involved estimating the effective search half-width and then estimating the encounter rate. Model selection was carried out using the AIC (Akaike Information Criterion) and the BIC (Bayesian Information Criterion). The best model for the detection process included the wind speed and sightability as covariates, and the best model for the encounter process included month, sea surface temperature, a latitude-longitude interaction, and the interaction between month and latitude. SC/52/RMP3 could not identify any obvious changes in the density index in the central part of the western North Pacific from the plots of smooth terms for the best model. Monthly changes in the density index distribution suggested the seasonal feeding migration of western North Pacific minke whales. The monthly high density area in sub-area 9 corresponds to the area with a sea surface temperature of about 12°C.

In discussion, it was suggested that examination of the residuals about the fits would give information on whether the selected model actually fits the data. If the fit is overdispersed relative to that expected under the assumption of a Poisson process, this may lead to the selection of overly complicated models.

SC/52/RMP16 further examined morphological heterogeneity in North Pacific minke whales based on an alternative stratification. Sub-area 9 was divided into two sectors at 162°E based on the results of an mtDNA analysis that showed genetic heterogeneity in the western part of this sub-area in 1995. SC/52/RMP16 conducted regression analyses for 12 external measurements using data collected during the 1995 and 1994-99 JARPN surveys. No significant differences between the western and eastern sectors of sub-area 9 were found using the 1995 data, and results consistent with that obtained when the entire dataset for sub-area 9 was analysed. SC/52/RMP16 concluded that the analyses conducted provided no evidence for additional stock structure (e.g. 'W' stock) in sub-area 9.

Taylor commented that the analyses reported in SC/52/RMP16 were based on implementing the recommendations of the JARPN review (SC/52/Rep2 item 10.2.3) but that the recommendation of the JARPN review did not fully reflect the intent of the meeting. She suggested that the analyses in SC/52/RMP16 could be extended by taking a multi-variate approach and by including the data for sub-areas 7, 8 and 9.

SC/52/RMP17 presented further analyses of biological information in response to a recommendation made during the JARPN review. A logistic regression model using categorical variables (sub-areas, sampling months and sampling years) and JARPN data were used to analyse data for the proportion of males, and the maturity rates of males and females. The best model was selected by AIC and, as needed, BIC. The proportion of males in sub-area 11 was low, but high in sub-areas 7, 8 and 9. Although females were present in a relatively high proportion on the Okhotsk side of sub-area 11, males dominated in sub-areas 7, 8 and 9. The proportion of mature males was high in July and August, and then decreased in September. The model suggested that it is

possible that the proportion of mature females changed by month, although the sample size is small. Mature animals predominated in the JARPN research area although some immature animals are found in this area in spring and early autumn. JARPN data were insufficient to identify where immature animals are located. However, based on the migration pattern of immature animals reported by Hatanaka and Miyashita (1997) and the stranding and incidental take records in Japan, it is reasonable to assume that the majority of immature animals are distributed near the Pacific coast of Japan. SC/52/RMP17 concluded that the results presented did not change the conclusion from previous analyses that there is no evidence for a 'W' stock.

Taylor queried whether analyses had been conducted to assess whether the hypothesis that all of the 'O' stock juveniles are found in coastal areas of Japan could be supported. Punt responded that the *Implementation Simulation Trials* were designed to ensure that the model predictions of the age- and sex-structure of minke whales in the western north Pacific are roughly compatible with the available information. Schweder commented that better resolution of the data might be possible by treating sex and maturity as joint categorical variables.

SC/52/RMP7 examined the relationship between space and/or time and genetic distance for different partitions in the western North Pacific. MtDNA sequence data from sub-areas 7, 8 and 9 collected during JARPN were analysed by the 'isolation by distance' method. This analysis was conducted in response to a recommendation in SC/52/Rep2 for additional mtDNA analysis. The Mantel test was used to test the degree of correlation between genetic distance and geographical distance. A total of 10,000 random permutations was conducted in each test. Results obtained for different stratifications of the data suggest no significant correlation between geographical and genetic distances. The mtDNA heterogeneity found in sub-area 9 in 1995 can be explained by a relatively high frequency of a sequence haplotype ('9') in the sample from the western part of sub-area 9 in 1995, in comparison with the frequencies of this haplotype to the west and east of that sector. These differences could reflect either: (i) additional stock structure in sub-area 9; or (ii) sampling bias.

Taylor commented that sub-areas 7, 8 and 9 do not necessarily constitute the best strata for testing stock structure hypotheses and that Mantel tests were unlikely to detect stock structure even if there were multiple stocks. She suggested that consideration should be given to examining the outliers in SC/52/RMP7 to assess whether they tend to correspond to the same time or location. Pastene noted that the analyses conducted were specifically requested during the JARPN review but nevertheless welcomed Taylor's suggestion and agreed to work with her to implement it. Baker suggested that consideration could be given to taking a full matrix approach as the location of each sample is known.

SC/52/RMP6 presented the results of a re-examination of the estimate of the mixing proportion between 'O' and 'J' stocks in coastal areas of Japan. The analysis was conducted in response to a recommendation from the JARPN review (SC/52/Rep2) to examine the sensitivity of the estimate to the omission of the samples from sub-area 9 taken in 1995, which had showed some degree of mtDNA heterogeneity. The proportion of the J stock in sub-area 7 was estimated for two stratifications for the baseline sample of the 'O' stock: (i) sub-area 9, total sample; and (ii) sub-area 9 excluding 1995 data. For the three genetic markers used, mtDNA control region RFLP, control region sequencing and nuclear

DNA (microsatellite), there were no substantial differences in the estimation of stock mixing in sub-area 7 between the two stratifications. These results confirmed the conclusions of SC/F2K/J27 presented to the JARPN review.

Baker expressed disappointment that the analyses in SC/52/RMP6 continued to be based on the 28 samples collected off Korea almost 20 years ago. Analyses (e.g. SC/52/RMP19) have suggested that the diversity for samples of 'J' stock animals from Korea exhibited a statistically significantly greater haplotype diversity than these 28 samples. Baker argued that the additional samples from the Sea of Korea should be used in analyses such as those conducted in SC/52/RMP6. Pastene agreed that future analyses should be based on the larger sample. However, he reminded members that SC/52/RMP6 was written in response to a specific recommendation from the JARPN review.

At the JARPN review, Taylor had presented an example of how statistical power could be estimated for a given dispersal rate using the genetic data gathered in JARPN. Simulations used a base-case trial from the *Implementation Simulation Trials* and assumed that 'O' stock was sub-areas 7 and 8 and 30% of sub-area 12 and 'W' stock was sub-area 9 plus 70% of sub-area 12. This original simulation used a mutation rate of  $\mu = 0.0001$  and a dispersal rate of  $d = 0.005$ . For the most powerful statistic ( $\chi^2$ ), power when  $a = 0.05$  was 0.49 and power when  $a = \beta$  was 0.77 (and consequently  $a = \beta = 0.23$ ). Using this mutation rate both the number of sampled haplotypes and haplotypic diversity were higher in the simulations than observed from JARPN. Taking the results above into account, further simulations were conducted at different dispersal and mutation rates. The observed level of differentiation was incompatible with a very low dispersal rate ( $d = 0.0005$ ). Using a mutation rate estimated to yield the correct haplotypic diversity ( $\mu = 0.00005$ ) resulted in both sampled number of haplotypes and haplotypic diversity compatible with observed levels. As expected, the lower mutation rate translated to lower power for the same dispersal rate. Three additional simulations were run to bracket the most likely dispersal rate ( $d = 0.001, 0.002, 0.00275$ ). Of these,  $d = 0.002$  had the highest probability of obtaining the observed value, which corresponded to a power of 0.90 using the decision criterion of  $a = \beta$ , and a power of 0.81 using  $a = 0.05$ . The latter would make a Type 2 error (managing for one stock when there were two) four times more often than a Type 1 error (managing for two stocks when there was one).

In response to a question about sample size, Taylor noted that doubling the sample size would increase power greatly but commented that the relationship between sample size and power should be based on analyses conducted for several alternative sample sizes.

SC/52/SD10 was prepared in response to a comment during the JARPN review that previous examinations of the performance of the RMP suggested that unintended stock depletion becomes less likely with dispersal rates of 0.5%. It illustrated how such dispersal estimates could be interpreted within a management/harvest framework. A simple source/sink model was used to characterise an 'O'-'W' type stock scenario where harvests come only from 'O' stock and are based on abundance estimates of both stocks combined. A range of scenarios of the proportion of 'O' to the total stock were explored together with different dispersal, maximum growth and harvest rates. Many combinations resulted in extirpation of the 'O' stock, especially when 'O' stock constituted less than half of the total. Results were also given in terms of time to extirpation and subsequent recovery

to 50% of *K*. Taylor emphasised that intermediate dispersal rates, including those suggested by the observed values for minke whales, were most risky. Although the extremely low dispersal rates produced the most rapid extirpations, they would also be easily detected genetically so that stock structure would be likely to be detected and such an error would be unlikely. When dispersal rates were more than 0.5% per year the time to extirpation was likely to be sufficient to detect unexpected negative trends in abundance and the time to recovery was lessened by the rescue effect of the neighbouring population. For  $d = 0.00275$ , time to extirpation was only 17 years and recovery (assuming no further harvest) took 76 years. This scenario assumed that 'O' stock was roughly half of the total, the maximum growth rate was 0.04 and the harvest rate was 2% per year.

Cooke stated that the earlier findings from the *Implementation Simulation Trials* for Southern Hemisphere minke whales that dispersal makes unintended depletions less likely, were based on fixed management boundaries. When the dispersal rate is approximately 0.5% the appropriate boundaries are difficult to determine from genetic data. Thus, the risk of depletion can be greater than the no dispersal case, if the dispersion leads to an inappropriate choice of management areas.

The sub-committee considered the conclusions of the JARPN review (SC/52/Rep2) and the new information presented to the current meeting in the context of the specifications of the *Implementation Simulation Trials* for western North Pacific minke whales.

Hatanaka stated that he maintained the position he took at the JARPN review, namely that the available information does not provide any evidence for the existence of a 'W' stock. He believed that future trials should not consider any 'W' stock hypotheses. Other members did not support this conclusion based on the discussions at the JARPN review, including the results of the genetic analyses for sub-area 9 and the generally low power of methods of identifying stock structure. Walløe believed that the results from JARPN had reduced the likelihood that there is a 'W' stock. Noting the disagreement, the sub-committee agreed to continue to include trials that incorporate 'W' stock hypotheses as well as trials in which there is no 'W' stock.

The JARPN review had agreed that if the analyses it recommended did not provide evidence for the presence of a 'W' stock west of sub-area 9, then sub-areas 7 and 8 need not be distinguished. Taylor commented that several of the recommendations of the JARPN review were designed to attempt to find a more suitable boundary between the putative 'O' and 'W' stocks. For example, the GAM analysis of SC/52/RMP3 aimed to identify a hiatus in distribution which would provide a natural place for a boundary for the trials that involve a 'W' stock.

Taylor noted that the *p*-values based on the application of the  $\chi^2$  test comparing mtDNA haplotype frequencies between sub-areas 7+8 and 9 was 0.06 (Taylor, 2000) and 0.7 between sub-areas 7 and 8. Based on the results presented in the JARPN review and the new information reviewed, the sub-committee agreed to consider three stock-structure hypotheses in the Pacific: (a) no 'W' stock; (b) 'O' stock in sub-areas 7 and 8, and 'W' stock in sub-area 9; and (c) 'O' stock in sub-areas 7, 8 and 9, and 'W' stock in sub-area 9. It also agreed that for trial purposes sub-areas 7 and 8 would be combined, i.e. the population structure for the 'O' stock in these sub-areas would be assumed to be the same and sub-areas 7 and 8 would be combined into a single *Small Area* when applying the RMP in the context of *Implementation Simulation Trials* (see Item 9.5).

### 9.5 Re-specification of trials

The sub-committee considered several issues relating to the specification of trials, as discussed below, and agreed revised specifications for the North Pacific minke whales *Implementation Simulation Trials* (Appendix 10). The sub-committee **recommends** that the Secretariat conduct the trials during the intersessional period and report the results to next year's meeting.

Four years ago, the sub-committee had established an Intersessional Steering Group to consider and resolve any inconsistencies that remained in the trials, and to make decisions about the choices related to the selection of trials to run. The sub-committee re-established this Steering Group with membership Allison, Butterworth (Chair), Cooke, Hatanaka, Kim, Kawahara, Okamura, Polacheck, Punt, Smith, Taylor and Walløe, with a revised set of terms of reference (Appendix 11).

In trials in which the existence of a 'W' stock is assumed, the sub-committee agreed to take account of a dispersal rate between the 'O' and 'W' stocks. Trials will be conducted for three alternative values for this dispersal rate: the 5<sup>th</sup> percentile, mean and 95<sup>th</sup> percentiles of the distribution for the dispersal rate based on the methods outlined in Taylor (2000) with the assumption that the mutation rate,  $\mu$ , is 0.00005. It was noted that the values for the dispersal rate would depend to some extent on the values chosen for the initial population sizes for the 'O' and 'W' stocks. However, it was agreed that estimates of dispersal rate need only be calculated for three trials (101, 103 and 112) unless the estimates based on these trials are notably different. The calculations will be conducted intersessionally by Taylor with guidance from the Intersessional Steering Group. The sub-committee agreed that sub-areas 7 and 8 would be treated as one for trial purposes but that 'J' stock animals will be assumed to be found in sub-area 7 only.

The sub-committee agreed to conduct trials in which the fraction of 'O' stock animals in sub-area 9 is zero (no 'O' stock in sub-area 9), 0.8 and 1.0 (no 'W' stock). The value 0.8 is based on the observation that the only area that has shown some genetic difference from sub-areas 7 and 8 over three years of sampling is the west sector of sub-area 9 and that only in 1995. Hatanaka argued that there was no basis in data for the scenario in which no 'O' stock animals are found in sub-area 9. Taylor responded that the purpose of the trials was to bracket the plausible set of hypotheses. She believed that the hypothesis that 'W' stock animals occur only in the west of sub-area 9, surrounded to the east and to the west by 'O' stock animals, was implausible and hence that the scenario that only 'W' stock animals are found in sub-area 9 was plausible given the available information.

The sub-committee reviewed the information used to specify the proportion of 'J' stock animals in sub-area 12 (IWC, 1997a, pp.214-5). Several members commented that the data for this sub-area, both spatial and temporal, are limited and believed that it was appropriate to consider a scenario in which the trials are conditioned so that the fraction of 'J' stock animals in sub-area 12 is higher than is implied by the current specifications. Kato commented that it was entirely plausible that 'J' stock females do not enter sub-area 12 in large numbers given the differences between 'O' and 'J' stock animals in their conception dates and hence when females give birth. The sub-committee agreed to consider an alternative hypothesis in which the average proportion of 'J' stock animals in sub-area 12 in 1973-75 is greater than the current value of roughly 4% (as implied by analyses of conception date/flipper colour data). This case will use the highest proportion less than 20% that is

consistent with the other data used for conditioning, and that does not lead to more than 50% (median of simulations) of mature 'J' stock females in sub-area 12. The median percentage of mature 'J' stock females in sub-area 12 in 1973-75 in June-August will be output by the control program to examine the extent to which this specification can be satisfied.

Several members reiterated comments regarding limitations of the Korean CPUE data, the analysis of these data, and the use of CPUE data generally (see Item 9.1). The sub-committee considered whether the existing survey estimates of abundance could be used for conditioning the 'J' stock but agreed, after some discussion, to consider three pre-determined values (15%, 30% and 50%) for the depletion of the mature female component of the 'J' stock in 2000. Some members wished to consider higher values for this depletion. However, most members believed this to be unnecessary because results from such trials would not be informative about the performance of the RMP which takes catches primarily from the 'O' and 'W' stocks. The sub-committee agreed that the number of 1+ animals in sub-areas 6 and 10 in 1992 and 2000 (August and September) will be output by the control program for diagnostic purposes; 1992 and 2000 were chosen because they are the years for which survey data are available for the Sea of Japan. It was noted that the average annual rate of decline in the recruited population in the Sea of Japan over the period 1973-86 is already output by the control program and would be available to interested members.

The sub-committee agreed the trials in Table 1. The four baseline trials (101-104) consider two bounding scenarios regarding the 'W' stock (no 'W' stock, no 'O' stock animals in sub-area 9) and *MSY* rates of 1% and 4%. The specifications related to the depletion of the 'J' stock in 2000, the percentage of 'O' stock animals in sub-area 12, and the dispersal rate between the 'O' and 'W' stocks for the baseline trials are the intermediate values, and sensitivity is explored to the ends of the ranges considered for *MSYR* and the 'W' stock. In addition to sensitivity tests that examine the bounds for these factors, sensitivity tests also examine the three factors identified last year to have a substantial impact on the results of trials (trials NPM112, NPM113 and NPM115), a trial in which the depletion of the 'J' stock is set to 0.15 and the proportion of 'J' stock animals in sub-area 12 is as close to 20% as possible given the constraint on the fraction of mature females in sub-area 12 (as described above). It was noted that this last trial may be too extreme. All the trials in Table 1 will be run for the J(i) and J(ii) scenarios regarding bycatch off Japan (see Appendix 10).

The sub-committee agreed to change the initial year for the future projections from 1999 to 2000 to allow the new information on incidental catches to be incorporated in the trials. It noted that the specifications for when future (and past) surveys are conducted need revision and agreed that this would be completed intersessionally by the Steering Group. The sub-committee revised the RMP management options to be examined based on its decision not to distinguish sub-areas 7 and 8. Its deliberations are reflected in Section D of Appendix 10. The sub-committee agreed to follow previous practice and divide the task of conducting the trials into first performing a set of initial trials (Table 2) and then conducting the full set of 30 trials for a subset of the *Small Area* definitions/RMP management options.

It was noted that, as has occurred in the past, it will not be possible to finalise Appendix 10 before the end of the Scientific Committee meeting. The sub-committee agreed that the draft of this Appendix would be sent prior to

Table 1  
The Implementation Simulation Trials for North Pacific minke whales. Further details are given in Appendix 10.

Trial no. (NPM-)	Old trial equivalent	No. of stocks	MSYR (Mixing matrices)			J stock status in 2000	% O in sub-area 12	Description
			Stock J	Stock O	Stock W			
<b>Base line trials</b>								
101	NPM1	3	1 (A/B)	1 (F)	1 (K)	30% K	30	Base-case
102	NPM3	2	1 (A/B)	1 (G)	-	30% K	-	2 stock variant
103	NPM5	3	4 (A/B)	4 (F)	4 (K)	30% K	30	NPM-101 + MSYR=4%
104	NPM7	2	4 (A/B)	4 (G)	-	30% K	-	NPM-102 + MSYR=4%
<b>Other trials</b>								
105		3	1 (A/B)	1 (G)	1 (K)	30% K	30	NPM-101 + some O in sub-area 9 (80%)
106		3	1 (A/B)	1 (F)	1 (K)	30% K	30	NPM-101 + lower dispersal rate
107		3	1 (A/B)	1 (F)	1 (K)	30% K	30	NPM-101 + higher dispersal rate
108		3	1 (A/B)	1 (F)	1 (K)	15% K	30	NPM-101 + lower J stock depletion
109		3	1 (A/B)	1 (F)	1 (K)	50% K	30	NPM-101 + higher J stock depletion
110		3	1 (A/B)	1 (F)	1 (K)	30% K	30	NPM-101 + 20% J in sub-area 12 (or max. achievable)
111		3	1 (A/B)	1 (F)	1 (K)	15% K	30	NPM-101 + lower J stock depletion + 20% J in sub-area 12 (or max. achievable)
112	NPM11	3	1 (A/B)	1 (F)	1 (K)	30% K	100	NPM-101 + no W stock in sub-area 12
113	NPM9	3	1 (A/B)	1 (F)	1 (K)	30% K	10	NPM-101 + 10% O stock in sub-area 12
114		3	1 (A/B)	1 (F/H)	1 (K)	30% K	30	NPM-101 + some O animals in sub-area 10
115	NPM41	3	1 (A/B)	1 (F)	1 (K)	30% K	30	NPM-101 + $g(0) = 0.5$
116	NPM49	3	1 (A/B)	1 (F)	1 (K)	30% K	30	NPM-101 + misreport Japan incidental catch

Table 2

The initial set of trials to be conducted for the North Pacific minke whales. Further details are given in Appendix 10.

Combination no.	Trial	Japanese incidental catch option	Small Area definition	Management procedure variant
1	NPM101	Ji	(i)	Small areas
2	NPM101	Ji	(ii)	Small areas
3	NPM101	Ji	(iii)	Small areas
4	NPM101	Ji	(i)	Cap
5	NPM101	Ji	(i)	Cascade
6	NPM101	Ji	(ii)	Cascade
7-12	NPM101	Jii	As for combinations 1-6	
13-18	NPM102	Ji	As for combinations 1-6	
19-24	NPM102	Jii	As for combinations 1-6	
24-30	NPM103	Jii	As for combinations 1-6	
31-36	NPM104	Jii	As for combinations 1-6	

publication for comment to all members of the Steering Group and any other members of the Scientific Committee who request it.

### 9.6 JARPN II – stock structure

The sub-committee noted that elucidation of stock structure of minke whales was not the primary objective of the JARPN II programme. The research plan for the two-year feasibility study is to sample respectively 50 minke whales each year in the coastal (sub-area 7) and offshore (sub-area 9) sub-areas east of Japan. JARPN II aims to investigate whether the hypothesised 'W' stock exists in sub-area 9 and, if so, to investigate its spatial and temporal extent. It is also the intention to use the information collected from sub-area 7 to refine the estimates of the proportion of 'J' stock animals in sub-area 7. Although the methodology to be employed for stock structure elucidation is the same as that employed in JARPN, the programme involves several new aspects and is hence a feasibility study to assess whether the elements of the research programme will work together.

Taylor commented that the key questions related to stock structure for minke whales are better resolution of stock structure in the east of sub-area 8 and in sub-areas 9 and 12. She argued therefore that additional data for sub-areas 7 and

11 were not required, especially given that there is a possibility of sampling 'J' stock animals.

Hatanaka responded that sub-area 9 is the focus for stock-structure work while the primary focus in sub-area 7 relates to the feeding ecology objective although the data collected from this sub-area would contribute to the estimate of 'J'/'O' mixing rates in sub-area 7. He stated that it is the intention of the Government of Japan to obtain permission from the Russian Federation to conduct research and sample whales in sub-area 12 and the parts of sub-areas 7 and 8 in Russian waters. If permission is obtained, Japan is prepared to initiate the research in Russian waters immediately. However, to date, this has not proved possible.

The sub-committee agreed that additional information for sub-area 9 would potentially be valuable for specifying *Implementation Simulation Trials*. However, because the elucidation of stock structure is not the primary objective of JARPN II, some members were concerned about the impact of this on the sampling design and hence interpretation of the data. They noted that some Japanese scientists had already attributed the near-significant comparison of mtDNA haplotype frequencies between sub-areas 7+8 and 9 to sampling biases. They further noted the lack of detailed cruise plans in the proposal and that it is proposed to survey only a fraction of sub-area 9. They also indicated that the sampling strategy should be based on specific stock structure hypotheses.

Hatanaka responded that sampling in sub-area 9 will be conducted as for JARPN, i.e. whales will be sampled randomly within the survey area. This will extend the current dataset and hence permit consideration of inter-annual variability of the occurrence of possible 'W' stock animals in the west of sub-area 9. Hatanaka stated that the results from the feasibility study will be used to determine whether a full-scale programme is to be planned. Fujise stated that the survey area north of 40°N in sub-area 9 was chosen because it is the primary area of minke whale distribution at the time the surveys are to be conducted.

Bravington commented that an additional two years of information from the west of sub-area 9 was unlikely to provide sufficient information to quantify inter-annual variability in distribution patterns.

Hatanaka responded that data were already available for three years from JARPN and an additional two years of data will be obtained from the two-year feasibility study. He stated that the programme would continue if this is necessary to fully address the issue.

The JARPN review had recommended 'Research potentially employing new technology should be undertaken to find the breeding grounds, recognising that the most definitive stock structure data will likely come from such grounds' as one of the longer-term tasks. Kawahara stated that a sightings survey in low latitude waters of the Pacific is planned for winter 2001, an objective of which is to identify the breeding grounds for minke whales. Acoustic data will be collected and radio tagging will be attempted if breeding grounds are identified. The sub-committee welcomed the plans for this work.

## 10. WESTERN NORTH PACIFIC BRYDE'S WHALES

### 10.1 Progress on *Implementation Simulation Trials*

The sub-committee noted that the RMP *Implementation Simulation Trials* had been given low priority last year; no progress had been made. Hatanaka regretted this, and asked that this task be given higher priority over the coming year. It was noted that this would need to be taken up in the sub-committee's work plan.

SC/52/RMP8 described a detailed analysis to address a question raised last year (IWC, 2000a, p.88) about the validity of species identification of Bryde's and sei whales in commercial catches in Japanese pelagic whaling in 1973 and 1974. The analyses of individual allozyme and operational information implied that the species identification was correct. The sub-committee welcomed this analysis, and agreed that it resolved the uncertainties raised last year.

### 10.2 Sightings surveys

SC/52/RMP9 described a three vessel sightings survey conducted in August-September 1999 as part of a multiyear survey schedule aimed at providing abundance estimates for use in the RMP. In 6,634 n.miles of trackline, 167 sightings of Bryde's whales were made, of which 11 included a mother-calf pair. The survey was conducted in the region 165°E to 180° and 10°-43°N. Pastene and Nishiwaki provided Committee oversight, and the sub-committee judged that the survey had been conducted acceptably for use in the RMP.

Biopsy sampling was attempted using both a compound crossbow and an airgun for 19 sighted schools, with five samples being obtained from 39 shooting attempts. The sub-committee welcomed the information on successful biopsy sampling.

The sub-committee identified that it would be useful also to include information on the sighting angles and distances and on the experiments conducted as discussed above for minke whale surveys. The SCANS type independent observer mode will not be used in the future.

The reporting requirements for sightings data to be used in the RMP are given in IWC (1997b, pp.227-235). It was suggested that earlier access to these data may be useful in allowing the Committee the opportunity to identify any data collection issues that may need to be addressed. The use of DESS for such data was raised, but there are workload and timing issues that need to be addressed relative to including the data in DESS in the near future.

SC/52/RMP10 described the next in this series of sightings surveys. This survey will be conducted using one

vessel instead of two, resulting in an extension in the planned completion of the series from four years to five. The survey will be conducted in August and September in the band from 137°30'-145°E, again from 10-43°N.

The sub-committee asked Shimada to provide Committee oversight.

The design of the northern portion of the planned trackline was noted to be parallel to the Japanese coastline and to the prevailing Kuroshiro current. The sub-committee noted that such survey design was not ideal, and recommended that that portion be restructured to work on- and off-shore to the degree possible. It was noted that surveys conducted between George's Bank and the north wall of the Gulf Stream in the Atlantic had addressed this problem, and those involved might provide insight into the importance of this.

The sub-committee **recommends** that the Commission request the relevant authorities of the Federated States of Micronesia, the Commonwealth of the Northern Mariana Islands, and the United States of America to grant permission in a timely fashion for Japanese vessels to survey in their respective EEZ waters.

### 10.3 JARPN II – stock structure

JARPN II aims to provide additional information that could be used to elucidate stock structure for western North Pacific Bryde's whales for use in *Implementation Simulation Trials*. It is proposed to achieve this by collecting additional samples in sub-area 1 (see fig. 2 of IWC, 2000a, p.87). Sub-area 1 is large and information for some parts of it is limited (IWC, 2000a, p.86).

Taylor noted that commercial catches had occurred over a very wide area and queried whether samples from those catches could be used to examine stock structure. Kato responded that samples from catches during the 1980s were used for isozyme analyses by Wada (1989), while Pastene and his colleagues had used all of the available genetic samples in previous DNA analyses, but that these were limited.

Hatanaka stated that the sample sizes for the two-year feasibility study may be insufficient to fully address the stock structure objective but the results from those data could be used for designing a future full-scale programme. Taylor noted that Bryde's whales had been successfully biopsied by US scientists on the high seas. Fujise responded that biopsies would be attempted where possible and Miyashita stated that attempts will be made to collect additional biopsy samples during sighting surveys in August and September 2000.

## 11. NORTH ATLANTIC MINKE WHALES

### 11.1 Sightings surveys

Øien presented SC/52/RMP13 which reported on the Norwegian 1999 sightings survey for minke whales. This was the fourth survey year in a six-year programme over the period 1996-2001 to cover the north-eastern Atlantic to obtain abundance estimates for *Small Areas* EB, EC, ES, EN and CM to be used for calculating catch limits by the RMP at the end of the survey period. In 1999 the sub-area ES (Svalbard waters) was covered and the survey was conducted over the period 28 June to 5 August 1999. The survey procedures followed were the same as in NILS-95. About 342 hours, or approximately 3,400 n.miles of survey effort were conducted in total for the two participating vessels. The total number of primary observations of minke whales from all platforms combined was 297 sightings. Compared to the search effort within the ES *Small Area* as realised in 1995, the 1999 efforts represent about 90% of the

1995 level. Distance and angle estimation experiments and training were conducted on both the participating vessels. One humpback whale, two fin whales, one blue whale and two minke whales were instrumented with satellite tags. Of these, one fin, one minke and the blue whale returned signals. Biopsies were collected from 10 white-beaked dolphins, 2 humpback whales, 8 fin whales, 1 blue whale and 2 sperm whales. In addition, fluke photos from about 20 humpback whales were collected.

The sub-committee judged that the surveys continued to be conducted in a manner suitable for use in the RMP, and asked Øien to continue in his oversight role. As discussed above, the cruise report could usefully be augmented with displays of the sighting angle and distance data, as well as more details about the experimental data. The need for additional data on dive times for use in analyses of these types of surveys was reiterated. The sub-committee welcomed the new satellite tagging data collected during this survey.

Noting that the next survey is planned for the *Small Area* that includes Russian Federation EEZ waters, and that a previous attempt to survey this area had been made, the sub-committee **recommends** that the Commission request the relevant authorities of the Russian Federation to grant permission in a timely fashion for Norwegian research vessels to survey in its EEZ waters.

### 11.2 Other

A project to explore the relationship between West and East Greenland minke whale stocks had been conducted by the Greenland Institute of Natural Resources, and preliminary results were presented in four papers (SC/52/AS8, 9, 10 and 11). Techniques used were genetics (mtDNA, microsatellites), fatty acid composition in blubber, persistent organochlorine levels and stable Pb isotope composition of kidney, liver and muscle tissue. The genetics study concluded that minke whales sampled in the North Sea area differed from those sampled at Greenland and in the remaining Northeast Atlantic region, and whales in the two latter areas do not differ. This conclusion is partly confirmed by the other analyses. It is expected that the analyses will be finalised next year and thus be available for a re-evaluation of North Atlantic minke whale stock structure in one or two years time.

The sub-committee agreed with Walløe's suggestion that an RMP implementation review for North Atlantic minke whales could usefully be conducted in 2002, when a new estimate of abundance from Norway's series of annual surveys (SC/52/RMP13) and analyses of samples collected over the last five years would be available.

## 12. WORK PLAN

The sub-committee agreed that the following items should be part of its work plan.

- (1) Incorporate program CATCHLIMIT into the Secretariat suite of programs that implement the RMP and its *Implementation Simulation Trials*, including modifying the convergence criteria as appropriate (see Item 5).
- (2) Retune the RMP using program CATCHLIMIT and rerun a selection of simulation trials (see Item 5).
- (3) Undertake simulation trials to assist the Committee in understanding the implications of the choices of modelling density-dependence and defining *MSYL* in the *Implementation Simulation Trials* (see Item 7).

- (4) Evaluate abundance estimates against simulated datasets. In particular, initiate the process of evaluation of estimators against datasets conditioned on data from North Pacific surveys for minke and Bryde's whales and, secondarily, against datasets incorporating responsive movement (see Items 8.1 and 8.4).
- (5) Plan for a Working Group to meet at next year's meeting to address the issue of estimation of incidental catch and other human-induced mortality of baleen whales, particularly with respect to stocks of current interest in the development of *Implementation Simulation Trials* (see Items 6 and 9.2).
- (6) Code and run *Implementation Simulation Trials* for North Pacific minke whales, including resolving any inconsistencies remaining as specified in Appendix 10 (see Item 9.5).
- (7) Begin coding *Implementation Simulation Trials* for western North Pacific Bryde's whales as specified in IWC (2000b, pp.118-123; see Item 10.1).

Items (1) and (2) will be overseen by the Intersessional Steering Group established under Agenda Item 5. Work under Item (4) will be taken forward by the Intersessional Working Group comprising established under Item 8.4. Work under Item (6) will be undertaken by the Secretariat under the guidance of an Intersessional Steering Group established under Item 9.5.

The sub-committee gave priority to those items requiring Secretariat time in the following order: (1), (2), (6), (3), (7). Item (4) would be taken up by members of the sub-committee intersessionally. The priority to be assigned to Item (5) was referred to the full Committee.

## 13. ADOPTION OF REPORT

The report was adopted at 17:14 on 23 June 2000. The sub-committee expressed its appreciation to the Chairman and rapporteurs.

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## Appendix 1

### AGENDA

1. Convenor's opening remarks
  2. Election of Chairman and appointment of rapporteurs
  3. Adoption of agenda
  4. Review of documents
  5. Evaluation of *CLA* program and tuning
  6. Total catches over time
  7. Component of population to which *MSYR*, *MSYL* and density-dependence should apply
  8. Abundance estimation
    - 8.1 Report of Intersessional Working Group
    - 8.2 Estimates from multi-year surveys
    - 8.3 Other
    - 8.4 Future work
  9. North Pacific minke whales
    - 9.1 Results of *Implementation Simulation Trials* run intersessionally
    - 9.2 Incidental catches
    - 9.3 Sightings surveys
    - 9.4 Mixing and stock structure
    - 9.5 Re-specification of trials
    - 9.6 JARPN II - stock structure
  10. Western North Pacific Bryde's whales
    - 10.1 Progress on *Implementation Simulation Trials*
    - 10.2 Sightings surveys
    - 10.3 JARPN II - stock structure
  11. North Atlantic minke whales
    - 11.1 Sightings surveys
    - 11.2 Other
  12. Work plan
  13. Adoption of report
-

## Appendix 2

### REPORT OF THE WORKING GROUP ON TOTAL CATCHES OVER TIME

**Members:** Butterworth, Cooke, Donovan.

The request from the Commission to the Scientific Committee for advice on the issue of total catches is contained in Commission Resolution 1998-2 (IWC, 1999, p.42) and a further clarifying statement in the report of 1999 Commission meeting. The Commission has asked the Scientific Committee to provide 'suitable wording for consideration by the Commission for inclusion in the RMS in time for next year's meeting'. Since the Commission has previously agreed (Resolution IWC 1996-6, IWC, 1997, p.51) that adoption of all elements of the RMS into the Schedule is a pre-requisite for its implementation, the text provided should be in a form suitable for inclusion into the Schedule.

It is not immediately clear how the Committee should interpret the phrase 'Human-induced mortalities that are known or can be reasonably estimated' in the Commission's request. The RMP specification provides only partial guidance in this regard, because it refers to historical catch only and does not specify methods of estimation. The RMP specification states that: All known removals from a *Region* shall be included in the catch series<sup>16</sup>. The attached annotation (16) specifies:

Thus, known or estimated 'indirect' catches, e.g. whales killed through entanglement in fishing gear (including those that subsequently strand), should also be included in the catch history, in addition to whales caught or struck and lost in direct whaling operations. On the other hand, stranding is assumed to be part of natural mortality, and numbers of whales stranded due to natural causes should not be included in the catch history.

The Committee has not yet addressed in detail the question of how best to estimate or predict incidental catches of baleen whales beyond those which are known. The issue has arisen in the deliberations of the RMP sub-committee with respect to the choice of assumed incidental take levels for input into *Implementation Simulation Trials* for North Pacific minke whales. However, the Committee has been unable to devote time for an in-depth discussion of estimates of incidental catch and other human-induced mortalities.

In view of the Commission's request for suitable wording to be supplied in time for its coming meeting, but recognising that the question of incidental catch estimation

requires more detailed consideration than was possible at this meeting, the following two-point plan is proposed.

- (1) Offer the Commission a form of words that covers the issue without getting into the specifics of estimation; a suggestion is given below.
- (2) Identify the issue of estimation of incidental catch and other human-induced mortality of baleen whales for the Committee's agenda next year, particularly with respect to stocks of current interest in an RMP implementation context. A Working Group to meet next year should identify methods to consider, e.g.
  - (a) extrapolation methods (scaling up catches from monitored fisheries to obtain a total estimate);
  - (b) genetic methods, e.g. numbers of distinct individuals identified, 'mixed stock' analysis, capture-recapture analysis.

The Working Group should consider the papers presented this year and in previous years, as well as new papers.

#### **Suggested wording in response to the Commission's request:**

Catch limits calculated under the Revised Management Procedure shall be adjusted downwards to account for human-induced mortalities due to sources other than commercial catches.

Each such adjustment shall be based on an estimate provided by the Scientific Committee of the size of adjustment required to ensure that total removals over time from each population and area do not exceed the limits set by the Revised Management Procedure. Total removals include commercial catches and other human-induced mortalities, to the extent that these are known or can reasonably be estimated.

#### REFERENCES

- International Whaling Commission. 1997. Chairman's Report of the Forty-Eighth Annual Meeting. Appendix 6. IWC Resolution 1996-6. Resolution of provisions for completing the revised management scheme. *Rep. int. Whal. Commn* 47:51.
- International Whaling Commission. 1999. Chairman's Report of the Fiftieth Annual Meeting. Appendix 3. IWC Resolution 1998-2. Resolution on total catches over time. *Ann. Rep. Int. Whaling Comm.* 1998:42.



### Appendix 3

#### REPORT OF THE WORKING GROUP ON *MSYL*, *MSYR* AND DENSITY-DEPENDENCE TRIALS

**Members:** Punt (convenor), Allison, Bravington, Butterworth, Cooke, Givens, Polacheck

The objective of the 64 trials described below is to compare the values of three performance statistics in terms of the mature and 1+ components. Each trial involves applying the *CLA* for 100 years for 100 simulations per trial. The results of these trials will enable decisions to be made on whether or not differences between specifications on the component to which *MSYL* and density-dependence relate are substantial. In addition to presenting the results of the trials, the following will also be provided for each combination of assumptions about *MSYR*, *MSYL* and the density-dependent component:

- (i) *MSYL* defined in terms of the 1+ and mature components of the population (to enable conversion rates to be calculated);
- (ii) plots of the fecundity rate (calves per 'mature' female) as a function of the depletion of the component to which density-dependence relates.

The results will facilitate an evaluation of the magnitude of differences in statistics caused by changing the component for *MSYL* and density-dependence and whether such differences are easily interpreted after translating the results to a scale appropriate for the component choices.

- (i) Population component to which density-dependence is functionally related: (a) 1+, (b) mature.
- (ii) Specification of  $A$  and  $z$  (the resilience and degree of compensation parameters) to achieve: (a)  $MSYL_{mat} = 0.6$ ;  $MSYR_{mat} = 0.01$ ; (b)  $MSYL_{mat} = 0.6$ ;  $MSYR_{mat} = 0.04$ ; (c)  $MSYL_{1+} = 0.6$ ;  $MSYR_{mat} = 0.01$ ; and (d)  $MSYL_{1+} = 0.6$ ;  $MSYR_{mat} = 0.04$ .
- (iii) The biological parameters (natural mortality-at-age, maturity ogive): (a) those for the single stock *CLA* first stage screening trials; (b) those corresponding to the median values for the base-case bowhead AWMP trial (BE01).

- (iv) Harvest options (defined in terms of the recruitment ogive): (a) uniform selectivity harvesting of the 1+ component of the population; (b) uniform selectivity harvesting of the mature component of the population.
- (v) Initial depletion of the 1+ component of the population at the start of the simulation: (a) 0.3; (b) 0.99.

#### Performance statistics

The statistics reported for each trial of a 100-year application of the *CLA* are the 5, 50 and 95 percentiles of the statistics  $N_{100}^{1+}/K^+$ ,  $K_{100}^{mat}/k^{mat}$ ,  $N_{100}^{1+}/MSYL^{1+}$ ,  $n_{100}^{mat}/MSYL^{mat}$ ,  $RR^{mat}$  and  $RR^{1+}$ . IWC (2000, pp.148-9) provides the definition of the relative recovery (*RR*) statistic.

The terms of reference of the group were to 'define modelling work that would be useful to the Committee in understanding the implications of the choices of modelling density-dependence and defining *MSYL* in management procedure performance'. The group noted that the objective of *Implementation Simulation Trials* for populations potentially subject to commercial whaling is to compare variants of the RMP (including catch capping and catch cascading) in situations in which stock-structure is uncertain. Most members of the group believed that different specifications for *MSYL* and the density-dependence component would not have a significant impact on the relative performance of different RMP options.

#### REFERENCE

International Whaling Commission. 2000. Report of the Standing Working Group (SWG) on the Development of an Aboriginal Subsistence Whaling Management Procedure. Annex E. Appendix 3B. Fishery type 2: Implementation for Bering-Chukchi-Beaufort bowhead whales. *J. Cetacean Res. Manage. (Suppl.)* 2:143-52.

### Appendix 4

#### REPORT OF THE WORKING GROUP ON ABUNDANCE ESTIMATES

**Members:** Butterworth, Cooke, Palka (convenor), Polacheck, Schweder, Skaug.

#### Terms of reference

- (1) Technical issues that should be considered when estimating additional variance using methods described in SC/52/RMP12.
- (2) What issues relating to abundance estimates from multi-year surveys to be used in the RMP need to be

resolved, and what process is needed to resolve these issues?

- (3) What are the priority issues that should be addressed by the Intersessional e-mail Group?

#### Conclusions

- (1) A technical issue from SC/52/RMP12 raised by Skaug during the sub-committee meeting was, whether additional variance should be determined for regions within *Small Areas* or between *Small Areas*? The

Working Group recommended that additional variance between/across *Small Areas* should be accounted for when capping or cascading is used.

- (2) Last year (IWC, 2000, p.81), six issues were flagged for the Committee's consideration. Of these issues (1), (5) and (6) were dealt with last year. This leaves the following issues to be resolved:
- (a) Time stamp of a multi-year survey? The Working Group recommended that every estimate for a Management Area should have a time stamp that is an effort-weighted average and rounded to the nearest integer.
  - (b) How should the Phaseout Rule be applied when multi-year surveys are being used? In the RMP the Phaseout Rule applies only to *Small Areas*. Thus in the case of capping or cascading, each *Small Area* has its individual time stamp and the Phaseout Rule applies to that time stamp.
  - (c) At what spatial scale should statistical methods be used to fill in 'holes' in survey coverage? The Working Group recommended that for single year surveys, if the area surveyed is too small to be

representative of the survey stratum, then the survey must be considered carefully, assigning a zero abundance to the area missed, if necessary. For multi-year surveys, it may be possible to interpolate the missing area with multi-year regression analysis, provided additional variance is taken into account.

- (3) Priority issues were not discussed by the Working Group due to the time constraints. Potential priority topics include continuing work suggested in past years. In particular, to condition simulated datasets on North Pacific sighting surveys for minke and/or Bryde's whales and evaluate abundance estimators that might be used to produce estimates used in the RMP when responsive movement is occurring.

#### REFERENCE

- International Whaling Commission. 2000. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 2:79-92.



## Appendix 5

## PRELIMINARY RESULTS FROM NORTH PACIFIC MINKE WHALE TRIALS

Table 1 gives a summary of the results of North Pacific minke whale trial numbers 1, 3, 5, 7, 9 and 11. The trials specifications are given in IWC (2000, pp.105-117), with the list of trials given as table 7. The output statistics are described in section I.

These results are setting catches by *Small Area* where *Small Areas* = sub-areas. Depletion levels refer to mature females.

## REFERENCE

International Whaling Commission. 2000. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure. Appendix 5. Specifications of the North Pacific minke whaling trials. *J. Cetacean Res. Manage. (Suppl.)* 2:105-17.

Table 1  
Summary of results for first six trials.

		Stock J			Stock J		Stock O			Stock O		Median catch/yr		Av. catch/yr	
		Initial depletion			Final depletion		Initial depletion			Final depletion		Comm+I	Comm	J	O
		5%	Median	96%	5%	Median	5%	Median	96%	5%	Median				
NPM 1-J1	Com+I	0.44	0.49	0.56	0.40	0.49	0.39	0.48	0.56	0.44	0.52	213	137	75	45
NPM3-J1	Com+I	0.43	0.49	0.68	0.38	0.49	0.68	0.74	0.82	0.58	0.64	208	128	76	139
NPM5-J1	Com+I	0.47	0.57	0.72	0.83	0.89	0.55	0.68	0.76	0.89	0.92	273	166	102	64
NPM7-J1	Com+I	0.50	0.57	0.84	0.86	0.89	0.85	0.91	0.94	0.88	0.92	255	150	101	156
NPM9-J1	Com+I	0.41	0.49	0.66	0.31	0.49	0.27	0.37	0.46	0.34	0.45	215	135	75	30
NPM11-J1	Com+I	0.36	0.48	0.70	0.26	0.48	0.59	0.71	0.83	0.48	0.57	218	129	75	117

Table 2  
Detailed results for each trial.

(a) Case: NPM1-J1, MSYR: 1/1/1, Base case J1. Type: 0 catches by Small Areas; Small Areas = sub-area.

Stock	Initial depletion			Final depletion			Low population			Continuing catch		
	Median	5%	96%	Median	5%	96%	Median	5%	96%	Median	5%	96%
J	0.49	0.44	0.56	0.49	0.40	0.59	0.48	0.40	0.56	53.7	45.7	62.7
O	0.48	0.39	0.56	0.52	0.44	0.59	0.47	0.39	0.54	27.7	22.7	31.9
W	0.99	0.99	0.99	0.82	0.77	0.85	0.81	0.76	0.85	40.3	31.5	52.8

Area	Average total catch			Average catch last 10yrs			Average total catch			Average catch last 10yrs		
	(Excluding incidental catch)						(Including incidental catch)					
	Median	5%	96%	Median	5%	96%	Median	5%	96%	Median	5%	96%
1			None - trial specification				0.3	0.3	0.3	0.3	0.3	0.3
2			None - trial specification				12.9	12.1	13.5	13.6	12.4	14.8
3			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
4			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
5			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
6			None - trial specification				72.3	69.3	77.0	72.6	67.5	76.9
7	0.0	0.0	5.3	0.0	0.0	0.0	0.8	0.7	6.0	0.8	0.7	0.9
8	10.8	6.9	16.7	9.3	5.0	15.0	10.8	6.9	16.7	9.3	5.0	15.0
9	22.0	15.0	32.9	13.0	5.3	27.1	22.0	15.0	32.9	13.0	5.3	27.1
10			None - trial specification				0.1	0.1	0.1	0.1	0.1	0.1
11	0.5	0.0	14.6	0.0	0.0	7.9	0.6	0.1	14.7	0.1	0.1	8.0
12	85.1	59.8	122.7	64.1	33.5	119.2	85.1	59.8	122.7	64.1	33.5	119.2

Summary of initial conditions.

	Condition	Av. target	Minimum	5%	Median	95%	Maximum
5+6+10 slope	(c)	-0.035	-0.035	-0.035	-0.035	-0.035	-0.035
O:O+W in 12 in 1995	(d)	0.300	0.299	0.299	0.300	0.300	0.301
J whales in Japan catch	(e)		0.128	0.131	0.145	0.171	0.193

Average fit = 18.0.

(b) Case: NPM3-J1, MSYR: 1/1 J1. Type: 0 catches by Small Areas; Small Areas = sub-area.

Stock	Initial depletion			Final depletion			Low population			Continuing catch		
	Median	5%	96%	Median	5%	96%	Median	5%	96%	Median	5%	96%
J	0.49	0.43	0.68	0.49	0.38	0.76	0.48	0.38	0.68	54.0	41.0	77.8
O	0.74	0.68	0.82	0.64	0.58	0.69	0.63	0.57	0.67	49.7	42.1	66.7

Area	Average total catch			Average catch last 10yrs			Average total catch			Average catch last 10yrs		
	(Excluding incidental catch)						(Including incidental catch)					
	Median	5%	96%	Median	5%	96%	Median	5%	96%	Median	5%	96%
1			None - trial specification				0.3	0.3	0.3	0.3	0.3	0.3
2			None - trial specification				11.2	10.5	11.7	10.8	9.8	11.7
3			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
4			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
5			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
6			None - trial specification				72.3	64.9	80.5	72.7	60.5	80.8
7	0.0	0.0	3.9	0.0	0.0	0.0	0.7	0.6	4.5	0.6	0.5	0.7
8	3.1	1.9	5.3	2.5	1.4	6.0	3.1	1.9	5.3	2.5	1.4	6.0
9	28.2	18.6	42.6	19.5	7.4	39.2	28.2	18.6	42.6	19.5	7.4	39.2
10			None - trial specification				0.1	0.1	0.1	0.1	0.1	0.1
11	0.6	0.0	10.5	0.0	0.0	3.7	0.7	0.1	10.6	0.1	0.1	3.8
12	88.2	61.8	152.2	61.0	33.6	140.7	88.2	61.8	152.2	61.0	33.6	140.7

Summary of initial conditions.

	Condition	Av. target	Minimum	5%	Median	95%	Maximum
5+6+10 slope	(c)	-0.035	-0.042	-0.038	-0.035	-0.035	-0.035
O:O+W in 12 in 1995	(d)	0.300	0.000	0.000	0.000	0.000	0.000
J whales in Japan catch	(e)		0.125	0.130	0.144	0.171	0.194

Average fit = 17.0.

(c) Case: NPM5-J1, MSYR: 4/4/4, J1. Type: 0 catches by Small Areas; Small Areas = sub-area.

Stock	Initial depletion			Final depletion			Low population			Continuing catch		
	Median	5%	96%	Median	5%	96%	Median	5%	96%	Median	5%	96%
J	0.57	0.47	0.72	0.89	0.83	0.94	0.57	0.47	0.72	109.3	89.0	128.2
O	0.68	0.55	0.76	0.92	0.89	0.94	0.68	0.55	0.76	59.4	45.6	80.4
W	1.00	1.00	1.00	0.94	0.92	0.96	0.93	0.90	0.94	95.1	58.1	152.0

Area	Average total catch			Average catch last 10yrs			Average total catch			Average catch last 10yrs		
	(Excluding incidental catch)						(Including incidental catch)					
	Median	5%	96%	Median	5%	96%	Median	5%	96%	Median	5%	96%
1			None - trial specification				0.4	0.4	0.4	0.4	0.4	0.5
2			None - trial specification				15.2	13.8	17.9	15.8	14.0	19.2
3			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
4			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
5			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
6			None - trial specification				98.6	79.3	115.4	106.2	79.8	125.3
7	0.4	0.0	12.8	0.0	0.0	4.7	1.4	0.8	13.6	1.0	0.8	5.6
8	11.7	7.6	17.9	11.0	6.2	17.0	11.7	7.6	17.9	11.0	6.2	17.0
9	24.3	16.3	36.6	18.0	7.8	34.7	24.3	16.3	36.6	18.0	7.8	34.7
10			None - trial specification				0.1	0.1	0.2	0.1	0.1	0.2
11	2.8	0.0	21.7	1.6	0.0	20.4	2.9	0.1	21.8	1.7	0.1	20.5
12	113.4	76.5	192.8	106.7	61.0	201.2	113.4	76.5	192.8	106.7	61.0	201.2

Summary of initial conditions.

	Condition	Av. target	Minimum	5%	Median	95%	Maximum
5+6+10 slope	(c)	-0.035	-0.037	-0.037	-0.035	-0.035	-0.035
O:O+W in 12 in 1995	(d)	0.300	0.299	0.299	0.300	0.300	0.300
J whales in Japan catch	(e)		0.125	0.131	0.144	0.170	0.192

Average fit = 19.0.

(d) Case: NPM7-J1 MSYR: 4/4 J1. TYPE:0 catches by Small Areas; Small Areas = sub-area.

Stock	Initial depletion			Final depletion			Low population			Continuing catch		
	Median	5%	96%	Median	5%	96%	Median	5%	96%	Median	5%	96%
J	0.57	0.49	0.74	0.89	0.86	0.94	0.57	0.49	0.74	109.1	90.2	122.4
O	0.91	0.85	0.94	0.92	0.89	0.95	0.88	0.81	0.90	130.7	88.8	178.5

Area	Average total catch			Average catch last 10yrs			Average total catch			Average catch last 10yrs		
	(Excluding incidental catch)						(Including incidental catch)					
	Median	5%	96%	Median	5%	96%	Median	5%	96%	Median	5%	96%
1			None - trial specification				0.4	0.4	0.4	0.4	0.4	0.5
2			None - trial specification				12.3	12.1	12.6	12.4	12.2	12.8
3			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
4			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
5			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
6			None - trial specification				98.7	82.3	107.2	106.9	84.4	116.5
7	0.2	0.0	4.4	0.0	0.0	0.0	0.9	0.7	5.1	0.7	0.7	0.8
8	3.3	2.0	5.8	2.9	1.6	7.0	3.3	2.0	5.8	2.9	1.6	7.0
9	32.3	21.5	47.7	27.3	12.6	51.7	32.3	21.5	47.7	27.3	12.6	51.7
10			None - trial specification				0.1	0.1	0.2	0.2	0.1	0.2
11	1.0	0.0	13.2	0.0	0.0	6.4	1.1	0.1	13.3	0.1	0.1	6.5
12	101.1	67.1	140.5	84.8	54.3	147.9	101.1	67.1	140.5	84.8	54.3	147.9

Summary of initial conditions.

	Condition	Av. target	Minimum	5%	Median	95%	Maximum
5+6+10 slope	(c)	-0.035	-0.037	-0.036	-0.035	-0.035	-0.035
O:O+W in 12 in 1995	(d)	0.300	0.000	0.000	0.000	0.000	0.000
J whales in Japan catch	(e)	0.128	0.131	0.144	0.174	0.198	

Average fit = 16.0.

(e) Case: NPM9-J1 MSYR: 1/1/1, 10% O in 12. Type: 0 catches by Small Areas; Small Areas = sub-area.

Stock	Initial depletion			Final depletion			Low population			Continuing catch		
	Median	5%	96%	Median	5%	96%	Median	5%	96%	Median	5%	96%
J	0.49	0.41	0.66	0.49	0.31	0.71	0.49	0.31	0.66	53.4	35.4	75.9
O	0.37	0.27	0.46	0.45	0.34	0.55	0.37	0.27	0.46	22.2	17.0	26.8
W	0.99	0.99	1.00	0.81	0.76	0.85	0.81	0.75	0.84	49.1	35.9	90.4

Area	Average total catch			Average catch last 10yrs			Average total catch			Average catch last 10yrs		
	(Excluding incidental catch)						(Including incidental catch)					
	Median	5%	96%	Median	5%	96%	Median	5%	96%	Median	5%	96%
1			None - trial specification				0.3	0.3	0.3	0.3	0.2	0.3
2			None - trial specification				13.7	12.7	14.3	15.1	13.1	16.2
3			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
4			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
5			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
6			None - trial specification				71.8	63.2	80.7	72.3	58.1	78.3
7	0.0	0.0	4.9	0.0	0.0	0.0	0.8	0.7	5.7	0.9	0.7	1.0
8	11.1	7.2	17.3	9.4	5.2	15.1	11.1	7.2	17.3	9.4	5.2	15.1
9	23.0	15.6	34.4	13.2	5.6	27.9	23.0	15.6	34.4	13.2	5.6	27.9
10			None - trial specification				0.1	0.1	0.1	0.1	0.1	0.1
11	1.4	0.0	14.5	0.0	0.0	8.1	1.5	0.1	14.6	0.1	0.1	8.2
12	90.9	60.0	208.7	66.1	31.7	163.0	90.9	60.0	208.7	66.1	31.7	163.0

Summary of initial conditions.

	Condition	Average	Minimum	5%	Medium	95%	Maximum
5+6+10 Slope	(c)	-0.035	-0.039	-0.038	-0.035	-0.035	-0.035
O:O+W in 12 in 1995	(d)	0.100	0.099	0.099	0.100	0.100	0.101
J whales in Japan catch	(e)	0.124	0.130	0.145	0.172	0.197	

Average fit = 19.0.

(f) Case: NPM11-J1 MSYR: 1/1/1, No W in 12. Type:0 catches by Small Areas; Small Areas = sub-area.

Stock	Initial depletion			Final depletion			Low population			Continuing catch		
	Median	5%	96%	Median	5%	96%	Median	5%	96%	Median	5%	96%
J	0.48	0.36	0.70	0.48	0.26	0.76	0.48	0.26	0.70	53.9	27.8	83.0
O	0.71	0.59	0.83	0.57	0.48	0.65	0.56	0.47	0.63	44.0	30.3	69.6
W	0.99	0.98	0.99	0.94	0.93	0.95	0.94	0.93	0.95	16.0	11.2	24.0

Area	Average total catch			Average catch last 10yrs			Average total catch			Average catch last 10yrs		
	(Excluding incidental catch)						(Including incidental catch)					
	Median	5%	96%	Median	5%	96%	Median	5%	96%	Median	5%	96%
1			None - trial specification				0.3	0.3	0.3	0.3	0.2	0.3
2			None - trial specification				10.9	9.8	11.5	10.1	8.7	11.4
3			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
4			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
5			None - trial specification				0.0	0.0	0.0	0.0	0.0	0.0
6			None - trial specification				71.9	59.2	82.4	72.1	53.3	82.5
7	0.0	0.0	4.8	0.0	0.0	0.0	0.7	0.6	5.4	0.6	0.5	0.7
8	11.6	7.5	18.0	10.8	5.8	16.9	11.6	7.5	18.0	10.8	5.8	16.9
9	21.0	13.5	31.4	14.7	6.3	27.6	21.0	13.5	31.4	14.7	6.3	27.6
10			None - trial specification				0.1	0.1	0.1	0.1	0.1	0.1
11	1.9	0.0	14.8	0.0	0.0	6.3	2.0	0.1	14.9	0.1	0.1	6.4
12	97.9	60.8	184.6	66.8	28.3	167.3	97.9	60.8	184.6	66.8	28.3	167.3

Summary of initial conditions.

	Condition	Av. target	Minimum	5%	Medium	95%	Maximum
5+6+10 Slope	(c)	-0.035	-0.043	-0.039	-0.035	-0.035	-0.035
O:O+W in 12 in 1995	(d)	1.000	0.998	0.999	0.999	1.000	1.000
J whales in Japan catch	(e)	0.124	0.129	0.142	0.170	0.191	

Average fit = 26.0.

## Appendix 6

### SUMMARY OF NON-NATURAL MORTALITY OF WHALES IN KOREA 1999

Zang Geun Kim

All non-natural mortality of cetacean species, bycaught from coastal fishing gears and stranded in Korea were obligatorily reported to marine police and fisheries authorities in accordance with the guideline of the MOMAF.

Tables 1-2, and Figs 1-2 summarise the Korean progress report (SC/52/ProgRepKorea) submitted to the Scientific Committee.

Table 1  
Summary of non-natural mortality of minke whales for the year 1999.

Species	Area/stock	Male	Female	Total	Cause	Methodology
Minke whale	East Sea	6	13	19	Set net	Post-mortem
		2	3	5	Drift gillnet	
		5	9	14	Gillnet	
		4	11	15	Trap net	
South Sea		2	2	2	Trap net	
		1	1	1	Set net	

Table 2  
Summary of strandings for the year 1999.

Species	Year	Area	Total
Minke whale	1999	East Sea	6

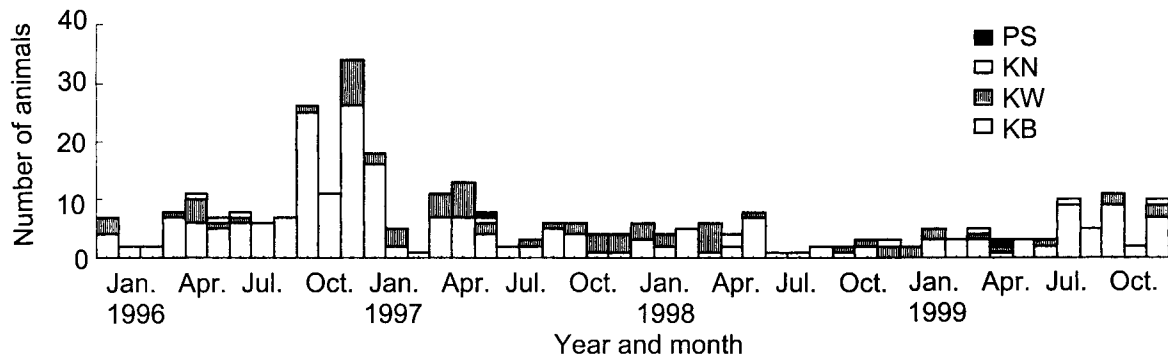


Fig. 1 Number of minke whales affected by non-natural mortality in Korean waters, 1996-1999. South Eastern and Western South sea (PS: Pusan City, KN: Kyeong-Nam Province); Northern Eastern sea (KW: Kang-Won Province); and Central Eastern sea (KB: Kyeong-Buk Province).

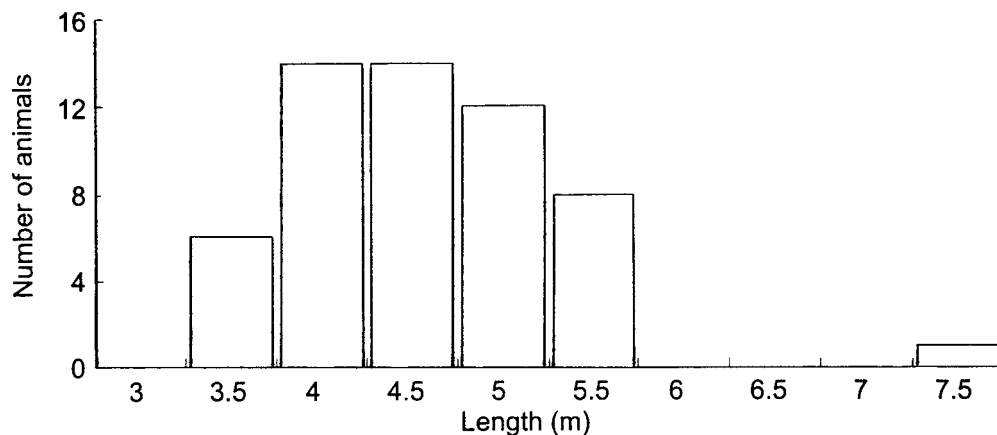


Fig. 2. Size distribution of minke whales affected by non-natural mortality in Korean waters in 1999.

## Appendix 7

### COMMENTS BY PASTENE IN RESPONSE TO DATA ISSUES RELATING TO BAKER *ET AL.* (2000)

Pastene responded that the explanations given were insufficient; the reference sequences were supplied for forensic purposes only. They were explicitly used in Fig. 1 of Baker *et al.* (2000) (without acknowledgement). Regarding the JARPEN genetic data, the sequences have been used in different papers submitted to the Scientific Committee meeting. These data have been contributed to the work of the Scientific Committee on management strategies for the North Pacific minke whales, and the mtDNA RFLP data have been already published. The data were used to demonstrate striking differences between 'J' and 'O' stocks and to estimate the mixing proportion of 'J' and 'O' stocks in sub-area 11 (Goto and Pastene, 1997; Pastene *et al.*, 1998); this information has been used in the *Implementation Simulation Trials*. The status of DNA sequence data is different. These data have been produced recently and have not been published yet. Discussion of these data is still taking place at Scientific Committee meetings and the sequence information presented in Scientific Committee documents

cannot be used for publication by other parties. Baker and colleagues used the sequence data without permission and the authors had not been consulted or informed about the plan to publish such information. This is unacceptable.

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## Appendix 8

## ESTIMATED INCIDENTAL TAKES OF NORTH PACIFIC MINKE WHALES FROM THE COAST OF JAPAN BASED ON MARKET SURVEY BY THE FISHERIES AGENCY, GOVERNMENT OF Japan (SC/52/SD7)

C.S. Baker, G. Lento, M. Dalebout and F. Cipriano

At the 1999 meeting of the IWC, the Scientific Committee expressed its concern at the implications of incidental catches for the status of the protected J stock of North Pacific minke whales found in the Sea of Japan (East Sea), Yellow Sea and East China Sea (IWC, 2000a, p.8). To address this concern, Baker *et al.* (2000) undertook a more comprehensive analysis of market products initially used for estimation of Japanese incidental takes for input into the *Implementation Simulation Trials* at the 1999 meeting (IWC, 2000b, p.84). The resulting estimate of approximately 100 whales per year was based on a mixed-stock analysis and maximum-likelihood methods using mtDNA haplotype frequencies from two source populations (the O and J stock) and the market sample. This estimate is substantially higher than the 25 per year average (bycatch and strandings) reported by the Fisheries Agency, Government of Japan, in its annual progress reports to the IWC, but close to the independent estimate of undocumented takes based on extrapolation of reported takes and the effort of coastal fisheries (Tobayama *et al.*, 1992).

An independent estimate of this incidental take can be calculated, using similar methods, from the markets surveys undertaken in 1996 and 1999/2000 by the Fisheries Agency, Government of Japan (JFA). In their molecular identification of the products collected in these market surveys, Goto and Pastene (SC/52/SD7) use the presence of a 'G' at position 298 of the mtDNA control region as a marker characteristic of J-stock origins. This method is comparable to the use of the 'G' at position 298 or an 'A' at position 463, as described by Congdon *et al.* (1999), and used by Baker *et al.* (2000). However, the single site method of Goto and Pastene will underestimate, to some degree, the J-stock types in comparison to the two-site method of Congdon *et al.* (1999).

In the 1996 survey by the JFA, 9 of the 65 (13.8%) North Pacific minke whale products were identified as J type (some numbers for multiple haplotypes are missing from fig. 2 of SC/52/SD7). In the 1999/2000 survey, 13 of the 30 (43.3%) North Pacific minke whale products were identified as J type. It is noted in SC/52/SD7 that these estimates are not adjusted for possible duplicate products from the same individual. These independent surveys provide alternative

estimates of J stock products of 23% (weighted) or 28.6% (unweighted): both are within the 95% confidence limits of the 31% reported by Baker *et al.* (2000). At least some of this difference can be attributed to the reduced resolution of J types resulting from the single-site criterion used by Goto and Pastene in SC/52/SD7. For example, the 'AA' types found in both the Korean (7.8%) and Japanese (5%) market would not be recognised (see fig. 2 of Baker *et al.*, 2000). Further, the survey undertaken by the JFA in 1995 (and reported to the Commission as IWC/49/INF3) provides a phylogenetic tree suggesting that several of the 12 products identified as North Pacific minke whale would likely be classified as J type. If information on position 298 becomes available, these products could be included to give a total of 107 products identified as this species in the JFA surveys. An improved maximum-likelihood estimate of the J-stock market proportion could be derived by combining all datasets ( $n=88$ ) and standardising the use of the mtDNA control region position used as a marker for the J stock in both market products and the JARPEN takes. Preferably, this standardisation should include the two positions used by Baker *et al.* (2000) or additional information on sequence variation distinguishing the two stocks.

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**Appendix 9**

**COMMENTS ON THE SAMPLING METHOD OF MARKET SURVEYS**

H. Hatanaka

- (1) Dizon *et al.* (2000) reported that ‘collections were aimed mainly at covering a diversity of sources rather than proportional sampling’ and that ‘care was taken to purchase products from a variety of outlets, including large department stores and smaller shops’. This sampling method covers samples widely but does not cover proportionally the frequency distributions of type of outlets, and makes a bias toward lesser chance of sampling the same animal (Fig. 1).
- (2) Dizon *et al.* (2000) described that ‘purchases tended to be targeted towards products that were unusual’. As the usual meats are from JARPN, this method tends to avoid the meats from JARPN, and therefore it makes lesser rate of O stock.
- (3) Dizon *et al.* (2000) described that ‘sampling strategy was to limit collection of duplicate samples from the same individual’. This method also makes a bias so that the chance of sampling the same animal is smaller.
- (4) There is a description that the outlet at which unusual meat was once purchased was re-visited the next year. This method makes a bias so that the chance of duplicate sampling makes smaller and that the common meat from JARPN has lesser chance.
- (5) In conclusion, the substantial biases in both mixing rate of J and O and estimated number of individual whales are exist in market survey. Therefore we should not use such estimates.

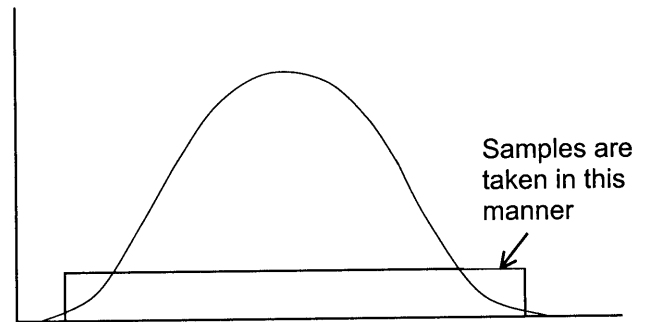


Fig. 1

REFERENCE

Dizon, A., Baker, S., Cipriano, F., Lento, G., Palsbøll, P. and Reeves, R. 2000. Molecular Genetic Identification of Whales, Dolphins, and Porpoises: Proceedings of a Workshop on the Forensic Use of Molecular Techniques to Identify Wildlife Products in the Marketplace, La Jolla, CA, USA, 14-16 June 1999. US Department of Commerce, NOAA Technical Memorandum, NOAA-TM-NMFS-SWFSC-286. 52pp+xi.

**Appendix 10**

**SPECIFICATIONS OF THE NORTH PACIFIC MINKE WHALING TRIALS**

*Additional details have been added to these specifications following the Scientific Committee meeting, in consultation with the Steering Group.*

**A. Basic concepts and stock structure**

The objective of these trials is to examine the performance of the RMP in scenarios that relate to the actual problem of managing a likely fishery for minke whales in the North Pacific. The trials attempt to bound the range of plausible hypotheses regarding the number of minke whale stocks in the North Pacific, how they feed (by sex and age) and recruit and how surveys index them. The underlying dynamics model is age- and sex-structured and allows for multiple stocks. Allowance is made for possible dispersal (permanent transfer of animals between stocks).

The region to be managed (the western North Pacific) is divided into 13 sub-areas (see Fig. 1 of main report). Future surveys are unlikely to cover sub-areas 1, 2, 3, 4, 5, 6, 10 and 13 (see Table 1) so for these trials, these sub-areas are taken to be *Residual Areas* (although allowance is made for future incidental catches from some of these sub-areas – see section D). The term ‘stock’ refers to a group of whales from the same breeding ground. The model considers two hypotheses in this regard: (1) that there are three stocks, the J stock (‘home’ area - Sea of Japan and perhaps also the Yellow Sea and East China Sea), the O Stock (‘home’ area - the Okhotsk

Sea, the east coast of Japan) and the W (West Pacific) Stock: (2) only the J and O stocks. The reason for considering the W stock is that, by unintentionally counting whales from such a stock during surveys, catch limits may be set which lead to over-exploitation of a coastal O stock.

Table 1  
Plan for future sighting surveys of minke whales in the western North Pacific.

Season	Sub-area				
	7	8	9	11	12
2000				Aug.-Sep.	Aug.-Sep.
2001				Aug.-Sep.	Aug.-Sep.
2002			Aug.-Sep.		
2003	Aug.-Sep.	Aug.-Sep.			
2004				Aug.-Sep.	Aug.-Sep.
2005			Aug.-Sep.		
2006	Aug.-Sep.	Aug.-Sep.			
2007	Continuing in this pattern				

**B. Basic dynamics**

Further details of the underlying age-structured model and its parameters can be found in IWC (1991, p.112), except that the model has been extended to take sex-structure and dispersal into account. The 1+ population of a stock is

governed by Equations 1(a) for the J stock for which there is no dispersal (permanent movement between stocks) and by Equations 1(b) for the O and W stocks:

$$\begin{aligned} R_{t+1,a+1}^{m/f,s} &= \tilde{R}_{t,a}^{m/f,s} + \tilde{U}_{t,a}^{m/f,s} \delta_{a+1} & 0 \leq a \leq x-2 \\ R_{t+1,x}^{m/f,s} &= \tilde{R}_{t,x}^{m/f,s} + \tilde{R}_{t,x-1}^{m/f,s} & (B.1a) \\ U_{t+1,a+1}^{m/f,s} &= \tilde{U}_{t,a}^{m/f,s} (1 - \delta_{a+1}) & 0 \leq a \leq x-2 \end{aligned}$$

$$\begin{aligned} R_{t+1,a+1}^{m/f,s} &= (1 - D^{s,s'}) \tilde{R}_{t,a}^{m/f,s} + D^{s,s'} \tilde{R}_{t,a}^{m/f,s'} \\ &+ \left( (1 - D^{s,s'}) \tilde{U}_{t,a}^{m/f,s} + D^{s,s'} \tilde{U}_{t,a}^{m/f,s'} \right) \delta_{a+1} & 0 \leq a \leq x-2 \end{aligned}$$

$$\begin{aligned} R_{t+1,x}^{m/f,s} &= (1 - D^{s,s'}) (\tilde{R}_{t,x}^{m/f,s} + \tilde{R}_{t,x-1}^{m/f,s}) \\ &+ D^{s,s'} (\tilde{R}_{t,x}^{m/f,s'} + \tilde{R}_{t,x-1}^{m/f,s'}) & (B.1b) \end{aligned}$$

$$U_{t+1,a+1}^{m/f,s} = \left( (1 - D^{s,s'}) \tilde{U}_{t,a}^{m/f,s} + D^{s,s'} \tilde{U}_{t,a}^{m/f,s'} \right) (1 - \delta_{a+1}) \quad 0 \leq a \leq x-2$$

$R_{t,a}^{m/f,s}$  is the number of recruited males/females of age  $a$  in stock  $s$  at the start of year  $t$ ;

$U_{t,a}^{m/f,s}$  is the number of unrecruited males/females of age  $a$  in stock  $s$  at the start of year  $t$ ;

$\delta_a$  is the fraction of unrecruited animals of age  $a-1$  which recruit at age  $a$  (assumed to be independent of stock and sex);

$x$  is the maximum (lumped) age-class (all animals in this and the  $x-1$  class are assumed to be recruited and to have reached the age of first parturition);

$\tilde{R}_{t,a}^{m/f,s}$  is the number of recruited males/females of age  $a$  in stock  $s$  at the start of year  $t$  that survive to the end of the year:

$$\tilde{R}_{t,a}^{m/f,s} = \left( R_{t,a}^{m/f,s} - C_{t,a}^{m/f,s} \right) S_a \quad (B.1c)$$

$\tilde{U}_{t,a}^{m/f,s}$  is the number of unrecruited males/females of age  $a$  in stock  $s$  at the start of year  $t$  that survive to the end of the year:

$$\tilde{U}_{t,a}^{m/f,s} = U_{t,a}^{m/f,s} S_a \quad (B.1d)$$

$S_a$  is the instantaneous survival rate of animals of age  $a$ , and is equal to  $\exp(-M_a)$  where  $M_a$  is the instantaneous natural mortality rate for animals of age  $a$  (assumed to be independent of stock, sex and whether or not an animal is recruited);

$C_{t,a}^{m/f,s}$  is the catch of males/females of age  $a$  from stock  $s$  during year  $t$ ; and

$D^{s,s'}$  is the dispersal rate (i.e. the probability of an animal moving permanently) from stock  $s$  to  $s'$ .

Note that year  $t=0$ , for which catch limits might first be set, corresponds to 2000.

For computational ease, the numbers-at-age and by sex are updated at the end of each year only even though catching is assumed to occur from April to September. This simplification is unlikely to affect the results substantially for two reasons: (1) catches are at most only a few percent of the size of the recruited stock; and (2) sightings survey estimates are subject to high variability so that the resultant slight positive bias in abundance estimates is almost certainly inconsequential.

### Births

Density-dependence is assumed to act on the female component of the mature population. The convention of referring to the mature population is used here, although this

actually refers to animals that have reached the age of first parturition.

$$\begin{aligned} U_{t,0}^{m/f,s} &= 0.5(1 - \alpha_0) B^s N_t^{f,s} \{1 + A^s (1 - (N_t^{f,s} / K^{f,s})^{z^s})\} \\ R_{t,0}^{m/f,s} &= 0.5\alpha_0 B^s N_t^{f,s} \{1 + A^s (1 - (N_t^{f,s} / K^{f,s})^{z^s})\} & (C.1) \end{aligned}$$

$B^s$  is the average number of live births (both sexes) per year for mature females in stock  $s$  in the pristine population;

$A^s$  is the resilience parameter for stock  $s$ ;

$z^s$  is the degree of compensation for stock  $s$ ;

$N_t^{f,s}$  is the number of mature females in stock  $s$  at the start of year  $t$ :

$$N_t^{f,s} = \sum_{a=1}^x \beta_a (R_{t,a}^{f,s} + U_{t,a}^{f,s}) \quad (C.2)$$

$\alpha_0$  is the proportion of animals of age 0 which are recruited (assumed to be zero for this case);

$\beta_a$  is the proportion of females of age  $a$  which are mature (assumed to be independent of stock, year and whether or not an animal is recruited); and

$K^{f,s}$  is the number of mature females in stock  $s$  in the pristine (pre-exploitation, denoted by  $t = -\infty$ ) population:

$$K^{f,s} = \sum_{a=1}^x \beta_a (R_{-\infty,a}^{f,s} + U_{-\infty,a}^{f,s}) \quad (C.3)$$

The values for the parameters  $A^s$  and  $z^s$  for each stock are calculated from pre-specified values for  $MSYL^s$  and  $MSYR^s$  as detailed in IWC (1991, p.112). Their calculation ignores the impact of dispersal and assumes harvesting equal proportions of males and females.

### D. Catches

The operating model considers two sources for non-natural mortality (incidental catches and commercial catches). In future ( $t \geq 2000$ ), the former are pre-specified, while the latter are set by the RMP. In cases in which the catch limit set by the RMP is less than the (pre-specified) level of incidental catch, the total removals are taken to be the incidental catch only whereas if the RMP catch limit exceeds the incidental catch, the level of the commercial removals is taken to be the difference between the RMP catch limit and the incidental catch. In trials when future incidental catches are mis-reported (trial NPM116 – see Section G) the level of the commercial removals is set by subtracting the *reported* incidental catch from the catch limit set by the RMP.

Catch limits are set by *Small Area*. (Catches are always reported by *Small Area*, i.e. the RMP is not provided with catches by sub-area for cases in which sub-areas are smaller than *Small Areas*.) As it is assumed that whales are homogeneously distributed across a sub-area, the catch limit for a sub-area is allocated to stocks by sex and age relative to their true density within that sub-area, and a catch mixing matrix  $V$  that depends on sex, age and time of the year (and may also depend on year), i.e.:

$$\begin{aligned} C_{t,a}^{m/f,s} &= \sum_k \sum_q C_{t,a}^{m/f,s,k,q} \\ C_{t,a}^{m/f,s,k,q} &= C_t^{m/f,k,q} \{ V_{t,a}^{m/f,s,k,q} R_{t,a}^{m/f,s} / \\ &\quad \sum_j \sum_{a'=1}^x V_{t,a'}^{m/f,j,k,q} R_{t,a'}^{m/f,j} \} & (D.1) \end{aligned}$$

$C_{t,a}^{m/f,s,k,q}$  is the catch of males/females of age  $a$  from stock  $s$  in sub-area  $k$  during month  $q$  of year  $t$ ; and  $C_t^{m/f,k,q}$  is the catch of males/females from sub-area  $k$  during month  $q$  of year  $t$ .

Each entry in the catch mixing matrix,  $V_{t,a}^{m/f,s,k,q}$ , is the fraction of males/females of age  $a$  from stock  $s$  which are found in sub-area  $k$  during month  $q$  of year  $t$ . The catch mixing matrix is different for each month to reflect the effects of migration between the breeding and the feeding grounds. Table 2 gives the catch mixing matrices considered. The rationale for the values used is given in IWC (1997a, p.225-6). The catch mixing matrices give the relative fraction of an age-class in each of the sub-areas during the months April-September. Once the values of the mixing rate parameters  $\gamma_1 - \gamma_{16}$  are specified (these are estimated separately for each trial in the conditioning process), the catch mixing matrices can be converted to fractions of each age-class in each sub-area. The values for the parameters  $\gamma_1 - \gamma_{16}$  are determined to mimic available data (see Section F). In many trials, the catch mixing matrix for each of the 100 simulations and for each of the years of the associated pre-management and 100-year management periods is selected at random from two possibilities (e.g. matrices A and B for the J stock). In this case, a random number is generated for each year from U[0,1]; if this number is larger than 0.5, then the catch mixing matrix used for stock J is matrix A, otherwise it is matrix B.

Catch mixing matrices are specified for ages 4 and 10 (these being three years below and above the assumed age-at-50%-maturity). Few animals of age 4 are mature while most of age 10 are. The catch mixing matrices for ages 0-3 are assumed to be the same as that for age 4, and those for ages 11+ the same as that for age 10. The catch mixing matrices for ages 5-9 are calculated by interpolating linearly between those for ages 4 and 10.

The model considers a future six-month whaling season (April-September). In order to account for historical catches outside these months, all catches in January-March are added to those in April and the catches after September are assumed to have been taken in September. The historic commercial and scientific catches by sex, sub-area, month and year are given in Table 3.

The trials are conducted assuming that the sub-areas for which future catch limits might be set are:

sub-areas 7,8,9 (April) and 7,8,9,11,12 (May - September)<sup>1</sup>

The future ( $t \geq 2000$ ) commercial catches by sex, sub-area, month and year are calculated using the equation:

$$C_t^{m/f,k,q} = C_t^k Q^{m/f,k,q} \quad (D.2)$$

$Q^{m/f,k,q}$  is the fraction of the commercial catch in sub-area  $k$  which is taken during month  $q$  and are males/females, the values of which are given in Table 4; and

$C_t^k$  is the commercial catch limit for sub-area  $k$  and year  $t$  ( $t \geq 2000$ ). Note that  $C_t^k$  is equal to the catch limit set by the RMP less the reported incidental catch.

Some of the entries in the  $Q$  matrix are determined by the options related to the sub-areas for which catch limits might be set (i.e.  $Q$  is zero in April for sub-areas 11 and 12). The

non-zero entries in the  $Q$  matrix (see Table 4) reflect the historical breakdown of catches over the last 10 years of commercial whaling (1978-87) within each sub-area. In sub-areas for which there was no catch between 1978-87 (8, 9, and 12), the entries in the  $Q$  matrix are set using the entire historic commercial and scientific catch in these sub-areas. Sensitivity to these assumptions may be investigated in future trials. For the trials based on *Small Areas* that are combinations of sub-area 11 and other sub-areas, the entire catch is assumed to be taken from sub-area 11 as this should reflect the highest risk. For trials based on *Small Areas* that are combinations of sub-areas including sub-area 7 but not sub-area 11, the entire catch is assumed to be taken from sub-area 7.

Incidental catches of minke whales are known to occur off the Republic of Korea and Japan but the level of such catches is uncertain (IWC, 2000a, p.84). Two options are considered for the incidental catch off Japan. The incidental catches are apportioned to stock and age class in the same way as for the commercial catches (i.e. using Equation D.1).

#### *Incidental catch off the Republic of Korea:*

The incidental catch off the Republic of Korea in sub-area 6 is assumed to be zero until 1988 after which it increases linearly to 78 in 1995. It is 129 in 1996, 78 in 1997, 45 in 1998 and 56 in 1999. The catch in each year is apportioned to month according to the average of the proportions of the annual incidental catch by month taken in 1996-99 (Table 5(a)) and is apportioned by sex according to the incidental catches in 1998 and 1999 (the only years for which the sex of the incidental catches are known). These values are also given in Table 5(a). In future years the incidental catch in year  $t$  is set at  $P_t^{k=6} / P_{1997/8}^{k=6}$  where 61 is the mean catch in 1997-98 and  $P_t^{k=6}$  is the mean 1+ population size (over all time periods) in year  $t$  in sub-area 6. The catch is apportioned by month and sex as for the historic catch above.

The rationale for these levels of catch is (a) comments by Kim that minke whales returned to inshore areas only gradually after the end of commercial whaling in 1986 - hence the linear increase; (b) indications by Kim that 1996 was environmentally abnormal, so that the incidental catch that year was atypically high; and (c) suggestions, in part in the light of (a), that such catches should therefore be expected to increase in the future should the population size increase.

#### *Incidental catch off Japan:*

##### OPTION (J)

The incidental catches off Japan between 1955-1999 are given in Table 5(b) where the catches from 1979-99 are taken to be the reported catches as listed in Japanese progress reports. Future catches are taken in proportion to the population size in the sub-area and are given by  $C_t^k = \tilde{C}^k P_t^k / \bar{P}^k$  where  $\bar{P}^k$  is the mean 1+ population size (over all time periods) in sub-area  $k$  from 1996-98 and  $\tilde{C}^k$  is the reference incidental catch as given in Table 5(c). The total reference catch is 25 whales and it is allocated to sub-areas in the ratio of the 1996-98 catch. The sex and timing within the year of both historic and future catches are selected according to the historic ratio of catches off Japan within the relevant sub-area since 1979, or if there was none then the entire historic catch.

The RMP is given the actual historic and future catch series, except in Trial NPM116 (see Section G) when the reported catch is over-reported at a level equal to 3 times ( $= 75/25$ ) the actual values.

<sup>1</sup> Note: The  $Q$  matrix is zero for sub-areas 8 and 9 in April so no catches will be allocated. The elements in  $Q$  for these sub-areas are based on a very small number of catches. In practice, the split by month will be dictated by operational factors as well as by the numbers of whales available (which the historic catches are intended to represent).

Table 2

The catch mixing matrices (the sightings mixing matrix is calculated from the catch mixing matrices for August and September). Differences from the base-case matrices (A, B, F and K) are highlighted using bold type. The rationale for the values used is given in IWC (1997) pp.225-6. W Stock (Option L) is identical to Option K except there are no W whales in sub-area 8 (i.e the sub-area 8 column is replaced with zeros).

Month/ Age-class	Sub-area											
	1	2	3	4	5	6	7	8	9	10	11	12
<b>J Stock (Option A)</b>												
Age 4												
April	1	0	0	0	1	1	0	0	0	1	$\gamma_1$	0
May	0	0	0	0	1	1	0	0	0	2	$\gamma_2$	0
June	0	0	0	0	1	1	0	0	0	2	$\gamma_2$	0
July	0	0	0	0	1	1	0	0	0	1	$\gamma_2$	0
August	0	0	0	0	1	1	0	0	0	1	$\gamma_{12}^1$	0
September	1	0	0	0	1	2	0	0	0	1	0	0
Age 10 - female												
April	1	0	0	0	1	1	0	0	0	1	$2\gamma_1$	0
May	0	0	0	0	1	1	0	0	0	2	$2\gamma_2$	0
June	0	0	0	0	1	1	0	0	0	2	$2\gamma_2$	0
July	0	0	0	0	1	1	0	0	0	1	$2\gamma_2$	0
August	0	0	0	0	1	1	0	0	0	1	$\gamma_2$	0
September	1	0	0	0	1	2	0	0	0	1	0	0
Age 10 - male												
April	1	0	0	0	1	1	0	0	0	1	$\gamma_1$	0
May	0	0	0	0	1	1	0	0	0	2	$\gamma_2$	0
June	0	0	0	0	1	1	0	0	0	2	$\gamma_2$	0
July	0	0	0	0	1	1	0	0	0	1	$\gamma_2$	0
August	0	0	0	0	1	1	0	0	0	1	$\gamma_{11}$	0
September	1	0	0	0	1	2	0	0	0	1	0	0
<b>J Stock (Option B) some animals in sub-area 7 in August/September and in sub-area 12 in May-August.</b>												
Age 4												
April	1	0	0	0	1	1	$\gamma_{13}$	0	0	1	$\gamma_1$	0
May	0	0	0	0	1	1	$\gamma_{14}$	0	0	2	$\gamma_2$	0
June	0	0	0	0	1	1	0	0	0	2	$\gamma_2$	0
July	0	0	0	0	1	1	0	0	0	1	$\gamma_2$	0
August	0	0	0	0	1	1	$2\gamma_4$	0	0	1	$\gamma_{12}^1$	0
September	1	0	0	0	1	2	$2\gamma_4$	0	0	1	0	0
Age 10 - female												
April	1	0	0	0	1	1	0	0	0	1	$2\gamma_1$	0
May	0	0	0	0	1	1	0	0	0	2	$2\gamma_2$	$\gamma_3$
June	0	0	0	0	1	1	0	0	0	2	$2\gamma_2$	$\gamma_3$
July	0	0	0	0	1	1	0	0	0	1	$2\gamma_2$	$\gamma_5$
August	0	0	0	0	1	1	$\gamma_4$	0	0	1	$\gamma_2$	$\gamma_5$
September	1	0	0	0	1	2	$\gamma_4$	0	0	1	0	0
Age 10 - male												
April	1	0	0	0	1	1	0	0	0	1	$\gamma_1$	0
May	0	0	0	0	1	1	0	0	0	2	$\gamma_2$	$\gamma_3$
June	0	0	0	0	1	1	0	0	0	2	$\gamma_2$	$\gamma_3$
July	0	0	0	0	1	1	0	0	0	1	$\gamma_2$	$\gamma_5$
August	0	0	0	0	1	1	$5\gamma_4$	0	0	1	$\gamma_{11}$	$\gamma_5$
September	1	0	0	0	1	2	$5\gamma_4$	0	0	1	0	0
<sup>1</sup> $\gamma_{12} = (\gamma_2 + \gamma_{11})/2$												
<b>O Stock (Option F) for trials with O and W stocks</b>												
Age 4												
April	0	2	0	0	0	0	4	0	0	0	$\gamma_7$	0
May	0	1	0	0	0	0	4	0	0	0	$\gamma_7$	$\gamma_6$
June	0	0	0	0	0	0	4	0	0	0	$\gamma_7$	$\gamma_6$
July	0	0	0	0	0	0	4	0	0	0	$\gamma_7$	$\gamma_6$
August	0	0	0	0	0	0	4	0	0	0	$\gamma_7$	$\gamma_6$
September	0	0	0	0	0	0	4	0	0	0	$\gamma_7$	0
Age 10 - female												
April	0	2	0	0	0	0	4	0	0	0	$2\gamma_7$	$2\gamma_6$
May	0	1	0	0	0	0	2	0	0	0	$2\gamma_7$	$3\gamma_6$
June	0	0	0	0	0	0	1	0	0	0	$2\gamma_7$	$3\gamma_6$
July	0	0	0	0	0	0	1	0	0	0	$2\gamma_7$	$3\gamma_6$
August	0	0	0	0	0	0	1	0	0	0	$\gamma_7$	$2\gamma_6$
September	0	0	0	0	0	0	1	0	0	0	$\gamma_7$	$\gamma_6$
Age 10 - male												
April	0	2	0	0	0	0	4	0	0	0	$\gamma_7$	$\gamma_6$
May	0	1	0	0	0	0	4	0	0	0	$\gamma_7$	$\gamma_6$
June	0	0	0	0	0	0	4	0	0	0	$\gamma_7$	$\gamma_6$
July	0	0	0	0	0	0	4	0	0	0	$\gamma_7$	$\gamma_6$
August	0	0	0	0	0	0	4	0	0	0	$\gamma_7$	$\gamma_6$
September	0	0	0	0	0	0	4	0	0	0	$\gamma_7$	$\gamma_6$
<b>O Stock (Option G) for trials with an O stock only</b>												
Age 4												
April	0	2	2	2	0	0	4	1	0	0	$\gamma_7$	0
May	0	1	1	1	0	0	4	1	0	0	$\gamma_7$	$\gamma_6$
June	0	0	0	0	0	0	4	1	0	0	$\gamma_7$	$\gamma_6$
July	0	0	0	0	0	0	4	1	0	0	$\gamma_7$	$\gamma_6$
August	0	0	0	0	0	0	4	1	0	0	$\gamma_7$	$\gamma_6$
September	0	0	0	0	0	0	4	1	0	0	$\gamma_7$	0
Age 10 - female												
April	0	2	2	2	0	0	4	1	$4\gamma_{15}$	0	$2\gamma_7$	$2\gamma_6$
May	0	1	1	1	0	0	2	1	$2\gamma_{15}$	0	$2\gamma_7$	$3\gamma_6$
June	0	0	0	0	0	0	1	1	$\gamma_{15}$	0	$2\gamma_7$	$3\gamma_6$
July	0	0	0	0	0	0	1	1	$\gamma_{15}$	0	$2\gamma_7$	$3\gamma_6$
August	0	0	0	0	0	0	1	1	$\gamma_{15}$	0	$\gamma_7$	$2\gamma_6$
September	0	0	0	0	0	0	1	1	$\gamma_{15}$	0	$\gamma_7$	$\gamma_6$
Age 10 - male												
April	0	2	2	2	0	0	4	2	$4\gamma_{15}$	0	$\gamma_7$	$\gamma_6$
May	0	1	1	1	0	0	4	2	$2\gamma_{15}$	0	$\gamma_7$	$\gamma_6$
June	0	0	0	0	0	0	4	2	$2\gamma_{15}$	0	$\gamma_7$	$\gamma_6$
July	0	0	0	0	0	0	4	2	$2\gamma_{15}$	0	$\gamma_7$	$\gamma_6$
August	0	0	0	0	0	0	4	2	$2\gamma_{15}$	0	$\gamma_7$	$\gamma_6$
September	0	0	0	0	0	0	4	2	$2\gamma_{15}$	0	$\gamma_7$	$\gamma_6$
<b>O Stock (Option H) for trials with O and W stocks (Some O stock animals in sub-area 10, compared to option F)</b>												
Age 4												
April	0	2	0	0	0	0	4	0	0	0	$\gamma_7$	0
May	0	1	0	0	0	0	4	0	0	0	$\gamma_8$	$\gamma_7$
June	0	0	0	0	0	0	4	0	0	0	$\gamma_8$	$\gamma_7$
July	0	0	0	0	0	0	4	0	0	0	$\gamma_8$	$\gamma_7$
August	0	0	0	0	0	0	4	0	0	0	$\gamma_8$	$\gamma_7$
September	0	0	0	0	0	0	4	0	0	0	$\gamma_7$	0
Age 10 - female												
April	0	2	0	0	0	0	4	0	0	0	$\gamma_7$	$2\gamma_6$
May	0	1	0	0	0	0	2	0	0	0	$2\gamma_8$	$2\gamma_7$
June	0	0	0	0	0	0	1	0	0	0	$2\gamma_8$	$2\gamma_7$
July	0	0	0	0	0	0	1	0	0	0	$2\gamma_8$	$2\gamma_7$
August	0	0	0	0	0	0	1	0	0	0	$\gamma_7$	$2\gamma_6$
September	0	0	0	0	0	0	1	0	0	0	$\gamma_7$	$\gamma_6$
Age 10 - male												
April	0	2	0	0	0	0	4	0	0	0	$\gamma_7$	$\gamma_6$
May	0	1	0	0	0	0	4	0	0	0	$\gamma_8$	$\gamma_7$
June	0	0	0	0	0	0	4	0	0	0	$\gamma_8$	$\gamma_7$
July	0	0	0	0	0	0	4	0	0	0	$\gamma_8$	$\gamma_7$
August	0	0	0	0	0	0	4	0	0	0	$\gamma_7$	$\gamma_6$
September	0	0	0	0	0	0	4	0	0	0	$\gamma_7$	$\gamma_6$
<b>O Stock (Option J) for trials with O and W stocks (Some O stock animals in sub-area 8, compared to option F)</b>												
Age 4												
April	0	2	0	0	0	0	4	$\gamma_9$	0	0	$\gamma_7$	0
May	0	1	0	0	0	0	4	$\gamma_9$	0	0	$\gamma_7$	$\gamma_6$
June	0	0	0	0	0	0	4	$\gamma_9$	0	0	$\gamma_7$	$\gamma_6$
July	0	0	0	0	0	0	4	$\gamma_9$	0	0	$\gamma_7$	$\gamma_6$
August	0	0	0	0	0	0	4	$\gamma_9$	0	0	$\gamma_7$	$\gamma_6$
September	0	0	0	0	0	0	4	$\gamma_9$	0	0	$\gamma_7$	0
Age 10 - female												
April	0	2	0	0	0	0	4	$\gamma_9$	0	0	$2\gamma_7$	$2\gamma_6$
May	0	1	0	0	0	0	2	$\gamma_9$	0	0	$2\gamma_7$	$3\gamma_6$
June	0	0	0	0	0	0	1	$\gamma_9$	0	0	$2\gamma_7$	$3\gamma_6$
July	0	0	0	0	0	0	1	$\gamma_9$	0	0	$2\gamma_7$	$3\gamma_6$
August	0	0	0	0	0	0	1	$\gamma_9$	0	0	$\gamma_7$	$2\gamma_6$
September	0	0	0	0	0	0	1	$\gamma_9$	0	0	$\gamma_7$	$\gamma_6$
Age 10 - male												
April	0	2	0	0	0	0	4	$2\gamma_9$	0	0	$\gamma_7$	$\gamma_6$
May	0	1	0	0	0	0	4	$2\gamma_9$	0	0	$\gamma_7$	$\gamma_6$
June	0	0	0	0	0	0	4	$2\gamma_9$	0	0	$\gamma_7$	$\gamma_6$
July	0	0	0	0	0	0	4	$2\gamma_9$	0	0	$\gamma_7$	$\gamma_6$
August	0	0	0	0	0	0	4	$2\gamma_9$	0	0	$\gamma_7$	$\gamma_6$
September	0	0	0	0	0	0	4	$2\gamma_9$	0	0	$\gamma_7$	$\gamma_6$

cont.

Table 2. Continued.

Month/ Age-class	Sub-area											
	1	2	3	4	5	6	7	8	9	10	11	12
<b>W Stock (Option K) for trials with O and W stocks</b>												
Age 4												
April	0	0	1	1	0	0	0	0	0	0	0	0
May	0	0	1	1	0	0	0	0	0	0	0	0
June	0	0	1	1	0	0	0	0	0	0	0	0
July	0	0	1	1	0	0	0	0	0	0	0	0
August	0	0	1	1	0	0	0	0	0	0	0	0
September	0	0	1	1	0	0	0	0	0	0	0	0
Age 10 - female												
April	0	0	2	2	0	0	0	1	2	0	0	$\gamma_{10}$
May	0	0	1	1	0	0	0	1	1	0	0	$2\gamma_{10}$
June	0	0	0	0	0	0	0	1	1	0	0	$2\gamma_{10}$
July	0	0	0	0	0	0	0	1	1	0	0	$3\gamma_{10}$
August	0	0	0	0	0	0	0	1	1	0	0	$3\gamma_{10}$
September	0	0	0	0	0	0	0	1	1	0	0	$2\gamma_{10}$
Age 10 - male												
April	0	0	2	2	0	0	0	1	2	0	0	$\gamma_{10}$
May	0	0	1	1	0	0	0	1	3	0	0	$\gamma_{10}$
June	0	0	0	0	0	0	0	2	4	0	0	$2\gamma_{10}$
July	0	0	0	0	0	0	0	2	4	0	0	$2\gamma_{10}$
August	0	0	0	0	0	0	0	2	4	0	0	$\gamma_{10}$
September	0	0	0	0	0	0	0	2	3	0	0	$\gamma_{10}$

**OPTION (Jii)**

An incidental catch of 75 animals (IWC, 2000a, p.84-5) is assumed to have been taken in each year from 1900 to the present (Table 5(d)). Future catches are taken in proportion to the population size in the sub-area and are given by  $C_t^k = \tilde{C}^k P_t^k / \tilde{P}^k$  where  $\tilde{P}^k$  is the mean 1+ population size (over all time periods) in sub-area  $k$  from 1979-99 and  $\tilde{C}^k$  is the reference incidental catch as given in Table 5(d). Catches (both historic and future) are allocated among sub-areas in the same ratio as the 1979-99 catches listed in Table 5(b), and the sex and timing within years as for option Ji. For this option, the RMP is not given the true historic catch series, but is rather given the smaller Japanese catches listed for Option Ji. The RMP is given the actual future catches, except in Trial NPM116 when the future reported catch is under-reported at a level equal to 1/3 times (=25/75) the actual values.

Some of the incidental catch by Japan is taken from sub-areas for which a catch limit is set. For all trials the total catch (commercial + incidental) from the sub-areas is taken as equal to the catch limit set by the RMP if the RMP catch limit exceeds the incidental catch.

**E. Generation of data**

The estimates of absolute abundance (and their associated CVs) for the years prior to 1996 provided to the CLA are identical to the actual estimates and CVs for North Pacific minke whales from surveys conducted in August/September (see Table 6(a)). To allow for results of surveys already conducted, but for which the results are not yet available, estimates of abundance are generated for sub-areas 7 and 8 in 1996 and for sub-areas 11 and 12 in 1999 using the same method as for future estimates.

The sightings mixing matrix for a year in which a survey takes place is the average of the catch mixing matrices for August and September for that year. The values for the parameters of the various distributions have been selected to achieve CVs for *Small Areas* comparable to those for the surveys in Table 6(a). The future estimates of abundance for a *Small Area* (say *Small Area E*) are generated using the formula:

Month/ Age-class	Sub-area											
	1	2	3	4	5	6	7	8	9	10	11	12
<b>W Stock (Option M) for trials with O and W stocks (some W stock animals in the Japanese coastal waters)</b>												
Age 4												
April	0	0	1	1	0	0	0	0	0	0	0	0
May	0	0	1	1	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	1	0	0	0	0
July	0	0	0	0	0	0	0	1	0	0	0	1
August	0	0	0	0	0	0	0	1	0	0	0	1
September	0	0	0	0	0	0	0	1	0	0	0	0
Age 10 - female												
April	0	0	2	2	0	0	0	1	2	0	0	$\gamma_{10}$
May	0	0	1	1	0	0	0	1	1	0	0	$2\gamma_{10}$
June	0	0	0	0	0	0	0	1	1	0	0	$2\gamma_{10}$
July	0	0	0	0	0	0	0	1	1	0	0	$3\gamma_{10}$
August	0	0	0	0	0	0	0	1	1	0	0	$3\gamma_{10}$
September	0	0	0	0	0	0	0	1	1	0	0	$2\gamma_{10}$
Age 10 - male												
April	0	0	2	2	0	0	0	1	2	0	0	$\gamma_{10}$
May	0	0	1	1	0	0	0	1	3	0	0	$\gamma_{10}$
June	0	0	0	0	0	0	0	2	4	0	0	$2\gamma_{10}$
July	0	0	0	0	0	0	0	2	4	0	0	$2\gamma_{10}$
August	0	0	0	0	0	0	0	2	4	0	0	$\gamma_{10}$
September	0	0	0	0	0	0	0	2	3	0	0	$\gamma_{10}$

$$\hat{P} = PY_w / \mu = P^* \beta^2 Y_w \quad (E.1)$$

$Y$  is a lognormal random variable  $Y = e^\varepsilon$  where  $\varepsilon \sim N[0, \sigma^2]$  and  $\sigma^2 = \text{Ln}(\alpha^2 + 1)$ ;

$w$  is Poisson random variable with  $E(w) = \text{var}(w) = \mu = (P / P^*) / \beta^2$ ;

$Y$  and  $w$  are independent;

$P$  is the average current total (1+) population size in the *Small Area (E)* over August-September:

$$P = P_t^E = \frac{1}{2} \sum_{k \in F} \sum_{q \in \text{Aug/Sept}} \sum_s \sum_{a=1}^x (V_{t,a}^{m,s,k,q} (R_{t,a}^{m,s} + U_{t,a}^{m,s}) + V_{t,a}^{f,s,k,q} (R_{t,a}^{f,s} + U_{t,a}^{f,s})) \quad (E.2)$$

$P^*$  is the reference population level, and is equal to the mean total (1+) population size in the *Small Area* prior to the commencement of exploitation in the area being surveyed; and

$F$  is the set of sub-areas making up *Small Area E*.

Note that under the approximation  $\text{CV}^2(ab) = \text{CV}^2(a) + \text{CV}^2(b)$ :  $E(\hat{P}) = P$  and  $\text{CV}^2(\hat{P}) = \alpha^2 + \beta^2 P^* / P$ .

For consistency with the first stage screening trials for a single stock (IWC, 1991, p.109; IWC, 1994), the ratio  $\alpha^2 : \beta^2 = 0.12 : 0.025$ , so that:

$$\text{CV}(\hat{P}) = \tau(0.12 + 0.025 P^* / P)^{1/2} \quad (E.3)$$

and the CV of a survey estimate prior to the commencement of exploitation in the area being surveyed would be:

$$\sqrt{(\alpha^2 + \beta^2)} = 0.38\tau \quad (E.4)$$

The value of  $\tau$  is calculated from the equation defining the true value of the CV by substituting the value of the CV for each abundance estimate and the depletion to which it corresponds (Equation 9), and solving for  $\tau$ . If more than one abundance estimate exists for a particular sub-area, the value assumed for  $\tau$  is calculated taking the true CV to be the root



Table 3. Continued.

Area	Year	Males						Females						Area	Year	Males						Females					
		J-A	M	J	J	A	S-D	J-A	M	J	J	A	S-D			J-A	M	J	J	A	S-D	J-A	M	J	J	A	S-D
07	1961	22	33	16	4	8	5	30	39	16	3	3	1	10	1955	2	1	6	11	0	0	0	5	0	2	0	0
07	1962	13	20	10	2	5	3	17	23	92	2	2	1	10	1956	3	10	17	17	0	0	0	2	5	6	0	0
07	1963	13	21	10	3	5	3	17	24	10	2	2	1	10	1957	1	5	8	16	1	0	1	2	6	4	0	0
07	1964	22	33	16	4	8	6	30	40	16	3	3	1	10	1964	0	0	4	1	0	0	0	1	3	0	0	0
07	1965	15	22	19	4	0	0	21	35	36	0	0	0	10	1967	0	0	2	0	0	0	0	1	2	0	0	0
07	1966	22	34	16	4	8	6	34	46	18	3	4	2	10	1968	0	0	2	0	0	0	0	0	12	0	0	0
07	1967	14	21	10	3	5	3	23	31	12	2	3	1	10	1969	0	0	5	2	0	0	0	1	4	0	0	0
07	1968	14	20	12	1	2	4	24	39	13	2	2	1	10	1970	0	1	6	1	0	0	0	2	2	0	0	0
07	1969	4	12	7	1	3	1	8	17	6	1	2	0	10	1971	0	0	5	2	1	0	0	2	5	2	0	0
07	1970	19	64	10	7	4	2	27	54	6	5	0	0	10	1972	0	0	2	0	0	0	0	0	1	1	0	0
07	1971	23	20	34	7	3	0	23	19	22	4	1	0	10	1973	0	1	12	0	2	0	0	1	4	0	1	0
07	1972	15	13	5	0	1	12	35	38	2	0	0	4	10	1974	0	0	5	1	0	0	0	0	0	0	0	0
07	1973	32	42	11	1	14	18	34	36	25	2	4	5	10	1975	0	7	11	0	0	2	0	1	5	0	0	0
07	1974	15	27	7	5	24	13	34	34	1	3	12	5	10	1976	0	0	6	1	0	3	0	0	2	3	0	6
07	1975	11	27	2	16	38	10	13	33	0	6	13	7	10	1977	0	0	0	0	0	0	0	0	2	0	0	0
07	1976	32	17	2	6	7	10	51	19	1	5	9	9	10	1979	0	0	8	0	0	0	0	0	7	0	0	0
07	1977	11	21	2	20	24	29	16	28	0	7	1	5	10	1980	0	0	0	5	5	0	0	0	5	0	0	0
07	1978	37	46	9	32	51	53	47	46	1	12	4	6	10	1981	0	0	0	7	6	0	0	0	0	2	0	0
07	1979	34	53	9	31	55	64	26	21	3	10	9	8	10	1982	0	0	4	5	0	0	0	0	6	0	0	0
07	1980	33	22	25	37	9	35	40	40	7	9	1	5	10	1983	0	0	1	2	3	0	0	0	0	1	4	0
07	1981	30	38	55	38	25	3	32	29	11	9	3	2	10	1985	0	0	0	0	2	0	0	0	3	0	1	1
07	1982	37	34	46	25	13	7	38	24	14	12	6	1	11	1930	0	0	0	0	0	0	0	1	1	0	0	0
07	1983	24	34	24	32	10	10	42	27	18	13	6	4	11	1931	0	0	0	0	0	0	0	1	1	0	0	0
07	1984	37	22	18	16	17	42	29	7	19	13	10	16	11	1932	0	0	0	0	0	0	0	1	1	0	0	0
07	1985	30	7	37	35	12	43	17	16	18	10	4	7	11	1933	0	0	0	0	0	0	1	1	1	0	0	0
07	1986	44	13	20	28	20	33	26	9	12	17	5	15	11	1934	0	0	0	0	0	0	0	1	1	0	0	0
07	1987	32	46	15	13	10	50	25	17	11	6	2	12	11	1935	0	0	0	0	0	0	0	1	1	0	0	0
07	1996	0	0	0	0	15	13	0	0	0	1	0	2	11	1936	0	0	0	0	0	0	0	1	1	0	0	0
07	1997	0	0	2	0	0	0	0	0	0	0	0	0	11	1937	0	0	0	0	0	0	0	1	1	0	0	0
07	1998	0	47	1	0	0	0	0	7	0	0	0	0	11	1938	0	0	0	0	0	0	0	1	1	0	0	0
08	1949	0	0	0	0	0	0	0	0	1	0	0	0	11	1939	0	0	0	0	0	0	0	1	1	0	0	0
08	1952	0	0	0	0	0	0	0	0	0	0	1	0	11	1940	0	0	0	0	0	0	0	1	1	0	0	0
08	1953	0	0	0	0	0	0	0	0	0	0	0	1	11	1941	0	0	0	0	0	0	0	1	1	0	0	0
08	1954	0	0	0	0	0	1	0	0	0	0	0	0	11	1942	0	0	0	0	0	0	0	1	1	0	0	0
08	1955	0	0	0	0	0	0	0	0	0	1	0	0	11	1943	0	0	0	0	0	0	0	1	1	0	0	0
08	1956	0	0	0	0	0	0	0	0	0	1	0	0	11	1944	0	0	0	0	0	0	0	1	1	0	0	0
08	1957	0	0	0	0	0	1	0	1	0	1	0	0	11	1945	0	0	0	0	0	0	0	1	1	0	0	0
08	1959	0	0	0	0	0	0	0	0	0	0	1	0	11	1946	1	1	3	4	1	2	5	8	7	4	1	1
08	1960	0	0	0	0	1	0	0	0	0	0	0	0	11	1947	1	1	3	5	1	2	6	9	9	5	1	1
08	1973	0	0	0	0	0	14	0	0	0	0	0	7	11	1948	0	1	2	13	7	3	19	10	9	12	1	0
08	1996	0	0	0	11	5	0	0	0	0	0	0	0	11	1949	0	0	4	1	1	0	6	8	6	3	4	0
08	1997	0	0	0	30	0	0	0	0	0	1	0	0	11	1950	0	5	5	3	0	5	0	12	16	3	0	1
08	1998	0	9	32	0	0	0	0	1	3	0	0	0	11	1951	1	3	3	7	0	0	27	17	20	6	0	0
09	1949	0	0	0	0	1	1	0	0	0	1	0	0	11	1952	1	7	3	9	0	0	30	37	20	9	0	0
09	1950	0	0	0	1	1	0	0	0	0	0	0	0	11	1953	2	3	12	18	1	0	12	17	19	9	0	0
09	1951	0	0	0	0	0	0	0	0	2	1	0	0	11	1954	10	9	21	18	0	0	15	30	53	21	1	1
09	1952	0	0	0	1	0	0	0	0	1	0	0	0	11	1955	0	1	17	16	4	5	15	33	37	26	5	3
09	1953	0	0	0	0	3	0	0	0	0	1	1	0	11	1956	2	4	9	25	13	15	9	22	11	22	11	8
09	1954	0	0	0	0	0	0	0	0	0	0	1	0	11	1957	2	1	7	6	2	12	10	31	14	3	1	10
09	1955	0	0	0	0	0	1	0	0	0	0	0	0	11	1958	1	9	32	32	14	5	9	25	50	40	22	8
09	1956	0	0	1	0	1	0	0	0	0	1	1	0	11	1959	1	5	17	18	8	2	5	14	27	22	12	4
09	1957	0	0	0	1	0	0	0	0	0	0	0	0	11	1960	1	4	14	15	6	2	4	11	23	18	10	4
09	1958	0	0	0	1	0	0	0	0	1	0	1	0	11	1961	1	5	19	20	9	3	5	15	31	25	14	5
09	1960	0	0	0	1	0	0	0	0	0	0	0	0	11	1962	1	4	17	17	8	2	5	13	27	21	12	4
09	1969	0	0	0	0	3	0	0	0	0	0	8	0	11	1963	1	4	14	14	6	2	4	11	22	18	10	3
09	1970	0	0	1	1	4	0	0	0	0	0	0	0	11	1964	0	4	14	14	6	2	4	11	22	17	10	3
09	1994	0	0	0	6	8	4	0	0	0	2	1	0	11	1965	1	5	16	31	13	1	9	21	22	22	18	1
09	1995	0	7	14	56	21	0	0	1	3	0	0	0	11	1966	1	7	24	25	11	3	5	15	30	24	13	5
09	1997	0	20	35	0	0	0	0	7	5	0	0	0	11	1967	1	5	19	19	9	2	5	14	28	23	12	5
10	1949	0	0	0	1	4	0	1	1	0	0	3	0	11	1968	0	2	11	5	5	1	1	12	25	8	6	4
10	1950	0	3	2	1	2	5	0	0	0	0	0	0	11	1969	1	3	15	18	5	1	2	24	38	17	11	5
10	1951	0	2	3	0	0	0	0	1	0	1	0	0	11	1970	1	2	27	6	1	1	6	11	30	12	2	4
10	1952	0	0	5	4	0	0	0	0	0	0	0	0	11	1971	2	4	11	21	10	6	6	6	10	13	9	8
10	1953	12	13	11	2	0	0	0	3	1	0	0	0	11	1972	1	1	22	40	17	1	4	5	37	56	21	7
10	1954	9	4																								

Table 3. Continued.

Area	Year	Males					Females						
		J-A	M	J	J	A S-D	J-A	M	J	J	A S-D		
11	1974	0	6	12	25	10	7	2	11	21	19	9	3
11	1975	0	4	20	17	12	5	0	8	28	11	5	2
11	1976	6	10	15	27	17	2	5	15	19	27	19	9
11	1977	1	16	17	5	3	12	4	10	9	2	3	0
11	1978	2	8	3	3	1	0	8	24	7	0	0	0
11	1979	0	2	10	3	0	1	10	22	16	4	0	1
11	1980	1	4	9	7	7	11	3	23	31	1	2	2
11	1981	0	2	6	4	1	14	10	11	14	12	0	9
11	1982	0	2	1	1	0	1	15	15	6	10	0	1
11	1983	1	2	1	0	0	0	13	3	10	2	2	1
11	1984	1	22	16	1	4	2	14	34	27	0	0	0
11	1985	0	17	5	0	1	5	16	20	8	0	2	9
11	1986	1	7	6	1	2	2	13	25	7	1	4	0
11	1987	0	3	3	5	3	2	15	18	10	1	2	3
11	1996	0	0	0	0	19	0	0	0	0	0	11	0

Area	Year	Males					Females						
		J-A	M	J	J	A S-D	J-A	M	J	J	A S-D		
12	1949	0	0	0	2	0	0	0	0	1	0	0	0
12	1950	0	0	1	0	0	0	0	0	0	1	0	0
12	1951	0	0	0	0	0	0	0	1	0	0	1	0
12	1952	0	0	0	0	0	0	0	1	0	0	0	0
12	1953	0	0	0	0	0	0	0	0	0	0	1	0
12	1954	0	0	0	0	0	1	0	0	0	0	0	2
12	1955	0	0	0	2	1	0	0	0	0	2	0	0
12	1956	0	0	0	0	0	1	0	0	1	1	0	0
12	1957	0	0	0	0	0	0	0	0	1	1	0	0
12	1958	0	0	0	0	0	0	0	0	0	0	0	1
12	1960	0	0	0	0	0	0	0	1	0	0	1	0
12	1961	0	0	0	0	0	0	0	0	1	0	0	0
12	1962	0	0	0	0	0	0	0	0	1	0	0	0
12	1973	0	0	0	11	9	10	0	0	4	14	14	6
12	1974	0	0	1	22	3	0	0	0	1	18	16	0
12	1975	0	0	0	8	4	0	0	0	0	11	7	5

mean square of the values obtained from the abundance estimates for that sub-area, and the depletion to be the mean value over the corresponding years. The values of  $\tau$  applicable to each sub-area are calculated separately for each replicate once the conditioning has been accomplished.

An estimate of the CV,  $X_i$  is also generated for each sightings estimate,  $\hat{P}_i$ :

$$X_i = \sqrt{(\sigma^2 \text{CHISQ} / n)} \quad (E.5)$$

where  $\sigma^2 = Ln(1 + \alpha^2 + \beta^2 P^* / \hat{P})$ , and CHISQ is a random number from a Chi-square distribution with  $n = 10$  degrees of freedom. The value 10 is chosen to roughly indicate the number of trackline segments in a sightings survey in a *Small Area*.

Table 1 lists the pattern for future surveys. The trials assume that it takes two years for the results of a sighting survey to become available to be used by the management procedure, i.e. a survey conducted in 2000 would first be used for setting the catch limit in 2002.

Trial NPM 115 considers the case where  $g(0) = 0.5$ . To implement this, the observed  $P$  is taken to be half of its actual value (Equation 8).

In trials in which *Small Areas* which are comprised of sub-areas which are surveyed in different years, the abundance estimate is taken to be a summation of the estimates of abundance in the sub-areas over three years and taken to refer to the mean year (IWC, 1999).

**F. Parameter values**

Following the decision by the sub-committee on North Pacific minke whales (IWC, 1992a, p.160), the values of the biological and technological parameters are taken to be equal to those for the North Atlantic minke *Implementation Simulation Trials* (IWC, 1992b, p.249), i.e.:

$$r_{50} = 4; \quad \sigma_r = 1.2 \quad \text{where } r \text{ is recruitment}$$

$$m_{50} = 7; \quad \sigma_m = 1.2 \quad \text{where } m \text{ is maturity}$$

$$MSYL = 0.6$$

The maturity ogive is modified so that the first age at which a female can be mature is three, i.e.  $\beta_0 = \beta_1 = \beta_2 = 0$ .

Natural mortality is age-dependent, and identical to that for the North Atlantic minke trials:

$$M_a = \begin{cases} 0.085 & \text{if } a \leq 4 \\ 0.0775 + 0.001875a & \text{if } 4 < a < 20 \\ 0.115 & \text{if } a \geq 20 \end{cases}$$

The MSYR scenarios are specified in Section G. The MSYR used does not apply to the recruited populations defined for this model, but rather applies to the rates that would apply if the age at recruitment were equal to the age at maturity.

The process used to select the initial (pre-exploitation) sizes of each of the stocks and the values for the parameters  $\gamma_1 - \gamma_{16}$  used to define the catch mixing matrices is known as the conditioning process. This process involves first generating the target data, as detailed in steps (a) to (i) below, that will be 'fitted' to the above model. Values for the initial population sizes and the  $\gamma$ s are then selected by minimising the negative of a log-likelihood which contains terms related to the target data generated in steps (a)-(i). The number of animals in sub-area  $k$  at the start of year  $t$  is calculated starting with guessed values of the initial population size and projecting the operating model forward to 2000 in order to obtain values of abundance etc. for comparison with the generated data. (When performing the projections, mixing is stochastic, and the catches from each sub-area are set to their historic values - Tables 3 and 5.) A different set of data is

Table 4

Q matrix: the fraction of the catch in sub-area  $k$  which is taken by sex and month. Dashes indicate sub-areas/months for which catch limits are defined to be zero

	Males							Females						
	Jan.-Apr	May	Jun.	Jul.	Aug.	Sep.-Dec.	Sample size	Jan.-Apr.	May	Jun.	Jul.	Aug.	Sep.-Dec.	Sample size
1-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	0.127	0.118	0.097	0.108	0.083	0.127	1,760	0.121	0.088	0.043	0.042	0.019	0.028	909
8	0.0	0.073	0.258	0.331	0.048	0.129	104	0.0	0.016	0.032	0.032	0.016	0.065	20
9	0.0	0.087	0.221	0.294	0.182	0.026	187	0.0	0.030	0.039	0.048	0.074	0.074	44
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	0.113	0.098	0.041	0.031	0.062	211	-	0.319	0.223	0.051	0.020	0.043	400
12	-	0.0	0.010	0.236	0.089	0.063	76	-	0.016	0.052	0.251	0.209	0.073	115



Table 5a

Table of incidental catches by Korea by month, provided by Kim. (The catches for Jan-Apr and for Sept-Dec will be combined for input to the trials).

Month	Monthly catch			
	1996	1997	1998 (M:F)	1999 (M:F)
Jan.	7	18	1:5	0:2
Feb.	2	5	0:4	1:4
Mar.	2	1	0:5	1:2
Apr.	8	11	1:5	2:3
May	11	11	2:2	0:2
Jun.	7	7	3:5	0:2
Jul.	8	3	1:0	1:1
Aug	6	3	0:1	3:6
Sep.	7	6	0:2	2:3
Oct.	26	6	0:2	3:7
Nov.	11	4	1:2	1:1
Dec.	34	3	0:3	3:6
Total	129	78	9:36	17:39

Table 5b

Table of incidental catches by Japan Option (Ji).

Year/Sub-area	1	2	6	7	10	11	Total
1955-1978 <sup>a</sup>	0	0.1	2.2	1.1	0.2	0.2	3.8
1979	0	0	0	0	0	0	0
1980	0	0	1	2	0	0	3
1981	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0
1983 <sup>b</sup>	0	0	5	1.7	0.7	0.7	8
1984	0	0	0	2	1	1	4
1985	0	0	2	0	0	0	2
1986	0	1	9	3	0	0	13
1987	0	0	3	1	0	0	4
1988 <sup>c</sup>	0	1.6	4.8	1.6	0	0	8
1989 <sup>d</sup>	0	2.7	4	1.3	0	0	8
1990	0	1	4	15	0	0	20
1991	0	2	2	1	0	0	5
1992	0	1	7	0	0	0	8
1993	0	4	9	1	0	0	14
1994	0	9	6	1	0	0	16
1995	0	8	12	0	0	0	20
1996 <sup>b</sup>	1	11	13	1.3	0.3	0.3	27
1997	0	18	8	1	0	0	27
1998	0	9	15	0	0	0	24
1999	1	4	13	1	0	0	19
Total (1979-1999)	2	72.3	117.8	33.9	2	2	230

<sup>a</sup> Catches are assumed to begin in 1955 when fishery nets were substantially improved. Catches are taken to equal the mean values from 1979 to 1987 (years of commercial whaling). <sup>b</sup> Catches off Hokkaido are allocated evenly to sub-areas 7, 10 and 11. <sup>c</sup> Catches in 1988 are allocated to sub-areas using information from 1987 and 1989. <sup>d</sup> Two individuals in 1989, whose catch position is unknown, were allocated in proportion to the composition of the six of known position.

Table 5c

Table of reference catches  $\tilde{C}^k$  used in setting future incidental catches by Japan, Option(Ji). The division of numbers by sub-area are taken from the incidental catch in years 1996-98, as given in Table 5b.

Year/Sub-area	1	2	6	7	10	11	Total
Reference catch $\tilde{C}^k$	0.3	12.2	11.6	0.7	0.1	0.1	25

Table 5d

Table of historic incidental catches  $\tilde{C}^k$  and the reference catches to be used in setting future incidental catches by Japan, Option(Jii). The division of numbers by sub-area are taken from the reported incidental catch in years 1979-99, as given in Table 5b.

Year/Sub-area	1	2	6	7	10	11	Total
1900 – present	0.7	23.6	38.4	11.1	0.6	0.6	75
Reference catch $\tilde{C}^k$	0.7	23.6	38.4	11.1	0.6	0.6	75

generated (and hence a different set of parameters selected) for each of the 100 replicates within a trial. (Note that not all of the ts are estimated in all trials - for example,  $\gamma_8$  is used only in mixing matrix H and hence is estimated only for trial NPM114.) The results showing the fits to the conditioning data will be forwarded to the Steering Group. If the fits are not sufficiently good, extra free parameters should be added to the mixing matrices to improve them, and to ensure that the initial conditions modelled are such that all of the historic catches are taken.

The information used in the conditioning process is as follows.

- (a) The target values for the historical abundance by sub-area (excepting for the minimum values, which are taken to be their actual values – see below) are generated using the formula:

$$P_t^k = O_t^k \exp[\mu_t^k - (\sigma_t^k)^2 / 2] \quad \mu_t^k \sim N[0; (\sigma_t^k)^2] \quad (F.1)$$

$P_t^k$  is the abundance for sub-area  $k$  in year  $t$ ;

$O_t^k$  is the actual survey estimate for sub-area  $k$  in year  $t$  (see Table 6(a)); and

$\sigma_t^k$  is the CV of  $O_t^k$ .

The levels of abundance listed in Table 6(a) for sub-areas 6 and 10, and one of those for sub-area 7, are assumed to be minima – in the conditioning process the terms for those sub-areas/years are not added to the log-likelihood but the ‘true’ abundance in those sub-areas must exceed the specified values.

- (b) Estimates of the proportion of recruited J stock whales in sub-areas 7, 11 and 12 are generated from the appropriately truncated normal distributions that correspond to the observed data (see Table 6(b)) and are based on isozyme, mtDNA, conception date and flipper colour information. Although data do exist for sub-areas other than those listed in Table 6(b), the sample sizes are so low that their information content is effectively nil.

The data for sub-area 12 is limited and so a trial (110) has been added to simulate a higher proportion of J stock animals in this sub-area. In trial 110 the proportion estimates for sub-area 12 are replaced by the highest value for the 1973-75 average proportion of recruited J stock whales in sub-area 12 in June-August which is  $\leq 20\%$  and consistent with the other data used in conditioning, and which does not lead to more than 50% (median value over the 100 simulations) of mature J stock females being in sub-area 12 in June-August 1973-75.

- (c) The trials shall be conditioned by fixing the depletion level of the mature female component of the J stock to a certain percentage of its pre-exploitation size at the start of 2000. Three values for this depletion are used in the trials: 15%, 30% and 50%

- (d) The fraction of the O stock (1+ animals) in sub-area 12 is fixed by specifying the percentage which the O stock comprises of the combined O-W abundance in that sub-area in August-September 1995. The base-case choice for this percentage is 30%. Some sensitivity tests (NPM112 and 113) consider alternative choices of 10% and 100%. The operating model parameter values are selected to satisfy this requirement exactly. The base-case choice is derived from the estimates of abundance from sub-areas 7, 8, 9 and 11 in August to September on the assumption that the ratio of O to W animals in sub-area 12 in August-September is roughly the same as that the ratio of the abundance in sub-areas 7 and 11 to that in sub-areas 8 and 9. The rationale for using these data is that at the time of the surveys the bulk of the animals in these sub-areas are males whilst

Table 6a  
The abundance data used to condition the trials.

Sub-area	Timing	Estimate	CV	Estimate also used by CLA?	Source
6	Aug.-Sep. 1992	893 <sup>1</sup>	0.67	No	Miyashita and Shimada, (1994)
7	Aug.-Sep. 1990	1,741 <sup>1</sup>	0.655	No	Buckland <i>et al.</i> (1992); IWC (1997a) p.211
7	Aug.-Sep. 1991	2,202	0.383	Yes	IWC (1997a) p.211
8	Aug.-Sep. 1990	1,057	0.706	Yes	Buckland <i>et al.</i> (1992); IWC (1997a) p.211
9	Aug.-Sep. 1990	8,264	0.396	Yes	Buckland <i>et al.</i> (1992); IWC (1997a) p.211
9	Jun.-Jul. 1994	4,673	0.441	No	IWC (1997a) p.211
9	Jun.-Jul. 1995	2,145 <sup>2</sup>	0.315	No	IWC (1997a) p.211
10	Aug.-Sep. 1992	707 <sup>1</sup>	0.57	No	Miyashita and Shimada (1994)
11	Aug.-Sep. 1990	2,120	0.449	Yes	Buckland <i>et al.</i> , (1992); IWC (1997a) p.211
12	Aug.-Sep. 1990	15,641	0.363	Yes	IWC (1997a) p.211
12	Aug.-Sep. 1992	11,948	0.46	Yes	Miyashita and Shimada (1994); 91.2% areal coverage (IWC, 1997a, p.203)

<sup>1</sup> Minimum estimate. <sup>2</sup> Estimate based on some extrapolation to unsurveyed areas.

Table 6b  
Estimates of the proportion of recruited 'J' whales used to condition the trials.  
(See text re combining estimates.)

Sub-area (months)	Years	Estimate	SE	Data used	Source
7 (Apr.-May)	1980-87	0.0	0.0	Isozyme	IWC (1997a) p.214
7 (Apr.)	1983-87	0.058	0.058	Micro-satellite	IWC (2000) p.115
7 (May)	1983-87	0.089	0.075	Micro-satellite	IWC (2000) p.115
7 (Aug.)	1983-87	0.0	0.0	Micro-satellite	IWC (2000) p.115
7 (Sep.)	1983-87	0.040	0.077	Micro-satellite	IWC (2000) p.115
11 (Apr.)	1980-87	0.512	0.045	Isozyme/mtDNA	IWC (1997a) p.214-5
11 (May)	1980-87	0.049	0.023	Isozyme	IWC (1997a) p.214
11 (Jun.-Jul.)	1980-87	0.076	0.016	Isozyme	IWC (1997a) p.214
11 (Aug.) Males	1980-87	0.315	0.116	Isozyme	Pastene <i>et al.</i> (1997a)
11 (Aug.) Females	1980-87	0.044	0.069	Isozyme	Pastene <i>et al.</i> (1997a)
12 (Jun.)	1973-75	0.089	0.051	Conception/flipper colour	IWC (1997a) p.215
12 (Jul.)	1973-75	0.013 <sup>1</sup>	0.008	Conception/flipper colour	IWC (1997a) p.215
12 (Aug.)	1973-75	0.015 <sup>1</sup>	0.009	Conception/flipper colour	IWC (1997a) p.215

<sup>1</sup> Based on the centre of the confidence interval.

females predominate in catches in sub-area 12. The base-case choice should be reasonably conservative in terms of possibly over-estimating the fraction of O animals because at least some of the animals in sub-area 9 should migrate to the north of this sub-area (which has never been surveyed) instead of to sub-area 12.

- (e), (f) and (g) Options not used in these trials, but for consistency with previous trials the options are not re-labelled.
- (h) For trial NPM115 (case for which  $g(0) = 0.5$ ) the values of the operating model abundances are halved for comparison with the conditioning targets.
- (i) The fraction of the O stock (1+ animals) in sub-area 9 is fixed by specifying the percentage which the O stock comprises of the combined O-W abundance in that sub-area in August-September 1995. Three values for this fraction are used in the trials: 0% (no O stock in sub-area 9), 80% and 100% (no W stock). The value of 80% is based on the observation that the only area that has shown some genetic difference from sub-areas 7 and 8 over three years of sampling is the west sector of sub-area 9 and that only in 1995.
- (j) Dispersal rate. The best, higher and lower estimates of the mean dispersal rate ( $D$ ) between the O and W stocks are 0.2%, 1.0% and 0.05%. The values were provided to the Steering Group intersessionally by B. Taylor. To ensure equilibrium in the pristine population:

$$K^{1+,O} D^{O,W} = K^{1+,W} D^{W,O} \quad (F.2)$$

where

$$K^{1+,s} = \sum_{a=1}^x R_{-\infty,a}^{f,s} + U_{-\infty,a}^{f,s} \quad (F.3)$$

$D^{O,W}$  and  $D^{W,O}$  are evaluated by setting the mean dispersal rate  $D$  equal to the pertinent value above, where the mean dispersal rate is defined by the formula:

$$D = (K^{1+,W} D^{W,O} + K^{1+,O} D^{O,W}) / (K^{1+,W} + K^{1+,O}) \quad (F.4)$$

The abundance in sub-area 13 is taken to be 0 for all of the trials because abundance estimates are unavailable for this sub-area, and because allowing for animals in sub-area 13 may lead to over-optimistic results if catches are taken from sub-areas 8 and 9 as well as from coastal Japanese waters and the Okhotsk Sea.

### G. Trials

The set of trials is given in Table 7. The trials are variants of the base line trials NPM101-104. The option used to define the level of Japanese incidental catch is specified in Section H (Table 8).

### H. Management options

Two issues relate to specifying the management options: (a) the designation of *Areas* (*Small*, *Medium* and *Large*); and (b) the management procedure variants to consider. The

Table 7  
The Implementation Simulation Trials for North Pacific minke whales.

Trial No. (NPM-)	Old Trial Equivalent	No. of Stocks	MSYR (Mixing matrices)			J stock status in 2000	% O in sub-area 12	Description
			Stock J	Stock O	Stock W			
<b>Base line trials</b>								
101	NPM1	3	1 (A/B)	1 (F)	1 (K)	30% <i>K</i>	30	Base-case
102	NPM3	2	1 (A/B)	1 (G)	-	30% <i>K</i>	-	2 stock variant
103	NPM5	3	4 (A/B)	4 (F)	4 (K)	30% <i>K</i>	30	NPM-101 + MSYR=4%
104	NPM7	2	4 (A/B)	4 (G)	-	30% <i>K</i>	-	NPM-102 + MSYR=4%
<b>Other trials</b>								
105		3	1 (A/B)	1 (G)	1 (K)	30% <i>K</i>	30	NPM-101 + some O in sub-area 9 (80%)
106		3	1 (A/B)	1 (F)	1 (K)	30% <i>K</i>	30	NPM-101 + lower dispersal rate
107		3	1 (A/B)	1 (F)	1 (K)	30% <i>K</i>	30	NPM-101 + higher dispersal rate
108		3	1 (A/B)	1 (F)	1 (K)	15% <i>K</i>	30	NPM-101 + lower J stock depletion
109		3	1 (A/B)	1 (F)	1 (K)	50% <i>K</i>	30	NPM-101 + higher J stock depletion
110		3	1 (A/B)	1 (F)	1 (K)	30% <i>K</i>	30	NPM-101 + 20% J in sub-area 12 (or max. achievable)
111		3	1 (A/B)	1 (F)	1 (K)	15% <i>K</i>	30	NPM-101 + lower J stock depletion + 20% J in sub-area 12 (or max. achievable)
112	NPM11	3	1 (A/B)	1 (F)	1 (K)	30% <i>K</i>	100	NPM-101 + no W stock in sub-area 12
113	NPM9	3	1 (A/B)	1 (F)	1 (K)	30% <i>K</i>	10	NPM-101 + 10% O stock in sub-area 12
114		3	1 (A/B)	1 (F/H)	1 (K)	30% <i>K</i>	30	NPM-101 + some O animals in sub-area 10
115	NPM41	3	1 (A/B)	1 (F)	1 (K)	30% <i>K</i>	30	NPM-101 + g(0) = 0.5
116	NPM49	3	1 (A/B)	1 (F)	1 (K)	30% <i>K</i>	30	NPM-101 + misreport Japan incidental catch

selections listed below may be reconsidered once the results of the trials specified in this Appendix have been carried out.

*Designation of areas*

**SMALL AND RESIDUAL AREAS**

Sub-areas 1, 2, 3, 4, 5, 6, 10 and 13 are *Residual Areas*. There are three alternative *Small Area* definitions.

- (i) Sub-areas 7+8, 9, 11 and 12.
- (ii) Sub-areas 7+8+11+12 and 9.
- (iii) Sub-areas 7+8+9+11+12.

Note: for the trials based on *Small Areas* that are combinations of sub-area 11 and other sub-areas, the entire catch is assumed to be taken from sub-area 11 as this should reflect the highest risk. For trials based on *Small Areas* that are combinations of sub-areas including sub-area 7 but not sub-area 11, the entire catch is assumed to be taken from sub-area 7.

**MEDIUM AREAS**

*Medium Areas* are supposed to represent the known or suspected range of distinct biological stocks. Only one *Medium Area* (sub-areas 2, 3, 4, 7, 8, 9, 10, 11 and 12) is defined in the North Pacific because future surveys will not cover most of the sub-areas.

**LARGE AREA**

There is no *Large Area*.

**COMBINATION AREAS**

The *Combination area* comprises all sub-areas 7, 8, 9, 11, 12 (i.e. a ‘West Pacific - East of Japan’ combination area). This means that for *Small Areas* option (i), catches will be from taken from sub-areas 7, 9, 11 and 12 and for option (ii) from sub-areas 9 and 11.

*Management procedure variants*

The following three management variants are considered for each of trials listed in Section G for each of the *Small Area* definitions, following selection of conditioning choices and the Japanese incidental catch option as detailed in Section G.

- (a) Catch limit calculations by *Small Area*, no *capping* and no *cascading*.
- (b) Catch limit calculations by *Small Area* with *Medium Area capping*, no *cascading* (initially base-case trials only because results with *capping* are unlikely to differ much from those with no *capping* and no *cascading*).
- (c) *Cascading* over the *Combination Area*.

The selection of the initial combinations of trials and management variants is given in Table 8. When these trials have been conducted, the intersessional steering group will use the results to select a small number of management variants to run with trials NPM 103-116.

Table 8  
The initial set of 36 trials to be conducted.

Combination no.	Trial	Japanese incidental catch option	<i>Small Area</i> definition	Management procedure variant
1	NPM101	Ji	(i)	Small areas
2	NPM101	Ji	(ii)	Small areas
3	NPM101	Ji	(iii)	Small areas
4	NPM101	Ji	(i)	Cap
5	NPM101	Ji	(i)	Cascade
6	NPM101	Ji	(ii)	Cascade
7-12	NPM101	Jii	As for combinations 1-6	
13-18	NPM102	Ji	As for combinations 1-6	
19-24	NPM102	Jii	As for combinations 1-6	
24-30	NPM103	Jii	As for combinations 1-6	
31-36	NPM104	Jii	As for combinations 1-6	

**I. Output statistics**

Population-size and continuing catch statistics are produced for each stock, and catch-related statistics for each sub-area. Catch related statistics are produced both for the total catches (commercial and incidental) and for the commercial catches alone.

- (1) Total catch (TC) distribution: (a) median; (b) 5th value; (c) 95th value.
- (2) Initial mature female population size ( $P_{2000}$ ) distribution: (a) median; (b) 5th value; (c) 95th value.

- (3) Final mature female population size ( $P_f$ ) distribution: (a) median; (b) 5th value; (c) 95th value.
- (4) Lowest mature female population over 100 years ( $P_{low}$ ) distribution: (a) median; (b) 5th value; (c) 95th value.
- (5) Average catch over the last 10 years of the 100 year management period: (a) median; (b) 5th value; (c) 95th value.
- (6) Continuing catch ( $C_c$ ): (a) median; (b) 5th value; (c) 95th value.
- (7) Catch by sub-area, stock and catch-type (incidental or commercial): (a) median; (b) 5th value; (c) 95th value.
- (8) The median percentage of mature J stock females being in sub-area 12 in June-August 1973-75.
- (9) The median annual rate of decline in the number of whales assumed recruited to the Korean fishery over the period 1973-1986.
- (10) The median 1+ population size for animals in sub-areas 6 and 10 in August-September in 1992 and in 2000 (corresponding to Sea of Japan surveys).
- (11) The mean proportion of J whales in the total (scientific, commercial and incidental) catch taken by Japan from 1993-98 is output in trials, for comparison with results obtained from market samples.

The continuing catch statistic is defined as follows.

The 'sustainable yield' function of population size is defined as:

$$SY(P) = \begin{cases} MSY & \text{for } P > MSYL \\ \text{long-term equilibrium RY} & \text{for } P < MSYL \end{cases}$$

The average catch over the final ten years of the simulation,  $\bar{C}$ , and the average 'sustainable yield' over this period,  $\bar{SY}$ , are calculated. The continuing catch statistic is defined as the minimum of  $\bar{C}$  and  $\bar{SY}$ .

The continuing catch statistic is evaluated under the assumption that the dispersal rate is zero, even in trials where there is actually dispersal between stocks.

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## Appendix 11

**TERMS OF REFERENCE FOR AN INTERSESSIONAL STEERING GROUP FOR NORTH PACIFIC MINKE WHALE IMPLEMENTATION SIMULATION TRIALS**

- (1) Consider and resolve possible inconsistencies that might arise when trials are conditioned and run (this might require adjustments to the mixing matrices as currently defined).
- (2) Provide guidance for the calculation of the dispersal rates between the 'O' and 'W' stocks.
- (3) Refine the table that specifies where and when future surveys will occur and refine the specifications for the generation of surveys after 1995.
- (4) In the light of the results of the 36 initial trials defined in Table 2, decide for which combinations of *Small Area* definitions and RMP variants to run the full set of trials.