# Report of the AWMP Workshop Focusing on the PCFG Gray Whale *Implementation Review*

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## 1. INTRODUCTORY ITEMS

The Workshop was held at the Southwest Fisheries Science Center, La Jolla, California, USA, from 19-23 March 2012. The list of participants is given as Annex A.

### 1.1 Convenor's opening remarks

Donovan welcomed the participants to the meeting and thanked Weller and the Southwest Fisheries Science Center for hosting the meeting and making the local arrangements. He recalled that at its last Annual Meeting, the Scientific Committee had agreed that it would hold a Workshop on matters related to the AWMP with:

(1) a focus on the completion of the *Implementation Review* of eastern gray whales at the 2012 Annual Meeting, with emphasis on the Pacific Coast Feeding Group (PCFG); and
(2) an initial consideration of operating models for West Greenland fin whales (although progress on all species will be considered).

Given the availability of personnel and the travel distances involved, it had been agreed that the primary focus of the Workshop will be on Item (1). Greenlandic participants will join the Workshop via a telephone link on 22 March to discuss progress with Item (2).

### 1.2 Election of Chair

Donovan was elected Chair.

### 1.3 Appointment of rapporteurs

Allison, Punt and Butterworth acted as rapporteurs, with assistance from the Chair.

### 1.4 Adoption of Agenda

The adopted Agenda is shown in Annex B.

### 1.5 Documents available

The documents considered by the Workshop were SC/M12/AWMP1-4 (see Annex C) and extracts from the reports of past meetings.

## 2. *IMPLEMENTATION REVIEW* OF EASTERN GRAY WHALES WITH EMPHASIS ON THE PCFG

At the 2010 Annual Meeting (IWC, 2011), it had been agreed that new information on stock structure and hunting warranted the development of trials as part of a new *Implementation Review* to evaluate the performance of *SLA*s for hunting in the Pacific northwest, with a primary focus on the PCFG (Pacific Coast Feeding Group). It also agreed that the 2010 *Implementation Review* had shown that the eastern gray whale population as a whole was in a healthy state and that the adopted *Gray Whale SLA* (IWC, 2005) remained appropriate for providing management advice, but that over the next few years, further work should be undertaken to investigate the possibility of structure on the northern feeding grounds, especially in the region of the Chukotkan hunts.

*Presented to the meeting as SC/64/Rep3.

### 2.1 Summary of work at the 2011 Annual Meeting

The basic operating model and structure of the trials were developed at the March 2011 Workshop (IWC, 2012a) and the basic structure of the *SLA*s to be considered was provided by the Makah Tribal Council at that Workshop. The trials consider three geographic regions. The north area is north of 52°N (roughly northern Vancouver Island), the PCFG area is between 41°N and 52°N, and the 'south' area is south of 41°N. The trials consider two stocks ('PCFG' and 'north'). Some PCFG whales will be found outside of the PCFG area at various times during the year. However, this is not problematic since the historical catches north of 52°N occurred well north of 52°N and future catches will either occur in the Bering Sea or in the Makah U&A[1].

A review of published and 'gray' literature on PCFG gray whales (Scordino *et al.*, 2011) provided information that strongly suggested that some level of immigration is occurring to the PCFG. As a result, it was agreed that some degree of immigration from the ENP must be considered in the trials and there should be recognition of potential negative bias to population estimates of the PCFG. Results presented at the 2011 Annual Meeting showed that the trials specified during the 2011 March Workshop led to poor residual patterns for the fits to the revised abundance estimates for the PCFG. To address this issue the Scientific Committee identified the following four 'broad' base-case models which captured hypotheses for the trend in the abundance data for PCFG area.

(1) The 1998 abundance estimate is biased due to the assumption that capture probability=1 in the first year and 20 whales immigrated into the PCFG stock from the northern stock in each of 1999 and 2000 (hypothesis P).
(2) There has been no pulse immigration into the PCFG stock; rather the abundance estimates are subject to time-varying bias (hypothesis B).
(3) There has been no pulse immigration into the PCFG stock and the abundance estimates are unbiased (hypothesis E).
(4) Ten whales immigrated into the PCFG stock from the northern stock in each of 1999 and 2000 and the abundance estimates are subject to time-varying bias (but not to the extent as for hypothesis B) (hypothesis I).

The Committee revised the list of *Evaluation* and *Robustness Trials* during the 2011 Annual Meeting to cover the plausible range of the factors which might impact eventual performance and could help the Committee select which trials to focus on. The factors considered were:

(a) $MSYR_{1+}$;
(b) 'need' in the Russian hunt;
(c) the probability of harvesting a PCFG whale during an April hunt in the PCFG area;
(d) the struck and lost rate in the PCFG hunt;

[1]'Usual and accustomed fishing grounds'. Although these include the Strait of Juan de Fuca the hunt will be prohibited there due to the large portion of PCFG whales photographed in that area. The hunt will be limited to 1 December-30 May to minimise the likelihood of catching PCFG whales.

(e) low-level (non-pulse) immigration into the PCFG stock from the northern stock;
(f) episodic events; and
(g) the sex-ratio of future catches in the PCFG area. In addition, the Committee selected a number of diagnostic plots and tables to help it understand the behaviour of the models and trials.

### 2.2 Validation of the control program and updates to tasks

All the changes to the trial structure identified at the 2011 Annual Meeting (IWC, 2012b, p.136-37) were implemented by Punt during the intersessional period. Brandão validated both the code implementing the control program and the program producing the summary statistics. Her comments led to some changes to the control program and to the trial documentation. The Workshop expressed its appreciation to Punt and Brandão for conducting this work.

### 2.3 Final selection of *Strike Limit Algorithm* for PCFG for use in trials

The management plan (*SLA*) proposed by the Makah Tribe is given in Annex D. Some alternative *SLA*s were also proposed for analysis as given in Table 1. These variants explore:

(1) how the allowable bycatch level[2] (ABL) of PCFG whales is calculated (three options);
(2) the time of year in which the hunt is modelled to occur and hence whether struck and lost animals are counted against the ABL (two options); and
(3) the effectiveness of the *SLA* if only PCFG whales are available for harvest.

Variants 1-3 use the ABL formula presented in the proposed plan, variants 4-9 have fixed bycatch limits, and variants 10 and 11 explore the impact of not having a limit on bycatch of PCFG whales (i.e. the hunt is only stopped if the total *Strike Limit* is reached or the number of struck-and-lost animals reaches its limit). Unless otherwise specified in Table 1, these variants follow the management plan proposed by the Makah Tribe as the base case.

Table 1

The Makah Tribe's proposed hunt and suggested Variants for evaluation noting which management measure is altered as compared to the Makah Tribe's proposed management plan.

| Variant number | Bycatch limit | Modelled time period of hunt | Availability of PCFG |
|---|---|---|---|
| Makah proposal | ABL formula | December to April | Trial specified |
| 2 | ABL formula | May only | Trial specified |
| 3 | ABL formula | May only | PCFG=100% |
| 4 | 1 | December to April | Trial specified |
| 5 | 1 | May only | Trial specified |
| 6 | 1 | May only | PCFG=100% |
| 7 | 2 | December to April | Trial specified |
| 8 | 2 | May only | Trial specified |
| 9 | 2 | May only | PCFG=100% |
| 10 | No limit | December to May | Trial specified |
| 11 | No limit | May only | PCFG=100% |

[2]The Makah Tribe has proposed a hunt management plan with time and area restrictions to target migrating ENP whales, yet there is still a chance that PCFG whales are incidentally harpooned as bycatch to the targeted ENP gray whale hunt.

### 2.4 Final specifications of trials

*2.4.1 Summary of progress with intersessional tasks*

The set of trials established at the 2011 meeting of the Scientific Committee was revised following discussions within the Steering Committee (Donovan, Allison, Brandon, Butterworth, Givens, Punt, Scordino and Weller). Issues considered when making these refinements included: (a) whether the trial is likely to be informative; (b) whether conditioning seemed likely to be possible; and (c) any missing factors. In summary, the Steering Committee had agreed to the following changes:

(a) trials based on hypotheses E and I, except those which vary the number of immigrating animals were eliminated (these trials are intermediate between those based on hypotheses P and B, and their elimination substantially reduced the workload without the loss of important information);
(b) trials based on $MSYR^{1+}$=6% were eliminated (these were at the extreme of the plausible range and had proved impossible to condition);
(c) trials in which the proportion of females for future catches was 0.59 were eliminated (these trials differ only trivially from the base case trials and thus would provide no valuable additional information); and
(d) several *Robustness Trials* were added to assess the sensitivity of the results to different levels of historical and future incidental catches.

Punt reported that he had conditioned all of the 48 remaining trials that required conditioning and had provided diagnostic plots for each to the Steering Group. Updated estimates of abundance for the PCFG area to include data for 2009 and 2010 had been provided by Jeff Laake (see Item 2.4.2 below) and incorporated into the trials together with the 2010 catches. The Workshop thanked Punt for completing this intersessional work, the results of which formed an important component of the discussions below.

*2.4.2 Discussion of outstanding issues including abundance estimates*

**2.4.2.1 ABUNDANCE ESTIMATES**

SC/M12/AWMP2 updated the analysis presented in Calambokidis *et al.* (2010) with the addition of data from 2009 and 2010. Estimates of abundance were presented for four nested regions: MUA-SVI (Makah U&A and southern Vancouver Island ~48-9°N), OR-SVI (Oregon to SVI ~42-9°N), OR-NBC (Oregon to the northern end of Vancouver Island ~42-52°N) and NCA-NBC (~41-52°N). Estimates were constructed using two closed models (Lincoln-Petersen (LP), and limited LP), and two open Jolly-Seber models (JS1, a modified estimator developed at the March 2011 Workshop, and JS2, a standard estimator applied to the data after removing the whales only seen in one year).

The Workshop thanked Laake and Calambokidis for providing these updated abundance estimates, as recommended by the Committee last year. Preliminary versions of the updated abundance estimates were provided to Punt in February 2012, who used them in the conditioning analyses presented to the Workshop (see Item 2.4.1).

The Workshop evaluated the four methods for estimating abundance in SC/M12/AWMP2. It agreed that 'open' population estimators provide the best estimates for the PCFG area. The JS1 and JS2 methods differ in terms of how transient whales (whales present in only a single year - previously referred to as 'stragglers') are handled. The simulations conducted in SC/M12/AWMP2 showed (as might be expected) that the JS2 method would lead to somewhat negatively biased estimates of abundance for the

final years of the time-series because all newly recruited whales in the final year (2010) are removed, as well as any new whales seen in 2009, but not in 2010. The magnitude of the bias depends on the number of new whales that were non-transients (whales present in more than one year). The JS1 and JS2 methods are both negatively biased for the earliest years of the time-series, with the bias decreasing with time and as a function of the detection probability.

Given these limitations of the JS2 approach, the Workshop **agreed** to base the trials on the estimates from the JS1 method, excluding the 1998 estimate which will be negatively biased to an appreciable extent for likely values of the detection probability for animals available to the surveys for the first time. The 1999 estimate was shown to be much less negatively biased in the simulations and was retained. The Workshop also **agreed** that the operating model would be fitted to the abundance estimates for the NCA-NBC area while the *Strike Limit Algorithms* would be based on the abundance estimates for the smaller OR-SVI area (see Table 2).

Table 2

JS1 abundance estimates (N) and standard errors in OR-SVI and NCA-NBC after exclusion of known calves from the year in which they were identified as calves.

| Year | N | SE(N) |
|---|---|---|
| **Region: OR-SVI** | | |
| 1998 | 63 | 4.1 |
| 1999 | 78 | 8.4 |
| 2000 | 89 | 11.9 |
| 2001 | 117 | 8.9 |
| 2002 | 133 | 15 |
| 2003 | 151 | 13.7 |
| 2004 | 157 | 15.5 |
| 2005 | 162 | 15.7 |
| 2006 | 154 | 15.3 |
| 2007 | 152 | 14.5 |
| 2008 | 150 | 12.5 |
| 2009 | 146 | 14.9 |
| 2010 | 143 | 16.8 |
| **Region: NCA-NBC** | | |
| 1998 | 101 | 6.2 |
| 1999 | 135 | 12 |
| 2000 | 141 | 13.2 |
| 2001 | 172 | 12.6 |
| 2002 | 189 | 9.2 |
| 2003 | 200 | 16.4 |
| 2004 | 206 | 14.9 |
| 2005 | 206 | 22.6 |
| 2006 | 190 | 18.8 |
| 2007 | 183 | 23.1 |
| 2008 | 191 | 16.1 |
| 2009 | 185 | 23.2 |
| 2010 | 186 | 18.7 |

The Workshop noted that the abundance estimates in SC/M12/AWMP2 and those used in previous gray whale trials include calves. However, since the estimates of abundance are assumed to be estimates of 1+ abundance in conditioning, Laake updated the estimates to exclude calves (see Table 2). These estimates were used in further analyses and form the basis for the final trials.

#### 2.4.2.2 USE OF GENETICS DATA TO PLACE BOUNDS ON LEVELS OF IMMIGRATION

Lang and Martien reported on the results of a simulation-based assessment of plausible levels of external recruitment into the PCFG stock (SC/M12/AWMP4). The generation of simulated datasets followed the steps outlined in TOSSM (IWC, 2007). The demographic matrices from TOSSM were updated with new information and both the updated and the original TOSSM matrices were used in an individual-based population model to create simulated datasets. The scenarios simulated incorporated annual immigration probabilities ranging from 0 to 0.0008 both with and without additional pulse immigration and population histories including either a pre-commercial whaling or a post-whaling split from the larger ENP population. The mtDNA haplotype data produced by the simulations were analysed, and the summary statistics generated were compared to those reported for empirical data representing the PCFG and Chukotka strata in Lang *et al.* (2011). Comparison of all frequency-based summary statistics (number of haplotypes, haplotypic diversity, and $F_{ST}$) generated from the simulated and observed data indicated that an annual immigration rate of zero animals per year was inconsistent with the empirical results under all scenarios tested. Most of these statistics were less informative about the upper boundary on the number of immigrants that could be recruited into the PCFG stock, although comparison of the number of haplotypes in the simulated versus the observed datasets suggested that annual immigration rates greater than 0.0003 to 0.0004 (corresponding to 6-8 animals/year once the larger ENP population reached carrying capacity) were inconsistent with the empirical data. All measures of the genetic diversity in the simulated datasets representing the larger ENP population were higher than the observed values, raising concern that the mutation rate utilised to generate the simulated datasets may need to be tuned to produce data more consistent with what has been observed for this population.

The Workshop thanked Lang and Martien for providing the initial results from their work. The Workshop noted that the results presented implied that the scenario of zero immigration was inconsistent with the results of the genetics data and that >6 to 8 immigrants per year (at carrying capacity) was inconsistent with the data on the number of haplotypes in the PCFG stock. The work is still underway, and the Workshop identified several topics for future work in priority order.

*Short-term tasks*

(a) Adjust the parameters of the model (e.g. the mutation parameter and/or spreading the historical whaling relating impact over a longer period) so that the model-predicted number of haplotypes for the northern population more closely matches the observed number of haplotypes. If this results in a mismatch in haplotype diversity, then further options should be examined to better match the observed haplotype diversity. The observed haplotype diversity and observed number of haplotypes for the northern population should be based on pooling all of the data sets.

(b) Ensure that the simulated animals are sampled in a way which is consistent with when (the years) actual sampling took place. Animals should be sampled without replacement from the populations; if the same animal is selected twice, it should be allocated to the first sampling occasion.

(c) Ensure that the pulse migration in the model occurs during 1999 and 2000 (impacting the population size counts at the start of 2000 and 2001).

(d) Examine what changes to the specifications of the model would lead to zero annual immigration into the PCFG stock being consistent with the genetics data such as: (i) the PCFG splitting from the northern stock after 1930 and subsequent pulse immigration; and (ii) a 'large' 'carrying capacity' for the PCFG stock.

(e) Consider additional levels of immigration per year (in particular one individual per year).
(f) Consider different maximum rates of increase for the PCFG stock (e.g. corresponding to $MSYR^{1+}$=1% and $MSYR^{1+}$=2%) by modifying the calf and/or the juvenile survival rate.
(g) Consider modelling a scenario in which immigration takes the form of periodic pulses.
(h) Replace the assumption that births are Poisson-distributed with the assumption that whether a female gives birth or not is a Bernoulli process[3].

*Longer-term tasks (to be discussed further with the Working Group on Stock Definition at the 2012 Annual Meeting)*

(a) Examine sensitivity to the assumption that the immigration rate is constant (e.g. consider a density-dependent immigration rate).
(b) The assumption that animals die once the population exceeds 10% above carrying capacity is unrealistic. Consider a sensitivity test in which carrying capacity is lower than 200, but animals do not die if the population is larger than carrying capacity, to confirm that the results are not sensitive to this assumption.
(c) Implement emigration explicitly (with different rates of emigration for animals which join the population during the 1999/2000 pulse event and other animals).
(d) Consider ways to address issues surrounding hypervariable sites.

The Workshop does not expect that any of these modifications is likely to change the conclusion that an immigration rate of zero is incompatible with the genetics data. The Workshop also **recommended** that the numbers immigrating annually should be plotted for a few representative simulations. Finally, the Workshop **strongly supported** continued collection of genetic samples, particularly throughout the range of the northern stock.

#### 2.4.2.3 OTHER ISSUES

When reviewing the results of the intersessional conditioning it was noted that some trials have a high proportion of posterior adult survival rates >0.99, which was considered implausible. The trade-off between age of maturity and survival given a fixed value for MSYR was noted. The Workshop **agreed** that adult survival should be constrained to be <0.99 in future trials.

The upper bound for the maximum pregnancy rate (in the limit of low population size) is 0.6, implying that some females would be pregnant and lactating at the same time. No simultaneously pregnant and lactating females had been reported by Rice and Wolman (1971) but Allison noted that a very small number of such individuals (2 pregnant and lactating plus 1 ovulating and lactating) had been reported for the Chukotkan hunt. The Workshop **agreed** to retain the upper limit of 0.6.

The Workshop noted that in earlier versions of the trial specifications (IWC, 2012b) equation B1.5 was in error in indicating that the expected value of a log-normal distribution is equal to its median (this equation had been used in all previous implementations). It noted further that the underlying assumption of the overall formulation is that the true abundance is the median of the log-normal distribution.

[3]Lang reported to the meeting that Allan Strand had been contacted to modify RMetaSim.

In discussion, the issue of emigration of whales from the PCFG was raised. This had not been considered thus far in the operating model. The hypothesis raised was that whales that appeared in the 'pulse event' may emigrate (or die) at a greater rate than other PCFG whales. To investigate this further, the mark-recapture data were reanalysed incorporating an additional covariate in the capture-recapture model which split whales into two groups for estimation of post-first-year survival. Whales seen initially as calves and any whale newly seen in 1998 or which was in the Cascadia catalogue because it had been seen prior to 1998, were assigned to one group and the remaining whales newly seen in 1999 or later were assigned to another group. The expectation was that the first group would have higher post-first-year survival because many of the newly seen whales that entered after the stranding event in 1999/2000 might eventually emigrate. When this covariate was included it made such a large improvement that any model without it would have no support. Therefore, it was included in all 10 models for survival. The model-averaged estimates for NCA-NBC were 0.968 (SE=0.0093) for calves and whales first seen in 1998 or earlier and 0.881 (SE=0.0217) for whales first seen in 1999 or later and not identified as a calf. The models and estimates are provided in SC/M12/AWMP2. The difference in the apparent survival rates for whales first seen after 1999 could be due to:

(a) the immigrants in the 1999 pulse being less healthy and hence having a higher mortality rate; or
(b) subsequent emigration.

The Workshop **agreed** that emigration should be included in the trials and would be modelled such that equal numbers of whales immigrate into the PCFG stock as emigrate out when the north and PCFG stocks are both at carrying capacity. Further details are given in Annex F.

Laake reported that the estimate of the proportion of whales during November-May classified as PCFG had changed given the additional data. The Workshop **agreed** to base the trials on the revised value (0.3).

### *2.4.3 Graphical and tabular summaries*

The final list of graphical and tabular summaries are given in Annex F. The following changes to the graphical and tabular summaries were **agreed** by the Workshop:

(1) the Block Need Satisfaction statistic (N5) is redundant because other statistics capture the same intent for the gray whale case and the statistic has thus been deleted;
(2) the descriptions of the need satisfaction statistics will be clarified to highlight when a statistic is based on annual catches or catches by block;
(3) a vertical line will be added to the trajectory plots at 2011 marking the change from trajectories fitted to the historical data to those projected into the future;
(4) the median negative log likelihood will be added to the tabular trial results, to provide information on the quality of the fit. Although this statistic includes the fit to the abundance data for the north stock, most of the variability appears to be due to the PCFG stock. (It was noted that all hypotheses have the same number of estimated parameters); and
(5) pair-wise plots of the posteriors of some biological parameters (fecundity, adult survival, age-at-maturity and juvenile survival) will be used to confirm that the areas of parameter space sampled are not unrealistic.

### *2.4.4 Conclusions and final specifications*

The list of factors considered in the trials is given as Table 3.

Table 3

Details of factors considered in trials.

| Factors | Levels (reference levels shown bold and underlined) |
|---|---|
| *MSYR* $_{1+}$ (north) | **2%**, **4.5%** |
| *MSYR* $_{1+}$ (PCFG) | **1%**, **2%**, **4.5%** |
| Immigration rate (annual) | **0, 1, 2**, 4, 6 |
| Pulse immigration (1999/2000) | **0**, 10, **20**, 30 |
| Proportion of PCFG whales in PCFG area, $\phi_{fut}$ | 0, **0.3**, 0.6, 1 |
| Struck and lost rate (PCFG area) | 0, **50%**, 75% |
| Northern need in final year (linear change from 150 in 2010) | **340**, 530 |
| Historic survey bias | **None/Appendix 2, Table 6**, increasing between 1967 to 2002 from 0.5→1 (north only) 50% (PCFG only) |
| Future episodic events[1] | **None**, 3 events occur between yrs 1-75 (with at least 2 in yrs 1-50) in which 20% of the animals die. Events occur every 5 years in which 10% of the animals die[2] |
| Time dependence in *K* | **Constant**, halve linearly over 100yr; double linearly over 100yr |
| Time dependence in natural mortality, *M* * | **Constant**, double linearly over 100yr |
| Parameter correlations | Yes, **No** |
| Probability of mismatching north whales, $p_2$ | 0, **0.01**, 0.01-0.05 |
| Probability of mismatching PCFG whales, $p_1$ | **0**, 0.5 |
| Frequency of PCFG surveys | **Annual**, 6-year |
| Incidental catch | **Reference**, double reference, half reference |
| Future sex ratio | **0.5:0.5**, 0.2:0.8 (M:F) |
| Episodic events with future pulse events[1] | **None**, 3 events occur between yrs 1-75 (with at least 2 in yrs 1-50) in which 20% of the north stock die and a pulse of 20 animals is added to the PCFG stock. |

[1]The average value for adult survival needs to be adjusted to ensure the population is stable for these trials. [2]Selected to mimic the implications of stochasticity in the population dynamics.

#### 2.4.4.1 *EVALUATION TRIALS*

The Workshop **agreed** the set of *Evaluation Trials* given in Table 4. The scenario with two immigrants/year into the PCFG stock when the north stock is 20,000 animals (Trials 1A, B, C and D) forms the base case given the results of the simulation-based analyses (see Item 2.4.2.2), which imply that zero immigration is likely to be inconsistent with the results of the genetics data. Trials with zero immigration (except perhaps for a pulse in 1999/2000) were retained (Trials 2A-D) to fully span the parameter space. An additional base case trial (1B) with an MSY rate of 2% for the PCFG and 4.5% for the north stock was added to ensure a wide range of scenarios regarding MSYR for the PCFG stock are included in the *Evaluation* set. The 'E' trials were dropped from further consideration because the results of conditioning confirmed that the operating model is unable to mimic the abundance estimates for the PCFG area without either a pulse of immigrants from the north stock or survey bias. Trials with one immigrant/year (Trials 3A-B) were added to allow the Committee to more fully understand the behaviour of the *SLA*s for different rates of immigration, especially given the simulation analyses had yet to consider an immigration rate from the north to the PCFG stock between zero and two animals each year. Trials 5A-B with six immigrants/year were retained, although some of these trials may be dropped depending on the outcomes of conditioning.

*Evaluation Trials* 9A-B with future episodic events in the north stock in conjunction with a pulse event in the PCFG were retained given that this situation has occurred in the past and may recur in future. The low struck and lost rate trials were revised to use a loss rate of 25% instead of 0%. Struck and lost whales may have occurred during the Makah hunt so 0% is unrealistic. *Evaluation Trials* 11 and 12 test rates of 25% and 75%, which should allow interpolation of results over the expected range. *Evaluation Trials* 6A-B with high need for the Russian hunt are retained. It was noted that when more whales are removed from the north stock, there will be lower immigration into the PCFG stock. However, this effect is not likely to be marked for these trials and levels of need.

The trials in which the CV for the north stock is underestimated were dropped given the new approach to estimating abundance during the southbound migration (Laake *et al.*, 2012). The trials with perfect detection ($p_1$=0; $p_2$=0) were also dropped because this scenario is unrealistic (and the implications of the assumption of perfect detection are easy to determine). The bulk of the *Evaluation Trials* only consider two choices for $MSYR_{1+}$ (PCFG: 2%; North: 4.5%; PCFG: 4.5%; North 4.5%) because the possibility of a major change in survey bias for the north stock is low, as is the possibility of a major (>4-fold) difference in $MSYR_{1+}$ between the north and PCFG stocks.

#### 2.4.4.2 *ROBUSTNESS TRIALS*

The Workshop agreed the set of *Robustness Trials* listed in Table 5. Unlike the *Evaluation Trials*, the Workshop made no attempt to 'balance' the *Robustness Trials*. Rather the *Robustness Trials* were selected either to focus on scenarios for which risk to the PCFG stock is higher or to provide increased understanding of the behaviours of the *SLA*s. The changes made to the *Robustness Trials* are as follows.

(1) *Robustness Trial* 12 was added in which the sex ratio of the future catch is 0.2:0.8 male: female. The choice of 0.2: 0.8 reflects both a lack of data on the likely sex ratio of future harvests and the fact the value (0.59) used in the earlier trials is close to the value used in the Evaluation Trials.
(2) The *Robustness Trials* in which carrying capacity or natural mortality change over time were modified to focus on scenarios which will have higher risk for the PCFG stock. These trials were recognised to also capture the scenario where emigration increased in the future.
(3) *Robustness Trials* 10 and 11 with different levels of incidental catch were retained as they are particularly important in the context of low $MSYR_{1+}$. It was noted that the number of set nets is declining but these trials may be used as a proxy for any non-deliberate kills.
(4) *Robustness Trial* 1 was changed from surveys occurring every five years to every six years, given the possible future change to biennial Commission meetings.

Table 4

The *Evaluation Trials*. Values given in bold type show differences from the base case trial. The final three columns indicate which trials apply to which 'broad' hypotheses. For 'broad' hypotheses B and I, the number given is the plus in 1999/2000. Unless specified otherwise $\phi_{PCFG}$=0.3, the struck and lost rate is 0.5, and there are no stochastic dynamics or episodic events.

| Trial | Condition | Description | $MSYR_{1+}$ North | $MSYR_{1+}$ PCFG | Final Need | Annual immigration | Survey freq. | Survey bias (north) | Hypothesis P | B | I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A | Y | $MSYR_{1+}$=4.5%/4.5% | 4.5% | 4.5% | 340/7 | 2 | 10/1 | 1 | 20 | Y | 10 |
| 1B | Y | $MSYR_{1+}$=4.5%/2% | 4.5% | 2% | 340/7 | 2 | 10/1 | 1 | 20 | Y | 10 |
| 1C | Y | $MSYR_{1+}$=4.5%/1% | **4.5%** | **1%** | 340/7 | 2 | 10/1 | 1 | 20 | Y | 10 |
| 1D | Y | $MSYR_{1+}$=2%/2% | **2%** | **2%** | 340/7 | 2 | 10/1 | **0.5→1** | 20 | Y | 10 |
| 2A | Y | Immigration=0 | 4.5% | 4.5% | 340/7 | **0** | 10/1 | 1 | 20 | Y | 10 |
| 2B | Y | Immigration=0 | 4.5% | 2% | 340/7 | **0** | 10/1 | 1 | 20 | Y | 10 |
| 2C | Y | Immigration=0 | **4.5%** | **1%** | 340/7 | **0** | 10/1 | 1 | 20 | Y | 10 |
| 2D | Y | Immigration=0 | **2%** | **2%** | 340/7 | **0** | 10/1 | **0.5→1** | 20 | Y | 10 |
| 3A | Y | Immigration=1 | 4.5% | 4.5% | 340/7 | **1** | 10/1 | 1 | 20 | Y | 10 |
| 3B | Y | Immigration=1 | 4.5% | 2% | 340/7 | **1** | 10/1 | 1 | 20 | Y | 10 |
| 4A | Y | Immigration=4 | 4.5% | 4.5% | 340/7 | **4** | 10/1 | 1 | 20 | Y | 10 |
| 4B | Y | Immigration=4 | 4.5% | 2% | 340/7 | **4** | 10/1 | 1 | 20 | Y | 10 |
| 5A | Y | Immigration=6 | 4.5% | 4.5% | 340/7 | **6** | 10/1 | 1 | 20 | Y | 10 |
| 5B | Y | Immigration=6 | 4.5% | 2% | 340/7 | **6** | 10/1 | 1 | 20 | Y | 10 |
| 6A | | High northern need | 4.5% | 4.5% | **530/7** | 2 | 10/1 | 1 | 20 | Y | |
| 6B | | High northern need | 4.5% | 2% | **530/7** | 2 | 10/1 | 1 | 20 | Y | |
| 7A | | 3 episodic events | 4.5% | 4.5% | 340/7 | 2 | 10/1 | 1 | 20 | Y | |
| 7B | | 3 episodic events | 4.5% | 2% | 340/7 | 2 | 10/1 | 1 | 20 | Y | |
| 8A | | Stochastic events 10% every 5 years | 4.5% | 4.5% | 340/7 | 2 | 10/1 | 1 | 20 | Y | |
| 8B | | Stochastic events 10% every 5 years | 4.5% | 2% | 340/7 | 2 | 10/1 | 1 | 20 | Y | |
| 9A | | Episodic events with future pulse events | 4.5% | 4.5% | 340/7 | 2 | 10/1 | 1 | 20 | Y | |
| 9B | | Episodic events with future pulse events | 4.5% | 2% | 340/7 | 2 | 10/1 | 1 | 20 | Y | |
| 10A | | Relative probability of harvesting a PCFG whale, $\phi_{PCFG}$=0.6 | 4.5% | 4.5% | 340/7 | 2 | 10/1 | 1 | 20 | Y | |
| 10B | | Relative probability of harvesting a PCFG whale, $\phi_{PCFG}$=0.6 | 4.5% | 2% | 340/7 | 2 | 10/1 | 1 | 20 | Y | |
| 11A | | Struck and lost (25%) | 4.5% | 4.5% | 340/7 | 2 | 10/1 | 1 | 20 | Y | |
| 11B | | Struck and lost (25%) | 4.5% | 2% | 340/7 | 2 | 10/1 | 1 | 20 | Y | |
| 12A | | Struck and lost (75%) | 4.5% | 4.5% | 340/7 | 2 | 10/1 | 1 | 20 | Y | |
| 12B | | Struck and lost (75%) | 4.5% | 2% | 340/7 | 2 | 10/1 | 1 | 20 | Y | |
| 13A | Y | Higher 1999-2000 pulse | 4.5% | 4.5% | 340/7 | 2 | 10/1 | 1 | **30** | | |
| 13B | Y | Higher 1999-2000 pulse | 4.5% | 2% | 340/7 | 2 | 10/1 | 1 | **30** | | |
| 13C | Y | Higher 1999-2000 pulse | **4.5%** | **1%** | 340/7 | 2 | 10/1 | 1 | **30** | | |
| 14A | Y | Lower 1999-2000 pulse | 4.5% | 4.5% | 340/7 | 2 | 10/1 | 1 | **10** | | |
| 14B | Y | Lower 1999-2000 pulse | 4.5% | 2% | 340/7 | 2 | 10/1 | 1 | **10** | | |

(5) *Robustness Trials* 8, 9, 10 and 11 (trials for which conditioning is required) are only conducted for $MSYR_{1+}$ for the PCFG stock of 2% as this will test the conservation performance of the *SLA*s to a greater extent than $MSYR_{1+}$ for this stock of 4.5%.

### 2.5 Review results of trials

The Workshop was unable to fully review the conditioning and trial results because of changes made to the trials and the trial structure during the meeting. However, the work plan below was developed to enable the work to be completed prior to the 2012 Annual Meeting.

### 2.6 Overall conclusions and recommendations

The Workshop agreed to the following work plan for the tasks to be undertaken prior to the 2012 Annual Meeting.

(1) Evaluate the need to revise the scenarios regarding incidental catches (Punt, Scordino, Weller) [by Friday 30 March].
(2) Recondition all of the trials and distribute summary files using the Dropbox to the Steering Group [by April 15].
(3) Brandon, Punt, and Scordino to review the results of the conditioning and provide a suggestion to the Steering Group whether any trials should be discarded owing to problems with conditioning.
(4) Laake to conduct further simulations to provide guidance on the plausibility of the trials in which bias is time-varying [by SC/64].
(5) Lang and Martien to conduct further TOSSM-based simulation to explore the plausibility of different levels of immigration into the PCFG [by SC/64].

## 3. PROGRESS ON DEVELOPING *SLAS* FOR ALL GREENLAND HUNTS BEFORE THE END OF THE INTERIM PERIOD WITH A FOCUS ON FIN WHALES

### 3.1 Fin whales

*3.1.1 Summary of discussions at the Annual Meeting*

The Committee agreed that the first step in developing *SLA*s for West Greenland fin and common minke whales was to define appropriate operating models. It noted that this would require examination of the existing operating

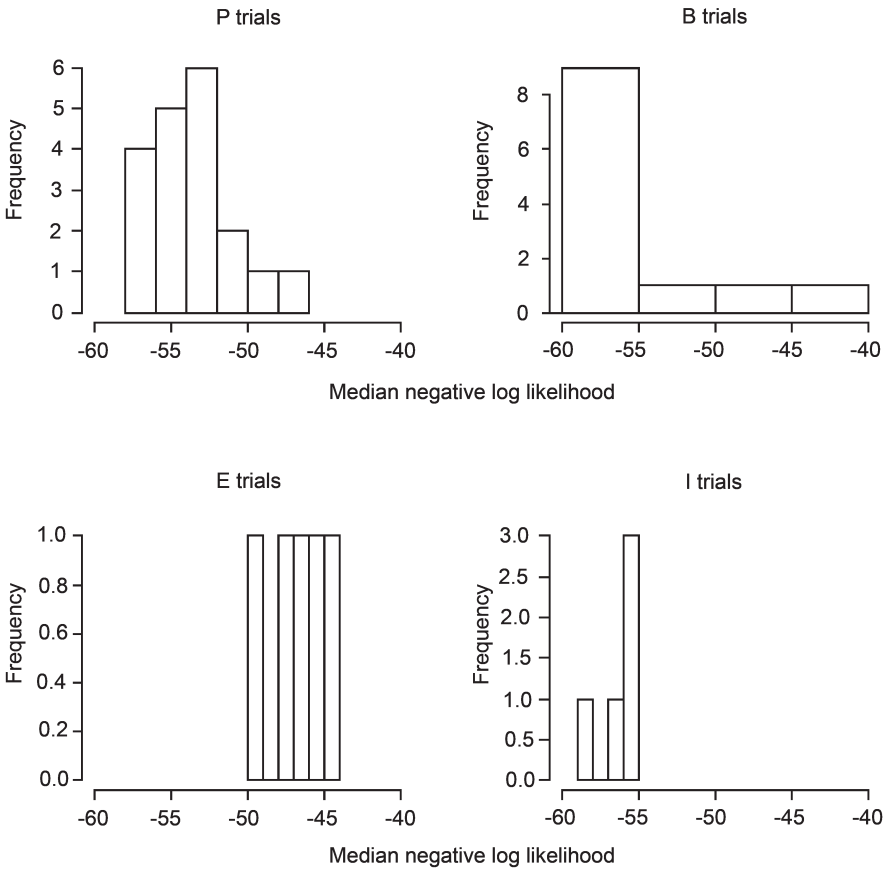


Fig 1. Histograms of the median log likelihood for fits to replicates of the data.

Table 5

The *Robustness Trials*.

| Trial | Condition | Description | $MSYR_{1+}$ north | $MSYR_{1+}$ PCFG | Survey freq. | Hypothesis P | Hypothesis B |
|---|---|---|---|---|---|---|---|
| 1A | | 6 year surveys | 4.5% | 4.5% | 10/6 | 20 | Y |
| 1B | | 6 year surveys | 4.5% | 2% | 10/6 | 20 | Y |
| 2A | | Linear decrease in $K^{1+}$ [$K$ halves over years 0-99] | 4.5% | 4.5% | 10/1 | 20 | Y |
| 2B | | Linear decrease in $K^{1+}$ [$K$ halves over years 0-99] | 4.5% | 2% | 10/1 | 20 | Y |
| 3A | | Linear decrease in PCFG $K^{1+}$ [$K$ halves over years 0-99] | 4.5% | 4.5% | 10/1 | 20 | Y |
| 3B | | Linear decrease in PCFG $K^{1+}$ [$K$ halves over years 0-99] | 4.5% | 2% | 10/1 | 20 | Y |
| 4A | | Linear increase in $M$ [$M$ halves over years 0-99] | 4.5% | 4.5% | 10/1 | 20 | Y |
| 4B | | Linear increase in $M$ [$M$ halves over years 0-99] | 4.5% | 2% | 10/1 | 20 | Y |
| 5A | | Linear increase in PCFG $M$ [$M$ halves over years 0-99] | 4.5% | 4.5% | 10/1 | 20 | Y |
| 5B | | Linear increase in PCFG $M$ [$M$ halves over years 0-99] | 4.5% | 2% | 10/1 | 20 | Y |
| 6A | | Perfect detection; $p_1$ =0; $p_2$=0.01-0.05 | 4.5% | 4.5% | 10/1 | 20 | Y |
| 6B | | Perfect detection; $p_1$ =0; $p_2$=0.01-0.05 | 4.5% | 2% | 10/1 | 20 | Y |
| 7A | | $p_1$ = 0.5 | 4.5% | 4.5% | 10/1 | 20 | Y |
| 7B | | $p_1$ = 0.5 | 4.5% | 2% | 10/1 | 20 | Y |
| 8B | Y | Survey bias PCFG + $p_1$ = 0.5 | 4.5% | 2% | 10/1 | 20 | Y |
| 9B | Y | Correlation (draw for N; same quantile in the range for PCFG) | 4.5% | 2% | 10/1 | 20 | Y |
| 10B | Y | Double incidental catches | 4.5% | 2% | 10/1 | 20 | Y |
| 11B | Y | Halve incidental catches | 4.5% | 2% | 10/1 | 20 | Y |
| 12A | | Sex ratio = 0.2: 0.8 | 4.5% | 4.5% | 10/1 | 20 | Y |
| 12B | | Sex ratio = 0.2: 0.8 | 4.5% | 2% | 10/1 | 20 | Y |
| 13A | | Relative probability of harvesting a PCFG whale, $\phi_{PCFG}$ =1 | 4.5% | 4.5% | 10/1 | 20 | Y |
| 13B | | Relative probability of harvesting a PCFG whale, $\phi_{PCFG}$ =1 | 4.5% | 2% | 10/1 | 20 | Y |

models that were developed for the RMP *Implementations* and *Implementation Reviews*. It recognised that given the focus of the RMP work (Icelandic common minke whale and fin whale operations and Norwegian common minke whale operations) that refinements would be necessary to account for the West Greenland situation. Ultimately such discussions will need to take place with the sub-committee on the RMP.

*3.1.2 Consideration of proposed framework*

SC/M12/AWMP1 provided an example how the RMP *Implementation Simulation Trials* for the North Atlantic fin whales could be modified such that the catches from the West Greenland sub-area can be evaluated/determined using candidate *SLA*s. Example trials were conducted in which one of the RMP variants considered for the North Atlantic fin whales was used to set RMP catch limits, while strike

limits for West Greenland were based on the 'interim' *SLA* adopted by the Committee and Commission (IWC, 2009a). Example results were shown in terms of the performance statistics selected for evaluating RMP variants.

The Workshop thanked Punt for undertaking this work. It noted that this framework allowed for simultaneous consideration of commercial whaling under the RMP and aboriginal whaling when removals from the same stock might be occurring. Advice would need to be sought from the Commission on the relative priorities to be accorded to satisfying potentially conflicting objectives in these circumstances, e.g. satisfying need for the aboriginal whaling *vs* maximising catch for commercial operations.

The Workshop stressed that considerable additional work is required to modify the existing RMP framework, especially with respect to stock structure hypotheses for the western Atlantic region, and in particular for West Greenland and the eastern seaboard of North America that had not formed the focus of the RMP *Implementation*.

The Workshop noted that RMP trials have been based on MSYR defined in terms of the mature component of the population, whereas AWMP trials have used MSYR specified in terms of the 1+ component (e.g. IWC, 1998). It was **agreed** that this matter will require further discussion at the forthcoming Scientific Committee meeting.

*3.1.3 Candidate SLAs*

The Workshop recognised that the development process usually incorporates more than one group producing candidate *SLA*s. While it is clear that one candidate should be the present interim *SLA*, the Workshop encouraged the involvement of others in developing candidate *SLAs* in this process. Witting noted that he would be considering other possible *SLA*s once the testing framework had been developed. Witting advised that trials could proceed under the assumptions of surveys every five and ten years (he also noted that a new survey would take place before 2015).

*3.1.4 Conclusions and recommendations for work prior to IWC/64*

The Workshop **agreed** that SC/M12/AWMP1 had demonstrated that the RMP trials framework for North Atlantic fin whales provided a satisfactory basis for extension to allow testing of candidate *SLAs* for Greenland hunts of fin whales.

It **recommended** that Witting co-operate with other scientists in the western North Atlantic region to prepare a document for the forthcoming Annual Meeting summarising present information and available data relevant to stock structure of fin whales in the western Atlantic, so as to facilitate refinement of the stock structure hypotheses that had been used for the RMP trials for North Atlantic fin whales. In addition, information on a 'need envelope' (IWC, 1998) for fin whales will be required, recognising that the multispecies nature of the Greenland hunts will eventually need to be considered (IWC, 2012b).

### 3.2 Common minke whales

*3.2.1 Summary of discussions at the Annual Meeting*

See discussion under Item 3.1.1.

*3.2.2 Discussion and work plan*

As with fin whales, the Workshop agreed that the existing RMP trials framework for North Atlantic common minke whales provided a satisfactory basis to test candidate *SLAs* for Greenlandic hunts of this species, provided that there were extensions to this framework to include refined stock structure hypotheses for the western Atlantic region. It noted that an *Implementation Review* for North Atlantic common minke whales is scheduled for 2013. This *Implementation Review* will be based on applying the Requirements and Guidelines for *Implementation*s under the Revised Management Procedure (IWC, 2012c), which will involve a thorough examination of stock structure. At least for the discussions of stock structure, it would be appropriate for this work to be carried out in co-operation with the sub-committee on the RMP. The issues related to MSYR definitions and possible conflicts with commercial whaling for fin whales also apply for common minke whales.

Again Witting was requested to co-operate with other scientists in the region to prepare a document summarising information and available data on stock structure of common minke whales in the western Atlantic, so as to facilitate development of these refined hypotheses at the time of the next *Implementation Review* of the RMP for North Atlantic minke whales. In addition, information on a 'need envelope' (IWC, 1998) for common minke whales off West and East Greenland will be required, recognising that the multispecies nature of the Greenland hunts will eventually need to be considered (IWC, 2012b).

### 3.3 Humpback whales (Witting, 2011a)

*3.3.1 Summary of discussions at the Annual Meeting*

The Committee had noted that focusing on the West Greenland feeding aggregation as a management unit may allow it to pay less attention to:

(1) overall stock structure in the North Atlantic; and
(2) problems associated with the allocation of past historical catches.

*3.3.2 Discussion and work plan*

The Workshop noted previous agreement to treat the West Greenland aggregation of humpback whales as a single stock for the purposes of *SLA* development. Difficulties that standard population models had experienced in producing plausible results given the catches taken some time in the past (see Punt *et al.*, 2006) could be addressed by considering only recent years and specifying alternative initial depletions in the operating models to be developed for *SLA* testing (*cf* the approach adopted for eastern North Pacific gray whales).

Witting was requested to compile a document summarising the factors considered in previous trials of *SLAs* (the *Bowhead SLA*, *Gray Whale SLA* and the *interim SLA*) to assist the development of the trials structure. In addition, information on a 'need envelope' (IWC, 1998) for humpback whales will be required, again recognising that the multispecies nature of the Greenland hunts will eventually need to be considered (IWC, 2012b).

### 3.4 Bowhead whales (Witting, 2011b)

*3.4.1 Summary of discussions at the Annual Meeting*

The Committee had noted that the very small 'need' for bowhead whales when compared to the abundance estimates available should allow the development of a relatively simple *SLA*.

*3.4.2 Discussion and work plan*

The Workshop noted that although the small size of bowhead catches was a simplifying factor, there was also the complication of catches by a non-member nation in this case. Furthermore, although the working hypothesis of the Committee was for a single bowhead stock, current hypotheses for stock structure beyond that of a single

stock have not yet been ruled out (IWC, 2008; 2009b). The Workshop noted that stock structure of bowhead whales in this region was a primary topic for discussion in the BRG sub-committee at the next Scientific Committee meeting. The document to be developed by Witting on previous trial factors (and a need envelope) referred to under Item 3.3.2 is also relevant for this hunt.

### 3.5 Development of timetable for completion of work

The Workshop stressed the importance of completing the work on long-term *SLA*s for the Greenland hunts (see IWC, 2012b, and Item 4 below) as soon as possible and certainly by 2017 (because some will be more complex than others). The SWG will be able to focus on this work after the completion of the *Implementation Reviews* for the B-C-B bowhead whales and the PCFG gray whales at the 2012 Annual Meeting. Determining a detailed timetable for this work will be a priority at the forthcoming Scientific Committee meeting. It was noted that one or more intersessional meetings would be required, and that these needed to be planned together with the RMP *Implementation Reviews* for various species in the North Atlantic to avoid duplicate discussion of common topics.

## 4. IMPLICATIONS OF POSSIBLE MOVE TO BIENNIAL MEETINGS WITH RESPECT TO LENGTH OF BLOCK QUOTAS

The Commission is considering a change from annual to biennial meetings. This has raised the issue within two Commission working groups as to whether there are any scientific implications for the Commission moving to setting block quotas for an even number of years rather than the present five-year intervals.

The Workshop recalled that trials for the B-C-B bowhead whale and eastern North Pacific gray whale *SLAs* had shown satisfactory performance for surveys at intervals of 10 years (and even for some *Robustness Trials* for 15 years). The Workshop **agreed** that there are no scientific reasons for the Commission not to set catch limits for blocks of even numbers of years up to eight years for these stocks. However, it drew attention to its discussions of the AWS where it noted that despite the trial results it would not be appropriate for catches to be left unchanged if new abundance estimates were not available after 10 years (IWC, 2004).

The Workshop noted that this would not mean that the Committee would need to change its regular process of *Implementation Reviews* approximately every five years (with the provision for 'emergency' reviews should circumstances arise) or an annual examination of new information and provision of advice.

The Workshop noted that interim *SLAs* for the Greenland hunts had also been tested for surveys at 10-year intervals and shown satisfactory performance and had been adopted by the Committee and the Commission in 2008. However, as noted at the time those tests had been for a restricted number of scenarios than the wider range of hypotheses customarily considered for such trials. It had thus been **agreed** that this *SLA* was appropriate for the provision of advice for up to two blocks (i.e. approximately 10 years) or approximately 2018. The Workshop **agreed** that there were no scientific reasons why the next quota block for the Greenland hunts could not be for a six-year period, noting that the long-term *SLA*s will be available for implementation for the following block quota.

## 5. PROGRESS ON FOLLOW-UP WORK ON CONVERSION FACTORS FOR THE GREENLANDIC HUNT

The Workshop referred to the Committee's previous recommendations on the collection of additional data relevant to the issue of conversion factors from weight of products to numbers of whales. Witting informed the Workshop that Greenland will produce a report for the forthcoming Scientific Committee meeting on progress on the work on conversion factors for the Greenlandic hunt.

## 6. ADOPTION OF THE REPORT

The Chair thanked the SWFSC for providing excellent facilities and the rapporteurs (and participants) for their hard work in getting the report almost to completion by the end of the Workshop. The participants thanked the Chair for his usual efficiency and good humour in steering the Workshop to a successful conclusion.

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# Annex A

# List of Participants

**USA**

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John Brandon
John Calambokidis
Aimee Lang
Jeff Laake
Karen Martien
Jeffrey Moore
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**DENMARK (GREENLAND)**

Lars Witting (by phone on 22 March 2012)

**INVITED PARTICIPANTS**

Doug Butterworth
Andre Punt

**IWC SECRETARIAT**

Cherry Allison
Greg Donovan

# Annex B

# Agenda

1. Introductory items
   - 1.1 Convenor's opening remarks
   - 1.2 Election of Chair
   - 1.3 Appointment of rapporteurs
   - 1.4 Adoption of Agenda
   - 1.5 Documents available
2. *Implementation Review* of eastern gray whales with emphasis on the PCFG
   - 2.1 Summary of work at the 2011 Annual Meeting
   - 2.2 Validation of the control program and updates to tasks
     - 2.2.1 Summary of progress with intersessional tasks
     - 2.2.2 Discussion of outstanding issues
     - 2.2.3 Summary and conclusions
   - 2.3 Final selection of *Strike Limit Algorithm* for PCFG for use in trials
   - 2.4 Final specifications of trials
     - 2.4.1 Summary of progress with intersessional tasks
     - 2.4.2 Discussion of outstanding issues including abundance estimates
     - 2.4.3 Graphical and tabular summaries
     - 2.4.4 Conclusions and final specifications
   - 2.5 Review results of trials
   - 2.6 Overall conclusions and recommendations
3. Progress on development of *SLA*s for all Greenland hunts before the end of the interim period with a focus on fin whales (via teleconference)
   - 3.1 Fin whales
     - 3.1.1 Summary of discussions at Annual Meeting
     - 3.1.1 Summary of discussions at Annual Meeting
     - 3.1.2 Consideration of proposed framework
     - 3.1.3 Candidate *SLA*s
     - 3.1.4 Conclusions and recommendations for work prior to IWC/64
   - 3.2 Common minke whales
     - 3.2.1 Summary of discussions at Annual Meeting
     - 3.2.2 Discussion and work plan
   - 3.3 Humpback whales
     - 3.3.1 Summary of discussions at Annual Meeting
     - 3.3.2 Discussion and work plan
   - 3.4 Bowhead whales
     - 3.4.1 Summary of discussions at Annual Meeting
     - 3.4.2 Discussion and work plan
   - 3.5 Development of timetable for completion of work
4. Implications of possible move to biennial meetings with respect to length of block quotas
5. Progress on follow-up work on conversion factors for Greenlandic hunt
6. Adoption of Report

# Annex C

# List of Documents

**SC/M12/AWMP**

1. Punt, A.E. How the current North Atlantic fin whale *Implementation Simulation Trials* can be used to evaluate a *Strike Limit Algorithm* for the fin whales off West Greenland.

2rev Calambokidis, J., Laake, J.L. and Klimek, A. Updated analysis of abundance and population structure of seasonal gray whales in the Pacific Northwest, 1998-2010.

3. Punt, A.E. Notes related to conditioning the trials for the eastern North Pacific gray whales.
4. Lang, A. and Martien, K. Using a simulation-based approach to evaluate plausible levels of recruitment into the Pacific Coast Feeding Group of gray whales: Progress report and preliminary results.

# Annex D

# Proposed Makah Hunt Management Plan and Alternatives for Analysis

### PROPOSED HUNT - BASE CASE

Need Envelope: The Tribe has a need of 20 whales landed per five year quota with a maximum of five whales in any calendar year.

Strike Limit: There will be a limit of seven strikes in any calendar year.

Struck and Lost: There will be a maximum of three stuck and lost whales in any calendar year.

Hunting Area: The Tribe proposes to limit the hunt to Pacific Ocean waters within the Makah Usual and Accustomed Fishing Grounds.

Hunt Timing: The Tribe proposes to limit the hunt to the migratory season of gray whales defined as 1 December through 31 May. In the *Implementation Review* this is modeled as December through April because of additional conservation measures in the month of May (see Other Limits).

PCFG Allowable Bycatch Limit (ABL): The Tribe proposes to set a limit on the bycatch of landed PCFG whales. The amount of bycatch will be defined by the formula:

$$\mathrm{ABL} = \mathrm{N}_{\min}^{OR-SVI} * 0.5R_{\max} * F_r$$

where:

$$\mathrm{N}_{\min}^{OR-SVI} = \mathrm{N}^{OR-SVI} / \exp\left(0.842 * \left[\ln\left(1+\mathrm{CV}(\mathrm{N})^2\right)\right]^{½}\right)$$

$\mathrm{N}_{\min}^{OR-SVI}$ Estimated number of PCFG whales between Oregon and Southern Vancouver Island.

$R_{\max}$ Maximum growth rate set to 4%.

$F_r$ Recovery factor which is set as 1.0.

**Other limits**

The striking of a whale calf or any whale accompanied by a calf will be prohibited.

A whale that is struck and lost between May 1 and May 31 will be presumed to be a member of the PCFG and will count toward the ABL for that calendar year unless photographs of the whale, when compared with the NMML funded photo-identification catalogue maintained by Cascadia Research Collective, demonstrate that it is not a member of the PCFG.

### VARIANTS FOR ANALYSIS

The Makah Tribe presents alternative management plans in Table 1 for analysis. These Variants explore: (1) the impact of altering how bycatch of PCFG whales is managed, and the time of year in which the hunt is modelled to occur; and (2) the effectiveness of the management plan if only PCFG whales are available for harvest. Variants 2 and 3 use the same ABL formula as presented in the proposed plan, Variants 4-9 have fixed bycatch limits, and Variants 10 and 11 explore the impact of not having a limit on bycatch of PCFG whales. Unless otherwise specified in Table 1 these Variants will follow the management plan proposed by the Makah Tribe as the base case.

Table 1

The Makah Tribe's proposed hunt and suggested Variants for evaluation noting which management measure is altered as compared to the Makah Tribe's proposed management plan.

| Variant number | Bycatch limit | Modelled time period of hunt | Availability of PCFG |
|---|---|---|---|
| Makah proposal | ABL formula | December to April | Trial specified |
| 2 | ABL formula | May only | Trial specified |
| 3 | ABL formula | May only | PCFG=100% |
| 4 | 1 | December to April | Trial specified |
| 5 | 1 | May only | Trial specified |
| 6 | 1 | May only | PCFG=100% |
| 7 | 2 | December to April | Trial specified |
| 8 | 2 | May only | Trial specified |
| 9 | 2 | May only | PCFG=100% |
| 10 | No limit | December to May | Trial specified |
| 11 | No limit | May only | PCFG=100% |

# Annex E

# PCFG Abundance Estimates Excluding Observed Calves

J. Laake

The abundance estimates in SC/M12/AWMP2 include calves whereas the population model is presumed to include 1+ whales. Not every calf can be identified as a calf because much of the survey effort is conducted when calves could have been weaned. As an approximation to the 1+ abundance, observed calves were removed from the $u_j$ in JS1. The following is taken from table 24 of SC/M12/AWMP2.

Table 1

JS1 abundance estimates (N) and standard errors in OR-SVI and NCA-NBC after exclusion of known calves from the year in which they were identified as calves.

| Year | N | SE(N) |
|---|---|---|
| **Region: OR-SVI** | | |
| 1998 | 63 | 4.1 |
| 1999 | 78 | 8.4 |
| 2000 | 89 | 11.9 |
| 2001 | 117 | 8.9 |
| 2002 | 133 | 15 |
| 2003 | 151 | 13.7 |
| 2004 | 157 | 15.5 |
| 2005 | 162 | 15.7 |
| 2006 | 154 | 15.3 |
| 2007 | 152 | 14.5 |
| 2008 | 150 | 12.5 |
| 2009 | 146 | 14.9 |
| 2010 | 143 | 16.8 |
| **Region: NCA-NBC** | | |
| 1998 | 101 | 6.2 |
| 1999 | 135 | 12 |
| 2000 | 141 | 13.2 |
| 2001 | 172 | 12.6 |
| 2002 | 189 | 9.2 |
| 2003 | 200 | 16.4 |
| 2004 | 206 | 14.9 |
| 2005 | 206 | 22.6 |
| 2006 | 190 | 18.8 |
| 2007 | 183 | 23.1 |
| 2008 | 191 | 16.1 |
| 2009 | 185 | 23.2 |
| 2010 | 186 | 18.7 |

# Annex F

# Trials Specifications

This Annex outlines a set of trials to evaluate the performance of *SLA*s for hunting in the Pacific northwest, with a primary focus on the PCFG (Pacific Coast Feeding Group). The operating model assumes the two groups (the 'north' group and the PCFG) are separate stocks, but with possible immigration of 'north' group animals into the PCFG group. The operating model considers four strata (north of 52°N, south of 41°N, PCFG December-May, and PCFG June-November) because the relative vulnerability of the two stocks to whaling and incidental mortality differs among these strata. The final trials specifications are published in this *Supplement* as Appendix 2 of Annex E of the full Scientific Committee Report, pp.153-164.