

**Report of the Fourth AWMP
Workshop on the Development of
SLAs for the Greenlandic Hunts**

Report of the Fourth AWMP Workshop on the Development of *SLAs* for the Greenlandic Hunts*

The Workshop was held at the Grønlands Repræsentation, Copenhagen from 15-18 December 2012. The list of participants is given as Annex A.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Donovan welcomed the participants to the Workshop. He noted that the focus of the Workshop would be to:

- (1) progress work on the development of a trial structure for the Greenlandic humpback and bowhead whale hunts such that candidate *SLAs* can be evaluated and if possible adopted at the 2013 Scientific Committee meeting;
- (2) review RMP/AWMP-lite and develop some preliminary scenarios in order to allow developers to begin to consider the more difficult cases of common minke and fin whales prior to the 2013 Scientific Committee meeting, recognising that final *SLA* development will be considered in the context of the relevant RMP *Implementation Reviews* and the forthcoming (after the 2013 Annual Meeting) workshop on common minke whale stock structure that will occur; and
- (3) finalise the trials for the Makah hunt so that the *Implementation Review* can be completed at the 2013 Scientific Committee meeting.

1.2 Election of Chair

Donovan was elected Chair.

1.3 Appointment of rapporteurs

Allison, Butterworth, Punt, and Witting were appointed as rapporteurs.

1.4 Adoption of Agenda

The adopted agenda is given as Annex B.

1.5 Documents available

The documents available to the meeting were SC/D12/AWMP1-5 (see Annex C).

2. SUMMARY OF DISCUSSIONS AT SC/64 AND INTERSESSIONAL PROGRESS

Donovan summarised the discussions at the 2012 Scientific Committee meeting with respect to the Greenlandic hunts (IWC, 2013a).

The Committee had re-emphasised the importance of developing long-term candidate *SLAs* for the Greenlandic hunts as soon as possible and certainly before the Commission's biennial meeting in 2018, given that the interim approach for providing management advice had been agreed (IWC, 2009a) to be valid for up to two blocks. It had agreed that it should be possible to develop an appropriate trial structures and operating models for the more straightforward cases of the humpback and bowhead whale hunts before the 2013 Annual Meeting to enable candidate *SLAs* to be evaluated. To assist in this process it had agreed a research project (IWC, 2013c) to be undertaken by Punt to develop a draft approach for consideration at an intersessional Workshop.

The Committee had also emphasised the importance of developers beginning to consider the development of candidate *SLAs* for fin whales and common minke whales, recognising that this needed to be in the context of the work being undertaken on stock structure with the RMP sub-committee and the joint AWMP/RMP proposal for work on the stock structure of North Atlantic common minke whales (Donovan *et al.*, 2013). To assist this process, the Punt research project noted above also incorporated the development of an AWMP/RMP-lite program.

The Workshop noted that papers SC/D12/AWMP1 and AWMP2 presented the contract work undertaken by Punt. They are discussed below under the relevant agenda items. It thanked Punt for his usual prompt and thorough work, recognising that without this, the Workshop would not have been able to complete its agenda on time.

3. GENERAL ISSUES

3.1 Candidate *SLAs* including guiding principles

The Workshop noted that considerable effort had been put into general consideration of the development of *SLAs* at the beginning of the AWMP process (IWC, 2000; 2001a; 2001b; 2002). It also recognised that a document (co-ordinated by Donovan, Punt and Scordino) that provides advice on the development of *SLAs* and their evaluation will be presented at the 2013 Scientific Committee meeting.

However it agreed that it would be useful at this Workshop to briefly outline some guiding principles for *SLAs* to assist developers of candidate *SLAs* prior to the 2013 Annual Meeting. These are summarised below.

- (a) The primary objective of any *SLA* is to meet the objectives set by the Commission with respect to need satisfaction and conservation performance, with priority given to the latter.
- (b) *SLAs* must incorporate a feedback mechanism.
- (c) Once need has been met for the 'high' need envelope while giving acceptable conservation performance, then there is no need to try to improve the performance of an *SLA* further.
- (d) Simple *SLAs* are to be preferred, providing this simplicity does not compromise achieving the Commission's objectives.
- (e) With respect to (d), empirical procedures may prove preferable to population model based procedures because: (1) they are more easily understood by stakeholders; and (2) the low likelihood of much updating of population model parameters (e.g. MSYR) over time as the extent of additional data will probably be limited for populations subject to aboriginal whaling only. Nevertheless, the choice of the form for any candidate *SLA* lies entirely in the hands of its developer, with selection amongst candidates to be based only on performance in trials.

More specifically with respect to the Greenlandic hunts, the Workshop recalled (IWC, 2009c) that the agreed 'interim' approach is 2% of the lower 5% confidence interval for the most recent estimate of absolute abundance. The 'interim' *SLA* will form the basis of at least one of the candidate *SLAs*

*Presented to the meeting as SC/65a/Rep02.

(to be chosen, alternative candidate *SLAs* must at least show improved performance compared to this). However, it was also **agreed** to modify the 'interim' *SLA* to include a variant that allowed additional abundance estimates by using an approach similar to that used under the *catch-cascading* option of the RMP (this is discussed further below and see Annex D).

The Workshop also noted that under the Aboriginal Subsistence Whaling Scheme (IWC, 2003a; 2003b; 2003c) agreed by the Committee (although not yet adopted by the Commission), if an acceptable new abundance estimate (relative or absolute as pertinent to the case concerned) is not obtained by the 10th year after the previous such estimate, a 'grace period' of up to 5 years applies during which the strike limit allowed previously is reduced by 50% until an acceptable new abundance estimate is obtained. After 5 further years, the allowed strike limit will drop to zero. This will be incorporated as necessary into the trial structure (see Annex D).

3.2 Component of the population to which MSYR refers

During the development of *SLAs* for the Bering-Chukchi-Beaufort Seas (B-C-B) bowhead and Eastern North Pacific (ENP) gray whale populations, there had been considerable discussions within the Scientific Committee as to what was the appropriate 'currency' in which to express MSYR. Given the case-specific AWMP approach and the nature of the data available on bowhead and gray whales, the Scientific Committee **agreed** that it was most appropriate to express MSYR in terms of the 1+ component of the population (i.e. non-calves). This differed from the approach adopted for the generic Revised Management Procedure approach for commercial whaling of baleen whales which has expressed MSYR in terms of the mature component of the population. The Committee has discussed and accepted these two different approaches in the past (IWC, 1998; 2000).

The Workshop reiterated that use of different 'currencies' did not imply any differences in biology/productivity.

For species/populations not subject to commercial whaling (i.e. bowhead, gray and humpback whales), the Workshop **agreed** that the 1+ currency remains the most appropriate.

However, the Workshop noted that for North Atlantic populations of common minke and fin whales, the situation arises in which species within the same ocean basin are subject to commercial whaling (for which RMP *Implementations* and *Implementation Reviews* have been carried out) and aboriginal subsistence whaling off Greenland. The most appropriate approach to take here requires further consideration by the Scientific Committee. One option is that provided appropriate currency conversions are used to ensure that assumptions about biology and productivity are the same, then the AWMP process can still evaluate performance in the context of 1+.

3.3 Presentation of results and selection of *SLAs*

The Workshop agreed that the existing presentation style for the results of AWMP trials and the procedures used in the past to select amongst candidate *SLAs* remain appropriate (e.g. see IWC, 2008b).

4. DEVELOPMENT OF TRIAL STRUCTURE FOR HUMPBACK WHALES OFF WEST GREENLAND

4.1 Stock structure hypotheses

4.1.1 Present hypothesis/es

In 2007, the Committee had noted that the humpback whales found off West Greenland belong to a separate feeding aggregation whose members mix on the breeding grounds in the West Indies, with individuals from other similar feeding aggregations (IWC, 2008a, p.21). It therefore had agreed that the West Greenland feeding aggregation was the appropriate management unit to consider when formulating management advice.

4.1.2 New information

SC/D12/AWMP5 provided maps of tracks of 30 humpback whales tagged with satellite linked radio transmitters on their feeding grounds in Disko Bay, West Greenland, in June 2008, 2009 and 2010. The whales used the continental shelf areas along West Greenland between 60 and 70°N extensively and made few excursions outside the areas covered by aerial surveys in 2005 and 2007 during August-September. Two whales departed from West Greenland and took a route south along Labrador and Newfoundland. One of them had already departed from West Greenland in June and reached Newfoundland in July.

The Workshop thanked Heide-Jørgensen for his work and encouraged him to continue tagging whales as it may provide information on early migration, movement between feeding areas and behaviour during the survey period. It was noted that the animal that left West Greenland in June might indicate that some animals leave the West Greenland area before the time of surveys (August), leading to a negative bias in the abundance estimates.

The Workshop recognised the potential of photographs to provide alternative evidence of movement between feeding areas and it **agreed** that Witting should confirm that all photographs from West Greenland have been submitted to the North Atlantic humpback Catalogue; Donovan agreed to check with Carlson to see whether any matches have been made.

4.1.3 Hypothesis/es for use in trials

The Workshop **endorsed** the previous Scientific Committee recommendation that the West Greenland feeding aggregation was the appropriate management unit. Therefore it **recommended** that it should be treated as a single stock in the trials, noting that there is no evidence to suggest other hypotheses should be tested.

4.2 Abundance estimates and trends

See Table 1.

Table 1

Estimates of absolute abundance for West Greenland humpback whales from an aerial survey in 2007.

Year	<i>n</i>	CV	Remarks	Reference
2007*	2,154	0.36	Initial strip census analysis (Heide-Jørgensen <i>et al.</i> , 2008) accepted by the Committee in 2008 (IWC, 2009a) was 3,039 (CV=0.45) – see text	Heide-Jørgensen <i>et al.</i> (2012)
2007	3,272	0.50	The initial MRDS estimate accepted by the Committee was 3,299 (CV=0.57)	Heide-Jørgensen <i>et al.</i> (2008)

*Agreed for use in the trials.

4.2.1 Review of estimates for use in conditioning and trials

The Committee has agreed absolute abundance and trend estimates for West Greenland humpback whales (Heide-Jørgensen *et al.*, 2008; IWC, 2009a). The absolute estimates were obtained from aerial survey data using two different analytical methods: strip census and mark-recapture distance sampling (MRDS). As both estimates were similar, the Committee had accepted both estimates (although noting that the sample size was rather low for undertaking a MRDS analysis) but had adopted the strip census estimate as the 'best' estimate *inter alia* given its smaller CV. The Workshop noted that the subsequently published version of the paper (Heide-Jørgensen *et al.*, 2012) had a revised strip census estimate (2,154, CV=0.36 versus the original 3,039, CV=0.45) in response to comments from the referees. The Workshop **requested** Heide-Jørgensen to provide a short working paper for discussion at the 2013 Annual Meeting documenting the changes such that the Committee can agree a 'final' best estimate. For the present purposes, the Workshop **agreed** to use the published strip census value (see Table 1). The agreed annual rate of increase was 9.4% per year (SE 0.01) which was unchanged in the published paper.

The Workshop **agreed** to use the estimates of relative abundance from aerial surveys given in Table 2a to condition the trials. By contrast, the abundance estimates from the mark-recapture studies (Table 2b) cover a shorter period and are heavily correlated so it was **agreed** that at present these will only be used in a *Robustness Trial*. However, the Workshop **agreed** that given that mark-recapture abundance estimates may become common in the future for both humpback and bowhead whales, efforts should be made to develop ways to better integrate them into operating models.

Both absolute and relative estimates of abundance are expected in the future. The next aerial survey is planned for 2015 to cover a similar area to the previous survey and with humpback whales as one of the priority species. Given present abundance and the **agreed** estimated rate of increase (insert value), the Workshop **agreed** that future sample sizes should be sufficient to allow absolute abundance estimates to be obtained from future surveys. In view of this, only absolute estimates will be generated into the future.

4.2.2 Conclusions

The Workshop **agreed** that both the absolute estimates of abundance given in Table 1 and the relative estimates of abundance from aerial surveys given in Table 2a will

be used to condition the trials. In addition, it **agreed** that the relative abundance estimates from the mark-recapture studies (Table 2b) will be used in a *Robustness Trial*. Only absolute estimates will be generated into the future.

4.3 Removals history

4.3.1 Direct catches

The full historic catch series for North Atlantic humpback whales was reviewed in Smith and Reeves (2010). There is considerable uncertainty concerning the level of catches prior to 1930. However, because of known difficulties with fitting a population model for the western North Atlantic from its pre-exploitation level, the inability to assign many of the past catches to feeding aggregations and the decision to treat the West Greenland feeding aggregation as the appropriate management unit, it was **agreed** that trials would begin in the year 1960, under the assumption that the age structure at the start that year is steady. Thus the catch series used in the trials (and see Annex E) is provided from 1960 onwards, since when the catches are known reliably and there is no need for an alternative series to be considered.

None of the photographic recaptures of humpback whales from St. Vincent and The Grenadines have been with animals from the West Greenland feeding aggregation, so these catches are not included in the catch series.

However, given possible migration routes (e.g. from telemetry data), the Workshop noted that Greenland animals may have been subject to direct catches outside the West Greenland area. In particular, it was noted that known direct catches occurred from whaling stations off the east coast of Canada after 1960 (see Annex E).

Making simple assumptions (Greenland whales are estimated to be off Newfoundland for ~1 month in comparison to Canadian whales which are there for ~6 months and taking the relative abundances of the two populations into account) leads to an estimated potential direct catch of Greenland humpbacks off Canada of up to 5% of the total direct catch. The Workshop **agreed** that this will be incorporated into the catch series. No future direct catches off Canada will be simulated.

4.3.2 Bycatches

Bycatches of humpback whales are known to occur off West Greenland; Table 3 presents the information available in National Progress reports since 2000. It was **agreed** that Allison will ensure that animals incorporated into the direct catch series (some were reported as shot for humane reasons) are not double counted; bycaught animals will be considered separately. Heide-Jørgensen noted that many of the bycaught animals were taken in the crab fishery which has now peaked. The Workshop **agreed** that future bycatches will be generated assuming that the exploitation rate due to bycatch in the future equals that estimated for the trial in question over the most recent five-years.

No bycatches were reported for the 1960-2000 period for West Greenland. It was noted that this assumption is conservative in that bycatches will be assumed for the future.

As was the case for direct catches, the Workshop noted that animals may be subject to bycatches outside the West Greenland area outside the feeding season. In particular it was noted that known bycatches occur down the east coast of Canada and especially Newfoundland/Labrador. Ledwell and Huntington (2010; 2012); and Ledwell *et al.* (2011) report recent entanglements off Newfoundland and Labrador. From 1979 to 2011 a total of 1,314 whales were entangled, with ~80% of these being humpback whales.

Table 2

Estimates of relative abundance for West Greenland humpback whales.

Year	Estimate	CV
(a) Aerial surveys		
1984	99	0.4
1985	177	0.44
1987	220	0.62
1988	200	0.74
1989	272	0.75
1993	873	0.53
2005*	1,158	0.35
2007	1,020	0.35
(b) Photo-id mark-recapture		
1982	271	0.13
1989	357	0.16
1990	355	0.12
1991	566	0.42
1992	376	0.19
1993	348	0.12

*In 2009 the Committee had agreed that this uncorrected estimate was suitable for use in assessments.

Table 3

List of bycatches and ship strikes of West Greenland humpback whales since 2000 (taken from the National Progress Reports).

Year	Bycatch	Ship strike
2000	2	0
2001	2	0
2002	3	0
2003	1	0
2004	2	0
2005	5	0
2006	0	0
2007	2	0
2008	3	0
2009	0	0
2010	1	0
2011	1	0

Declines in entanglement rates were observed following the 1992 moratorium on Atlantic cod fisheries, and an average of ~9 individual humpback whales were entangled each year from 2010 to 2012. Of these, on average, 1.5 were found dead, while 2 were successfully released.

These will be incorporated into the trial specifications and will be included in Annex E developed after the Workshop. As for direct catches, it was **agreed** that the estimated potential bycatch of Greenland humpbacks off Canada could be up to 5% of the total Canadian bycatch, including both dead and released animals.

4.3.3 Ship strikes

There are no known reports of ship strikes off West Greenland. Donovan and Allison will examine whether there are reports of ship strikes of humpback whales off Canada and if so, the same approach as for direct catches and bycatches will be used to generate ship strike series. Information will be included in Annex E developed after the Workshop.

4.3.4 Conclusions with respect to series to use

A single direct catch series will be used. The historic bycatch series will be finalised by Donovan and Allison and will be included in Annex E developed after the Workshop. Future bycatches will be generated assuming that the exploitation rate due to bycatch in the future equals the mean value over the most recent five-years.

4.4 Biological parameters

Prior distributions need to be specified for three biological parameters: (a) the non-calf survival rate; (b) the age-at-maturity; and (c) the maximum pregnancy rate. The objective is to develop priors (taken to be uniform for all three parameters) which are plausible based on the range of estimates in the literature. The values for these parameters

used in the actual trials will encompass a narrower range than these priors because the priors will be updated by the data on abundance and trends in abundance during the conditioning process.

The Workshop **agreed** that the prior for non-calf survival, S_{1+} , will be $U[0.9, 0.995]$. The lower bound for this prior is the lower 95% confidence interval for the estimate of non-calf survival obtained by Larsen and Hammond (2004) while the upper bound is the upper 95% confidence interval for the estimate of non-calf survival rate for humpback whales in Prince William Sound, Alaska reported by Zerbini *et al.* (2010). Zerbini *et al.* (2010) based their estimates of maximum rates of increase on the non-calf survival rate estimate for this population.

The maximum pregnancy rate, f_{\max} , is the pregnancy rate in the limit of zero population and thus is not measureable but is expected to be higher than observed pregnancy rates. Based on its review of the available information, the Workshop **agreed** that the prior will be $U[0.4, 0.8]$. The lower bound for this prior is close to the average of the estimates of pregnancy rate for humpback whale stocks reported by Zerbini *et al.* (2010). The upper bound was based on the view that the theoretical maximum (i.e. all mature females giving birth every year) is infeasible but that an estimate that involved a high proportion of animals on a one-year cycle (individuals have been observed to do this) should be considered.

The Workshop **agreed** that the prior for the age-at-maturity will be $U[4, 12]$. This is based on data from individually identified whales and incorporated the lower ages-at-first parturition reported by Clapham (1992) and Gabriele *et al.* (2007) and the high value reported by Robbins (2007).

Recognising the great uncertainty in these priors given the paucity of data, the Workshop **agreed** that it was important to develop a *Robustness Trial* (see Item 4.7) in which the priors for the biological parameters are modified by lowering the upper bounds for the priors for S_{1+} and f_{\max} and increasing the lower bound for a_m .

The abundance data are not informative about carrying capacity. The Workshop **agreed** that trials should be based on the prior for carrying capacity, K , proposed in SC/D12/AWMP2, $U[0, 30,000]$, noting that the estimated total catch of North Atlantic humpback whales is approximately 30,000 (Smith and Reeves, 2010).

The **agreed** priors are summarised in Table 4.

4.5 Need

SC/D12/AWMP4 presented need envelope considerations following internal discussions in Greenland and proposed a

Table 4

The prior distributions for humpback and bowhead whales for use in the trials.

Parameter	Humpback	Bowhead
Non-calf survival rate, S_{1+}	$U[0.90, 0.995]$	$N(1.059, 0.0378^2)$, truncated at 0.995
Age-at-maturity, a_m	$U[4, 12]$	$N(20, 3^2)$ truncated at 13.5 and 26.5
K^{1+}	$U[0, 30,000]$	$U[0, 40,000]$
$MSYL_{1+}$	Pre-specified	Pre-specified
$MSYR_{1+}$	Pre-specified	Pre-specified
Maximum pregnancy rate, $1/f_{\max}$	$U[1.25, 2.5]$	$U[2.5, 4]$
Additional variation (population estimates), CV_{add} , in year ψ	$U[0, 0.35]$	$U[0, 0.35]$
Abundance in year ψ , P_{ψ}	$\ln P_{2002} = N(\ln 3,270; (0.50^2 + CV_{add}^2))$	A: $\ln P_{2002} = N(\ln 6,340; (0.38^2 + CV_{add}^2))$ B: $\ln P_{2006} = N(\ln 1,229; (0.47^2 + CV_{add}^2))$
Additional variation (relative indices), CV_{add2}	$U[0.2, 0.6]$	$U[0.2, 0.6]$
Bias of relative abundance indices, B_c	$\ln B_c \sim U[-\infty, \infty]$ (see ¹)	$\ln B_c \sim U[-\infty, \infty]$ (see ¹)

¹This is the non-informative prior for a scale parameter.

way forward for the purposes of the trials. Development and consideration of need envelopes is the pragmatic approach used in the *SLA* development process to enable management advice to be provided to the Commission for possible increases in agreed need over time (e.g. due to increasing human populations) without requiring that additional trials be developed and run. It should be stressed that the size and shape need envelopes (which are proposed by those representing the subsistence hunters) do not imply that need requests will necessarily increase or that the Commission will accept such requests. Any need requests that are for scenarios outside the need envelopes tested will require additional trials and may require further *SLA* development. Need envelopes that are very wide may mean that candidate *SLAs* that fully meet need objectives cannot be developed.

For the ENP gray whales and B-C-B bowhead whales, three need envelopes were considered that started at current need levels: one remained constant through time, one increased linearly over the 100-year period to twice the present level and one increased linearly over the 100-year period to three times the current level. SC/D12/AWMP4 suggested a similar approach for West Greenland humpback whales but with some modifications to account for: (a) the preference of the hunters for humpback whales rather than fin whales (see below); and (b) the multispecies nature of the fishery and the overall expression of need in terms of edible products.

That Greenlanders would generally rather catch humpback whales than fin whales is reflected in the historical catches. It was only in the 1980s that concerns over the status of humpback whales led to the move to catches of fin whales and the removal of the traditional exemption allowing Greenlanders to take humpback whales despite its protected status in the North Atlantic. Recently, the Commission has allowed a resumption of the hunt on humpback whales and Witting explained that the currently expressed need for ten humpback whales is to some degree a compromise between the historical limits agreed for fin and humpback whales. To allow for more flexibility in the expression of actual need on fin and humpback whales in the near future, he suggested that the starting level of the need envelopes on humpback whales should be around twenty whales. Reiterating that the determination of catch limits is a matter for the Commission but recognising that the Committee needs to be in a position to provide scientific advice on any need requests, the Workshop **agreed** that need envelopes that increased over the initial three quota blocks from ten to twenty whales should capture this issue. Hence, the following three need

envelopes were agreed [10, 15, 20-20], [10, 15, 20-40] and [10, 15, 20-60], with the middle envelope being considered the base case (see Fig. 1).

Witting also proposed that a further case be examined to cope with unforeseen circumstances that may result in the allowable catch of especially minke whales being reduced. Using the interim conversion factors developed in Donovan *et al.* (2010), the amount of edible products from 50, 75 or 100 minke whales corresponds to the amount of edible products from 8, 12 and 16 humpback whales. He suggested consideration of an additional 'backup' scenario of initially adding ten humpback whales to the base case envelope (this would compensate for a decline in the minke whale strike limits of up to approximately 60 minke whales).

Witting agreed to discuss these need envelopes once again with managers in Greenland, and to report any suggested changes back to the AWMP Steering Group before the Annual Meeting.

4.6 *SLAs* to be considered

The general issue of the design of *SLAs* is discussed under Item 3.1. The Workshop **agreed** that all of the trials would be conducted for three 'reference *SLAs*', in addition to any other *SLAs* which might be proposed by developers (Annex D):

- (1) the *Strike Limit* is set to the need;
- (2) the *Strike Limit* is based on the interim *SLA* (IWC, 2009b); and
- (3) the *Strike Limit* is based on a variant of the interim *SLA* which makes use of all of the estimates of abundance, but downweights them based on how recent they are.

The Workshop **agreed** that the developers would be provided with:

- (1) total need for the next block;
- (2) catches by sex;
- (3) mortalities due to bycatch in fisheries and ship strikes; and
- (4) estimates of absolute abundance and their associated CVs.

Witting and Butterworth/Brandão **confirmed** that they will be developing candidate *SLAs*.

4.7 Development of Evaluation and Robustness Trials

SC/D12/AWMP2 had provided a set of draft specifications for *Evaluation* and *Robustness Trials* for humpback whales off West Greenland based on those developed for the Eastern North Pacific stock of gray whales (IWC, 2005). One key feature was that the population dynamics model is initiated in a recent year (1960 for most of the trials) rather than under the assumption that the population was at carrying capacity at the start of the first year with catches. The Workshop **endorsed** this approach as suggested previously (IWC, 2013b) given the past difficulties to find population dynamics models which capture the entire period of exploitation and are able to fit the abundance data for the North Atlantic humpback whales adequately (Punt *et al.*, 2006) and the difficulties in assigning past catches to the West Greenland feeding aggregation. The operating model is conditioned to estimates of absolute and relative abundance. The trials proposed in SC/D12/AWMP2 explored the implications of uncertainty about $MSYR_{1+}$, the first year considered in the operating model, episodic events, need, survey frequency, and changes over time in natural mortality and carrying capacity.

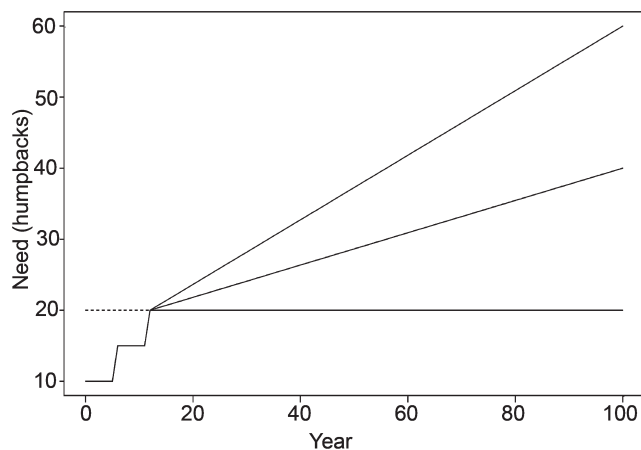


Fig. 1. Need envelope for humpback whales (with the backup envelope shown by the dotted line).

Table 5
Factors to be tested in the trials for humpback and bowhead whales.

Factors	Other levels (Reference levels shown bold and underlined)	
	Humpback whales	Bowhead whales
$MSYR_{1+}$	1%, 3%, <u>5%</u> , 7%	1%, <u>2.5%</u> , 4%
Time dependence in K^*	<u>Constant</u> , halve linearly over 100 years.	
Time dependence in natural mortality, M^*	<u>Constant</u> , double linearly over 100 years.	
Episodic events*	<u>None</u> , 3 events occur between years 1-75 (with at least 2 in years 1-50) in which 20% of the animals die. Events occur every 5 years in which 5% of the animals die.	
Need in final year (linear change from 5/10 in 2011)	<u>A:</u> <u>B:</u> <u>A:</u> <u>D:</u>	<u>A: $5 \geq 5$ over 100 years</u> <u>B: $5 \geq 10$ over 100 years</u> <u>C: $5 \geq 15$ over 100 years</u>
Survey frequency	5 years, <u>10 years</u> , 15 years	
Historic survey bias	0.8, <u>1.0</u> , 1.2	0.5, <u>1.0</u>
First year of projection, τ	<u>1960</u>	<u>1940</u>
Alternative Priors	$S_{1+} \sim U[0.9, 0.99]$; $f_{max} \sim U[0.4, 0.6]$; $a_m \sim U[5, 13]$	
Strategic surveys	Extra survey if a survey estimate is half of the previous survey estimate.	
Canadian catches	N/A	A: $5 \geq 5$ B: $5 \geq 10$ C: $5 \geq 15$ D: $2.5 \geq 2.5$

*Effects of these factors begin in year 2011 (i.e. at start of management). The adult survival rate is adjusted so that in catches were zero, then average population sizes in 250-500 years equals the carrying capacity. Note: for some biological parameters and levels of episodic events, it may not be possible to find an adult survival rate which satisfies this requirement.

Table 6
The Evaluation Trials for humpback whales. Values given in **bold** type show differences from the base trial.

Trial	Description	$MSYR_{1+}$	Need scenarios	Survey frequency	Historic survey bias	Conditioning option
1A	$MSYR_{1+}=5\%$	5%	A, B, C, D	10	1	Y
1B	$MSYR_{1+}=3\%$	3%	A, B, C, D	10	1	Y
1C	$MSYR_{1+}=7\%$	7%	A, B, C, D	10	1	Y
2A	5 year surveys	5%	B, D	5	1	1A
2B	5 year surveys	3%	B, D	5	1	1B
3A	15 year surveys	5%	B, D	15	1	1A
3B	15 year surveys; $MSYR_{1+}=3\%$	3%	B, D	15	1	1B
4A	Survey bias=0.8	5%	B, D	10	0.8	Y
4B	Survey bias=0.8; $MSYR_{1+}=3\%$	3%	B, D	10	0.8	Y
5A	Survey bias=1.2	5%	B, D	10	1.2	Y
5B	Survey bias=1.2; $MSYR_{1+}=3\%$	3%	B, D	10	1.2	Y
6A	3 episodic events	5%	B, D	10	1	1A
6B	3 episodic events; $MSYR_{1+}=3\%$	3%	B, D	10	1	1B
7A	Stochastic events every 5 years	5%	B, D	10	1	1A
7B	Stochastic events every 5 years; $MSYR_{1+}=3\%$	3%	B, D	10	1	1B

The Workshop considered the proposals in SC/D12/AWMP2 in light of its discussions above and the uncertainties involved. In particular, it **agreed**:

- trials will incorporate an assumption that additional variance is the same for all sighting surveys given that there are insufficient data to update the prior for additional variance by individual survey;
- Strike Limits* will be updated every six years rather than every five years to reflect the move to biennial Commission meetings;
- $MSYR_{1+}$ of 3%, 5%, and 7% will be examined (3% is low compared to observed rates of increase for other humpbacks stocks and well as humpback whales off West Greenland, 5% is close to the best estimate of the current rate of increase for West Greenland humpback whales and 7% is consistent with the rates of increase for other stocks of humpback whales of 10+%); and
- trials for which the survey period is every 15 years should be conducted with and without application of the rule related to the grace period (such trials also examine the situation in which the intention is to conduct surveys every 10 years, but a survey estimate cannot be produced that frequently).

With respect to *Robustness Trials* the Workshop **agreed** that *inter alia* these should include:

- trials in which the priors for the biological parameters exclude more productive values because the combination of the upper ends of the priors for S_{1+} and f_{max} along with the lower end of the prior for the age-at-maturity may be unlikely;
- at least one trial in which $MSYR_{1+}=1\%$;
- a 'strategic survey' trial which assumes that a survey will be conducted in year $y+1$ if the survey in year y led to an estimate which is less than half of that from the preceding survey; and
- a trial in which the operating model is conditioned also to the mark-recapture estimates of abundance under the assumption that the estimates are independent.

Table 5 summarises the factors the Workshop **agreed** should be considered in the trials. Tables 6 and 7 summarise the **agreed Evaluation and Robustness Trials**. Annex F (to be completed after the Workshop¹) provides the full specifications for the trials.

¹See Annex E [the Report of the Standing Working Group on the Aboriginal Whaling Management Procedure] Appendix 2, this volume pp.205-213.

4.8 Consideration of results and/or future work

The code implementing the trials will be updated inter-sessionally and provided to potential developers. The full work plan and timeline is outlined in Item 9.

5. DEVELOPMENT OF TRIAL STRUCTURE FOR BOWHEAD WHALES OFF WEST GREENLAND

5.1 Stock structure hypotheses

The current working hypothesis in the Scientific Committee is a single Baffin Bay-Davis Strait stock of bowhead whales (see Fig. 2). However, pending the availability of some genetic analyses, the Committee has agreed that the possibility that there are in fact two different stocks present in the overall area, with the second located in the Foxe Basin-Hudson Strait region, cannot be ruled out (e.g. see IWC, 2009d).

No new information was available to the Workshop to revise this understanding of stock structure with its current uncertainties. Given that the Workshop's objective was to develop an *SLA* for the Greenland hunt of bowhead whales, it **agreed** to proceed first on a conservative basis that assumed that the absolute abundance of bowhead whales on the West Greenland wintering area would be informed by abundance estimates from data for that region only (see below). Only if such an *SLA* proved unable to meet need would abundance estimate information and stock structure considerations from the wider area shown in Fig. 2 be taken into account. This is discussed further under Item 5.7.

5.2 Abundance estimates and trends

Table 8 lists the abundance estimates for North Atlantic bowhead whales.

It is not possible to create an estimate of abundance for the entire Davis Strait-Baffin Bay-Foxe Basin area as would be required to model the total population as a single stock because the survey in Prince Regent Inlet was conducted in 2002 whereas the Foxe Basin-Hudson Bay survey was conducted in 2003: combining estimates from the two surveys could risk double counting animals. The Workshop agreed to condition the operating model using data for Davis Strait-Baffin Bay stock only (see Items 5.1 and 5.6).

The Workshop noted that the 2002 survey in Prince Regent Inlet might not be conducted again whereas regular surveys will be conducted off West Greenland. The Workshop therefore agreed to conduct trials: (a) in which the estimate for Prince Regent Inlet is treated as an estimate of absolute abundance; and (b) in which the estimates from West Greenland are treated as estimates of absolute abundance.

The sex ratio data from ~600 biopsy samples taken off West Greenland over the past 13 years show that the ratio of female:male animals in this area is ~80:20 (Heide-Jørgensen *et al.*, 2010a). There is no reason to expect that the current

whole population does not have a 50:50 sex ratio since the large numbers of historical (pre-1900) catches were taken over the entire range and the catch ratio of recent Canadian catches is close to 50:50. Thus it is assumed that there is sex segregation on the feeding grounds. In view of this the trials will assume that the proportion of males available to the surveys will be the observed average male/female ratio in the biopsy samples.

Table 7
The Robustness Trials for humpback whales.

Trial no.	Factor	Need scenario	Conditioning option
1A	Linear decrease in K ; $MSYR_{1+}=5\%$	B, D	1A
1B	Linear decrease in K ; $MSYR_{1+}=3\%$	B, D	1B
2A	Linear increase in M ; $MSYR_{1+}=5\%$	B, D	1A
2B	Linear increase in M ; $MSYR_{1+}=3\%$	B, D	1B
3A	Strategic surveys; $MSYR_{1+}=5\%$	B, D	1A
3B	Strategic surveys; $MSYR_{1+}=3\%$	B, D	1B
4A	Alternative priors; $MSYR_{1+}=5\%$	B, D	4A*
4B	Alternative priors; $MSYR_{1+}=3\%$	B, D	4B*
4C	Alternative priors; $MSYR_{1+}=7\%$	B, D	4C*
5D	$MSYR_{1+}=1\%$	B, D	5D*
6A	Include mark-recapture estimates in the conditioning; $MSYR_{1+}=5\%$	B, D	6A*
6B	Include mark-recapture estimates in the conditioning; $MSYR_{1+}=3\%$	B, D	6B*

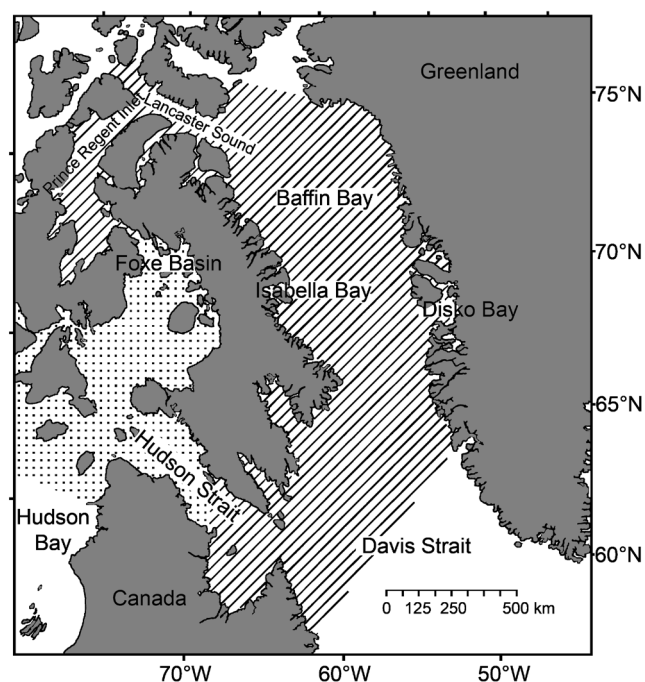


Fig. 2. Stock structure hypotheses for bowhead whales and place names referred to in the text. Hatched lines are for a Davis Strait-Baffin Bay stock while the dotted area refers to a Foxe Basin-Hudson Bay stock.

Table 8
Aerial survey estimates of bowhead whales.

Stock-Region	Year	n	CV/95%CI	Remarks	Reference
Prince Regent Inlet	2002	6,340	CI=3,119-12,906	Agreed to be used for management advice under alternative hypothesis	IWC (2009d)
Foxe Basin-Hudson Bay	2003	1,525	CI=333-6,990	Agreed to be used for management advice under alternative hypothesis	IWC (2009d)
West Greenland	2007	1,229	CV=0.47	Winter season – agreed to be used for management advice under alternative hypothesis	Heide-Jørgensen <i>et al.</i> (2007)
West Greenland	2012	829	CV=0.35	Preliminary (March-April surveys) – agreed for use in conditioning	Rekdal <i>et al.</i> (2013)
Isabella Bay	2009	1,105	CV=0.39	Summer season	Hansen <i>et al.</i> (2012)

Table 9
Estimates of relative abundance from aerial surveys.
Data from 2012 are preliminary.

Year	Effort (units)	Sightings
1981	951	1
1982	2,273	1
1990	591	1
1991	1,088	3
1993	577	0
1994	1,092	0
1998	1,184	5
1999	1,104	0
2006	791	9
2012	1,574	25

Table 10
Estimates of relative abundance from genetic mark-recapture studies.
Data from 2011 and 2012 are preliminary.

Year	Estimate	CV
2010	1,410	0.23
2011	1,681	0.28
2012	1,219	0.23

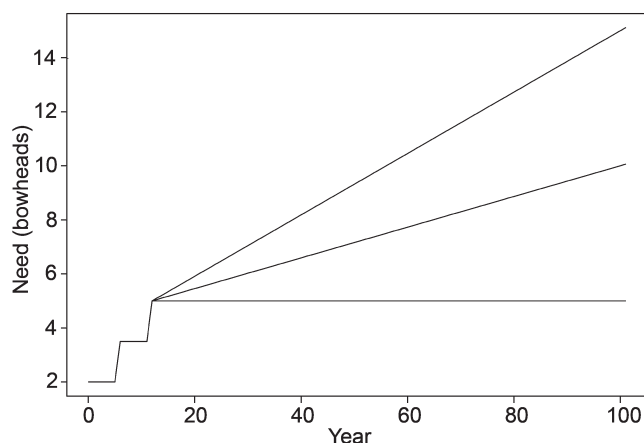


Fig.3. Need envelope for bowhead whales.

Estimates of relative abundance from aerial surveys are given in Table 9. The Workshop **agreed** that an overdispersion parameter should be estimated for these sightings data under the assumption that the data are negative binomially distributed.

The information provided to the *SLA* will be the results of surveys off West Greenland (relative indices if the operating model is conditioned to the estimate of abundance for Prince Regent Inlet and absolute if the operating model is conditioned to the estimate of abundance for West Greenland).

Estimates of relative abundance are also available from genetic mark recapture studies (Table 10). The potential of these mark recapture estimates (which are expected to continue in the future) was noted, but since time-series are not independent estimates, it will take some work to incorporate them into the trials. The Workshop **recommends** that work continue to enable these data to be used in the future, however, it accorded the work low priority at this time.

5.3 Removals

All the recent known direct catches of bowhead whales by Canada and Denmark (Greenland) are listed in Annex E. The catch series is believed to be complete for the period since

1940 (when the trials begin – see below) and the Workshop **agreed** that there was no need to consider an alternative catch series.

For 2011, Canada set an allowance of a maximum of four bowhead whales to be hunted in the Eastern Canadian Arctic. It is not known whether this allowance is for landed whales alone or whether it includes struck and lost whales. Allison will investigate this further.

The Workshop **agreed** that four scenarios regarding future Canadian catches should be considered (constant 5, 5 increasing to 10 over 100 years; five increasing to 15 over 100 years, constant 2.5; the last case reflects a situation in which half of the Canadian catches are taken from a different stock than the West Greenland catches).

The sex-ratio for the West Greenland catches should be set to the sex ratio observed in the biopsy samples taken off West Greenland over the 2002-11 period while that for the Canadian catches should be set to the observed sex-ratio (the observed ratio for the Baffin Bay/Davis Strait whales taken by Canada from 2002-11 is 6 male, 7 female, 4 unknown).

Recent bycatches of bowhead whales by Denmark (Greenland) and any information Donovan and Allison may find for Canada will be included in Annex E developed after the Workshop. It was noted that in future, if the number of ship strikes increases as the Northwest Passage opens up, this could trigger an *Implementation Review*.

5.4 Biological parameters

The Workshop received no new information on biological parameters. It therefore **agreed** to use the priors for f_{\max} , S_{1+} , and a_m used for the *Implementation* for the Bering-Chukchi-Beaufort Seas bowhead whales, noting that these incorporate considerable uncertainty for all three parameters.

5.5 Need

SC/D12/AWMP3 suggested three scenarios: each of which involves an increase to the need from two to five at the start of the projection period followed by either: (1) no increase of need; (2) a doubling; and (3) a tripling of need in a linear fashion over the total time period (and see Fig. 3).

5.6 SLAs to be considered

The Workshop **agreed** that the *SLA* developers will be provided with the total need for the next block, the catches by sex (separated into commercial and aboriginal catches [combined] and catches due to bycatch in fisheries and ship strikes [also combined], and catches by Canada), and the estimates of absolute abundance and their associated CVs. The *SLA* for bowhead whales may also wish to make use of the estimate of absolute abundance for Prince Regent Inlet of 6,340 (CV 0.38), noting that it cannot be assumed that abundance estimates from other than the West Greenland wintering area will be available in the future.

Witting and Butterworth/Brandão **confirmed** that they will be developing candidate *SLAs*.

5.7 Development of Evaluation and Robustness Trials

SC/D12/AWMP2 also provided a set of draft specifications for *Evaluation* and *Robustness Trials* for bowhead whales off West Greenland. As for humpback whales and for similar reasons, the Workshop **endorsed** the approach that population projections should begin from a recent year (1940). This is earlier than for humpback whales because of the extended age-structure of the population.

Given the uncertainty in stock structure (Item 5.1), trials could be conducted for one-stock and two-stock scenarios.

Table 11

The *Evaluation Trials* for bowhead whales (each conducted conditioning to the estimates of abundance for Prince Regent Inlet and West Greenland as absolute). Values given in **bold** type show differences from the base trial.

Trial	Description	$MSYR_{1+}$	Need scenario	Survey frequency	Historic survey bias	Conditioning option	
(b) Bowhead whales (each conducted conditioning to the estimates of abundance for Prince Regent Inlet and West Greenland as absolute)							
1A	$MSYR_{1+}=2.5\%$	1%	A, B, C	10	A	1	Y
1B	$MSYR_{1+}=1\%$	2.5%	A, B, C	10	A	1	Y
1C	$MSYR_{1+}=4\%$	4%	A, B, C	10	A	1	Y
2A	5 year surveys	2.5%	A, C	5	A	1	1A
2B	5 year surveys; $MSYR_{1+}=1\%$	1%	A, C	5	A	1	1B
3A	15 year surveys	2.5%	A, C	15	A	1	1A
3B	15 year surveys; $MSYR_{1+}=1\%$	1%	A, C	15	A	1	1B
4A	Survey bias=0.5	2.5%	A, C	10	A	0.5	Y
4B	Survey bias=0.5; $MSYR_{1+}=1\%$	1%	A, C	10	A	0.5	Y
5A	3 episodic events	2.5%	A, C	10	A	1	1A
5B	3 episodic events; $MSYR_{1+}=1\%$	1%	A, C	10	A	1	1B
6A	Stochastic events every 5 years	2.5%	A, C	10	A	1	1A
6B	Stochastic events every 5 years; $MSYR_{1+}=1\%$	1%	A, C	10	A	1	1B
7A	Alternative future Canadian catches	2.5%	A, C	10	B, C, D	1	1A
7B	Alternative future Canadian catches; $MSYR_{1+}=1\%$	1%	A, C	10	B, C, D	1	1B

Table 12

The *Robustness Trials* for bowhead whales.

Trial no.	Factor	Need scenario	Conditioning option
1A	Linear decrease in K ; $MSYR_{1+}=2.5\%$	A, C	1A
1B	Linear decrease in K ; $MSYR_{1+}=1\%$	A, C	1B
2A	Linear increase in M ; $MSYR_{1+}=2.5\%$	A, C	1A
2B	Linear increase in M ; $MSYR_{1+}=1\%$	A, C	1B
3A	Strategic surveys; $MSYR_{1+}=5\%$	A, C	1A
3B	Strategic surveys; $MSYR_{1+}=3\%$	A, C	1B

Neither scenario is straightforward to model, *inter alia* because: (a) no estimate of abundance for the entire Davis Strait-Baffin Bay-Foxe Basin area is available (the Prince Regent Island and Foxe basin surveys were surveyed in different years and cannot therefore be added together); (b) it is difficult to assign catches to stocks under the two-stock hypotheses; and (c) there is no guarantee that Canadians will undertake future abundance surveys.

The Workshop therefore **agreed** to condition the operating model using abundance data for the Davis Strait-Baffin Bay area only and remove all catches from the modelled Davis Strait-Baffin Bay-Foxe Island population. Both assumptions are conservative.

With respect to the Prince Regent Inlet survey estimate of 6,340 (CV 0.38), it was **agreed** to conduct trials initially only for the case in which the estimate of 1,229 (CV 0.47) off West Greenland is treated as an estimate of absolute abundance (after adjusting for the sex ratio), recognising that this clearly is an underestimate. The rationale is that if an *SLA* performs adequately when the operating model is conditioned to the West Greenland estimate alone, the *SLA* will perform adequately even in the absence of future surveys in Prince Regent Inlet. The information provided to the *SLA* will be the results of surveys off West Greenland. If it is not possible to develop an acceptable *SLA* under this assumption, then scenarios can be considered where the operating model is conditioned to the estimate of abundance for Prince Regent Inlet and estimates of abundance for West Greenland are considered to be relative.

The Workshop **agreed** that an overdispersion parameter should be estimated for the sightings data under the assumption that the data are negative binomially distributed, and that four scenarios regarding future Canadian catches

should be considered (constant 5, 5 increasing to 10 over 100 years, 5 increasing to 15 over 100 years, constant 2.5; the last case reflects a situation in which half of the Canadian catches are not taken from the same stock as the West Greenland catches). The sex-ratio for future West Greenland catches should be set to the sex ratio of the biopsy samples off West Greenland over 2002-11 while that for future Canadian removals should be set to the observed sex-ratio.

The historical catches of bowhead whales were taken throughout the entire Davis Strait-Baffin Bay-Foxe Basin area, so it is reasonable to assume that the sex ratio of the entire population(s) at the start of 1940 is 50:50, despite the recent female-biased catches off West Greenland. The latter reflects the sex ratio of the animals found in the West Greenland wintering area as determined from over 600 biopsy samples. Clearly not all males in the population(s) are available when the survey is conducted.

The Workshop noted the factors that had been agreed for humpback whales, recognising that most of these were also appropriate for bowhead whales. Table 5 summarises the factors the Workshop **agreed** should be considered in the trials. Tables 11 and 12 summarise the **agreed** *Evaluation* and *Robustness Trials*. Annex E provides the full specifications for the trials.

5.8 Consideration of results and/or future work

The code implementing the trials will be updated intersessionally and provided to potential developers. The full work plan and timeline is outlined in Item 9.

6. PROGRESS WITH RESPECT TO COMMON MINKE WHALES AND FIN WHALES

6.1 Use of RMP/AWMP-lite

SC/D12/AWMP1 provided the specifications for RMP/AWMP-lite, which is a platform written in R which implements an MSE (management strategy evaluation) framework for evaluating the performance of catch and strike limit algorithms. The essence of RMP/AWMP-lite is the use of an age-aggregated model rather than an age-structured model to considerably speed up calculations; this will allow developers more easily to explore the properties of candidate *SLAs* before they are submitted to rigorous full testing. This framework can be used to evaluate management schemes where multiple stocks of whales are exploited

by a combination of commercial and aboriginal whaling operations. The operating models can be conditioned to the actual data to allow an evaluation of whether stock structure assumptions and other hypotheses are comparable with the available data. The framework is applied for illustrative purposes to fin whales in the North Atlantic.

The Workshop welcomed SC/D12/AWMP1, which will help the Committee as it designs a trial structure for the North Atlantic common minke and fin whales, and will assist potential developers prepare for the development process. The Workshop **agreed** that the following modifications should be made to RMP/AWMP-like prior to the *Implementation Review* for the North Atlantic fin whales, which is scheduled to start during a pre-meeting prior to the 2013 meeting of the Scientific Committee:

- (a) allow the *SLAs* to be coded as an executable file which is called from RMP/AWMP-lite so that developers do not need to be familiar with R;
- (b) add headers to all output files;
- (c) replace the Schaefer production model by a Pella-Tomlinson model so that $MSYL$ can be specified to occur at $0.6K$;
- (d) allow $MSYR$ to be a parameter of the model (instead of the intrinsic growth rate).
- (e) simplify the use of folders so that it is easy for users to implement the software on their machines;
- (f) add a tagging likelihood so that the tagging data can be used to inform the values in the mixing matrices;
- (g) allow the population model to be initiated in a recent year and apply this version of the model to data for the North Atlantic fin whales; and
- (h) extend the model to allow for dispersal among breeding stocks and use this extension of the model to implement Stock Structure Hypotheses I, II, III, V, and VI for the North Atlantic fin whales (IWC, 2009b).

The Workshop **agreed** that this work should be funded from the AWMP Developers Fund.

The Workshop recognised that production models can be biased compared to age-structured models. However, it **agreed** that any such bias was unlikely to be marked for baleen whales because the age-at-recruitment and the age-at-maturity are often similar and are usually not very different from age 1. The $MSYR$ parameter in RMP/AWMP-lite should therefore be treated as being effectively in the $MSYR_{1+}$ currency. The Workshop noted that RMP/AWMP-lite can make use of 'minimum estimates' of abundance; minimum estimates are those for which coverage and precision are such that true abundance will certainly be larger than the point estimate from the survey.

6.2 Stock structure

The Commission has agreed that in cases of overlap, achievement of aboriginal need has a higher priority than allowing for commercial catches. Therefore, the process of developing *SLAs* and RMP *Implementations* for stocks in regions where both commercial and aboriginal catches occur should be: (a) development of a trials structure which adequately captures uncertainties regarding stock structure, mixing, $MSYR$, etc.; (b) identification of an *SLA* which performs as adequately as possible if there are no commercial catches; and (c) evaluation of the performance of RMP variants given the *SLA* selected at step (b).

6.2.1 Fin whales

Six stock structure hypotheses were identified during the *Implementation* (IWC, 2009b). These hypotheses will be reviewed during the *Implementation Review* scheduled for the 2013 meeting of the Scientific Committee.

The Workshop had an initial discussion regarding whether it would be possible to base the *SLA* for fin whales off West Greenland on operating models which considered West Greenland only, i.e. in effect assuming that the animals found off West Greenland comprise a single stock that is adequately represented by the abundance estimates obtained off West Greenland. The rationale for this is that even if there are multiple stocks off West Greenland (as was suggested in some hypotheses considered during the RMP *Implementation*), it may be reasonable to assume that they are susceptible to capture in the aboriginal hunt proportionally to their abundance when the survey is conducted. In contrast, varying proportions of the multiple stocks over time would violate this assumption. The Workshop **agreed** that the RMP *Implementation Review* should be asked to consider carefully any evidence that there may be more than one stock mixing off West Greenland.

6.2.2 Common minke whales

The trials structure for North Atlantic minke whales was developed for the 1992 RMP *Implementation* (IWC, 1993). The stock structure hypotheses considered at that time (and in subsequent *Implementation Reviews*) focused on the central and eastern stocks. Clearly additional focus on the western end of the range is required to adequately capture the range of hypotheses regarding stock structure for the minke whales hunted off West Greenland. Information on, for example, changes over time in catch sex ratios (or the lack thereof) confirms that the minke whales hunted off West Greenland do not comprise an entire stock. The Committee has recognised the need for a full evaluation of common minke whale stock structure in the North Atlantic in both an AWMP and RMP context. It has therefore agreed that a joint AWMP/RMP stock structure workshop be held in the intersessional period between the 2013 and 2014 Annual Meetings. The results of this Workshop will clearly be essential to the *SLA* development process.

6.3 Abundance estimates

The abundance estimates agreed by the Committee for the West Greenland fin and minke whales are listed in tables 3 and 4 of Witting (2013). The Workshop noted that the published paper (Heide-Jørgensen *et al.*, 2010b2) had updated the estimates originally accepted by the Committee; the Workshop **recommends** that the published estimates be accepted by the Committee.

6.4 Removals

The removals due to commercial and subsistence whaling are well documented for West Greenland fin and minke whales. However, the RMP *Implementation Reviews* will need to document and include information on bycatches and ship strikes.

6.5 Biological parameters

Unless new information becomes available, the existing biological parameter values used in the RMP should also be used for the AWMP.

6.6 Need

6.6.1 Fin whales

Witting advised the Workshop that the three scenarios (see Fig. 4) regarding the need envelope were:

- (1) 19 whales in each year over the 100-year projection period;
- (2) 19 whales each year increasing to 38 over the 100-year projection period; and
- (3) 19 whales each year increasing to 57 over the 100-year projection period.

6.6.2 Minke whales

Witting advised the Workshop that the three scenarios (see Fig. 5) regarding the need envelope were:

- (1) 200 whales in each year over the 100-year projection period;
- (2) 200 whales each year increasing to 400 over the 100-year projection period; and
- (3) 200 whales each year increasing to 600 over the 100-year projection period.

6.7 Candidate SLAs/developing teams

Witting and Brandão/Butterworth indicated that they were likely to develop candidate SLAs for common minke and fin whales.

6.8 Potential trials structure

6.8.1 Fin whales

The residual pattern for the fit of the operating model to the abundance estimates is common across areas, which

suggests that there is model mis-specification. Future trials should consider alternative model structures such as initialising the population dynamics model more recently than the year corresponding to the first catches. The Workshop **recommends** that this matter be further considered by at the forthcoming *Implementation Review*.

6.8.2 Minke whales

The trials structure needs to account for the sex-ratio of past and future catches during the aboriginal and commercial hunts. Consideration should be given to sex-biased migration. A structure to allow for such migration is given in Witting (2012).

7. FUTURE CONSIDERATION OF OPERATIONAL MULTISPECIES ASPECTS IN THE PROVISION OF MANAGEMENT ADVICE

Earlier discussions (IWC, 2011; Witting, 2008) on this matter have noted that Greenland's need is expressed in terms of tonnes of edible products, and for operational reasons some flexibility to allow for temporal variability in the species composition of this tonnage is important and would be preferred. The inclusion of such flexibility within a set of SLAs for a number of species, where these SLAs would need to be inter-linked, is a challenging scientific task in terms of designing the necessary simulation tests. The Workshop re-iterated previous advice (IWC, 2012) that this aspect is best pursued only after separate SLAs, which operate independently for each species, have been developed and accepted.

8. COMPLETION OF GRAY WHALE SLA EVALUATION FOR THE MAKAH HUNT (VIA SKYPE)

Following the discussions at the 2012 Scientific Committee meeting, SC/D12/AWMP3 noted that two SLA variants (one with research provisions) were agreed by the Committee to meet the conservation objectives of the Commission. However, the Committee also noted that the two variants did not exactly mimic the proposed hunt and expressed concern that the actual conservation outcome of the proposed hunt was not fully tested. The reason that an exact variant was not tested was because there is a temporal rule in the proposed hunt, such that all struck and lost whales from December through April are not counted against the Allowable PCFG Limit (APL), whereas any struck and lost whales in May are counted against the APL. There are insufficient data to determine the proportion of strikes that would occur in May or prior to May, and hence the two variants of the hunt were developed to bracket the range of possible monthly strikes. SC/D12/AWMP3 proposed the testing of the following six variants to span the full range of possible strikes occurring in May or prior to May.

- (1) Allow only one strike prior to May.
- (2) Allow two strikes prior to May.
- (3) Allow three strikes prior to May.
- (4) Allow four strikes prior to May.
- (5) Allow five strikes prior to May.
- (6) Allow six strikes prior to May.

The Workshop **endorsed** the approach outlined in SC/D12/AWMP3 and **recommended** that the full set of trials be repeated for these six variants (in addition to the two SLAs agreed by the Committee [1 and 2]). Annex G summarises the performance for the eight trials used by the Committee during 2012 to contrast SLAs 1 and 2 for these six variants.

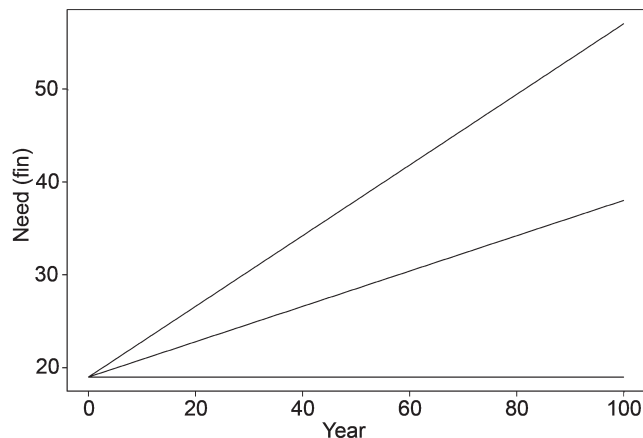


Fig.4. Need envelope for fin whales.

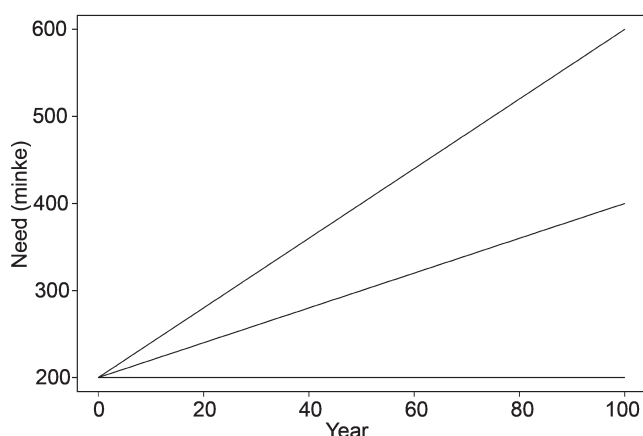


Fig.5. Need envelope for common minke whales.

Table 13

Work plan.

Task	Species	Who	When
Get final catch series (to 2012) [by sex]	Both	CA	15 April 2013
Get bycatches	Both	GD, LW	15 April 2013
Get Canadian catches [by sex]	Bowheads	CA	15 April 2013
Scenarios for ship strikes	Both	GD, LW	15 April 2013
Specifications for grace period	Both	GD?	15 April 2013
Negative binomial likelihood implemented	Bowheads	AEP	12 January 2013
Estimate overdispersion parameter (in R)	Bowheads	AEP	12 January 2013
Implement and test grace period	Both	AEP	12 January 2013
Generate 'q' for relative index	Bowheads	AEP	12 January 2013
Additional variance the same for relative and absolute indices	Both	AEP	12 January 2013
Pass additional catch series to the SLA code	Both	AEP	12 January 2013
Add switch to select among default SLAs	Both	AEP	12 January 2013
Read in historical and future Canadian catches (assign future catches to sex)	Bowheads	AEP	12 January 2013
Read in historical and future bycatches and ship strikes	Both	AEP	12 January 2013
6-year strike limit	Both	AEP	12 January 2013
Implement strategic surveys	Both	AEP	12 January 2013
SLA coded as executable option	Both	AEP	12 January 2013
Distribute all conditioning files, runstreams, etc.	Both	AEP	12 January 2013
Update graphs	Both	AEP	12 January 2013
Specifications document updated	Both	AEP	12 January 2013
All runstreams checked	Both	AB/CA	31 January 2013
Check whether all photographs from West Greenland have been submitted to the College of the Atlantic catalogue and confirm whether any matches have been made	Humpback whales	GD/LW	15 April 2013
Produce short paper documenting any changes in published abundance estimates from papers presented to Scientific Committee meetings	All (especially humpback)	MPHJ	1 May 2013
Further discussion of need envelopes with managers in Greenland	All (especially humpback)	LW	1 May 2013
Develop an approach for simulating the availability of future mark-recapture estimates of abundance	General	AEP/CA/AB	'Low priority'

The Workshop also **recommends** that the photo-id catalogue for the Eastern North Pacific gray whales that will be used to assess whether landed whales are from the PCFG be made publicly available as it is a key component of the management approach. It was pleased to be informed that funding is available to digitise the catalogue.

9. WORK PLAN

The Workshop **agreed** to the work plan given in Table 13.

10. ADOPTION OF REPORT

The report was adopted at 15:45 on 18 December 2012 apart from some editorial work and fact checking. The Chair thanked the participants for a constructive and successful Workshop. In particular, he thanked Mads-Peter Heide-Jørgensen and the staff of the Grønlands Repræsentation for the excellent facilities, Alice Heide-Jørgensen for helping out so efficiently at the weekend, and the rapporteurs. Finally he thanked Jette Donovan Jensen for acting as social secretary. The Workshop thanked the Chair for his usual effective and good humoured chairing of the Workshop.

REFERENCES

- Clapham, P.J. 1992. Age at attainment of sexual maturity in humpback whales, *Megaptera novaeangliae*. *Can. J. Zool.* 70(7): 1,470-72.
- Donovan, G., Palka, D., George, C., Levermann, N., Hammond, P. and Witting, L. 2010. Report of the small working group on conversion factors (from whales to edible products) for the Greenlandic large whale hunt. Paper IWC/62/9 presented to the IWC Commission meeting, 21-25 June 2010, Agadir, Morocco (unpublished). 54pp. [Paper available from the Office of this Journal].
- Donovan, G., Pampoulie, C., Palsbøll, P.J., Skaug, H.J., Tiedemann, R., Vikingsson, G., Witting, L. and Øien, N. 2013. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 6. Proposal for a process and joint workshop to assist AWMP and RMP develop a common framework for stock structure of common minke whales in a management context. *J. Cetacean Res. Manage. (Suppl.)* 14: 117.
- Gabriele, C.M., Straley, J.M. and Neilson, J.L. 2007. Age at first calving of female humpback whales in southeastern Alaska. *Mar. Mammal Sci.* 23(1): 226-39.
- Hansen, R.G., Heide-Jørgensen, M.P. and Laidre, K.L. 2012. Recent abundance of bowhead whales in Isabella Bay, Canada. *J. Cetacean Res. Manage.* 12(3): 317-19.
- Heide-Jørgensen, M.P., Laidre, K., Borchers, D. and Samarra, F. 2007. Surprising recovery of bowhead whales. Paper SC/59/BRG23 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 8pp. [Paper available from the Office of this Journal].
- Heide-Jørgensen, M.P., Laidre, K., Hansen, R.G., Burt, M.L., Simon, M., Borchers, D.L., Hanssen, J., Harding, K., Rasmussen, M.H., Dietz, R. and Teilmann, J. 2012. Rate of increase and current abundance of humpback whales in West Greenland. *J. Cetacean Res. Manage.* 12(1): 1-14.
- Heide-Jørgensen, M.P., Laidre, K.L., Hansen, R.G., Rasmussen, K., Burt, M.L., Borchers, D.L., Dietz, R. and Teilmann, J. 2008. Revised abundance estimates of humpback whales in West Greenland. Paper SC/60/AWMP7 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 35pp. [Paper available from the Office of this Journal].
- Heide-Jørgensen, M.P., Laidre, K.L., Wiig, Ø., Postma, L., Dueck, L. and Bachmann, L. 2010a. Large scale sexual segregation of bowhead whales. *Endanger. Species. Res.* 13: 73-78.
- Heide-Jørgensen, M.P., Witting, L., Laidre, K.L., Hansen, R.G. and Rasmussen, M.H. 2010b. Fully corrected estimates of minke whale abundance in West Greenland in 2007. *J. Cetacean Res. Manage.* 11(2): 75-82.
- International Whaling Commission. 1993. Report of the Scientific Committee, Annex I. Report of the Working Group on Implementation Trials, Appendix 4. Specifications of the North Atlantic minke whaling trials. *Rep. int. Whal. Commn* 43:189-95.
- International Whaling Commission. 1998. Report of the Scientific Committee. Annex I. Report of the Standing Working Group on the Development of an Aboriginal Subsistence Whaling Management Procedure (AWMP). *Rep. int. Whal. Commn* 48:203-36.
- International Whaling Commission. 2000. Report of the Scientific Committee. Annex E. Report of the Standing Working Group (SWG) on the Development of an Aboriginal Subsistence Whaling Management Procedure (AWMP). *J. Cetacean Res. Manage. (Suppl.)* 2:125-54.
- International Whaling Commission. 2001a. Report of the Scientific Committee. Annex F. Report of the Sub-Committee on Aboriginal Subsistence Whaling. *J. Cetacean Res. Manage. (Suppl.)* 3:161-76.
- International Whaling Commission. 2001b. Report of the Second Workshop on the Development of an Aboriginal Subsistence Whaling Management Procedure (AWMP), Seattle, Washington, November 1999. *J. Cetacean Res. Manage. (Suppl.)* 3:417-47.

- International Whaling Commission. 2002. Report of the Scientific Committee. Annex E. Report of the Standing Working Group (SWG) on the Development of an Aboriginal Subsistence Whaling Management Procedure (AWMP). *J. Cetacean Res. Manage. (Suppl.)* 4:148-77.
- International Whaling Commission. 2003a. Chair's Report of the Fifty-Fourth Annual Meeting. Annex C. Report of the aboriginal subsistence whaling sub-committee. *Ann. Rep. Int. Whaling Comm.* 2002:62-75.
- International Whaling Commission. 2003b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 5:1-92.
- International Whaling Commission. 2003c. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on the Development of an Aboriginal Subsistence Whaling Management Procedure (AWMP). *J. Cetacean Res. Manage. (Suppl.)* 5:154-255.
- International Whaling Commission. 2005. Report of the Scientific Committee. Annex E. Report of the Standing Working Group (SWG) on the Development of an Aboriginal Subsistence Whaling Management Procedure (AWMP). Appendix 3. Fishery Type 2: *Implementation* for Eastern North Pacific gray whales. *J. Cetacean Res. Manage. (Suppl.)* 7:127-38.
- International Whaling Commission. 2008a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 10:1-74.
- International Whaling Commission. 2008b. Report of the Scientific Committee. Annex E. Report of the standing working group on the development of an aboriginal subsistence management procedure. Appendix 2. *Implementation Review* for bowhead whales. *J. Cetacean Res. Manage. (Suppl.)* 10:137-43.
- International Whaling Commission. 2009a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 11:1-74.
- International Whaling Commission. 2009b. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure (RMP). Appendix 6. The specifications for the Implementation Simulation Trials for North Atlantic fin whales. *J. Cetacean Res. Manage. (Suppl.)* 11:114-25.
- International Whaling Commission. 2009c. Report of the Scientific Committee. Annex E. Report of the standing working group on the Aboriginal Whaling Management Procedures. *J. Cetacean Res. Manage. (Suppl.)* 11:145-68.
- International Whaling Commission. 2009d. Report of the Scientific Committee. Annex F. Report of the sub-committee on bowhead, right and gray whales. *J. Cetacean Res. Manage. (Suppl.)* 11:169-92.
- International Whaling Commission. 2011. Report of the Third Intersessional Workshop on the Review of MSYR for Baleen Whales, Seattle, 20-24 April 2010. *J. Cetacean Res. Manage. (Suppl.)* 12:399-411.
- International Whaling Commission. 2012. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on an Aboriginal Subsistence Whaling Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 13:130-53.
- International Whaling Commission. 2013a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 14:1-86.
- International Whaling Commission. 2013b. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on the Aboriginal Whaling Management Procedure (AWMP). *J. Cetacean Res. Manage. (Suppl.)* 14:137-71.
- International Whaling Commission. 2013c. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on the Aboriginal Whaling Management Procedure (AWMP). Appendix 6. Development of an operating model for West Greenland humpback and bowhead whales. *J. Cetacean Res. Manage. (Suppl.)* 14:170.
- Larsen, F. and Hammond, P.S. 2004. Distribution and abundance of West Greenland humpback whales *Megaptera novaeangliae*. *Journal of Zoology (London)* 263: 343-58.
- Ledwell, W. and Huntington, J. 2010. Whale, leatherback sea turtles and basking sharks entrapped in fishing gear in Newfoundland and Labrador and a summary of the strandings, sightings and education work during 2009-2010. A preliminary report to Fisheries and Oceans Canada, March 31, 2010. [Available from: Whale Release and Strandings Group, 244 Tolt Road, Portugal Cove-St. Philip's, NL, A1M 1R2, Canada.].
- Ledwell, W. and Huntington, J. 2012. Incidental entanglements of cetaceans and leatherback sea turtles in fishing gear reported during 2011-2012 and a summary of the whale release and strandings group activities. A preliminary report submitted to the Department of Fisheries and Oceans, Canada, March 31, 2012. [Available from: Whale Release and Strandings Group, 244 Tolt Road, Portugal Cove-St. Philip's, NL, A1M 1R2, Canada.].
- Ledwell, W., Huntington, J. and Kelly, N. 2011. Incidental entanglements of cetaceans and leatherback sea turtles in fishing gear reported during 2010-2011 and a summary of the whale release and strandings group activities. A preliminary report submitted to the Department of Fisheries and Oceans, Canada, March 31, 2011. [Available from: Whale Release and Strandings Group, 244 Tolt Road, Portugal Cove-St. Philip's, NL, A1M 1R2, Canada.].
- Punt, A.E., Friday, N. and Smith, T.D. 2006. Reconciling data on the trends and abundance of North Atlantic humpback whales within a population modelling framework. *J. Cetacean Res. Manage.* 8(2): 145-59.
- Rekdal, S.L., Hansen, G.R., Borchers, D., Bachmann, L., Laidre, K.L., Wiig, Ø., Nielsen, N.H., Sabrina Fossette, S., Tervo, O. and Heide-Jørgensen, M.P. 2013. Monitoring bowhead whales in Disko Bay, West Greenland. *Mar. Mammal Sci.* Submitted.
- Robbins, J. 2007. Structure and dynamics of the Gulf of Maine humpback whale population. Phd thesis, University of St Andrews, Scotland. [Available at: <http://hdl.handle.net/10023/328>].
- Smith, T. and Reeves, R. 2010. Historical catches of humpback whales, *Megaptera novaeangliae*, in the North Atlantic Ocean: estimates of landings and removals. *Mar. Fish. Rev.* 72: 1-43.
- Witting, L. 2008. Long-term safety of strike limits for large whales off West Greenland. Paper SC/60/AWMP2 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 65pp. [Paper available from the Office of this Journal].
- Witting, L. 2012. Information of relevance on Evaluation Trials for West Greenland minke whales. Paper SC/64/AWMP15 presented to the IWC Scientific Committee, June 2012, Panama City (unpublished). 11pp. [Paper available from the Office of this Journal].
- Witting, L. 2013. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on the Aboriginal Whaling Management Procedure (AWMP). Appendix 5. Biological information relating to *SLA* development for the large whale hunts in Greenland. *J. Cetacean Res. Manage. (Suppl.)* 14: 168-69.
- Zerbini, A.N., Clapham, P.J. and Wade, P.R. 2010. Plausible maximum rates of increase in humpback whales. *Mar. Biol.* 157: 1225-36.

Annex A

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. Summary of discussions at SC/64 and intersessional progress
3. General issues
 - 3.1 Candidate *SLAs* including guiding principles
 - 3.2 Component of the population to which MSYR refers
 - 3.3 Presentation of results and selection of *SLAs*
4. Development of trial structure for humpback whales off west Greenland
 - 4.1 Stock structure hypotheses
 - 4.1.1 Present hypothesis/es
 - 4.1.2 New information
 - 4.1.3 Hypothesis/es for use in trials
 - 4.2 Abundance estimates and trends
 - 4.2.1 Review of estimates for use in conditioning and trials
 - 4.3 Removals history
 - 4.3.1 Direct catches
 - 4.3.2 Bycatches
 - 4.3.3 Ship strikes
 - 4.3.4 Conclusions with respect to series to use
 - 4.4 Biological parameters
 - 4.5 Need
 - 4.6 *SLAs* to be considered
 - 4.7 Development of *Evaluation* and *Robustness Trials*
 - 4.8 Consideration of results and/or future work
5. Development of trial structure for bowhead whales off west Greenland
 - 5.1 Stock structure hypotheses
 - 5.2 Abundance estimates and trends
 - 5.3 Removals
 - 5.4 Biological parameters
 - 5.5 Need
 - 5.6 *SLAs* to be considered
 - 5.7 Development of *Evaluation* and *Robustness Trials*
 - 5.8 Consideration of results and/or future work
6. Progress with respect to common minke whales and fin whales
 - 6.1 Use of RMP/AWMP-lite
 - 6.2 Stock structure
 - 6.2.1 Fin whales
 - 6.2.2 Common minke whales
 - 6.3 Abundance estimates
 - 6.4 Removals
 - 6.5 Biological parameters
 - 6.6 Need
 - 6.6.1 Fin whales
 - 6.6.2 Minke whales
 - 6.7 Candidate *SLAs*/developing teams
 - 6.8 Potential trials structure
 - 6.8.1 Fin whales
 - 6.8.2 Minke whales
7. Future consideration of operational multispecies aspects in the provision of management advice
8. Completion of gray whale *SLA* evaluation for the Makah hunt (via Skype)
9. Work plan
10. Adoption of report

Annex B

List of Participants

Denmark

Mads-Peter Heide-Jørgensen
Lars Witting

USA (via Skype)

Jonathan Scordino
John Brandon
Dave Weller
Steve Stone

Japan

Toshihide Kitakado

Invited Participants

Doug Butterworth
Anabela Brandão
André Punt

Secretariat

Greg Donovan
Cherry Allison

Annex C

List of Documents

SC/D12/AWMP

1. PUNT, A.E. A Full Description of RMP/AWMP-lite.
2. PUNT, A.E. Trial specifications for humpback and bowhead whales off west Greenland.
3. BRANDON, J. AND SCORDINO, J. Suggested additional *SLA* variants to further evaluate the proposed Makah hunt.
4. WITTING, L. Suggestions for need envelopes.
5. HEIDE-JØRGENSEN, M-P. Maps of humpback whales tracked by satellite in West Greenland 2008-2010.

Annex D

A weighted-average interim-*SLA*-like *SLA*

André E. Punt

The interim-*SLA* determines the *Strike Limit* as the lesser of need and

$$0.02\hat{N}_e^{-1.645CV} \quad (1)$$

where \hat{N} is the most recent estimate of abundance and CV is the coefficient of variation of \hat{N} .

Equation 1 has the disadvantage of ignoring all the estimates of abundance except for the most recent estimate. An alternative estimator which uses all of the abundance estimates (but ignores any trend in the population size) would replace \hat{N} and CV in Equation 1 by:

$$\hat{N} = \exp \left[\frac{\sum_i \frac{0.9^{t_i} \ln N_i}{CV_i^2}}{\sum_i \frac{0.9^{t_i}}{CV_i^2}} \right] \quad CV = \sqrt{\frac{\sum_i 0.9^{2t_i} / CV_i^2}{\sum_i 0.9^{t_i} / CV_i^2}} \quad (2)$$

Where:

N_i is the i^{th} estimate of abundance,

CV_i is the coefficient of variation of N_i and

t_i is the time (in years) between when the i^{th} estimate of abundance was obtained and the first year of the block for which a *Strike Limit* is needed.

Annex E

Direct catches, bycatches and ship strikes to be included in the trials for humpback and bowhead whales

A revised version of the Catch Series is given in Annex F of the January 2014 Workshop report, available on the IWC website, <http://www.iwc.int>.

Annex F

Trial specifications for humpback and bowhead whales off West Greenland

See Annex E, Appendix 2, in this volume (pp.205-213).

Annex G

Summary results from additional runs requested for the proposed Makah hunt of gray whales

SLA variant	Final depletion		Rescaled final depletion		Final depletion		Rescaled final depletion	
	Low 5%	Median	Low 5%	Median	Low 5%	Median	Low 5%	Median
Trial GB01C								
SLA 1	0.259	0.343	0.314	0.383	0.357	0.458	0.505	0.594
6 strikes before May	0.259	0.343	0.314	0.383	0.357	0.458	0.505	0.594
5 strikes before May	0.259	0.342	0.314	0.383	0.357	0.460	0.505	0.596
4 strikes before May	0.262	0.344	0.317	0.383	0.359	0.462	0.512	0.598
3 strikes before May	0.267	0.346	0.323	0.386	0.365	0.463	0.509	0.601
2 strikes before May	0.273	0.349	0.330	0.394	0.371	0.468	0.525	0.611
1 strike before May	0.280	0.356	0.338	0.403	0.384	0.484	0.542	0.628
SLA 2	0.290	0.365	0.352	0.414	0.396	0.504	0.560	0.656
Trial GP01C								
SLA 1	0.382	0.461	0.400	0.472	0.492	0.556	0.492	0.557
6 strikes before May	0.382	0.461	0.400	0.472	0.492	0.556	0.492	0.557
5 strikes before May	0.382	0.460	0.400	0.472	0.492	0.556	0.492	0.557
4 strikes before May	0.390	0.464	0.406	0.476	0.487	0.560	0.487	0.562
3 strikes before May	0.396	0.468	0.414	0.479	0.508	0.566	0.510	0.567
2 strikes before May	0.405	0.476	0.424	0.488	0.533	0.584	0.535	0.584
1 strike before May	0.417	0.494	0.439	0.509	0.550	0.604	0.552	0.606
SLA 2	0.438	0.515	0.460	0.528	0.575	0.633	0.576	0.635
Trial GP02C								
SLA 1	0.231	0.272	0.255	0.295	0.330	0.442	0.475	0.578
6 strikes before May	0.231	0.272	0.255	0.295	0.330	0.442	0.475	0.578
5 strikes before May	0.231	0.272	0.256	0.295	0.330	0.442	0.475	0.582
4 strikes before May	0.234	0.276	0.260	0.299	0.341	0.441	0.486	0.579
3 strikes before May	0.241	0.281	0.267	0.304	0.343	0.443	0.489	0.582
2 strikes before May	0.258	0.297	0.284	0.319	0.345	0.451	0.497	0.595
1 strike before May	0.274	0.320	0.303	0.345	0.360	0.466	0.517	0.610
SLA 2	0.299	0.347	0.334	0.372	0.364	0.482	0.528	0.635
Trial GI01C								
SLA 1	0.378	0.446	0.399	0.459	0.475	0.536	0.476	0.538
6 strikes before May	0.378	0.446	0.399	0.459	0.475	0.536	0.476	0.538
5 strikes before May	0.378	0.449	0.399	0.46	0.475	0.537	0.476	0.538
4 strikes before May	0.381	0.451	0.401	0.465	0.475	0.542	0.476	0.543
3 strikes before May	0.387	0.455	0.407	0.469	0.482	0.549	0.483	0.549
2 strikes before May	0.395	0.465	0.416	0.478	0.508	0.566	0.510	0.567
1 strike before May	0.414	0.477	0.433	0.491	0.528	0.587	0.530	0.588
SLA 2	0.434	0.497	0.457	0.513	0.556	0.619	0.557	0.621
Trial GB08B								
SLA 1	0.259	0.343	0.314	0.383	0.357	0.458	0.505	0.594
6 strikes before May	0.259	0.343	0.314	0.383	0.357	0.458	0.505	0.594
5 strikes before May	0.259	0.342	0.314	0.383	0.357	0.460	0.505	0.596
4 strikes before May	0.262	0.344	0.317	0.383	0.359	0.462	0.512	0.598
3 strikes before May	0.267	0.346	0.323	0.386	0.365	0.463	0.509	0.601
2 strikes before May	0.273	0.349	0.330	0.394	0.371	0.468	0.525	0.611
1 strike before May	0.280	0.356	0.338	0.403	0.384	0.484	0.542	0.628
SLA 2	0.290	0.365	0.352	0.414	0.396	0.504	0.560	0.656
Trial GB10B								
SLA 1	0.382	0.461	0.400	0.472	0.492	0.556	0.492	0.557
6 strikes before May	0.382	0.461	0.400	0.472	0.492	0.556	0.492	0.557
5 strikes before May	0.382	0.460	0.400	0.472	0.492	0.556	0.492	0.557
4 strikes before May	0.390	0.464	0.406	0.476	0.487	0.560	0.487	0.562
3 strikes before May	0.396	0.468	0.414	0.479	0.508	0.566	0.510	0.567
2 strikes before May	0.405	0.476	0.424	0.488	0.533	0.584	0.535	0.584
1 strike before May	0.417	0.494	0.439	0.509	0.550	0.604	0.552	0.606
SLA 2	0.438	0.515	0.460	0.528	0.575	0.633	0.576	0.635
Trial GP08B								
SLA 1	0.231	0.272	0.255	0.295	0.330	0.442	0.475	0.578
6 strikes before May	0.231	0.272	0.255	0.295	0.330	0.442	0.475	0.578
5 strikes before May	0.231	0.272	0.256	0.295	0.330	0.442	0.475	0.582
4 strikes before May	0.234	0.276	0.260	0.299	0.341	0.441	0.486	0.579
3 strikes before May	0.241	0.281	0.267	0.304	0.343	0.443	0.489	0.582
2 strikes before May	0.258	0.297	0.284	0.319	0.345	0.451	0.497	0.595
1 strike before May	0.274	0.320	0.303	0.345	0.360	0.466	0.517	0.610
SLA 2	0.299	0.347	0.334	0.372	0.364	0.482	0.528	0.635
Trial GP10B								
SLA 1	0.378	0.446	0.399	0.459	0.475	0.536	0.476	0.538
6 strikes before May	0.378	0.446	0.399	0.459	0.475	0.536	0.476	0.538
5 strikes before May	0.378	0.449	0.399	0.46	0.475	0.537	0.476	0.538
4 strikes before May	0.381	0.451	0.401	0.465	0.475	0.542	0.476	0.543
3 strikes before May	0.387	0.455	0.407	0.469	0.482	0.549	0.483	0.549
2 strikes before May	0.395	0.465	0.416	0.478	0.508	0.566	0.510	0.567
1 strike before May	0.414	0.477	0.433	0.491	0.528	0.587	0.530	0.588
SLA 2	0.434	0.497	0.457	0.513	0.556	0.619	0.557	0.621