Response to the 'Panel Report of the JARPAII Special Permit Review Workshop'

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ABSTRACT
The International Whaling Commission's Scientific Committee (IWC SC) convened a workshop to review the progress made in the research conducted under the Japanese Whale Research Program under Special Permit in the Antarctic–Phase II (JARPA II) in its first six years (2005/06-2010/11). The review followed the guidelines specified in the Annex P. An international Panel of experts (Review Panel) carried out the review on the basis of 38 scientific papers prepared by the proponents, eight prepared by IWC SC members and five prepared by the proponents in response to some of the documents from the IWC SC members. Scientists involved in the JARPAII research participated in the workshop only to present papers on particular agenda items and to respond to questions of clarification and substance regarding the work that had been undertaken or further work that was expected to be undertaken. The report of the Review Panel is presented in document SC/65b/Repx. The present paper summarizes the views of scientists involved in the JARPAII research on the evaluation and scientific suggestions from the Review Panel. The scientists consider that, in general, the workshop report produced by the Review Panel represents a fair and balanced evaluation of the work conducted by the JARPAII in its first six years. The Review Panel welcomed the scientific contribution of JARPA/JARPAII. At the same time it identified those areas where further work is required and provided suggestions and recommendations that if correctly implemented, will contribute to improve analyses from the first six years of research as well as future research.

INTRODUCTION

The International Whaling Commission's Scientific Committee (IWC SC) convened a workshop to review the progress made in the research conducted under the Japanese Whale Research Program under Special Permit in the Antarctic–Phase II (JARPAII) in its first six years (2005/06-2010/11). The review workshop was conducted under the IWC SC guidelines specified in Annex P (IWC, 2013). According to Annex P the TOR of the workshop were the following:

a) Evaluate how well the initial, or revised, objectives of the research have been met;
b) Evaluate other contributions to important research needs;
c) Evaluate the relationship of the research to relevant IWC resolutions and discussions;
d) Evaluate the utility of the lethal techniques used by the Special Permit Programme compared to non-lethal tecnniques;
e) Provide advice on: i) practical and analytical methods, including non-lethal methods, that can improve research relative to stated objectives; ii) appropriate sample sizes to meet the stated objectives, especially if new methods are suggested under item i); iii) effects on stocks in light of new knowledge on status of stocks; and iv) when a further review should occur.

An international group of experts (Review Panel) examined a total of 38 scientific documents prepared by Japanese scientists (proponents), eight documents from IWC SC members, and five documents from the proponents responding to some of the documents prepared by IWC SC members. The report of the Review Panel is presented in document SC/65b/Repx.

The objective of the present paper is to summarize the views of scientists involved in the JARPAII research on the JARPAII evaluation and scientific recommendations from the Review Panel. It should be noted the short time between the date when the Review Panel report became available to the proponents and the deadline for

providing comments and responses to the report. Therefore in addition to the comments provided in this paper, the proponents will give further considerations to the suggestions and recommendations from the Review Panel during the next intersessional period.

The list of papers presented to the JARPAII review workshop by the proponents is shown in the Appendix 1. Specific analyses conducted in response to some short-term suggestions and recommendations are presented in documents SC/65b/J8, 9, 13, 27, 28, 29, 31, 32Rev and SC/65b/R1Rev.

OVERVIEW OF JARPAII OBJECTIVES

To understand the context of the research review by the Review Panel and the responses from the proponents, it is considered convenient to briefly summarize the research objectives of JARPAII. See details in Pastene *et al.* (2014).

The rationale for and research needs addressed by JARPAII were explained in the original research plan, which was presented and discussed at the IWC SC in 2005 (Government of Japan, 2005). The development of the research objectives of JARPAII took the findings of the JARPA into consideration (see details in Pastene *et al.*, 2014).

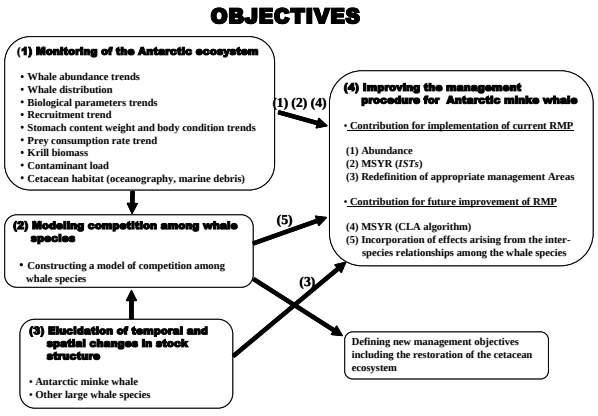
Objective 1 of JARPAII is the **'Monitoring of the Antarctic ecosystem'**: i) monitoring of whale abundance trends and biological parameters, ii) monitoring krill abundance and the feeding ecology of whales, iii) monitoring the effects of contaminants on cetaceans and iv) monitoring of cetacean habitat. Specific questions to be addressed under this objective were listed in Pastene *et al*. (2014).

Model building is essential for understanding, interpreting, and predicting the possible shift in the Antarctic ecosystem indicated under the Objective 1. Models would also contribute to the improvement of the IWC conservation and management measures, as indicated under Objective 4 of JARPAII. Objective 2 of JARPAII is therefore **'Modelling competition among whale species (to inform) future management objectives'**: i) constructing a model of competition among whale species; ii) new management objectives including the restoration of the cetacean ecosystem. Specific questions to be addressed under this objective were listed in Pastene *et al*. (2014).

Objective 3 of JARPAII is the **'Elucidation of temporal and spatial changes in stock structure'**; i) Antarctic minke whale; ii) other baleen whale species. Stock structure information is a basic requirement for the IWC conservation and management measures. In the case of the Antarctic minke whale it is essential for any future implementation of the RMP on this species in the Antarctic.

Objective 4 of JARPA II is **'Improving the management procedure for Antarctic minke whale stocks'**. The goals under Objective 4 will be addressed with progress of the work under the other three Objectives.

Figure below shows the interaction among the four Objectives of the JARPAII. Several parameters considered 'indicators' of change in the ecosystem are studied and monitored under **Objective 1**. The modelling exercise under **Objective 2** aims to provide interpretations to the pattern of changes observed under Objective 1: can these changes be explained only by the prey-predators interaction without the need for recourse to environmental change hypotheses? **Objective 4** depends on the results obtained under the other objectives: stock structure of Antarctic minke whale under **Objective 3**; abundance, MSYR and natural mortality of Antarctic minke whale under Objective 1, and multi-species interaction under Objective 2.



GENERAL COMMENTS

1. General view

The proponents consider that, in general, the workshop report produced by the Review Panel represents a fair and balanced evaluation of the work conducted by the JARPAII in its first six years. For each of the JARPAII research objectives as well for 'other important research needs', the Review Panel welcomed the scientific contribution of JARPA/JARPAII. At the same time it identified those areas where further work is required and provided suggestions and recommendations that if correctly implemented, will contribute positively to improved analyses from the first six years of research as well as future research.

2. Consideration of previous recommendations from the IWC SC

Most of the analyses conducted by the proponents followed previous agreed recommendations from the IWC SC. The list of previous recommendations and the way on how the proponents addressed those recommendations can be found in Appendix 4 of Pastene *et al*. (2014). One of the problems the proponents found during this review workshop was that the Review Panel did not always evaluate the analyses conducted in the context of the previous IWC SC recommendations. For some particular topics the IWC SC had previously made certain requests and some lines of analysis, only for the Review Panel to say they prefered something else. For example this was the case of the analyses on blubber thickness and stomach content weight (see below). Often, as here, each review 'group' wants something different, and naturally each is entitled to its own views. Nevertheless when the SC comes to consider the Panel Report and this response, the SC does need to take cognizance of the difficulties which arise for proponents in responding to issues raised when the next review 'group' disagrees with what the previous one wanted done.

3. Objectives of the JARPAII

The development of research objectives in JARPAII, their inter-relationship, and the scientific questions to be addressed under each of the objectives were clearly explained in Pastene *et al*. (2014). The proponents believe that this explanation contributed greatly to the smooth review of JARPAII results by the Review Panel. The proponents however agree that the objectives of JARPAII (particularly Objectives 1 and 2) could be further clarified by adjusting them to allign more closely with the guidelines of Annex P (which were developed after the JARPAII program was developed), as recommended by the Review Panel (see below).

4. Effect on the research of external disruptions

The proponents appreciate the recognition of the Review Panel of the external disruptions (sabotage from anti-whaling groups) that affected the research conducted using lethal and non-lethal approaches. Nevertheless for the oceanographic and krill biomass topics, the Review Panel expressed concern about the lack of oceanographic and krill biomass surveys in some years, yet apparently failed to recognize that the main reason for this was the external disruptions. The Panel should have drawn attention to this in the relevant section of the report (see below).

5. Competition among krill predators

The proponents were clear in explaining that competition among krill predators, and the possible effect of this on Antarctic minke whale biology, is a plausible hypothesis consistent with several kinds of data. They stated that this hypothesis should be further tested when future krill biomass time estimates and outputs of the ecosystem models become available (Pastene *et al*., 2014). Furthermore the proponents have also listed alternative hypotheses including an environmental one (global warming). In discussing the possibility of competition the Review Panel was to our view, too sensitive/defensive regarding this possibility, and attributed the proponents a position somewhat different to that explained in this paragraph (see below).

SPECIFIC COMMENTS AND RESPONSES

Relevant texts from the Review Panel report are copied here in plain letters and quotation marks, while the proponent comments and responses are written in italics.

1. Monitoring Cetacean habitat

'The proposal was implemented during the first four years of JARPA II by collecting data via XBTs, CTDs, an Electric Particle Counting and Sizing System (EPCS), and an echo sounder at the same times as the visual whale abundance survey was being conducted. Collection of such simultaneous data is an important component of being able to relate the physical and biological habitat with whale distribution and density and ultimately to assist

in developing an understanding of the role of whales in the ecosystem. Unfortunately, this was not done for the last two years (2009/10 and 2010/11) when only TDR data were collected'.

Oceanography and krill surveys under JARPAII were suspended from 2009/10 because of security concerns. In the past, anti-whaling sabotage vessels had attacked the dedicated oceanographic and krill survey vessel directly, and anti-whaling groups had increased qualitatively and quantitatively their sabotage activities in recent years. For security concerns these surveys have been stopped in recent years (see Annex 6 of Pastene et al., 2014). See also section 'General Comment 4' above.

'The Panel **recognises** the contribution of the long-term time series represented by the JARPA and JARPA II programmes, particularly in the context of simultaneous collection of whale and environmental data. However, the Panel is concerned that the necessary analytical work to fulfil the objectives of the programme has not received the attention and resources that it deserves. If the programme is to meet its objectives in the medium to long-term, the Panel makes the following **recommendations:**

(1) the collection of the full suite of oceanographic data be resumed in the coming season and the necessary calibration work be undertaken;
(2) the proponents investigate the availability and utility of other oceanographic and related data, including data on sea ice, archived in other Japanese or world databases and incorporate these with the data collected from the JARPA and JARPA II programmes to form a more comprehensive dataset (a useful catalogue of available data with links to many national Antarctic data centres is available from the Antarctic Master Directory at www.gcmd.nasa.gov/portals/amd/);
(3) the proponents consider make their oceanographic data available to other international programmes;
(4) the existing TDR and EPCS data are analysed to fully describe the datasets contents and review their usefulness in future habitat and whale analyses;
(5) concerted efforts begin to analyse the oceanographic and other environmental data in the light of the obtained cetacean sightings survey and biological data (more details are provided under the relevant agenda items below).

Item (1) can begin immediately. Work on Items (2)-(5) should also begin as soon as possible and the initial results presented within the next two-three years. Items (2) and (3) will also fulfil the aim in the original proposal to actively cooperate with international organizations and projects on oceanographic surveys which to date has not been achieved. In these times of limited funds and resources, such cooperation is important to maximise efficiency and benefit'.

The proponents concur with the Review Panel on these recommendations and will make effort to implement them in the timeframe suggested. They note however that recommendation (1) above will depend on the security conditions in the next surveys (see also section 'General Comments 4' above). If a continuous time series of oceanographic data are considered valuable, the proponents hope that the IWC SC in its 2014 annual meeting will make a statement condemning the sabotage activities against the research conducted under JARPAII (similar to previous Commission statements), including the oceanographic surveys, this being a necessary consequence of agreement with the Panel's recommendations.

Regarding point (3) above, the proponents are pleased to inform the IWC SC that all oceanographic data collected by JARPA and JARPAII in Antarctic Areas IIIE-VIW have been made open to the scientific community through the Institute of Cetacean Research web site, under the conditions specified there.

'The Panel **commends** the collection of debris data, both in the environment and in the stomachs of the whales that can provide valuable baseline data. Such information should regularly (the need to do this annually or less frequently should be evaluated) be analysed and presented to the IWC'.

Study of debris in the environment and in the stomachs of the whales will continue and the proponents will make efforts to analyze the data and present results to annual meetings of the IWC SC as suggested by the Review Panel. The appropriate frequency of the analyses and presentation of results will be considered and decided by the proponents in the next intersessional period.

2. Elucidate temporal and spatial changes in stock structure

'Scope of the studies

The Panel **agrees** that information resulting from the JARPA and JARPA II programmes has considerably increased our understanding of stock structure within the research area, which directly addresses Objective 3.

However, the Panel noted that Antarctic minke whales and other baleen whale species are more-or-less continuously distributed around the Antarctic continent; in contrast, the JARPA II research area represents just under half of the circumpolar area. Given the stated objective, the lack of information provided for areas outside the programmes' research area presents some inherent difficulties in fully meeting the objective to elucidate spatial and temporal variations in stock structure, even though the information developed under JARPA II is probably sufficient for the purposes of developing trials to evaluate RMP variants within the area of sampling. This issue is discussed in more detail below with respect to minke whales'.

Admittedly Objective 1 refers to the "Antarctic ecosystem" for simplicity of expression, but no research programme can in practice include studying "anything and everything" – priorities and resource limitations always have to be factored in. Nevertheless the JARPAII research area represents as much as about half of the circumpolar area, as is mentioned here as well in other sections of the report. As explained in Pastene et al. (2014), Objective 3 of the JARPAII (Elucidation of temporal and spatial changes in stock structure) is part of the JARPAII objectives directly related to assessment (fin, humpback, souther right and blue whales) and management under the RMP (Antarctic minke whale). As the Review Panel already noted, the information on stock structure developed under JARPAII is probably sufficient for the purposes of developing trials to evaluate RMP variants within the area of sampling, which is the area where Japan plans to carry out commercial whaling in the future under IWC regulation. In regions such as the western North Pacific and eastern North Atlantic the IWC SC has completed RMP implementations based only on stock structure data of the area concerned and not from the entire ocean basin.

The proponents agree that sampling from areas outside the JARPAII would be valuable, and the original JARPAII plan already considers the possibility to extend the sampling to adjacent areas giving consideration to logistics (Government of Japan, 2005), but naturally this depends ultimately on the resources available.

'Genetic data

The Panel **welcomes** the fact that the authors of SC/F14/J27 referenced the IWC guidelines for DNA data quality control (IWC, 2009) as had been recommended at the JARPNII review (IWC, 2010). However, the Panel **recommends** that a revised paper be submitted that explains in more detail how far the guidelines were able to be followed (the present paper did note why the proponents had not been able to follow one recommendation regarding sequencing of microsatellite loci)'.

The proponents agree with this recommendation from the Review Panel and consequently a revised document will be presented to the 2014 IWC SC meeting (SC/65b/J27Rev).

'*Antarctic minke whales*

SC/F14/J28 described new mtDNA and microsatellite genetic analyses of minke whales. The Panel welcomed the fact that, in response to comments from the JARPA review Workshop (IWC, 2008), the authors had doubled the number of microsatellite markers, sequenced a portion of the mtDNA molecule, and performed additional analyses, including use of the clustering program STRUCTURE (Pritchard *et al.* 2000) to evaluate evidence for more than one gene pool. This paper excluded samples from the putative mixing area, which were considered in SC/F14/J29. The Panel **acknowledges** the extensive laboratory and analytical work behind the paper. However, there are a number of places where additional information is required to fully interpret the results. For example, if the authors' hypothesis is correct that different proportions of stocks I and P mix in part of Area IV, then the F_{IS} values for that area should on average be positive, reflecting a deficiency of heterozygotes. Furthermore, the loci showing the most positive F_{IS} values should be the loci having the highest F_{ST} values among the two putative stocks (see Waples 2011). If the two-stocks-with-mixing hypothesis is true, then the analysis suggested above should also produce a positive correlation between F_{IS} and F_{ST} for samples taken from the area of putative mixing that were not considered in this analysis. Similarly, the magnitude of linkage disequilibrium at pairs of loci should be proportional to the product of F_{ST} at the two loci involved (Waples 2011). The mean F_{ST} estimated between the two stocks in this case is quite small (< 0.001), so these correlations might be hard to detect. If these analyses are conducted, it would be reasonable to start by evaluating only females, which show the strongest signal of differentiation.

The Panel makes the following detailed **recommendations** concerning SC/F14/J28:

(1) samples from the putative pure I and P Stocks have statistically significant differences in allele frequencies – a revised paper should provide the locus-specific F_{ST} or theta values for these comparisons to identify which loci are responsible for the differences;

(2) Table 4 presents evidence for overall deviations from Hardy-Weinberg (HW) expectations in both putative stocks – a revised paper should include F_{IS} values for each locus in each stock to provide information about the direction and magnitude of HW deviations and thus the biological importance of this result;
(3) the discussion section should be expanded to consider the results of the analyses suggested above'.

The proponents agree with these suggestions and recommendations from the Review Panel and consequently a document including those additional analyses will be presented to the 2014 IWC SC meeting (SC/65b/J28Rev).

'The Panel **welcomes** this effort to integrate genetic and non-genetic data (SC/F14/J29), noting that this is in accord with the Scientific Committee's view that stock structure can best be addressed using a suite of techniques and data types. The Committee has recognised that developing a quantitative integrative approach is complex. In terms of developing a revised paper in time for the forthcoming Scientific Committee meeting, the Panel makes the following **recommendations:**

(1) notation in the paper should be improved to avoid using the same index for individual and stock;
(2) the estimates of the parameters and their standard errors should be reported – this information could be used to identify which of the morphometric measurements is most informative regarding stock mixing;
(3) diagnostic statistics for the fits to the morphometric data should be presented;
(4) the meaning of the statement: 'The variables *G* and *M* are further assumed independent within an individual, and also between individuals' should be clarified – it is not clear whether this means that matrix *G* is assumed independent of matrix *M*, or that the different elements of *M* are assumed to be independent (i.e. is the Σ diagonal?);
(5) the parameters for each model should be documented to clarify how many of the parameters of the mean function and variance-covariance matrix (morphometric data) as well as the baseline allele frequencies (genetic data) are estimated parameters; and
(6) the discussion should explore the fact that one of the main results of this study—that morphometric data had a stronger influence on results than the genetic data—differs from that found in many other such studies, and the authors should suggest a possible biological explanation for this result'.

The proponents agree with these recommendations from the Review Panel and consequently a document including those additional analyses will be presented to the 2014 IWC SC meeting (SC/65b/J29Rev).

'In the longer-term, the Panel **recommends** that:

(1) the model be formulated as a random effects model (Bayesian or maximum likelihood). This may eliminate some of the problems associated with lack of convergence for some of the more complicated models – this might also reduce some of the large inter-annual fluctuations in mixing proportions, which a plot produced during the Workshop (Fig. 3) shows are generally very imprecise;
(2) more flexible functions for the relationship between longitude and proportion should be considered; and
(3) the benefits of applying the integrated model to all data (i.e., data aggregated by sex and maturity state) should be re-evaluated since, for example, there are clear between-sex differences in some of the morphometric measurements such as V7 (fig. 3 of SC/F14/J29) - a model with sex-specific values for the mean and variance functions for the morphometric data, but sex-independent distribution proportions should be explored'.

The proponents will consider these suggestions from the Review Panel in a new document that will be prepared for publication in a journal in the period between the 2014 and 2015 IWC SC meetings.

'Management procedure considerations on stock structure focus on developing plausible interpretations of available data not simply the single 'best' interpretation when examining uncertainty. In this spirit, the Panel **recommends** that during the coming year, the authors of SC/F14/J28 and SC/F14/J29 consider the merits of an alternative to the two-stocks-with-mixing hypothesis: a single stock that exhibits one-dimensional isolation by distance along a longitudinal gradient. This alternative is suggested by visual inspection of fig. 3 in SC/F14/J29, which shows how morphometric scores for individual whales vary by longitude. Morphology appears to vary more or less linearly along the zone of sampling, rather than being constant at the eastern and western extremes, with an area of mixing in between. Under isolation-by-distance, statistical comparisons of samples from the extreme eastern and western sampling regions could produce the types of results described in SC/F14/J28 (see Schwartz and McKelvey 2009)'.

In this and the following two paragraphs of the review report, the Review Panel agreed that consideration should be given to an alternative hypothesis on stock structure: single stock that exhibits isolation by distance along a longitudinal gradient.

The proponents do not agree with this suggestion for the following reasons.

It seems that the Review Panel developed this alternative hypothesis based on a single source of information that is Figure 3 of Document SC/F14/J29. However, the hypothesis of two stocks with mixing, proposed and accepted during the 2006 JARPA review meeting, was based on a parsimonious interpretation of several kinds of information, both genetics and non-genetics (see Pastene, 2006).

The Review Panel seems to have failed to recognize that the main motivation for the analyses in SC/F14/J29 was a recommendation from the JARPA review workshop in 2006 (IWC, 2008; see also Annex 4 of Pastene et al. (2014)), based on the two stock with mixing hypothesis. See also section 'General Comment 2 above'. The specific recommendation was the following: 'Transitional area could be studied by fitting a mixing model where the fraction of whales belonging to one putative population is a function of the longitude at which it was sampled. This could be a simple logistic regression model coupled with two-product multinomial models describing the allele frequencies in the two putative stocks either side of the transition area' (IWC, 2008).

Furthermore sighting data in low latitude areas suggests high density areas on both eastern Indian Ocean and western South Pacific. Although no genetic information is available for low latitude areas, the fact that these high density areas coincide with the western and eastern sectors of the JARPAII research area (which showed significant genetic differences) is consistent with the hypothesis of two stocks with mixing.

As the Review Panel noted, interpretation of results of any isolation-by-distance analyses will be complicated by the fact that Antarctic minke minke whales are migratory, and the genetic data are collected on the feeding grounds rather the breeding grounds, and by the fact that the magnitude of genetic differentiation is small (see also discussion on the analysis of isolation-by-distance in North Pacific minke whales, IWC, 2001).

'Pastene (2006) provided a useful historical perspective and summary of hypotheses and results of studies regarding stock structure of Antarctic minke whales. This summary was particularly valuable as it included discussion of a number of potential stock-structure indicators in addition to genetics, including tagging data, pollution studies, ecological markers, morphometrics, size at physical maturity, and sighting and catch distributions. However, some types of information collected by JARPA II (such as oceanographic data) were not integrated into the analysis. The Panel **recommends** that the Proponents attempt to collect/incorporate other types of information that were not discussed but which potentially could be important to elucidate temporal and geographical changes in minke whale stock structure, including building upon recent developments in satellite tags (the Panel recognises the practical difficulties but believes that the gains could be important for a number of topics under the programme in addition to stock structure), stable isotopes of C, N and O, and fatty acids (e.g. see IWC, 2014)'.

The proponents will consider this recommendation but will need to give consideration to the utility and feasibility of the alternative approaches for stock structure studies of the Antarctic minke whale.

'SC/F14/J31 reported results for microsatellite DNA analysis of the Antarctic samples (but not the lower latitude samples) of humpback whales analysed for mtDNA in SC/F14/J30. The authors increased the number of loci from 6 to 14 in response to the recommendation of the JARPA review Workshop (IWC 2008). Table 3 of SC/F14/J31 shows that each sample was in agreement with overall Hardy-Weinberg (HW) equilibrium, but no information was given in the text about the results of these tests or how they varied among loci. Other tables show p-values for heterogeneity tests comparing samples from different areas or times. The Panel **recommends** that an updated paper be submitted in which the tables also include the effect size (e.g. F_{ST} values)'.

The proponents agree with this recommendation from the Review Panel and consequently a document with an updated Fst table will be presented to the 2014 IWC SC meeting (SC/65b/J31Rev).

'While welcoming the new information on fin whale stock structure (SC/F14/J32) (a subject that has not been examined by the Scientific Committee for many years; Donovan, 1991), the Panel was concerned at some aspects of the analyses and interpretation. It therefore **recommends** that an updated paper be provided that:

(1) omits the analysis using *post-hoc* groupings unless the authors can provide a robust statistical justification for this approach;
(2) discusses in more detail the fact that three microsatellite loci showed significant departures from Hardy-Weinberg (HW) expectations after accounting for multiple testing before the data are used in other analyses;
(3) provides F_{IS} values for each locus in table 7 of SC/F14/J32, which would indicate whether the HW departures represent an excess or deficiency of heterozygotes; (that information is essential to understand the possible causes for the deviations);
(4) shows how the samples were arranged into management Areas in fig.1; and
(5) recognises that conclusions about possible differences between Areas IV and V are provisional until the nature, cause, and influence of these HW deviations are resolved'.

The proponents agree with these recommendations from the Review Panel and consequently a document with those additional analyses will be presented to the 2014 IWC SC meeting (SC/65b/J32Rev).

'In the longer term, in order to increase sample sizes the proponents should examine the availability of historic tissues that may be used for genetic studies (e.g. from commercial whaling or biopsy samples from other research cruises)'.

The proponents agree with this recommendation from the Review Panel and will spend time in the next intersessional period to examine other sources of genetic samples of fin whales, and their utility.

3. Monitoring whale abundance trends and distribution

'Given the importance of $g(0)$ estimation to the Antarctic minke whale abundance estimation (IWC, 2013) and the necessarily *ad hoc* approach used in SC/F14/J3 to account for this in the JARPA and JARPA II programmes where the independent observer approach had not been implemented, the Panel **recommends** that consideration be given to using an independent observer approach in future surveys'.

The proponents agree with this recommendation from the Review Panel, and the option of 'passing with Independent Observer mode' will be planned for inclusion in future dedicated sighting surveys in the Antarctic as has been the case of previous sighting survey proposals (e.g. Matsuoka et al., 2013), which could not be implemented due to external sabotage by anti-whaling groups.

'It is important to remember that the estimates of abundance and trends presented in the papers to the Workshop represent numbers (and trends) of animals within particular geographic areas at particular times of the year. In some cases, such as Antarctic minke whales, humpback whales and blue whales, this probably covers the peak of their distribution in the austral summer. However, for others such as fin whales, this is not the case based on their past distributions. In perhaps the most extreme case of sperm whales, only large males penetrate south of 60°S. While the authors note these issues, the Panel **reiterates** that considerable care should be given to their interpretation'.

The proponents agree with this observation from the Review Panel. This issue was addressed in the published papers on Antarctic minke and humpback whale abundance estimates, and will be carefully considered in the interpretation of the abundance estimates of fin, blue, southern right whale when papers on these species are prepared for publication (see below).

'In all cases, *if* the results are intended to provide inferences of population trends, then careful consideration needs to be given to the questions of stock structure; this can be particularly complex for cases/areas where separate breeding stocks overlap on the feeding grounds. While this is covered briefly in the papers presented, these matters need to be considered more thoroughly by the authors in the discussion sections of their papers'.

The proponents agree with this observation from the Review Panel. One of the important issues in the next step of JARPAII will be the integration of information obtained under different objectives. For example the refined information on stock structure obtained under the Objective 3 in the first period of JARPAII will be used in the interpretation of the abundance estimates and abundance trend under the Objective 1 (see also below).

'Recognising the value of these datasets and welcoming the analyses presented, the Panel **recommends** that a revised stand-alone paper for the 'other' baleen whale species (i.e. not the Antarctic minke and humpback whales – these have already been published) is developed (and submitted for publication) that:

(1) presents a more thorough description of methods and assumptions used (bringing in some of the information presented in other papers such as SC/F14/O2):
(2) highlights the issues related to small sample size and the recommendations made at the JARPA review meeting, including those relating to use of the SSV data and the treatment of non-surveyed areas);
(3) identifies more clearly the differences between ideal and realised tracklines by year including percentage achieved coverage;
(4) explains more fully the treatment of additional variance components in the estimation of rates of increase;
(5) includes more extensive discussion than at present of the results including interpretation of the results with respect to stock structure and proportion of range covered, the implications of the sensitivity results on the confidence intervals obtained within the 'base case', the merits of the inclusion or exclusion of abundance estimates that rely on considerable extrapolation within the trend estimation process; and
(6) includes an updated power analysis of the effects of survey interval and estimation of trend to inform consideration of levels of effort and survey design in the future.

The proponents agree that a revised stand-alone paper for the 'other' baleen whale species should be prepared, considering Recommendations (1)-(5) above, during the next two years. Calculations related to (6) will also be considered.

'With respect to the toothed whale estimates, there are some additional issues that arise in the context of $g(0)$, which is considerably more difficult to estimate for sperm and bottlenosed whales given their diving behaviour. The authors need to consider, given these issues and the lack of knowledge of the full distribution of these species, whether the production of absolute abundance estimates is feasible or valuable'.

The proponents agree to consider these important issues and will decide whether the production of absolute abundance estimates is feasible or valuable for the toothed whales.

'The Panel also **recommends** the collection of data on the ecotype of killer whales to try to allow estimates of abundance to be developed for each. This information is of importance to ecosystem modelling given their different feeding habits and in particular to evaluate the consequences of predation on minke whales'.

Currently the vessels do not close on the sightings of killer whales so it is not possible to identify ecotypes if the sighting occurs far from the vessel track. In future if an initial sighting occurs near to a vessel, effort will be make in identifying the ecotype of killer whale.

SCAA analyses
We assume that responses on technical suggestions and recommendations from the Review Panel will be addressed by the author of SC/F14/O2. Here the proponents comment on some general aspects of the review of this research topic.

'MSYR
As the author noted, the variability in MSYR in the sensitivity tests (SC/F14/O2, table 8) indicates that the model is not able to reliably estimate MSYR. It appears that there is little contrast in the data required to estimate MSYR. Previous versions of the model had given MSYR estimates. However this may have been an artefact of the relatively inflexible nature of model structure. The Panel **recommends** that the ability to estimate MSYR should be revisited in the future in light of the availability of new data'.

The term MSYR is simply a convenience to summarise considerations of resource productivity. The proponents agree that the results provided indicate that these SCAA models cannot estimate the literal MSYR (the MAXIMUM sustainable yield rate) robustly. That however does NOT imply that the SCAA results provide NO information on minke whale productivity. What IS robustly estimated by the SCAA is a pre-exploitation rate of increase of Antarctic minke whales which is certainly well above what would be compatible with the minimum MSYR1+ value of 1% currently accepted for use in RMP Implementation Simulation Trials (ISTs). This obviously has very important implications for conditioning ISTs for Antarctic minke whales, and the relative plausibilities to be assigned to different levels of minke whale productivity in such trials.

'The Panel also noted that if further analysis of genetic and morphometric variations in minke whales from the JARPA II study area supports the alternative hypothesis of a single stock in which individuals are isolated by distance (see Item 5.2) rather than two stocks which mix, substantial revision to the SCAA model would be required'.

The proponents consider that the basis of the Review Panel for proposing examination of the alternative stock structure is weak (see above for details on the proponents view on this issue).

'Changes in growth rates through time

The model produces estimates of rapid growth in the early time period and slower growth in more recent years, with a transition between the early 1980s and around 1990 (SC/F14/O2, fig. 5). The estimated growth rates are, however, largely determined by data on the smallest individuals, and few small individuals were caught during the commercial hunt. Therefore, estimated growth rates in the earliest period may be unreliable. This issue should be considered further because, at present, it is difficult to reconcile the age-at-maturity time series presented in SC/F14/J8 with the growth rates estimated by the SCAA model. The time series presented in SC/F14/J8 suggests that growth rates did not decline during the 1980s and were relatively constant for all cohorts born since about 1965. The Panel **recommends** that the proponents and developers of the SCAA work to resolve this apparent inconsistency'.

This issue should be addressed after the suggested analyses on age at sexual maturity are completed (see below). Nevertheless the proponents will start discussing this issue with the developers of the SCAA during the 2014 IWC SC meeting.

'The Panel **agrees** that sensitivity tests such as those undertaken to examine the effects of including (excluding) the JARPA/JARPA II abundance data from the SCAA are useful for considering the future design of JARPA II. For example, if the annual JARPA II abundance data have little effect on results from the SCAA, the proponents might be presented with an opportunity to spend less time conducting sightings surveys while spending more time addressing other issues. For example, if a sighting survey was not conducted one year, the time at sea could be used to conduct a process study focussed on field work that examines the possibility of competition between whale species (see Item 6.3.3 above)'.

The proponents do not agree with the last suggestion from the Review Panel. The proponents would be surprised if it turns out that these data do indeed have little effect, but even if they do the JARPAII sighting surveys are not conducted for the aim of the SCAA analyses only but also for some other aspects of the research related to Objective 1 and 2 as well (e.g. abundance trend by the Line Transect Method, input for ecosystem models). Those objectives require consistent annual surveys in the research area. Furthermore, with subsequent RMP application in mind, it is important to continue such surveys to provide a level of input to the CLA which will lead to efficient usage of the resource.

'Alternative approaches to abundance estimation

SC/F14/J7 reported results of a preliminary evaluation of use of paternity analysis to estimate abundance of Antarctic minke whales. This exercise genotyped 137 female-foetus pairs collected during 2003/04 JARPA cruises and searched for matches among the > 1,700 males in the genetic dataset. One likely match to a male parent was found. The analytical procedures used and the caveats provided were generally appropriate. The Panel **welcomes** this general approach because it has considerable potential to provide useful information and had the following comments on this preliminary evaluation:

(1) a point estimate of abundance based on a single parent-offspring match is of questionable value, since (a) the confidence intervals are so wide - Bravington *et al.* (in a report on southern bluefin tuna, awaiting full reference) shows how to calculate the number of matches required to produce an estimate with a specified coefficient of variation and (b) the point estimate is unstable in that the addition of even a single recapture dramatically reduces the point estimate; and
(2) although a brief mention is made of the importance of random sampling, this crucial topic merits a fuller treatment, given the fact that all samples are restricted to an area that represents less than half of the summer distribution of the species'.

The proponents agree with those comments from the Review Panel which were addressed at some extent in SC/F14/J7. These comments will be considered in more details when the proponents develop this genetic method for abundance estimation further.

'Distribution

While welcoming the use of more quantitative approaches to examining distribution, the Panel **notes** the methods used are somewhat simplistic. The Panel therefore **recommends** that a more rigorous area occupancy analysis should be undertaken that incorporates recent advances in spatial modelling (e.g. Bravington and Hedley, 2012), accounting for whale detectability and the encounter rate process, including autocorrelation, and thus reflecting spatially-explicit differences in density. In addition, the choice of explanatory variables in spatial models should better reflect the environment that describes the distribution of each species, such as sea-ice, primary production and oceanography, incorporating a broader dataset than simply using JARPA and JARPA II data alone (and see Item 4). Recommended remote sensing resources, as used in other analyses (e.g. Beekmans *et al*. 2010) are, *inter alia*, bathymetry databases (GEBCO or others) and related indices such as distance to shelf break and other contours; ocean colour for chlorophyll concentration (NASA Sea-viewing Wide Field-of-view Sensor, SeaWiFS) or related; sea ice concentration and related ice indices, including distance to the sea ice edge, maximum and minimum seasonal sea ice extent, and sea ice season duration; sea surface temperature (SST); frontal zone location positions of the Southern Antarctic Circumpolar Current Front (SACCF) and the Southern Boundary of the Antarctic Circumpolar Current (SBACC), and sea surface velocities (SSV)'.

'The Panel **agrees** that the index of area occupancy to predict presence-absence also needs to be improved by re-formulating the analysis as a line-transect based spatial model. This will increase the accuracy of fine-scale prediction and will improve the analysis of segregation in distribution range between minke and humpback whales. In addition, the index used to investigate the extent of overlap in distribution ($z_i = p_{x,i} - p_{y,i}$ where i is a small scale prediction grid cell, $p_{x,i}$ is the probability of presence of minke whales, and $p_{y,i}$ of humpback whales) is not valid in its present form, as it is based on models and predictions independently derived for each species. Moreover, many different combinations of $p_{x,i}$ and $p_{y,i}$ yield identical z_i values, although the interpretation of those values could be very different. A proposed solution to this problem is modelling together the spatially-explicit probabilities of absence of both species ($p_{00,i}$), presence of minke whales ($p_{x0,i}$), presence of humpback whales ($p_{0y,i}$), and presence of both species ($p_{xy,i}$) in response to spatial covariates. The observed presence of each species in a grid cell can be treated as a sample from a multinomial distribution, and estimation in a GAM analysis context can be achieved as in Beare et al. (2003) using a binomial or Poisson regression approach, or alternative solutions'.

The proponents generally agree with these sections by the Review Panel. The model developed by the Bravington and Hedley (2012) used double platform data. However, because such data were not collected, the model cannot be applied to JARPA/JARPAII directly. As the aim of the analysis was not to examine relationship between environmental factors and spatial distribution of whales, but rather estimation of spatial distribution itself, the proponents consider that the use of fewer covariates would be sufficient to achieve that goal. However, the proponents will consider the inclusion of other environmental factors in the model to try to understand distributional ecology of whales. Because remote sensing environmental data at the time of the survey are scarce, especially in the early period of the JARPA, the proponents will investigate the use of climatological data as in the case of Beekmans et al. (2010). The proponents will also consider improvement of the index of area occupancy estimate as suggested by the Review Panel.

'As part of their discussion of distribution, the proponents note that a major motivation of the work presented is in response to Objective 2, and in particular inter-specific competition. Their main emphasis is on Antarctic minke and humpback whales, and the ecological consequences of their competition. However, the Panel **agrees** that despite the apparent changes in distribution and relative abundance of these two species, any firm conclusion is premature[1] and is but one of several possible hypotheses to explain existing data and for use in modelling. The Panel **notes** that at this stage the proponents have failed to develop a proposed underlying hypothesis for this competition, or the formulation of a conceptual model to develop an analytical framework. Studies on whale competition are rare, and mostly investigate the partition of resources utilised by different species on the feeding grounds (e.g. Friedlander et al. 2009, Santora et al. 2010). This requires a characterisation of the spatial distribution of each whale species in relation with environmental variables, and the distribution, abundance and behaviour of their common prey'.

'To this aim, the Panel **recommends** that the focus of future effort should include work that will enable specification of a hypothesis as to how the proposed competition in the Antarctic ecosystem is taking place as well as other alternative hypotheses. The Proponents should show that the attribution of correlational results to competition is not confounded by the consequences of oceanographic shifts and changes in carrying capacity

[1] SC/F14/J18 stated that 'The results indicated that competition between humpback and Antarctic minke whales for habitat in Area IV during the period of JARPA and JARPAII was intensified as abundance of humpback whales increased'.

leading to changes in prey and whale distribution and abundance. This requires conclusive evidence of foraging preferences, shared use of the same prey field by different whale species and information that the prey field is somehow unable to satisfy the demands of all predators that are sharing the resource. For this, the Panel **recommends** the use of dedicated methods such as TDRs linked to satellite telemetry to characterise species-specific diving ranges in relation with the size and distribution of krill aggregations; and use of indirect methods to compare prey preferences. The Panel **refers** to the full discussion of related matters in the context of the SOWER 2000 programme (IWC, 2000). It **stresses** the importance of swarm size as well as average density with respect to studies of energetics and successful feeding of baleen whales. In order to develop plausible hypotheses for use in ecosystem modelling as part of JARPA II, the Panel **recommends** that the proponents invest effort in some and preferably all of the following:

(1) analysis of proximity of whale species in the sighting survey tracklines – this can be done with existing data and initial analyses should be possible within the next year;
(2) focused studies of prey swarming behaviour and density in relation with local whale distribution and abundance – this may require a change of fieldwork focus for one or more seasons and integrated data from focal follows, telemetry (radio and/or satellite), krill abundance and density estimates and biopsy sampling (for *inter alia* stable isotope analysis);
(3) comparison of prey in stomach contents in areas where both species overlap in distribution, and in areas where they segregate, including investigation of whether whale species and krill length-maturity classes exhibit distinct spatial segregation in their distribution patterns – this can begin with existing samples and it should be possible to present a progress report within the next two years; and
(4) analysis of stable isotope ratios of C, N and O from tissue samples – initial examination of the discriminatory power of such analyses can occur with existing samples preserved dry or frozen'.

The proponents welcome the Review Panel's recognition of the apparent changes in distribution and relative abundance of Antarctic minke and humpback whales based on the results of JARPA/JARPAII. The Review Panel seems however to have misunderstood the view of the proponents regarding the hypothesis on competition. Like the Review Panel, the proponents consider the competition as a plausible hypothesis among other possible hypotheses, including the effect of environment change. The proponents also consider that the overlap of spatial distribution as revealed by the analysis presented to the review workshop and the partition of resources revealed by other studies, can be used as inferential evidence of the existence of competition among whale species. The results of these processes would ultimately result in changes of population parameters. In this regard, the proponents are attempting to develop ecosystem models to try capture such aspects.

The proponents agree with the view of the Review Panel that studies on whale competition are rare. Furthermore, scaling up and down the competitive relationship among whale species from at the level of individual to population have not been thoroughly studied in the community of whale scientists. JARPAII is an ideal platform to investigate competition among whale species which is challenging, but important for understand their ecology. Integration of several analytical methods would be required to achieve the goal. The proponents will consider refining the formulation of a conceptual model to develop an integrated analytical framework based on the suggestions by the Review Panel. The proponents will also consider carefully each of these useful specific recommendations in the intersessional period including their feasibility and relevance to JARPAII objectives.

Overall though, the proponents have the sense that the Review Panel is overemphasizing the need for detailed models of fine scale mechanisms to reflect competition in such models. Rather, and consistent with discussions in the Ecosystem Model Sub-Committee in the 2013 IWC SC meeting, the proponents consider it more likely that fits of more empirical models (SC/F14/J29) including competition effects to time-series data will provide the most productive approach for advance in this area.

4. Monitoring krill abundance and feeding ecology of whale stocks

'Krill abundance

The estimation of krill abundance represents a fundamental component of JARPA II and is central to its ability to meet its ecosystem-related objectives. As described in section 10.2.1.1, a reliable time series of krill abundance is required in order to quantify possible competition between whale species. SC/F14/J19 presented the results of two directed surveys for krill. While welcoming the work to estimate krill abundance the Panel had concerns over the interpretation of results in the paper. In particular, the size compositions used for classifying acoustic targets as Antarctic krill, *E. superba*, appear to be contaminated by data on other euphausiid species. For example, fig. 3a of that document indicates that no Antarctic krill were included in the size-frequency

distribution of animals collected from stratum IV-NW during 2007/08. The Panel **recommends** that the biomass estimates reported in SC/F14/J19 be recomputed using size compositions that, in northern strata, are representative of *E. superba* only since this is the primary species of krill that minke whales consume in these strata. For strata IV-SW and V-SE, which respectively include Prydz Bay and the Ross Sea, the Panel **recommends** that separate size-frequency distributions and biomass estimates be made for *E. superba* and *E. crystallorophias'.*

The proponents agree with these two recommendations. Recognizing that the number of tows is small in some strata, the proponents will investigate the availability and utility of body length data of krill in the stomachs of Antarctic minke whale as an alternative data source. A progress report paper will be prepared for the next year (2015) IWC SC meeting.

'The Panel **recommends** that the recomputed biomass estimates reported in SC/F14/J19 be compared to biomass estimates made from acoustic data collected during JARPA as soon as possible. As the authors themselves have noted, to make this comparison, the acoustic data from both JARPA and JARPA II must be processed in the same way. Such comparisons have the potential to provide the first direct evidence as to whether there have been changes in the biomass of krill in the JARPA II study area'.

The proponents agree with this important recommendation from the Review Panel. They will give high priority to this work and it hope to complete it in a 1-2 years period.

'However, the Panel also highlighted the fact that the data from the JARPA and JARPA II programmes alone are limited. It therefore **recommends** that any such comparisons also include biomass estimates from the BROKE (Nicol *et al.*, 2000) and BROKE-WEST (Nicol *et al.*, 2010) surveys. It is important to note that during the BROKE survey, acoustic data were collected at only two frequencies. To compare JARPA and JARPA II acoustic biomass estimates to that from BROKE, it might be necessary to reprocess the existing JARPA and JARPA II data using only the frequencies used in BROKE. The Panel **stresses** that limiting processing of acoustic data collected during future surveys to two frequencies is **not** recommended'.

As a first step, the proponents will examine in detail the krill biomass estimates from the BROKE and BROKE-WEST surveys to decide if a sound combination of both data sets is possible. This examination will be made in the next intersesional period.

'The understanding of krill biomass (and any trends in it) is fundamental to future work under JARPA II if it is to meet its objectives. Whilst recognising issues associated with outside disturbance, the Panel is **concerned** that not enough effort has thus far been made in JARPA II to address this issue. The Panel **notes** that the IKMT net used during JARPA II is appropriate for the objective of observing the species and size compositions of euphausiids in the JARPA II study area, but **agrees** that an insufficient number of IKMT tows were made during the two krill surveys reported in SC/F14/J19. The relatively few tows that were made during surveys conducted in 2007/08 and 2008/09 were not likely to have provided representative data on the species composition of euphausiids nor on the size composition of *E. superba* in the study area. For example, only two tows were made in the IV NW stratum during 2007/08, and *E. superba* were not caught in either tow'.

While the proponents agree with this observation from the Review Panel, the Review Panel should again draw attention to the fact that this non-lethal survey was also affected by external sabotage. The report gives the impression that the Panel underestimated the actions and effects on the krill surveys of the external sabotage by anti-whaling groups. This said, the proponents will make efforts first to re-start krill biomass surveys and then to increase the number of IKMT tows in the strata. See also 'General Comment 4'.

'The Panel **welcomes** the fact that a substantial number of random krill samples (about 200g per sample) were collected from the stomachs of whales sampled during JARPA and JARPA II and archived at the ICR (Table 1). Some of the krill samples have already been processed to provide size-frequency distributions (using about 50-150 krill per sample). A smaller number of samples have also been processed to provide maturity-stage distributions of the krill. All krill samples archived from collections made prior to 1996/97 have been processed, but a substantial number of the samples archived from collections made since 1996/97 have yet to be processed. Size and maturity distributions are extremely valuable for understanding the dynamics of the krill stock in the JARPA II study area and the Panel **recommends** that the archived krill samples be processed to characterize size-frequency and maturity-stage distributions as a matter of priority. The Panel also **recommends** that the proponents collaborate with Members of SC-CCAMLR to use data collected from the archived samples in an effort to study the population dynamics of krill'.

The proponents agree with the first recommendation from the Review Panel and will organize the relevant work in the next intersessional period. Regarding the second recommendation, the proponents will contact members of the SC-CCAMLR in the next intersessional period to discuss methods for examining the data collected on krill which are focused to understand the population dynamics of this species in the JARPAII research area.

'The Panel **recommends** that future krill surveys conducted during JARPA II employ survey design standards, including the spacing between net-tow stations along the acoustic transect lines, similar to those developed and implemented for the CCAMLR 2000 (Trathan *et al.* 2001), BROKE (Nicol *et al*. 2000), and BROKE-West surveys (Nicol et al. 2010). It would also be useful for the proponents to discuss survey design issues with scientists outside the JARPA II programme that have experience in conducting krill surveys.

The Panel **notes** that the backscattering strength threshold (log $S_v \leq$ -80dB) used thus far during JARPA II is potentially biasing low the acoustic krill biomass estimates. The proponents indicated that the threshold values were selected to accommodate the excessive noise of the research vessel, recognising that this would affect the detection of small krill. The depths over which backscattering data were integrated to estimate krill biomass (15-150m) were also limited by vessel noise (more typically, backscattering data on krill are integrated down to 250m). The Panel **recommends** that future krill surveys be conducted using a more appropriate vessel since krill biomass estimates are required to meet the objectives of JARPA II. Noise standards for conducting acoustic surveys have been discussed by ICES (1995).

Future krill surveys should be frequent because the density of krill in any given stratum may vary significantly from year to year, and the objectives of JARPA II require a time-series view of how the prey field is changing over time. The JARPA II study area is very large, and it is probably not possible to survey the entire study area every year with a single survey vessel. Thus, the Panel **recommends** either using multiple survey vessels to synoptically cover the JARPA II study area every 1-3 years or using one vessel to survey alternating halves of the study area every year (similar to the approach taken for sighting surveys)'.

The proponents thank the Review Panel for all these suggestions and recommendations. Regarding to the first recommendation the proponents will contact members of the SC-CCAMLR to discuss the best way to conduct the krill surveys including number of tows and distance between stations. Regarding to the last two recommendations the proponents note that economic considerations will need to be taken into account in their implementation, but they will nevertheless consider them further.

'Feeding ecology, consumption rates and inputs to ecosystem modelling
The Panel **agreed** that the approach proposed in SC/F14/R1 is both a positive development and a useful way forward. However this work is at its beginnings only; without the results of a thorough analysis, the Panel is unable to determine whether JARPA II has provided or will provide consumption estimates within a sufficiently narrow range. The Panel **recommends** that work proposed in SC/F14/R1 be further developed and allocated high priority. Ideally a new paper should be submitted to the next meeting of the Scientific Committee. As a minimum, this should advance the outlined work plan by including in the Monte Carlo simulations, uncertainty in:

(1) *r* (the ratio of low/high feeding intake) and the length of the feeding season for Method 1; and
(2) the extent of night feeding for Method 2.

The Panel also **recommends** that the work is extended by computing a time series of Monte Carlo results for the total potential consumption of krill using abundance estimates of minke whales (preferably those estimated by the SCAA model) and the uncertainties around these estimates.

Further development of the work plan proposed in SC/F14/R1 will be presented to the 2014 IWC SC meeting (SC/65b/R1Rev), and the work will start after considering comments from the IWC SC members.

These analyses are an essential consideration as to the extent to which the JARPA II programme in its present form is able to meet its objectives. The Panel therefore **recommends** that the results of the Monte Carlo work be used to re-evaluate the future research and sampling in JARPA II. This should include an exploration of the sensitivity of the Monte Carlo distributions of consumption estimates (for both individuals and for the total stock(s) of whales) to a reduction in the uncertainty of each parameter and to the choice of allometric relationship between body mass and metabolic rate. Future research should be targeted to reduce uncertainties in the parameters to which the Monte Carlo distributions of consumption estimates are most sensitive. Such approach could also be used both to aid determination of future sample sizes by estimating how many samples

would be needed to reduce uncertainties in consumption estimates by a desired level and to assess whether lethal or non-lethal sampling or a combined approach represents best way of reducing such uncertainties.

The proponents note that, according to the original JARPAII plan, survey design and sample size in JARPAII depend on several other research items of JARPA II, mainly those related to Objective 1 such as age at sexual maturity, pregnancy rate and blubbler thickness temporal trends, not on stomach content analysis alone. This suggestion could nevertheless be useful in case survey design and sample size of JARPAII are re-evaluated in future.

'The Panel **agrees** that results presented in SC/F14/J16 (figs 4-6) indicate substantial overlap in the sizes of krill that are consumed by Antarctic minke whales and fin whales when sampled near the same locations and times, noting also that the sample size for fin whales is small, restricted to smaller individuals and outside the species main distribution area. As elsewhere in this report, however, the Panel **cautions** the proponents over any over-interpretation that this proves that there is 'inter specific interaction' or competition between these species in any limiting sense (e.g. see SC/F14/J18), rather than it being one of several potential hypotheses. SC/F14/J16 suggests that differences in the size composition of krill consumed by both species will be determined by the size-specific distribution of krill. The Panel notes that while the distributions of minke and fin whales overlap, minke whales are most abundant farther south and fin whales are most abundant farther north; the size compositions of krill in the areas where these whales are most abundant may differ, and, if so, that would tend to lessen the strength of interactions between them. The Panel also noted that when the best available point estimate of krill biomass in Area IV during 2007/08 (12.5 million tonnes, SC/F14/J19) is compared with the best available point estimates of krill consumption by minke whales (0.37 million tonnes using Method 1 and 0.33 million tonnes using Method 2, SC/F14/J15) and fin whales (0.05-0.42 million tonne using three different allometric relationships between body mass and metabolic rate, SC/F14/J16), the hypothesis that minke whales and fin whales are competing for krill in a limiting sense does not seem well supported. These point estimates suggest that together both species of whales might have consumed about 6% annually of the standing biomass of krill and thus that krill biomass was not limiting'.

Again the Review Panel seems to have misunderstood the view of the proponents regarding the hypothesis on competition (see also 'General Comment 5' and the proponents response in item 6.3.4). Like the Review Panel, the proponents consider the competition as a plausible hypothesis among other possible hypotheses, including the effect of environment change. In none of the documents or oral presentations made at the workshop the proponents stated that the data and analyses presented 'proved' or 'confirmed' this hypothesis. They stated that this plausible hypothesis should be further tested when future krill biomass time estimates and outputs of the ecosystem models become available (Pastene et al., 2014).

Here the Review Panel is concerned about the possibility of competition, and queries its plausibility by referring to the combined annual consumption being much less than the standing stock of krill (a ratio of only about 6%). However the appropriate comparison is not to krill biomass, but to a measure of krill production. The annual krill production available to major predators has been estimated to be in the range of 15-25% of biomass (Mori and Butterworth, 2004), so that the ratio which the Review Panel quote should be more in the range of about 25 - 40%. This puts the proponents' claim of competition in a quite different light of being not at all unreasonable.

5. Monitoring biological parameters

'The Panel **agrees** that the analyses presented in SC/J14/J8 require further refinement in addition to updating with respect to stock structure, as the authors' themselves note. In particular, it **recommends** that a revised paper should:

(1) use the approach of Thomson *et al.* (1999) to better account for truncation bias (which is considered in SC/F14/J8) as well as the fringe effect, which relates to the low proportion of animals with ages slightly higher than the age-at-maturity, an issue likely related to the need for contrast to detect a transition phase in an earplug;
(2) incorporate the effects of age reading errors presented in SC/F14/J11;
(3) take into account the problems of the representativeness of samples in recent years due to disruption of the programme discussed under Item 12.1.2;
(4) compare analyses of t_m from the transition phase with those using corpora counts and, if available, histological studies of testes;
(5) compare the results of the revised study with those (re-analysed to the extent possible following Thomson *et al.*, 1999) for fin and sei whales from the Antarctic to examine whether any observed trends

are synchronous, which may provide information on whether there is a cross-specific (e.g. outside environmental) cause to the trends;
(6) evaluate alternative models (e.g. where trends are shared across sex, stock or both); and
(7) include a more detailed description of the models evaluated and a more detailed discussion of the results that considers all plausible explanations for observed trends.

The Panel **recognises** that incorporating all of these suggestions will probably not be possible for the next Scientific Committee meeting. However, it believes that an updated paper that at least includes an improved discussion and a workplan and timetable should be presented'.

The proponents agree with all those specific recommendations. With regard recommendation (4) they note that most of the JARPA/JARPAII ovary samples were lost after the 2011 tsunami. Presence/absence of corpora was determined on board the research base vessel so that information on female maturity is available for all animals. Recommendation (4) can be addressed for JARPA samples only because corpora counting was made before the loss of samples, unlike the case of JARPAII samples, which were lost before the corpora counting could be made.

As suggested by the Review Panel a revised paper will be presented at the 2014 IWC SC meeting which will include an improved discussion and a workplan (SC/65b/J8Rev).

'SC/F14/J9 examined pregnancy rate data from JARPA and JARPA II. The Panel **notes** that 'pregnancy rates' identified in the paper are more appropriately called 'apparent pregnancy rates'. The Panel **stresses** that pregnancy rate (or apparent pregnancy rate) data should not be over-interpreted. In terms of effects at the population level the ultimate parameters of interest are successful births and calf survival rather than pregnancy rates *per se*. The Panel **agrees** that the analyses presented in SC/J14/J9 require further refinement in addition to updating with respect to stock structure, as the authors' themselves note. It **recommends** a number of improvements that should be incorporated into a revised version of the paper:

(1) further discussion of the limitations of the criteria used to identify a pregnant female – in particular, better account should be taken of the fact that small foetuses may be missed by scientists and that foetuses may be lost due to abortion during the hunt or loss during towing leading to an underestimate of true pregnancy rate; and
(2) to assist with (1), the authors should consider examination of other criteria for pregnancy (in some cases this may be possible from existing data or tissue samples) including diameter of the largest uterine horn, histology of the uterine mucosa, examination of the mammary glands and examination of hormone levels in blubber.

With respect to (2), the Panel **recognises** that identification of lactating females is more difficult in Antarctic minke whales because births occur in winter and lactation lasts only about three months, while harvesting takes place in the summer i.e. some months after weaning. The Panel **recommends** that the feasibility of using histological examination of mammary glands to assess recent lactation is examined. If this is possible, the proportions of recently lactated to [apparently] pregnant females and to mature females would be a more appropriate index of reproductive success that would likely be more sensitive to environmental fluctuations than crude pregnancy rates because perinatal mortality or abandonments of newborns by females in low nutritive condition is known to occur in many mammal species. The possibility of undertaking a feasibility study using existing samples should be examined and the results reported to the Scientific Committee'.

The proponents agree with these recommendations from the Review Panel. Consequently the proponents will present a revised paper to the next IWC SC meeting which will address the two points above as well the proponents' ideas on the feasibility of using histological examination of mammary glands to assess recent lactations (SC/65b/J9Rev).

'The Panel **notes** that while age at attainment of sexual maturity is the result of conditions affecting the individual over a period of several years, pregnancy/lactation is more directly linked to the conditions prevailing in the season when the whale had been caught or in the immediately previous one. Given the proponents' primary objective of studying biological parameters in order to monitor changes in the ecosystem, the Panel **recommends** that the relationship between reproductive parameters and the information available on body condition, krill consumption and environmental covariates such sea surface temperature (SST), location, and other factors be examined on an annual basis. This may help to explain anomalous years like the 1990-91 or the 1994-95 seasons, when low apparent pregnancy rate values were observed'.

The proponents note that this recommendation is in the context of the integration which they have identified as a priority for the second step of JARPAII, and as such they will consider implementing this recommendation with high priority.

'The Panel also **recommends** that:

(1) existing sampling protocols be examined to ensure that uterine horn and mammary gland measurements are recorded and mammary gland tissue and uterine mucosa are collected for histological analysis; and
(2) the programme takes the opportunity to examine the efficacy of approaches to examine pregnancy using blubber analyses and faecal samples found for some other mysticetes (see Mansour *et al.*, 2002; and Kellar *et al.*,2013)

The proponents will address recommendation (1) above within the revised paper SC/65b/J9Rev.

Regarding to recommendation (2) first the proponents note that this recommendation is not related to the research on JARPAII objective examined in this section, but nevertheless provide the following comment.

The proponents note that these approaches have been useful in other species. However the proponents are of the opinion that this approach is of limited utility for the case of the Antarctic minke whale e.g. experiments can be successful with the JARPAII samples and data already collected, but future application would require the collection of biopsies and faeces from Antarctic minke whale in the field, which is not feasible.

'Age estimation

The use of the Aspartic Acid Racemization (AAR) age estimation method, adapted for mammals by Bada *et al.* (1980), has recently regained interest for use with cetaceans. It is useful for species where standard methods are not applicable (e.g., species lacking teeth or readable earplugs) as well as comparison with standard methods. SC/J14/J15 offers some new approaches to the AAR technique including a correction for the effect of acid-hydrolysis extractions and a correction for 'foetus age' in the DL_o estimate. The authors were able to measure differences in the *DL* ratios of developing foetuses (n=20), which suggests good precision in their *DL* measurements. One of the usual challenges of this method is obtaining a sufficient sample of 'age 0' animals which is not a problem for the present study.

The Panel **welcomes** this work and makes the following **recommendations** for an updated paper:

(1) improve the estimates of SE which were artificially optimistic in that (a) they did not incorporate all sources of error, such as error in K_{asp} (the time-temperature change constant of aspartic acid), the DL_o measurement, and the *DL* measurements for each individual and (b) were applied incorrectly to calculate the SE of the age estimates (in fact they estimate the mean SE of the regression as a function of age);
(2) with respect to (1) a more appropriate method is the bootstrapping as in Rosa et al (2012) or the Delta method as in George et al. (1999);
(3) better specification of how the correction for a hydrolysis effect on the DL measurements was developed and applied;
(4) a fuller explanation in the methods sections as to how the lens nucleus was dissected without contaminating it with 'modern' tissue from the exterior of the lens or with blood or fluids;
(5) present the earplug estimates side-by-side with the AAR estimates;
(6) for ovaries collected from mature females, include the total number of corpora for both ovaries in the analysis to determine ovulation rates and age relationships (e.g. George *et al.*, 2011); corpora data should be collected as part of future age studies; and
(7) correct the labels in fig. 3 and carefully check the use of K_{asp} vs 2 K_{asp} in the manuscript.

In the longer term, the sample size should be increased'.

The proponents thank the Review Panel for these recommendations, which will be considered in an updated document. Regarding to recommendation (6) they reiterate their comments above on the loss of the ovary samples as a result of the 2011 tsunami. Sample size will be increased in the next intersessional period.

Nutritional conditions
Detailed responses to the conclusions and recommendations from the Review Panel are given in Documents SC/65b/J13Rev. Here the proponents provide some general comments on the Panel's review on this topic.

First the proponents note that the analyses conducted in SC/F14/J13 and 14 followed recommendations offered by the JARPA review meeting and subsequent IWC SC meetings (e.g. see IWC, 2008 and Annex 4 of Document SC/F14/J1). In their evaluation of this topic it seems that the Review Panel had not examined/considered these previous recommendations in detail (see also section General comments 2).

'The Panel **recommends** that the authors of SC/F14/J13 and SC/F14/J14 first develop a conceptual model of the system under consideration and use that to identify a set of covariates to consider in the modelling'.

The proponents consider that this had already been done when the research started around 2006. The reasons to start measure blubber thickness and fat weight were the investigation on whether there were any changes in energy storage with time or with latitude and/or longitude. The values of four other variables also needed to be recorded: date, sex, body length and diatom. These should be included in the model. As a result of the discussions in the IWC SC meetings, other dependent variables and interaction terms between the independent variables have also been investigated.

'Following the selection of which factors to consider in the modeling, the following steps should be undertaken:

(1) identify whether any of the covariates are highly correlated and either (a) exclude a subset of the covariates so that the remaining covariates are uncorrelated or (b) develop new covariates which represent independent aspects of the current covariates (using for example PCA);
(2) select a 'full model' (this may be difficult if the data set is unbalanced) and base selection of which factors and their interactions to treat as random effects - the models should be fitted using REML and a model selection approach such AIC, BIC or standard hypothesis testing approach applied; and
(3) select the fixed effects structure given the random effects structure selected at step (2), where the models are fitted using maximum likelihood;
(4) use REML to fit the best model identified in (3) above'.

The correlations between covariates (1) have already been addressed (see details in SC/65b/J13Rev and discussions at the IWC, 2012). The variables age, body length and body weight were highly correlated, which is one reason the proponents preferred only to use length (the two others were not present for all whales). With age and weight excluded all the remaining independent variables had correlations less than about 0.1.

Suggestions (2), (3) and (4) are addressed by the calculations presented in SC/65b/J13Rev.

'SC/F14/J13 and SC/F14/J14 do not report many fit diagnostics. The Panel **recommends** that any revised papers provide at least plots of the residuals versus the predictor variables (including year and stratum), histograms of residuals and random effects, plots of residuals spatially, and Q-Q plots for the 'best model' (although there may be more appropriate diagnostic statistics for these analyses given the unbalanced nature of the data set)'.

The proponents agree with this recommendation from the Review Panel. Residual plots for the proponent's best models and for each of the five dependent variables are presented in SC/65b/J13Rev.

'The Panel **notes** too that the original estimates of the power to detect changes in blubber thickness only accounted for sampling error. It **recommends** as a more appropriate way to assess power, use of the results of existing data analyses to characterise both sampling error and other sources of error and to use all error when simulating data as the basis for power calculations'.

Additional analyses of power has not been mentioned or recommended in past IWC SC discussions on body conditions which have extended over several years.

'The Panel also **recommends** that future analyses of the data on the condition of Antarctic minke whales include (a) consideration of a model in which year is a categorical variable and is treated as a random effect if a plot of residuals against year show there are residual patterns by year, and (b) examination of how robust the results in SC/F14/J14 are to basing model selection on BIC rather than AIC'.

The proponents agree on the recommendation (a) above but only if the residuals plotted against year show patterns. The better performance of BIC compared to the AIC in the case of large sample size has already been justified in SC/F14/R5. Further discussions will be carried out on the issue on how to select the best model in a complex situation.

'The Panel **notes** that the recommendation from the previous review of the JARPA programme (IWC, 2008) to improve analyses of body condition by using more accurate proxies, such as the lipid content of the blubber has, for the most part, not been followed by the proponents, although this may partly be due to the text not being as clear as it might have been. Although blubber thickness has an overall correlation with blubber lipid content, the relation between the two variables is poor and tends to fit an asymptotic relationship where lipid contents fall precipitously in individuals with thin blubber; moreover, blubber would tend to thicken when body girth decreases (Aguilar *et al*., 2007, pp. 6-7 and fig.2). As a consequence of both processes, blubber thickness would tend to underestimate lower body condition stages. The Panel thanked the proponents for some preliminary analyses of a small number of samples during the workshop but **recommends** that further studies should incorporate blubber lipid content analyses for all samples, and that the collection of current measurements also continues to ensure comparability with past and future data'.

The proponents disagree with this observation and recommendation from the Review Panel. To explain the reasons for the disagreement it is necessary first to examine the discussions and recommendations from the JARPA review meeting (IWC, 2008):

'Food habit and krill consumption of Antarctic minke whales.
(3) use of GLM or similar approaches to examine trends, incorporating covariates such as age, size and reproductive status of whales as well as the date and time of day.

Although the authors' analysis as presented showed a declining trend in the blubber thickness measurement chosen, some members argued that the conclusion of a trend in energy storage was premature and could not be confirmed until improved analyses had been conducted. In particular this involves the examination of other factors including age, latitude, distance from ice-edge and non-linearity in trends.

In addition, even if it is assumed that the trend is real, consideration should be given to whether the particular blubber thickness measurement chosen was actually a good proxy for energy storage (for example, lipid content can vary considerably without necessarily affecting the thickness of blubber).

The Workshop recommended that the analysis be expanded to incorporate, in an integrated manner, the other extensive information available from the JARPA dataset that relates to energy storage (e.g. other blubber measurements, organ weights, etc.)' (IWC, 2008).

The proponents offer the following views:

a) *Most of the recommendations from the JARPA review meeting were considered in the analyses presented in SC/F14/J13 and SC/F14/J14. It is not balanced to highlight only a recommendation that, according to the Review Panel, was not followed.*
b) *The recommendation from the JARPA review meeting* 'consideration should be given to whether the particular blubber thickness measurement chosen was actually a good proxy for energy storage' *is different from what the Review Panel summarize above.*
c) *At the JARPAII review workshop data were presented showing a significant correlation between blubber thickness and amount of lipid content.*
d) *In addition to blubber thickness, body condition was also examined using two girth measurements and fat weight as dependent variables, all of which show a similar pattern of temporal change.*

'The Panel further **notes** that several cetacean research programmes include the collection of faeces from wild populations to assess diet and food habits. The JARPA II programme is in position to assess the efficacy and accuracy of this non-lethal approach. In that regard, the Panel **recommends** that faecal samples (from the colon) be compared with stomach samples for species composition (and see Item 12.4)'.

First the proponents note that this recommendation is not related with the research on JARPAII objective examined in this section, but nevertheless provide the following comment.

The proponents agree that the JARPAII is in position to assess the efficacy and accuracy of this approach to assess diet and food habit, and in fact some preliminary research was carried out based on JARPA data in a Masters degree thesis titled 'The feeding ecology of baleen whales based on the DNA analysis of the colon content' *(Kobayashi, 2010). In addition to that the proponents are currently conducting a cooperative research project with an outside research company to apply next generation sequencing method for this purpose. At this*

moment the proponents are using North Pacific minke or Bryde's whale samples, but in the future they will test this method on Antarctic minke whale.

However the proponents do not consider this approach as a practical approach for investigating the diet and food habit of whales, including the Antarctic minke whale, because of the difficulty of collecting faeces from wild populations. JARPAII has carried out observations of faeces in the Antarctic minke whale and the number of incidences is extremely low. Another important point is that this non-lethal approach does not provide quantitative information of food consumed, which is important for the development of ecosystem models.

6. Monitoring effects of contaminants on cetaceans

'Given the low pollutant levels traditionally observed in Antarctic minke whales based on the previous JARPA analyses, the Panel **recommends** that if the programme continues, pollution studies should be given lower priority and the resources used to address other higher priority issues. While sampling and appropriately storing of tissue and krill samples should continue for reference purposes in case of evidence for a new pollutant in the region or the occurrence of a shift in trends, the Panel **agrees** that it would be sufficient to undertake analyses on a suitably chosen subsample at periodic intervals (say 3-5 years)'.

The proponents thank the Review Panel for this suggestion. However the proponents are of the view that continuation of this sampling/analysis on a yearly basis is desirable. This is one of the research item related to Objective 1 of the JARPAII. Temporal trends can be detected even at low levels of pollutant accumulation.

The Panel also **welcomes** the research on marine debris, a type of pollution on which little information is available for the Antarctic Ocean. It **notes** that information on this had also been collected by the now discontinued SOWER programme. This topic has also been recently identified as a priority by the IWC (2014). The Panel also **notes** the low incidence of both ingested debris and occurrence of debris in the sea surface. It **recommends** continuation of these observations and that the data be shared with other international efforts.

The proponents agree with this recommendation and will make efforts to implement it.

7. Model of competition among whale species

'The Panel therefore **recommends** that considerably more effort and resources are allocated to this aspect of JARPA II (and see other recommendations such as those detailed under Items 6.3.4 and 7.2.2). Without this, it is not possible to state whether the programme can meet its objectives. Such work will also be of importance in reviewing future priorities for field work'.

'The proponents agree with this recommendation from the Review Panel and will investigate in the intersessional period how to allocate more effort and resource to this important work'.

'The Panel therefore **recommends** that future high priority be given to obtaining new estimates to allow an area-based time-series of krill biomass estimates, if JARPA II is to meet objectives 1 and 2. The Panel also **agrees** with the proponents that the time series can be extended into the past by reanalysing the JARPA krill data with revised target strength values to make past data compatible with more recent observations. This is discussed under Item 7.2 but is mentioned again here given the importance of krill biomass trends as a critical component of modelling whale consumption and competition'.

The proponents reiterate their previous agreement with this recommendation. They will spend more effort in the construction of a time series of krill biomass by combining JARPA and JARPAII data as well data from other research programs.

'The Panel therefore **recommends** that the Monte Carlo approach developed by Gaichas *et al.*, (2012) to characterise uncertainty in Ecopath results be applied. The Panel also **recommends** that, to account for observed trends in the abundance of whales in the JARPA II study area, 'biomass accumulation' terms be included in the development of a revised Ecopath'.

The proponents agree with this two recommendations from the Review Panel, which are useful not only to improve the mass-balancing but also for future projections, and accordingly will make efforts to implement them.

'The multispecies production model described in SC/F14/J26 has the potential to model the interactions among various whale species. However the model is currently at an early stage in development. The Panel **strongly encourages** continued development of this approach and increased allocation of effort. The model is rather ambitious for a first stage in model development, with four whale species and one seal species. The level of data availability is much greater for minke and humpback whales than for the other species, and the Panel **suggests** that it may be useful to start the modelling work by constructing a model containing only these two whale species'.

The proponents agree with this recommendation from the Review Panel.

'The Panel **recommends** that simulation be used to determine the data needed to reliably distinguish among competing hypotheses to explain the available data, including the proponents' preferred option, competition among species. Artificial datasets of known properties allow for testing of model behaviour, including identifying whether the model is able to respond in predictable ways to known signals in the data. This process can also be used to identify the required level of precision in the data to parameterise the model'.

The proponents agree with this recommendation from the Review Panel. The proponents have already carried out a limited simulation study to see if random effect models which 'borrow' information from cetacean species generally through allometric relationships, improve the estimation performance or not. However, the proponents agree that more comprehensive simulation studies would help to understand the nature of models and estimation performance, and also to assess the estimation performance. Therefore the proponents will make effort to implement this recommendation.

'The Panel **emphasises** that producing ecosystem models is a long-term exercise, which requires the integration of a large amount of data as well as ecological and biological knowledge of the system. The work conducted to date represents a useful start. However, the Panel **recommends** increased collaboration with other researchers from outside the JARPA II area to improve the modelling. This should be in the form of incorporating data from adjacent areas where possible, and by sharing expertise and knowledge with other ecosystem and multispecies modelling experts. Furthermore, model development should not only draw on data from the existing elements of the JARPA II project, but should also inform the development of the project (and future projects) to address data deficiencies identified during the model development process'.

The proponents agree with this recommendation from the Review Panel. The proponents have recognised the importance of monitoring krill and its dependent predators and they have also identified a lack of information on the krill abundance and trends in the research area. However the IWC SC has identified a number of important knowledge gaps including krill trends, the functional relationships between cetacean species and krill, and the effects of environmental variability on cetacean species. In this regard, collaboration between the IWC SC and CCAMLR SC would improve understanding of the ecosystem. This sort of collaboration would be benefitial for the development of ecosystem modelling in the JARPAII research area. The proponents will contribute and support any initiative toward the aim of such collaboration.

8. Improve management procedure for Antarctic minke whales

'The stock structure hypotheses on which the original trials were based were very broad, with the aim to encompass most likely actual situations. The information from JARPA and JARPA II, along with other information obtained since the original trials were developed, would be very useful if the current protocol were to be applied, as they should refine the set of hypotheses on which trials would be based. In particular, the information on stock structure collected during JARPA/JARPA II could be used to develop stock structure hypotheses for Areas III-E to IV-W which are conditioned on data, while the revised estimates of abundance would be used for conditioning. The information from the SCAA and similar analyses could be used to develop hypotheses related to changes in carrying capacity, natural mortality, and variation in birth rates.

The operating models on which *Implementation Simulation Trials* have been based have considered multiple stocks but have not explicitly allowed for hypotheses related to competition and ecosystem change. In principle, the work on ecosystem modelling could be used to develop a set of operating models which allow for competition. However, the ecosystem models need to be developed with sufficient resolution (e.g. age- and sex-structure for minke whales)'.

The proponents agree with this summary from the Review Panel.

9. Summary and conclusion (General issues)

Specification of objectives

'The Panel **welcomes** the clarification of the objectives and their inter-relationships provided by the proponents in SC/F14/J01, but **notes** that within such broad and long-term overall objectives as (1) and (2), almost any information can be said to be contributing to them in some way; this made the task of the Panel to assess how well the programme was meeting its own stated objectives, somewhat difficult. It also **notes** that previous Panels have encountered similar difficulties.

The Panel therefore **recommends** that for the benefit of any future Panel reviews as well as for the proponents' own internal review and evaluation process, the proponents read the guidelines for proposed permits developed by the Scientific Committee (IWC, 2013b) after JARPA II was developed, and consider developing refined objectives and sub-objectives with timelines for progress. This will allow performance to be more easily assessed in future and will better enable the timing of the next ongoing review (normally, this is every six years)'.

The development of research objectives in JARPAII, their inter-relationship, and the scientific questions to be addressed under each of the objectives were clearly explained in Pastene et al. (2014). The proponents believe that this explanation contributed greatly to the smooth review of JARPAII results by the Review Panel. The proponents however agree that the objectives of JARPAII (particularly Objectives 1 and 2) could be further clarified by adjusting them to allign more closely with the guidelines of Annex P (which were developed after the JARPAII program had commenced), as recommended by the Review Panel.

'The Panel also **notes** that the original special permit programme also covered fin and humpback whales. It **believes** that the proponents should have considered the fact that their original sampling design was not carried out more carefully and provided information on any implications for future sampling and the overall multi-species modelling objective'.

The decision not to take humpback whales was a political one. The Government of Japan decided to suspend sampling of humpback whales in response to a request from the Chair of the IWC in order to contribute to the creation of a positive atmosphere for the negotiations to resolve the stalemate in the IWC that were initiated at the 2007 Annual Meeting of the Commission. On the other hand there were practical problems in taking fin whales, but these are being addressed over time through making modifications to the base research vessel. These difficulties will naturally lead to some delay in being able to utilize information from these sources in the ecosystem models under development.

Sampling design and protocols

'The Panel **is concerned** that the inability to realise the designed sampling scheme will severely compromise the ability of the programme's objectives to be met (some examples of this can be seen in SC/F14/O05). While the Panel **recognises** that the disruption by protestors is outside the proponents' control, it is clear that under these difficult circumstances, considerable effort must be made to ensure that the sampling remains representative rather than only focussing on sample size (the Panel noted that the size restrictions with respect to fin whales compromise the representativeness of that dataset within the research area). The Panel **recommends** that an explicit protocol is developed to specify *a priori* how the design is modified if disruption by protestors occurs; simulation studies based on existing data should assist in this. The aim of this protocol should be to (a) maximise the extent to which sampled animals are representative of the survey estimates of abundance and (b) ensure that the data remain compatible with the past datasets. If disruption continues, consideration should be given to not starting the survey at the same longitude in each study area so that it is reasonable to expect that all of the study area is covered over time. Development of protocols to account for disruptions should be undertaken by analysts as well as by those who conduct the surveys'.

The proponents again draw attention to the fact that any departure from the planned survey design of JARPAII was due to the dangerous and escalating sabotage activities by the anti-whaling groups operating from Australian ports. Further they note that any departure from the original survey might have different implications for the research depending on the JARPAII objectives.

The proponents are willing to examine the positive suggestions from the Review Panel on the development of a protocol to account for disruptions by anti-whaling groups. However the best way to avoid any departure from the original survey design is by an end to the practice of violent groups operating in the JARPAII research area.

In this context the proponents invite the IWC SC to make a strong statement (in line with previous Commission statements) at its 2014 Annual Meeting condemning the violent sabotage against the research conducted under JARPAII, thereby diminishing the value of the research.

Integration of results from within each component of the programme and from outside the programme

'The Panel **recognises** that this is the first period of the JARPA II programme but **notes** that the programme arose out of the long JARPA programme and that many of the papers analysed data from both programmes. It **agrees** that the analyses presented on the different objectives would have benefitted considerably from better integration of all aspects of the programme with the modelling work, in order to have allowed better identification of key parameters and the degree of accuracy and precision that would allow for robust conclusions to be drawn. The Panel **notes** that this was recognised in several of the proponents' presentations. It **recommends** that this should be undertaken as a matter of priority and a more complete evaluation of uncertainty undertaken in terms of model inputs to allow an updated evaluation of sampling design, size, research methods and priorities'.

The proponents agree with the Review panel that the research evaluated correspond only to the first six years of the JARPAII program. They also note that although in many analyses JARPA and JARPAII data were combined, the research objectives of JARPAII are different from those in JARPA.

As noted by the Review Panel, the proponents have emphasized that in the next part of JARPAII an integration of the results from within each component of JARPAII and from outside of JARPAII will have a high priority. Some specific examples for this kind of integration have been suggested through this response paper. The integration of the information on stock structure in several large whale species (Objective 3 of JARPAII) with information on abundance and estimation of biological parameters (Objective 1 of JARPAII) is one of those examples. Another one is the integration of the information on krill biomass of JARPA/JARPAII with that from other research programs.

'The Panel **welcomes** the considerable work that was put into field and laboratory work and the development of papers. However, as is apparent from a number of its recommendations, it is **essential** that further analytical work integrating the information available from the various aspects of the programme is undertaken. In particular, given the objectives of 'monitoring changes' and understanding the ecosystem, the Panel **stresses** the importance of trying to obtain as much information as possible on the environment (oceanographic, prey related, etc.) at appropriate geographical and temporal scales, and to integrate the analyses of such data in a coherent manner. Without such efforts, meeting stated objectives will not be possible. In this context, the Panel **notes** that the analyses of the extensive data collected was in many cases overly simplistic and isolated from other aspects of the programme. It **strongly recommends** that considerably more effort and resources be put into the analytical side of the programme, both via more thorough analyses of individual datasets where indicated in this report and especially through better integration amongst the datasets. As noted earlier this will also assist greatly in re-examining field priorities and strategy. It is already clear that the estimation of krill abundance (within or outside the programme) is **essential** to meeting ecosystem-related objectives'.

*The proponents agree that more analytical work integrating the information available from the various aspects of the program should be undertaken, as noted in several of the proponents' presentations to the workshop. However they disagree with the sentence 'In this context, the Panel **notes** that the analyses of the extensive data collected was in many cases overly simplistic and isolated from other aspects of the programme'. Many of the analysis of individual data sets have been comprehensive and rigorous, and more importantly, they have followed agreed recommendations from the IWC SC, which the Review Panel seem to have failed to realize on several occasions (see also 'General Comment 2'). As already recognized by the proponents, at the first part analyses were conducted within each of the JARPAII objectives and the next priority will be to integrate the results from the different objectives.*

Archiving and use of past samples

The Panel **agrees** that a number of questions potentially could be addressed with material that may have been preserved from the historical commercial catch. Examples include genetics on minke whales from outside the JARPA/JARPA II study area, genetics on fin and other whale species, stable isotopes on any species and area, or retrospective pollution studies on Antarctic minke whales and other species to better assess occurrence of temporal trends. While reports from JARPA and JARPA II detail the availability of tissue samples from these programs, no similar information is available from the historical catch. The Panel **recommends** that a detailed

list of available historical samples be produced, specifying details on species, date of sampling, associated biological data, and preservation method (e.g. formaldehyde, alcohol, frozen, dry, etc).

In principle the proponents agree that such list of available historical samples could be useful. However they note that the institute in charge of conducting JARPA and JARPAII (ICR) is not in charge of the past commercial whaling samples, and therefore responding to this recommendation will involve consultation with other research institutions in Japan. They further note that some of the historical samples have been already been checked in relation to their utility for some of the research conducted under the JARPA/JARPAII. For example following a previous recommendation from the IWC SC to investigate the utility of existing commercial samples to address stock identity (IWC, 1998), Goto et al. (1998) conducted some detailed genetic analysis by separating the samples according to the distance from the ice-edge, and concluded that samples collected along the ice-edge (as it was the case of past commercial whaling) provided limited information on the stock structure of the Antarctic minke whales.

Effects of catches on the stocks

'While the Panel **agrees** broadly with the conclusion that such catches will not adversely affect Antarctic minke whales in the research area, it also notes that the most appropriate way to assess the impact of future Special Permit catches on stocks is within the framework of an RMP-type process; that approach explicitly accounts for uncertainty in a more appropriate way than a simple HITTER approach with sensitivity tests. The Panel **notes** that the IWC Scientific Committee has not undertaken a full *Implementation* of Antarctic minke whales under the current guidelines and requirements, as a result of the instruction of the Commission after the establishment of an IWC Sanctuary in the Southern Ocean.

The actual catches of fin whales were small given the estimated abundance within the research area (which does not cover the major distribution of fin whales based on past catches). Given this, and the abundance estimates available for the research area, the Panel **agrees** that the catches would not have affected the stock(s). No humpback whales were taken in the first phase of the programme. Again it notes that an RMP-type process is required to fully address questions concerning the effect of ongoing catches on stocks'.

The proponents agree with the conclusions of the Review panel that the current catch levels of Antarctic minke and fin whales will not adversely affect those species in the research area. The proponents look forward to the IWC SC developing RMP ISTs for Antarctic minke and other baleen whale species, which would allow the further computations which the Review Panel suggests.

10. Summary and conclusion (Achievements of objectives)

The proponents reiterate their comments and responses given in the previous sections of this paper.

11. Summary and conclusion (Relationship to IWC Resolutions)

'The Panel **agrees** that a number of aspects of the JARPA II programme are relevant to these resolutions. The submission of the present Workshop papers fulfils the request that these types of analyses be submitted to the IWC. Submitting revised or new papers that incorporate the Panel recommendations will provide better information related to the resolutions and discussions.

In addition to the work related to ecosystems and environmental change discussed above, the Panel **agrees** that the work on stock structure and abundance, in addition to information from photo-identification studies is directly relevant to the Scientific Committee's work on the in-depth assessments of the Antarctic minke whale, humpback, blue and right whales'.

The proponents agree with these comments and conclusions of the Review Panel.

12. Summary and conclusion (Utility of lethal and non-lethal techniques)

'Therefore, the Panel **recommends** that the proponents examine the approaches for comparison used in the Icelandic programme be conducted and develop an approach to formally and objectively compare the results from different approaches in the light of the programme's objectives. More specifically, conclusions about diet and nutritional status based on analysis of stomach contents could be compared to conclusions drawn from analysis of fatty acids or stable isotope ratios based on internal tissues and organs and tissue derived from

mimicked biopsies (skin and outermost blubber). This can then be used by the proponents and future Panel's to better address this issue in a quantitative way.

Under Item 8.3.2, the Panel recommended collecting faeces to conduct DNA and diet composition analyses. These samples could also be used in the comparison study of lethal and non-lethal techniques'.

The proponents will consider this recommendation to compare the utility of lethal and non-lethal approaches.

The proponents reiterate that they agree that the JARPAII is in position to assess the efficacy and accuracy of this non-lethal approaches to assess diet and food habit, but that the future application of non-lethal approaches (if they prove to be accurate after the analyses of JARPAII samples) will not be possible because the difficulty of collecting faeces from wild populations and because some approaches involve the biopsy of skin samples, which is not practical for the Antarctic minke whales, at least in offshore areas where JARPAII is conducted.

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Appendix 1

List of Primary Documents presented to the JARPAII Review Workshop by the proponents

SC/F14/J1. Pastene, L.A., Fujise, Y. and Hatanaka, H. The Japanese Whale Research Program under Special Permit in the Antarctic (JARPA II): origin, objectives, research progress made in the period 2005/06-2010/2011, and relevance for management and conservation of whales and the ecosystem.

SC/F14/J2. Nishiwaki, S., Ishikawa, H., Goto, M., Matsuoka, K. and Tamura, T. Review of general methodology and survey procedure under the JARPA II.

SC/F14/J3. Hakamada, T. and Matsuoka, K. Estimates of abundance and abundance trend of the Antarctic minke whale in Areas IIIE-VIW, south of 60ºS, based on JARPA and JARPAII sighting data (1989/90-2008/09).

SC/F14/J4. Hakamada, T. and Matsuoka, K. Estimates of abundance and abundance trend of the humpback whale in Areas IIIE-VIW, south of 60ºS, based on JARPA and JARPAII sighting data (1989/90-2008/09).

SC/F14/J5. Matsuoka, K. and Hakamada, T. Estimates of abundance and abundance trend of the blue, fin and southern right whales in Areas IIIE-VIW, south of 60ºS, based on JARPA and JARPAII sighting data (1989/90-2008/09).

SC/F14/J6. Hakamada, T. and Matsuoka, K. Estimates of abundance and abundance trend of the sperm, southern bottlenose and killer whales in Areas IIIE-VIW, south of 60ºS, based on JARPA and JARPAII sighting data (1989/90-2008/09).

SC/F14/J7. Kanda, N., Goto, M. and Pastene, L.A. Paternity analysis on Antarctic minke whales using JARPA and JARPAII samples.

SC/F14/J8. Bando, T., Kishiro, T. and Kato, H. Yearly trend in the age at sexual maturity of Antarctic minke whales examined by transition phase in earplugs collected during JARPA and JARPAII surveys.

SC/F14/J9. Bando, T. and Hakamada, T. Yearly trend in the proportion of pregnant animals among mature female Antarctic minke whales in the JARPA and JARPAII period.

SC/F14/J10. Mogoe, T., Bando, T., Maeda, H., Kato, H. and Ohsumi, S. Biological observations of fin whales sampled by JARPAII in the Antarctic.

SC/F14/J11. Kitakado, T., Lockyer, C. and Punt, A.E. A statistical model for quantifying age-reading errors and its application to the Antarctic minke whales.

SC/F14/J12. Yasunaga, G., Bando, T. and Fujise, Y. Preliminary estimation of the age of Antarctic minke whales based on aspartic acid racemization.

SC/F14/J13. Konishi, K. and Walloe, L. Time trends in the energy storage in the Antarctic minke whales during the JARPA and JARPAII research periods.

SC/F14/J14. Konishi, K., Hakamada, T., Kiwada, H., Kitakado, T. and Walloe, L. Decrease in stomach contents in the Antarctic minke whale (*Balaenoptera bonaerensis*) in the Southern Ocean. (This paper can not be cited except in the context of IWC meetings until is formally published in *Polar Biology*).

SC/F14/J15. Tamura, T. and Konishi, K. Prey composition and consumption rate by Antarctic minke whales based on JARPA and JARPA II data.

SC/F14/J16. Tamura, T. Preliminary analyses on prey consumption by fin whales based on JARPAII data.

SC/F14/J17. Matsuoka, K. and Hakamada, T. Distribution pattern of whale species sighted in the Antarctic based on JARPA and JARPAII sighting surveys (1987/88-2008/2009).

SC/F14/J18. Murase, H., Matsuoka, K., Hakamada, T. and Kitakado, T. Preliminary analysis of changes in spatial distribution of Antarctic minke and humpback whales in Area IV during the period of JARPA and JARPAII from 1989 to 2006.

SC/F14/J19. Wada, A. and Tamura, T. Estimation of krill biomass based on JARPAII acoustic surveys.

SC/F14/J20. Watanabe, T., Okazaki, M. and Matsuoka, K. Results of oceanographic analyses conducted under JARPA and JARPAII and possible evidence of environmental changes.

SC/F14/J21. Naganobu, M., Matsuoka, K., Murase, H. and Kutsuwada, K. Consideration on the Kerguelen-Davis Oscillation Index (KDOI) influencing variability on environmental ecosystem in the Prydz Bay Region, east Antarctic: data exploration.

SC/F14/J22. Isoda, T., Tamura, T., Nishiwaki, S and Pastene, L.A. Observation of marine debris in the Antarctic based on JARPA and JARPAII data.

SC/F14/J23. Yasunaga, G., Bando, T. and Fujise, Y. Pattern of mercury accumulation in the Antarctic minke whale and its prey based on JARPAII data.

SC/F14/J24. Yasunaga, G., Bando, T. and Fujise, Y. Pattern of organochlorine accumulation in the Antarctic minke whale based on JARPAII data.

SC/F14/J25. Yasunaga, G. and Fujise, Y. A note on mercury and organochlorine accumulation in the Antarctic fin whale based on JARPAII data.

SC/F14/J26. Kitakado, T., Murase, H., Tamura, T. and Yonezaki, S. An attempt to ecosystem modelling for species in Area IV in the Antarctic Ocean using JARPA and JARPAII data.

SC/F14/J27. Kanda, N., Goto, M., Oikawa, H. and Pastene, L.A. A note on sampling and laboratory procedure protocols of the genetic work at the Institute of Cetacean Research.

SC/F14/J28. Pastene, L.A., Goto, M. and Kanda, N. An update of the genetic study on stock structure of the Antarctic minke whale based on JARPAII samples.

SC/F14/J29. Kitakado, T., Schweder, T., Kanda, N., Pastene, L.A. and Walloe, L. Dynamic population segregation by genetics and morphometrics in Antarctic minke whales.

SC/F14/J30. Pastene, L.A., Kitakado, T., Goto, M. and Kanda, N. Mixing rates of humpback whales from Stocks D, E and F in the Antarctic feeding grounds based on mitochondrial DNA analyses (Doc. SC/65a/SH13. This paper can be cited only in the context of the IWC meetings).

SC/F14/J31. Kanda, N., Goto, M. and Pastene, L.A. Stock structure of humpback whales in the Antarctic feeding grounds as revealed by microsatellite DNA data.

SC/F14/J32. Goto, M., Kanda, N. and Pastene, L.A. Genetic analysis on stock structure of fin whales in the Antarctic based on mitochondrial and microsatellite DNA.

SC/F14/J33. Kanda, N., Goto, M., Nishiwaki, S. and Pastene, L.A. Long-distance longitudinal migration of southern right whales suspected from mtDNA and microsatellite DNA analysis on JARPA and JARPAII biopsy samples.

SC/F14/J34. Matsuoka, K. and Pastene, L.A. Summary of photo-identification information of blue, southern right and humpback whales collected by JARPA/JARPAII.

SC/F14/J35. Nagai, H., Mogoe, T., Ishikawa, H., Hochi, S., Ohsumi, S. and Fukui, Y. 2007. Follicle size-dependent changes in follicular fluid components and oocyte diameter in Antarctic minke whales (*Balaenoptera bonaerensis*). *Journal of Reproduction and Development* 53(6): 1265-1272.

SC/F14/J36. Ono, N., Yamaguchi, T., Ishikawa, H., Arakawa, M., Takahashi, N. Saikawa, T. and Shimada, T. 2009. Morphological varieties of the Purkinje fiber network in mammalian hearts, as revealed by light and electron microscopy. *Arch Histol Cytol*. 72(3), 139-149.

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