Report of the Expert Panel of the final review on the western North Pacific Japanese Special Permit programme (JARPN II)

Contents

Executive summary

The Expert Panel Workshop of the final review on the western North Pacific Japanese Special Permit programme (JARPN II) was held in the Toyomi Center Building, Tokyo from 22-26 February 2016.

The primary objective of the Expert Panel Workshop for this final review was to review the scientific aspects of the JARPN II programme in the light of the stated programme objectives. In particular, the Panel was to:

(1) assess the extent of the programme's scientific output;
(2) assess the degree to which the programme coordinated its activities with related research projects;
(3) evaluate other contributions to important research and information needs outside the original set of objectives; and
(4) evaluate how well the objectives of the research were met, and the extent to which results have led to demonstrated improvements in the conservation and management of whales and/or other marine living resources.

The Panel received a total of 55 primary papers, 37 'for information' papers, 1 observer statement and a response by the proponents to that statement. An important component of the review was to examine progress made by the proponents with response to the recommendations of the 2009 Expert Panel. The proponents' responses to those recommendations and the Panel's evaluation are discussed in the report and summarised in Annex D.

The Panel noted that this 'final' review was somewhat unusual in that the field component of the JARPN II programme was not expected to finish until 2016. The Panel's general comments and recommendations on (a) timing, (b) the nature of final reports, (c) the work being undertaken from 2014-2016 to compare lethal and non-lethal techniques and (d) ways to improve consideration of progress with recommendations are given under Item 11.1 of this report. Annex G contains some suggestions for potential guidelines for an integrated final report from a special permit programme.

With respect to JARPN II's scientific output, the Panel noted that the programme thus far had results in 31 peer-reviewed papers related to the programmes primary objectives and 30 arising from ancillary studies that contributed to research not related to the primary objectives. It had had also produced a large number of IWC papers that had contributed to Scientific Committee work on the RMP and in-depth assessments. The Panel strongly encouraged the submissions of further analyses to peer-reviewed journals.

The Panel welcomed much improved collaboration with other research projects compared to 2009 (most of which was within Japan). It encouraged additional collaboration with respect to any future analyses of the data.

In terms of evaluating the extent to which the results met the objectives of the programme and have improved conservation and management, the Panel considered this in two stages. The first was to examine how well they had met sub-objectives developed by the proponents after 2009 that had been finalised in 2014. The Panel's views are summarised in Table 10 of the report. The second stage was to review how well the proponents had met their three main objectives (noting the timing issue raised under Item 11.1) and to consider how the work had contributed to conservation and management. The Panels views are given below (apart from with respect to the sperm whale component which it agreed had produced little of scientific value).

OBJECTIVE 1: FEEDING ECOLOGY AND ECOSYSTEM STUDIES

The ultimate goal of this objective was to provide multispecies management advice. As noted by the 2009 Panel, this was an extremely ambitious task and one likely to take many years. The level of field and laboratory work has been impressive and the examination of uncertainty with respect to the prey consumption and prey preferences has been greatly improved since 2009 although analytical improvements can still be made. However, the question of the effects of sampling design (see Item 3.4.2) requires further consideration and, primarily as a result of a lack of allocated resources (despite the 2009 Panel recommendation), the modelling work remains preliminary.

Even allowing for the complexity of the issue, there are examples of MRM/MICE[1] models that that can be parameterised by fitting to data which are used to provide input to tactical assessment models and there are better developed food web and extended single species models; with additional resources, progress could (and should) have been made in the development of intermediate model types. The Panel **concludes** that at this stage of development, the modelling results are not suitable for addressing strategic management questions[2]. At present, at least, the results have not led to improved conservation and management of cetaceans or of other marine living resources or the ecosystem.

[1] Minimum Realistic Models/ Models of Intermediate Complexity for Ecosystem Assessment

[2] Ecosystem models such as Ecopath with Ecosim, Atlantis, and other large complex models which are difficult to parameterize by fitting to data are not suitable for tactical management anywhere in the world at present and probably far into the future. Single species models with predation and multispecies (MICE) models could be used to provide tactical advice in the future.

OBJECTIVE 2: MONITORING ENVIRONMENTAL POLLUTANTS IN CETACEANS AND THE MARINE ECOSYSTEM

This objective related to monitoring pollutants in the environment and cetaceans including (a) pattern of accumulation in cetaceans; (b) bioaccumulation through the food chain and (c) the relationship between pollutants and cetacean health. The Panel notes that the achievement of this objective was hampered considerably by the loss of samples as a result of the tsunami. It also acknowledges the efforts made to follow the recommendations of the 2009 Panel. The level of field and laboratory work has been good and understanding of chemical pollutants and cetaceans off Japan has been greatly improved. However, the Panel **concludes** that only partial progress has been made towards addressing the objectives and more effort needs to be put on improved analyses and interpretation of results (see discussion and recommendations under Item 8.4). This is especially true in terms of the relationship of pollutants and cetacean health, which is most relevant to improved conservation and management of cetaceans. It is not clear from the papers presented if (and if so how) the work undertaken has contributed to the conservation of other marine resources or the ecosystem.

OBJECTIVE 3: STOCK STRUCTURE OF LARGE WHALES

The broad objectives simply related to the stock structure of large whales (common minke whales, sei whales, Bryde's whales and sperm whales), although this was clarified at the 2009 Panel workshop to be primarily related to developing or narrowing the number of hypotheses to be considered by the IWC Scientific Committee in its work related to the RMP and in-depth assessments. The level of field, laboratory and analytical work has been impressive, as was the effort put into responding to the 2009 Panel recommendations. The Panel did make some recommendations for improved analyses, particularly related to power and the ability to distinguish amongst weakly-differentiated populations. The Panel **concludes** that the stock structure component of JARPN II has made, and will continue to make, important contributions to the conservation and management of cetaceans by providing fundamental data and analyses for the RMP *Implementation Reviews* of common minke whales and Bryde's whales, and the in-depth assessment of sei whales.

In general, the Panel recognised the extensive field and laboratory components of the programme but was concerned that this was not matched by the analytical effort. To this end it made almost 40 recommendations for improved analyses, of which around 15 could be achieved in the short-term (by the 2016 or at the latest 2017 Annual Meeting of the Scientific Committee).

Annex E contains a summary table of all Panel recommendations and expected actions by the proponents with a timeline.

The Expert Panel Workshop of the final review on the western North Pacific Japanese Special Permit programme (JARPN II) was held in the Toyomi Center Building, Tokyo from 22-26 February 2016. The list of participants is given as Annex A.

1. INTRODUCTORY ITEMS

1.1 Opening remarks
The Scientific Committee chair welcomed the Panel members, observers and Japanese proponents to Tokyo and thanked the Fisheries Agency of Japan for hosting the Workshop on the final review of the western North Pacific Japanese Special Permit programme (JARPN II). Morishita (IWC Commissioner for Japan) also welcomed the Panel and all participants.

The meeting was organised following the previous style of expert workshops. Mornings comprised open sessions with summary presentations by the proponents and the opportunity for questions and discussion (Panel members, proponents and observers present), followed by afternoon closed sessions for the Panel to discuss the morning topics and begin to outline relevant sections of its report and assign writing tasks.

1.2 Appointment of Chair and rapporteurs
Fortuna, as Chair of the IWC Scientific Committee, chaired the Workshop.

Donovan co-ordinated the report writing. All members of the Panel contributed to the sections of the report.

1.3 Adoption of Agenda
The adopted agenda is given as Annex B

1.4 Review of available documents
The list of documents is given as Annex C. A total of 55 primary papers (SC/F16/JR1-55) were available, along with 37 for information papers, one Observer's statement and one response by Japan (SC/F16/O1-O2) to the Observer's statement (SC/F16/O1).

1.5 Structure of the report
For most items in the report, the first section is a summary of the relevant part of the JARPN II by the proponents - the Panel has not edited those sections and they represent the views of the proponents only; these sections are shown in a smaller font and indented and the table and figure numbers are preceded by a 'P'. The final sections of each item represent the comments and conclusions of the Panel. Item 11 presents the overall conclusions of the Panel alone.

According to Annex P, the report must be available to the proponents by 11 March 2016. It will be made available on the IWC website on 22 April 2016.

A summary of all of the recommendations from the 2009 Panel report, the response of the proponents to those recommendations and the present Panel's evaluation of the response to those recommendations is given as Annex D. A summary of all of the recommendations made by the present Panel is provided as Annex E.

2. OBJECTIVES OF THE WORKSHOP
The Head of Science provided an introduction to the Annex P review process. This was revised at the 2015 Scientific Committee meeting in response to Commission Resolution 2014. The revised Annex P was recommended by consensus by the Committee to the Commission (IWC, 2016). A simple schematic of the process is given as Fig. 1.

The overall objective of the Annex P process is to provide a full, fair, independent, balanced and objective review. The first component of this is the Expert Panel workshop. The Panel members, who should not have conflicts of interest, are selected by the Chair and Vice-Chair of the Scientific Committee and Head of Science, in consultation with a Standing Steering Group (SSG) comprising the previous four chairs of the Scientific Committee. The number of panel members depends on the subject matter of the review and the aim is to include a balance of experts from outside and inside the Committee, depending on subject. For the present final review, the selection also took into account membership of the mid-term review in 2009 for consistency and experience. In addition to the Chair, Head of Science and one member of the SSG, the Panel included three regular members of the Committee, three former members who have not attended for some years, and five non-members of the Committee; one member participated by correspondence only.

The primary objective of the Expert Panel Workshop for this final review was to review the scientific aspects of the JARPN II programme in the light of the stated programme objectives. In particular, the Panel was to:

(1) assess the extent of the programme's scientific output, and whether this was appropriate in light of the stated research objectives and the time elapsed;

(2) assess the degree to which the programme coordinated its activities with related research projects; this included assessment of whether the degree of coordination was sufficient to ensure that the field and analytical methods were appropriate and best practice to achieve the stated objectives and whether the degree of coordination was sufficient to avoid unnecessary duplication;
(3) evaluate other contributions to important research and information needs that were not part of the original set of objectives of the research programme;
(4) consider any other relevant matters as decided by the Scientific Committee; and
(5) evaluate how well the initial, or revised, objectives of the research were met, and the extent to which results have led to demonstrated improvements in the conservation and management of whales, for broad categories of objectives 1 (‘*improve the conservation and management of whale stocks*’) and 2 (‘*improve the conservation and management of other living marine resources or the ecosystem of which the whale stocks are an integral part*’).

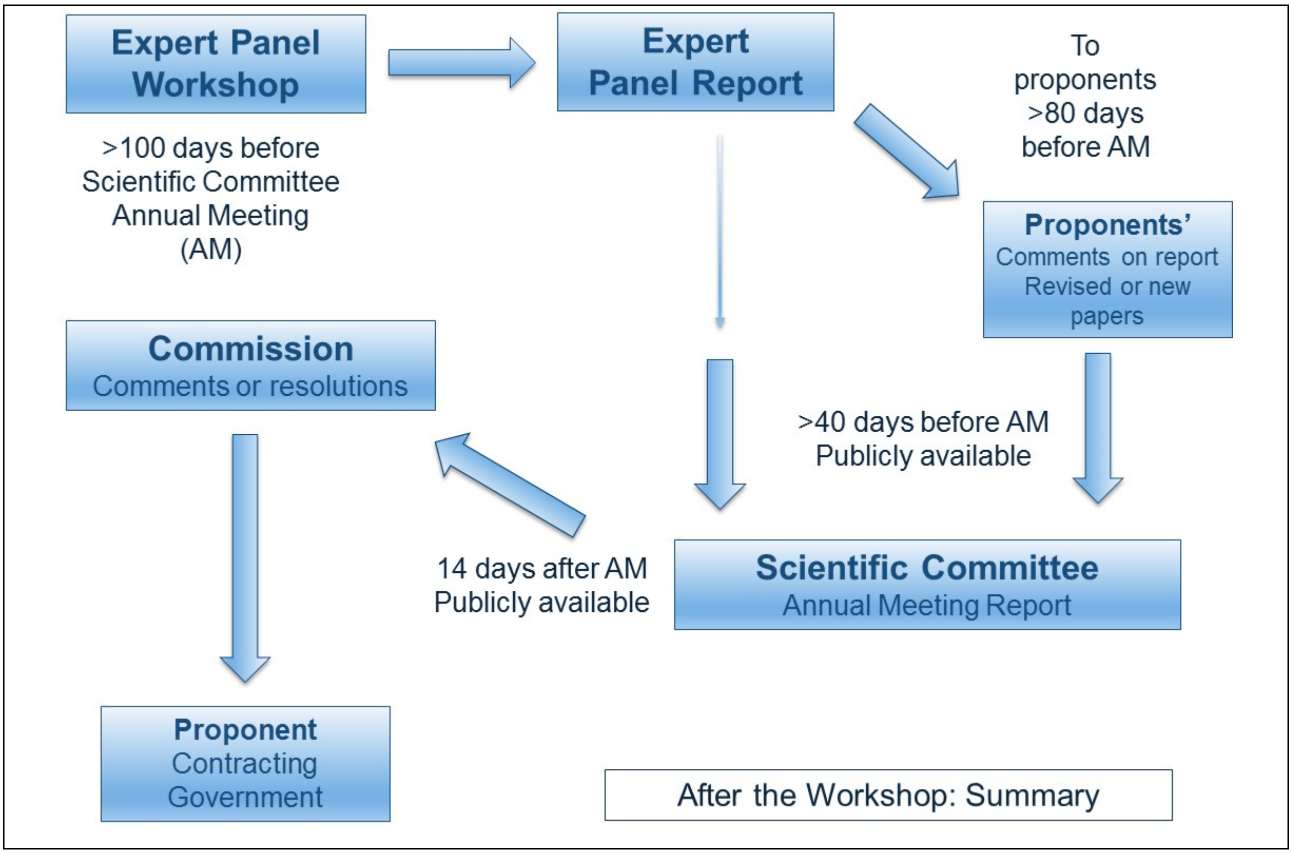

Fig. 1. Schematic of the Annex P process from the start of an expert workshop (see text).

For a final review, the Panel is not asked to comment on matters such as effect of catches, lethal versus non-lethal techniques or future field studies. However, aspects of the first two matters are briefly considered in the context of progress with the recommendations of the 2009 ‘mid-term’ review (IWC, 2010).

The review of the initial proposal was held by the Scientific Committee in 2000 (IWC, 2001a, pp. 61-64). As noted above, the mid-term review was held in 2009 (IWC, 2010) and consideration of progress with the recommendations of that review was an important component of the Panel’s evaluation of the final results of the programme.

It was noted that this is an unusual ‘final’ review, in that the field component of the JARPN II programme is not formally intended to be completed until 2016 – originally this review was expected to be a review of an ongoing programme and it was only in 2015 that it was changed to a ‘final’ review; these are normally expected to occur within three years of the close of a programme to allow consolidated and integrated analyses of the full datasets. The Panel makes some general comments on how this has affected the present review and recommendations on the implications of this for the future in its conclusions under Item 11. Given the ‘adjustments’ made to JARPN II from 2014 (see SC/F16/JR54) in the light of the deliberations at the International Court of Justice (ICJ) with respect to Japan’s special permit programme in the Antarctic, the Panel’s primary focus was on the period up to 2013.

3. SHORT GENERAL OVERVIEW OF JARPN II

3.1 Proponents' overview of general objectives and any changes over time

The three main objectives of JARPN II were the following:

Objective 1: Feeding ecology and ecosystem studies, including (i) prey consumption by cetaceans, (ii) prey preference of cetaceans, and (iii) ecosystem modelling.

Objective 2: Monitoring environmental pollutants in cetaceans and the marine ecosystem, including (i) pattern of accumulation of pollutants in cetaceans, (ii) bioaccumulation process of pollutants through the food chain, and (iii) relationship between chemical pollutants and cetacean health.

Objective 3: Stock structure of large whales, including (i) common minke whale, (ii) Bryde's whale, (iii) sei whale, and (iv) sperm whale.

These main research objectives have not been changed since the start of the program. However and following 2009 JARPN II review workshop recommendations, several sub-objectives within each main objective were identified. The background of each objective and sub-objective is explained in more details under agenda items 4, 5, 6, 7 and 8.

The origin of JARPN II is related with the research outputs from the previous JARPN program. JARPN provided both qualitative and quantitative information on prey species of whales in the western North Pacific. The analysis of stomach contents demonstrated that common minke whales fed on several prey species, all of which were also the target of commercial fisheries in Japan. The JARPN review workshop in 2000 (IWC, 2001b) made a series of recommendations to strengthen the feeding ecology part of the JARPN program.

Following this development, JARPN II was started in 2000 with the primary purpose to study the interactions between fisheries and cetaceans through ecosystem modelling in a 'hot-spot' area in the Pacific side of Japan, one of the most productive areas in the world. The output of JARPN II can assist in the formulation of effective ecosystem-based fisheries management policies.

3.2 Summary of general conclusions and recommendations from the 2009 Workshop

A short overview of general recommendations (i.e. relevant to two or more of the objectives) made at the 2009 Workshop (IWC, 2010) was provided by the Chair. Summaries of the topic-specific recommendations are provided under the relevant agenda items. Overall, the 2009 Panel had recognised that an enormous amount of scientific work has been undertaken in the field, laboratory and in analysis during the first six years of the programme. In addition to its comments under specific objectives of the programme it had raised several general issues.

3.2.1 Objectives

The 2009 Panel had noted that the objectives for the programme were general and long-term – this made it difficult to undertake a full mid-term review. The 2009 Panel recommended that well specified and quantified objectives and sub-objectives should be developed as soon as possible, with reference to timelines.

3.2.2 Sampling design, sample size and areas

The 2009 Panel had recommended that for each objective it is necessary to specify the quantities of interest that need to be determined to achieve the objective, and for each quantity of interest, all the sources of uncertainty in its estimation should be identified and quantified, and in particular it should be determined which of these are functions of sample size. The results of this analysis should then be used to determine:

(a) how much the research has contributed, in quantitative terms, to achieving the objectives;
(b) what further quantitative progress towards the objectives can be expected from completing the programme;
(c) the extent to which increasing/decreasing sample size would enhance/reduce the rate of progress towards achieving the objectives; and
(d) the extent to which the sample design is the most appropriate for achieving the objective and in particular for maximising the information gained from the chosen sample size.

3.2.3 Data analyses and modelling

The 2009 Panel noted that for many of the analyses, associated uncertainty had either not been addressed or only partly addressed. Insufficient use had been made of existing datasets (e.g. JARPN and early JARPN II data) for comparative and sensitivity analyses, cross-validation of models and assessment of uncertainty.

Particular attention had been drawn to the fact that most programme emphasis to date had been on data collection rather than full analyses and model development. It had recommended that more resources must be dedicated to this 'if there is to be a reasonable chance of meeting the programme's objectives in a reasonable time-frame'. It had also noted the value of even simple or preliminary ecosystem models to assist with and refine sampling design and sample size.

The 2009 Panel had also noted that several papers presented had overstated the conclusions that could be made.

The present Panel's general view of how the proponents have responded to the 2009 review is given under Item 3.4. Specific recommendations are dealt with objective by objective under the relevant agenda items. The full list of 2009 recommendations is tabulated in Annex D, along with a summary of the view of the proponents on whether and how they had been addressed and the conclusions of the Panel.

3.2.4 Other matters not the focus of a final review

LETHAL AND NON-LETHAL RESEARCH TECHNIQUES

The 2009 Panel had recommended that the proponents add a sub-objective to their programme to allow a quantitative comparison on all aspects of lethal and non-lethal techniques in the context of the programme's other objectives and sub-objectives, including suggestions as to how such a sub-objective could be realised, including analyses of precision and uncertainty, evaluation of practicalities and logistics of field and laboratory techniques. Aspects of this are considered under Item 3.4.

EFFECTS OF CATCHES UPON THE STOCKS

The 2009 Panel had noted that Scientific Committee guidance as to how to evaluate the effect of catches upon stocks may be valuable. It noted that this might include (a) providing projections where the permit catch is equal to zero as well as for the permit catches alone, (b) using a range of MSYR values, and (c) using *Implementation Simulation Trials (ISTs)* as the basis of an evaluation where these exist (not the same as using the RMP/*CLA* to provide the advice itself). With respect to common minke whales it had noted that the approach presented by the proponents at the time was not sufficient and had noted the need to use updated *ISTs* when these had been developed as part of an RMP *Implementation Review*. The 2009 Panel had accepted that the catches of Bryde's and sperm whales would not pose a problem to the stocks and had asked that additional analyses be undertaken for sei whales before it could provide advice. Aspects of this are discussed under Item 11.

FURTHER REVIEW

The 2009 Panel had noted that given its recommendations for additional work regarding sample size and the effects of catches on two of the stocks, it could not complete its review and asked the Scientific Committee to consider the most appropriate way to ensure that it was completed. Aspects of this are discussed under Item 11.

3.3 Proponents' overview of broad sampling scheme including sample size, areas and strategy including changes over time and response to the 2009 Workshop recommendations

SC/F16/JR2, 3, 4 described the methodology and procedures of the JARPN II field surveys. In general, survey procedures were the same to those presented to the 2009 Workshop, which reviewed data and results obtained between 2002 and 2007. The JARPN II involved two survey components, an 'offshore' component which was covered by the research base vessel *Nisshin Maru* and sighting and sampling vessels, and a 'coastal' component which was covered by small-type whaling vessels. The offshore component covered the broad offshore areas in the western North Pacific from sub-area 7 to sub-area 9, and the coastal component was conducted in the two coastal areas, Sanriku in spring and Kushiro in autumn.

In principle, whale sampling was made along pre-determined track lines, and all of the sighted whales were targeted for sampling excluding mother and calf pair (SC/F16/JR3, 4). Annual sample size for the offshore component was started as 100 common minke, 50 Bryde's and 10 sperm whales in 2000-2001 feasibility studies. A total of 50 sei whales was added in the full-scale offshore survey started in 2002, and the sample size was changed to 100 in 2004. The coastal component was started in 2002 targeting 50 minke whales as a feasibility study, and the full-scale coastal survey was started in 2004 with sample size of 60 minke whales for each coastal area per year.

As same as in the previous 2000-2007 surveys, dedicated sighting surveys and prey species surveys were also carried out as part of the multidisciplinary research program. Dedicated sighting surveys were conducted to estimate the number of whales migrating to the research area (SC/F16/JR2). Methodology of the sighting surveys followed the IWC survey guidelines. Non-lethal experiments, such as photo-ID and biopsy were conducted from the sighting vessels. Co-operative and concurrent surveys of whale sampling and acoustic/trawl preys and oceanographic survey were conducted by the dedicated prey survey vessels (SC/F16/JR4).

SC/F16/JR54 describes the adjustments made to JARPN II from 2014. Following the Judgment of the International Court of Justice (ICJ) in March 2014, the Government of Japan voluntarily reviewed the JARPN II program in response to the Judgment. The voluntary review resulted in the reprioritization of research objectives as well as recalculation of sample sizes. Sampling of sperm and common minke whales in the offshore component was suspended. Comparative studies for verifying the feasibility and practicability of non-lethal methods, including biopsy sampling and faeces collection, are being carried out from 2014 to 2016.

At the request of the Panel, more information is provided in Annex F.

3.4 Panel comments and conclusions on general issues

3.4.1 Objectives

The Panel welcomed the fact that the proponents had developed sub-objectives for the JARPN II programme as recommended by the 2009 Panel. However, it **notes** that whilst work to develop sub-objectives had begun in 2010 they had not been finalised until 2014, five years after the review. In addition, the sub-objectives had not been accompanied by shorter-term objectives (i.e. targets and timeline) (Table 1). Whilst development of a timeline became moot in 2015 when Japan asked that the present review be considered as a final review, in 2014, it was expected that the 2016 review would represent a periodic review.

Table 1

Summary of Panel's evaluation of the proponents' response to the 2009 recommendations with respect to objectives (see text).

Brief summary of 2009 Recommendations/suggestions	Panel evaluation
Develop refined, more quantified sub-objectives and short-term objectives	Partly met but no timeline

The Panel **notes** that Annex P requires that new proposals do contain sub-objectives and a timeline and **agrees** that this should be an essential component of any long-term research programme, irrespective of whether it contains a lethal sampling component.

3.4.2 Sampling design and sample size

3.4.2.1 SAMPLING DESIGN AND AREAS

The 2009 Panel had noted that for several of the objectives there was insufficient justification of sample sizes, design and sampling areas. It had noted that this should be done for the quantities of interest (parameters) relevant to the revised and quantified sub-objectives by (1) undertaking exploratory analyses on the existing datasets, including power and sensitivity analyses, for each of the components of the research and (2) examining the effects of sample size on the ability and time to meet the sub-objectives (IWC, 2010, p.432).

The Panel **agrees** that this recommendation had not been addressed. However, it recognised that given that this is a final review, the emphasis now is rather on whether the sampling design and sample sizes were adequate to meet the objectives. This is considered further under specific agenda items below.

With respect to sampling design and areas, the Panel requested additional information from the proponents during the Workshop, and specifically, maps showing the survey design by year and season (early or late), along with realised tracks and sampling locations. These are given in Annex F. The sampling scheme is complicated (see Fig. 2 and Annex F), with changes over time in where sampling for prey occurred (the co-operative sampling areas) owing in part to the need to coordinate with fishery surveys.

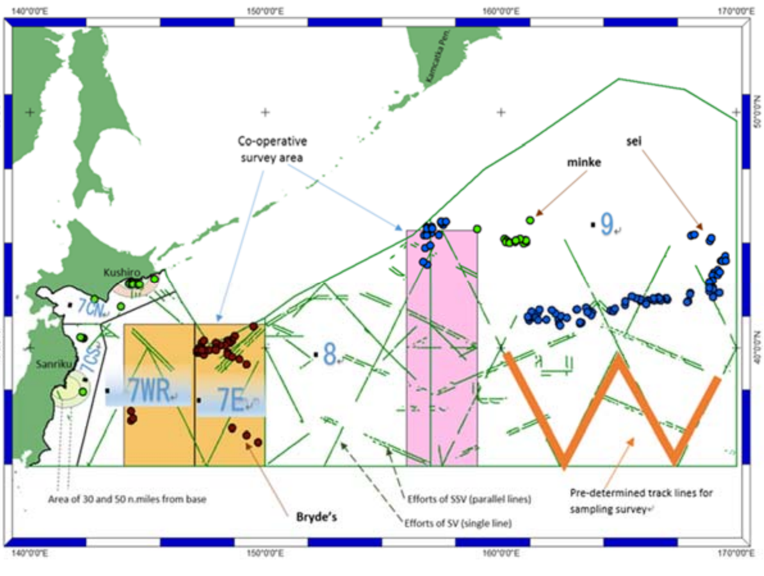

Fig. 2. Overview of the survey design under JARPN II.

There are several survey components under JARPN II:

(a) dedicated sighting surveys;
(b) whale sampling surveys (coastal and offshore);
(c) concurrent whale/prey surveys in offshore areas;
(d) and prey surveys in coastal areas.

In the example figure here, pre-determined track lines for whale sampling surveys in the offshore component are shown in orange; on effort track lines of dedicated sighting (single line) and whale sampling (parallel lines) surveys in green. Concurrent whale/prey surveys are shown by coloured squares.

Only the research areas are shown for Sanriku and Kushiro in this figure.

Kindly produced by the proponents

With respect to the offshore component, the design for the sightings surveys seems reasonable and the fulfilled tracklines are adequate. However, with respect to the sampling, there are worrying differences between the proposed sampling tracklines (which it appears may be broadly adequate although quite variable in terms of blocks and direction from year to year - the rationale for the design is not presented) and the actual sampling. The Panel was informed that this was a function of decisions that had to be taken in the face of poor weather but an examination of the maps (Annex F) shows that in many years, the samples were not taken along the pre-determined tracks and in some cases (e.g. 2012 in the 'late' season), many of the catches lay along new lines with no apparent rationale. This raises important concerns as to whether such samples can be taken as representative of the animals within the surveyed areas. As a minimum, the proponents should have addressed this issue for those analyses for which this is an important assumption (e.g. many of the feeding ecology studies).

The Panel **recommends** that a new document based upon Annex F is developed by the proponents and submitted to the 2016 Annual Meeting of the Scientific Committee. In addition to the information on sightings, the document should record, for each year and season:

(a) the predetermined tracklines for sampling and the rationale for those lines; and

(b) the actual coverage of those tracklines and the rationale for any decisions taken to deviate from the predetermined lines including the rationale for any new lines developed.

The paper should address the issue of whether the actual sampling can be said to be representative of the animals in the surveyed area and discuss the extent to which this may affect those objectives/parameters/analyses for which this is or may be important (e.g. feeding ecology studies). Finally, the Panel also **notes** that the JARPN II sampling area does not cover the spatial extent of any of the stocks (e.g. JE, O, OW, and OE) postulated to be found east of Japan. The paper should also comment upon the implications of this for any analyses that are or might be dependent upon an assumption that the samples are representative of biological populations (e.g. with respect to age data). The Panel **agrees** that a document of this nature (i.e. with respect to proposed and actual sampling and sighting effort) should be part of any future periodic or final reviews (see Item 11).

The sampling scheme for the inshore component (the Kushiro and Sanriku sampling areas and their 30 and 50 n.miles radii sub-blocks) appears to be based upon logistics and no consideration of representativeness, either within the sampling areas or for the populations. The implications of this for the analyses based upon such assumptions must be considered by the proponents in a more quantitative manner. The Panel **recommends** that this be fully addressed in revised papers submitted to the 2016 Annual Meeting.

3.4.2.2 SAMPLE SIZE

The Panel **agrees** that the 2009 recommendation related to sample size and meeting objectives had not been addressed (see Table 2). The only objective for which an attempt has been made to fully quantify uncertainty is estimation of total consumption (e.g. see SC/F16/JR15) where a target CV of 0.2 was chosen. The value of 0.2 was apparently based upon Winship and Trites (2003) work on Stellar sea lions. However, those authors' attempts to address objectives related to the use of consumption estimates for estimating prey preference and ecosystem modelling, if anything, call into question the choice of a single value of 0.2. As noted by the 2009 Panel, a more appropriate method to examine this is to use even simple ecosystem models for the JARPN II area to evaluate the consequences of different levels of precision of estimates of consumption (and other parameters of interest) and hence sample sizes. Aspects of this issue are discussed further under Item 6.4.

Table 2

Summary of Panel's evaluation of the proponents' response to the 2009 recommendations with respect to sampling design and sample size (see text).

Brief summary of 2009 Recommendations/suggestions	Panel evaluation
Quantify for each quantity of interest for each objective sources of uncertainty and relationship with sample size and use to evaluate progress on meeting objectives, effect of changing sample size on meeting objectives and suitability of sampling design.	Not addressed

The Panel **agrees** to make some brief comments in response to SC/F16/JR54, although this is formally outside the scope of this review whose focus is on the period up to 2013 prior to the Government of Japan's changes to the programme in the context of the ICJ ruling (related to a reprioritisation of the objectives, the addition of an objective and a change in sample size):

(1) the only parameter used to address sample size was related to total consumption and this was in relation to a target CV of 0.2 – however the rationale for this was unclear as two explanations were given, one related to Winship and Trites (2003) in SC/F16/JR54 and another in which additional information presented to the meeting related to the approach used by the Government of Norway in its special permit programme in the 1990s (NMMRP, 1992);

(2) with respect to common minke whales this led to lower sample sizes in the inshore component and the suspension of sampling of minke whales in the offshore component – however the implications of this in terms of meeting the original objectives were not fully explored;

(3) with respect to sei and Bryde's whales, the present sample sizes were estimated to be too small but no changes were made – again the implications with respect to meeting the original objectives were not fully explored;

(4) the addition of an objective to compare lethal and non-lethal techniques was in line with the recommendation from the 2009 Panel, but the explanation of this with respect to sample sizes was confusing and the protocols for the comparison were not provided – the Panel refers to the advice provided as how to do such a comparison given in the 2009 report.

The Panel **recommends** that a single document be provided to the 2016 Annual Meeting that:

(1) provides a clearer rationale for the changes in sample sizes and any implications for meeting the original objectives of the programme (e.g. related to time series of data, analyses and sample size); and

(2) provides the field and analytical protocols for the comparison of using lethal and non-lethal techniques for each key parameter taking into account the advice provided in 2009.

4. STOCK STRUCTURE

Although this is not the first primary objective of the programme, it is fundamental to understanding many of the other aspects of the programme (e.g. distribution, abundance and status) and thus was discussed first.

4.1 Proponents' summary of objectives including modifications, if any, since the start of the programme

The main objective 3 of the JARPN II research plan was to investigate the stock structure of large whales such as the common minke, Bryde's, sei and sperm whales in the North Pacific.

Stock structure information is important for the development of RMP *ISTs* in the case of the common minke and Bryde's whales, and for the in-depth assessments (IA) of other large whale species such as the sei, sperm and right whales. Fig. P1 shows a schematic representation of the data, analyses and outputs within this main objective.

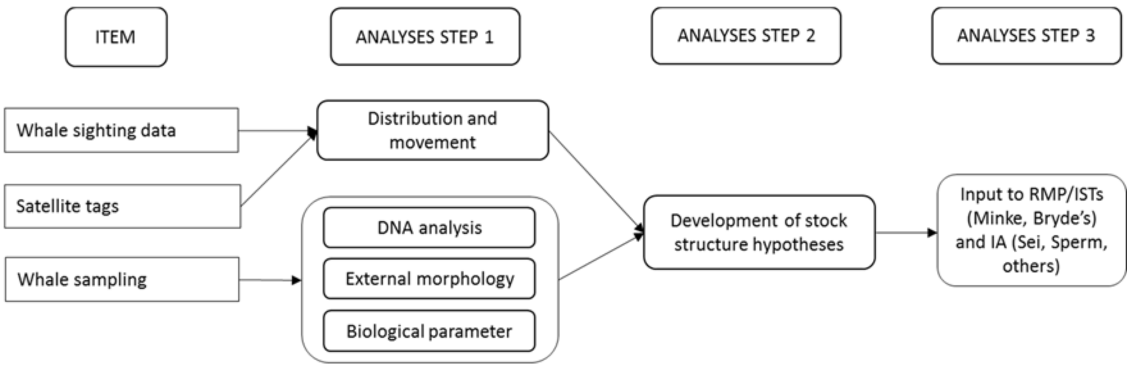

Fig. P1. Schematic representation of research components under Objective 3 of JARPN II.

Common minke whale

The IWC SC completed the *Implementation Review* (*IR*) of the western North Pacific common minke whale at its 2012 and 2013 Annual meetings (IWC, 2013; 2014). Most of the information on stock structure presented and discussed during the IR was based on data and information from JARPN and JARPN II. A total of 22 sub-areas were set for the aim of the *IR* (Fig. P2a), and three stock structure hypotheses were used (Fig. P2b-d).

The plausibility of the three stock structure hypotheses was discussed at the 2012 IWC SC Annual meeting. A group of five geneticists summarized their interpretation of the relative support for and against the five hypothesized stocks (JE, JW, OE, OW and Y) involved in the different hypotheses (IWC, 2013, p.135). It should be noted that their evaluation was made based on the available genetic information only despite plenty of non-genetic information was available for the *IR*.

Despite this effort by geneticists, it was not possible for the IWC SC to agree on plausibility of the three stock structure hypothesis. As a consequence, all three main stock structure hypotheses were 'no agreement' and were therefore treated as if they had been assigned 'Medium' plausibility in the trials (IWC, 2013, p.126).

There are, however, some interesting points in the evaluation of different stocks by the five geneticists. From their summary table (IWC, 2013, p.135), it is clear that the plausibility of additional structure in the J stock is low, and consequently further analyses under the JARPN II were not focused to investigate subdivision within this stock. The J stock distributes mainly in the Sea of Japan but mixes with the O stock in the coast of northern Hokkaido and in the Pacific side of Japan. What it is important is the study of the dynamics of the J stock around the Japanese coast, and the interaction with the O stock, mainly in the Pacific side of Japan. This is the basis for the first sub-objective under Objective 3 of JARPN II:

> *Objective 3, Sub-objective 1:*
>
> *Monitoring of the spatial and temporal distribution of J stock on both west and east coasts of Japan using genetics and non-genetics approaches, and all sources of samples available e.g. JARPN, JARPN II and by-catches (Relevant documents: SC/F16/JR38, JR39).*

With regard to the O stock, the genetic evidence summarized in the summary table (IWC, 2013, p.135) cannot discard definitively the possibility of additional structure within the O stock. Therefore the second sub-objective within Objective 1 is the following:

> *Objective 3, Sub-objective 2:*
>
> *Using genetic and non-genetic data from JARPN and JARPN II, investigate whether or not the sub-division of the O stock into OW and OE is plausible. The genetic analysis should include those approaches mentioned in Table 1 as providing support for the existence of the OW (e.g. PCA analyses) (Relevant documents: SC/F16/JR40-41; SC/F16/JR43; Kishiro and Miyashita (2011) [SC/F16/JR42]).*

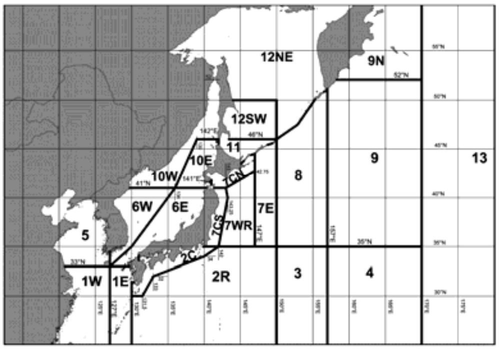

Fig. P2a The 22 sub-areas used for the *Implementation Simulation Trials* for North Pacific common minke whale.

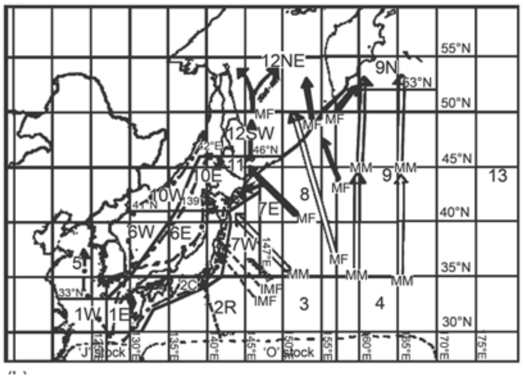

Fig. P2b. Schematic diagram of Hypothesis I.

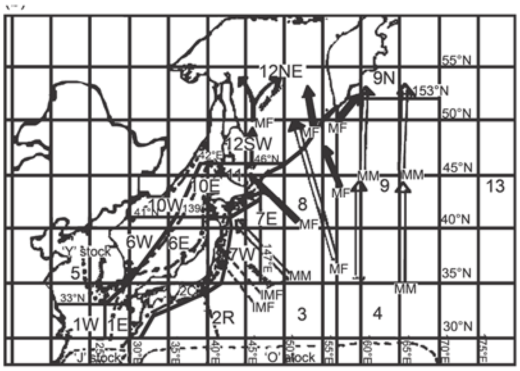

Fig. P2c. Schematic diagram of Hypothesis II.

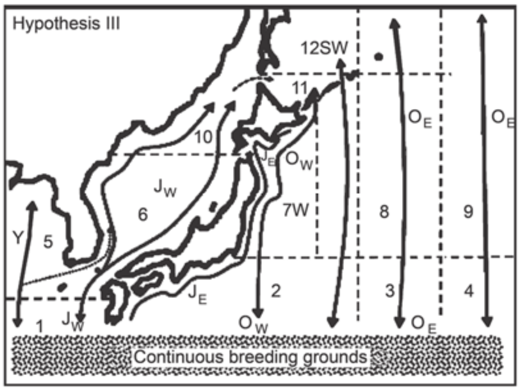

Fig. P2d. Schematic diagram of Hypothesis III.

Bryde's whale

The RMP *Implementation* for western North Pacific Bryde's whale was completed by the IWC SC in 2007 (IWC, 2008, p.9). During the *Implementation* two sub-areas (Fig. P3a; IWC (2009, p.7), and four stock structure hypotheses (Fig. P3b; IWC (2007a, p.8), were considered.

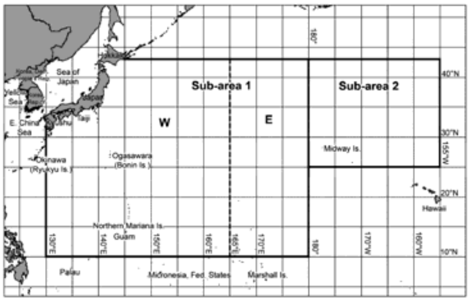

Fig. P3a. Sub-areas used for the RMP *Implementation* of western North Pacific Bryde's whale.

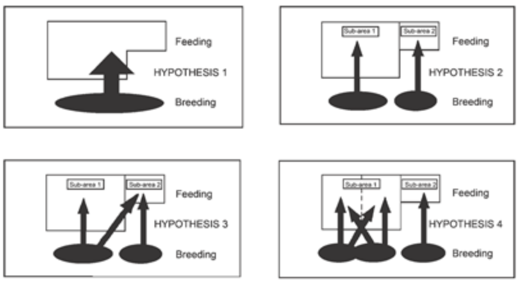

Fig. P3b. Stock structure hypotheses selected for the RMP *Implementation* of western North Pacific Bryde's whale

The IWC SC examined the plausibility of the four hypotheses based on the genetics and non-genetics information available in 2006. That information was summarized in IWC (2007b). Based on such information, the IWC SC assigned the following plausibility to the four hypotheses: Hypothesis 1= High; Hypothesis 2= High; Hypothesis 3= High; Hypothesis 4= Medium.

It should be noted that a substantial number of genetic samples have been accumulated since the *Implementation* of Bryde's whale in 2007. For example larger sample sizes are now available for Sub-areas 1W and 1E, from JARPN II, dedicated sighting and IWC POWER surveys. This allowed new analyses to be conducted to evaluate the plausibility of Hypothesis 4, which propose two stocks within sub-area 1. In addition, genetic samples are now available for Sub-area 2 from the IWC POWER surveys. Genetic analyses of such samples would allow the evaluation of plausibility of Hypotheses 2 and 3, which propose two stocks in those sub-areas.

Therefore the following sub-objective related to Bryde's whale, which is relevant in the context of the RMP *Implementation*, was defined:

> *Objective 3, Sub-objective 3:*
>
> *To investigate the plausibility of i) stock sub-division within Sub-area 1 as proposed under Hypothesis 4, and ii) sub-division between Sub-areas 1 and 2 as proposed under Hypotheses 2 and 3, using all genetic samples available from different sources till 2014, different genetic markers and satellite tracking (Relevant documents: SC/F16/JR44, Murase et al. (2016) [SC/F16/JR45].*

Sei whale

The in-depth assessment of North Pacific sei whale started at the 2015 IWC SC meeting. The IWC SC agreed to proceed with two initial alternative stock structure hypotheses: i) a single stock in the entire North Pacific as proposed by Kanda *et al.* (2015), based on several pieces of evidences included the genetics; and ii) a five-stock hypothesis proposed in Mizroch *et al.* (2015), based mainly on the interpretation of mark-recapture data: Japan coastal; North Pacific pelagic; Aleutian Islands and Gulf of Alaska; eastern North Pacific migratory; and Southern North American coastal stock (coastal California) (IWC, 2015b). The IWC SC agreed that discriminating between these two hypotheses is difficult in the absence of genetic data from the potentially extirpated stocks, and thus both hypotheses are plausible (IWC, 2015a).

The sub-objective related to sei whale is the following:

> *Objective 3, Sub-objective 4:*
>
> *To investigate the plausibility of a single stock of sei whale in the pelagic regions of the North Pacific ('North Pacific pelagic'), using all genetic samples available from different sources till 2014, and different genetic markers (Relevant documents: SC/F16/JR46-47; Kanda et al. (2015) [SC/F16/JR48].*

Other species

There are a number of genetic samples collected under JARPN II from sperm whale (catches) and North Pacific right whales (biopsy). The number of samples is small and then, detailed analyses on stock structure were not possible. However, genetic studies based on microsatellite and mtDNA were conducted on these two species to investigate levels of genetic diversity and the utility of such genetic markers for future studies on stock structure, in addition to a new worldwide phylogenetic study in the case of the right whale (see Documents SC/F16/JR49-51).

4.2 Overview of conclusions and recommendations from the 2009 Workshop

A short overview of the conclusions and recommendations made at the 2009 Workshop (IWC, 2010) on the stock structure component of JARPN II was provided by the Head of Science.

The Panel had noted the considerable work undertaken by the proponents that had led to a uniquely large genetic dataset for common minke, Bryde's and sei whales in the region. The analyses that were presented had been generally sound and provided useful information for RMP *Implementation Reviews* (common minke and Bryde's whales) and the future in-depth assessment of sei whales, although it was not possible at that time to conclude that the number of plausible hypotheses had been reduced. It had noted that the incorporation of non-genetic information was valuable. However, it noted that the programme had made no meaningful contribution with respect to sperm whales and was unlikely to do so in the future.

In terms of the main problems identified, these were identified as being related to either (a) poor specification of the original objectives and/or (b) generic difficulties (i.e. not associated with this particular programme) related to weakly-differentiated populations.

Some general limitations identified by the 2009 Panel that should be addressed related to the need to (a) assess demographic linkage (there was an over reliance on hypothesis testing in the analyses presented); (b) examine the statistical power of results suggesting no differentiation; (c) consider non-genetic-equilibrium scenarios; and (d) examine the implications of the use of the Bonferroni correction.

In order to address these issues the Panel had made a number of recommendations and suggestions.

In terms of 'simple issues', the Panel recommended that in the revision of papers presented and in future work the proponents should:

(a) explain data quality procedures;
(b) estimate divergence and uncertainty not just homogeneity;
(c) report p-values for all loci combined;
(d) consider the use of the 'False Discovery Rate' (FDR) rather than the Bonferroni correction approach;
(e) improve the presentation of results for analyses using the 'STRUCTURE' program; and
(f) better explain the influence of sampling design related to specific stock structure hypotheses.

With respect to more extensive issues, the Panel had recommended that the proponents should:

(a) integrate data on common minke sampled by the Republic of Korea into analyses;
(b) improve the assessment of the power for various approaches (e.g. using simulation studies);
(c) test for population genetic equilibrium;
(d) estimate divergence using non-equilibrium approaches;
(e) examine the spatial distribution of relatives;
(f) consider additional analyses with respect to morphology and pollutants; and
(g) develop a telemetry programme.

The Panel had also stressed that the small sample size for sperm whales precluded any useful information (it had made an overall recommendation for the sperm whale component of JARPN II to be removed).

4.3 Proponents' summary of the results (incl. response to 2009 Workshop)

Studies on stock structure of large whales under JARPN II were based on a large and comprehensive data/sample set, and involved the use of both genetics (mtDNA control region sequences and microsatellite DNA) and non-genetic (morphometric, morphologic, satellite tracking).

Regarding to genetics, the combination of large sample sizes and powerful genetic markers was an appropriate tool to examine stock structure in weakly differentiated populations as shown below.

Objective 3, Sub-objective 1:

Monitoring of the spatial and temporal distribution of J stock common minke whale on both west and east coasts of Japan using genetics and non-genetics approaches, and all sources of samples available e.g. JARPN, JARPN II and by-catches.

SC/F16/JR38 examined a total of 4,275 western North Pacific common minke whales with a set of 16 microsatellite DNA loci and the program STRUCTURE to assign individual to either J or O stocks. Samples were available from JARPN/JARPN II (1994-2014; n= 2,637)), and by-catches (2001-2014; n= 1,638), from different management sub-areas (SA) around Japan. Results of the Bayesian clustering analysis confirmed that the whales came from two genetically differentiated stocks, J and O stocks. The number of unassigned individuals ('unknown') decreased with the increase in the number of microsatellite loci used, and they were widely distributed. By using 16 loci, more than 90% of the individual whales were assigned to either stocks. Almost all of the individuals collected from the Sea of Japan side (SA6 and SA10E) belonged to the J Stock, whereas almost all of the individuals from the offshore North Pacific (east of SA7WR) belonged to the O stock. Intermediate areas (SA7CN, 7CS and SA11) contained individuals from both stocks. The SA2 was mainly occupied by the J stock. In SA2 the J stock was predominant (around 80% in proportion) around the year. In SA7CS and SA7CN the proportion of the J stock increase in autumn/winter and decrease in spring/summer. A phylogenetic tree of mtDNA haplotypes showed several clades but none supported by high bootstrap values. There was no stock-specific clade although most of the individuals assigned to the J stock shared a same clade. Most of the individuals assigned to the O stocks share clades where the J stock individuals were less frequent. The unknown samples were widely distributed through the clades.

SC/F16/JR39 focused on the unique white patch on the flipper of the common minke whale to differentiate between J and O stocks. Animals collected from JARPN II research during 2012 and 2013 were used; assignment of individual whales to the O and J stocks was based on microsatellite analysis (n = 220). The morphological differences in the size and pattern of the white patch on the flipper of each whale was examined. The length of the white patch along the anterior (ventral) margin of the flipper tends to be proportionally larger in O stock animals. The pattern of the boundary area of the white patch named as the "Grayish Accessary Layer (GAL)" was remarkably different between stocks. Of the total animals with "no GAL" type, 94% were J stock. Conversely, of the total animals with GAL expanding over the half the flipper width, 98% were O stock. It is concluded that there were clear morphological differences in the body color pattern of the flipper between J and O stocks.

In conclusion, JARPN II was able to monitor the O and J stock common minke whales around Japanese waters. Almost all animals from the Sea of Japan belonged to the J stock while all animals in the Pacific side east of SA7WR belonged to the O stock. Intermediate sub-areas (7CN, 7CS, and 11) contained animals from both stocks.

In SA2 the J stock animals were predominant through the year while in SA7CS and SA7CN the proportion of J stock animals increased in autumn/winter and decreased in spring/summer. The O stock had a reverse trend.

The number of 'unknown' individuals in the STRUCTURE analysis decreases as the number of loci increases. They are widely distributed in the research area and through the mtDNA phylogenetic clades. Therefore whales assigned to J and O stocks by the STRUCTURE analysis can be subjected to examination of sub-structure using different analytical approaches, and there is no problem of 'circularity' in such analyses.

Objective 3, Sub-objective 2:

Using genetic and non-genetic data from JARPN and JARPN II, investigate whether or not the sub-division of the O stock common minke whale into OW and OE is plausible. The genetic analysis should include those approaches mentioned as providing support for the existence of the OW (e.g. PCA analyses).

SC/F16/JR40 examined the genetic population structure of 'O' stock common minke whale in the western North Pacific based on mitochondrial DNA control region sequencing (487bp) and microsatellite DNA (16 loci). Samples used in the tests of homogeneity were obtained during the surveys of the JARPN and JARPN II in sub-areas of the Pacific side of Japan between 1994 and 2014 (n= 2,071 for microsatellite; n= 2,070 for mtDNA). Whales were assigned to the 'O' stock by the analysis of STRUCTURE presented in SC/F16/JR39. Tests based on both genetic markers and different grouping of the samples showed no evidence of sub-structuring in the 'O' stock common minke whale in the Pacific side of Japan. A simulation exercise showed that the statistical power of the homogeneity test was high. In addition, a Discriminant Analysis of Principal Components (DAPC) based on the total samples used in SC/F16/JR38 showed clear differentiation between J and O stock whales but no evidence of sub-structuring within the O stock samples. Consequently the results of this study suggested a low plausibility for the hypothesis of sub-division of the O stock common minke whale into OW and OE.

SC/F16/JR41 examined stock structure of western North Pacific common minke whales by using external measurement data collected during 1994 and 2014 JARPN and JARPN II surveys. Most of the analyses conducted followed recommendations from the 2009 JARPN II review workshop. External measurements of mature males were first compared between O and J stock animals assigned by the microsatellite DNA analysis. Then, only O stock animals were compared among sub-areas. The analytical procedures used were the Analysis of Covariance (ANCOVA) and DAPC. Significant differences were detected between O and J stock whales. J stock animals had longer head region compared to O stock animals. No significant differences were detected in O stock animals among sub-areas. The results of the present study provided no evidences for sub-structuring of the O stock into OW and OE as proposed in one of the hypotheses used in the RMP *Implementation*, as common minke whales from coastal and offshore sub-areas did not differ in morphometric characters.

Kishiro and Miyashita (2011) [SC/F16/JR42] described an experiment on satellite tracking conducted on common minke whales in the Pacific side of Japan, specifically in coastal water off Hokkaido in autumn 2010. Using a handy air gun, a satellite tag (Argos transmitter) was attached on one common minke whale on 13 September (estimated body size: 7.8m). The movement of the whale was tracked for a period of 27 days. The whale stayed in the coastal waters off Kushiro, for at least four weeks in the autumn season. The JARPN II review workshop in 2009 had recommended satellite tracking experiments on the whale species studied, as a long-term task. This study started such experiments in the common minke whale. Further satellite tracking experiments have the potential to elucidate whether or not a coastal-resident stock of common minke whale occur in waters off Hokkaido (OW) as proposed by one of the current stock structure hypotheses.

In SC/F16/JR43 the catch-at-age data for minke whales in the western North Pacific provided by the JARPN/JARPN II were used to refine existing RMP ISTs in a simple way, so as to investigate the relative plausibility of the single- and two stock hypotheses for the O stock whales in the Pacific side of Japan. While the single stock scenario seems consistent with these age data, it is difficult to reconcile the two stock hypothesis (OW and OE) with them because of the relative absence of particularly younger whales in a supposedly separate discrete OE stock. The analysis demonstrated the importance for management purposes of obtaining age data for the common minke whales in the western North Pacific, which in turn necessitates lethal sampling. Such age data need to be incorporated in the conditioning of revised RMP ISTs for common minke whales in this region.

During the Power Point presentation the proponents informed on the ongoing kinship analysis in common minke whale. A total of 22 cases of potential parent-offspring cases were identified.

In conclusion, the most parsimonious interpretation of different analyses conducted on J-purged O stock animals (hypothesis testing including an evaluation of the power, discriminant analysis of principal components, morphometrics, and catch-at age data) is that a single O stock occurs from the Japanese coast till at least approximately 170°E. Based on the updated scientific evidences presented at this workshop, the plausibility of an OW stock is 'Low' or 'Very low'.

An important implication of the research conducted under this sub-objectives is that in future RMP *ISTs*, the conditioning needs to take age-structure data into account to better reflect the underlying dynamics of this population.

As explained in Section 4.1, the next sub-objective involves Bryde's whales. The RMP *Implementation* for western North Pacific Bryde's whales completed by the IWC SC in 2007 involved two sub-areas and four stock structure hypotheses. The following sub-objective addresses the plausibility of three of the stock structure hypotheses.

Objective 3, Sub-objective 3:

To investigate the plausibility of i) stock sub-division within Sub-area 1 as proposed under Hypothesis 4, and ii) sub-division between Sub-areas 1 and 2 as proposed under Hypotheses 2 and 3, using all genetic samples available from different sources till 2014, different genetic markers and satellite tracking.

SC/F16/JR44 examined a total of 1,019 and 1,026 samples of North Pacific Bryde's whales with microsatellite DNA (17 loci) and mitochondrial DNA sequencing (299bp), respectively, to examine the plausibility of four stock structure hypotheses used by the IWC SC during the 2007 RMP *Implementation*. Samples were from different sources: JARPN II (catches), Japanese dedicated sighting surveys (biopsy); IWC/POWER surveys (biopsy) and past commercial whaling (catches). No significant genetic heterogeneity was found between the Western and Eastern Sectors of sub-area 1, a result supported by high statistical power. However both genetic markers showed significant differences (for males, females and sexes combined) between sub-areas 1 and 2. Phylogenetic analysis of mtDNA haplotypes revealed no subarea-specific clades. It is proposed that a longitudinal sector around 180° could represent a hard boundary or a transition area where the two stocks mix. Based on these results, it is suggested that the plausibility of the stock structure hypotheses for western North Pacific Bryde's whale used in the 2007 *Implementation* whale should be re-examined. The results of this study suggest that the two-stock hypotheses (Hypotheses 2 and 3) could be more plausible than the one-stock hypothesis (Hypothesis 1) and the three-stock hypothesis (Hypothesis 4).

Murase *et al.* (2016) [SC/F16/JR45] reported the movement of two individual Bryde's whales using satellite-monitored radio tags in offshore waters of the western North Pacific (sub-area 1). One whale was recorded for 13 days 4 hours 57 minutes from 13 to 26 July 2006. The other whale was recorded for 20 days 5 hours 5 minutes from 24 July to 13 August 2008. It has been documented that the subarctic-subtropical transition area (around 40°S) is one of the feeding areas of Bryde's whales in summer. However, the results of this study revealed that some Bryde's whales move from the subarctic-subtropical transition area to the sub-tropical area even in summer. This study provided the first information on continuous movement of Bryde's whales in the offshore western North Pacific in summer. The JARPN II review workshop in 2009 had recommended satellite tracking experiments on the whale species studied, as a long-term task. This study started such experiments in the Bryde's whale. Further satellite tracking experiments have the potential to complement the genetic studies on stock structure in sub-areas 1 and 2.

In conclusion the results of the genetics, which included an evaluation of the statistical power, mark-recapture and satellite tracking analyses suggested a single stock in sub-area 1. Genetic analyses suggested the possibility of additional stock structure in sub-area 2.

Based on these results, it may be necessary to re-consider the plausibility of the four hypotheses on stock structure agreed during the RMP *Implementation* in 2007. Hypotheses 1 (single stock) and 4 (three stocks) should be assigned lower plausibility.

Objective 3, Sub-objective 4:

To investigate the plausibility of a single stock of sei whale in the pelagic regions of the North Pacific ('North Pacific pelagic'), using all genetic samples available from different sources till 2014, and different genetic markers.

SC/F16/JR46 examined genetically a total of 1,554 sei whales with mtDNA control region sequencing (487bp) and microsatellite DNA (17 loci) to investigate population genetic structure of this species in the North Pacific. Samples were available from different sources, JARPN II (catches) (2002-2014), POWER (biopsy) (2010-2012) and past commercial (catches) (1972-73). For the heterogeneity test two longitudinal sectors were defined in the North Pacific: Western and Eastern at 180°, which covered this ocean basin widely from approximately 145°E to 135°W. No significant spatial genetic heterogeneity was found by the two genetic markers. A phylogenetic tree of 82 mtDNA haplotypes showed several clusters, but none was supported by high bootstrap values. Whales from both Western and Eastern sectors were widely distributed through the clusters. Taken as a whole, the genetic information in this study is consistent with the view that the oceanic regions of the North Pacific are occupied by a single stock of sei whale.

SC/F16/JR47 used microsatellite DNA markers to analyse samples of sei whales collected widely from the North Pacific at the same time of the year in order to test spatial genetic heterogeneity in this ocean basin. Although we have been reporting results of the genetic studies on the North Pacific sei whales to previous IWC/SC meetings, this study is the first to utilize temporally similar (collected at the same year), yet geographically very different, samples (covered west-end to east-end of the North Pacific). This study used samples collected from the northwestern (JARPN II), northcentral (POWER), and northeastern (POWER) areas of the North Pacific in the same summer seasons in 2010, 2011 and 2012. No evidences of significant genetic differences between the samples from JARPN II and POWER in each of the three years were found. Each yearly sample was then combined as JARPN II as well as POWER samples, respectively. No significant genetic differences were detected between these two samples. We used genotypic profiles of each whale in the POWER biopsy samples to find any cases of matching to the individuals in the JARPN II samples, no matching was found at all. In conclusion, this study failed to demonstrate evidence of multiple stocks of sei whales in the North Pacific.

Kanda *et al.* (2015) [SC/F16/JR48] presented a review of past studies on sei whales in order to describe stock structure hypotheses for the species in the North Pacific. Evidence obtained from different kinds of the analyses using mark-recapture, sighting, catch history, and genetic data shed light on patterns of distribution and migration of the sei whales, facilitating the hypothesis development. The mark-recapture data indicated that whales from the same breeding area distribute widely in the feeding area over almost the entire North Pacific. Although historical catch data from commercial whaling era had shown heterogeneous distribution of the sei whales, genetic evidence indicated no temporal and spatial genetic differences among the whales obtained from the entire North Pacific. The heterogeneous catch distribution appeared to reflect non-random operations of the commercial whaling as well as patchy distribution of their prey species. Overall, based on the series of the available evidence we propose a single stock hypothesis for sei whales in the North Pacific.

In conclusion, results of the genetic analysis confirmed the view of a single stock of sei whale in pelagic regions of the North Pacific, as agreed previously by the IWC SC. This information is useful for the IWC SC's in depth assessment of this species in the North Pacific.

Other species and analyses
SC/F16/JR49 examined genetic variation at 15 microsatellite DNA loci and mitochondrial DNA (mtDNA) control region sequences (338bp) in sperm whales collected during JARPN II from 2000 to 2013 in order to examine the effectiveness of these genetic markers for studies of stock structure in this species. Analyses of mtDNA and microsatellite markers in a total of 56 sperm whales (16 males; 40 females) confirmed that these genetic markers were variable enough to explore stock structure of sperm whales. The overall heterozygosity over 15 loci was 0.730 while the nucleotide and haplotype diversity were 0.0038 and 0.7188, respectively. Statistical tests found no evidence of deviation from the expected Hardy-Weinberg genotypic proportion at all of the 15 microsatellite loci. At this point, no signal of multiple stocks of sperm whale in the western North Pacific off Japan was detected.

SC/F16/JR50 examined genetic variation at 14 microsatellite DNA loci and mitochondrial DNA (mtDNA) control region sequences (275bp) in right whales from the western North Pacific and Antarctic Area IV. Genetic analyses were based on biopsy samples collected during the surveys of the JARPN II in 2011 and 2012 (n=15), and JARPAII in 1993/94-2009/10 (n=67). The overall heterozygosity was 0.630 and 0.650 for North Pacific and southern right whales, respectively, while the nucleotide diversity/haplotype diversity were 0.0222/0.9048 and 0.0234/0.7743, respectively. Statistical tests found no evidence of deviation from the expected Hardy-Weinberg genotypic proportion in each of the oceanic basins. The Kimura's two parameter net interpopulational distance was 0.0358 (mtDNA) while the Nei's genetic distance (Da) was 0.7582 (microsatellite DNA), between North Pacific and southern right whale. A phylogenetic tree separated mtDNA haplotypes of the North Pacific, North Atlantic and southern right whales.

SC/F16/JR51 examined the distribution of the number of nucleotide substitutions between all pairs of individuals within western North Pacific O and J stock common minke, Bryde's, sei and right whales, to investigate whether the pattern of distribution is indicative of exponential population growth (in evolutionary terms), and thus of non-equilibrium. According to Slatkin and Hudson (1991), unimodality of the frequency distribution is indicative of exponential population growth, and this pattern was found in the O stock common minke and sei whales. In contrast multimode pattern in the frequency distribution was found in the J stock common, Bryde's and right whales, which is inconsistent with exponential population expansion.

In conclusion, the genetic markers used are useful for future studies on stock structure in the sperm and North Pacific right whales. Right whales from different ocean basins were confirmed as phylogenetically distinct. Preliminary analyses suggested that the O stock common minke, sei and possibly Bryde's whales are under exponential population growth.

Respond to recommendations from the 2009 JARPN II review workshop
Most of the simple, more extensive and long term matters recommended in 2009 were addressed in the analyses on stock structure presented to the workshop (see proponents' response column in Annex D).

4.4 Panel review, conclusions and recommendations

4.4.1 Overview

The Panel **notes** the substantial amount of field, laboratory and analytical work undertaken under the JARPN II programme. The proponents presented information and analyses on stock structure related issues in 25 papers (SC/F16/JR/38-41; Kishiro and Miyashita (2011) [SC/F16/JR42]; SC/F16/JR43-44; Murase *et al.* (2016) [SC/F16/JR45]; SC/F16/JR46-47; Kanda *et al.* (2015) [SC/F16/JR48]; SC/F16/JR49-51 and 11 'FORINFO' papers), with a focus on elucidating stock structure hypotheses for common minke whales, Bryde's whales and sei whales, as well as providing information on sperm whales and right whales in the North Pacific and Sea of Japan. The data presented included genetic data (mainly microsatellite genotypes and mitochondrial control region DNA sequences) as well as age data, morphological data (e.g. length and flipper patch variation) and telemetry data.

The Panel **notes** that most documents on stock identity relied heavily upon reference to previous IWC Scientific Committee unpublished papers, IWC Reports and other SC/F16/JR documents, which made it difficult to assess the information and employed protocols. The Panel **refers** to its over-arching recommendation relating to the need for a single consolidated and integrated paper for each objective (see Items 10 and 11).

The Panel **agrees** that most of the recommendations and suggestions proposed by the 2009 Panel have been addressed, for example those related to data quality procedures, estimates of genetic divergence, p-values, applying FDR and assessment of statistical power (and see Item 4.4.3). It noted earlier recommendations suggesting the application of non-equilibrium methods to the analysis of stock structure. However, the Panel **recognises** that such approaches do not work well at very low levels of genetic divergence (i.e., $F_{ST} < 0.01$), which may imply that they cannot be successfully applied to these data.

A key and fundamental issue raised by the 2009 Panel, that is applicable to studies within and outside the JARPN II programme, is the need to assess demographic linkage, i.e. what is a 'stock' within the specific context in which it is being used and hence whether different stocks, should they occur, are detectable using the applied analytical approaches. This is discussed further below.

ASSESSMENT OF GENETIC DATA TO IDENTIFY DIFFERENT 'STOCKS'

The genetic data sets generated are uniquely comprehensive for microsatellite-based studies, typically consisting of 14-17 microsatellite loci typed in 100s (e.g. right whales) to several thousand samples (e.g. common minke whale), a non-trivial effort which the Panel **commends**.

The focus of most analyses was testing the current RMP-defined stock hypotheses, i.e. the objective was to provide information relevant to management and conservation. The population genetic assessments undertaken were similar across most species, including the estimation of standard indices of genetic diversity, the estimation of the degree of genetic divergence among sample partitions and homogeneity tests. In addition, clustering algorithms (e.g. STRUCTURE and DAPC) were applied to some data sets. In response to the 2009 Panel, an assessment of the power to reject homogeneity at different migration rates was estimated (using EASYPOP).

With the exception of Bryde's whale (see below) statistically significant deviations from homogeneity were only detected between samples from different hemispheres (i.e., Southern Hemisphere and western North Pacific right whales) or between the O and J stocks of common minke whales. In all other homogeneity tests, F_{ST} estimates were close to zero and homogeneity was not rejected. The assessment of statistical power suggested high power to reject panmixia at migration rates below 100 ($\sim F_{ST} < 0.001$, $p > 0.8$).

The proponents inferred the low levels of spatio-temporal genetic divergence and general inability to reject homogeneity as support for a single stock in the case of common minke whale O stock, sei whales and sperm whales.

The Panel **notes** that although the presented analyses show evidence of spatial genetic homogeneity in most species, the biological interpretation (and hence management implications) of low genetic divergence is unclear in general, including for JARPN II.

The Panel also **notes** that in the absence of deriving the qualitative and quantitative expectations at different levels of genetic divergence among stocks, it is impossible to determine if genetic homogeneity implies strong support for a single stock. Similarly, statistical power cannot be assessed properly if the target effect size is unknown. Accordingly, the Panel **proposes** that a quantitative working definition of what constitutes a 'stock' in the targeted species/area is developed by the proponents for consideration by the Scientific Committee (see Item 4.4.3.1).

The Panel **notes** that several assessments were of a qualitative, rather than quantitative, nature. One such example is SC/F16/JR/38 where the possibility of a sub-O stock origin of 'unassigned' common minke whale samples (i.e. samples with assignment probabilities below 90% to either O or J stock) was rejected based upon the apparent randomness in phylogenetic placement of mitochondria control region haplotypes and the absence of a restricted geographic location of such unassigned samples.

In general, the genetic data analyses continue to rely heavily on homogeneity tests as well as moment-based estimators of genetic divergence, such as F_{ST}. This point was made by the 2009 Panel as well, which suggested that non-equilibrium approaches (i.e. for divergence) be applied to the data, which could explain the low levels of genetic divergence; a suggestion that the Panel **reiterates** (see Item 4.4.3.1).

Although some assessments employed non-spatial approaches (e.g., STRUCTURE and DAPC for the case of O stock common minke whales, SC/F16/JR/40) most assessments relied upon testing for spatial heterogeneity and/or estimating spatial divergence, which harbours a risk of failure to detect the presence of two 'stocks' within a single spatial stratum (see Item 4.4.2.1).

While the sample sizes in most species are exceptional, the Panel **notes** that increasing the number of genotyped loci per sample, as opposed to the number of individuals, is likely to add substantially to the precision and accuracy of the estimates of population genetic parameters (i.e. θ, Nm and population divergence time).

The 2009 Panel recommended that data quality procedures be explained. In terms of the genetic data generated for this review, most primary papers referred to Kanda *et al.* (2014b) with regards to data generation and quality control of the presented genetic data. Kanda *et al.* (2014b) adheres to the IWC guidelines for DNA data quality standards. However, the Panel **notes** that no procedures or estimates of genotyping and DNA sequence error rates were reported in Kanda *et al.* (2014b) or in the SC/F16/JR documents.

SC/F16/JR43 outlines a statistical catch-at-age model for common minke whales east of Japan (the areas where the putative OW- and OE-stocks are found). It is fitted to estimates of abundance and catch age-composition data under two stock structure hypotheses (mimicking the A and C stock structure hypotheses of the current *Implementation Simulation Trials*). The model is noted to be a first step towards using the age data for conditioning and to select among stock structure hypotheses. Age data have been used previously when conditioning operating models to evaluate variants of the RMP, (e.g. for the North Atlantic fin whales) and have informed other implementations (e.g. for Western North Pacific Bryde's whales). Thus, if the *Implementation Simulation Trials* for the western North Pacific minke whales are to be revised in the future, the age data should be included in the conditioning process. The specific assumptions underlying SC/F16/JR43 will need to be refined before the age data are included in the conditioning process. In particular, consideration should be given to (a) using alternative selectivity patterns, (b) using a spatial structure that better matches that underlying the trials, and (c) fitting to the actual abundance estimates rather than the output from trials. In terms of selectivity, it would be expected that the selectivity pattern would be dome-shaped for the inshore areas, at least for the case in which there is a single O-stock. Ageing of commercial data could be used to inform the pre-1987 selection pattern, which is currently pre-specified based on values estimated for North Atlantic minke whales. See Item 9.1.1 for additional discussion of the age data.

Concerning the specific sub-objectives 1- 4 (Objective 3, above) the Panel **agrees** that substantial progress was made with regards to sub-objective 1 in terms of the spatio-temporal distribution of J stock common minke whales in the waters off either side of Japan. The Panel **notes** that an assessment of putative OW and OE common minke whale stocks was undertaken following the recommendations by the 2009 Panel. However, the Panel **realises** that further progress on this sub-objective relies (due to the absence of genetic heterogeneity) on identifying the defining dispersal rates between the putative OW and OE 'stocks' and the genetic expectations at these dispersal rates.

The Panel **agrees** that the same issue pertains to identifying stocks in North Pacific sei whales (sub-objective 4) where equally low levels of spatial heterogeneity were observed.

The Panel **agrees** that progress was made in terms of reducing the number of RMP stock hypotheses of North Pacific Bryde's whales (sub-objective 2) although additional data analyses with existing data could potentially assess further sub-structuring within Sub-areas 1 and 2.

4.4.2 Evaluation of progress with the 2009 recommendations (see Annex D for a complete summary table)

The 2009 Panel had made a large number of recommendations to further the work on stock structure. All but two of these had been fully or partly addressed as shown in Table 3.

4.4.3 Recommendations

4.4.3.1 MEDIUM-LONG TERM RECOMMENDATIONS

The Panel has developed the following **recommendations** for the medium-term, i.e. normally to be completed 2-3 years after the 2016 Annual Meeting.

(1) In order to facilitate a more definitive discrimination between single and multiple stock hypotheses, work should be undertaken to determine the demographic dispersal rates among areas at which whales in different areas can be managed as a single stock. Such an assessment of 'critical' dispersal rates by specific case (i.e. species, area(s) and management objective) and the corresponding levels of genetic divergence, should enable the rejection of 2+ stock hypotheses and hence confirmation of a single stock where applicable. This general and difficult issue had been raised by the 2009 Panel, but without specific recommendations as to how it might be achieved. However, recently an illustrative example of how this might be achieved has been presented in Van der Zee and Punt (2014) and this approach is recommended to the proponents.
(2) As recommended by the 2009 Panel**,** analytical approaches should be applied that do not assume mutation-drift-migration equilibrium, such as the IM methods (Hey, 2010).
(3) Serious consideration should be given to using genome-wide SNP genotyping approaches, such as RAD sequencing and GBS (Elshire *et al.*, 2011; Miller *et al.*, 2007). This will increase the data per sample thereby improving the accuracy and precision of genetic parameter estimates and facilitate additional analyses (Hey and Machado, 2003; Robinson *et al.*, 2014).
(4) A focussed satellite tagging programme should be developed to greatly increase sample size to assess individual migration in the context of stock structure hypotheses more thoroughly.

4.4.3.2 SHORT TERM RECOMMENDATIONS

The Panel has developed a number of **recommendations** for the short-term, i.e. to be completed ideally by the 2016 Annual Meeting but certainly by the 2017 Annual Meeting.

(1) All inferences regarding 'randomness' of observations (e.g. unassigned common minke whales) should be substantiated by a statistical assessment of the presumed randomness.
(2) The presence of multiple stocks within sample partitions should be assessed (employing, e.g., STRUCTURE and DAPC) for Bryde's and sei whales.
(3) More explicit information on quality checks be provided in each study as well as study-specific estimates or genotyping and DNA sequencing error rates.

In addition, in Table 4 the Panel makes a number of specific comments on individual papers to assist the proponents in their revisions, ideally for the 2016 Annual Meeting. These comments are made in the context of the over-riding recommendation for a consolidation of papers found under Items 10 and 11.

Table 3

Summary of Panel's evaluation of the proponents' response to the 2009 recommendations with respect to sampling design and sample size (see text).

Brief summary of 2009 Recommendations/suggestions	Panel evaluation	Panel comments
The genetic assessments should include a brief description of procedures to ensure data quality (with reference to IWC guidelines for DNA data quality).	Largely addressed	Kanda *et al.* (2014b) (a revised version of Kanda *et al.* (2014a) presented a summary of the sampling and laboratory protocols employed for the genetic studies under Objective 3 of the JARPN II conducted at the Institute of Cetacean Research. The individual stock structure-related documents also confirm that the IWC guidelines for DNA data quality (Tiedemann *et al.*, 2012) have been adhered to.
Revised papers should include estimates of genetic divergence (along with levels of uncertainty) in addition to probabilities of homogeneity.	Largely addressed	F_{ST} estimates were provided when appropriate. Levels of uncertainty associated with divergence estimates were, however, not reported
P values (and divergence estimates) should be reported for all loci combined rather than for each locus separately.	Addressed	
Multiple testing issues: (a) apply False Discovery Rates; (b) exercise discretion in the number of pairwise comparisons evaluated.	Addressed	
Provide more details on the analyses involving the program STRUCTURE.	Addressed	
Include a brief discussion of experimental design with respect to sampling (explaining how the design specifically addresses uncertainties related to stock structure, e.g. whether the spatial and temporal coverage of samples of minke whales has been sufficient to test adequately the alternative stock structure hypotheses).	Partly addressed	Sampling procedures were adequately described, but no explanations of the sampling rationale in relation to resolving the uncertainties related to stock structure were provided
Redo the Boundary Rank analyses (Taylor and Martien, 2002) with new data for common minke whales.	No longer relevant	
Integrate Korean by-catch samples into the new datasets to look at heterogeneity for common minke whales.	Addressed	
Undertake the assessments of power to simulate data to evaluate power to detect a specified fraction of a putative stock (e.g. the hypothetical W stock of common minke whales) in an overall sample using simulated data.	Partly addressed	Assessments of statistical power were performed with regards to rejecting homogeneity under different migration rates
Undertake tests for population genetic (drift-mutation-migration) equilibrium.	Partly addressed	Non-equilibrium was tested for long-term demographic population trends via mismatch distribution analysis of mitochondrial DNA. However, assessments of short-term deviations from mutation-drift equilibrium (Piry *et al.*, 1999) were not undertaken. However, these assessments may be infeasible.
Employ approaches that do not rely upon the assumption of mutation-drift-migration equilibrium when estimating population divergence.	Not addressed	
Attempt the detection of related pairs of individuals	Partly addressed	Spatially-explicit relatedness analyses are underway but only preliminary results were shown at the Workshop itself
Undertake multivariate analyses of morphological data with respect to stock structure.	Largely addressed	Results presented for some cases, mainly for O and J stock common minke whales.
Use of past and present contaminant data should be an integrative study of stock structure.	Not applicable	There are insufficient Persistent Organic Pollutant (POP) data for this to be productive
Initiate satellite tagging to narrow the range of plausible stock structure hypotheses.	Partly addressed	Proof of principle has been achieved by tagging a single common minke whale and two Bryde's whales, but many more must be tagged if the results are to be used to inform discussions.

Table 4

Comments on individual papers presented related to stock structure to assist with their revision

Paper SC/F16/	Comments
JR/38	The Panel noted the somewhat arbitrary choice of a 90% assignment probability as criterion for assigning individuals to a specific cluster. The Panel acknowledged that the assignments of samples to the O and J stock 'clusters' likely did capture general spatio-temporal trends in the samples. The observation that number of successful assignments (e.g. at >90% assignment probability) is correlated with the number of loci is well-known. However, this observation does not prove the absence of further stock structure as suggested in SC/F16/JR/38 without further assessment. Such an assessment would entail simulations with increasing numbers of loci including a third 'cluster' at a level of divergence that it would go 'undetected' by a STRUCTURE estimation of the number of clusters. The inferred randomness in haplotype affinities of specimens classified 'unknown' should be tested for statistically. In addition, representation of mtDNA data in un-rooted haplotype networks (integrating haplotype frequency, relatedness and geographical occurrence) might be superior to the NJ trees presented in SC/F16/JR/38.
JR/39	The Panel noted that the sample size for the 'no GAL' flipper type was low (n = 16). Overall the results in SC/F16/JR/39 confirmed the oft observed distinction of the J and O stock in the common minke whale, but do not allow for unambiguous stock assignment of individuals, as some morphotypes are found both in J and O stock individuals.
JR/40	The Panel noted the very low degree of genetic divergence among areas, as has been reported earlier. In light of the low degree of divergence among cluster O stock assigned samples it is unsurprising that clustering algorithms, such as STRUCTURE and DAPC fail to detect any additional sub-structuring. This result is further exacerbated by the 'purging' of assumed non-O stock samples. The Panel agreed to the assessment of statistical power by simulation. However, the biological/management interpretation of the failure to detect additional clusters depends upon what dispersal (and hence *Nm*) rates are considered critical in terms of delineating stocks in this specific case. As a rough illustration consider 133 migrants per generation. If the generation time is at 10 years this migration rate (not necessarily the same as the dispersal rate) would correspond to ~13 migrants/year. In the case of an effective population size at 6,660 individuals, 13 migrants correspond to 0.2% which may be little migration from a demographic perspective, but sufficient to maintain the observed genetic cohesion. This example underlines the need to define what dispersal rates are relevant for the specific management objectives for the North Pacific common minke whale.
JR/41	The Panel generally agreed with the analysis which provides an indication that the divergence among J and O stock is reflected not only in genetics, but also in morphometry. However, it notes that PCA plots of individuals might aid visualisation of potential outliers/further substructure. It also notes that the objective for using PCA was to reduce 11 morphometric measurements to fewer principal components (PC) to use in discriminant analyses, e.g. to discriminate between J stock and O stock minke whales. The sample size of J stock whales was smaller than that of O stock whales: 24 compared to 760. O stock whales were sampled in all 20 years included in the analysis, but J stock whales in only 9; 376 O stock whales were sampled in those 9 years. All 760 O stock whales were used in the discriminant analysis comparing O and J stocks, but only the years with J stock whales should have been used.
JR/43	The use of age data is discussed under Item 9.
JR/44	The Panel **noted** that the homogeneity tests conducted in SC/F16/JR/44 were aimed only at assessing spatial heterogeneity within sub-area 1 as well as between sub-areas 1 and 2. However, no additional analyses (e.g., STRUCTURE or DAPC) were undertaken to assess the possible presence of multiple clusters (i.e., populations) in each sub-area (or both sub-areas) making difficult to make inferences about the number of stocks in the sub-areas. Therefore, the conducted analysis is only able to reject stock structure hypothesis 1. It cannot distinguish between hypotheses 2 and 3 and did not test hypothesis 4.
JR/46	The Panel **noted** that the homogeneity tests performed tested for spatial heterogeneity only and not for the presence of multiple clusters (e.g., using STRUCTURE or DAPC). Consequently, the conclusion of a single stock is premature. It would be helpful to be more explicit in how the covered area relates to the stock hypotheses forwarded by Mizroch *et al.* (2015).
JR/47	The Panel **noted** that the sample sizes in the POWER data set are small (*n* = 13, 29 and 35) which introduces potential issues of statistical power. For example, the comparison between the JARPN II (2010) and POWER (2010) samples resulted in a F_{ST} at 0.011. In other assessments at similar degrees of divergence with larger sample sizes (as well as simulations aimed at testing statistical power, see SC/F16/JR/40) such a degree of divergence resulted in rejection of panmixia.
Kanda *et al.* (2015) [JR/48]	The Panel **agreed** this review of available data is relevant to sei whale stock structure in the North Pacific. The presented information favours a single-stock hypothesis, but did not explicitly conduct a statistical evaluation of alternative hypotheses. It is unclear whether the presented mark-recapture data contain (or are identical to) those presented by Masaki (1976), then interpreted as being indicative of three stocks. Also, no consideration of the stock hypotheses forwarded by Mizroch *et al.* (2015) is provided.
JR/49	The Panel **notes** that any inference of stock structure on sperm whale is preliminary, given the small sample size and incomplete geographical coverage. Nonetheless, at this stage, a hypothesis-free analysis (e.g., STRUCTURE, DAPC) could be informative. The analyses should take into account the possibility that multiple individuals may have been sampled from the same matrilineal pod, which may bias estimations of population divergence based upon mitochondrial (and potentially nuclear) data. (Bogstad *et al.*, 2015)
JR/51	The Panel **understood** that the analysis was performed to address previous recommendations aimed at assessing the presence and effects of deviations from the mutation-migration-drift equilibrium that is an underlying assumption to many population genetic inferences and parameter estimations. However, mismatch distributions in mitochondrial DNA generally capture (if Ne is large) longer time scale expansions in a single population. In terms of stock structure, the aspect of concern is whether a low divergence between populations represent recent divergence (but little gene flow) or high gene flow; cases with potentially very different management consequences. An example of approaches to estimate Nm at mutation-migration-drift disequilibrium is the so-called IM (isolation with migration) methods.
Kanda *et al.* (2009)	The Panel **notes** that this paper principally covers the same subject as SC/F16/JR38 and SC/F16/JR40. Here, STRUCTURE outputs are provided for k=2 and k=3. This analysis favours the two stock (i.e., J and O) hypothesis. Generally, it would be desirable to adjoin the information of this paper and the papers SC/F16/JR38 and SC/F16/JR40 in order to arrive at a synopsis statement on common minke whale stock structure.

Paper SC/F16/	Comments
Kanda *et al.* (2010)	The validity of the inferred divergence within the Korean samples as well as between some Korean and Japanese samples is, however, difficult to assess, as p-values for pairwise F_{ST} estimates are not provided and apparently no correction for multiple pairwise comparisons was performed.
Kanda *et al.* (2014b)	The Panel generally **welcomes** this description of procedures. With regard to error assessments, however, it is necessary to provide quantitative information with regard to the number of samples re-typed. In addition, the encountered error rates should be reported
Kanda *et al.* (2006)	The Panel **notes** that this paper covers a similar topic as SC/F16/JR46, albeit with much fewer samples. No hypothesis-free analysis (e.g., STRUCTURE, DAPC) was performed on the data, such that the inference of a single stock appears premature. Further comments made to SC/F16/JR46 also apply here.

5. FEEDING ECOLOGY AND ECOSYSTEM STUDIES: PART 1. GENERAL INFORMATION TO INFORM ECOSYSTEM MODELLING ON OCEANOGRAPHY, DISTRIBUTION, ABUNDANCE AND STATUS OF WHALE STOCKS

5.1 Proponents' summary of objectives including modifications, if any, since the start of the programme

The following three sub-objectives under main Objective 1 were considered under this agenda item:

Sub-objective 1: To investigate the oceanographic conditions that are relevant for the understanding of prey species distribution and abundance in the research area.

Sub-objective 2: To investigate the distribution pattern of baleen whales in the research area and the possible factors affecting such pattern.

Sub-objective 3: To estimate abundance of baleen and sperm whales using JARPN II sighting data and standard IWC SC methodology.

Initially, in-situ oceanographic observations (e.g. CTD) were planned to obtain the data (Government of Japan, 2000). However, analyses presented to this workshop relied on the data from an ocean model and satellites as the techniques and technologies are developed substantially in the period of JARPN II. In the abundance estimation using standard method (i.e. design based method) presented to this workshop, Beaufort Sea state was used as a covariate of detection function. These two are major modifications since the start of the programme.

5.2 Overview of conclusions and recommendations from the 2009 Workshop

A short overview on the 2009 conclusions and recommendations on the component of JARPN II on oceanographic features related to whale distribution, distribution and abundance of whales was provided by the Chair. On these aspects, the 2009 Panel had noted that the programme was progressing towards addressing its objectives and had recommended that this work continues. In terms of relationships between oceanographic features and whale distribution the 2009 Panel had made a number of recommendations in relation to data analyses:

(a) to incorporate into the index of density, the sightability of detected groups (e.g. effective strip half widths that include appropriate covariates such as weather conditions);

(b) to test whether any chosen model is an improvement over a null, uninformative model and to validate model results (e.g. by comparing the modelled results, not only with index of densities from the JARPN II, but also with JARPN and/or other survey data and by exploring cross-validation type techniques);

(c) to conduct more spatial modelling analyses (e.g. using other appropriate modelling techniques such as GAMs or logistic regressions); and

(d) to incorporate shipboard oceanographic data in future models, together with potential additional oceanographic/biological features, including modelling the satellite or in situ measurements of chlorophyll to estimate primary productivity.

In terms of fieldwork, the 2009 Panel had also suggested that the proponents consider conducting future oceanographic surveys over an area larger than at present, not only to further investigate oceanographic relationships, but also to improve abundance estimates for a variety of species.

With respect to abundance data, the 2009 Panel had emphasised that this is of the great importance for estimating consumption, biomass, energy requirements, exchange rates and, therefore, ecosystem modelling, and had recommended that the proponents should: (a) investigate whether data collected over the 1994-2007 period for a variety of large whales can be used to provide information on trends; (b) work up the photo-identification data and compare with catalogues elsewhere in the North Pacific; and (c) improve the precision of the abundance estimates that are used to extrapolate to population-level rates, for both the coastal (possibly with regular well-designed aerial surveys) and the offshore regions (with a full synoptic survey).

5.3 Proponents summary (incl. response to 2009 Workshop)

5.3.1 Oceanography

5.3.1.1 PROPONENTS SUMMARY OF THE RESULTS (INCL. RESPONSE TO 2009 WORKSHOP)

SC/F16/JR5 examined oceanographic conditions in the JARPN II survey area on a broad scale while SC/F16/JR6 examined oceanographic conditions on a local scale (i.e. off Kushiro). Data from the ocean forecast system, FRA-ROMS, were used in the analyses. FRA-ROMS is an ocean forecast system developed by Fisheries Research Agency (FRA) based on Regional Ocean Modeling System (ROMS).

In the previous workshop held in 2009, the panel suggested that the salinity CTD data must be corrected/calibrated using the water samples that were simultaneously collected with the CTD data. The suggestion was not applicable directly as the analyses presented to this workshop relied on the data from an ocean model and satellites. Nevertheless, calibrated CTD data were used as one of the inputs to the model.

Changes in area (km^2) of four water types (Oyashio, cold, warm and Kuroshio) by each month (April-September) in the whole JARPN II survey area from 2000 to 2013 was investigated in SC/F16/JR5. There was no statistically significant trend for the area except the cold water in September. Negative values of annual mean of the Pacific Decadal Oscillation (PDO) index were dominant in the period from 2000 to 2013. Generally, sea surface temperature in the western North Pacific is high in the negative phase of the PDO. The results of this paper indicated that overall oceanographic conditions in the whole JARPN II survey area from 2000 to 2013 were relatively stable although year to year variations and spatial heterogeneity of distribution of water types were observed. It was reported that the climate regime in the North Pacific changed in 1998. The regime of the period of JARPN II cannot be determined until next regime shift is detected although the PDO indicated that the regime might be shifted after 2013.

Oceanographic conditions in the survey area of JARPN II coastal component off Kushiro were investigated in SC/F16/JR6. Oyashio was dominant water type in subsurface in the survey area. Mean water temperature at 10m water depth in the survey in September was generally decreased from 2000 to 2004 then increased to 2006. It decreased again to 2009. It was relatively stable from 2009 to 2013. Spatial distribution of water temperature at 10m depth was highly variable from year to year.

In conclusion, JARPN II from 2000 to 2013 were conducted in relatively stable oceanographic conditions on a broader scale while oceanographic conditions on a local scale (i.e. off Kushiro) in the same period were highly variable. Further monitoring of oceanographic conditions in the survey area is required to determine the regime of the period of JARPN II.

5.3.2 Distribution of large whales

5.3.2.1 PROPONENTS SUMMARY OF THE RESULTS (INCL. RESPONSE TO 2009 WORKSHOP)

A total of four papers including two peer reviewed papers were presented to the workshop (SC/F16/JR07; Murase *et al.* (2014) [SC/F16/JR08]; SC/F16/JR09; Sasaki *et al.* (2013) [SC/F16/JR10]. In addition, two papers related to this agenda item were also presented (SC/F16/JR16 and SC/F16/JR25).

Meso and micro scales linking feeding ecology with distribution were considered in the papers. The following definition of the scales was described in the IWC/SC report (IWC, 2003, p.67). At meso scale, whales move over days and weeks in search of preferred local abundance of food while they dive and search for food within localized area at micro scale. Meso scale distribution was considered in SC/F16/JR07; Murase *et al.* (2014) [SC/F16/JR08]; SC/F16/JR09; and Sasaki *et al.* (2013) [SC/F16/JR10] while micro scale distribution was considered in SC/F16/JR16 and SC/F16/JR25. The results from these papers were integrated to obtain a synthesis on spatial distribution of whales in relation to feeding ecology.

Spatial distribution and relative abundance of common minke, sei and Bryde's whales in JARPN II (2003-2013) were estimated using GAMs in SC/F16/JR7. All species shifted their distribution area toward the north of the survey area from May to September but the extents of shift different among species. Relative abundance of common minke whales was high in coastal area of Japan. Relative abundance of sei whales was high in the offshore area of the survey area where SST was moderate within the area. Relative abundance of Bryde's whales was high in the southern part of the survey area where SST was high. The results suggested that spatial distributions of three baleen whale species were segregated in the JARPN II survey area although some overlaps occurred. Extent of direct competition (e.g. competitive exclusion of feeding area) could be minimal among the species but indirect competition for prey might occur as they share same prey species.

Preliminary estimates of prey consumption of sei whales in JARPN II (2003-2013) obtained in SC/F16/JR16 (see also Item 6.3.1). The paper was an extension of SC/F16/JR7. Two levels of models are constructed to achieve the goal. Firstly, relative abundance of sei whales in relation with oceanographic conditions was estimated by using a GAM (SC/F16/JR7). Secondary, amount of prey consumed by a sei whale in relation with oceanographic conditions was also estimated by using GAM. Finally, prey consumption of sei whales in the JARPN II survey area is calculated as the product of these two models. SST was selected as environmental covariate in the first and second models. However, the shape of functional form for the first level model (prey consumption) was relatively flat in comparison with the second level model (abundance).

Diving behaviour of sei whales and vertical distribution of their prey were studied in SC/F16/JR25 (see also Item 6.3.2). Small acoustic time depth transmitters (pingers) were attached to two sei whales and their behaviours were recorded for 10.2 and 32.0 hours, respectively. The results illustrated their complex feeding behaviour at micro scale.

In conclusion, the integrative approach conducted under JARPN II revealed new insight on spatial distribution of whales in relation to feeding ecology. Spatial distribution of sei whales at meso scale could be largely determined by oceanographic conditions such as SST (SC/F16/JR7). Sei whales could then search for their prey under the optimal oceanographic conditions at micro scale (SC/F16/JR16 and SC/F16/JR25). Relationship between meso and micro scale should be investigated further to clarify mechanism of feeding ecology of whales with distribution. Such study will contribute to improve analyses on abundance and ecology of whales.

The relationship between the distribution of sei whales and oceanographic fronts was investigated using GAM in Murase *et al.* (2014) [SC/F16/JR08]. Sei whales were concentrated north and south of the Subarctic Front (SAF) and the areas from 250 to 300 km north and from 100 to 200km south of the SAF were estimated as high-density areas of sei whales. The entire inter-frontal zone between the polar front (PF) and SAF featured an elevated concentration of sei whales, and the area south of the PF and along the SAF was identified as an important feeding ground of sei whales in July from 2000 to 2007.

The monthly distribution patterns of blue, fin, humpback and North Pacific right whales from May to September in the western North Pacific were investigated in SC/F16/JR9. Such information has not been available since the cessation of commercial whaling. Further continuation of the systematic sighting surveys including in foreign EEZ areas is required to improve information on seasonal distribution of baleen whales.

The habitat differentiation between sei and Bryde's whales in the western North Pacific was investigated in Sasaki *et al.* (2013) [SC/F16/JR10]. Data obtained from May to August 2004 and 2005 in JARPN II were used. This study examined the relationship between oceanographic features derived from satellite data and the distribution of sei and Bryde's whales using basic statistics. We investigated oceanographic features including sea surface temperature (SST), sea surface chlorophyll a (Chl-a), sea surface height anomalies (SSHA), and depth of the habitat. These two whale species used habitats with different SST, Chl-a, and SSHA ranges. The 0.25 mg/m^3 Chl-a contour (similar to the definition of the Transition Zone Chlorophyll Front) was a good indicator that separated the habitats of sei and Bryde's whales. Then generalized linear models were used to model the probabilities that the whale species would be present in a habitat and to estimate their habitat distribution throughout the study area as a function of environmental variables. The potential habitats of the two species were clearly divided, and the boundary moved north with seasonal progression.

In conclusion, these three papers (Murase *et al.*, 2014; Sasaki *et al.*, 2013) [SC/F16/JR09-10] and SC/F16/JR09) provided new information of spatial distribution of baleen whales in the western North Pacific. The results could be used as baseline information for in-depth assessment of these species such as sei whales.

5.3.3 Abundance and status of stocks

5.3.3.1 PROPONENTS SUMMARY OF THE RESULTS (INCL. RESPONSE TO 2009 WORKSHOP)

SC/F16/JR11 examined the number of western North Pacific common minke whales distributed in JARPN II coastal survey areas. In order to examine an impact of common minke whales on Japanese fisheries in Kushiro and Sanriku regions through estimating the amount of prey consumed by minke whales or using an ecosystem model, it was required to estimate the number of common minke whales distributed in each of the survey areas during the JARPN II survey periods. Because it was considered that the impact of minke whales was important in the operation area of the coastal fishery, the numbers of common minke whales there were estimated .The estimated number off Kushiro were 461 and 433 in early (May-June) and late season (September) in 2012, respectively. The estimated number off Sanriku in the early season was 124 in 2012. Note that these numbers are not abundance estimates of the minke whale stock in the areas because the sighting data we used for the estimation covered only a part of the stock distribution.

SC/F16/JR12 examined the number of western North Pacific common minke, Bryde's and sei whales in the JARPN II offshore survey area. In order to examine an impact of large whales, such as common minke, Bryde's and sei whales on Japanese fisheries through estimating the amount of prey consumed by these whales or using ecosystem models, it was required to estimate the number of these whales in the JARPN II survey area (subareas 7, 8 and 9 excluding foreign EEZ). Considering the migration pattern of these whales in the area suggested by previous analysis, the number of the whales needed to be estimated separately for the early and late seasons for each whale species. The estimates were 3,629 (in 2009) and 2,122 (in 2011 and 2012) in the early and 3,080 (in 2008) in the late season for the common minke whale assuming g(0) = 0.789; 2,957 (in 2009) and 1,851 (in 2011 and 2012) in the early and 13,306 (in 2008) in the late season for the Bryde's whales; 4,734 (in 2009) and 2,988 (in 2011 and 2012) in the early and 5,086 (in 2008) in the late season for the sei whales, assuming g(0)=1. It is important to note that these estimates should not be used for assessment because the estimated figures represent only a part of the population considered.

SC/F16/JR13 examined the number of blue, fin, humpback and North Pacific right whales in the JARPN II offshore survey area based on 2008-2014 JARPN II surveys. The numbers are to be used for prey consumption estimation and ecosystem modelling in the western North Pacific. Given that the area is a migration corridor of the whales, the numbers were estimated for early season (May-June) and late season (July-Sep.). The estimates were 38 (in 2009) and 161 (in 2011 and 2012) in the early and 958 (in 2008) in the late season for blue whales; 413 (in 2009) and 1,369 (in 2011 and 2012) in the early and 3,958 (in 2008) in the late season for the fin whales; 1,136 (in 2009) and 1,921 (in 2011 and 2012) in the early and 392 (in 2008) in the late season for the humpback whales; 1,147 (in 2011 and 2012) in early season and 416 (in 2008) in late season for the North Pacific right whales. It is important to note that these estimates should not be used for assessment because the estimated figures represent only a part of the population considered.

SC/F16/JR14 examined the number of sperm whales in the JARPN II offshore survey area based on 2008-2014 JARPN II surveys. The numbers are to be used for prey consumption estimation and ecosystem modelling in the western North Pacific. Given that the area is a migration corridor of the whales, the numbers were estimated for early season (May-June) and late season (July-Sep). The estimates were 11,459 (in 2009) and 11,652 (in 2011 and 2012) in the early and 10,843 (in 2008) in the late season for the sperm whales, assuming that g(0)=1. It is important to note that these estimates should not be used for assessment because the estimated figures represent only a part of the population considered.

In conclusion, the number of whales distributed in the research area was estimated using the Line Transect method and IWC SC standard methodology. This was done for common minke, Bryde's, sei, blue, fin, humpback, North Pacific right and sperm whales. Numbers obtained are not representative of the abundance of each stock but they represent the number of animals distributed in the research area at specific research periods. The numbers obtained were used for the estimation of prey consumption in common minke, Bryde's and sei whales, and as input for the ecosystem modelling (all species except for the North Pacific right whale).

Respond to recommendations from the 2009 JARPN II review workshop

Most of the matters recommended in 2009 related to items 5.3.1.1, 5.3.2.1 and 5.3.3.1 were addressed in the analyses summarized above (and see proponents' comments in Annex D).

5.4 Panel review, conclusions and recommendations

5.4.1 Overview

5.4.1.1 OCEANOGRAPHY

The Panel **agrees** that the proponents have begun to incorporate oceanographic information into their analyses; the selection of appropriate oceanographic parameters is crucial to detecting important changes in oceanographic conditions that are relevant for understanding prey and whale distribution and abundance. In trying to address this, SC/F16/JR5 examined changes in areas by four water types by month within the entire survey area and concluded that oceanographic conditions had been relatively stable during 2000-2013. However, the parameters used were based on mean temperature at deeper depths (100m and 200m), i.e. less variable parameters than at shallower depths. It is not clear whether these parameters are sensitive enough to detect important oceanographic changes; their behaviour should be examined in relation to recent regime shifts in 1988 and 1998.

Another paper, SC/F16/JR6 examined mean water temperature at 10m depth in September off Kushiro and indicated that the temperature was highly variable from 2009 to 2013. However, the Panel noted that this area has been characterised by significant SST (sea surface temperature) warming during the summer (July-September) from 2010[3]. The Panel noted that that the dominant pelagic prey species for minke whales changed from saury and anchovy to sardine and mackerel from 2012 in this area (SC/F16/JR24). Summer warming off Kushiro may have contributed to a decrease in saury (cold-water fish) migration and an increase in sardine and mackerel (warm-water fish) migration into this area during summer, although this may also have been related to natural fluctuations of the stocks. This potentially important change in oceanographic condition and pelagic prey composition was not discussed in the paper.

5.4.1.2 DISTRIBUTION

The Panel **notes** the close relationship between distribution and abundance, in part given that much of the information comes from the same surveys. For the purposes of this report, especially with respect to progress with recommendations, it has followed the same allocation of topics amongst the two as provided in the 2009 report.

The Panel **welcomes** the papers presented on distribution of large whales and the considerable effort undertaken to produce new analyses of whale distribution since the mid-term review. The Panel also **welcomes** the effort to combine oceanographic, prey distribution and whale survey data in a spatial modelling framework to achieve a more integrated view of the whale's distribution, their habitat and feeding ecology.

Considerable progress has been made in the improvement of the use of spatial modelling to examine whale distribution, and in a first attempt at combining multiple data sources to achieve a more integrated view of the whale ecology in the JARPN II survey areas. This has increased the understanding of whale movement and segregation between species in the areas, and contributed to a first attempt at mapping food consumption by species geographically and by season. The common use of satellite records to input oceanographic variables in spatial models is also a welcome improvement since the 2009 review. However, there are a number of methodological issues which need to be addressed to improve the work presented (see Item 5.4.3.2). This is particularly true with respect to combining survey data across years to try to address changes in distribution and abundance (and potentially spatially-explicit prey consumption) over time. As the proponents note, this is exacerbated by inconsistency between survey areas and coverage during the JARPN II surveys, but given its fundamental importance to the modelling work, increased efforts must be put into examining this (see Item 5.4.3.2).

5.4.1.3 ABUNDANCE

The Panel **notes** that abundance estimates are important for a number of the programme's objectives, including *inter alia* the assessment of total consumption, energy requirements and their use in ecosystem modelling; as well as in the assessment of exchange rates and stock structure. They are also important for the work of the IWC Scientific Committee on conservation and management via *Implementation Reviews* and in-depth assessments.

The proponents presented abundance estimates for baleen and sperm whales for the JARPN II research area. In addition to estimates presented at the 2009 review, data were collected and analysed for dedicated surveys conducted from 2008-2014 using procedures in accordance with IWC Scientific Committee guidelines; $g(0)$ was estimated from independent observer (IO) data for minke whales (Okamura *et al.*, 2010), and was assumed to be 1.0 for larger baleen and sperm whales. The 2009 Panel noted that confidence intervals of existing estimates were wide, which required increasing survey effort as a priority to improve the previous estimates. The 2009 Panel also noted that extrapolations were not suitable to examine effects on stocks. Estimates of abundance of common minke, sei and Bryde's whales (SC/F16/JR12), blue, fin, humpback and North Pacific right whales (SC/F16/JR13) and sperm whales (SC/F16/JR14) in the JARPN II offshore survey area by stratum are available for years 2008, 2009, 2011 and 2012.

The Panel **welcomes** the new estimates and especially the increased effort directed at improved precision whilst accommodating heterogeneity in detectability and other sources of uncertainty. New numbers of North Pacific common minke whales in coastal areas by stratum are now available for early (May-June) and late (July-September) 2012 (SC/F16/JR11). While the new estimates provide up to date numbers, a number of concerns remain. Abundance estimates are provided for all areas and species within the research area, although the geographic coverage was not consistent among areas and between years. This has neither improved the comparability between survey years, or the precision of estimates across years. This, combined with the fact that the surveys do not cover the full summer range of the putative stocks, makes estimation of trends in either abundance or distribution difficult. This also affects the work on the programmes' objectives that use abundance and trend information.

5.4.2 Evaluation of progress with the 2009 recommendations

The Panel **welcomes** the fact that the proponents had addressed or partly addressed all but one of the 2009 recommendations as summarised in Table 5 (with the exception of one recommendation which the Panel considers no longer relevant).

[3] Japanese Meteorological Agency http://www.jma.go.jp/jma/indexe.html

5.4.2.1 OCEANOGRAPHY

The Panel **agrees** that use of the data from an ocean model and satellites is more appropriate for monitoring oceanographic condition of the survey areas than using sparse shipboard observations (CTD data) made during the sightings survey. This renders the 2009 recommendation regarding calibration of CTDs no longer applicable.

5.4.2.2 DISTRIBUTION

The Panel **agrees** that the proponents have addressed or partly addressed most of the 2009 recommendations with respect to distribution. As noted earlier, the main weaknesses relate to problems with survey coverage and areas by year that render examination of changes in distribution (and linking that to other factors such as prey distribution and abundance) difficult. This problem is also relevant to the abundance estimation, and is important with respect to feeding ecology and ecosystem modelling.

5.4.2.3 ABUNDANCE

The Panel **agrees** that the proponents have only partly addressed two of the three recommendations from the 2009 review whilst the other, despite its importance (examining trends) has not been addressed other than by providing an explanation of the difficulties.

The 2009 Panel noted that abundance estimates are of great importance for improving consumption estimation and reducing uncertainty, and thus recommended the improvement of the precision of the abundance estimates that are used to extrapolate to population-level rates, for both the coastal and the offshore regions. In particular, to focus on the sources or causes of variability in order to understand the mechanistic linkages involved. Additionally, for the coastal region, it considered the possibility of regular well-designed aerial surveys, and a full synoptic survey for the offshore region. The present Panel **appreciates** the effort to use improved methods to estimate abundance, and in particular the effort to identify sources and causes of variability using multi-covariate analysis of the detection function. In particular, the proponents incorporated consideration of school size, year and Beaufort as potential covariates of the detection function. However, as the proponents acknowledge, the estimates are not representative of the entire stocks concerned because of limitations in area coverage; they thus cannot be extrapolated to population level. Thus the increased allocation of survey effort in the recent JARPN II surveys, whilst improving the precision of area abundance estimates, has not lead to improved precision in population level abundance estimates.

The Panel **notes** that although some progress has been made with respect to collating the photo-identification data collected during the JARPN II programme, work to compare the data with other catalogues is only slowly progressing.

Table 5

Summary of Panel's evaluation of the proponents' response to the 2009 recommendations with respect to oceanography, distribution and abundance (and see text)

Brief summary of 2009 recommendations and suggestions	Panel evaluation
Pool or compare results with other datasets to increase sample size and increase the possibility of data covering periods of changing relationships (e.g. previous regime changes), thus allowing patterns to be detected.	Addressed.
Consider conducting future oceanographic surveys over an area larger than at present.	Addressed.
In the long term, integrate into analyses oceanographic and other data collected on the cruises (bottom depth, water column temperature, salinity, and density) with satellite derived data, such as SST, chlorophyll, and sea surface height.	Partly addressed.
Correct/calibrate CTD data using simultaneously collected water samples.	No longer applicable.
Conduct additional analyses (including using techniques such as GAMs or logistic regressions).	Addressed.
Incorporate the sightability of detected groups into the index of density and test whether the chosen model is an improvement over a null, uninformative model and try to validate the model results using cross-validation techniques and use of outside data.	Partly addressed.
Investigate whether sightings data from 1994-2007 can be used to provide information on trends.	Not addressed.
Work up photo-identification data and compare with other North Pacific catalogues.	Partly addressed.
Increased effort to obtain better estimates should be a high priority.	Partly addressed.

5.4.3 Recommendations

5.4.3.1 OCEANOGRAPHY

Further efforts should be made by the proponents to determine appropriate oceanographic parameters for monitoring in the context of prey and whale species. The offshore survey area and that off Kushiro correspond to high primary productive regions during summer, with significant interannual variations (Shiozaki *et al.*, 2004). In the short-term, the Panel **recommends** that at least chl-*a* concentration should be examined as a potential proxy for the food environment for whales; chl-*a* concentration is considered to reflect zooplankton production as food for prey species. In the medium-long term, the Panel **recommends** further oceanographic monitoring to compare with prey species distribution and abundance in the new regime.

5.4.3.2 DISTRIBUTION

In the medium-term, the Panel **recommends** that considerable effort be put into the methodological improvement of the spatial modelling in the various analysis related with the objectives on distribution of large whales and oceanography. A particular focus must be on the combination of survey data from the different years to make them more comparable in terms of distribution (and abundance) over time; use of data from other sources (e.g. the IWC POWER programme). This work is not only valuable in itself but is essential for a better parameterisation of ecosystem models.

The Panel also **recommends** that additional effort be placed on fulfilling the 2009 recommendation with respect to the photo-identification data. This will contribute to the understanding of large scale movements and whale distribution within and outside the JARPN II survey area for several species.

Before the 2016 Annual Meeting, the Panel **recommends** with respect to the papers that used spatial modelling (SC/F16/JR07; Murase *et al.* (2014) [SC/F16/JR08]; SC/F16/JR09; Sasaki *et al.* (2013) [SC/F16/JR10] and SC/F16/JR16) that revised versions are developed that:

(1) include statistical summaries on model fit (R^2 and % deviance explained) and model comparison and spatial covariate selection (e.g. AIC, BIC, GCV scores), which are currently lacking;
(2) avoid extrapolation of the regression models to data-poor areas or areas lacking coverage (especially when combining food consumption with sightings data); and
(3) include variance plots of the fitted prediction surfaces in order to address precision and data sparseness.

5.4.3.3 ABUNDANCE
With respect to abundance, the Panel **recommends:**

(1) exploration of methods to account for sampling differences between areas and years to obtain measures of short- and long-term variation and trends and estimates the extent of additional variance due to changes over time in spatial distribution; *inter alia* this will be essential for modelling efforts (e.g. food consumption models and ecosystem models);
(2) comparison of results from the design-based estimates of abundance with those of model-based estimates, which can be directly obtained from spatial models of distribution (e.g. SC/F16/JR16) and using additional data (e.g. from IWC POWER and other North Pacific surveys) - model-based estimates could potentially address problems of unequal sampling coverage between surveys and with further development could also account for additional sources or causes of variability.

6. FEEDING ECOLOGY AND ECOSYSTEM STUDIES: PART 2, FIELD AND LABORATORY STUDIES

6.1 Proponents' summary of objectives including modifications, if any, since the start of the programme

As explained under section 3.1, within the main Objective 1 there are three main objectives: (i) prey consumption by cetaceans, (ii) prey preference of cetaceans, and (iii) ecosystem modelling, and within them there are several sub-objectives. The following sub-objectives were identified:

Sub-objective 4: To estimate the prey consumption by baleen whales using JARPN II data and samples, and taking into account the uncertainties identified at the 2009 JARPN II review.

Sub-objective 5: To evaluate the feeding impact by whales on fisheries resources using JARPN II data and samples, and information from commercial fisheries and other research sources in coastal areas.

Sub-objective 6: To estimate prey abundance using JARPN II data, complemented with information available from other sources.

Sub-objective 7: To investigate the prey preference of whales in offshore areas, using JARPN II data and samples.

Sub-objective 8: To investigate feeding habits of baleen and toothed whale species in the research area, and the environmental factors involved in determining such habits.

Sub-objective 9: To investigate the yearly trend in body condition of baleen whales using JARPN II data and samples.

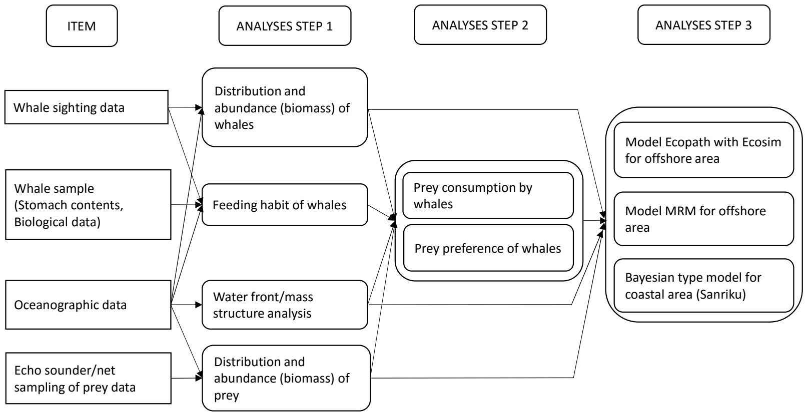

Fig. P4. Schematic representation of research components under Objective 1 of JARPN II.

6.2 Overview of conclusions and recommendations from the 2009 Workshop

A short overview on the 2009 conclusions and recommendations for the JARPN II components on prey consumption, (including biomass estimation of prey species), prey preference (including whales' feeding habits) and body condition was provided by the Chair.

The 2009 Panel had highlighted a few critical aspects of the work undertaken, including that insufficient work had been undertaken to address uncertainty and that the rationale for choice of sampling areas was unclear. It also concluded that the presented consumption rates were not reliable until further analyses have been undertaken. Therefore, it recommended that the proponents should: (a) provide a clear rationale for sampling areas; (b) provide the scientific rationale used for the modelling formulations and proposed ranges; (c) clearly explain methods used to extrapolate from daily to annual rates and amounts; (d) incorporate information from other studies (e.g. JARPN I, PICES, ESSAS); and (e) present the estimates of consumption by whales in terms of fisheries and prey biomass.

In terms of treatment of uncertainty, the 2009 Panel had indicated that the proponents should: (a) incorporate several reasonable models for estimating daily consumption as a function of body mass and include in their reports the range of possible results; (b) use that range in subsequent analyses (including any ecosystem modelling) that employ these daily/annual consumption estimates; and (c) undertake sensitivity analyses for the range of parameter values used in the consumption equations. The 2009 Panel had also provided specific instructions on how to characterise uncertainty and for which parameters. All details can be found in Annex F of the 2009 Panel report (IWC, 2010).

The 2009 Panel also recommended that in medium- to long-term approaches for predictive models, the proponents should: (a) combine oceanographic data, prey distributions and sighting survey data statistically to investigate how prey and whale distributions are associated with oceanographic conditions, and how whale distributions are related to distributions of prey; (b) combine data on prey distributions as observed in the area where the whales were caught with the diet of the whales (referred to as the micro scale) statistically to evaluate how well the whale's diet reflects prey availability in the area where it was caught; and (c) compare results from (a) and (b) with the results on selectivity already produced and presented at the 2009 Workshop.

6.3 Proponents summary of the coastal and offshore components (including response to 2009 Workshop)

Most of the recommendations from the 2009 Workshop related to Item 6.3 were addressed in the analyses summarized below (see details in Annex D).

6.3.1 Prey consumption, including biomass estimation of prey species

SUB-OBJECTIVE 4: TO ESTIMATE THE PREY CONSUMPTION BY BALEEN WHALES USING JARPN II DATA AND SAMPLES, AND TAKING INTO ACCOUNT THE UNCERTAINTIES IDENTIFIED AT THE 2009 JARPN II REVIEW.

SUB-OBJECTIVE 5: TO EVALUATE THE FEEDING IMPACT BY WHALES ON FISHERIES RESOURCES USING JARPN II DATA AND SAMPLES, AND INFORMATION FROM COMMERCIAL FISHERIES AND OTHER RESEARCH SOURCES IN COASTAL AREAS.

SC/F16/JR15 estimated the prey consumption by common minke, Bryde's and sei whales in the western North Pacific. Prey species of whales were identified by examining their stomach contents, and the amount of prey consumed in the research area was estimated by using information on prey consumption per capita and the numbers of whales distributed. There were seasonal and geographical changes in the preys consumed in each whale species. The extent of differences of estimates of consumptions among several models was 2.4-3.6 times. Based on the results obtained by three equations combined and Monte Carlo simulations, the daily prey consumptions per capita (kg) were estimated as shown in Table P1.

Table P1

Estimates of daily prey consumption (kg) - offshore.

Species	Immature male	Mature male	Immature female	Mature female
Common minke whale	86-94kg	129-141kg	83-94kg	158-166kg
Bryde's whale	419-434kg	577-637kg	417-428kg	642-707kg
Sei whale	397-421kg	524-539kg	436-468kg	610-647kg

The CVs of the daily prey consumption consumed by whales per capita were in the range 0.2-0.3. The seasonal prey consumptions during May-September in two periods (2000-2007, 2008-2013) by three baleen whale species are shown in Table P2 (in thousands of tons).

Table P2

Estimates of seasonal prey consumption (thousand tons) by common minke, Bryde's and sei whales – offshore.

Period	Prey	Consumption	Period	Prey	Consumption
2000-2007	Japanese anchovy	724	2008-2013	Japanese anchovy	674
	Pacific saury	56		Pacific saury	48
	Mackerels	43		Mackerels	70
	Total	1,117		Total	1,226

The CVs of the seasonal prey consumption by whales were in the range 0.3-0.4. These values were equivalent to 22-48%, 2-7% and 5-66% of the biomass of these fish resources in the western North Pacific, respectively. The total line includes all prey species, not just these three.

SC/F16/JR16 examined the preliminary attempt of spatial estimation of prey consumption by sei whales in the JARPN II survey area using data obtained from 2002 to 2013. Two levels of models are constructed to achieve the goal. First, relative abundance of sei whales in relation with oceanographic conditions is estimated by using a generalized additive model (GAM). Secondary, amount of prey consumed by a sei whale in relation with oceanographic conditions is also estimated by using GAM. Finally, prey consumption of sei whales in the JARPN II survey area is calculated as the product of these two models. Data obtained from 2002 to 2013 are used in the analysis. Spatial distribution of prey consumption shifted toward north as the season progress. Estimated amount of prey consumption by sei whales using the spatial model was comparable to estimates based on traditional methods (Tamura et al., 2016: SC/F16/JR15). SST was selected as environmental covariates in the first and second models. However, the shape of functional form for the first level model (prey consumption) was relatively flat in comparison with the second level model (abundance). The results indicated that spatial distribution of sei whales at meso-scale were largely determined by oceanographic conditions such as SST. Sei whales could then search for their prey with the optimal oceanographic conditions as indicated by feeding behaviour study (Ishii et al., 2016: SC/F16/JR25). Future study on feeding ecology of baleen whales should pursuit such an integrated approach further.

SC/F16/JR17 estimated the prey consumption by common minke whales off Sanriku and Kushiro regions. Prey species of whales were identified by examining their stomach contents, and the amount of prey consumed in the research area was estimated by using information on prey consumption per capita and the numbers of whales distributed. Based on the results obtained by three equations combined and Monte Carlo simulations, the daily prey consumptions (in kg) *per capita* of common minke whales in Sanriku and Kushiro are given in Table P3. The estimated seasonal consumption (in tons) in the two areas is given in Table P4 and variation by prey species in Table P5.

Table P3

Estimates of daily prey consumption (kg) - coastal

	Sanriku				Kushiro			
Maturity	Consumption	CV	95% CI LL	95% CI UL	Consumption	CV	95% CI LL	95% CI UL
Immature male	98	0.25	56	149	82	0.19	53	115
Immature female	106	0.26	60	162	81	0.19	53	112
Mature male	166	0.26	91	249	116	0.22	69	168
Mature female	223	0.30	112	356	155	0.23	91	225

Table P4

Estimates of seasonal prey consumption (tons) – coastal. *n* = estimated number of whales

	Sanriku					Kushiro				
Year	*n*	Consumption	CV	95% CI LL	95% CI UL	*n*	Consumption	CV	95% CI LL	95% CI UL
2002						551	3,469	0.17	2,747	5,436
2003						888				
2004						338	2,182	0.23	1,436	3,446
2005	401	4,234	0.16	3,066	5,767	290	2,601	0.23	1,569	3,757
2006	216	1,822	0.18	1,293	2,588	221	1,596	0.19	1,128	2,370
2007						130	782	0.25	568	1,515
2008										
2009										
2010										
2011										
2012	124	850	0.20	599	1,325	433	3,264	0.22	2,408	5,838
Average	247	2,302	0.18	1,653	3,227	407	2,316	0.21	1,643	3,727

Table P5

Estimates of seasonal prey consumption (tons) by species – coastal.

	Sanriku			Kushiro						
	Krill	Sandlance	Anchovy	Krill	Anchovy	Sardine	Saury	Mackerels	Pollock	Squid
2002				488	665	0	460	0	791	1,066
2003				-	-	-	-	-	-	-
2004				49	1,204	0	843	0	85	0
2005	302	3,709	223	627	220	0	18	0	1,546	190
2006	-	1,522	300	11	971	0	198	0	264	153
2007				41	338	0	170	0	233	0
2012	118	656	76	409	2	724	0	154	1,421	554
Average	210	1,962	199	271	567	121	282	26	723	327

In Sanriku the estimated sandlance consumption corresponded to 30-40% of the fisheries catch in two years before the tsunami. In Kushiro the estimated seasonal consumption of Pacific saury and walleye Pollock from 2002 to 2012 corresponded to approximately 2-3% of the fisheries catch on these resources.

In conclusion the estimates of prey consumption of whales in coastal and offshore waters were made with an improved level of precision. These estimates on prey consumption are useful as input data in ecosystem models. The spatial distribution of sei whales at mesoscale was largely determined by oceanographic conditions such as SST.

SUB-OBJECTIVE 6: TO ESTIMATE PREY ABUNDANCE USING JARPN II DATA, COMPLEMENTED WITH INFORMATION AVAILABLE FROM OTHER SOURCES.

Murase *et al.* (2012) [SC/F16/JR18] examined basin-scale distribution pattern and biomass estimation of Japanese anchovy in the western North Pacific using a quantitative echosounder. This was the first attempt at such a study in this region. Data were collected in summer from 2004 to 2007. The biomass was estimated using data collected at 38 kHz. Species compositions in the backscatterings from pelagic fish were assigned based on the results of trawl hauls taking account of sea surface temperature (SST). Japanese anchovy tended to be high density to the west of 153°E and were distributed in an SST range of 9–24 °C. Although the temporal and spatial coverage of the survey differed each year, at least 1.5–3.4 million tons of Japanese anchovy were present in the survey area between 2004 and 2007. To take account of the spatial coverage of the survey each year, the most reliable biomass estimate for this region in the time period was 3.4 million tons (coefficient of variation 0.22).

SC/F16/JR19 examined estimation of prey species biomass based on 2008 and 2009 JARPN II acoustic surveys around the Sanriku region. The survey was conducted concurrently with a sampling survey of common minke whales. Five stratified blocks were surveyed. Zigzag track lines were set in the blocks. A trawler type RV, *Takuyo-maru*, conducted the survey. Acoustic data were recorded continuously along track lines by a quantitative echo sounder. Samplings using a midwater trawl net were conducted to identify species and size compositions of acoustic backscatterings. Vertical oceanographic conditions were recorded by using a CTD. Surface oceanographic conditions were recorded continuously along track lines. The total biomass estimation of sand lance adult were 8,076t, sand lance juvenile were 1,237t, Japanese anchovy were 0.18t in block B and C in 2008. The total biomass estimation of sand lance adult were 2,512t, sand lance juvenile were 315t, Japanese anchovy were 0.64t in block B and C in 2009, respectively. It was not possible to evaluate any trend in sand lance and Japanese anchovy abundance with just two surveys conducted in small areas. However sand lance and Japanese anchovy estimates were used to compare sand lance and Japanese anchovy consumption by large whales and as input data for the development of ecosystem models for this area.

In conclusion, Japanese anchovy was the main prey item for the baleen whales in offshore and occasionally in coastal areas, while sandlance is important for common minke whales in the Sanriku area. Prey biomass estimates obtained were used as input data in the ecosystem model developed in both offshore and Sanriku areas.

6.3.2 Prey preference, including whales' feeding habits

SUB-OBJECTIVE 7: TO INVESTIGATE THE PREY PREFERENCE OF WHALES IN OFFSHORE AREAS, USING JARPNII DATA AND SAMPLES.

SC/F16/JR20 (Watanabe *et al.*, 2012) presented the first quantitative analysis of the characteristics of the distribution areas and stomach contents of common minke, sei and Bryde's whales in relation to oceanographic and prey environments in mid-summer in the western North Pacific. Common minke whales were distributed within subarctic regions and the northernmost region of the transitional domain, coinciding with the main habitat of their preferred prey, Pacific saury. Sei whales were mainly found in the northernmost part of the transition zone and showed prey preference for Japanese anchovy, which was significantly more abundant in the main distribution area of the whale than in its adjacent areas. "Hot spots" of Bryde's whales were found in several regions of the transition zone between the subarctic boundary and the Kuroshio front. This whale species preferred Japanese anchovy as prey, for which the distribution density was significantly higher in the main distribution area of the whale than in the adjacent areas. These results indicated that the summer distributions of Pacific saury and Japanese anchovy greatly influence the distributions of these whale species, suggesting that the whales' habitat selection is closely related to their prey selection.

SC/F16/JR21 (Murase *et al.*, 2007) conducted a study of common minke and Bryde's whales in the western North Pacific in the 2000 and 2001 summer seasons to estimate prey selection of cetaceans as this is an important parameter in ecosystem models. Whale sighting and sampling surveys and prey surveys using quantitative echosounder and mid-water trawl were carried out concurrently in the study. Biomasses of Japanese anchovy, walleye pollock and krill, which were major prey species of common minke and Bryde's whales, were estimated using an echosounder. The results suggested that common minke whales showed prey selection for Japanese anchovy while they seemed to avoid krill in both the offshore and coastal regions and walleye pollock in the continental shelf region. Selection for shoaling pelagic fish was similar to that in the eastern North Atlantic. Bryde's whale showed selection for Japanese anchovy in August 2000 and July 2001, while it showed prey selection for krill in May and June in 2001.

SC/F16/JR22 examined prey preferences of common minke, Bryde's and sei whales in the offshore component of JARPNII from 2002 to 2007 using data from the concurrent surveys of cetacean sampling and prey of cetaceans. The surveys were conducted as a part of the offshore component of JARPNII from 2002 to 2007. A prey preference index, Manly's α, was used in the analysis. The sum of Manly's α for all prey species is 1 and a large value of Manly's α for a prey species indicates a preference for it. Common minke whales showed preference toward pelagic fishes as previously reported. Bryde's whales showed preference for anchovy. Sei whales showed preference for copepods. Although the prey of three baleen whale species overlapped, Manly's α suggested their trophic niches were different from each other. Common minke and sei whales coexisted in the same survey blocks, but their prey utilization patterns were different.

In conclusion, differences in prey preferences among the three baleen whale species in the offshore area could be explained by different feeding strategies of sei and common minke whales. Results for the coastal waters off Kushiro suggested that prey preference differed according to maturity stages of the common minke whales. The feeding strategy of this species in this coastal locality might change in response to changes in the environment.

SUB-OBJECTIVE 8: TO INVESTIGATE FEEDING HABITS OF BALEEN AND TOOTHED WHALE SPECIES IN THE RESEARCH AREA, AND THE ENVIRONMENTAL FACTORS INVOLVED IN DETERMINING SUCH HABITS

SC/F16/JR23 examined decadal change in food composition of common minke, sei and Bryde's whales in the western North Pacific. Stomach content data obtained in May-October during 2000-2013 off the Pacific coast of Japan, were examined. The three species were highly dependent on small pelagic fishes, i.e. Japanese anchovy, Pacific saury and mackerels in addition to copepods and euphausiids. The yearly trend of food compositions differed among the three whale species. Sei whales showed a drastic change from Japanese anchovy in early 2000s to mackerels and Japanese sardine after 2010. This synchronized with the catch record of Japanese fishery in the western North Pacific. Copepods and euphausiids are also important prey species for sei whales and were steadily available in the blooming period. Bryde's whale had a more simple prey composition with Japanese anchovy and euphausiids as main prey species, and the composition of the two main prey species were highly variable among years and no remarkable change since 2000-2013. Food composition in common minke whale in offshore waters (east of 150°E) showed the Japanese anchovy and saury as the major species, but the composition differed among years. Among the three whale species, sei whale distributed most widely in latitude through Kuroshio extension to north of the subarctic front feeding at a variety of prey species in the JARPNII study area where abundant pelagic fish carried by Kuroshio-current and Neocalanus copepods in the blooming season, were available.

SC/F16/JR24 examined the relationship between maturity and feeding habit of common minke whales in the coastal region off Kushiro. A total of seven dominant preys, including one species of krill (Pacific krill), one of squids (Japanese common squid) and five of fishes (Japanese anchovy, Japanese sardine, chub mackerel, Pacific saury and walleye Pollock) were identified in 589 stomachs of common minke whales. Feeding habits of common minke whales off Kushiro in autumn differed between immature and mature whales. These results suggested that prey preference of common minke whales in the coastal waters off Kushiro in autumn differed with their maturity stage. Feeding strategy of common minke whales might change to adapt to local environments. Differences can be explained by the trade-offs of cost of foraging activity for prey and/or energy demands between immature and mature whales.

SC/F16/JR25 examined the feeding behaviour of sei whale. Diving behaviour of sei whales and vertical distribution of their prey were recorded simultaneously in 2013 JARPNII survey to study their feeding behaviour at micro scale. Small acoustic time depth transmitters (pingers) were attached to two sei whales and their behaviours were recorded for 10.2 and 32.0 hours, respectively. Vertical distributions and densities (volume backscattering strength, SV) of their prey were recorded by an echosounder following swimming path of the individuals. The diving behaviour deeper than 10m was classified into two shapes (U-shape, V-shape). It was assumed that U-shape was related to feeding behaviour, especially lunge feeding, while V-shape was related to other behaviour. It was suggested that sei whales actively fed on prey around dusk. Swimming depth of the whales was shallower than 10m after sunset while deep scattering layers (presumably myctophids) migrated from below 60m to around 30m. The results might indicate that they did not feed on prey in deep scattering layers at night. However, the possibility that sei whales feed on prey near surface at night cannot be discarded. The results of this study revealed that sei whales changed their diving behaviour in response to availability of their prey in daytime.

SC/F16/JR26 examined the feeding habits of sperm whales in the western North Pacific in spring and summer based on analysis of stomach contents of 56 animals examined from May to September in the years 2000-2013. A total of 49 undigested and half-digested prey items were found, including 28 species of cephalopods and six species of fish. The Index of Relative Importance (IRI) showed that *Belonella borealis* and *Histioteuthis* spp. were the dominant prey in the Subarctic Region, while B. borealis and *Galiteuthis phyllura* were the dominant prey in the Transitional Domain. *B. borealis* and *Taningia danae* were the dominant prey in the Northern part of the Transition Zone, while *T. danae* and *Histioteuthis* spp. were the dominant prey in the Southern part of the Transition Zone. In the Kuroshio Zone, *T. danae* and *Octopoteuthis* spp. were the dominant preys. The composition of prey items changed in relation to transitional change between north and south. Canonical Correspondence Analysis (CCA) indicated that environmental and biological factors significantly contributed to the prey composition of sperm whales. This study demonstrated that sperm whales moved along waters with different oceanographic conditions, feeding on a variety of prey species. Larger whales tend to feed at offshore waters. This flexibility and different size distribution in sperm whale seems to be important to maintain large body size and large abundance in the western North Pacific. The commercially important Neon flying squid *O. bartrami* was not an important prey of the sperm whales sampled in spring and summer, only one of which was a mature male.

In conclusion, the yearly trend of prey compositions in Bryde’s and sei whales was different in the offshore waters. Bryde’s whales showed no trend, feeding every year on krill and Japanese anchovy. On the other hand drastic yearly changes were observed in the prey species of sei whales, shifting from Japanese anchovy to mackerels and Japanese sardine after 2010. Prey availability (biomass) is likely to determine prey composition for large baleen whales. In coastal waters off Sanriku yearly changes in the prey species of common minke whale, were not observed. On the other hand, in coastal waters off Kushiro, the dominant prey species shifted from Japanese anchovy and Pacific saury to Japanese sardine and mackerels after 2011. It is suggested that the feeding strategy of common minke whales might change to adapt the local environments. The results of diving behaviour of sei whales by acoustic devices indicated that sei whales did not feed on prey in deep scattering layers at night. Such information could validate some of the assumptions made for the estimation of prey consumption in future. Sperm whale moved along different oceanographic waters in the research area, feeding on several mesopelagic squids.

6.3.3 Body condition of whales

SUB-OBJECTIVE 9: TO INVESTIGATE THE YEARLY TREND IN BODY CONDITION OF BALEEN WHALES USING JARPNII DATA AND SAMPLES

SC/F16/JR27 examined the annual trend in energy storage in sei, Bryde’s and common minke whales during the JARPN II period. Regression analyses showed that blubber thickness in sei whales has been increasing during the JARPNII period. The increase per year was estimated at approximately 0.1cm for mid-lateral blubber thickness. “Body length” and “Date” were included in the best model at the 5% level, while no year effects were included in the best model for other blubber thickness and girth measurements. The blubber thickness for mid-lateral probably is the most sensitive for detecting energy storage. In Bryde’s and common minke whales, no significant trends were observed in the regression analyses. The increase in the trend of body condition indicators and the recent change of prey composition suggest that food availability has changed favourably for sei whale in the study area.

In the review meeting, the author of JR27 conducted additional analyses based on the reviewer's comment that a technical error had been made. Following this correction, linear models with minimal covariates, i.e. body length, date, latitude, longitude and sex were first tested for four response variables, and then an interaction of the maturity stage with year was added separately. The year effects of the models differed among species and indices of nutritional condition, showing either no or negative effects for sei, a negative effect for Bryde's and both negative and positive effects for common minke whales.

6.4 Panel review, conclusions and recommendations

6.4.1 Overview

The data and information from JARPN II studies on whale food habits and prey preferences is substantial. The sampling programme was generally well-coordinated across a range of vessels and platforms, and there is a substantial amount of concurrently collected data. However, as noted under Item 3.4.2, there are concerns about how representative the whales sampled are with respect to (a) the study areas and (b) the populations. The Panel **reiterates** the importance of the proponents providing papers to the 2016 Annual Scientific Committee Meeting evaluating the potential impact of the realised sampling and sample sizes on the feeding ecology studies, as recommended under Item 3.4.2.

The Panel **notes** that the available datasets are pertinent to a broad range of topics, with wider relevance than within the JARPN II programme objectives. The Panel **agrees** that diet data can be used to (i) determine whale prey preferences, (ii) develop functional response curves when sampling is accompanied by simultaneous assessments of prey abundance and (iii) estimate the impacts of whales on their prey (when used in conjunction with estimates of total consumption and whale abundance). The diet data from JARPN II are compatible with these goals and, in addition, may serve as indicators of the potential prey selection of these whale species in other regions of the sub-Arctic oceans. These studies form a critical input into ecosystem modelling and can be used directly to understand species interactions (Bogstad *et al.*, 2015).

6.4.2. Evaluation of progress made on recommendations in 2009

As summarised in Table 6, the Panel **notes** that the proponents had addressed or partly addressed all but three of the 2009 recommendations (related to sampling areas, sampling and analytical strategies to reduce uncertainty and a comparison of the 2009 results with those from different approaches). More detailed consideration of these topics is given below.

The estimation of food consumption is based on models that account for *per capita* daily consumption, the weight of animals of different sexes and life stages, the caloric value of prey species, the assimilation efficiency, and the number of animals by sex and stage. The uncertainty of the estimates of consumption was quantified using a Monte Carlo approach in which the model parameters were assigned triangular distributions. Table 7 summarises the sources of uncertainty identified by the 2009 Panel and assesses which sources were considered in the Monte Carlo procedure. Most, but not all, of the sources of uncertainty were accounted for. The Panel **recommends** that all sources of uncertainty be quantified and an evaluation of which parameters contribute the most to uncertainty be conducted.

Table 6

Summary of Panel's evaluation of the proponents' response to the 2009 recommendations with respect to feeding ecology studies (see text).

Brief summary of 2009 recommendations	2016 Panel evaluation
Provide fuller rationale for sampling areas.	Not addressed.
Characterise uncertainty following advice provided for key parameters	Partly addressed.
Data analyses should: (a) incorporate several reasonable models for estimating daily consumption as a function of body mass and include the range of results; (b) use that range in subsequent analyses (including any ecosystem modelling); and (c) undertake sensitivity analyses for the range of parameter values used in the consumption equations.	Partly addressed.
Undertake additional analyses to identify the greatest sources of uncertainty and determine appropriate sampling and analytical strategies.	Not addressed.
Provide scientific rationale for used modelling formulations and proposed ranges.	Partly addressed.
Explain methods used to extrapolate from daily to annual rates and amounts.	Addressed.
Incorporate information from other studies.	Addressed.
Present estimates of consumption by whales in terms of fisheries and prey biomass.	Addressed.
Combine the oceanographic data, prey distributions and sighting survey data statistically to investigate how prey and whale distributions are associated with oceanographic conditions, and how whale distributions are related to distributions of prey.	Addressed.
Combine data on prey distributions as observed in the area where the whales were caught with the diet of the whales (referred to as the microscale) statistically to evaluate how well the whale's diet reflects prey availability in the area where it was caught.	Addressed.
Compare results from the approaches listed above with the results on selectivity already produced and presented at the Workshop.	Not addressed.

Table 7

Summary of sources of uncertainty and the treatment of these in the analyses presented to the Workshop.

Issue	Status
***Per capita* consumption in area of interest**	
Parameter uncertainty in the relationship between energy consumption and body mass (multiple and exponent)	Results shown for three relationships.
Residual variance of species values around the mean curve	Not considered
Proportion of annual energy requirement obtained during summer feeding season and length of the feeding season	Assumed to be triangular distributed
Variance in mean body mass (stratified by sex and life stage, e.g. mature/immature)	Assumed to be triangular distributed (separately by sex and life stage)
Diet composition	
Variance of average undigested biomass of each main prey group in the forestomach.	Assumed to be triangular distributed
Variance of the mean residence time of each main prey group in the forestomach.	Not considered
Variance of the average energy content per unit biomass of prey by prey type.	Included in the triangular distribution (but sample size is low for some prey items)
Variance of the average body weight of undigested prey items by species	Included in the triangular distribution
Variance of the relative frequencies of each species by counts of individuals and/or hard parts	Not considered
Abundance	
Variance (and possibly covariance) in estimates of abundance (mean number of whales present) in survey season by sub-area and time period, including *g*(0) variance, and process error.	Assumed to be triangular distributed

Triangular distributions were used to express uncertainty. However, the reason for selecting this distribution is unclear. The method selected to account for uncertainty should be improved to better reflect the statistical distributions of parameter uncertainty (e.g. log-normal for abundance). Mass was introduced into the equations as a triangular distribution with the mean, maximum and minimum mass samples for each maturity and sex class. The Panel **agrees** that the triangle distribution placed too much weight in the tails of the distribution, and that an approach such as a simple bootstrap of the data would have been more appropriate.

Captive studies are impractical for whales and thus alternative approaches are needed to estimate consumption. The proponents presented several allometric-consumption equations which provided a range of energy/consumption estimates, meant to bracket upper and lower limits of possible levels of consumption. The work that examined meal size using fresh stomach content material and foraging behaviour suggested that some allometric relationships of consumption may be too low (equation 2: SC/F16/JR15). The Panel **recommends** that this aspect of the analyses be developed further to refine the range of suitable allometric-energy intake/consumption relationships that would have provided a more useful range of consumption estimates.

The proponents also statistically examined relationships between oceanographic conditions, oceanographic data, prey distributions and sighting survey data to investigate how prey and whale distributions are associated with oceanographic conditions, and how whale distributions are related to distributions of prey. They statistically combined data on prey distributions as observed in the area where the whales were caught with the diet of the whales (referred to as the micro scale) to evaluate how well the whale's diet reflects prey availability in the area where it was caught.

Diet composition information is a key component of the JARPN II programme. In JARPN II, diet was reconstructed by focusing on the relative contribution of the fresh material, and weighting this by the number of digested prey identified to species. The fresh samples represent the most recent ingestion of prey. The impact of using the most recently ingested prey to weight the reconstruction is not clear, but may be important if the species composition changes over the period that prey are retained within the first and second stomach. In many diet composition studies, the diet is reconstructed using all material recovered from the stomach, not just by using recovery of fresh samples. This reduces the need to understand or place as much importance on understanding the mean residence time of each main prey group in the forestomach. For example, if fish or zooplankton differ in their rates of digestion, using only fresh material may overestimate the contribution of the group that is digested more slowly. Normally, the total number and mass of fish consumed are estimated through the number of otoliths or beaks, each scaled up to estimated original prey mass and summed to obtain a total mass for the meal. The relative contribution of each prey species to the stomach contents is determined based upon its estimated mass contribution to the total meal. The proponents collected information on prey size using the fresh stomach content material, but this could also be estimated from otolith-prey size allometric relationships, which would have increased sample size. Prey size information is also needed for analysing the contribution of whale predation to natural mortality of commercial fish stocks, particularly where different size classes may be targeted by whales or fisheries (e.g., sand lance, walleye pollock). The size composition of prey was presented in some (e.g. SC/F16/JR/17), but not all papers, and considered suggestive of differential selection of particular prey sizes by each species, but this was not quantified. The energy content of prey is expected to change seasonally. However, energy density of prey appears to have been examined for only a limited number of samples for each prey species and it is not clear if seasonal changes in energy density were considered. The Panel **agrees** that further work is needed (see Item 6.4.3).

When estimating energy requirements, it is important to account for the costs of energy storage, growth and reproduction. The proponents recognise this (equation 1, paper SC/F16/JR17), but it is not clear how costs of growth and energy storage have been incorporated into the analyses. It is possible that the information on condition factor (SC/F16/JR27) could have contributed to bioenergetics analysis. SC/F16/JR17 identified several allometric equations that have been used in other studies to estimate consumption. These provide a range of estimates of energy requirements for an individual. The equations should be compared to understand what each formulation was estimating. For example, Equation 3: $SMR = 863.6M^{0.783}$ (Sigurjónsson and Víkingsson, 1997) provides an estimate of energy requirements, described as the 'near basal energy requirement, times an activity factor of 1.5', but this does not take into account growth, seasonal changes in condition or reproduction. If the consumption models were not modelling energy gain (growth in protein and fat deposition, as well as reproduction explicitly), then an alternative could have been to apply a separate multiplier to take into account some of the additional costs associated with growth and reproduction. This would also contribute to model uncertainty, although uncertainty has not been identified in model development.

A critical factor in estimating consumption is the spatial distribution of prey and whales throughout the year. The JARPN II surveys were conducted during May/June and July-October. Estimates of consumption have been provided for the intervening months, but it is not clear how density and diet consumption have been extrapolated outside of the areas and months covered during the surveys and diet studies. The Panel **agrees** that the proponents clarify this (see Item 6.4.3.2).

Stomach contents provide information on species, size and relative contribution of prey to the diet. In common with all methods used to determine diet composition, the use of stomach contents has weaknesses. For example stomach contents only reflect what was consumed during the last 1-2 meals, within the last 24h. The 2009 Panel recommended the use of other methods to obtain information on diet composition in addition to stomach data, such as stable isotopes or fatty acid composition, but these methods have not been used. Both methods can use material either from sampled whales or from biopsies. These methods also have limitations such as information on what specific prey can appear in the diet, a need for a prey library, and an understanding of tissue turnover rates, as well as uncertainties about where the prey were ingested. However, the present Panel **reiterates** the need to consider other methods because of the potential not only to assess diet, but also to statistically evaluate overlap in trophic niche and distribution (Gavrilchuk *et al.*, 2014; Ryan *et al.*, 2013; Witteveen *et al.*, 2009). The use of these alternative methods provides insights into prey ingestion over periods that vary according to the tissue examined: several days or weeks (skin), several months (muscle), or long-term (bone) (Browning *et al.*, 2014; Giménez *et al.*, 2016; Yoshida and Miyazaki, 1991). Thus, they may extend the sampling window to determine diet composition from the last 24h to an improved understanding of long-term diet composition. Moreover, stable isotope analysis of sequential layers in baleen, a structure that grows continuously and is composed of metabolically inert tissue that does not experience isotopic turnover, provides information of the isotopic body pool composition during a period that depending on the species involved may extend up to the 2-4 years previous to sample collection (Aguilar *et* *al.*, 2014), thus allowing inference on migration route and breeding ground. The greatest information on diet composition can therefore be gained from using multiple methods in conjunction.

The ultimate objective of the dietary studies is to convert individual consumption to population consumption of different prey. This is a complex challenge because sampling of whales and prey is spatially and temporally limited. It is not clear how the conversion of the consumption estimates and prey preference from the level of the individual whale to the entire population, taking into account the temporal/spatial changes in diet composition and the spatial/temporal changes in whale distribution, was undertaken. Although any approach is likely to be limited, clarification of methods and how uncertainty was considered is needed.

6.4.3 Recommendations

6.4.3.1 MEDIUM-TERM

The Panel has developed the following **recommendations** for the medium-term i.e. normally to be completed 2-3 years after the 2016 Annual Meeting:

(1) all sources of uncertainty should be quantified and an evaluation of which parameters contribute the most to uncertainty be conducted and taken into account in the analyses and modelling;
(2) the studies on allometric relationships should be developed further to refine the range of suitable allometric-energy intake/consumption relationships;
(3) the analyses of diet composition should consider the effect of seasonal changes in energy density of the various prey species; and
(4) stable isotope analysis of whale tissues and their prey should be introduced not only into the assessment of diet, but also to statistically evaluate overlap in distribution and trophic niche between baleen whale species.

6.4.3.2 SHORT-TERM

The Panel has developed the following **recommendations** for the short-term i.e. to be completed ideally by the 2016 Annual Meeting but certainly by the 2017 Annual Meeting.

(1) The sampling distribution for the parameters should be used in the assessment of the uncertainty associated with the estimation of consumption;
(2) Clarification should be provided on how density and diet consumption have been extrapolated outside the areas and months covered during the surveys and diet studies.

7. FEEDING ECOLOGY AND ECOSYSTEM STUDIES: PART 3 ECOSYSTEM MODELLING

7.1 Summary of objectives including modifications, if any, since the start of the programme (by proponents)

With respect to ecosystem modelling, a new sub-objective was added:

> *Sub-objective 10: To develop several ecosystem models, in both coastal and offshore areas, using JARPN II data and samples as input. Model outputs are likely to provide information on i) the ecosystem structure, ii) effects of prey availability and consumption on the population dynamics of common minke and sei whales with consideration of levels of energy intakes, iii) predation impacts of common minke whales consumption on sandlance stock off Sanriku.*

7.2 Overview of conclusions and recommendations from the 2009 Workshop

A short overview on the 2009 workshop conclusions and recommendations on the ecosystem modelling component of JARPN II was provided by the Head of Science.

The 2009 Panel had noted that the overall objective regarding ecosystem management was both highly ambitious and very general. It had recommended the development of sub-objectives and a timeframe. It highlighted that it was unlikely that output sufficient for providing management advice would be available in a short time frame and it might take much longer. The preliminary approaches presented were a reasonable start but the conclusions were overstated and certainly not suitable as a basis for management. The Panel stressed that a variety of modelling approaches are required. It noted that the data from sperm whales made no worthwhile contribution to the modelling work.

The 2009 Panel made a number of general recommendations including:

(a) considerably more resources **must** be allocated to modelling work;
(b) models should be used to evaluate priorities by estimating which are the key parameters (and where effort should be targeted to reduce uncertainty) in the context of management-related outputs;
(c) a wider range of models must be considered;
(d) future work should aim towards fitting dynamic models to time series of data;
(e) separate models should be developed for the different ecological regions;
(f) considerably more effort should be directed at quantifying uncertainty with respect to all aspects of the input and model assumptions; and

(g) effort should be put into the incorporation of natural variability in dynamic processes.

The 2009 Panel had also made a number of specific recommendations related to:

(a) ensuring that all likely significant predators are included in the models not just whales

(b) not using Type I functional response relationships as these are unrealistic;

(c) the need to improve the Ecopath component with respect to the EwE (Ecopath with Ecosim) approach before moving to Ecosim e.g. by

    i. reviewing the species considered;
    ii. reviewing the parameter values used;
    iii. rebalancing Ecopath using different approaches; and
    iv. quantifying uncertainty

(d) further work on the MRM (minimum realistic model) approach with an emphasis on fitting to time series.

7.3 Proponents' summary of the ecosystem modelling work (incl. response to 2009 Workshop)

SC/F16/JR28 presented the results of ecosystem modelling in the western North Pacific from 1994 to 2013 using Ecopath with Ecosim (EwE). The recommendations/suggestions raised by the 2009 JARPNII review workshop were addressed in the paper except the treatment of uncertainties. Firstly, Ecopath in 2013 was constructed as available data for the modelling is relative rich. Ecopath in 1994 was then constructed based on the model in 2013. Finally, Ecosim is constructed based on Ecopath in 1994 using available time series data from 1994 to 2013. Regime of the period is relative stable in comparison with the past. A series of pre-balance diagnostics, "PREBAL" (Link, 2010) was conducted for both the 2013 and 1994 models to evaluate the initial static energy budget of Ecopath. An ecosystem network analysis indicator, mixed trophic impact (MTI), was used to assess the positive or negative effect of changes in the biomass of a species/group on the biomass of the other species/groups in the steady state ecosystem. Order of Trophic level (TL) of baleen whales was as follows (from high to low): common minke (4.1), Bryde's (3.9), sei (3.7), humpback (3.5), fin (3.3) and blue (3.2) whales. These species are in intermediate TL in the ecosystem. MTIs suggested that changes in biomass of forage fish impact most of species/groups from low to high trophic levels. Baleen whales impact forage fish negatively but the magnitude is weak. The Ecosim model with forced biomass trends of four forage fish species (Japanese sardine and anchovy, and chub and spotted mackerels) having 10 predator and prey search blocks attain the lowest AIC. Estimated trends of biomasses and total mortality by using the model are reasonably fitted to input time series data especially for cetaceans targeted by JARPNII. Overall results appear to be reasonable but it is still preliminary largely because of incompleteness of input data. The following are points to be improved in further exercises: (1) consistency of spatial resolution of input data, (2) development of regional models within our EwE area, (3) collection of diet composition data in regular interval, (4) resolution and quality of data on non-commercial and lower trophic level species and (5) evaluation of the sensitivity of Ecopath models to input data. Uncertainties in the model will be considered along with these additional works. The developed EwE would be used as a base model for broad-scale strategic management consideration of whales as well as other species such as small pelagic fish.

SC/F16/JR29 aimed at assessing predation impact on sandlance population by common minke whales off Sanriku region. A state-space delay-difference model, which is a two-stage population dynamics model with a stock-recruitment relationship, was used for the sandlance population to employ two independent time series indices for the juvenile and mature population sizes as well as catch and age-composition data. Predation impacts on the sandlance were assessed through common minke whales' consumption expressed as a functional response. To take into account several stochastic flexibilities such as process errors, a Bayesian method was used to estimate the parameters and latent variables in the model. The results showed that the predation by the common minke whales accounts for a certain proportion of the current adult biomass for the sandlance population although the level of proportion is sensitive to the model assumption.

The addendum of SC/F16/JR29 reported that there was a data-handling error in the analysis above. Due to time constraints, the authors of SC/F16/JR29 were not able to finalize all the analyses by the time of the review workshop. In the addendum, the outline of formulation and one example of outcomes (without any predation effect), were shown. The outcome suggested that a percentage of consumption by minke whales accounted for around 10% of total biomass of sandlance. The number would be higher if expressed in terms of adult natural mortality, as the estimate of natural mortality is less than 1. However, due to preliminary nature of this analysis, the authors insisted that the result should be taken as at best broadly indicative only. The authors plan to submit a full paper with more details on this analysis as well as the analysis with consideration of predation effects.

In conclusion, the ecosystem models presented to this workshop were improved significantly based on the recommendations/suggestions raised in the previous workshop held in 2009. They would serve as baseline models to test various types of marine ecosystem management options. It should be noted that the Panel of the workshop in 2009 pointed out that it might take a long time to obtain results of ecosystem modelling that are sufficiently reliable to inform management advice. The panel also pointed out that substantial data collection and analytical efforts are required to accomplish the goal. The proponents have developed ecosystem models bearing those suggestions in mind. Although JARPNII was terminated as a program, continuation of similar research is necessary to develop ecosystem models for the purpose of management advice.

7.4 Panel review, conclusions and recommendations

7.4.1 Overview

The Panel **reiterates** the 2009 Workshop comment that developing ecosystem models to the level that they could contribute in the provision of specific management advice constitutes a major, complex and ambitious undertaking, and that developing ecosystem models requires substantial data collection and analytical efforts. Ecosystem modelling is an ideal tool for integrating a range of different processes and data sources into a single coherent framework. Moreover, the Panel also **reiterates** the 2009 Workshop statement that there are benefits to developing a wide range of models and that the best ecosystem modelling approach depends on the question being addressed.

The Panel **agrees** that substantial progress has been made since 2009 on the Ecopath/Ecosim (EwE) model and an extended single species sandlance model with predation by common minke whales was presented for the Sanriku region. However, the work presented to the Panel remains preliminary, and the Panel was not able to review the results for the sandlance model as an error was found in the data used in the model. It is clear that substantial additional work remains to be done in order to develop a MRM/MICE[4] and before any ecosystem model could be used to provide managers with strategic advice as envisioned in the original objective. The Panel does **not** recommend using ecosystems models for tactical management.

The Panel **agrees** that the work presented in SC/F16/JR/28 and SC/F16/JR/29 forms a reasonable basis for further work. However, the work is incomplete in several ways and the modelling portion of the project was perhaps most negatively impacted by the review occurring before the originally envisioned end of the programme. The extended single species model shows promise as step towards a MRM/MICE to evaluate impacts of whales on fisheries.

The Panel **reiterates** that the EwE as developed is not suitable for use in addressing the strategic management questions outlined by the proponents involving whale-fishery interactions. Firstly, reasonable fits were obtained only when the model was driven with the biomass of small pelagic species which precludes its use to investigate the impact of whale predation on these small pelagics. Secondly, the EwE software imposes constraints on a full evaluation of the statistical properties of the model and an evaluation of uncertainty. Previous work (Gaichas *et al.*, 2011) has shown that a single 'best fit' to historical data without accounting for parameter uncertainty does not provide a sound basis for forecasts.

In conclusion, with respect to the extent to which the proponents have met their Objective 1, Sub-objective 10 ('To develop several ecosystem models, in both coastal and offshore areas, using JARPN II data and samples as input'), the Panel **agrees** that it has been only partly met in that whilst two models have been developed, they are preliminary and a planned MRM/MICE has not yet been developed.

The model outputs are likely to provide information on ecosystem structure. However, with respect to the effects of prey availability and consumption on the population dynamics of common minke and sei whales with consideration of levels of energy intakes, the Panel **agrees** that whilst a link has been demonstrated, the effects have not been investigated. Finally, with respect to estimating the predation impacts of common minke whales on the sandlance stock off Sanriku, the Panel **agrees** that whilst work is in progress, it has not been completed.

The Panel **stresses** that the lack of progress with respect to ecosystem modelling compared to that envisaged in 2009 is not a criticism of the scientists involved. Disappointingly, despite the recommendation from the 2009 Panel and the fact that it is central to being able to meet the primary objective, insufficient resources have been put into this aspect of the programme.

7.4.2 Evaluation of progress with the 2009 recommendations (see Annex D for a complete summary table)

The 2009 Panel had made a number of general recommendations to further the work on ecosystem modelling. None had been fully addressed but several had been partly addressed. Two, related to (a) using models to identify areas of uncertainty with the greatest impact on model outputs to improve sampling and (b) taking wider account of uncertainty at all stages of the modelling process, had not been addressed. As noted earlier, the relative lack of progress relates to the lack of resources allocated. Detailed comments are given in Table 8.

The 2009 Panel also made a number of specific recommendations for ecosystem modelling based on the papers presented at the time. Two were largely or fully addressed (related to improving Ecopath), two were partly addressed (related to parameter values in Ecopath) and three were not addressed (related to the inclusion of other predators in the sandlance model, taking account of the uncertainties in model inputs, and fitting time series of data within the MRM). Detailed comments are given in Table 8.

7.4.3 Recommendations

The Panel has developed the following **recommendations** for the medium-term i.e. normally to be completed 2-3 years after the 2016 Annual Meeting.

7.4.3.1 GENERAL RECOMMENDATIONS

(1) The generic recommendations identified by the 2009 Panel remain, and the Panel **endorses** them.
(2) Clear objectives on the ultimate use of the models must be established to make further progress. One model may meet a general objective of better understanding ecosystem linkages, while a very different model may be more suited to delivering tactical advice for fishery management. For example, EwE modelling demonstrates linkages between small pelagic species and whales, both in the static mass balance and in the dynamic model. However, it is not clear how such modelling could directly inform strategic management.
(3) Models can be better used in concert. The results of food web modelling should be used to establish key predation linkages to include in extended single-species or multispecies models. This best exploits the strengths of different

[4] Minimum Realistic Model/ Models of Intermediate Complexity for Ecosystem Assessment

types of models. Specifically, Ecopath should be used to define key relationships for further study within targeted statistical MRM/MICE models linked to specific objectives. In such a way the suite of available modelling tools can be used to integrate available knowledge.

(4) Stable isotopes provide information on long term feeding patterns to inform models about trophic relationships between whales and their prey (see also Item 6.4).

Table 8

Summary of the Panel's evaluation of the proponents' response to the 2009 recommendations on ecosystem modelling (see text).

Brief summary of the 2009 recommendations suggestions	Panel comments
Generic recommendations	
Considerably more resources must be allocated to the modelling work – without this, the likelihood that the objective of the programme will be reached in a reasonable timeframe will be minimal.	Partly addressed. Although progress has been made since the 2009 workshop, this is less than would have occurred had sufficient resources been allocated to this aspect of the programme. This is reflected in the preliminary nature of the work provided to the Panel.
The models developed should be used to identify the areas of uncertainty with the greatest impact on model outputs of relevance to management, and hence to guide the prioritisation of future data collection and the associated sample size/sampling design.	Not addressed. Given the preliminary nature of the modelling, the work had not fed through into the prioritisation of data collection during the programme or to issues of sample size or sampling design
A wider range of models needs to be considered if the objectives of the programme are to be met. Further work should aim towards fitting dynamic models to time series of data, especially abundance indices.	Partly addressed. Two models have been developed, although a planned MRM/MICE has not been developed. Both of the models presented are fit to the data, but the Ecosim model cannot provide adequate fits to the data unless the biomass of small pelagic species are pre-specified.
The area covered by JARPN II is not spatially homogeneous, and serious consideration should be given to developing separate models for three regions distinguished by the inshore or shelf region, the sub-Arctic oceanic region of the Oyashio current and the sub-tropical region of the Oyashio and Kuroshio transition zone.	Partly addressed. It has been addressed for the EwE model, but the extended single-species model has only been applied to one interaction in one region.
There is a need to take much wider account of uncertainty at all stages of the modelling process, including that associated with the prey consumption rates of whales.	Not addressed. Limited sensitivity analysis has been undertaken for the EwE model, while the extended single-species model is not sufficiently well developed for sensitivity testing to be undertaken. It is also dependent on progress with the feeding ecology work (see Item 6.4).
The importance, ultimately, of developing models which incorporate natural variability in dynamic processes (e.g. recruitment variability for prey species) was emphasised, although it was recognised that this might not be possible for certain ecosystem modelling packages.	Partly addressed. The extended single-species model includes process error in recruitment and the population dynamics (but the model currently under development has not been able to estimate the associated parameter well)
Specific recommendations	
Include other important sandlance predators in the single species model.	Not addressed.
It is important to concentrate first on improving the Ecopath component of this EwE analysis before moving on to the next step of extending the modelling effort from a static to a dynamic model such as Ecosim.	Largely addressed. While data limitations remain, the model presented to the Panel provides a reasonable synthesis of the available information (but see Item 7.4.3.2).
The species included in the Ecopath analysis should be reviewed giving attention to Ecopath models developed for other regions; in particular the inclusion of gelatinous zooplankton should be considered.	Addressed.
The values of the parameters of this Ecopath analysis should be compared with values for those others, with attention directed towards any instances of major discrepancies.	Partly addressed. PREBAL diagnostics were applied, so this was addressed to the extent that PREBAL diagnostics are based on general comparisons among models. However, specific comparisons with other North Pacific food web parameterizations were not included.
Alternative approaches for balancing the Ecopath model should be considered e.g. rather than use values for some parameters drawn from other regions, placing a bound on some relationships (e.g. P/C<0.6).	Partly addressed, but see recommendations (Item 7.4.3.2 (2)).
Analyses must take full account of the uncertainties associated with model inputs for Ecopath, e.g. using Ecoranger.	Not addressed. Ecoranger is not necessarily recommended, but another method should be considered.
Further work on MRM approaches is encouraged and should focus in particular on fitting such models to time series of data	Not addressed. Need recognised by proponent scientists. Critical for further progress.

7.4.3.2 EWE MODEL

(1) An evaluation of data quality for each input parameter, the 'pedigree' (Gaichas *et al.*, 2015) is needed to characterise uncertainty in model inputs.
(2) Further evaluation of PREBAL and other diagnostics should be conducted. The Panel was concerned by relatively low Ecotrophic Efficiencies for sardine and saury, which may indicate that predation on these species is not fully modelled. This would be worrying given the focus of the modelling on the relationship between small pelagic fishes and whales.
(3) The estimated vulnerabilities and other fit diagnostics could be presented more clearly and evaluated further. Software constraints inherent to Ecosim should not limit the consideration of uncertainty; sensitivity analysis using ranges of consumption estimates, for instance, could be done.

7.4.3.3 EXTENDED SINGLE-SPECIES MODEL

(1) The model should be developed to ensure that the majority of predation mortality is captured. A food web model (e.g. Ecopath) quantifies mortality from all predators in the ecosystem, and could be used to inform which major predators to include in this work.
(2) Additional diagnostics are needed. Specifically, there is a need to examine the fits to the fishery-independent survey data, the proportion information, and trends in fishing mortality. In additional, posterior predictive checks can be used to evaluate model fit in Bayesian models.
(3) The current spatial boundaries of the model and the use of fishery CPUE as an index of abundance should be more thoroughly justified.
(4) If CPUE for the dip net fishery is not considered likely to index abundance, the focus for model fitting should be the fishery independent survey.
(5) There is unlikely to be sufficient information to estimate the functional form of the feeding relationship and sensitivity to alternative plausible relationships should be examined.
(6) Some of the posteriors in SC/F16/JR29 appear implausible (e.g. the posterior for the intrinsic growth rate for the prey larger with most of its mass on values larger than 2 and the posterior mode for juvenile survival close to 1 in the absence of minke whales). This is likely a consequence of conflicts between the data sources or confounding of parameters due to insufficient data. The causes of the implausible posteriors can be explored by changing the weights assigned to the data sources and fitting the model.

8. MONITORING ENVIRONMENTAL POLLUTANTS IN CETACEANS AND THE MARINE ECOSYSTEM

8.1 Summary of objectives including modifications, if any, since the start of the programme (proponents)

In 1992 the Commission endorsed the plan of the IWC SC to pursue studies on environmental changes and their impacts on cetaceans. In particular, there was concern that pollutants may have a negative effect on the health of cetaceans resulting ultimately in a decrease in the abundance of the stocks.

The main Objective 2 of the JARPNII research plan was "monitoring environmental pollutants in cetaceans and the marine ecosystem", which is composed of the following three sub-objectives.

Objective 2, Sub-objective 1: Pattern of accumulation of pollutants in cetaceans (Relevant documents: SC/F16/JR30-34).

Objective 2, Sub-objective 2: Bioaccumulation process of pollutants through the food chain (SC/F16/JR30).

Objective 2, Sub-objective 3: Relationship between chemical pollutants and cetacean health (SC/F16/JR35; Niimi et al. (2014) [SC/F16/36]; Shimizu et al. (2013) [SC/F16/37].

A schematic representation of the research components under Objective 2 of JARPNII is shown in Fig. P5. Air and seawater samples, whale samples and their prey items were collected in the JARPNII surveys. Levels of pollutants such as mercury (Hg), organochlorines (OCs) and biomarkers in the samples were measured in laboratories of the ICR or the collaborative groups. And these data were analyzed for achievement of each sub-objective.

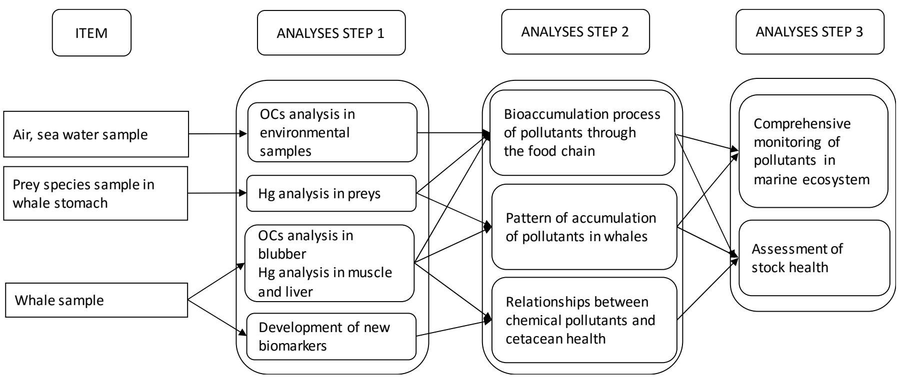

Fig. P5 Schematic representation of the research components under Objective 2 of JARPNII

8.2 Overview of conclusions and recommendations from the 2009 Workshop (Chair, Head of Science)

A short overview on the 2009 Panel conclusions and recommendations on the pollutant component of JARPN II was provided by the Head of Science.

The 2009 Panel had concluded that the JARPN II pollutant studies represent a valuable contribution to pollutant work. It agreed that the programme was addressing its objectives but it had recommended further work. In particular it noted that revised papers should include a general risk assessment for various pollutants, based on current ecotoxicological knowledge and information from other wildlife on likely thresholds for adverse health effects to be detected. For future studies it had recommended that polychlorinated biphenyl (PCB) concentrations should be reported on a lipid weight basis and that combined analyses of PCBs and Hg should be undertaken. Furthermore, it noted that it was important for the proponents to develop a more balanced, structured study design to allow statistically robust consideration of hypotheses, with all of the necessary data collected from each of the targeted individuals and with a control or comparison group. It was suggested that bycaught J-stock animals could be suitable as one comparison group. Recognising the continuing development of techniques, it had recommended that tissues should be archived for future retrospective analyses. It also suggested that priority should be given to ways to determine absolute age as an additional covariate for the interpretation of the results.

In terms of additional or more integrated studies, the 2009 Panel had recommended that the proponents should:

(a) include fatty acid profiles and stable isotope ratios to help discriminate among reasons for temporal changes (e.g. dietary changes or exposure variation with constant diet);

(b) place more emphasis on air and water studies; and

(c) undertake simple mass balance studies to improve knowledge of the partitioning and offloading of contaminants and potential impact of changes in exposure, noting that this would require additional analyses of blood, bile, faeces and urine.

Finally, it had recommended that the contaminant results be linked to prey consumption studies.

8.3 Proponents summary of the results (incl. response to 2009 Workshop)

Studies on comprehensive monitoring and assessment of environmental pollutants under the JARPNII were based on a large and comprehensive data/sample set, and involved the use of pollutant levels (Organochlorines and Hg) in whales and their prey items.

The combination of large sample size and detailed biological data was an appropriate tool to monitor pollutant levels in whales and their prey items, and assess whale health.

OBJECTIVE 2, SUB-OBJECTIVE 1: PATTERN OF ACCUMULATION OF POLLUTANTS IN CETACEANS

SC/F16/JR30 examined temporal trends in total Hg concentrations in muscle of mature male whales using samples obtained during JARPN and JARPNII (1994-2014). Common minke whales from sub-areas 7, 8, 9, off Kushiro and off Sanriku; sei whales from sub-area 9 and Bryde's whales from sub-areas 8 and 9 were sampled. Multiple regression analyses were carried out to determine whether year sampled, longitude, latitude, date, whale body length, blubber thickness and/or main prey species were significantly correlated with Hg concentrations in the muscle samples from the whales. Significant correlations with year and main prey species were observed in common minke whales from sub-areas 7 and 9. A significant time trend was also found for the sei whales but with no significant main prey species effects. However, body length had a small but significant positive coefficient for sei whales, suggesting that older sei whales might have somewhat higher Hg levels. Thus temporal trends in total Hg were detected in some but not all species and areas and could be affected by changes in prey species. SC/F16/JR30 also suggested that background levels of total Hg in the western North Pacific were stable during the 1994-2014 period.

SC/F16/JR31 looked for temporal trends in PCBs for common minke whales from sub-areas 7 (period 2002-2012), 8 (period 2002-2009), 9 (period 2002-2013), off Kushiro (period 2002-2014) and off Sanriku (period 2003-2014) from the western North Pacific. Multiple regression analyses were carried out. Data included adjustment for years, longitude, latitude, date, whale body length, blubber thickness and main prey species. No significant correlations with year and food items were found. It is suggested that background levels of PCB in the western North Pacific were stable through the 2002-2014 period.

SC/F16/JR32 examined the patterns of PCB congeners, DDT isomers, HCH isomers, HCB and CHL isomers in the blubber of five mature males of each of common minke, sei and Bryde's whales taken from the western North Pacific in 2012. For comparison, those compounds were also determined in the blubber of five mature males of Antarctic minke whales taken from Antarctic Area V in 2010/11. Concentrations of PCBs were highest among organochlorines in the whales from the western North Pacific, whereas they were lower than concentrations of HCB, DDTs and CHLs in Antarctic minke whales. Principal Component Analysis showed differences of trophic level and habitat of PCB congener profiles in the whales. Over 4 chlorinated chlorobiphenyl (CB) congeners in the studied whales contributed to the difference of trophic levels, and the CB-32, 16 and 25 contributed to the geographical difference. The main component isomers from pesticide products originating in DDTs and HCHs were comparatively lower, and those originating in CHLs were not detected in the whales from the western North Pacific. These results suggest that in the western North Pacific, a great deal of time would have passed from the release of DDTs, HCHs and CHLs into the environment.

SC/F16/JR33 examined differences of total Hg concentrations in muscle and liver of J- and O-stocks of common minke whales off Sanriku. Concentrations of total Hg in muscle and liver of 35 O- and 24 J-stock immature minke whales taken in the 2012 and 2013 JARPN II surveys were measured. Multiple linear regression analyses of total Hg concentrations of the whales were carried out. These included adjustment for confounders, age index, sex, stock, blubber thickness and year. Stock had no discernible effect. These findings suggest that there is no stock-dependent difference of total Hg exposure risk for the minke whales from off Sanriku.

SC/F16/JR34 examined the pollutants status of sperm whales in the western North Pacific. Total Hg, PCBs, DDTs, HCHs, HCB and CHLs were determined in samples of sperm whales in the period 2001-2013. Mean concentrations of total Hg in muscle of sperm whales in the periods 2001-2005 and 2011-2013 were 1.9 and 1.5 (ppm wet wt.), respectively. No significant difference was observed in their total Hg levels between the two periods. Mean concentrations of PCBs, DDTs, HCHs, HCB and CHLs in blubber samples in 2012 were 1.9, 0.74, 0.040, 0.077 and 0.65 (µg/g fat wt.), respectively. Levels of total Hg in muscle samples of sperm whales in the present study were slightly lower than those from Ayukawa, Japan in 1978 and 1979, and from the southern North Sea in 1994 and 1995. Levels of organochlorines, except for CHLs, in sperm whales from the western North Pacific were similar or lower than those in sperm whales from the middle latitudes of the northern hemisphere nearby human activity. In addition, there is no evidence that levels of total Hg in muscle of sperm whales increased in the period of 1970s to 2000s.

In conclusion, year-to-year trends in Hg and PCB levels in baleen whales from the western North Pacific were not observed, suggesting that the background levels of those pollutants were stable during the 2002-2014 research period.

Results of the organochlorines isomer analyses in whale tissues showed that almost no recent inputs of DDT, HCH and CHLs have been released into the JARPNII research area.

Initially it was expected that J stock common minke whales had more exposure to contaminants than O stock whales due to their coastal distribution. However, no significant differences were found in the total Hg exposure between J and O stocks minke whales off Sanriku. However it should be noted that future analyses should include older animals to confirm this conclusion.

OBJECTIVE 2, SUB-OBJECTIVE 2: BIOACCUMULATION PROCESS OF POLLUTANTS THROUGH THE FOOD CHAIN

SC/F16/JR30 examined the yearly changes of total Hg of common minke whales from sub-areas 7, 8, 9, off Kushiro and off Sanriku, sei whales from sub-area 9 and Bryde's whales from sub-areas 8 and 9. Multiple regression analyses were carried out. Data included adjustment for confounders, sampling years, sampling longitude, latitude, sampling date, body length, blubber thickness and main prey species. No significant correlations between total Hg and sampling years were observed in almost all whales except for minke whales from sub-areas 7 and 9 and sei whales from sub-area 9. Total Hg levels in common minke whales from sub-areas 7 and 9 and sei whales from sub-area 9 were simultaneously correlated with main food items. These findings suggest that yearly changes of total Hg in common minke whales from the western North Pacific could be affected by changes of their prey species.

In conclusion, the analysis of the relationship between total Hg levels in whale tissue and main prey species in whale's stomach revealed an effect of prey species on the level of contaminant in whales. This suggested that the level of Hg in whales depended on the trophic level position of the prey species.

OBJECTIVE 2, SUB-OBJECTIVE 3: RELATIONSHIP BETWEEN CHEMICAL POLLUTANTS AND CETACEAN HEALTH

SC/F16/JR35 examined the health risk of radioisotopes (RIs) for large whales from the western North Pacific. From 11 March 2011 onward, RIs were released to the marine environment from the Nuclear Power Plant in Fukushima following an earthquake and tsunami. To assess the presence of these RIs in the large whales, the I131, Cs134 and Cs137 levels in muscle samples of 53 common minke, 16 Bryde's, 32 sei and 3 sperm whales from JARPN II surveys were measured in the period 2011-2015. I131 was detected in muscle samples of large whales, except for two common minke whales off Kushiro in 2012. Ranges of Cs134 + Cs137 concentrations in common minke, sei, Bryde's and sperm whales were ND-31, ND-9.8, ND-7.1 and ND-0.59 Bq/kg wet wt., respectively. The radioisotope levels in all whales examined have been decreasing since 2011, and were also extremely lower than the radiation safety threshold for humans. Therefore, risk of acute toxicity levels for I131, Cs134 and Cs137 would be extremely low in the large whales from the western North Pacific.

SC/F16/JR36 (Niimi *et al.*, 2014) determined hepatic concentrations of persistent organochlorines (OCs) in the common minke whale from the North Pacific. To investigate the effects of OCs on the transcriptome, the study constructed a hepatic oligo array of this species where 985 unique oligonucleotides were spotted and further analysed the relationship between the OC levels and gene expression profiles of liver tissues. The stepwise multiple linear regression analysis identified 32 genes that correlated with hepatic OC levels. The mRNA expression levels of seven cytochrome P450 (CYP) genes, CYP1A1, 1A2, 2C78, 2E1, 3A72, 4A35, and 4V6 showed no clear correlations with the concentration of each OC, suggesting that the accumulated OCs in the liver did not reach levels that could alter CYP expression. Among the genes screened by the custom oligo array analysis, hepatic mRNA expression levels of 16 genes were further measured using quantitative real-time reverse transcription polymerase chain reaction. The mRNA levels of vitamin D-binding protein (DBP) were negatively correlated with non-ortho coplanar polychlorinated biphenyl (PCB) levels. Androgen receptor-associated coregulator 70 (ARA70) expression levels showed a significant positive correlation with concentrations of non-ortho coplanar PCB169. These correlations suggest that coplanar PCB-reduced DBP expression could suppress vitamin D receptor-mediated signalling cascades in peripheral tissues. Alternatively, the suppression of vitamin D receptor signalling cascade could be enhanced through competition with the androgen receptor signalling pathway for ARA70. In addition, a negative correlation between kynureninase and PCB169 levels was also observed, which suggest an enhanced accumulation of an endogenous aryl hydrocarbon receptor agonist, kynurenine in the minke whale population.

SC/F16/JR37 (Shimizu *et al.*, 2013) examined morbillivirus infection in marine mammals. Mass die-offs caused by this infection have repeatedly occurred in bottlenose and striped dolphins, both of which belong to the family Delphinidae, but not in other cetaceans. However, it is unknown whether sensitivity to the virus varies among cetacean species. The signalling lymphocyte activation molecule (SLAM) is a receptor on host cells that allows morbillivirus invasion and propagation. Its immunoglobulin variable domain-like (V) region provides an interface for the virus hemagglutinin (H) protein. In this study, variations in the amino acid residues of the V region of 26 cetacean species, covering almost all cetacean genera, were examined. Three-dimensional (3D) models of them were generated in a homology model using the crystal structure of the marmoset SLAM and measles virus H protein complex as a template. The 3D models showed 32 amino acid residues on the interface that possibly bind the morbillivirus. Among the cetacean species studied, variations were found at six of the residues. Bottlenose and striped dolphins have substitutions at five positions (E68G, I74V, R90H, V126I, and Q130H) compared with those of baleen whales. Three residues (at positions 68, 90 and 130) were found to alternate electric charges, possibly causing changes in affinity for the virus. This study shows a new approach based on receptor structure for assessing potential vulnerability to viral infection. This method may be useful for assessing the risk of morbillivirus infection in wildlife. In conclusion, I131, Cs134 and Cs137 levels in large whales from the western North Pacific were much lower than safety threshold in humans.

Information of new biomarkers was provided, which can be used in future studies on adverse effect of OCs and vulnerability to viral infection in whales.

8.4 Panel review, conclusions and recommendations

8.4.1 Overview

The second objective of the JARPN II programme related to 'monitoring environmental pollutants in cetaceans and the marine ecosystem'. This included investigations of (a) patterns of accumulation of pollutants in cetaceans, (b) the bioaccumulation process of pollutants through the food chain and (c) the relationship between chemical pollutants and cetacean health.

Papers detailing the results of the chemical analyses and discussion of the findings in relation to this objective and their sub-objectives were provided for the panel's consideration (SC/F16/JR/30-35; Shimizu *et al.* (2013) [SC/F16/JR36]; Niimi *et al.* (2014) [SC/F16/JR37]. These papers greatly improved the previous knowledge of chemical pollutants in large cetaceans from the North Pacific waters neighbouring Japan. The studies focused primarily on mercury (Hg) and organochlorine compounds (OCs), although one study (SC/F16/JR35) examined radioactive caesium (Cs) and iodine (I) concentrations in sperm and baleen whales, a subject of particular relevance after the Fukushima accident in 2011. These papers provided new information on concentrations of these pollutants in common minke whales, sei whales, Bryde's whales and sperm whales, their spatial and temporal variation, and, in the case of Hg, their relationship to those in prey. The Panel **commends** the effort undertaken both in the field and in the laboratory. The results are valuable although, as detailed below, in a number of aspects they require improvement and adequate ecological interpretation as well as more in-depth assessment of the risk they represent to whale populations.

8.4.2 Evaluation of progress with the 2009 recommendations

Table 9

Summary of Panel's evaluation of the proponents' response to the 2009 recommendations with respect to pollutants (and see text)

Brief summary of 2009 recommendations	Panel evaluation
Papers should include a risk assessment statement.	Partly addressed.
Analyses be carried out by age when age data become available.	Partly addressed.
Examine levels in the liver to facilitate comparison with other studies.	Addressed.
Use GAMs when examining non-linear trends in the Hg levels.	Not addressed.
Carry out future studies on a lipid weight basis.	Partly addressed.
Sample for PCBs and Hg from same individuals to allow combined analyses.	Partly addressed.
Revise paper SC/J09/JR25 (accumulation of total and methyl mercury and selenium) to highlight important ecotoxicological finding.	Addressed
Examine T-Hg total body burden estimates, sampling additional organs (e.g. brain, skin, blubber).	Not addressed.
Examine T-Hg in brain to compare more coastal bycaught animals to the coastal and offshore JARPN II samples.	Not addressed.
Continue comparative molecular phylogenetic research using mRNA isolated from fresh tissues.	Addressed.
Develop a balanced, structured study design and collect all necessary data from each targeted animal; include a control or comparison group (e.g. bycaught J-stock animals).	Partly addressed.
Archive tissues for future retrospective analyses.	Addressed.
Give priority to have absolute age as an additional covariate for the interpretation of the results.	Partly addressed.
Include fatty acid profiles and stable isotope ratios in analyses.	Not addressed.
Use air and water samples in a 'fate and behaviour' study.	Addressed.
Undertake simple mass balance studies.	Not addressed.
Eventually link contaminant results to the prey consumption studies.	Partly addressed.
Undertake power analyses for relationship between sample size and ability to detect changes at various levels.	Not addressed.
Evaluate covariates (e.g. age and sex) to determine animals chosen for more extensive sampling.	Partly addressed.
Examining the same individuals for each of the contaminants is emphasised.	Not addressed*.

* Apart from for two sperm whales

The Panel **acknowledges** the progress made since the mid-term review (IWC, 2010) and the substantial work undertaken to take into account the 2009 recommendations. Of 20 recommendations or suggestions, 13 had been addressed or partly addressed and 5 had not been addressed (see Table 9). However, from a general perspective it considers that, although substantial effort has been put into the field and the laboratory work, the statistical analyses as well as the physiological and ecological interpretation of the results requires improvement.

For example, the original statistical analyses presented in some papers were clearly incorrect. The results of the linear models presented in papers SC/F16/JR/27, 30 and 31 indicated that they had been incorrectly identified and fitted, leading to coefficients that were either identical, very large with high standard errors or equal to zero; also, the categorical variables were in some cases not correctly specified. These analyses were then re-specified during the Workshop to include an intercept term and the models were re-fitted to the data during the meeting. However, the mid-term review recommendation for the use of generalized additive models to investigate non-linear patterns in the Hg data has not yet been carried out.

The 2009 Panel had also recommended presenting OC concentrations calculated on the basis of the extractable lipid content of the sample. The present Panel was pleased that the OC concentrations reported in paper SC/F16/JR/32 were given as lipid weight but noted that others (e.g. SC/F16/JR/31) still presented concentrations calculated on a fresh tissue basis, making it difficult to reconcile the total concentrations and thus to compare the findings of the temporal trends with the results from the published literature. Whilst the proponents suggested that the lipid content in the blubber of the sampled animals was broadly similar and therefore wet weight comparisons would be appropriate, it has been well demonstrated that blubber lipid content, even in cetaceans in relatively good body condition, can vary between individuals and even minor variations among individuals are likely to influence the OC results. Similarly, Hg concentrations should be more appropriately calculated on the basis of the dry weight of the sample (dry weight basis) to allow comparison with published studies in other regions.

Age is known to be a critical variable when interpreting the tissue concentrations of most OC and Hg (Aguilar *et al.*, 1999). Following one of the 2009 recommendations, SC/F16/JR33 examined Hg concentrations through a multivariate analysis that included an index of age as a covariate. However, other papers continued to use body length as a covariate. This was because difficulties in ageing whales are only recently being overcome and thus age was not available for many of the sampled individuals at the time of writing the manuscripts. This is a serious impediment for the understanding of the dynamics of pollutants in whales, and the Panel **stresses** the value of including age in all statistical analyses as soon as this becomes available for any of the existing studied individuals.

A more general 2009 recommendation had related to the integration of results. The present Panel **reiterates** this and considered that some of the results and analyses could have been combined to give a more comprehensive, overall picture. For example, the analysis of Hg levels in muscle and liver samples were reported in two separate papers. The findings from the temporal trends paper could have been combined with the findings from the minke whale O and J coastal stock comparison study into a single paper. This would have allowed the latter to be more readily and easily interpreted within the context of the former.

The patterns of accumulation of the various OC classes and the differences among the different cetacean species were explored as recommended by the 2009 Panel, but the statistical analyses carried out were limited in scope; more questions could have been answered and more potential patterns explored using more in-depth approaches. A principal component analysis was included in paper SC/F16/JR/33 but the objective for applying this particularly statistical technique (and with a limited sample size) was not clearly stated. Linear models were used to determine the important factors affecting pollutant concentrations but, as stated above, the most important confounder of age was in most cases not included.

The bioaccumulation of pollutants in the cetaceans and their food items was also considered in papers SC/F16/JR/30-34, as recommended in 2009 (IWC, 2010), but the Panel **recognises** that these studies were severely hampered by the loss of samples caused by the 2011 earthquake.

However, some central aspects of bioaccumulation were not addressed. For example, neither the effect of trophic level on OC or Hg patterns of accumulation, nor the calculation of bioconcentration factors, were reported. This could have been done through the integration into the analysis of stable isotope values, but despite the 2009 recommendation, these were not determined. Papers SC/F16/JR/30 and 31 attempted to assess temporal trends, but the statistical analyses conducted only investigated linear declines or increases in contaminants which may fail if the variation over time was not linear. Generalized additive models (GAMs) would be more adequate to address this issue.

The relationship between chemical pollutants and cetacean health was only marginally addressed. SC/F16/JR/35 did refer to the potential risk to cetacean health (e.g. an increase in risk of the development of thyroid cancer) following exposure to radioisotopes, and SC/F16/JR36 (Niimi *et al.*, 2014) reported on cytochrome P450 transcript induction in relation to the concentration of specific PCB congeners in liver samples from minke whales. However, the expectation of the 2009 Panel was that an assessment of the impact on the health of the cetaceans and their populations would be included in the Hg and OC exposure papers SC/F16/JR/30-34 as well. There are many studies and threshold estimates for the effects on cetaceans of PCBs in particular, e.g. ~20 ppm in blubber is a good 'rule of thumb' based on Kannan *et al.* (2000). However, there was little attempt to assess the risk to the populations or to discuss whether the pollutant levels were high or low in comparison to elsewhere and to the estimated thresholds for effects in cetaceans or laboratory animal models (Hall *et al.*, 2006; Schwacke *et al.*, 2002; Wells *et al.*, 2005)).

In summary, the Panel **concludes** that the proponents had addressed the objectives for the pollution studies but that many more questions could be answered using these data if the better statistical analyses and a more comprehensive physiological and ecological interpretation were conducted. Overall the findings (with the exception of the two papers published in the primary literature) were not discussed in detail or in context, particularly with reference to the many other published studies relating to the bioaccumulation and impact of PCBs and Hg on cetaceans at both the individual and population levels.

8.4.3 Recommendations

8.4.3.1 MEDIUM-TERM

The Panel has developed the following **recommendations** for the medium-term i.e. normally to be completed 2-3 years after the 2016 Annual Scientific Committee Meeting.

(1) Since body length is a poor proxy for age, particularly in sexually mature whales, age data should be incorporated into the multivariate analysis of pollutant concentrations as soon as they become available.
(2) Stable isotope values should be included in the analyses to investigate the bioaccumulation process of pollutants through the food chain.
(3) The risk that these chemical pollutants present to the populations' abundance or distribution should be more widely assessed.

8.4.3.2 SHORT-TERM

The Panel has developed the following **recommendations** for the short-term i.e. ideally to be completed in revised papers to the 2016 Annual Scientific Committee Meeting.

(1) The statistical analyses should be improved, based on clear, well formulated hypotheses.
(2) The OC concentrations now presented on a fresh weight basis should be recalculated as values on a lipid weight basis, and the Hg concentrations now on a fresh weight basis should be recalculated a those on a dry weight basis. This can be done straightforwardly through the lipid content and the dry weight of the samples, variables that are always produced during the analytical processing of the tissue.
(3) Trends in pollutant concentrations should be explored using generalised additive models (GAMs) or other non-linear approaches, in addition to the linear models.
(4) The pollutant concentrations found should be evaluated in comparison with data from previous studies conducted in comparable species and available in the literature.

9. REVIEW OF OTHER CONTRIBUTIONS TO IMPORTANT RESEARCH NEEDS

9.1 Proponents' summaries

9.1.1 Age determination

SC/F16/JR52 (Maeda *et al.*, 2013), SC/F16/JR53 and SC/F16/JR55 presented basic information on earplugs and age reading for common minke and sei whales sampled by the JARPN and JARPN II. Age reading using earplugs of common minke whales are generally believed to be difficult and impractical because of their softness and poor formation of growth layers. However, under JARPN and JARPN II surveys, all earplugs were carefully collected and tried to read growth layers. Further, in 2007, new sampling techniques (Gelatinized extraction method) was developed to prevent damage of earplugs at the collection stage (Maeda *et al.*, 2013) [SC/F16/JR52]. As a result, age readability of this species could be improved from 8.7% in the past commercial whaling to 44.1% (45.2% for male, and 41.2% for female) in the JARPN and JARPN II surveys. Inter reader calibration experiment indicated the age reading outcomes of two readers appeared similar with no substantial differences. Based on these results, earplug of common minke whales in the western North Pacific was revealed as a valid ageing tool (SC/F16/JR53). Age reading of other species such as sei whale is ongoing (SC/F16/JR55). Using these age data, further studies on life history, stocks and population dynamics of the whales will be conducted in the near future.

9.1.2 Genetics

Sasaki *et al.* (2005) determined the complete mtDNA sequences of 10 extant Mysticeti species, inferred their phylogenetic relationships, and estimated node divergence times. The analysis concurred with previous molecular studies in the ordering of the principal branches, with Balaenidae as sister to all other mysticetes base. The analysis also suggested that four lineages exist within the clade of Eschrichtiidae+Balaenopteridae, including a sister relationship between the humpback and fin whales, and a monophyletic group formed by the blue, sei, and Bryde's whales, each of which represents a newly recognized phylogenetic relationship in Mysticeti.

Nikaido *et al.* (2005) studied the phylogenetic relationships of baleen whales comprising 11 extant species based on 36 informative SINE loci. One of the intriguing conclusions was that balaenopteridae and eschrichtiids radiated very rapidly during a very short evolutionary period. During this period, speciation occurred in balaenopterids and eschrichtiids while new inserted SINE loci remain polymorphic.

Pastene *et al.* (2007) tested the hypothesis that elevated ocean-surface temperatures can facilitate allopatry among pelagic populations and thus promote speciation. This hypothesis was tested by genetic analyses of populations of Antarctic and common minke whale. The study suggested that the two species diverged in the Southern Hemisphere less than 5Ma. This estimate places the speciation event during a period of extended global warming in the Pliocene. Different populations of common minke whales likely diverged after the Pliocene some 1.5Ma when global temperatures had decreased.

Pastene *et al.* (2010) investigated population structure and possible migratory links of common minke whales in western South Atlantic and western South Pacific using mtDNA. Whales from these two oceanic basins were phylogenetically distinct, and the genetic distance between them was similar to that between North Pacific and North Atlantic common minke whales.

Glover *et al.* (2010) based upon analyses of mtDNA and microsatellites, documented the case of a single Antarctic minke whale in 1996, and a hybrid with maternal contribution from Antarctic minke whale in 2007 in the Arctic Northeast Atlantic. This was the first documentation of Antarctic minke whales north of the tropics, and, the first documentation of hybridisation between minke whale species.

Glover *et al.* (2013) investigated the genetic ancestry of a pregnant female minke whale captured in the North Atlantic in 2010, and her foetus, using data from mtDNA, microsatellite and sex determining marker. The analyses demonstrated that the mother was a hybrid displaying maternal and paternal contribution from North Atlantic common and Antarctic minke whales, respectively. Her female foetus displayed greater genetic similarity to North Atlantic common minke whales than herself, strongly suggesting that the hybrid mother had paired with a North Atlantic minke whale.

9.1.3 Physiology

Birukawa *et al.* (2008) examined kidneys of baleen and sperm whales to test the hypothesis that cetaceans have unique actions of UTs (urea transporters) to maintain fluid homeostasis in marine habitat. Two protein kinase C consensus sites are present in the baleen whale UT-A2s, however, a single protein kinase C consensus site was identified in the sperm whale UT-A2. These different phosphorylation sites of whale UT-A2s may result in the high concentrations of urinary urea in whales, by reflecting their urea permeability.

9.1.4 Reproductive biology

Bhuiyan *et al.* (2008) determined the cumulus-oocyte-complexes (COCs) recovery rates with respect to reproductive status per sei and Bryde's whales. The study indicated that *in vitro* fertilized (IVF) in sei whales is possible to achieve cleaved embryos developing to morula stage. This was the first *in vitro* embryo attempt in sei and Bryde's whales.

Hiwasa *et al.* (2009) investigated effects of three semen extenders and storage temperatures on post-thaw characteristics of Bryde's whale spermatozoa. The study showed that a synthetic semen extender, AndroMed, could be used for cryopreservation of whale spermatozoa in addition to Tris-based extenders containing bovine serum albumin or egg yolk. Storage of the post-thaw Bryde's whale spermatozoa was better at 5C than room temperature or 35C. The frozen-thawed Bryde's whale spermatozoa maintained their motility and viability for at least two days at room temperature and for four days at 5C.

Lee *et al.* (2009) examined the feasibility of using subzonal cell injection with electrofusion for interspecies somatic cell nuclear transfer (iSCNT) to produce sei whale embryos and to improve their developmental capacity by investigating the effect of osmolarity and macromolecules in the culture medium on the *in vitro* developmental capacity. The results demonstrated that sei whale-porcine hybrid embryos may be produced by SCNT using subzonal injection and electrofusion.

Bhuiyan *et al.* (2010) investigated an effective embryo reconstruction method and an effective post-activation agent for in vitro production of sei whale interspecies somatic cell nuclear transfer (iSCNT) embryos. The study concluded that bovine oocytes have the ability to support development of sei whale nuclei up to the 6-cell stage.

Suzuki *et al.* (2010) investigated whether the equilibration steps (three or five steps), whale follicular fluid (WFF) addition and type of sugars (sucrose or trehalose) were effective for the viability and in vitro maturation (IVM) of vitrified immature oocytes in sei, Bryde's and common minke whales. The tested step number of cryoprotectan equilibration, WFF addition and type of sugars did not improve the maturation rate of vitrified baleen whale oocytes. However, the study showed that immature oocytes derived from three baleen whale species in the western North Pacific could be vitrified and matured *in vitro* at about 30% levels.

Inoue *et al.* (2014) examined seasonal changes in the testis of the common minke whale in the North Pacific from April to October. Results suggested that the spermatogenetic activity of the common minke whale has seasonal changes, namely, it reduce from May to June and is activated in August in preparation for the next breeding season.

Kitayama *et al.* (2015) examined the structure and function of placentas in common minke, Bryde's and sei whales with the aim of confirming the structural characteristics of the chorion, including the presence of the areolar part, and clarifying steroidogenic activities and foetomaternal interactions in the placentas of these whales. The study suggested that, in cetaceans, uteroferrin is used to supply iron to the foetus, and that trophoblast cells synthesize oestrogen in whale placentas. The study immunohistochemically revealed the localization of aromatase and uteroferrin in cetacean placentas during pregnancy for the first time.

9.1.5 Morphology

Nakamura *et al.* (2012) investigated the allometric growth pattern of common minke whales from the North Pacific by comparing skull length and skull width with body length. The skull proportion of large Balaenoptera whales (blue and fin whales) showed positive allometry, but that of the common minke whale showed negative allometry, despite being a related species. Such differences in intraspecific growth patterns could be the result of adaptation driven by feeding strategy.

9.2 Panel conclusions and recommendations

The Panel **welcomes** the provision of the information on additional studies undertaken in addition to those envisioned by the original objectives of the programme. This is in accord with the recommendations of previous Panels that every effort be made to maximise the information obtained from whales that are caught.

The Panel was particularly impressed by the work undertaken to improve ageing techniques for baleen whales. In particular it commended the progress in the development of the gelatinized extraction method and **encourages** its continued development. Age is a critical variable for many of the aspects of the JARPN II programme. In the case of the common minke whale, the low readability of earplugs, which is considered the most reliable source of absolute age determination in baleen whales at present, was a difficulty that now appears to have been in part overcome. Thus, with the new technique, the readability of earplugs increased from a previous 8.7% of individuals sampled to 44.1%. The Panel **recommends** investigation into whether there is any relationship between age or sex and readability that may affect the representativeness of the earplugs that can be read.

The addition of absolute age data has great potential to improve analyses relevant to all three of the primary objectives. The Panel **encourages** the proponents to age as many of the existing samples as possible and to incorporate age where appropriate in updated analyses (e.g. see the recommendations on pollutant studies, Item 8.4.3).

10. INTEGRATION OF RESULTS

10.1 Proponents' summary

Previous review workshops of JARPNII and JARPAII have recommended integration among the research components of these whale research programs. Such integration is important to respond appropriately the scientific questions raised in the programs as well to identify research needs for the future. Two kinds of integrative analyses were identified in JARPNII: i) analyses integrating similar data from different sources, and ii) analyses integrating different study fields/data on a particular research topic (these study/data can be from the same or from different sources).

The proponents identified a total 26 integrative analyses of the two kinds, with most of them already achieved in JARPNII. These integrations were important to respond a total of 17 scientific questions related to the main three research objectives of JARPNII. Examples are shown below.

One example of the first kind (i) was the integration of the same DNA data from different sources (e.g. DNA from Korean and Japanese by-catches, JARPN and JARPNII) in the case of the common minke whale. Such integration allowed the genetic analyses on stock structure to be conducted in a much large temporal and geographical scales. One example of the second kind (ii) was the integration of different analytical approaches (e.g. genetics, morphometric, discriminant analysis of principal components, age distribution, geographical distribution of relatives) to examine stock structure in the case of the common minke whale. Such integration allowed the postulation of hypotheses on stock structure with larger plausibility. Both integrations, summed to appropriate responses to previous recommendations, allowed the attainment of sub-objectives related to common minke whale within main objective 3.

Another example of the second kind (ii) was the ecosystem modelling exercise which integrated abundance information of whales, prey consumption by whales, oceanographic data and biomass of prey. Such integration, together with appropriate responses to previous recommendations, allowed a substantial improvement in the models. They would serve as baseline models to test various types of marine ecosystem management options.

10.2 Panel comments and conclusions

The Panel recognised at least three levels of integration:

(1) Within sub-objectives;

(2) Within objectives; and

(3) Amongst the JARPN II objectives as a whole.

The Panel **agreed** that the proponents had attempted to undertake some integration within (1) and (2) but that there was relatively little integration at stage (3) – either using JARPN II data alone or using additional data and information from other sources. For example, under (1) within the stock structure sub-objectives for common minke whales, the proponents had undertaken analyses using genetic data of various kinds (including genetic data from Korea outside the JARPNII samples and morphological data and in some cases age data and limited telemetry data) and additional analyses were proposed. The proponents had also undertaken spatial modelling using additional exploratory variables collected outside as well as within JARPN II to improve the limited analyses from 2009; again further work has been recommended on this.

Under level (2), the feeding ecology work had begun to incorporate information from a variety of sources within and outside the JARPN II programme including abundance of prey and cetaceans, oceanography in addition to the information on prey consumption, selectivity and diet. However, the pollution component had only integrated across sub-objectives in a limited way and several of the Panel's recommendations are focussed on improving this aspect of the work.

There has been relatively little work that integrates amongst the JARPN II objectives and the most obvious areas might be to incorporate the stock structure hypotheses into the ecosystem modelling work.

Finally, the Panel **agrees** that there is a general lack of integration amongst the papers addressing the same topic – this made it difficult for the Panel to evaluate many aspect of the programme including the level of integration. This is considered further under Item 11.1.2.

11. PANEL CONCLUSIONS WITH RESPECT TO ANNEX P

11.1 General issues

Before considering the specific items of the review outlined in Annex P, the Panel draws attention to a number of important general matters that have affected its review.

11.1.1 Timing

As explained in SC/F16/JR54, the closing of the JARPN II programme reflected a political decision related to the Government of Japan's response to the International Court of Justice decision regarding JARPA II, rather than a scientific evaluation that the JARPN II programme had attained its objectives or sub-objectives. In fact, this 'final review' of JARPN II is occurring before the formal completion of the programme in 2016, although the sample sizes and priorities for the period 2014-16 were revised by the Government of Japan (SC/F16/JR54).

Annex P envisions final reviews taking place within three years of the finish of a programme to reflect the fact that sufficient time needs to be given to the proponents to develop a comprehensive and integrated final report. It is clear from the discussion and recommendations above that despite the hard work of the scientists, resulting in a large number of working papers, that the analyses would have benefitted from considerably more time. Similarly, more time would have enabled the scientists to produce an integrated final report. The Panel **recommends** that the Scientific Committee considers including a guideline in Annex P either relating to the minimum time after completion of a programme that a final review can take place or establishing a small review group to determine whether the materials presented for a final review are in a sufficient state for a workshop to take place (this may also be worth considering for new and periodic reviews).

In addition, the fact that (a) the programme was completed early for political rather than scientific reasons and (b) there were no formal intermediate targets by timeline, meant that it was difficult for the Panel to properly assess the results of the programme against the original objectives.

11.1.2 The nature of 'final reports'

Annex P does not provide guidelines for the scope and structure of final reports. However, the Panel's experience in undertaking this review shows that formal guidance is necessary. The Panel **recommends** that Annex P should be revised to include such guidelines and offers the following comments to assist in that process.

The Panel's task was made considerably more difficult because the methods, analyses and conclusions were found within a very large number of documents of varying levels of completeness and quality. The Panel also noted that some documents (e.g. SC/F16/JR54 and part of section 4.3 of SC/F16/JR1) included information or discussion beyond the terms of reference for this final scientific review. Although the proponents produced a good brief overall summary document (SC/F06/JR1), it contained insufficient detail to allow a proper review and details of sampling design, strategy, field protocols, analytical methods and conclusions. For this, the Panel members had not only to examine over 90 working papers and documents, but also references to other unpublished sources (e.g. IWC papers) over the JARPN II period. This lack of integration, at least by objective, appears to be a function of the timing of the review (see Item 11.1.1) but it is not an efficient way to work and can make it rather difficult for the Panel (and especially members from outside the IWC system) to conduct a thorough review. A suggested outline for an integrated final report (and associated materials) is provided as Annex G.

11.1.3 Lethal and non-lethal techniques

Although formally outside the scope of this review whose focus is on the period up to 2013, as discussed under Item 3.4, Japan has modified and reprioritised the JARPN II programme until it is officially completed in 2016. One aspect of this relates to the addition of an objective to compare lethal and non-lethal techniques was in line with the recommendation from the 2009. This topic is central to many issues raised in Annex P for reviews of new and ongoing permits and the difficulties in addressing the issue have been raised by all of the expert Panels thus far. In this light, the Panel highlights the second part of the recommendation given under Item 3.4.2.2 that the proponents provide a single document to the 2016 Annual Meeting that provides the field and analytical protocols for the comparison of using lethal and non-lethal techniques for each key parameter taking into account the advice provided in 2009.

11.1.4 Review of progress of recommendations

As illustrated above, one important component of this review was an examination of the response of proponents to the recommendations of the 2009 review. In addition, the Panel also notes that the 2009 Panel had stated that given the extra work it had requested of the proponents on certain key matters (including with respect to assessing the effects of catches on some of the stocks) it had not been able to complete its review. The 2009 Panel had requested the Scientific Committee to consider '*the most appropriate way that this review is completed*'.

The Panel **recognises** that the Scientific Committee has agreed that it is not necessary to review in detail the results of ongoing permits every year. However, it believes that the regular and final reviews (and potentially reviews of new permit proposals) would be facilitated by a short (just a paragraph or two) biennial update by proponents as to progress with each of the recommendations after their initial response in the Annual Meeting following the review Workshop; this should also benefit the proponents' work.

The Panel **recommends** that the Scientific Committee should consider a mechanism (e.g. revision to Annex P) to provide for such a brief annual review of progress with recommendations. It also **reiterates** the request of the 2009 Panel that the Scientific Committee develops a mechanism to allow for the completion of expert Panel reviews if a Panel states that its review is incomplete until further information/analyses is provided.

11.2 Assessment of the programme's scientific output given the stated objectives and length of the programme
The Panel refers to its earlier comments regarding the timing of the final review and the reasons for the timing of the close of the programme; this also affects to some extent its ability to assess the programme's scientific output given the stated objectives and length of the programme. As shown in Annex H, the JARPN II programme thus far has resulted in 31 published papers related to the primary objectives of the programme and another 30 published papers that arose from additional studies not related to the primary objectives. In addition, the JARPN II programme has resulted in a large number of papers to the IWC Scientific Committee that made important contributions to the work on RMP *Implementations* and in-depth assessments. It is clear from the review that (a) considerable scientific work has been undertaken and that the output has been accepted in peer-reviewed journals and has influenced the work of the IWC Scientific Committee but also that (b) a much greater emphasis should have been put on improved analyses and modelling – that would increase considerably the value of the scientific output of the existing data collected. The Panel therefore **strongly encourages** the proponents to follow the recommendations provided in this report and submit further work to peer-reviewed scientific journals.

11.3 Consideration of the level of co-ordination with other relevant research projects
The Panel **welcomes** the much-improved collaboration with other research projects compared to that in 2009. It noted that most of that co-operation occurred within Japanese institutes (academic and governmental). This is perhaps not surprising for the coastal components which are within Japanese waters but it **encourages** additional co-operation with scientists from other research projects that address similar issues but for other regions with respect to any further analyses that are to be undertaken.

11.4 Evaluation of how well the stated objectives have been met and the extent to which the results have improved conservation and management
11.3.1 Evaluation by the most recent sub-objectives
The Panels' view of how well the recently developed sub-objectives have been met is given in Table 10. The overall Panel evaluation of the work presented against the original objectives, and comments on the extent to which the work has contributed to conservation and management is provided in the text below (Item 11.3.2) by objective.

Table 10 (continued on next page)

Overview of how well the proponents have met their stated sub-objectives within the overall objectives of JARPN II

Objective/Sub-objective	Panel evaluation	Comments
Objective 1: Feeding ecology and ecosystem studies		
Sub-objective 1.1: Investigate the oceanographic conditions that are relevant for the understanding of prey species' distribution and abundance in the research area.	Partial	Although some work has been done, additional work is needed to investigate more appropriate explanatory variables (see Item 5.4).
Sub-objective 1.2: To investigate the distribution pattern of baleen whales in the research area and the possible factors affecting such pattern.	Good	Good progress has been made with this sub-objective in what is a developing field of spatial and habitat modelling. However, more work is required to try to integrate the information from different seasons and other surveys within and outside the research area (see Item 5.4.2).
Sub-objective 1.3: To estimate abundance of baleen and sperm whales using JARPN II sighting data and standard IWC SC methodology.	Very good	Abundance estimates were presented using design-based methods. Effort now needs to be put into exploring methods for determining trends and comparison with model-based estimates.
Sub-objective 1.4: To estimate the prey consumption by baleen whales using JARPN II data and samples, and taking into account the uncertainties identified at the 2009 JARPN II review.	Good	Good progress was made with incorporating many aspects of the uncertainty identified in 2009, although some additional sources were identified (see Table 6) and improved methods to quantify the uncertainty have been recommended (see Item 6.4.2). The potential impact of sampling design requires evaluation (see Item 3.4).

Objective/Sub-objective	Panel evaluation	Comments
Sub-objective 1.5: To evaluate the feeding impact by whales on fisheries resources using JARPN II data and samples, and information from commercial fisheries and other research sources in coastal areas.	Progress made	Some progress has been made but the problems with model development (see sub-objective 1.10 in this table) and aspects of uncertainty mean that the proponents are not able to identify the feeding impact by whales in a robust way (see Item 6.4.2).
Sub-objective 1.6: To estimate prey abundance using JARPN II data, complemented with information available from other sources.	Sufficient	This work has been achieved, at least to inform initial modelling efforts. Additional work to estimate the uncertainty of extrapolating prey abundance outside the surveyed blocks/seasons would be useful (see Item 6.4).
Sub-objective 1.7: To investigate the prey preference of whales in offshore areas, using JARPN II data and samples.	Progress made	Prey preference studies have been undertaken based upon stomach content data and prey abundance information but further work is required to address issues of seasonality, uncertainty and sample design.
Sub-objective 1.8: To investigate feeding habits of baleen and toothed whale species in the research area, and the environmental factors involved in determining such habits.	Progress made	Some work was completed on trends in prey by species and feeding differences by habitat but additional analyses are required before firm conclusions can be reached. Work began using time depth recorders but sample size is small.
Sub-objective 1.9: To investigate the yearly trend in body condition of baleen whales using JARPN II data and samples.	Partial	In addition to the need analyse to further examine power, the question of sampling design also needs to be addressed.
Sub-objective 1.10: To develop several ecosystem models, in both coastal and offshore areas, using JARPN II data and samples as input. Output of the models are likely to provide information on i) the ecosystem structure, ii) effects of prey availability and consumption on the population dynamics of common minke and sei whales with consideration of levels of energy intakes, iii) predation impacts of common minke whales consumption on sandlance stock off Sanriku.	Progress made	Although progress has been made in some areas, insufficient resources have been allocated to this component of the programme. Although two models have been developed they are preliminary and a planned minimum realistic model is not complete. As such the modelling efforts are not suitable to provide management advice or characterize effects of prey on whale dynamics or impacts of whales on fisheries (see Item 7.4).
Objective 2: Monitoring environmental pollutants in cetaceans and the marine ecosystem		
Sub-objective 2.1: To investigate pattern of accumulation of pollutants in cetaceans and their food items.	Partial	Aspects of this issue have been addressed and the Panel recognized the difficulties caused by the loss of samples in the tsunami. However, some central aspects were not addressed or analyses were incomplete as discussed under Item 8.4.
Sub-objective 2.2: To investigate the bioaccumulation process of pollutants through the food chain.	Not achieved	This was not properly addressed and would require *inter alia* integration with stable isotope analyses (see Item 8.4).
Sub-objective 2.3: To investigate the relationship between chemical pollutants and cetacean health.	Partial	Some work was presented (e.g. regarding thyroid cancer and CYP450 induction) but there was little attempt to use comparative studies and consider possible population level effects.
Objective 3: Stock structure of large whales		
Sub-objective 3.1: Monitoring of the spatial and temporal distribution of J stock on both west and east coasts of Japan using genetics and non-genetics approaches, and all sources of samples available e.g. JARPN, JARPN II and by-catches.	Good	This work was thorough and contributed to the RMP *Implementation Review.*
Sub-objective 3.2: Using genetic and non-genetic data from JARPN and JARPNII, investigate whether or not the sub-division of the O stock into OW and OE is plausible. The genetic analysis should include those approaches mentioned in Table 1 as providing support for the existence of the OW (e.g. PCA analyses).	Good	This work was thorough and contributed to the RMP *Implementation Review.*
Sub-objective 3.3: To investigate the plausibility of (i) stock sub-division within Sub-area 1 as proposed under Hypothesis 4 and (ii) sub-division between Sub-areas 1 and 2 as proposed under Hypotheses 2 and 3, using all genetic samples available from different source till 2014, and different genetic markers included satellite tracking.	Partial	This work will contribute to the forthcoming RMP *Implementation Review* but additional analyses are recommended to assist in understanding the power of the results obtained and the telemetry programme, whilst showing that it is possible, has as yet only a very small sample size (2).
Sub-objective 3.4: To investigate the plausibility of a single stock of sei whale in the pelagic regions of the North Pacific ('North Pacific pelagic'), using all genetic samples available from different sources till 2014, and different genetic markers.	Partial	This work will contribute to the forthcoming in-depth assessment but additional analyses are recommended to assist in understanding the power of the results obtained, although it is recognised that past experience may show that the power is low.

11.3.2 Evaluation by original objectives with comments on contributions to conservation and management

The effect of the conclusion of the programme for political reasons on the ability to meet objectives was discussed under Item 11.1. The 2009 Panel had 'severely questioned' the scientific value of the sperm whale component of the programme (IWC, 2010, p.433) for reasons of sample size; the present Panel **agrees** that the sperm whale component of JARPN II has produced little of scientific value as expected.

OBJECTIVE 1: FEEDING ECOLOGY AND ECOSYSTEM STUDIES

The ultimate goal of this objective was to provide multispecies management advice. As noted by the 2009 Panel, this was an extremely ambitious task and one likely to take many years. The level of field and laboratory work has been impressive and the examination of uncertainty with respect to the prey consumption and prey preferences has been greatly improved since 2009 although analytical improvements can still be made. However, the question of the effects of sampling design (see Item 3.4.2) requires further consideration and, primarily as a result of a lack of allocated resources (despite the 2009 Panel recommendation), the modelling work remains preliminary.

Even allowing for the complexity of the issue, there are examples of MRM/MICE[5] models that that can be parameterised by fitting to data which are used to provide input to tactical assessment models and there are better developed food web and extended single species models; with additional resources, progress could (and should) have been made in the development of intermediate model types. The Panel **concludes** that at this stage of development, the modelling results are not suitable for addressing strategic management questions[6]. At present, at least, the results have not led to improved conservation and management of cetaceans or of other marine living resources or the ecosystem.

OBJECTIVE 2: MONITORING ENVIRONMENTAL POLLUTANTS IN CETACEANS AND THE MARINE ECOSYSTEM

This objective related to monitoring pollutants in the environment and cetaceans including (a) pattern of accumulation in cetaceans; (b) bioaccumulation through the food chain and (c) the relationship between pollutants and cetacean health. The Panel notes that the achievement of this objective was hampered considerably by the loss of samples as a result of the tsunami. It also acknowledges the efforts made to follow the recommendations of the 2009 Panel. The level of field and laboratory work has been good and understanding of chemical pollutants and cetaceans off Japan has been greatly improved. However, the Panel **concludes** that only partial progress has been made towards addressing the objectives and more effort needs to be put on improved analyses and interpretation of results (see discussion and recommendations under Item 8.4). This is especially true in terms of the relationship of pollutants and cetacean health, which is most relevant to improved conservation and management of cetaceans. It is not clear from the papers presented if (and if so how) the work undertaken has contributed to the conservation of other marine resources or the ecosystem.

OBJECTIVE 3: STOCK STRUCTURE OF LARGE WHALES

The broad objectives simply related to the stock structure of large whales (common minke whales, sei whales, Bryde's whales and sperm whales), although this was clarified at the 2009 Panel workshop to be primarily related to developing or narrowing the number of hypotheses to be considered by the IWC Scientific Committee in its work related to the RMP and in-depth assessments. The level of field, laboratory and analytical work has been impressive, as was the effort put into responding to the 2009 Panel recommendations. The Panel did make some recommendations for improved analyses, particularly related to power and the ability to distinguish amongst weakly-differentiated populations. The Panel **concludes** that the stock structure component of JARPN II has made, and will continue to make, important contributions to the conservation and management of cetaceans by providing fundamental data and analyses for the RMP *Implementation Reviews* of common minke whales and Bryde's whales, and the in-depth assessment of sei whales.

12. ADOPTION OF REPORT

The report was adopted by email on 11 March 2016. The Chair thanked all members of the Panel for their patience, tireless dedication, and for having served the Scientific Committee with their undoubted competence. She was grateful to them for having donated their time to this activity, which is not a trivial matter, and for having allowed a scientific and friendly discussion during the entire process (open and closed sessions, and email exchanges at impossible hours). The Chair also thanked the Proponents for their kindness and logistical support.

REFERENCES

Aguilar, A., Borrell, A. and Pastor, T. 1999. Biological factors affecting variability of persistent pollutant levels in cetaceans. *Journal of Cetacean Research and Management (special issue)* 1: 83-116.

Aguilar, A., Guimenez, J., Gomez-Campos, E., Cardona, L. and Borrell, A. 2014. $\delta^{15}N$ Value does not reflect fasting in mysticetus. *PLoS ONE* 9(3): e92288. doi:10.1371/journal.pone.0092288.

Bhuiyan, M.M.U., Suzuki, N., Watanabe, H., Matsuoka, K., Fujise, Y., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2008. Attempts at *in vitro* fertilization and culture of *in vitro* matured oocytes in sei (*Balaenoptera borealis*) and Bryde's (*B. edeni*) whales. *Zygote* 17: 19-28.

Bhuiyan, M.M.U., Suzuki, Y., Watanabe, H., Lee, E., Hirayama, H., Matsuoka, K., Fujise, Y., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2010. Production of sei whale (*Balaenoptera borealis*) cloned embryos by inter- and intra-species somatic cell nuclear transfer. *Journal of Reproduction and Development* 56(1): 131-39.

Birukawa, N., Ando, H., Goto, M., Kanda, N., Pastene, L.A. and Urano, A. 2008. Molecular cloning of urea transporters from the kidneys of baleen and toothed whales. *Comparative Biochemistry and Physiology B* 149: 227-35.

Bogstad, B., Gjøsæter, H., Haug, T. and Lindstrøm, U. 2015. A review of the battle for food in the Barents Sea: Cod vs. marine mammals. *Frontiers in Ecology and Evolution - Interdisciplinary Climate Studies* 3(29): DOI: 10.3389/fevo.2015.00029.

[5] Minimum Realistic Models/ Models of Intermediate Complexity for Ecosystem Assessment

[6] Ecosystem models such as Ecopath with Ecosim, Atlantis, and other large complex models which are difficult to parameterize by fitting to data are not suitable for tactical management anywhere in the world at present and probably far into the future. Single species models with predation and multispecies (MICE) models could be used to provide tactical advice in the future.

Browning, N.E., Dold, C., Jack, I.F. and Worthy, G.A. 2014. Isotope turnover rates and diet-tissue discrimination in skin of *ex situ* bottlenose dolphins (*Tursiops truncatus*). *Journal of Experimental Biology* 217(2): 214-21.
Elshire, R.J., Glaubitz, J.C., Sun, Q., Poland , J.A., Kawamoto, K., Buckler, E.S. and Mitchell, S.E. 2011. A robust, simple genotyping-by-sequencing (GBS) approach for high diversity species. *PLOS ONE* 6.
Gaichas, S., Aydin, K. and Francis, R.C. 2015. Wasp waist or beer belly? Modeling food web structure and energetic control in Alaskan marine ecosystems, with implications for fishing and environmental forcing. *Progress in Oceanography* 138: 1-17.
Gaichas, S.K., Aydin, K. and Francis, R.C. 2011. What drives dynamics in the Gulf of Alaska? Integrating hypotheses of species, fishing, and climate relationships using ecosystem modelling. *Canadian Journal of Fisheries and Aquatic Sciences* 68: 1,553-78.
Gavrilchuk, K., Lesage, V., Ramp, C., Sears, R., Bérubé, M., Bearhop, S. and Beauplet, G. 2014. Trophic niche partitioning among sympatric baleen whale species following the collapse of groundfish stocks in the Northwest Atlantic. *Marine Ecology Progress Series* 497: 285-301.
Giménez, J., Ramírez, F., Almunia, J., Forero, M.G. and de Stephanis, R. 2016. From the pool to the sea: Applicable isotope turnover rates and diet to skin discrimination factors for bottlenose dolphins (*Tursiops truncatus*). *Journal of Experimental Marine Biology and Ecology* 475: 54-61.
Glover, K.A., Kanda, N., Haug, T., Pastene, L.A., Oien, N., Goto, M., Seliussen, B.B. and Skaug, H.J. 2010. Migration of Antarctic minke whales to the Arctic. *PLoS ONE* 5(12).
Glover, K.A., Kanda, N., Haug, T., Pastene, L.A., Øien, N., Seliussen, B.B., Sørvik, A.G.E. and Skaug, H.J. 2013. Hybrids between common and Antarctic minke whales are fertile and can back-cross. *BMC Genetics* 14: 25.
Government of Japan. 2000. Research plan for cetacean studies in the western North Pacific under special permit (JARPN II) (feasibility study plan for 2000 and 2001). Paper SC/47/SH3 presented to the IWC Scientific Committee, May 1995 (unpublished). 9pp. [Paper available from the Office of this Journal].
Hall, A.H., McConnell, B.J., Rowles, T.K., Aguilar, A., Borrell, A., Schwacke, L., Reijnders, P.J.H. and Wells, R.S. 2006. An individual based model framework to assess population consequences of polychlorinated biphenyl exposure in bottlenose dolphins. *Environmental Health Perspectives* 114 (Suppl 1): 60-64.
Hey, J. 2010. Isolation with migration models for more than two populations. *Molecular Biology and Evolution* 27: 905-20.
Hey, J. and Machado, C.A. 2003. The study of structured populations - new hope for a difficult and divided science. *Nature Reviews Genetics* 4: 535-43.
Hiwasa, M., Suzuki, Y., Watanabe, H., Bhuiyan, M.M.U., Matsuoka, K., Fujise, Y., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2009. Effects of semen extenders and storage temperatures on characteristics of frozen-thawed Bryde's (*Balaenoptera edeni*) whale spermatozoa. *Journal of Reproduction and Development* 55(6): 599-606.
Inoue, S., Kishiro, T., Fujise, Y., Nakamura, G. and Kato, H. 2014. Seasonal changes in the testis of the North Pacific common minke whale. *Nippon Suisan Gakkaishi* 80(2): 185-90.
International Whaling Commission. 2001a. Report of the Scientific Committee. *Journal of Cetacean Research and Management (Supplement)* 3:1-76.
International Whaling Commission. 2001b. Report of the Workshop to Review the Japanese Whale Research Programme under Special Permit for North Pacific Minke Whales (JARPN), Tokyo, 7-10 February 2000. *Journal of Cetacean Research and Management (Supplement)* 3:375-413.
International Whaling Commission. 2003. Report of the Scientific Committee. *Journal of Cetacean Research and Management (Supplement)* 5:1-92.
International Whaling Commission. 2007a. Report of the Scientific Committee. *Journal of Cetacean Research and Management (Supplement)* 9:1-73.
International Whaling Commission. 2007b. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *Journal of Cetacean Research and Management (Supplement)* 9:88-128.
International Whaling Commission. 2008. Report of the Scientific Committee. *Journal of Cetacean Research and Management (Supplement)* 10:1-74.
International Whaling Commission. 2009. Report of the Scientific Committee. *Journal of Cetacean Research and Management (Supplement)* 11:1-74.
International Whaling Commission. 2010. Report of the Expert Workshop to Review the Ongoing JARPN II Programme, 26-30 January 2009, Yokohama, Japan. *J. Cetacean Res. Manage. (Suppl.)* 11(2):405-50.
International Whaling Commission. 2013. Report of the Scientific Committee. Annex D1. Report of the Working Group on the *Implementation Review* for Western North Pacific Common Minke Whales. *J. Cetacean Res. Manage. (Suppl.)* 14:118-36.
International Whaling Commission. 2014. Report of the Scientific Committee. Annex D1. Report of the Working Group on the *Implementation Review* for Western North Pacific Common Minke Whales. *J. Cetacean Res. Manage. (Suppl.)* 15:112-88.
International Whaling Commission. 2015a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 16:1-87.
International Whaling Commission. 2015b. Report of the Scientific Committee. Annex G. Report of the Sub-Committee on In-Depth Assessments. *J. Cetacean Res. Manage. (Suppl.)* 16:176-95.
International Whaling Commission. 2016. Report of the Scientific Committee. Annex P. Process for the Review of Special Permit Proposals and Research Results from Existing and Completed Permits as Modified at SC/66a in Light of Resolution 2014-5. *J. Cetacean Res. Manage. (Suppl.)* 17:409-14.
Kanda, N., Bando, T., Matsuoka, K., Murase, H., Kishiro, T., Pastene, L.A. and Ohsumi, S. 2015. A review of the genetic and non-genetic information provides support for a hypothesis of a single stock of sei whales in the North Pacific. Paper SC/66a/IA09 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 18pp. [Paper available from the Office of this Journal].
Kanda, N., Goto, M., Kishiro, T., Yoshida, H., Kato, H. and Pastene, L.A. 2009. Update of the analyses on individual identification and mixing of the J and O stocks of common mike whales around Japanese waters examined by microsatellite analysis. Paper SC/61/JR5 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 14pp. [Paper available from the Office of this Journal].
Kanda, N., Goto, M., Oikawa, H. and Pastene, L.A. 2014a. Note on sampling and laboratory procedure protocols of the genetic work at the Institute of Cetacean Research. Paper SC/F14/J27 presented to the JARPA II Special Permit Expert Panel Review Workshop, 24-28 February 2014, Tokyo, Japan (unpublished). 4pp. [Paper available from the Office of this Journal].
Kanda, N., Goto, M., Oikawa, H. and Pastene, L.A. 2014b. Update of note on sampling and laboratory procedure protocols of the genetic work at the Institute of Cetacean Research (SC/65b/J27rev). Paper SC/65b/DNA01 presented to the IWC Scientific Committee, May 2014, Bled, Slovenia (unpublished). 6pp. [Paper available from the Office of this Journal].
Kanda, N., Goto, M. and Pastene, L. 2006. Genetic characteristics of western north Pacific sei whales, *Balaenoptera borealis*, as revealed by microsatellites. *Marine Biotechnology* 8: 86-93.
Kanda, N., Park, J.-Y., Goto, M., An, Y.-R., Choi, S.-G., Moon, D.-Y., Kishiro, T., Yoshida, H., Kato, H. and Pastene, L.A. 2010. Genetic analyses of western North Pacific minke whales from Korea and Japan based on microsatellite DNA. Paper SC/62/NPM11 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 13pp. [Paper available from the Office of this Journal].
Kannan, K., Blankenship, A.L., Jones, P.D. and Giesy, J.P. 2000. Toxicity reference values for the toxic effects of polychlorinated biphenyls to aquatic mammals. *Human and Ecological Risk Assessment* 6(1): 181-201.
Kishiro, T. and Miyashita, T. 2011. Satellite tracking of a common minke whale in the coastal waters off Hokkaido, northern Japan in 2010. Paper SC/63/RMP10 presented to the IWC Scientific Committee, June 2011, Tromsø, Norway (unpublished). 10pp. [Paper available from the Office of this Journal].
Kitayama, C., Sasaki, M., Ishikawa, H., Mogoe, T., Ohsumi, S., Fukui, Y., Budipitojo, T., Kondoh, D. and Kitamura, N. 2015. Structure and functions of the placenta in common minke (*Balaenoptera acutorostrata*) Bryde's (*B. Brydei*) and sei (*B. Borealis*) whales. *Journal of Reproduction and Development* 61(5): 415-21.

Lee, E., Bhuiyan, M.M.U., Watanabe, H., Matsuoka, K., Fujise, Y., Ishikawa, H. and Fukui, Y. 2009. Production of cloned sei whale (*Balaenoptera borealis*) embryos by interspecies somatic cell nuclear transfer using enucleated pig oocytes. *Journal of Veterinary Science* 10(4): 285-92.

Link, J.S. 2010. Adding rigor to ecological network models by evaluating a set of pre-balance diagnostics: A plea for PREBAL. *Ecol. Model.* 221: 1582-93.

Maeda, H., Kawamoto, T. and Kato, H. 2013. A study on the improvement of age estimation in common minke whales using the method of gelatinized extraction of earplug. *NAMMCO Scientific Publications* DOI: http://dx.doi.org/10.7557/3.2609. [Published paper].

Masaki, Y. 1976. Biological studies on the North Pacific sei whale. *Bulletin of the Far Seas Fisheries Research Laboratory* 14: 1-104.

Miller, M.R., Dunham, J.P., Amores, A., Cresko, W.A. and Johnson, E.A. 2007. Rapid and cost-effective polymorphism identification and genetyping usinf restriction site associated DNA (RAD) markers. *Genome Research* 17: 240-48.

Mizroch, S.A., Conn, P.B. and Rice, D.W. 2015. The mysterious sei whale: its distribution, movements and population decline in the North Pacific revealed by whaling data and recoveries of Discovery-type marks. Paper SC/66a/IA14 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 113pp. [Paper available from the Office of this Journal].

Murase, H., Hakamada, T., Matsuoka, K., Nishiwaki, S., Inagake, D., Okazaki, M., Tojo, N. and Kitakado, T. 2014. Distribution of sei whales (*Balaenoptera borealis*) in the subarctic-subtropical transition area of the western North Pacific in relation to oceanic fronts. *Deep Sea Research Part II* 107: 22-28. [Published paper].

Murase, H., Kawabata, A., Kubota, H., Nakagami, M., Amakasu, K., Abe, K., Miyashita, K. and Oozeki, Y. 2012. Basin-scale distribution pattern and biomass estimation of Japanese anchovy *Engraulis japonica* in the western North Pacific. *Fisheries Science* 78: 761-73. [Published paper].

Murase, H., Tamura, T., Kiwada, H., Fujise, Y., Watanabe, H., Ohizumi, H., Yonezaki, S., Okamura, H. and Kawahara, S. 2007. Prey selection of common minke (*Balaenoptera acutorostrata*) and Bryde's (*Balaenoptera edeni*) whales in the western North Pacific in 2000 and 2001. *Fisheries Oceanography* 16(2): 186-201.

Murase, H., Tamura, T., Otani, S. and Nishiwaki, S. 2016. Satellite tracking of Bryde's whales *Balaenoptera edeni* in the offshore western North Pacific in summer 2006 and 2008. *Fisheries Science* DOI 10.1007/s12562-015-0946-8. [Published paper].

Nakamura, G., Kato, H. and Fujise, Y. 2012. Relative growth of the skull of the common minke whale *Balaenoptera acutorostrata* from the North Pacific in comparison to other *Balaenoptera* species. *Mammal Study* 37: 105-12.

Niimi, S., Imoto, M., Kunisue, T., Watanabe, M.X., Kim, E.Y., Nakayama, K., Yasunaga, G., Fujise, Y., Tanabe, S. and Iwata, H. 2014. Effects of persistent organochlorine exposure on the liver transcriptome of the common minke whale (*Balaenoptera acutorostrata*) from the North Pacific. *Ecotoxicology and Environmental Safety* 108: 95-105. [Published paper].

Nikaido, M., Hamilton, H., Makino, H., Sasaki, T., Takahashi, K., Goto, M., Kanda, N., Pastene, L.A. and Okada, N. 2005. Baleen Whale Phylogeny and a Past Extensive Radiation Event Revealed by SINE Insertion Analysis. *Proceedings of the SMBE Tri-National Young Investigators' Workshop 2005*: 9pp.

The Norwegian Marine Mammal Research Programme. 1992. A research proposal to evaluate the ecological importance of minke whales in the northeast Atlantic. Paper SC/44/NAB18 presented to the IWC Scientific Committee, June 1992 (unpublished). 85pp. [Paper available from the Office of this Journal].

Okamura, H., Miyashita, T. and Kitakado, T. 2010. *g*(0) estimates for western North Pacific common minke whales. Paper SC/62/NPM9 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 7pp. [Paper available from the Office of this Journal].

Pastene, L.A., Acevedo, J., Goto, M., Zerbini, A.N., Acuna, P. and Aguayo-Lobo, A. 2010. Population structure and possible migratory links of common minke whales, *Balaenoptera acutorostrata*, in the Southern Hemisphere. *Conserv. Genet.*(11): 1553-58.

Pastene, L.A., Goto, M., Kanda, N., Zerbini, A.N., Kerem, D., Watanabe, K., Bessho, Y., Hasegawa, M., Nielsen, R., Larsen, F. and Palsbøll, P.J. 2007. Radiation and speciation of pelagic organisms during periods of global warming: the case of the common minke whale, *Balaenoptera acutorostrata*. *Molecular Biology* 16(7): 1481-500.

Piry, S., Luikart, G. and Cornuet, J.M. 1999. BOTTLENECK: a computer program for detecting recent reductions in the effective population size using allele frequency data. *Journal of Heredity* 90: 502-03.

Robinson, J.D., Bunnefield, L., Hearn, J., Stone, G.N. and Hickerson, M.J. 2014. ABC inference of multi-population divergence with admixture from unphased population genomic data. *Molecular Ecology* 23: 4458-71.

Ryan, C., McHugh, B., Trueman, C.N., Sabin, R.C., Deaville, R., Harrod, C., Berrow, S.D. and O'Connor, I. 2013. Stable isotope analysis of baleen reveals resource partitioning among sympatric rorquals and population structure in fin whales. *MEPS* 479: 251-61.

Sasaki, H., Murase, H., Kiwada, H., Matsuoka, K., Mitani, Y. and Saitoh, S.I. 2013. Habitat differentiation between sei (*Balaenoptera borealis*) and Bryde's whales (*B. brydei*) in the western North Pacific. *Fisheries Oceanography* 22(6): 496-508. [Published paper].

Sasaki, T., Nikaido, M., Hamilton, H., Goto, M., Kato, H., Kanda, N., Pastene, L.A., Cao, K., Fordyce, R.E., Hasegawa, M. and Okada, N. 2005. Mitochondrial phylogenetics and evolution of mysticete whales. *Systematic Biology* 54(1): 77-90.

Schwacke, L.H., Voit, E.O., Hansen, L.J., Wells, R.S., Mitchum, G.B., Hohn, A.A. and Fair, P.A. 2002. Probabilistic risk assessment of reproductive effects of polychlorinated biphenyls on bottlenose dolphins (*Tursiops truncatus*) from the southeast United States coast. *Environmental Toxicology and Chemistry* 21(12): 2752-64.

Shimizu, Y., Ohishi, K., Suzuki, R., Tajima, Y., Yamada, T., Kakizoe, Y., Bando, T., Fujise, Y., Taru, H., Murayama, T. and Maruyama, T. 2013. Amino acid sequence variations of signaling lymphocyte activation molecule and mortality caused by morbilivirus infection in cetaceans. *Microbiology and Immunology* 57: 624-32. [Published paper].

Shiozaki, T., Ito, S.I., Takahashi, K., Saito, H., Nagata, T. and Furuya, K. 2004. Regional variability of factors controlling the onset timing and magnitude of spring algal blooms in the northwestern North Pacific. *Journal of Geophysical Research: Oceans* 119: 1-3. DOI: 10.1002/2013JC009187.

Sigurjónsson, J. and Víkingsson, G.A. 1997. Seasonal abundance of and estimated food consumption by cetaceans in Icelandic and adjacent waters. *Journal of Northwest Atlantic Fishery Sciences* 22: 271-87.

Slatkin, M. and Hudson, R.R. 1991. Pairwise comparisons of mitochondrial DNA sequences in stable and exponentially growing populations. *Genetics* 129: 555-62.

Suzuki, Y., Umatani, M., Bhuiyan, M.M.U., Watanabe, H., Mogoe, T., Matsuoka, K., Fujise, Y., Ishikawa, H., Ohsumi, S., Sasaki, M. and Fukui, Y. 2010. Effects of equilibriation steps, type of sugars and addition of whale follicular fluid on viability and *in vitro* maturation of vitrified whale oocytes. *Jpn. J. Zoo. Wildl. Med.* 15(2): 65-72.

Taylor, B.L. and Martien, K. 2002. Interpretation of Boundary Rank results for North Pacific minke whales. Paper SC/J02/NP2 presented to the Scientific Committee Workshop on North Pacific common minke (*Balaenoptera acutorostrata*) *Implementation Simulation Trials* held in Seattle, USA, 19-22 January, 2002 (unpublished). [Paper available from the Office of this Journal].

Tiedemann, R., Cipriano, F., Morin, P.A., Hoelzel, A.R., Palsbøll, P., Waples, R.S., Natoli, A., Bachmann, L., Postma, L., Double, M., Pampoulie, C., Skaug, H.J., Baker, C.S. and Jackson, J. 2012. Updated guidelines for DNA data quality control and error rate estimation, for genetic studies relevant to IWC management advice. Paper SC/64/SD2 presented to the IWC Scientific Committee, June 2012, Panama City (unpublished). 12pp. [Paper available from the Office of this Journal].

Van der Zee, J.P. and Punt, A.E. 2014. Evaluting ciritical dispersal rates for whale management under the IWCs Revised Management Procedure: an application for North Atlantic common minke whales. *J. Cetacean Res. Manage* 14: 125-32.

Watanabe, H., Okazaki, M., Tamura, T., Konishi, K., Inagake, D., Bando, T., Kiwada, H. and Miyashita, T. 2012. Habitat and prey selection of common minke, sei and Bryde's whales in mesoscale during summer in the subarctic and transition regions of the western North Pacific. *Fisheries Science* 78: 557-67. [Published paper].

Wells, R.S., Tornero, V., Borrell, A., Aguilar, A., Rowles, T.K., Rhinehart, H.L., Hofmann, S., Jarman, W.M., Hohn, A.A. and Sweeney, J.C. 2005. Integrating life history and reproductive success data to examine potential relationships with organochlorine contaminants for bottlenose dolphins (*Tursiops truncatus*) in Sarasota Bay, Florida. *Science of the Total Environment* 349(1-3): 106-19.

Winship, A.J. and Trites, A.W. 2003. Prey consumption of Steller sea lions (*Eumetopias jubatus*) off Alaska: how much prey do they require? *Fishery Bulletin* 101: 147-63.

Witteveen, B.H., Worthy, G.A., Wynne, K.M. and Roth, J.D. 2009. Population structure of North Pacific humpback whales on their feeding grounds revealed by stable carbon and nitrogen isotope ratios. *Marine Ecology Progress Series* 379: 299-310.

Yoshida, N. and Miyazaki, N. 1991. Oxygen isotope correlation of cetacean bone phosphate with environmental water. *Journal of Geophysical Research: Oceans* 96(C1): 815-20.

Annex A
List of Participants

Panel

Alex Aguilar	University of Barcelona (Spain)
Greg Donovan	IWC Secretariat (UK)
Jaume Forcada	British Antarctic Survey (UK)
Caterina Fortuna	National Institute for Environmental Protection and Research (Italy)
Sarah Gaichas	NOAA Fisheries Service, Northeast Fisheries Science Center (USA)
Ailsa Hall	Sea Mammal Research Unit, Scottish Oceans Institute, University of St Andrews (UK)
Michael Hammill	Canadian Department of Fisheries and Oceans (Canada)
Daniel Howell	Institute of Marine Research, Bergen (Norway)
Taro Ichii	Oceanic Resources Division, National Research Institute of Far Seas Fisheries (Japan)
Jason Link*	NOAA Fisheries (USA)
Per Palsbøll	Faculty of Mathematics and Natural Sciences, GELIFES-Groningen Institute for Evolutionary Life Sciences (The Netherlands)
André Punt	School of Aquatic and Fishery Sciences College of the Environment University of Washington (USA)
Ralph Tiedemann	Institute of Biochemistry and Biology, University of Potsdam (Germany)
Judith E. Zeh	Department of Statistics, University of Washington (USA)

*By correspondence

Proponents

Haruya Kumakiri	Fisheries Agency of Japan, Japan (FAJ)
Hiroyuki Morita	Fisheries Agency of Japan, Japan (FAJ)
Hideki Moronuki	Fisheries Agency of Japan, Japan (FAJ)
Naohito Okazoe	Fisheries Agency of Japan, Japan (FAJ)
Tatsuo Hirayama	Ministry of Foreign Affairs of Japan, Japan (MOFA)
Sayuri Muraki	Ministry of Foreign Affairs of Japan, Japan (MOFA)
Toshiya Kishiro	National Research Institute of Far Seas Fisheries, Japan (NRIFSF)
Hikari Maeda	National Research Institute of Far Seas Fisheries, Japan (NRIFSF)
Tomio Miyashita	National Research Institute of Far Seas Fisheries, Japan (NRIFSF)
Joji Morishita	National Research Institute of Far Seas Fisheries, Japan (NRIFSF)
Hiroto Murase	National Research Institute of Far Seas Fisheries, Japan (NRIFSF)
Hideyoshi Yoshida	National Research Institute of Far Seas Fisheries, Japan (NRIFSF)
Masachika Masujima	National Research Institute of Fisheries Science
Makoto Okazaki	National Research Institute of Fisheries Science
Toshihide Kitakado	Tokyo University of Marine Science and Technology, Japan (TUMSAT)
Takeharu Bando	Institute of Cetacean Research, Tokyo, Japan (ICR)
Dan Goodman	Institute of Cetacean Research, Tokyo, Japan (ICR)
Mutsuo Goto	Institute of Cetacean Research, Tokyo, Japan (ICR)
Takashi Hakamada	Institute of Cetacean Research, Tokyo, Japan (ICR)
Kenji Konishi	Institute of Cetacean Research, Tokyo, Japan (ICR)
Luis A. Pastene	Institute of Cetacean Research, Tokyo, Japan (ICR)
Tsutomu Tamura	Institute of Cetacean Research, Tokyo, Japan (ICR)
Genta Yasunaga	Institute of Cetacean Research, Tokyo, Japan (ICR)
Saemi Baba	Interpreter
Hiroko Yasokawa	Interpreter

Observers

W.K. de la Mare (Australia)
L. Walløe (Norway)
D.S. Butterworth (University of Cape Town, South Africa)

Annex B

Agenda

1. INTRODUCTORY ITEMS

1.1 Opening remarks

1.2 Appointment of Chair and rapporteurs

1.3 Adoption of Agenda

1.4 Review of available documents

1.5 Structure of the report

2. OBJECTIVES OF THE WORKSHOP

3. SHORT GENERAL OVERVIEW OF JARPN II

3.1 Proponents' overview of general objectives and any changes over time

3.2 Summary of general conclusions and recommendations from the 2009 Workshop

- 3.2.1 Objectives
- 3.2.2 Sampling design, sample size and areas
- 3.2.3 Data analyses and modelling
- 3.2.4 Other matters not the focus of a final review

3.3 Proponents' overview of broad sampling scheme including sample size, areas and strategy including changes over time and response to the 2009 Workshop recommendations

3.4 Panel comments and conclusions on general issues

- 3.4.1 Objectives
- 3.4.2 Sampling design and sample size
- 3.4.2.1 Sampling design and areas
- 3.4.2.2 Sample size

4. STOCK STRUCTURE

4.1 Proponents' summary of objectives including modifications, if any, since the start of the programme

4.2 Overview of conclusions and recommendations from the 2009 Workshop

4.3 Proponents' summary of the results (incl. response to 2009 Workshop)

4.4 Panel review, conclusions and recommendations

- 4.4.1 Overview
- 4.4.2 Evaluation of progress with the 2009 recommendations (see Annex D for a complete summary table)
- 4.4.3 Recommendations
- 4.4.3.1 Medium-long term recommendations
- 4.4.3.2 Short term recommendations

5. FEEDING ECOLOGY AND ECOSYSTEM STUDIES: PART 1. GENERAL INFORMATION TO INFORM ECOSYSTEM MODELLING ON OCEANOGRAPHY, DISTRIBUTION, ABUNDANCE AND STATUS OF WHALE STOCKS

5.1 Proponents' summary of objectives including modifications, if any, since the start of the programme

5.2 Overview of conclusions and recommendations from the 2009 Workshop

5.3 Proponents summary of 'oceanographic component' (incl. response to 2009 Workshop)

- 5.3.1 Oceanography
- 5.3.1.1 Proponents summary of the results (incl. response to 2009 Workshop)
- 5.3.2 Distribution of large whales
- 5.3.2.1 Proponents summary of the results (incl. response to 2009 Workshop)
- 5.3.3 Abundance and status of stocks
- 5.3.3.1 Proponents summary of the results (incl. response to 2009 Workshop)

5.4 Panel review, conclusions and recommendations

- 5.4.1 Overview
- 5.4.1.1 Oceanography
- 5.4.1.2 Distribution
- 5.4.1.3 Abundance
- 5.4.2 Evaluation of progress with the 2009 recommendations
- 5.4.2.1 Oceanography
- 5.4.2.2 Distribution
- 5.4.2.3 Abundance
- 5.4.3 Recommendations
- 5.4.3.1 Oceanography
- 5.4.3.2 Distribution
- 5.4.3.3 Abundance

6. FEEDING ECOLOGY AND ECOSYSTEM STUDIES: PART 2, FIELD AND LABORATORY STUDIES

6.1 Proponents' summary of objectives including modifications, if any, since the start of the programme

6.2 Overview of conclusions and recommendations from the 2009 Workshop

6.3 Proponents summary of the coastal and offshore components (including response to 2009 Workshop)

- 6.3.1 Prey consumption, including biomass estimation of prey species
- 6.3.2 Prey preference, including whales' feeding habits
- 6.3.3 Body condition of whales

6.4 Panel review, conclusions and recommendations

- 6.4.1 Overview
- 6.4.2. Evaluation of progress made on recommendations in 2009
- 6.4.3 Recommendations
- 6.4.3.1 Medium-term
- 6.4.3.2 Short-Term

7. FEEDING ECOLOGY AND ECOSYSTEM STUDIES: PART 3 ECOSYSTEM MODELLING

7.1 Summary of objectives including modifications, if any, since the start of the programme (by proponents)

7.2 Overview of conclusions and recommendations from the 2009 Workshop

7.3 Proponents' summary of the ecosystem modelling work (incl. response to 2009 Workshop)

7.4 Panel review, conclusions and recommendations

7.4.1 Overview

7.4.2 Evaluation of progress with the 2009 recommendations (see Annex D for a complete summary table)

7.4.3 Recommendations

7.4.3.1 General recommendations

7.4.3.2 EwE model

7.4.3.3 Extended single-species model

8. MONITORING ENVIRONMENTAL POLLUTANTS IN CETACEANS AND THE MARINE ECOSYSTEM

8.1 Summary of objectives including modifications, if any, since the start of the programme (proponents)

8.2 Overview of conclusions and recommendations from the 2009 Workshop

8.3 Proponents summary of the results (incl. response to 2009 Workshop)

8.4 Panel review, conclusions and recommendations

8.4.1. Overview

8.4.2 Evaluation of progress with the 2009 recommendations

8.4.3.1 Medium-Term

8.4.3.2 Short-Term

9. REVIEW OF OTHER CONTRIBUTIONS TO IMPORTANT RESEARCH NEEDS

9.1 Proponents' summaries

9. 2 Panel conclusions and recommendations

10. INTEGRATION OF RESULTS

10.1 Proponents' summary

10.2 Panel comments and conclusions

11. PANEL CONCLUSIONS WRT ANNEX P

11.1 General issues

11.1.1 Timing

11.1.2 The nature of 'final reports'

11.1.3 Lethal and non-lethal techniques

11.1.4 Review of progress of recommendations

11.2 Assessment of the programme's scientific output given the stated objectives and length of the programme

11.3 Consideration of the level of co-ordination with other relevant research projects

11.4 Evaluation of how well the stated objectives have been met and the extent to which the results have improved conservation and management

11.3.1 Evaluation by the most recent sub-objectives

11.3.2 Evaluation by original objectives with comments on contributions to conservation and management

12. ADOPTION OF REPORT

Annex C
List of Documents

Primary documents		
Document	**Title**	**Authors**
SC/F16/JR/1	The Japanese Whale Research Program under Special Permit in the western North Pacific Phase-II (JARPN II): results and conclusions in the context of the three main objectives, and scientific considerations for future research	Tsutomu Tamura, Toshiya Kishiro, Takeharu Bando, Genta Yasunaga, Hiroto Murase, Toshihide Kitakado & Luis A. Pastene
SC/F16/JR/2	Methodology and procedure of the dedicated sighting surveys in JARPN II (2008-2013) - Offshore component	Koji Matsuoka, Takashi Hakamada & Tomio Miyashita
SC/F16/JR/3	Methodology and survey procedure under the JARPN II – coastal component of Sanriku and Kushiro- during 2008 to 2014, with special emphasis on whale sampling procedures	Toshiya Kishiro, Hiseyoshii Yoshida, Genta Yasunaga, Takeharu Bando, Toshihiro Mogoe & Hidehiro Kato
SC/F16/JR/4	Methodology and survey procedures under the JARPN II offshore component- during 2008 to 2014 with special emphasis on whale sampling procedures	Takeharu Bando, Genta Yasunaga, Tsutomu Tamura, Koji Matsuoka, Hiroto Murase, Toshiya Kishiro & Tomio Miyashita
SC/F16/JR/5	Oceanographic conditions in the JARPN II survey area from 2000 to 2013 using FRA-ROMS data	Makoto Okazaki, Masachika Masujima, Hiroto Murase & Kenji Morinaga
SC/F16/JR/6	Oceanographic conditions in the survey area of JARPN II coastal component off Kushiro in September from 2000 to 2013 using FRA-ROMS data	Makoto Okazaki, Masachika Masujima, Hiroto Murase & Kenji Morinaga
SC/F16/JR/7	Seasonal spatial distributions of common minke, sei and Bryde's whales in the JARPN II survey area from 2002 to 2013	Hiroto Murase, Takashi Hakamada, Hiroko Sasaki, Koji Matsuoka & Toshihide Kitakado
SC/F16/JR/8	Distribution of sei whales (*Balaenoptera borealis*) in the subarctic–subtropical transition area of the western North Pacific in relation to oceanic fronts	Hiroto Murase, Takashi Hakamada, Koji Matsuoka, Shigetoshi Nishiwaki, Denzo Inagake, Makoto Okazaki, Naoki Tojo & Toshihide Kitakado
SC/F16/JR/9	Distribution of blue (*Balaenoptera musculus*), fin (*B. physalus*), humpback (*Megaptera novaeangliae*) and north pacific right (*Eubalaena japonica*) whales in the western North Pacific based on JARPN and JARPN II surveys (1994 to 2014)	Koji Matsuoka, Takashi Hakamada & Tomio Miyashita
SC/F16/JR/10	Habitat differentiation between sei (*Balaenoptera borealis*) and Bryde's whales (*B. brydei*) in the western North Pacific	Hiroko Sasaki, Hiroto Murase, Hiroshi Kiwada, Koji Matsuoka, Yoko Mitani & Sei-Ichi Saito
SC/F16/JR/11	The number of the western North Pacific common minke whales (*Balaenoptera acutorostrata*) distributed in JARPN II coastal survey areas	Takashi Hakamada, Koji Matsuoka, Kishiro Toshiya & Tomio Miyashita
SC/F16/JR/12	The number of western North Pacific common minke, Bryde's and sei whales distributed in JARPN II Offshore survey area	Takashi Hakamada & Koji Matsuoka
SC/F16/JR/13	The number of blue, fin, humpback, and North Pacific right whales in the western North Pacific in the JARPN II Offshore survey area	Takashi Hakamada & Koji Matsuoka
SC/F16/JR/14	The number of sperm whales in the western North Pacific in the JARPN II Offshore survey area	Takashi Hakamada & Koji Matsuoka
SC/F16/JR/15	Updated estimation of prey consumption by common minke, Bryde's and sei whales in the western North Pacific	Tsutomu Tamura, Kenji Konishi & Tatsuya Isoda
SC/F16/JR/16	Preliminary attempt of spatial estimation of prey consumption by sei whales in the JARPN II survey area using data obtained from 2002 to 2013	Tsutomu Tamura, Hiroto Murase, Hiroko Sasaki & Toshihide Kitakado

SC/F16/JR/17	Updated prey consumption by common minke whales and interaction with fisheries in coastal areas of the Pacific side of Japan	Tsutomu Tamura, Toshiya Kishiro, Hideyoshi Yoshida, Kenji Konishi, Genta Yasunaga, Takeharu Bando, Mitsuhiro Saeki, Keiichi Onodera, Masaki Mitsuhashi, Yuuho Yamashita, Tetsuichiro Funamoto & Hidehiro Kato
SC/F16/JR/18	Basin-scale distribution pattern and biomass estimation of Japanese anchovy *Engraulis japonicus* in the western North Pacific	Hiroto Murase, Atsushi Kawabata, Hiroshi Kubota, Masayasu Nakagami, Kazuo Amakasu, Koki Abe, Kazushi Miyashita & Yoshioki Oozeki
SC/F16/JR/19	Estimation of prey species biomass in the Sanriku region based on 2008 and 2009 JARPN II acoustic surveys	Atsushi Wada, Keiichi Onodera, Mitsuhiro Saeki & Tsutomu Tamura
SC/F16/JR/20	Habitat and prey selection of common minke, sei, and Bryde's whales in mesoscale during summer in the subarctic and transition regions of the western North Pacific	Hikaru Watanabe, Makoto Okazaki, Tsutomu Tamura, Kenji Konishi, Denzo Inagake, Takeharu Bando, Hiroshi Kiwada & Tomio Miyashita
SC/F16/JR/21	Prey selection of common minke (*Balaenoptera acutorostrata*) and Bryde's (*Balaenoptera edeni*) whales in the western North Pacific in 2000 and 200	Hiroto Murase, Tsutsomu Tamura, Hiroshi Kiwada, Yoshihiro Fujise, Hikaru Watanabe, Hiroshi Ohizumi, Shiroh Yonezaki, Hiroshi Okamura & Shigeyuki Kawahara
SC/F16/JR/22	Prey preferences of common minke (*Balaenoptera acutorostrata*), Bryde's (*B. edeni*) and sei (*B. borealis*) whales in offshore component of JARPN II from 2002 to 2007	Hiroto Murase, Tsutomu Tamura, Tatsuya Isoda, Ryosuke Okamoto, Shiroh Yonezaki, Hikaru Watanabe, Naoki Tojo, Ryuichi Matsukura, Kazushi Miyashita, Hiroshi Kiwada, Koji Matsuoka, Shigethosi Nishiwaki, Denzo Inagake, Makoto Okazaki, Hiroshi Okamura, Yoshihi
SC/F16/JR/23	Decadal change of feeding ecology in sei, Bryde's and common minke whales in the offshore of the Western North Pacific	Kenji Konishi, Tatsuya Isoda & Tsutomu Tamura
SC/F16/JR/24	Relationship between feeding habit and maturity status of common minke whale off Kushiro	Tsutomu Tamura, Toshiya Kishiro, Hideyoshi Yoshida, Kenji Konishi, & Hidehiro Kato
SC/F16/JR/25	A short note on feeding behaviour of sei whales observed in JARPN II	Midori Ishii, Hiroto Murase, Yoshiaki Fukuda, Kouichi Sawada, Toyoki Sasakura, Tsutomu Tamura, Takeharu Bando, Koji Matsuoka, Akira Shinohara, Sayaka Nakatsuka, Nobuhiro Katsumata, Kazushi Miyashita & Yoko Mitani
SC/F16/JR/26	Feeding habits of sperm whales (*Physeter macrocephalus*) in the western North Pacific in spring and summer	Tatsuya Isoda, Tsutomu Tamura, Kenji Konishi, Hiroshi Ohizumi & Tsunemi Kubodera
SC/F16/JR/27	Analyses of body condition in sei, Bryde's and common minke whales in the western North Pacific with JARPN and JARPN II dataset	Kenji Konishi
SC/F16/JR/28	Ecosystem modelling in the western North Pacific from 1994 to 2013 using Ecopath with Ecosim (EwE): some preliminary results	Hiroto Murase, Tsutomu Tamura, Takashi Hakamada, Shingo Watari, Makoto Okazaki, Hidetada Kiyofuji, Shiroh Yonezaki & Toshihide Kitakado
SC/F16/JR/29	Predation impacts on sandlance population by consumption of common minke whales off Sanriku region	Toshihide Kitakado, Hiroto Murase & Tsutomu Tamura
SC/F16/JR/30	Temporal trend of Total Hg levels in three baleen whale species based on JARPN II data for the period 1994-2014	Genta Yasunaga & Yoshihiro Fujise
SC/F16/JR/31	Temporal trend of PCB levels in common minke whales from the western North Pacific for the period 2002-2014	Genta Yasunaga & Yoshihiro Fujise
SC/F16/JR/32	Accumulation features of POPs of baleen whales in the western North Pacific based on samples collected during the 2012 JARPN II surve	Genta Yasunaga & Yoshihiro Fujise

SC/F16/JR/33	Comparison of total Hg levels in O and J type stock of common minke whales based on JARPN II coastal samples collected in 2012 and 2013	Genta Yasunaga & Yoshihiro Fujise
SC/F16/JR/34	A note on POPs and Hg accumulation in sperm whale based on JARPN II samples collected during 2001-2013	Genta Yasunaga & Yoshihiro Fujuse
SC/F16/JR/35	Status of I131, Cs134 and Cs137 in baleen and sperm whales from the western North Pacific during 2011-2015	Genta Yasunaga & Yoshihiro Fujise
SC/F16/JR/36	Effects of persistent organochlorine exposure on the liver transcriptome of the common minke whale (*Balaenoptera acutorostrata*) from the North Pacific	Satoko Niimi, Mai Imoto, Tatsuya Kunisue, Michio X. Watanabe, Eun-Young Kim, Kei Nakayama, Genta Yasunaga, Yoshihiro Fujise, Shinsuke Tanabe & Hisato Iwata
SC/F16/JR/37	Amino acid sequence variations of signalling lymphocyte activation molecule and mortality caused by morbillivirus infection in cetaceans	Yui Shimizu, Kazue Ohishi, Rintaro Suzuki, Yuko Tajima, Tadasu Yamada, Yuka Kakizoe, Takeharu Bando, Yoshihiro Fujise, Hajime Taru, Tsukasa Murayama & Tadashi Maruyama
SC/F16/JR/38	Temporal and spatial distribution of the 'J' and 'O' stocks of common minke whale in waters around Japan based on microsatellite DNA	Luis A. Pastene, Mutsuo Goto, Mioko Taguchi & Toshihide Kitakado
SC/F16/JR/39	Morphological differences in the white patch on the flipper between J and O stocks of the North Pacific common minke whale	Gen Nakamura, Ichiro Kadowaki, Shouka Nagatsuka, Ryotaro Hayashi, Naohisa K&a, Mutsuo Goto, Luis A. Pastene & Hidehiro Kato
SC/F16/JR/40	Updated genetic analyses based on mitochondrial and microsatellite DNA indicated no sub-structure of the 'O' stock common minke whale in the western North Pacific	Luis A. Pastene, Mutsuo Goto, Mioko Taguchi & Toshihide Kitakado
SC/F16/JR/41	Morphometric analysis on stock structure of the O stock common minke whale in the western North Pacific	Takeharu Bando & Takashi Hakamada
SC/F16/JR/42	Satellite tracking of a common minke whale in the coastal waters off Hokkaido, Northern Japan in 2010	Toshiya Kishiro & Tomio Miyashita
SC/F16/JR/43	Fitting to catch-at-age data for North Pacific common minke whales in the Pacific side of Japan	Toshihide Kitakado & Hikari Maeda
SC/F16/JR/44	Updated genetic analyses based on mtDNA and microsatellite DNA suggest possible stock differentiation of Bryde's whales between management sub-areas 1 and 2 in the North Pacific	Luis A. Pastene, Mutsuo Goto, Mioko Taguchi & Toshihide Kitakado
SC/F16/JR/45	Satellite tracking of Bryde's whales *Balaenoptera edeni* in the offshore western North Pacific in summer 2006 and 2008	Hiroto Murase, Tsutomu Tamura, Seiji Otani & Shigetoshi Nishiwaki
SC/F16/JR/46	Genetic analyses based on mtDNA control region sequencing and microsatellite DNA confirmed the occurrence of a single stock of sei whales in oceanic regions of the North Pacific	Luis A. Pastene, Mutsuo Goto, Mioko Taguchi & Toshihide Kitakado
SC/F16/JR/47	Genetic study on JARPN II and IWC-POWER samples of sei whales collected widely from the North Pacific at the same time of the year	Naohisa K&a, Koji Matsuoka, Mutsuo Goto & Luis A. Pastene
SC/F16/JR/48	A review of the genetic and non-genetic information provides support for a hypothesis of a single stock of sei whales in the North Pacific	Naohisa K&a, Takeharu Bando, Koji Matsuoka, Hiroto Murase, Toshiya Kishiro, Luis A. Pastene & Seiji Ohsumi
SC/F16/JR/49	A note on the genetic diversity of sperm whales in the western North Pacific as revealed by mitochondrial and microsatellite DNA	Luis A. Pastene, Mutsuo Goto, Mioko Taguchi & Toshihide Kitakado
SC/F16/JR/50	A note on the genetic diversity and phylogeny of western North Pacific and southern right whales based on mitochondrial and microsatellite DNA	Luis A. Pastene, Mutsuo Goto, Mioko Taguchi,, Shigetoshi Nishiwaki & Toshihide Kitakado
SC/F16/JR/51	A note on mismatch distributions of mtDNA control region sequences in baleen whales from the western North Pacific	Luis A. Pastene, Mutsuo Goto & Toshihide Kitakado

SC/F16/JR/52	A study on the improvement of age estimation in common minke whales using the method of gelatinized extraction of earplug	Hikari Maeda, Tadafumi Kawamoto & Hidehiro Kato
SC/F16/JR/53	Basic information of earplugs as age character of common minke whales in western North Pacific	Hikari Maeda, Takeharu Bando, Toshiya Kishiro, Toshihide Kitakado & Hidehiro Kato
SC/F16/JR/54	Japan's voluntary considerations and response to the ICJ judgement in relation to the adjustment of JARPN II program during the period from 2014 to 2016	fisheries Agency Of Japan
SC/F16/JR/55	Preliminary report on progress in earplug-based age determination of sei whales collected during 2002 to 2013 JARPN II surveys	Takeharu Bando, Hikari Maeda, Yuichiro Ishikawa, Toshiya Kishiro & Hidehiro Kato
Observer Statements		
Document Number	Title	Authors
SC/F16/O/1	Observers' Statement to the JARPN II Special Permit Expert Panel Final Review Workshop	William De La Mare, Michael Double, & John Mckinlay
SC/F16/O/2	A response to Document SC/F16/O/1 'Observers statement to the JARPN II Special Permit Expert Panel Final Review Workshop'.	Tamura, T., Kishiro, T., Murase, H., Kitakado, T. Yasunga, G., Morishita, J. and Pastene, L.
For Information Documents		
Document Number	Title	Authors
SC/F16/JR/For Info/1	Feeding Strategies and Prey Consumption of Three Baleen Whale Species within the Kuroshio-Current Extension. *J. Northw. Atl. Fish. Sci.,* Vol. 42: 27–40	Kenji Konishi, Tsutomu Tamura, Tatsuya Isoda, Ryosuke Okamoto, Takashi Hakamada, Hiroshi Kiwada, & Koji Matsuoka
SC/F16/JR/For Info/10	Molecular cloning and mRNA expression of cytochrome P4501A1 and 1A2 in the liver of common minke whales (Balaenoptera acutorostrata). *Marine Pollution Bulletin* 51 (2005) 784–793	Satoko Niimi, Michio X. Watanabe, Eun-Young Kim, Hisato Iwata, Genta Yasunaga, Yoshihiro Fujise, Shinsuke Tanabe
SC/F16/JR/For Info/11	Identification and hepatic expression profiles of cytochrome P450 1–4 isozymes in common minke whales (Balaenoptera acutorostrata). *Comparative Biochemistry and Physiology, Part B* 147 (2007) 667–681	Satoko Niimi, Eun-Young Kim, Hisato Iwata, Michio X. Watanabe, Genta Yasunaga, Yoshihiro Fujise, Shinsuke Tanabe
SC/F16/JR/For Info/12	Brucella spp. in the western North Pacific and Antarctic cetaceans: a review. *J. Cetacean Res. Manage*. 10(1):67–72, 2008	Kazue Ohishi, Yoshihiro Fujise & Tadashi Maruyama
SC/F16/JR/For Info/13	Cetacean Toll-like receptor 4 and myeloid differentiation factor 2, and possible cetacean-specific responses against Gram-negative bacteria. *Comparative Immunology, Microbiology and Infectious Diseases* 33 (2010) e89–e98	Reiko Shishido, Kazue Ohishia, Rintaro Suzuki, Kiyotaka Takishita, Dai Ohtsu, Kenji Okutsu, Koji Tokutake, Etsuko Katsumata, Takeharu Bando, Yoshihiro Fujise, Tsukasa Murayama, Tadashi Maruyama
SC/F16/JR/For Info/14	Population genetic structure of Bryde's whales (Balaenoptera brydei) at the inter-oceanic and trans-equatorial levels. *Conserv Genet* (2007) 8:853–864	Naohisa K&a, Mutsuo Goto, Hidehiro Kato,, Megan V. Mcphee & Luis A. Pastene
SC/F16/JR/For Info/15	Update of the analyses on individual identification and mixing of J and O stocks of common minke whale around Japanese waters examined by microsatellite analysis. SC/61/JR5	Naohisa K&a, Mutsuo Goto, Toshiya Kishiro, Hideyoshi Yoshida, Hidehiro Kato, & Luis A. Pastene
SC/F16/JR/For Info/16	Genetic analysis of western North Pacific minke whales from Korea and Japan based on microsatellite DNA. SC/62/NPM11	Naohisa K&a, Jung Youn Park, Mutsuo Goto, Yong-Rock An, Seok-Gwan Choi, Dae-Yeon Moon, Toshiya Kishiro, Hideyoshi Yoshida, Hidehiro Kato, & Luis A. Pastene
SC/F16/JR/For Info/17	Update of note on sampling and laboratory procedure protocols of the genetic work at the Institute of Cetacean Research (SC/65b/J27Rev). SC/65b/DNA01	Naohisa K&a, Mutsuo Goto, Hiroyuki Oikawa, & Luis A. Pastene

SC/F16/JR/For Info/18	Mitochondrial Phylogenetics and Evolution of Mysticete Whales. *Syst. Biol.* 54(1):77–90, 2005	Takeshi Sasaki, Masato Nikaido, Healy Hamilton, Mutsuo Goto, Hidehiro Kato, Naoisha K&a, Luis A. Pastene, Ying Cao, R. Ewan Fordyce, Masami Hasegawa & Norihiro Okada
SC/F16/JR/For Info/19	Genetic Characteristics of Western North Pacific Sei Whales, *Balaenoptera borealis*, as Revealed by Microsatellites. *Marine Biotechnology* Volume 8, 86–93 (2006)	N. K&a, M. Goto, L.A. Pastene
SC/F16/JR/For Info/2	Measurements of density contrast and sound-speed contrast for target strength estimation of *Neocalanus* copepods (*Neocalanus cristatus* and *Neocalanus plumchrus*) in the North Pacific Ocean. Fish. Sci. (2009) 75: 1377-1387	Ryuichi Matsukura, Hiroki Yasuma, Hiroto Murase, Shiroh Yonezaki, Tetsuichiro Funamoto, Satoshi Honda, Kazushi Miyashita
SC/F16/JR/For Info/20	Baleen Whale Phylogeny and a Past Extensive Radiation Event Revealed by SINE Insertion Analysis. *Proceedings of the SMBE Tri-National Young Investigators' Workshop* 2005	Masato Nikaido, Healy Hamilton, Hitomi Makino, Takeshi Sasaki,Kazuhiko Takahashi, Mutsuo Goto, Naohisa K&a, Luis A. Pastene, & Norihiro Okada
SC/F16/JR/For Info/21	Radiation and speciation of pelagic organisms during periods of global warming: the case of the common minke whale, Balaenoptera acutorostrata. *Molecular Ecology* (2007) 16 , 1481–1495	Luis A. Pastene, Mutsuo Goto, Naohisa K&a, Alex&re N. Zerbini, D& Kerem, Kazuo Watanabe, Yoshitaka Bessho, Masami Hasegawa, Rasmus Nielsen, Finn Larsen & Per J. Palsbøll
SC/F16/JR/For Info/22	Attempts at in vitro fertilization and culture of in vitro matured oocytes in sei (*Balaenoptera borealis*) and Bryde's (*B. edeni*) whales. *Zygote* 17 (February): 19-28 (2008)	M.M.M Bhuiyan, Y. Suzuki, H. Watanabe, K. Matsuoka, Fujise, Y., H Ishikawa, S. Ohsumi, Y. Fukui
SC/F16/JR/For Info/23	Molecular cloning of urea transporters from the kidneys of baleen and toothed whales. *Comparative Biochemistry and Physiology, Part B* 149 (2008) 227–235	Naoko Birukawa, Hironori &o, Mutsuo Goto, Naohisa K&a, Luis A. Pastene, Akihisa Urano
SC/F16/JR/For Info/24	Effects of Semen Extenders and Storage Temperatures on Characteristics of Frozen-Thawed Bryde's (*Balaenoptera edeni*) Whale Spermatozoa. *Journal of Reproduction and Development*, Vol. 55, No. 6, 2009	Mami Hiwasa, Yo Suzuki, Hiroyuki Watanabe, Mohammad Musharraf Uddin Bhuiyan, Kohji Matsuoka, Yoshihiro Fujise, Hajime Ishikawa, Seiji Ohsumi & Yutaka Fukui
SC/F16/JR/For Info/25	Production of cloned sei whale (*Balaenoptera borealis*) embryos by interspecies somatic cell nuclear transfer using enucleated pig oocytes. *J. Vet. Sci.* (2009), 10(4), 285-292	Eunsong Lee, Mohammad Musharraf Uddin Bhuiyan, Hiroyuki Watanabe, Kohji Matsuoka, Yoshihiro Fujise, Hajime Ishikawa, Yutaka Fukuii
SC/F16/JR/For Info/26	Comparison of physiologically significant imidazole dipeptides in cetaceans sampled in Japanese whale research (Short Paper). *Sci. Rep. Hokkaido Fish. Exp. Stn.* 74: 25-28 (2009) [In Japanese]	Koji Tsuji, Akiyuki Sato, Hiromi Kaneko, Genta Yasunaga, Yoshihiro Fujise & Hiroshi Nomata
SC/F16/JR/For Info/27	Population structure and possible migratory links of common minke whales, Balaenoptera acutorostrata, in the Southern Hemisphere. *Conserv Genet* (2010) 11:1553–1558	Luis A. Pastene, Jorge Acevedo, Mutsuo Goto, Alex&re N. Zerbini, Paola Acuna, Anelio Aguayo-Lobo
SC/F16/JR/For Info/28	Migration of Antarctic Minke Whales to the Arctic. *PLoS ONE* 5(2), issue 12, December 2010	Kevin A. Glover, Naohisa K&a, Tore Haug, Luis A. Pastene, Nils Oien, Mutsuo Goto, Bjorghild B. Seliussen, Hans J. Skaug
SC/F16/JR/For Info/29	Production of Sei Whale (*Balaenoptera borealis*) Cloned Embryos by Inter- and Intra-Species Somatic Cell Nuclear Transfer. J*ournal of Reproduction and Development,* Vol. 56, No. 1, 2010	Mohammad Musharraf Uddin Bhuiyan, Yo Suzuki, Hiroyuki Watanabe, Eunsong Lee, Hiroki Hirayama, Koji Matsuoka, Yoshihiro Fujise, Hajime Ishikawa, Seiji Ohsumi & Yutaka Fukui
SC/F16/JR/For Info/3	Acoustic characterization of biological backscatterings in the Kuroshio-Oyashio inter-frontal zone and subarctic waters of the western North Pacific in spring. *Fish. Oceanogr.* 18:6, 386–401, 2009	Hiroto Murase,Morio Ichihara, Hiroki Yasuma, Hikaru Watanabe, Shiroh Yonezaki, Hiroshi Nagashima, Shigeyuki Kawahara & Kazusho Miyashita

SC/F16/JR/For Info/30	Effects of equilibration steps, type of sugars and addition of whale follicular fluid on viability and in vitro maturation of vitrified whale oocytes. *Jpn. J. Zoo. Wildl. Med.* 15(2):65-72, 2010	Yo Suzuki, Masahiro Umatani, Mohammad Musharraf Uddin Bhuiyani, Hiroyuki Watanabe, Toshihiro Mogoe, Koji Matsuoka, Yoshihiro Fujise, Hajime Ishikawa, Seiji Ohsumi, Motoki Sasaki & Yutaka Fukui
SC/F16/JR/For Info/31	Technical improvements of the age character (earplug) collections in common minke whales. *Bull. Jpn. Soc. Fish. Oceanogr.* 76(2): 59-65 (2012) [In Japanese]	Hikari Maeda & Hidehiro Kato
SC/F16/JR/For Info/32	Relative growth of the skull of the common minke whale Balaenoptera acutorostrata from the North Pacific in comparison to other Balaenoptera species. *Mammal Study* 37: 105–112 (2012)	Gen Nakamura, Hidehiro Kato & Yoshihiro Fujise
SC/F16/JR/For Info/33	Hybrids between common and Antarctic minke whales are fertile and can back-cross. *BMC Genetics* 2013, 14:25	Kevin A Glover, Naohisa K&a, Tore Haug, Luis A Pastene, Nils Oien, Bjorghild B Seliussen, Anne G E Sorvik & Hans J Skaug
SC/F16/JR/For Info/34	Seasonal changes in the testis of the North Pacific common minke whale. *Nippon Suisan Gakkaishi* 80(2), 185-190 (2014)	Satoko Inoue, Toshiya Kishiro, Yoshihiro Fujise, Gen Nakamura & Hidehiro Kato
SC/F16/JR/For Info/35	Mitochondrial DNA analyses of J and O stocks common minke whale in the western North Pacific. Paper SC/62/NPM21 presented to the IWC Scientific Committee meeting	Jung Youn Park, Mutsuo Goto, Naohisa K&a, Toshiya Kishiro, Hideyoshi Yoshida, Hidehiro Kato & Luis A. Pastene
SC/F16/JR/For Info/36	Structure and functions of the placenta in common minke (*Balaenoptera acutorostrata*), Bryde's (*B. brydei*) and sei (*B. borealis*) whales. *Journal of Reproduction and Development* 61(5): 415-421 [2015]	Chiyo Kitayama, Motoki Sasaki, Hajime Ishikawa, Toshihiro Mogoe, Seiji Ohsumi, Yutaka Fukui, Teguh Budipitojo, Daisuke Kondoh & Nobuo Kitamura
SC/F16/JR/For Info/37	Variation in a color pattern of white patch on the flippers of North Pacific common minke whales: Potential application for their interoceanic difference. *La Mer* 52: 31-47 [2014]	Gen Nakamura, Ichiro Kadowaki, Shouka Nagatsuka, Yoshihiro Fujise, Toshiya Kishiro, Hidehiro Kato
SC/F16/JR/For Info/4	Application of a generalized additive model (GAM) to reveal relationships between environmental factors and distributions of pelagic fish and krill: a case study in Sendai Bay, Japan. I*CES Journal of Marine Science*, 66: 1417–1424.	Hiroto Murase, Hiroshi Nagashima, Shiroh Yonezaki, Ryuichi Matsukura, & Toshihide Kitakado
SC/F16/JR/For Info/5	Spatial analysis of isada krill (*Euphausia pacificia*) distribution in frontal environments in the North Pacific Ocean. *Spatial Analyses in Fishery and Aquatic Sciences* 4: 115-138	Naoki Tojo, Ryuichi Matsukura, Hiroki Yasuma, Shiroh Yonezaki, Hikaru Watanabe, Shigeyuki Kawahara, Hiroto Murase & Kazushi Miyashita
SC/F16/JR/For Info/6	Effect of Depth-Dependent Target Strength on Biomass Estimation of Japanese Anchovy. *Journal of Marine Science and Technology*, Vol. 19, No. 3, pp. 267-272 (2011)	Hiroto Murase, Atsushi Kawabata, Hiroshi Kubota, Masayasu Nakagami, Kazuo Amakasu, Koki Abe, Kazushi Miyashita, & Yoshioki Oozeki
SC/F16/JR/For Info/7	Comparison of measurements and model calculations of target strength of juvenile sandeel in Sendai Bay. *Nippon Suisan Gakkaishi* 79(4), 638-648 (2013) [In Japanese]	Ryuichi Matsukura, Kuichi Sawada, Koki Abe Kenji Minami, Hiroshi Nagashima, Shiroh Yonezaki, Hiroto Murase & Kazushi Miyashita
SC/F16/JR/For Info/8	Pathological and serological evidence of Brucella-infection in baleen whales (Mysticeti) in the western North Pacific. *Comparative Immunology, Microbiology and Infectious Diseases* 26 (2003) 125–136	Kazue Ohishi, Ryoko Zenitani, Takeharu Bando, Yoshitaka Goto, Kazuyuki Uchida, Tadashi Maruyama, Saburo Yamamoto, Nobuyuki Miyazaki, Yoshihiro Fujisec
SC/F16/JR/For Info/9	Chimeric Structure of omp2 of Brucella from Pacific Common Minke Whales (Balaenoptera acutorostrata). *Microbiol. Immunol.*, 49(8), 789–793, 2005	Kazue Ohishi, Kiyotaka Takishita, Masaru Kawato, Ryoko Zenitani, Takeharu Bando, Yoshihiro Fujise, Yoshitaka Goto, Saburo Yamamoto & Tadashi Maruyama

Annex D

Summary of responses to the 2009 Panel report by the proponents and an evaluation by the present Panel

This summary Table includes the recommendations from the 2009 Panel, the response of the proponents and a summary evaluation by the proponents. Comments explaining the Panel's summary evaluation are given in the relevant sections of this report.

Recommendations (R) [& suggestions (S)] from the 2009 Panel	Proponents response 2016 (mainly from SC/F16/JR1)	2016 Panel evaluation
Objectives		
1. Development of refined, more quantified sub-objectives for each component of the programme as a priority (R)	Sub-objectives were identified for each main objective of JARPNII (see SC/F16/JR1)	Partially addressed.
2. For any long-term programme such as this, in addition to long-term objectives, proponents should determine specific, shorter term objectives that are quantified to the extent possible. (R)	Some of the sub-objectives identified above were of a short-term nature. Proponents' general view regarding quantification of objectives and sub-objectives was provided in SC/F15/SP07 p.1-2.	Not addressed.
Sample size & design		
For each objective: (a) Specify quantities of interest needed to achieve objectives (b) For each quantity of interest: - Identify/quantify sources of uncertainty - Determine which are functions of sample size The results of such an analysis can be used to determine: - How much progress has been made to achieving objectives - What further progress can be expected - Effect of changing N on time to achieve objectives - Whether sampling design is most appropriate and maximises information for a given N. (R)	Proponents' general view regarding quantification of objectives and sub-objectives was provided in SC/F15/SP07 p.1-2. Sampling design and sample size estimates were based mainly on main objective 1 (feeding ecology and ecosystem studies). As noted by the 2009 review workshop, for the feeding ecology study determining the appropriate sample sizes is contingent on properly estimating the uncertainty surrounding the key parameters that are ultimately to be used in the modelling process. The proponents believe that in the context above, substantial progress was made in addressing the uncertainty in the whale's prey consumption estimate, which is one of the key parameters for ecosystem modelling.	Not addressed.
Comparison of lethal and non-lethal techniques		
1. Add it as sub-objective. (R)	Response to this recommendation was given in SC/61/JR1 p. 14.	Not addressed.
2. Analysis of the precision (and any associated biases) of the estimates obtained for the relevant parameters by each of the lethal and non-lethal techniques. (R)	Addressed in different analyses related to the three research objectives.	Partially addressed.
3. Evaluation of the practicalities and logistics of the field (and, if relevant, laboratory) techniques in the context of the integrated objectives, sub-objectives and analyses proposed. (R)	Being addressed in an ongoing research on the feasibility of non-lethal techniques (2014-2016).	Not addressed up to 2013
4. To maximise the information obtained from animals and re-evaluate the need for such sampling at appropriate intervals. (R)	Efforts were made to maximise the information from sampled animals. A large number of analyses were made on the same animals, resulting in a total of 61 peer-reviewed publications (30 of which were not related to the main objectives of the program), and a large number of IWC SC documents.	Partially addressed.
5. A full evaluation of relative merits be undertaken as soon as possible after relevant work completed (1) Specified and quantified objectives (2) Analysis of precision of estimates by technique (3) Evaluation of practicalities of field (lab) techniques in context of integrated objectives, sub-objectives and analyses proposed. (R)	-	Not applicable.
6. If lethal sampling occurs, design well-specified study to evaluate techniques. (R)	See response to this recommendation in SC/61/JR1 p.14. There is an ongoing research on the feasibility of non-lethal techniques (2014-2016).	Not addressed up to 2013.
Stock structure		
1. The genetic assessments should include a brief description of procedures to ensure data quality (with reference to IWC guidelines for DNA data quality). (R)	Addressed in document Kanda *et al.* (2014). The IWC SC welcomed this document and agreed that it responded appropriately to a previous recommendation.	Addressed.
2. Revised papers should include estimates of genetic divergence (along with levels of uncertainty) in addition to probabilities of homogeneity. (R)	Addressed in papers presented to the IWC SC after 2009. See also SC/F16/JR40 for common minke whales; SC/F16/JR44 for Bryde's whale; SC/F16/JR46 for sei whales.	Partially addressed.
3. P values (and divergence estimates) should be reported for all loci combined rather than for each locus separately. (R)	Addressed in papers presented to the IWC SC after 2009. See also SC/F16/JR40 for common minke whales; SC/F16/JR44 for Bryde's whale; SC/F16/JR46 for sei whales.	Addressed.
4. Multiple testing issues: a) use of the False Discovery Rate could be preferable to the Bonferroni correction; b) to exercise discretion in the number of pairwise comparisons evaluated (e.g. by only comparing samples that are geographically proximate and hence most likely to be connected demographically). (R)	The recommended False Discovery Rate (FDR) was used in all population genetic structure papers presented to this workshop.	Addressed.

5. Provide more details on the analyses involving the program STRUCTURE. (R)	More details were provided in documents Kanda *et al.* (2009) and Kanda *et al.* (2010). See also SC/F16/JR38 for the application of the STRUCTURE program to individual assignment to J and O stocks common minke whale.	Addressed.
6. Include a brief discussion of experimental design with respect to sampling (explaining how the design specifically addresses uncertainties related to stock structure, e.g. whether the spatial and temporal coverage of samples of minke whales has been sufficient to test adequately the alternative stock structure hypotheses). (R)	Sampling design in JARPNII was made mainly in the context of main objective 1. For the key species, samples obtained by JARPNII were examined for stock structure purposes based on the IWC SC's designed sub-areas used for management purpose.	Partially addressed.
7. Redo the Boundary Rank analyses (Taylor and Martien, 2002) with new data. (R)	In discussion at the IWC SC after 2009, this task was not assigned to JARPNII workers.	No longer applicable.
8. Integrate Korean bycatch samples into the new datasets to look at heterogeneity. (R)	Samples from Korean bycatches were incorporated in several genetic studies presented to the IWC SC after 2009 (Kanda *et al.*, 2010; Park *et al.*, 2010).	Addressed.
9. Undertake the assessments of power to simulate data to evaluate power to detect a specified fraction of a putative stock (e.g. The hypothetical W stock of NP minke whales) in an overall sample using simulated data (with programs SimCoal, ms, EasyPop9 or other freely available software). (R)	Addressed in SC/F16/JR40 for O stock common minke whale; SC/F16/JR44 for Bryde's whale.	Partially addressed.
10. Undertake tests for population genetic (drift-mutation-migration) equilibrium. (R)	Preliminary analyses presented in SC/F16/JR51.	Partially addressed.
11. Undertake using non-equilibrium approaches the estimations of divergence between sample partitions. (R)	Will be addressed in future following the discussions on JR51. The proponents believe that the IM approach suggested by the workshop is not useful for population with low effect sizes.	Not addressed.
12. Attempt the detection of pairs of individuals that are related (Skaug and Daníelsdóttir, 2006). (R)	Work has been started and preliminary results obtained for common minke whale.	Partially addressed.
13. Undertake multivariate analyses of morphological data with respect to stock structure (e.g. PCA, cluster analysis, discriminant analysis, SIMPER and ANOSIM). (R)	Addressed in Hakamada and Bando (2009) and SC/F16/JR41.	Addressed.
14. Use of past and present contaminant data should be an integrative study of stock structure. (R)	Previous studies showed that POPs levels in whales could be informative of the stock structure (Fujise *et al.*, 2000; Nakata *et al.*, 2000). Similar studies are planned for future.	Partially addressed.
15. Carry out satellite tagging programmes to narrow the range of plausible stock structure hypotheses. (R)	Work has been started. Successful experiment were conducted for North Pacific Bryde's (Murase *et al.*, 2016) and common minke (Kishiro and Miyashita, 2011) whales.	Partially addressed.
Oceanography & Distribution		
1. JARPN II data be pooled or compared with other datasets (e.g. JARPN I or other historical surveys) when possible. This will increase the sample size and increase the possibility of data covering periods of changing relationships (e.g. previous regime changes), thus allowing patterns to be detected. (R)	Several of the analyses in the documents presented to this workshop used pooled data from JARPN and JARPNII (see agenda item related to 'integration').	Addressed.
2. To consider conducting future oceanographic surveys over an area larger than at present, not only to further investigate oceanographic relationships, but also to improve abundance estimates for a variety of species. (R)	Addressed in SC/F16/JR5-8.	Addressed.
3. In the long term, to more fully understand the preferred habitat, prey preferences, niche separation of different species, functional response, and spatial and temporal trends in local abundance and other biological factors (such as blubber thickness, pollutants, presence of scars, and stock structure), the oceanographic data collected on the cruises (bottom depth, water column temperature, salinity, and density) and satellite derived data, such as SST, chlorophyll, and sea surface height be integrated into future analyses. (R)	The analyses were also recommended as medium to long term. The recommendation was addressed to some extent in published documents Watanabe *et al.* (2012) and Murase *et al.* (2007) [SC/F16/JR20-21], a document presented to the 2009 review workshop Murase *et al.* (2009) [SC/J09/JR18] and documents presented to this workshop (SC/F16/JR7, SC/F16/JR16 and SC/F16/JR27). All these studies but JR7, JR16 and JR27 were conducted at the mesoscale.	Partially addressed.
4. The salinity CTD data must be corrected/calibrated using the water samples that were simultaneously collected with the CTD data. (S)	In principle, the salinity data recorded under JARPNII were calibrated. Quality checks are carried out for input data of the FRA-ROMS.	Not applicable.
5. More of these types of analyses (including using other appropriate modelling techniques such as GAMs or logistic regressions) be conducted. (R)	GLM and GAM has been considered and some of the results were published in scientific literatures. Spatial distributions of common minke, sei and Bryde's are attempted and the results are presented to this meeting (SC/F16/JR7). Furthermore, prey consumption of sei whales is preliminary estimated (SC/F16/JR16).	Addressed.

6. The authors incorporate into the index of density, the sightability of detected groups (e.g. effective strip half widths that include appropriate covariates such as weather conditions). As for all modelling exercises, it is important to test whether the chosen model is an improvement over a null, uninformative model and to validate the model results. Approaches to such validation could include: comparison of the modelled results not only with index of densities from the present study but also with data that were collected from other years (e.g. JARPN or other survey data) and exploration of cross-validation type techniques. (R)	In abundance estimation using standard method (i.e. design based method), Beaufort Sea State was used as a covariate of detection function. Beaufort Sea State was selected as one of covariates for some of species (see SC/F16/JR11-14). SC/F16/JR7 conducted Generalized Additive Model (GAM) for relative abundance estimation of the common minke, sei and Bryde's whales. Model selection was conducted based on GCV scores. Sea surface temperature (SST) and seafloor depth was selected as covariates of the GAM for the common minke and sei whales. SST, sea surface height anomaly (SSHa), sea surface chlorophyll-a concentration (Chl-a) and the seafloor depth were selected for the GAM for Bryde's whales.	Partially addressed.
Abundance		
Using the sightings data collected over the 1994-2007 period for the variety of large whales, the Panel recommends investigation of whether these data can be used to provide information on trends. (R)	Geographic coverage of JARPNII survey was not always the same among the years. For this reason, it would be necessary to pool sighting data to obtain full geographical coverage to examine abundance trend. Possible approach may be that in SC/F16/JR9, in which sighting data were stratified by periods of 7-9 years.	Not addressed.
It also recommends that the photo-identification data be worked up and comparisons made with catalogues elsewhere in the North Pacific. (R)	Photo-identification data for blue, humpback and North Pacific right whales have been collected during JARPNII surveys. The number of the collected photo-ID data were provided in Annex 3. Collaboration between Russian and Japanese scientists is being prepared to conduct preliminary analysis of photo-id data for North Pacific right whales. Also analysis of photo-id data for blue and humpback whales will be conducted, and data from IWC-POWER surveys will be incorporated (in collaboration with IWC-POWER specialists).	Partially addressed.
Increased effort to obtain better estimates should be a high priority. (R)	After 2009 survey, design was made so that research areas were covered with sufficient effort by the dedicated sighting surveys.	Partially addressed.
Prey consumption, including biomass estimation of prey species & Prey preference, including feeding habits		
1. Fuller rationale for sampling areas is necessary. (R)	The rational for the research area was presented in the original research plan of JARPNII (SC/54/O2 p. 22-24, 31). The research area is a high productive area involving the Kuroshio, the Oyashio Currents, and the Transition Zone between them. The research area covered the distribution of resources caught by Japanese fisheries such as Pacific saury. Since 2003, coastal regions such as Sanriku and Kushiro were added to study the competition between whales and fisheries in a hot-spot area.	Not addressed.
2. Characterising uncertainty - steps needing variance estimates: ○ *Per capita* consumption in area of interest 1. Parameter uncertainty in the relationship between energy consumption and body mass (multiple and exponent) 2. Residual variance of species values around the mean curve 3. Propn of annual energy obtained during feeding season 4. Length of feeding season (to get daily energy requirement) 5. Variance in mean body mass (stratified by sex and life stage, e.g. mature/immature) ○ Diet composition 1. Ave. undigested biomass of prey group in forestomach 2. Mean residence time of prey group in the forestomach 3. Ave. energy content per unit biomass of prey by prey type. 4. Ave. body weight of undigested prey items by species 5. Relative frequencies of each species by counts of individuals and/or hard parts ○ Abundance (to scale up *per capita* consumption to population consumption) 1. Variance (and possibly covariance) in estimates of abundance (mean number of whales present) in survey season by sub-area and time period, including g(0) variance, and process error. (R)	Addressed in SC/F16/JR15, 17.	Partially addressed.

3. For the treatment of uncertainty JARPN II data analyses should: (a) incorporate the use of several reasonable models for estimating daily consumption as a function of body mass and include the range of possible results in reporting their work; (b) use that range in subsequent analyses (including any ecosystem modelling) that employ these daily/annual consumption estimates; and (c) undertake sensitivity analyses for the range of parameter values used in the consumption equations. (R)	Addressed in SC/F16/JR15, 17.	Partially addressed.
4. Panel recommends that additional analyses be undertaken to identify the greatest sources of uncertainty and to determine appropriate sampling and analytical strategies to address them. (R)	Uncertainties in the number of whales distributed in the research area, body weight of whales, consumption models, energy content of prey species, assimilation efficiency and the ratio of low/high feeding intake of whales were taken into account in the updated estimation (SC/F16/JR15, 17).	Not addressed.
5. In Ecosystem Modelling, scientific rationale on used modelling formulations and proposed ranges should be clearly given. (R)	Addressed in SC/F16/JR15, 17.	Partially addressed.
6. Methods used to extrapolate from daily to annual rates and amounts are not clearly explained. (R)	Addressed in SC/F16/JR15, 17.	Addressed.
7. Need for incorporating information resulting from other studies (e.g. JARPN I, PICES, ESSAS). (R)	Addressed in SC/F16/JR15, 17.	Addressed.
8. Present the estimates of consumption by whales in terms of fisheries and prey biomass (this can provide an index of relativity and an easy and immediate sense of the magnitudes of the various processes that can affect fish stock dynamics). (S)	Addressed in SC/F16/JR15, 17.	Addressed.
9. Combine the oceanographic data, prey distributions and sighting survey data statistically to investigate how prey and whale distributions are associated with oceanographic conditions, and how whale distributions are related to distributions of prey–in this regard the sei whale example spatial modelling approach given in SC/J09/JR36 needs to be refined and extended further. (R)	The analyses were recommended as medium to long term. The recommendation was addressed to some extent in published documents (SC/F16/20-21), a document presented to the 2009 review workshop (SC/J09/JR18) and documents presented to this workshop (SC/F16/JR7, SC/F16/JR16 and SC/F16/JR27). All these studies but JR7, J16 and JR27 were conducted at the mesoscale.	Addressed.
10. Combine data on prey distributions as observed in the area where the whales were caught with the diet of the whales (referred to as the micro scale) statistically to evaluate how well the whale's diet reflects prey availability in the area where it was caught. (R)	Addressed in SC/F16/JR16.	Addressed.
11. Compare results from the approaches listed above with the results on selectivity already produced and presented at the Workshop. (R)	To be addressed in future.	Not addressed.
Ecosystem modelling		
1. Considerably more resources must be allocated to the modelling work – without this, the likelihood that the objective of the programme will be reached in a reasonable timeframe will be minimal. The models developed should be used to identify the areas of uncertainty with the greatest impact on model outputs of relevance to management, and hence to guide the prioritisation of future data collection and the associated sample size/sampling design. (R)	Regarding the collection of data, collaboration with specialists in other disciplines (e.g. oceanography, pelagic fish and highly migratory fish [sharks and tunas]) has been strengthened for EwE modelling.	Partially addressed.
2. A wider range of models needs to be considered if the objectives of the programme are to be met. Further work should aim towards fitting dynamic models to time series of data, especially abundance indices. (R)	Results of two modeling exercises were presented here (SC/F16/JR28-29) and a third one (MRM) is being considered for the near future. Time series data from 1994 to 2013 was fitted in Ecosim to estimate vulnerability parameters which is one of important parameters in the model.	Partially addressed.
3. The area covered by JARPNII is not spatially homogeneous, and serious consideration should be given to developing separate models for three regions distinguished by the inshore or shelf region, the sub-Arctic oceanic region of the Oyashio current and the sub-tropical region of the Oyashio and Kuroshio transition zone. (R)	A quasi sub-model structure is established in EwE considering bottom topography and oceanography of the modelled area.	Partially addressed.

4. There is a need to take much wider account of uncertainty at all stages of the modelling process, including that associated with the prey consumption rates of whales. (R)	Uncertainty is not addressed fully in EwE although vulnerability parameters are estimated in Ecosim. In SC/F16/JR29, both observation and process errors were accounted for using a Bayesian state-space delay-difference model, and estimation uncertainty was of course addressed in posterior distributions for unknown and latent variables as in usual way.	Not addressed.
5. The importance, ultimately, of developing models which incorporate natural variability in dynamic processes was emphasised, although it was recognised that this might not be possible for certain ecosystem modelling 'packages'. (R)	A climate index, the Pacific Decadal Oscillation (PDO) index, is initially considered whether it can be used as forcing function in Ecosim. However, it is not considered in actual modelling because it appear that influence of PDO on biomass dynamics in the modelling period (1994-2013) is not strong. But it is still on the to-do list in the further modelling especially if the modelling period is expanded to the past.	Partially addressed.
6. This is in addition to taking account of uncertainty in model structure and parameter values. (R)	To be addressed in future.	Not addressed.
7. If there are other predators making individual contributions to sand lance natural mortality of similar size to that estimated for minke whales, their explicit inclusion in this model must be considered. It agrees that Type I functional relationships are unrealistic and need not be considered further. As noted earlier, any results presented should distinguish yields of the prey species to predators and the fishery. (R)	Type II functional response is employed in the state-space delay-difference model in SC/F16/JR29, but any predator other than common minke whales has not been taken into account for the assessment of predation impact because of its potentially biggest consumption in the region.	Not addressed.
8. It is important to concentrate first on improving the Ecopath component of this EwE analysis before moving on to the next step of extending the modelling effort from a static to a dynamic model such as Ecosim. (R)	A series of pre-balance diagnostics, "PREBAL" (Link, 2010) is conducted for both the 2013 and 1994 models to evaluate the initial static energy budget of Ecopath before Ecosim modelling is conducted.	Addressed.
9a. The species included in the Ecopath analysis should be reviewed giving attention to Ecopath models developed for other regions; in particular the inclusion of gelatinous zooplankton should be considered.	Because EwE mainly focuses on offshore instead of coastal area, it appears that gelatinous zooplankton is not key species. In addition, such data are scarce so far. Presented EwE modelling mainly focus on interaction between forage fish and their predators and the number of predators in the model is increased from the previous one.	Addressed.
9b. Furthermore the values of the parameters of this Ecopath analysis should be compared with values for those others, with attention directed towards any instances of major discrepancies. (R)	Values of basic parameters are compared with other models qualitatively.	Partially addressed
10. The need to rebalance the Ecopath model. Alternative approaches to doing so should be considered. For example, rather than use values for some parameters drawn from other regions, placing a bound on some relationship (e.g. P/C<0.6) may lead to an improved result overall. (R)	A series of pre-balance diagnostics, "PREBAL" (Link, 2010) is conducted for both the 2013 and 1994 models to evaluate the initial static energy budget of Ecopath before Ecosim modelling is conducted.	Partially addressed.
11. To take full account of the uncertainties associated with model inputs (e.g. using Ecoranger3). (R)	Ecoranger is not used in the modelling as its development is little so far.	Not addressed.
12. Further work on Minimal Realistic Modelling approaches is encouraged and should focus in particular on fitting such models to time series of data. (R)	In a MRM off Sanriku region, various kinds of time series data such as CPUE, catch series and age composition were used for fitting the model. The model is considered as an integrated model, where weighting to likelihood components is influential to the results. At this moment, this issue has not been dealt well in the paper, but different effective sample sizes will be used to check the sensitivity/robustness	Not addressed.
Pollution		
1. In general, where possible, papers should include a risk assessment statement, summarising the potential risk from exposure to the various pollutants, based on current toxicology data in model species and other wildlife in terms of the health of the animals and dynamics of the stocks. (R/S)	Addressed in SC/F16/JR35.	Partially addressed.
2. Analyses be carried out by age when age data become available. (R)	Addressed in SC/F16/JR33.	Partially addressed.
3. Future studies also should examine levels in the liver to facilitate comparison with other studies. (R)	Addressed in SC/F16/JR33-34.	Addressed.
4. A GAM fitted to these data would be a better method for determining the change points and examining non-linear trends in the Hg levels. (R)	To be addressed in a new paper for IWC SC 66b.	Not addressed.
5. Future studies must be carried out on a lipid weight basis. (R)	Addressed in SC/F16/JR32.	Partially addressed.

6. Sampling for PCBs and Hg from the same individuals is undertaken to allow combined analyses of these often co-occurring contaminants. (R)	Addressed in SC/F16/JR34.	Partially addressed.
7. SC/J09/JR25 investigated the accumulation of total and methyl mercury and selenium in baleen and sperm whales from the western North Pacific. The Panel recommends that in a revised paper submitted to the 2009 Annual Meeting, greater emphasis is given to this important ecotoxicological finding. (R)	The recommendation was mainly for sperm whales, for which samples are limited.	Partially addressed
8. T-Hg total body burden estimates, additional organs (additional to liver, kidney and muscle) would need to be included (e.g. brain, skin, and blubber). (R)	To be addressed in future.	Not addressed.
9. Examine T-Hg in brain tissue particularly for comparing the more coastal bycaught animals to the coastal and offshore JARPN II samples, as these would provide a valuable (perhaps more exposed) comparison group. (S)	Sampling other than for genetics is not possible for by-catches.	Not addressed.
10. To continue comparative molecular phylogenetic research using mRNA isolated from fresh tissues. (S)	Addressed in SC/F16/JR36.	Addressed.
11. Any future contaminant exposure and uptake studies should be based on a balanced, structured study design with a specific number of individuals sampled within each strata (e.g. by species, sex, stage, ocean regime and location). All the necessary data on exposure and confounding variables should be obtained from all of the specifically targeted individuals and a control or comparison group should be included. In this way a more powerful and statistically robust study to address clearly stated hypotheses could be designed and carried out. (R)	In the pollutant studies, the number of samples and strata (location, period, sex, and maturity) examined was carefully considered in function of the objective of the study.	Partially addressed.
12. Tissues should be archived (frozen at –20°C or lower if possible) for future retrospective analyses. (R)	All tissues and organs such as muscle, liver, kidney and blubber of all whales sampled by JARPNII were stored at -20ºC. Unfortunately a substantial number of samples were lost after the 2001 earthquake and tsunami.	Addressed.
13. Priority to have absolute age as an additional covariate for the interpretation of the results. (R)	Age was incorporate as a covariate in the analyses conducted in SC/F16/JR33.	Partially addressed.
14. Use of bycaught J-stock animals as comparison group. (R)	Samples from by-catch are available only for genetic analyses and such samples are not suitable for pollutant analyses. However J stock animals (24) sampled by JARPNII in Sanriku were used for pollutant analysis (Hg) (see SC/F16/JR33).	Not addressed.
15. Include fatty acid profiles and stable isotope ratios. This would help discriminate among reasons for temporal changes (i.e. dietary changes or exposure variation with constant diet). (R)	Samples from JARPN/JARPNII have not been analysed for stable isotope ratios and fatty acid yet. Future analyses are being considered.	Not addressed.
16. Air and water samples obtained could have been useful in a 'fate and behaviour' study (R)	This was already addressed in SC/J09/JR24. However such kind of analyses have been stopped because levels of OC isomers in air and water samples were extremely low or under detection limit.	Addressed.
17. Simple mass balance studies (input-output estimates) would contribute to our knowledge of the partitioning and offloading of contaminants in these species and the potential impact of changes in exposure. For this, additional analyses of blood, bile, faeces and urine are required. (R)	Preliminary attempts were made but results were not satisfactorily at this stage. Further attempts will be made in future.	Not addressed.
18. The contaminant results should eventually be linked to the prey consumption studies. (R)	Addressed in SC/F16/JR30 and SC/F16/JR31.	Partially addressed.
19. Undertake power analyses for relationship between N and ability to detect changes at various levels. (R)	To be addressed in future.	Not addressed.
20. Evaluate covariates (e.g. age and sex) to determine animals chosen for more extensive sampling. (R)	Addressed in SC/F16/JR33, and will be further addressed in future.	Partially addressed.
21. In terms of sampling strategy, the value of examining the same individuals for each of the contaminants is emphasised. (R)	To be addressed in future.	Not addressed.

References

Fujise, Y., Aoki, M., Niimi, S., Hakamada, T., Nakata, H., Honda, K. and Tanabe, S. 2000. An attempt to identify stocks in the western North pacific minke whale (*Balaenoptera acutorostrata)* using the accumulation levels of heavy metals and organochlorines as ecological tracers. Paper SC/F2K/J18 presented at the JARPN Review Meeting, Tokyo, Japan, 7-10 February 2000 (unpublished). 18pp. [Paper available from the Office of this Journal].

Hakamada, T. and Bando, T. 2009. Further morphometric analysis on stock structure in the western North Pacific common minke whales (*Balaenoptera acutorostrata*). Paper SC/61/JR6 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 4pp. [Paper available from the Office of this Journal].

Kanda, N., Goto, M., Kishiro, T., Yoshida, H., Kato, H. and Pastene, L.A. 2009. Update of the analyses on individual identification and mixing of the J and O stocks of common mike whales around Japanese waters examined by microsatellite analysis. Paper SC/61/JR5 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 14pp. [Paper available from the Office of this Journal].

Kanda, N., Goto, M., Oikawa, H. and Pastene, L.A. 2014. Update of note on sampling and laboratory procedure protocols of the genetic work at the Institute of Cetacean Research (SC/65b/J27rev). Paper SC/65b/DNA01 presented to the IWC Scientific Committee, May 2014, Bled, Slovenia (unpublished). 6pp. [Paper available from the Office of this Journal].

Kanda, N., Park, J.-Y., Goto, M., An, Y.-R., Choi, S.-G., Moon, D.-Y., Kishiro, T., Yoshida, H., Kato, H. and Pastene, L.A. 2010. Genetic analyses of western North Pacific minke whales from Korea and Japan based on microsatellite DNA. Paper SC/62/NPM11 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 13pp. [Paper available from the Office of this Journal].

Kishiro, T. and Miyashita, T. 2011. Satellite tracking of a common minke whale in the coastal waters off Hokkaido, northern Japan in 2010. Paper SC/63/RMP10 presented to the IWC Scientific Committee, June 2011, Tromsø, Norway (unpublished). 10pp. [Paper available from the Office of this Journal].

Link, J.S. 2010. Adding rigor to ecological network models by evaluating a set of pre-balance diagnostics: A plea for PREBAL. *Ecol. Model.* 221: 1582-93.

Murase, H., Tamura, T., Isoda, T., Okamoto, R., Yonezaki, S., Watanabe, H., Tojo, N., Matsukura, R., Miyashita, K., Kiwada, H., Matsuoka, K., Nishiwaki, S., Inagake, D., Okazaki, M., Okamura, H., Fujise, Y. and Kawahara, S. 2009. Prey preferences of common minke (*Balaenoptera acutorostrata*), Bryde's (*B. edeni*) and sei (*B. borealis*) whales in offshore component of JARPN II from 2002 to 2007. Paper SC/J09/JR18 presented to the Expert Workshop to Review Results of JARPN II, 26-30 January 2009, Tokyo, Japan (unpublished). 31pp. [Paper available from the Office of this Journal].

Murase, H., Tamura, T., Kiwada, H., Fujise, Y., Watanabe, H., Ohizumi, H., Yonezaki, S., Okamura, H. and Kawahara, S. 2007. Prey selection of common minke (*Balaenoptera acutorostrata*) and Bryde's (*Balaenoptera edeni*) whales in the western North Pacific in 2000 and 2001. *Fisheries Oceanography* 16(2): 186-201.

Murase, H., Tamura, T., Otani, S. and Nishiwaki, S. 2016. Satellite tracking of Bryde's whales *Balaenoptera edeni* in the offshore western North Pacific in summer 2006 and 2008. *Fisheries Science* DOI 10.1007/s12562-015-0946-8. [Published paper].

Nakata, H., Tanabe, S., Niimi, S., Minh, T.B., Sakakibara, A., Fujita, K. and Fujise, Y. 2000. Population structure in minke whale from the North Pacific examined by the persistent organic pollutants as chemical tracers. Paper SC/F2K/J17 presented at the JARPN Review Meeting, Tokyo, Japan, 7-10 February, 2000 (unpublished). 9pp. [Paper available from the Office of this Journal].

Park, J.Y., Goto, M., Kanda, N., Kishiro, T., Yoshida, H., Kato, H. and Pastene, L.A. 2010. Mitochondrial DNA analyses of J and O stocks common minke whale in the western North Pacific. Paper SC/62/NPM21 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished) 10pp. [Paper available from the Office of this Journal].

Skaug, H. and Daníelsdóttir, A.K. 2006. Relatedness of North Atlantic fin whales. Paper SC/58/PFI9 presented to the IWC Scientific Committee, May 2006, St. Kitts and Nevis, West Indies (unpublished). 8pp. [Paper available from the Office of this Journal].

Taylor, B.L. and Martien, K. 2002. Interpretation of Boundary Rank results for North Pacific minke whales. Paper SC/J02/NP2 presented to the Scientific Committee Workshop on North Pacific common minke (*Balaenoptera acutorostrata*) *Implementation Simulation Trials* held in Seattle, USA, 19-22 January, 2002 (unpublished). [Paper available from the Office of this Journal].

Watanabe, H., Okazaki, M., Tamura, T., Konishi, K., Inagake, D., Bando, T., Kiwada, H. and Miyashita, T. 2012. Habitat and prey selection of common minke, sei and Bryde's whales in mesoscale during summer in the subarctic and transition regions of the western North Pacific. *Fisheries Science* 78: 557-67. [Published paper].

Annex E

Summary of Panel recommendations

(see main report for full text and explanations)

	Sampling design and areas (Item 3.4.2.1)	**TIMELINE**
(1) (2)	A new paper that in addition to the information on sightings, it should document, for each year and season: (a) the predetermined tracklines for sampling and the rationale for those lines; and (b) the actual coverage of those tracklines and the rationale for any decisions taken to deviate from the predetermined lines including the rationale for any new lines developed. It should also address the issue of whether the actual sampling that occurred can be said to be representative of (a) the animals in the surveyed area and (b) those in the biological population(s) and discuss the extent to which this may affect those objectives/parameters/analyses for which this is or may be important. Papers using data from the inshore component must fully address the implications of the logistical rather than scientific sampling design.	2016 Annual Meeting of the Scientific Committee
	Sample size (Item 3.4.2.2)	
(3)	A new paper should be developed that: (a) provides a clearer rationale for the changes in sample sizes and any implications for meeting the original objectives of the programme; and (b) provides the field and analytical protocols for the comparison of using lethal and non-lethal techniques for each key parameter taking into account the advice provided in 2009.	2016 Annual Meeting of the Scientific Committee
	Stock structure (Item 4.4.3)	
(4) (5) (6)	All inferences regarding 'randomness' of observations (e.g., satellite tracks, mitochondrial DNA haplotypes and unassigned common minke whales) should be substantiated by a statistical assessment of the presumed randomness. The presence of multiple stocks within sample partitions should be assessed (employing, e.g., STRUCTURE and DAPC). More explicit information on quality checks be provided in each study as well as study-specific estimates or genotyping and DNA sequencing error rates.	2016 Annual Meeting of the Scientific Committee (or 2017 at the latest)
(7) (8) (9) (10)	To facilitate more definitive discrimination between single and multiple stock hypotheses, undertake work to determine the demographic dispersal rates among areas at which whales in different areas can be managed as a single stock. Identifying 'critical' dispersal rates by specific case and the corresponding levels of genetic divergence, should enable such discrimination. The approach of Van der Zee and Punt (2014) is commended. This will allow the development of a working definition of a 'stock'. Analytical approaches should be applied that do not assume mutation-drift-migration equilibrium (Hey, 2010). Serious consideration should be given to using genome-wide SNP genotyping approaches, such as RAD sequencing and GBS (Elshire *et al.*, 2011; Miller *et al.*, 2007). This will increase the data per sample thereby improving the accuracy and precision of genetic parameter estimates and facilitate additional analyses (Hey and Machado, 2003; Robinson *et al.*, 2014). A focussed satellite tagging programme should be developed to greatly increase sample size to assess individual migration in the context of stock structure hypotheses more thoroughly.	Expected to be completed 2-3 years after the 2016 Annual Meeting
	Feeding ecology and ecosystem studies – Oceanography (Item 5.4.3.1)	
(11)	Chl-*a* concentration should be examined as a potential proxy for the food environment for whales .	Within 2 years of the 2016 Annual Meeting
(12)	Oceanographic monitoring is required to compare with prey species distribution and abundance in the new 'decadal regime'	Several years

	Feeding ecology and ecosystem studies – Distribution (Item 5.4.3.2)	
(13)	With respect to papers SC/F16/JR7; Murase *et al.* (2014) [SC/F16/JR08]; SC/F16/JR09; Sasaki *et al.* (2013) [SC/F16/JR10] and SC/F16/JR16, develop revised versions that: (a) include statistical summaries on model fit (R^2 and % deviance explained) and model comparison and spatial covariate selection (e.g. AIC, GCV scores); (b) avoid extrapolation of the regression models outside to data-poor areas or areas lacking coverage (especially when combining food consumption with sightings data); and *(c)* include variance plots of the fitted prediction surfaces in order to address precision and data sparseness.	2016 Annual meeting
(14) (15)	Considerable effort be put into the methodological improvement of the spatial modelling in the various analysis related with the objectives on distribution of large whales and oceanography. A particular focus must be on the combination of survey data from the different years to make them more comparable in terms of distribution (and abundance) over time; use of data from other sources (e.g. the IWC POWER programme). This work is not only valuable in itself but is essential for a better parameterisation of ecosystem models. Additional effort be placed on fulfilling the 2009 recommendation with respect to the photo-identification data to contribute to the understanding of large scale movements and whale distribution within and outside the JARPN II survey area for several species.	Expected to be completed 2-3 years after the 2016 Annual Meeting
	Feeding ecology and ecosystem studies – Abundance (Item 5.4.3.3)	
(16) (17)	Explore methods to account for sampling differences between areas and years to obtain measures of short- and long-term variation and trends and estimates the extent of additional variance due to changes over time in spatial distribution (essential for modelling efforts, for example, in food consumption models and ecosystem models); Compare results from the design-based estimates of abundance with those of model-based estimates to potentially address problems of unequal sampling coverage between surveys and to potentially account for additional sources or causes of variability.	Expected to be completed 2-3 years after the 2016 Annual Meeting
	Feeding ecology and ecosystem studies - Field and laboratory studies (Item 6.4.3)	
(18) (19)	The sampling distribution for the parameters should be used in the assessment of the uncertainty associated with the estimation of consumption. Clarification should be provided on how density and diet consumption have been extrapolated outside the areas and months covered during the surveys and diet studies.	2016 Annual Meeting of the Scientific Committee (or 2017 at the latest)
(20) (21) (22) (23)	All sources of uncertainty should be quantified and an evaluation of which parameters contribute the most to uncertainty be conducted and taken into account in the analyses and modelling. The studies on allometric relationships should be developed further to refine the range of suitable allometric-energy intake/consumption relationships. The analyses of diet composition should consider the effect of seasonal changes in energy density of the various prey species. Stable isotope analysis of whale tissues and their prey should be introduced not only into the assessment of diet, but also to statistically evaluate overlap in distribution and trophic niche between baleen whale species.	Expected to be completed 2-3 years after the 2016 Annual Meeting
	Feeding ecology and ecosystem studies – Ecosystem modelling (Item 7.4.3)	
(25) (26) (27) (28)	Generic recommendations identified by the 2009 Panel remain. Establish clear objectives on the ultimate use of the models to make further progress (e.g. better understanding ecosystem linkages, delivering advice for fishery management) – ecosystem models are not suitable for tactical management. Use models in concert e.g. use food web modelling to establish key predation linkages for extended single-species or multispecies models. In such a way the suite of available modelling tools can be used to integrate available knowledge. Use stable isotopes to provide information on long term feeding patterns and inform models about trophic relationships between whales and their prey (see also Item 6.4).	Expected to be completed 2-3 years after the 2016 Annual Meeting
(29)	With respect to the EwE modelling: (a) evaluate data quality for each input parameter (the 'pedigree': e.g. Gaichas *et al.* (2015) to characterise uncertainty in model inputs; (b) further evaluate PREBAL and other diagnostics; (c) present more clearly and evaluate further the estimated vulnerabilities and other fit diagnostics (including sensitivity analysis using ranges of consumption estimates).	Within 2 years of the 2016 Annual Meeting

(30)	With respect to extended single-species modelling: (a) ensure that the majority of predation mortality is captured; (b) carry out additional diagnostics: (1) examine the fits to (a) fishery-independent survey data, (b) proportion information and (c) trends in fishing mortality; (2) use posterior predictive checks to evaluate Bayesian model. (c) provide thorough justification for the current spatial boundaries of the model and the use of fishery CPUE as an index of abundance. (d) focus the model fitting on the fishery-independent survey if CPUE not considered likely to index abundance; (e) examine sensitivity to alternative plausible functional forms of the feeding relationship; (f) explore the causes of the implausible posteriors (e.g. SC/F16/JR29) by changing the weights assigned to the data sources and fitting the model.	Within 2 years of the 2016 Annual Meeting
	Monitoring environmental pollutants in cetaceans and marine ecosystem (Item 8.4.3)	
(31) (32) (33) (34)	To improve the statistical analyses based on clear and well-formulated hypotheses. Recalculate OC concentrations as values on a lipid weight basis, and Hg concentrations on a dry weight basis. Explore trends in pollutant concentrations using generalized additive models (GAMs) or other non-linear approaches, in addition to the linear models. Evaluate the pollutant concentrations found in comparison with data from previous studies conducted in comparable species and available in the literature.	2016 Annual Meeting of the Scientific Committee (or 2017 at the latest)
(35) (36) (37)	Since body length is a poor proxy for age, particularly in sexually mature whales, incorporate age data into the multivariate analysis of pollutant concentrations as soon as they become available. To include stable isotope values in the analyses to investigate the bioaccumulation process of pollutants through the food chain. To assess more widely the risk that these chemical pollutants present to the populations' abundance or distribution.	Expected to be completed 2-3 years after the 2016 Annual Meeting
	Ageing (Item 9.1.2)	
(38)	To investigate into whether there is any relationship between age or sex and readability that may affect the representativeness of the earplugs that can be read.	Within 2 years of the 2016 Annual Meeting
(39)	To age as many of the existing samples as possible and to incorporate age where appropriate in updated analyses (e.g. see the recommendations on pollutant studies).	
	Recommendations to the Scientific Committee on process (Item 11)	
(40)	The Panel recommends that the Scientific Committee considers: (a) including a guideline either relating to the minimum time after completion of a programme that a final review can take place or establishing a small review group to determine whether the materials available are for a review workshop; (b) adopt guidelines for an integrated final report by the proponents (see Annex F). (c) to consider a mechanism for proponents to provide a short biennial update on progress with recommendations. (d) develop a mechanism to allow for the completion of expert Panel reviews if a Panel states that its review is incomplete until further information/analyses is provided.	At any periodic or final review.

References

Elshire, R.J., Glaubitz, J.C., Sun, Q., Poland , J.A., Kawamoto, K., Buckler, E.S. and Mitchell, S.E. 2011. A robust, simple genotyping-by-sequencing (GBS) approach for high diversity species. *PLOS ONE* 6.

Gaichas, S., Aydin, K. and Francis, R.C. 2015. Wasp waist or beer belly? Modeling food web structure and energetic control in Alaskan marine ecosystems, with implications for fishing and environmental forcing. *Progress in Oceanography* 138: 1-17.

Hey, J. 2010. Isolation with migration models for more than two populations. *Molecular Biology and Evolution* 27: 905-20.

Hey, J. and Machado, C.A. 2003. The study of structured populations - new hope for a difficult and divided science. *Nature Reviews Genetics* 4: 535-43.

Miller, M.R., Dunham, J.P., Amores, A., Cresko, W.A. and Johnson, E.A. 2007. Rapid and cost-effective polymorphism identification and genetyping usinf restriction site associated DNA (RAD) markers. *Genome Research* 17: 240-48.

Murase, H., Hakamada, T., Matsuoka, K., Nishiwaki, S., Inagake, D., Okazaki, M., Tojo, N. and Kitakado, T. 2014. Distribution of sei whales (*Balaenoptera borealis*) in the subarctic-subtropical transition area of the western North Pacific in relation to oceanic fronts. *Deep Sea Research Part II* 107: 22-28. [Published paper].

Robinson, J.D., Bunnefield, L., Hearn, J., Stone, G.N. and Hickerson, M.J. 2014. ABC inference of multi-population divergence with admixture from unphased population genomic data. *Molecular Ecology* 23: 4458-71.

Sasaki, H., Murase, H., Kiwada, H., Matsuoka, K., Mitani, Y. and Saitoh, S.I. 2013. Habitat differentiation between sei (*Balaenoptera borealis*) and Bryde's whales (*B. brydei*) in the western North Pacific. *Fisheries Oceanography* 22(6): 496-508. [Published paper].

Van der Zee, J.P. and Punt, A.E. 2014. Evaluting ciritical dispersal rates for whale management under the IWCs Revised Management Procedure: an application for North Atlantic common minke whales. *J. Cetacean Res. Manage* 14: 125-32.

Annex F

Proponents' response to Panel request for information on trackline designs and realised tracklines for JARPN II by year and season

DESIGN OF TRACK LINES IN JARPN II SURVEYS

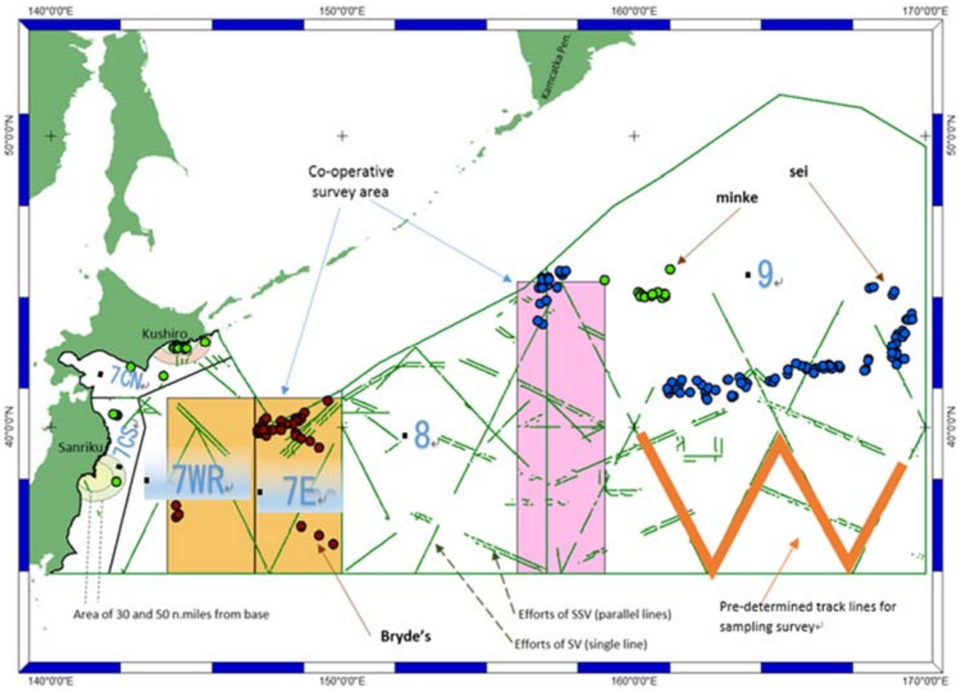

Fig. 1. Overview of the survey design under the JARPNII. There are several surveys components under the JARPNII: dedicated sighting survey; whales sampling surveys (coastal and offshore); concurrent whale/prey surveys in offshore areas; and prey surveys in coastal areas (see details of each survey below*). In the figure, pre-determined track lines for whale sampling surveys in the offshore component are shown in orange; on effort track lines of dedicated sighting (single line) and whale sampling (parallel lines) surveys in green. Concurrent whale/prey surveys are shown by color squares. Only the research areas are shown for Sanriku and Kushiro.

Dedicated sighting survey

Sighting surveys were conducted following the IWC survey guidelines. Zig-zag-shaped track lines were set in the research area independently from the whale sampling surveys. The whole research area was covered in early (April to June) and late (July to September).

Whale sampling survey (offshore component)

The survey order of sub-area/strata was decided based on seasonal distribution of whales and logistics, and zigzag-shaped track lines were set in the research area, reflecting the available information such as surface temperature. The track line consisted of one main and two parallel courses established seven n.miles apart from the main course. The Special Monitoring Survey (SMS) was conducted in areas where the density of targeted whale species were expected to be high. Track lines in the SMS were designed independently from the original track lines. The track lines of SMS consisted of one main and two parallel courses established seven n. miles apart from the main course. Design of track lines were determined by the cruise leader on the research base vessel.

Concurrent whale/prey surveys (offshore component)

For these surveys meso-scale research areas were defined in some years considering physical environmental information such as surface temperature. Zigzag-shaped track lines were set in the research area and both whale sampling vessels and prey survey vessels conducted surveys along the same track lines within a week. Prey survey vessel conducted quantitative echo-sounder, net sampling and oceanographic surveys.

Whale sampling survey (coastal component)
The predetermined course (direction from the port) at an angle of regular intervals (usually 10-15 degree intervals) were set up, and allocated to each research vessel. The vessels continued to search along the course until common minke whales were sighted, or until they reached 30 n. miles from the port. After 30 n. miles, the vessels changed the course freely within a 50 n. miles radius from the port. The predetermined course is changed every day to cover broad areas. When whales were caught, the vessels returned to the port to transport the animal to the research land station. After landing the whale, the vessel re-departed to the research area.

Prey survey (coastal component off Sanriku)
Since 2005, the prey survey area was divided into ten blocks (A, B, C, D, E, F, G, H, I, and J) based on bottom depth (20, 40, 100, and 200m), and prefectural boundaries (boundary between Miyagi and Fukushima Prefectures). Because of logistical constraint, the number of blocks changed in each year. In 2008 and 2009, six blocks (B, C, E, D, E and F) were surveyed. Saw tooth type zigzag lines were used in each survey. The survey was conducted during the daytime from an hour after sunrise to an hour before sunset. The research vessel used was a trawler-type vessel. The prey species were investigated using a quantitative echo sounder (EK 500; Simrad, Norway) and net sampling. Prey surveys were conducted during the survey period of whale sampling survey and independently from the whale sampling surveys.

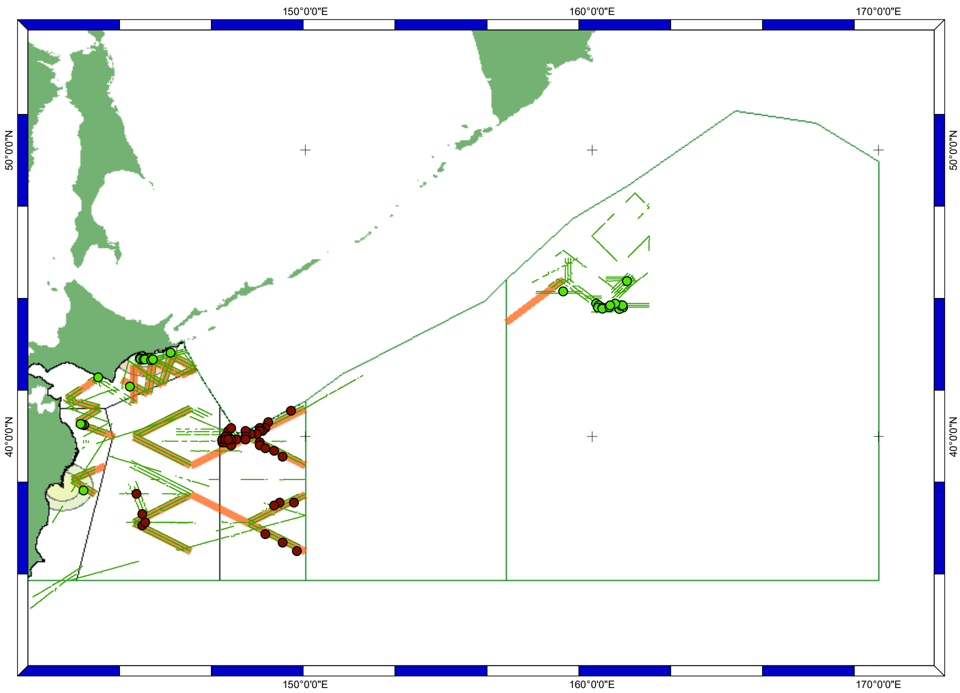

Figure 2. 2000 JARPNII in late season (July, August, September and October)
The survey in 2000 was conducted only in late season.

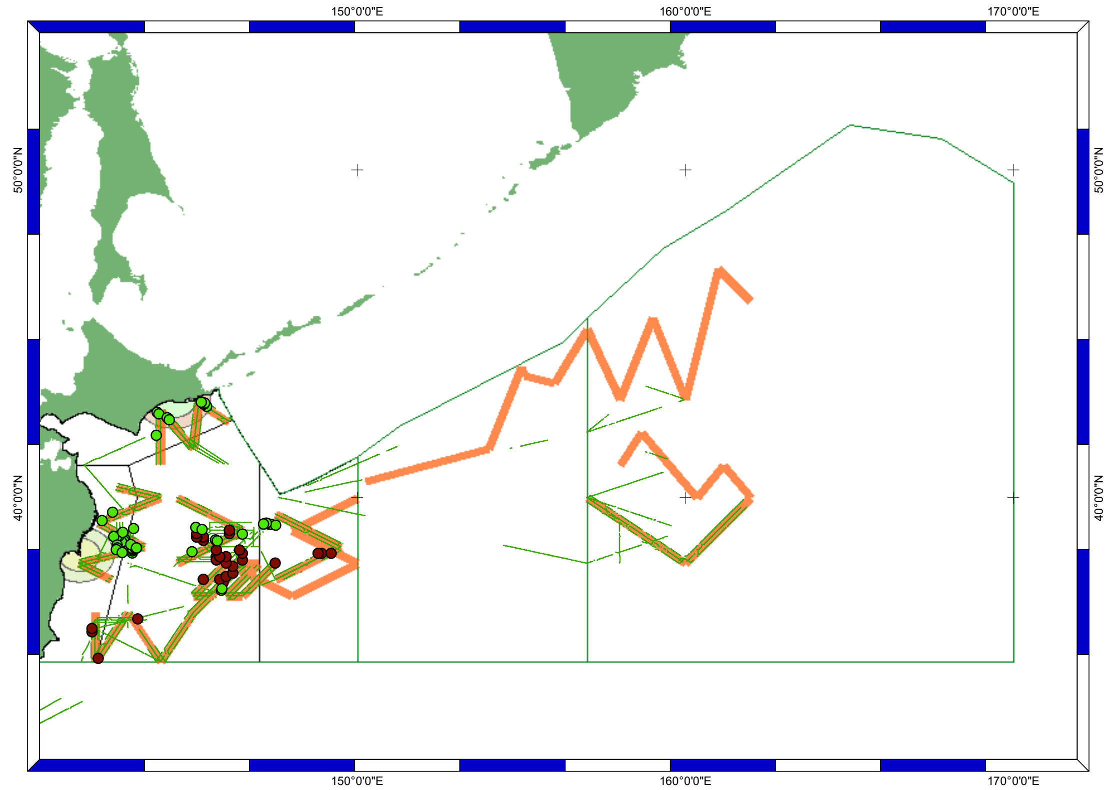

Figure 3. 2001 JARPNII in early season (April, May and June).

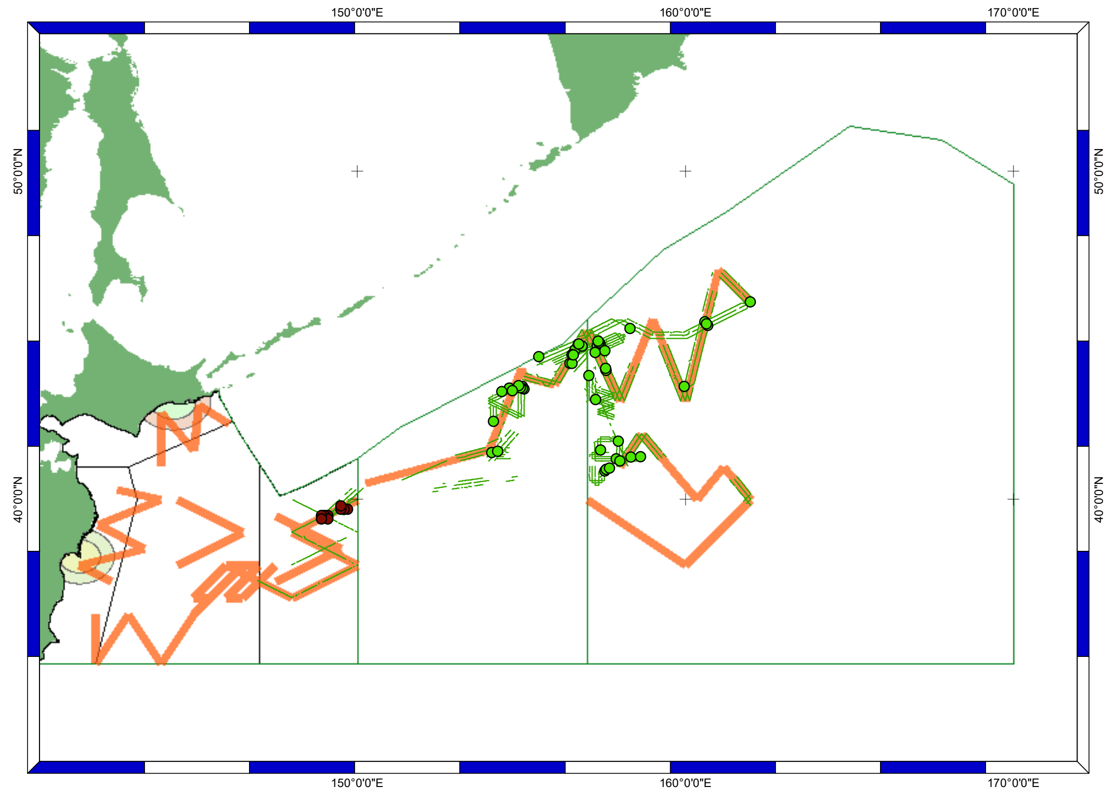

Figure 4. 2001 JARPNII in late season (July, August, September and October).

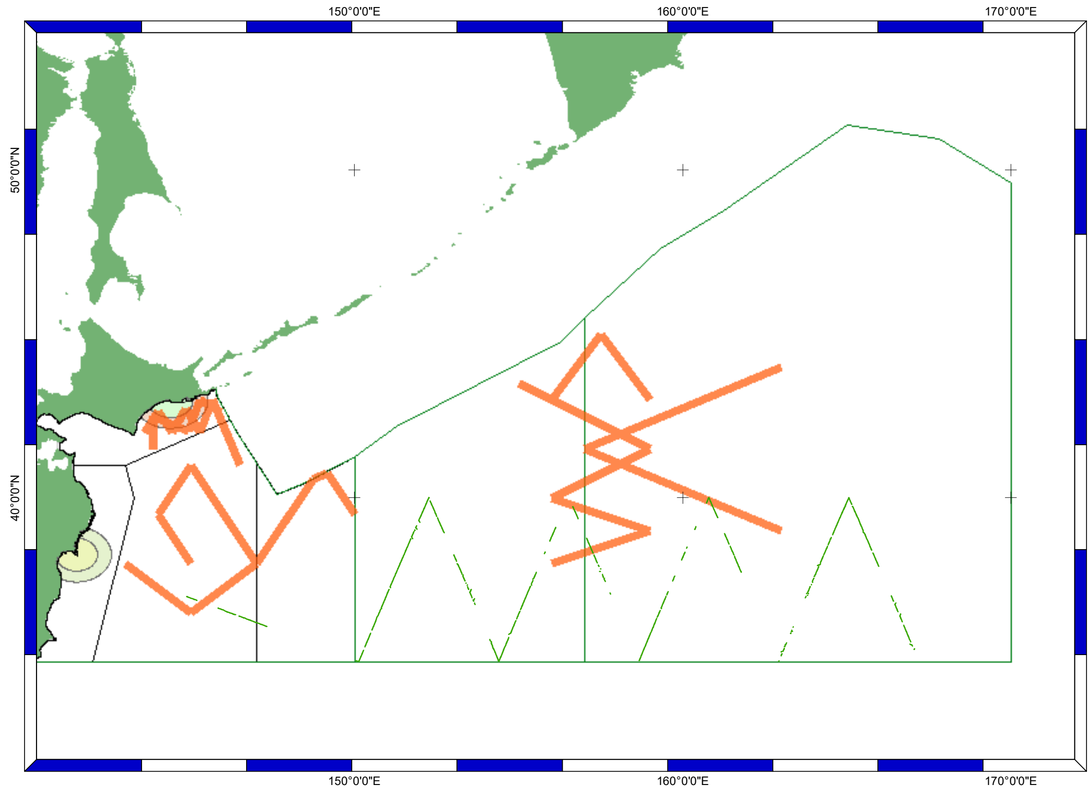

Figure 5. 2002 JARPNII in early season (April, May and June).

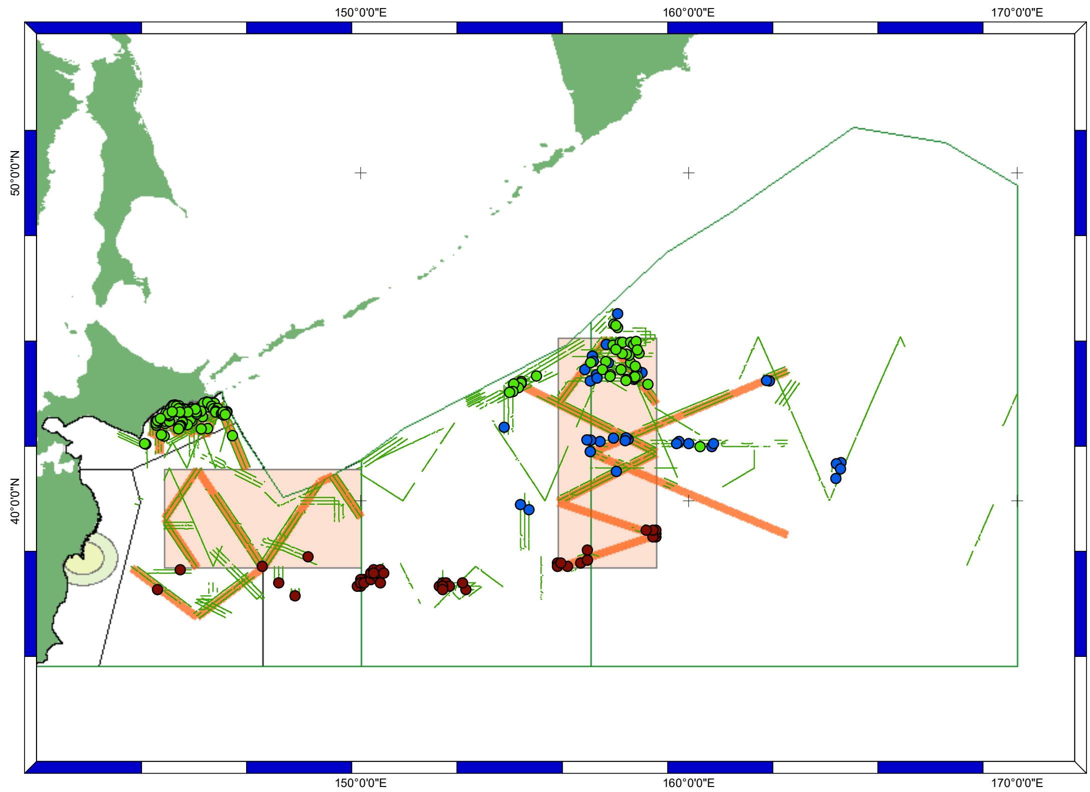

Figure 6. 2002 JARPNII in late season (July, August, September and October).

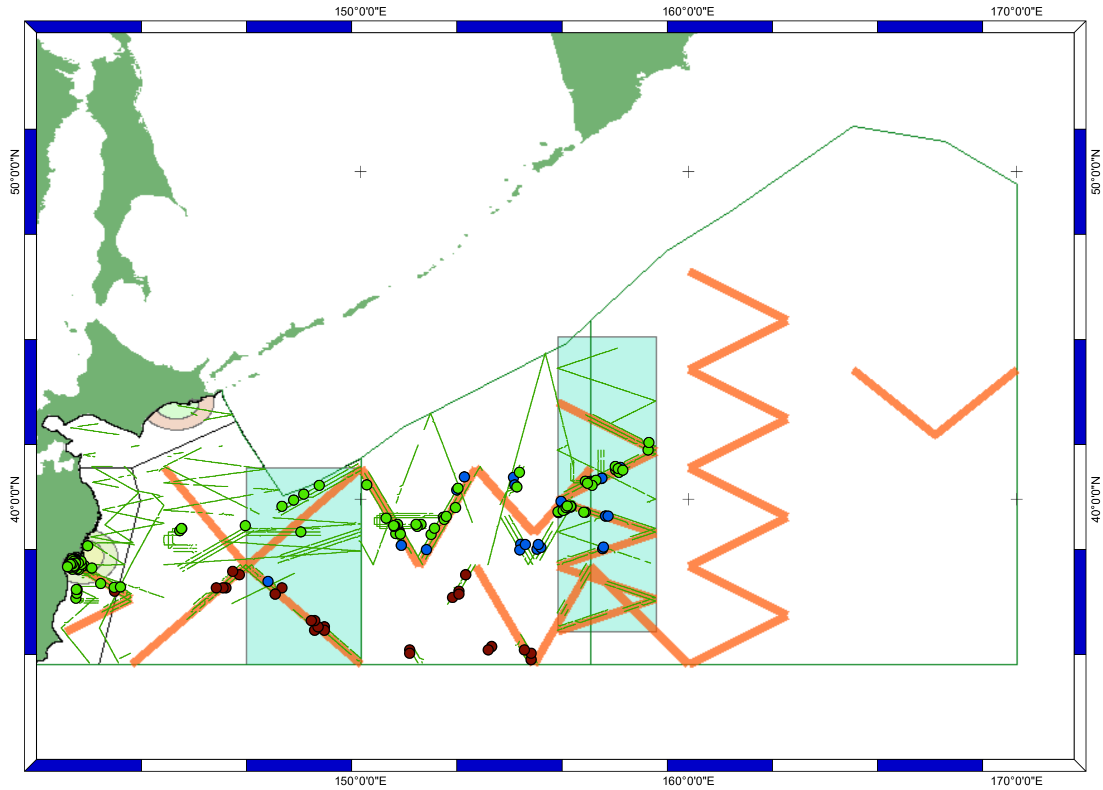

Figure 7. 2003 JARPNII in early season (April, May and June).

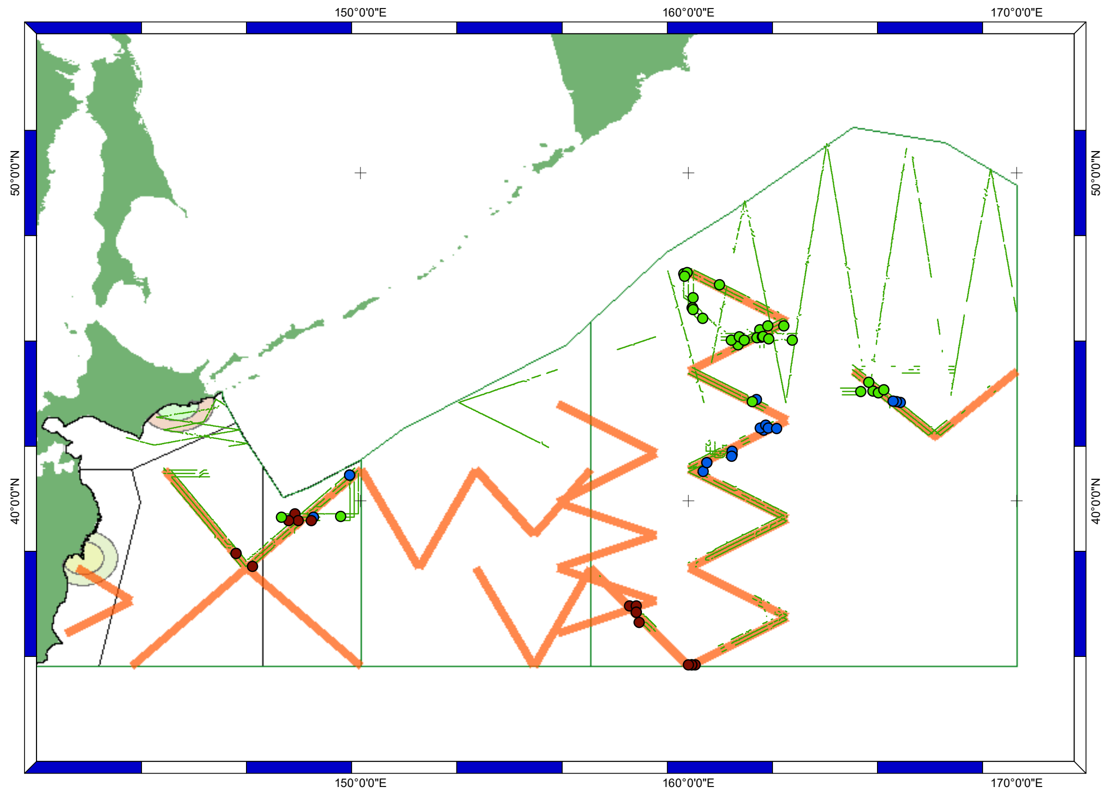

Figure 8. 2003 JARPNII in late season (July, August, September and October).

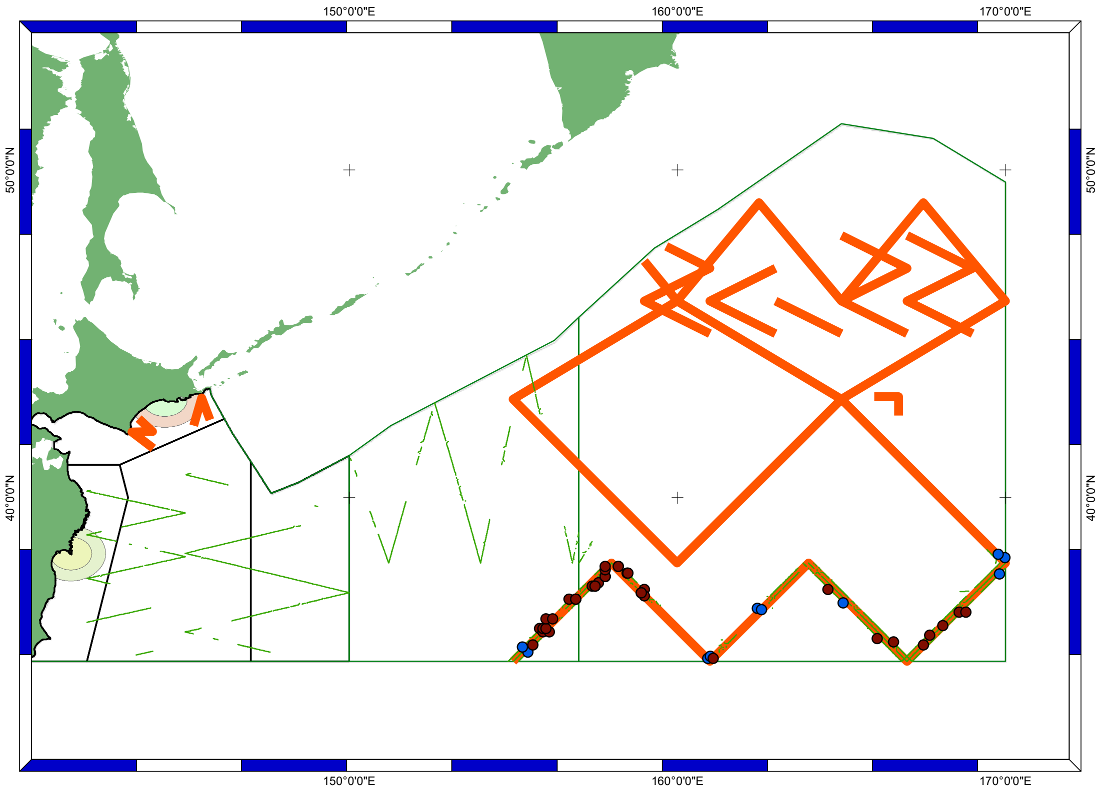

Figure 9. 2004 JARPNII in early season (April, May and June).

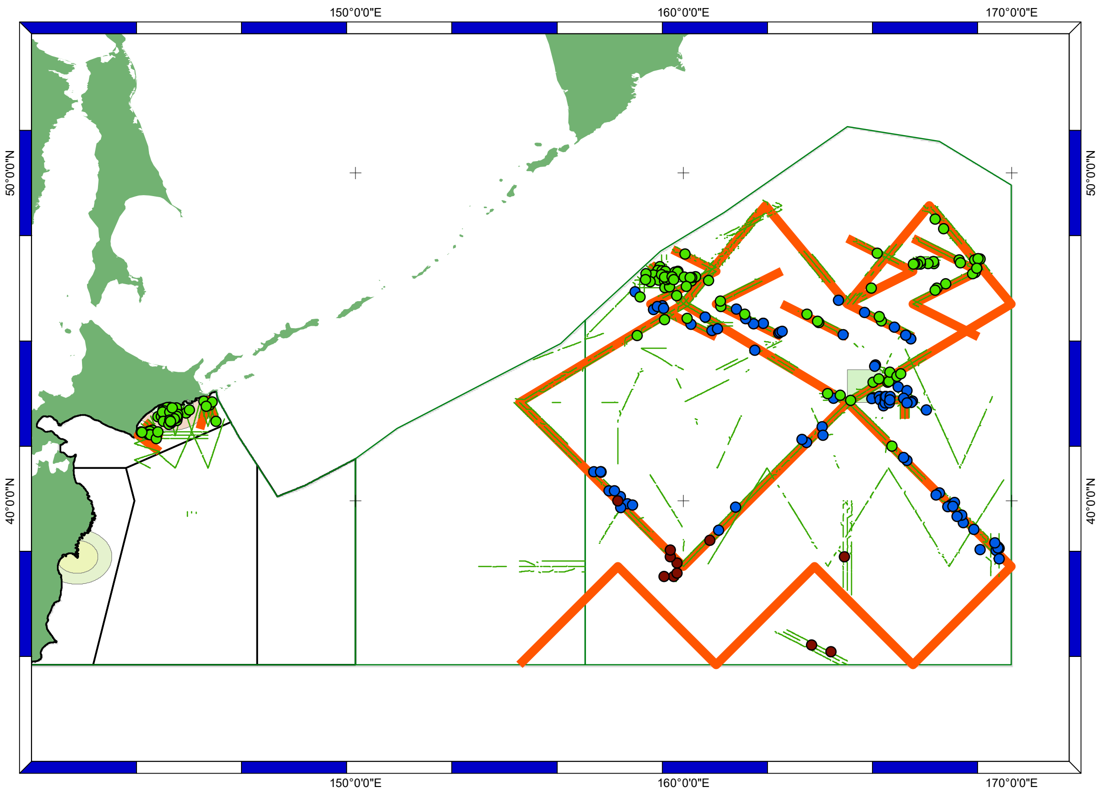

Figure 10. 2004 JARPNII in late season (July, August, September and October).

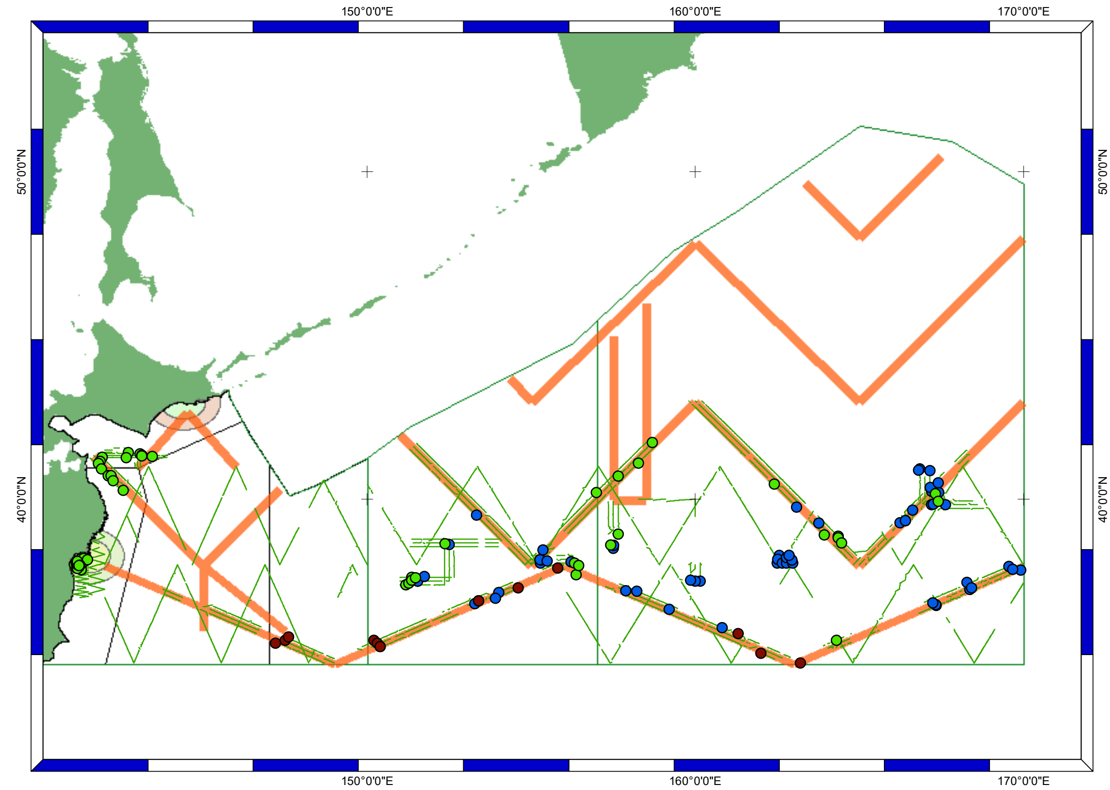

Figure 1 2005 JARPNII in early season (April, May and June).

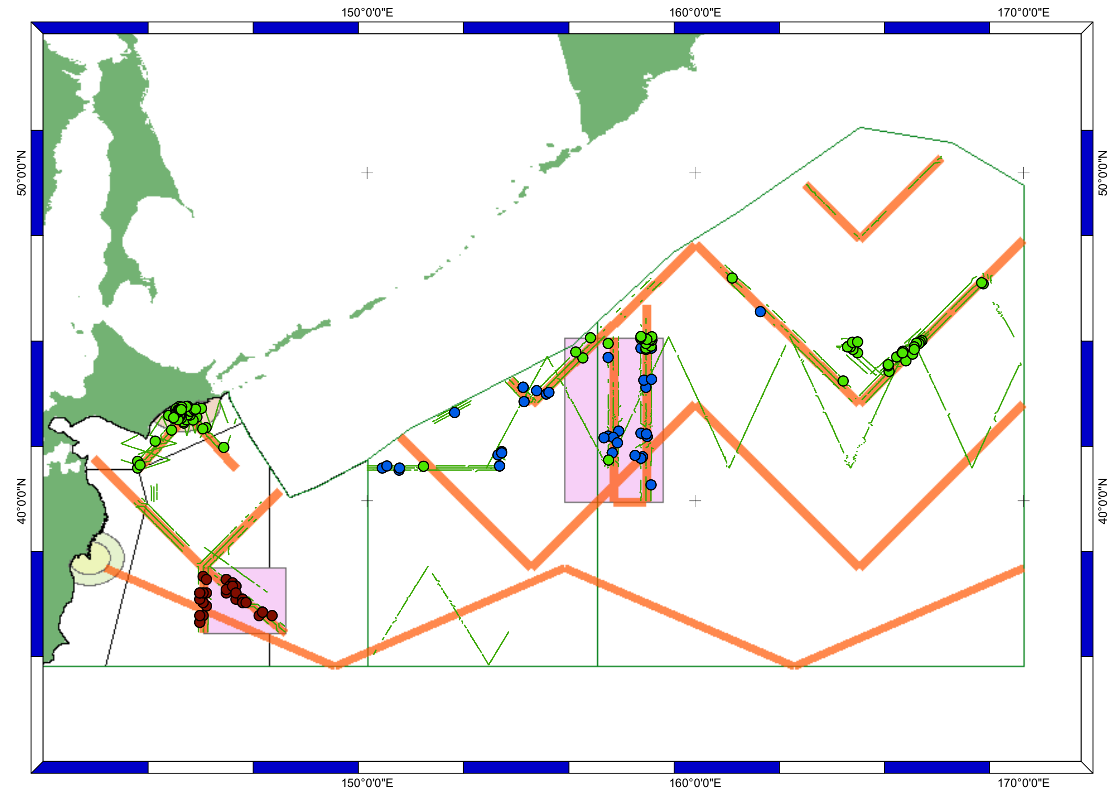

Figure 12. 2005 JARPNII in late season (July, August, September and October)

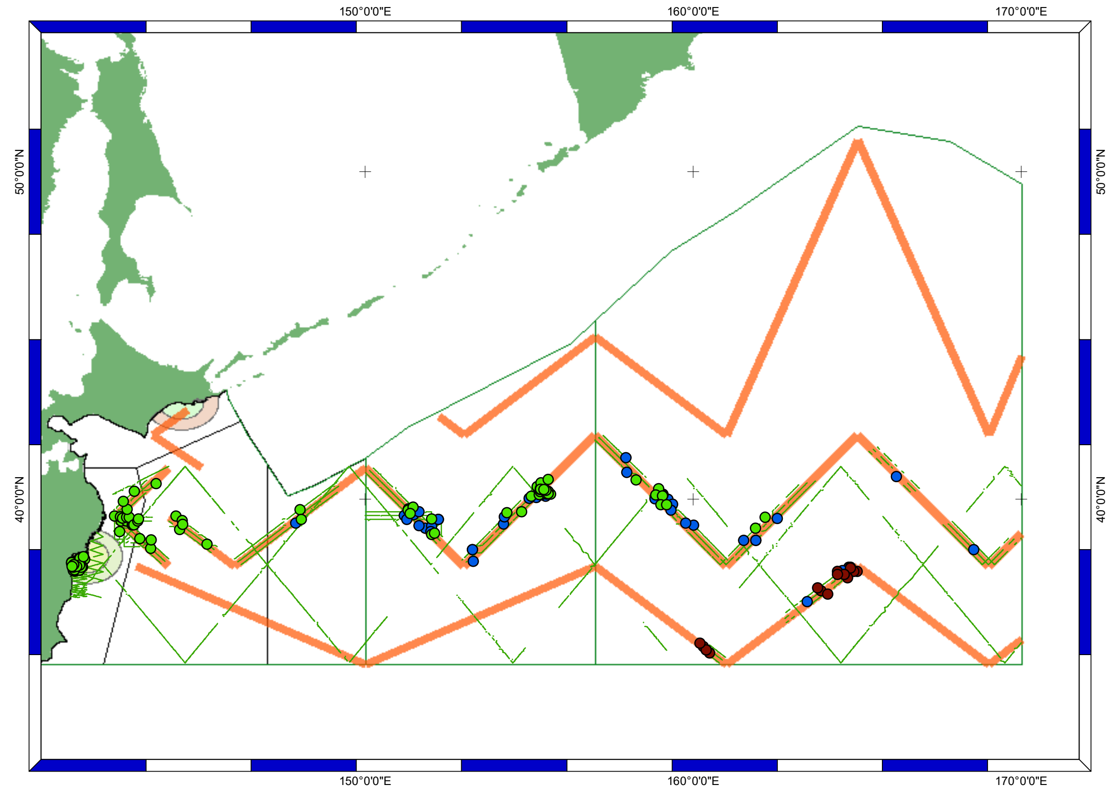

Figure 13. 2006 JARPNII in early season (April, May and June).

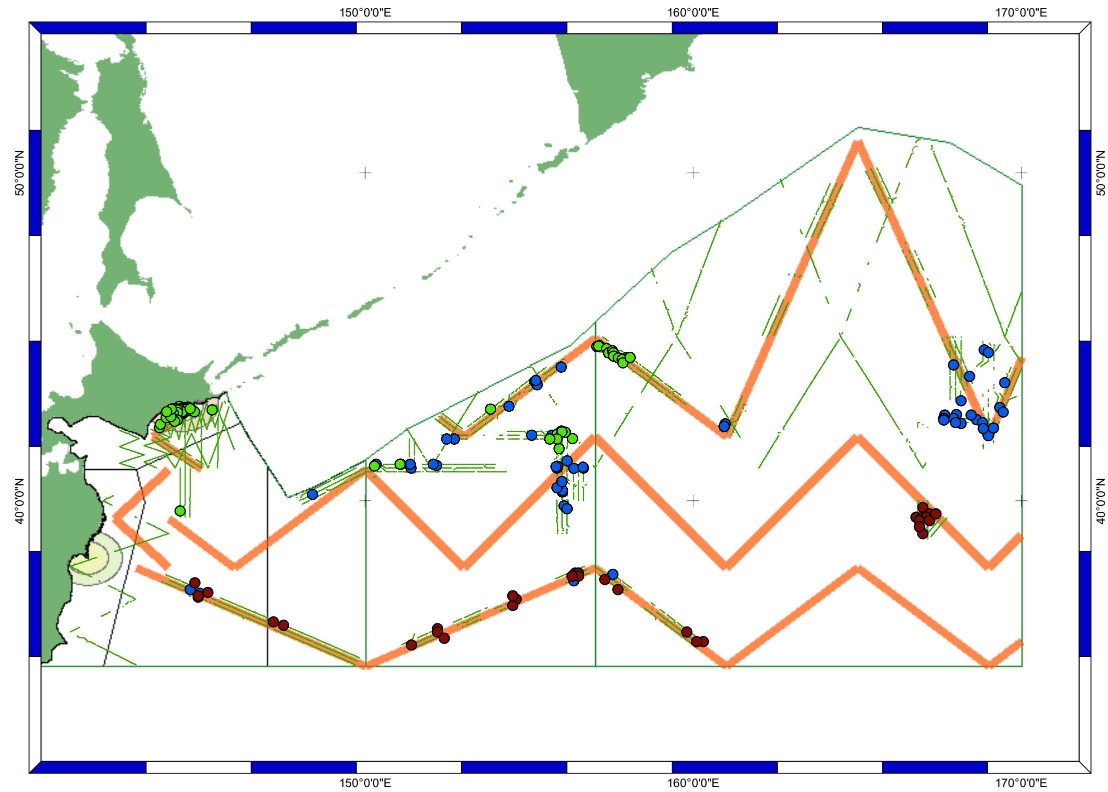

Figure 2 2006 JARPNII in late season (July, August, September and October)

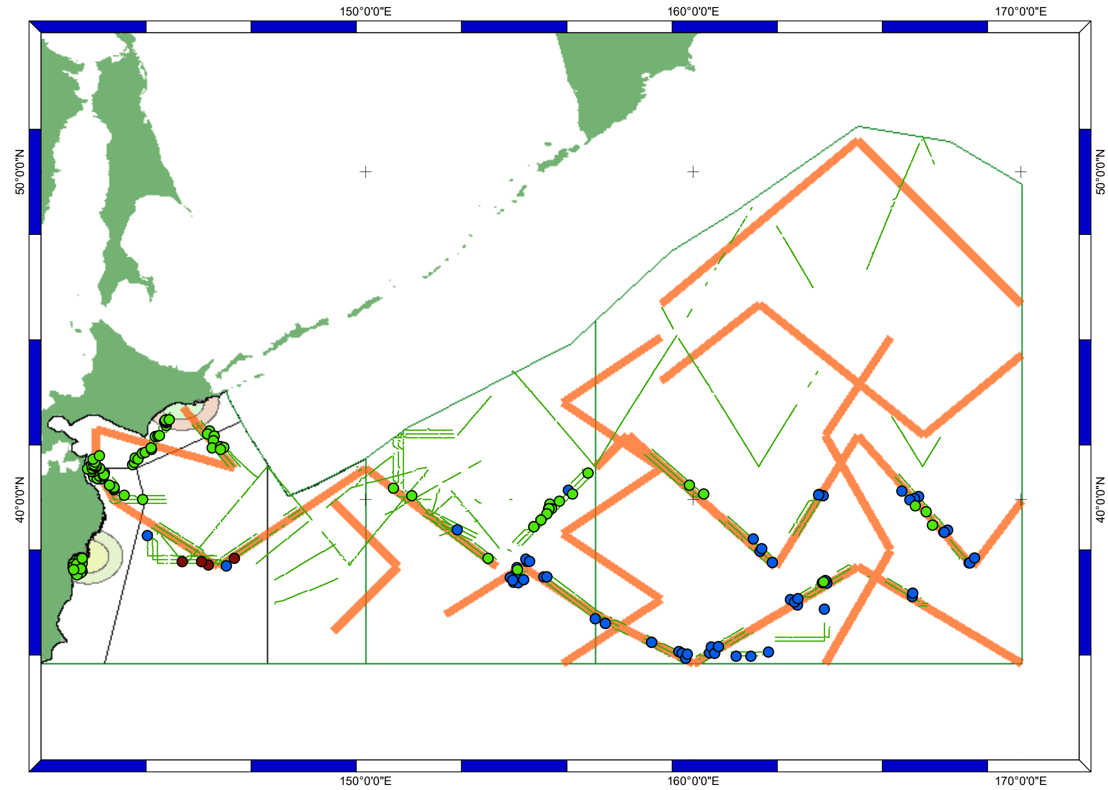

Figure 3 2007 JARPNII in early season (April, May and June)

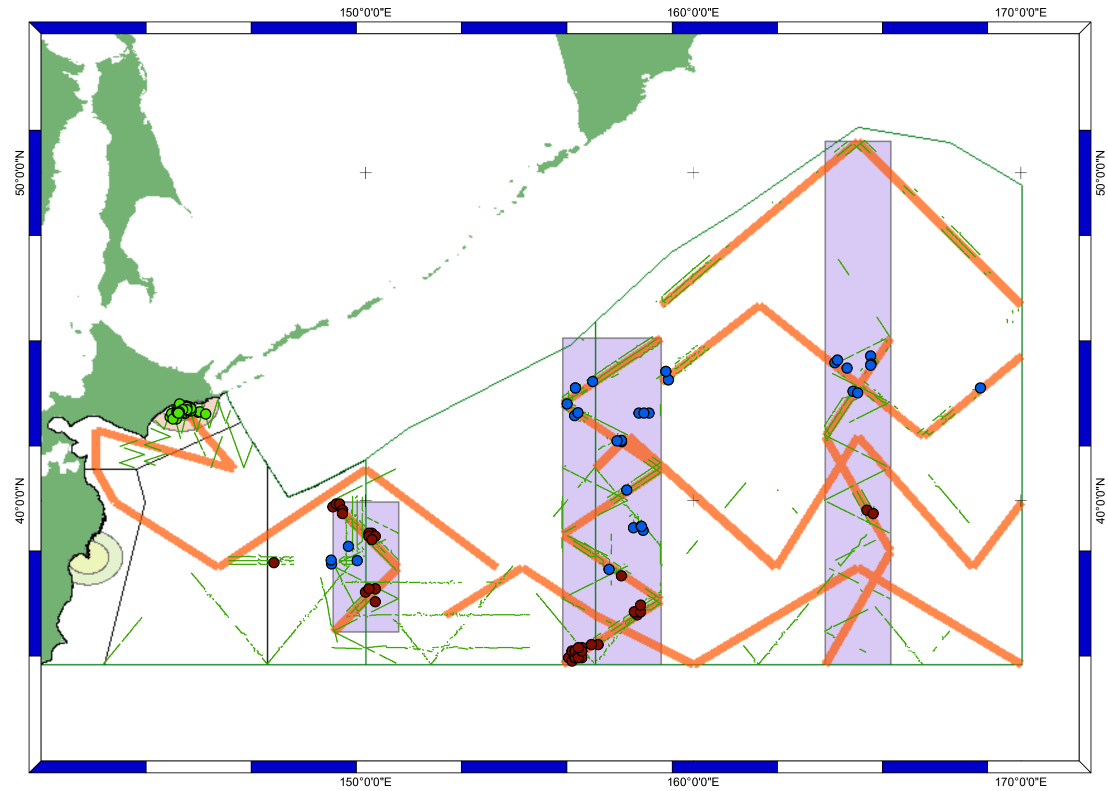

Figure 16. 2007 JARPNII in late season (July, August, September and October)

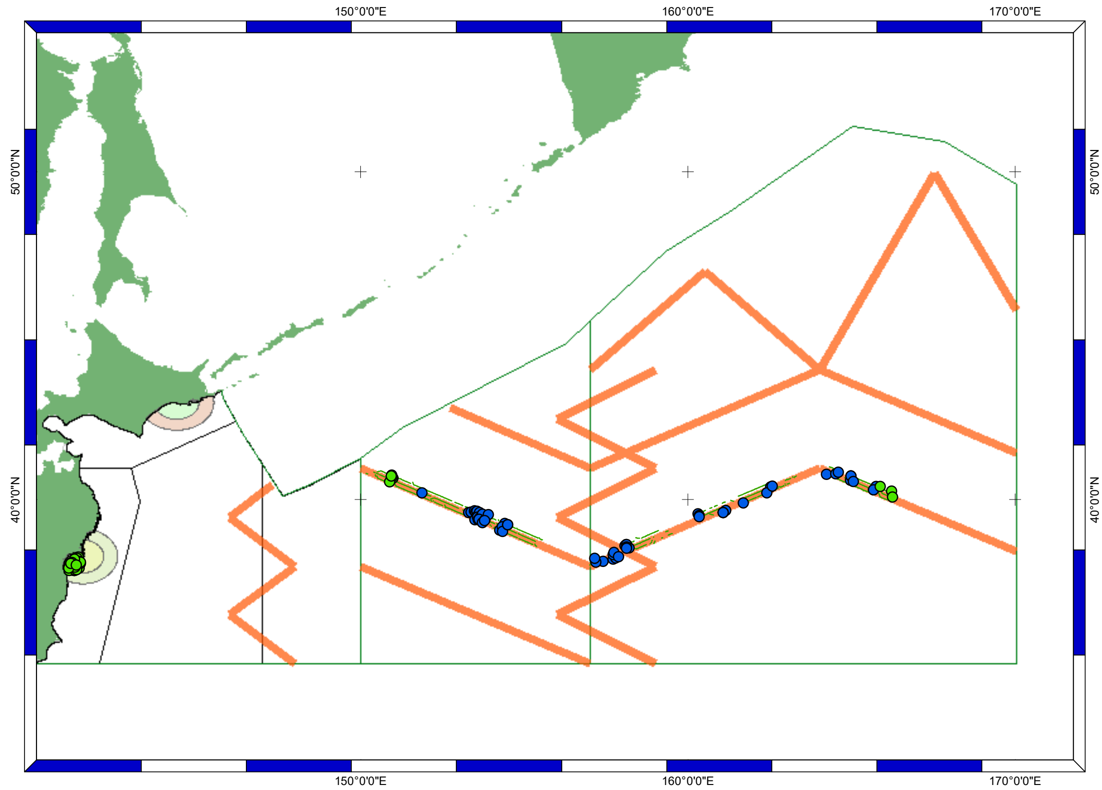

Figure 47. 2008 JARPNII in early season (April, May and June)

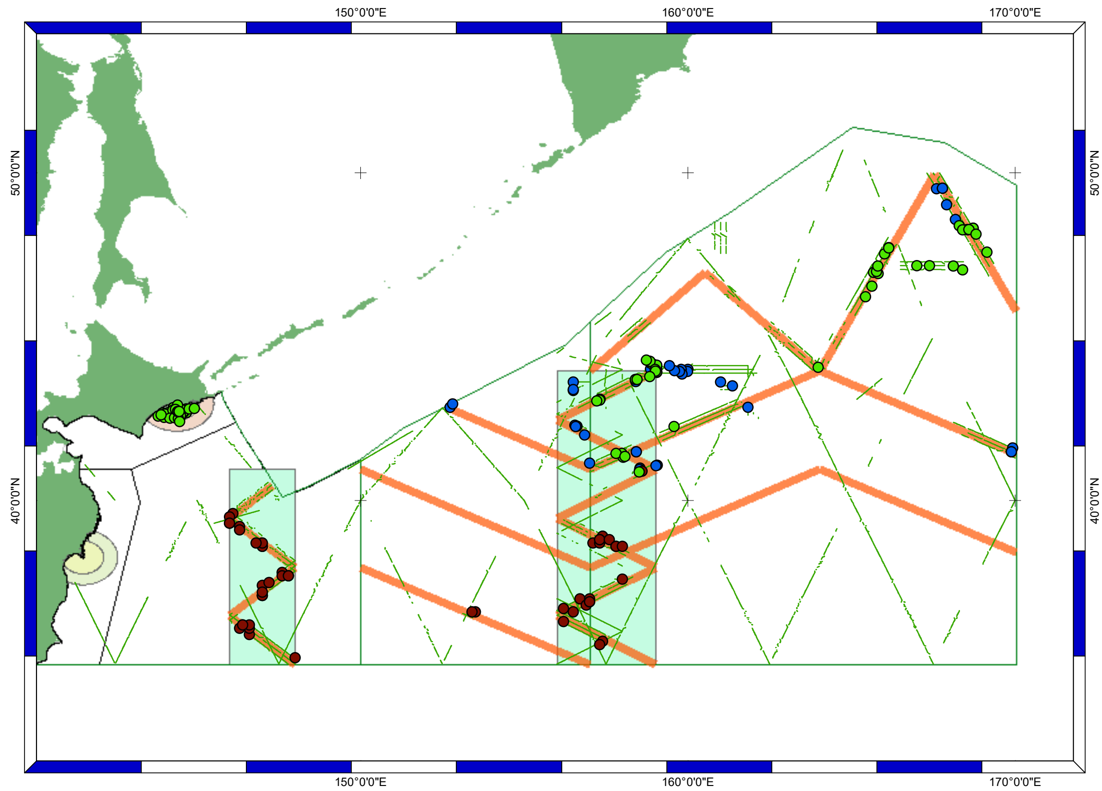

Figure 18. 2008 JARPNII in late season (July, August, September and October)

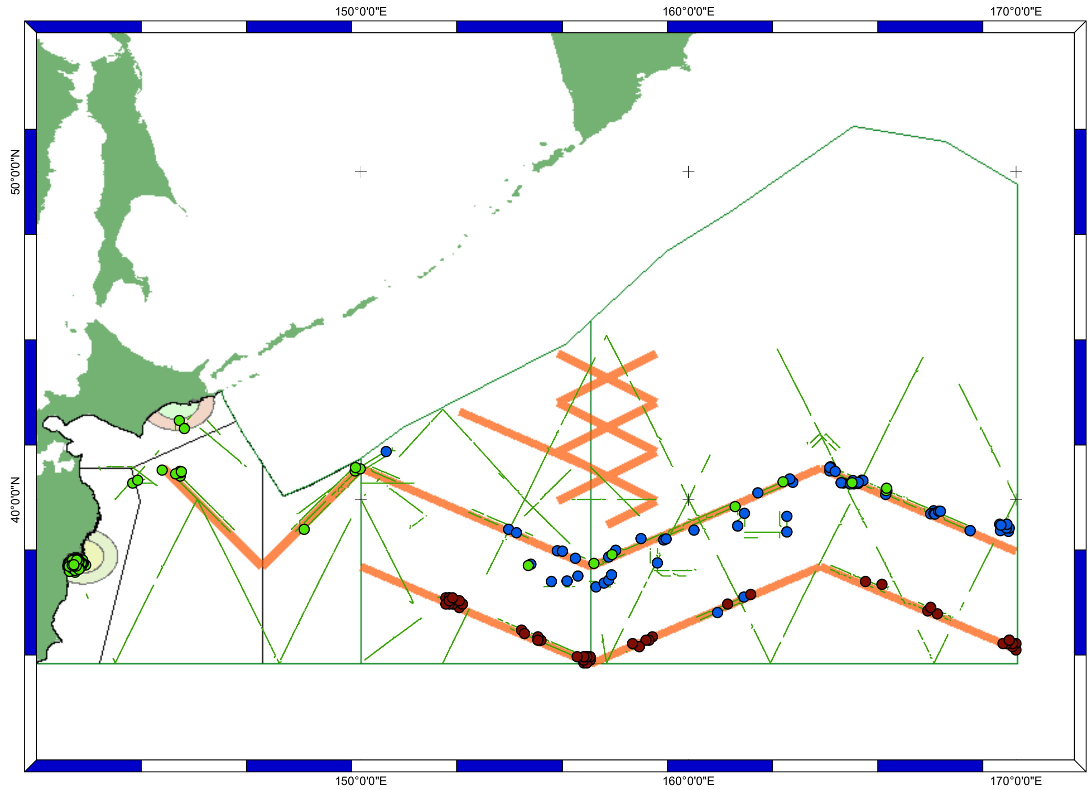

Figure 19. 2009 JARPNII in early season (April, May and June)

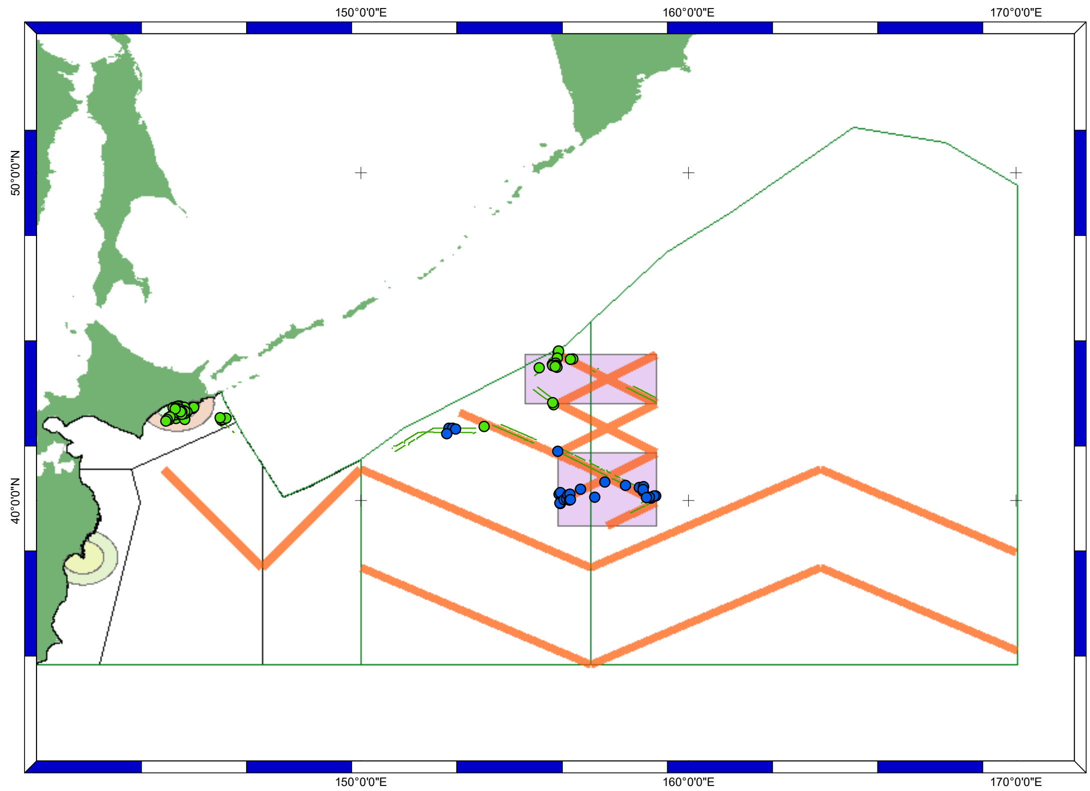

Figure 20. 2009 JARPNII in late season (July, August, September and October)

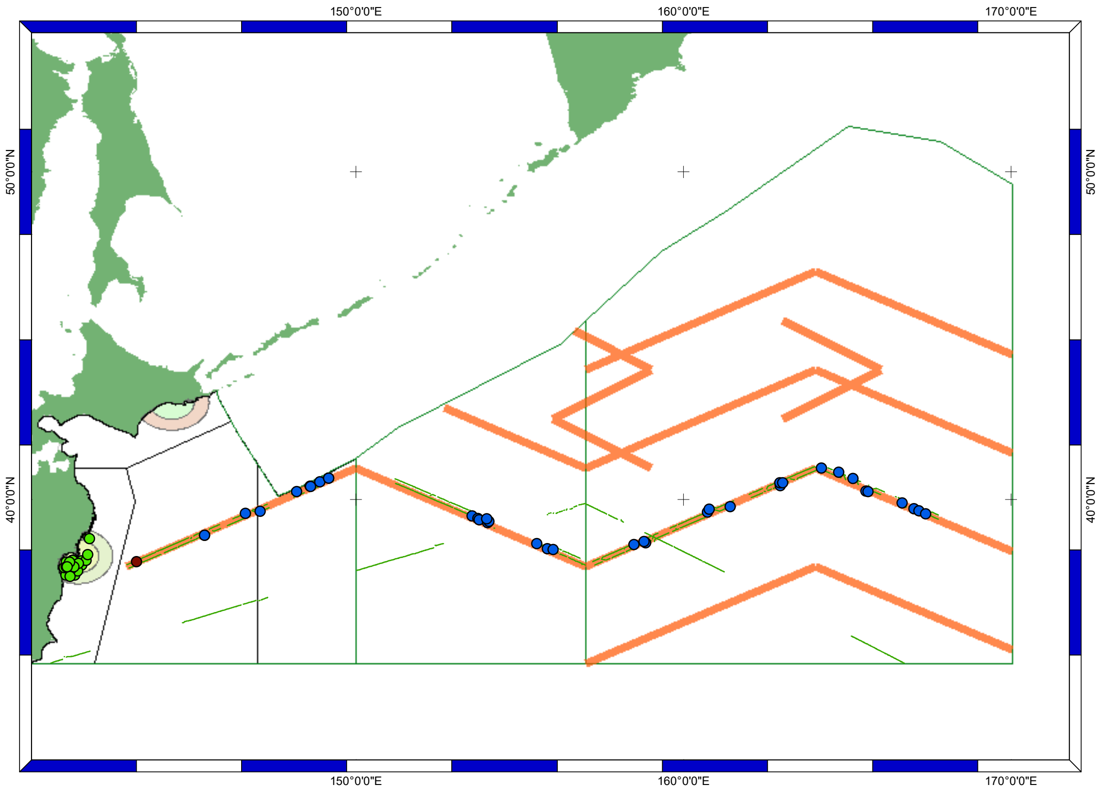

Figure 21. 2010 JARPNII in early season (April, May and June)

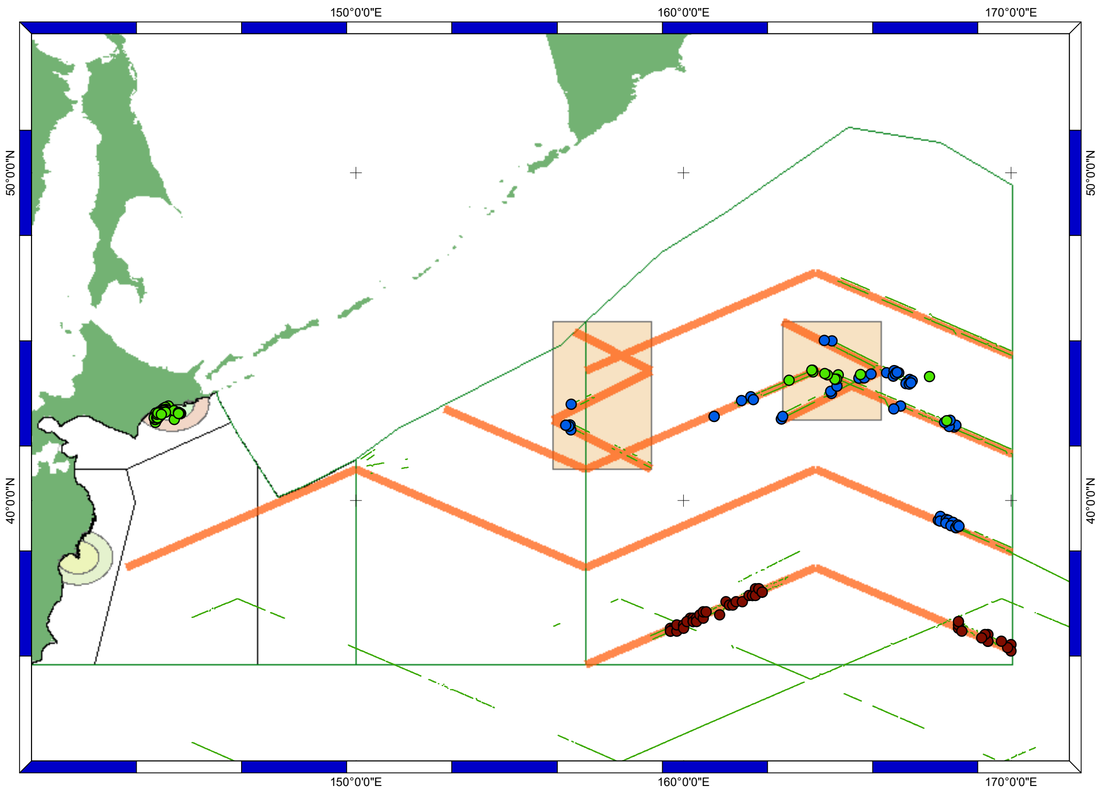

Figure 22. 2010 JARPNII in late season (July, August, September and October)

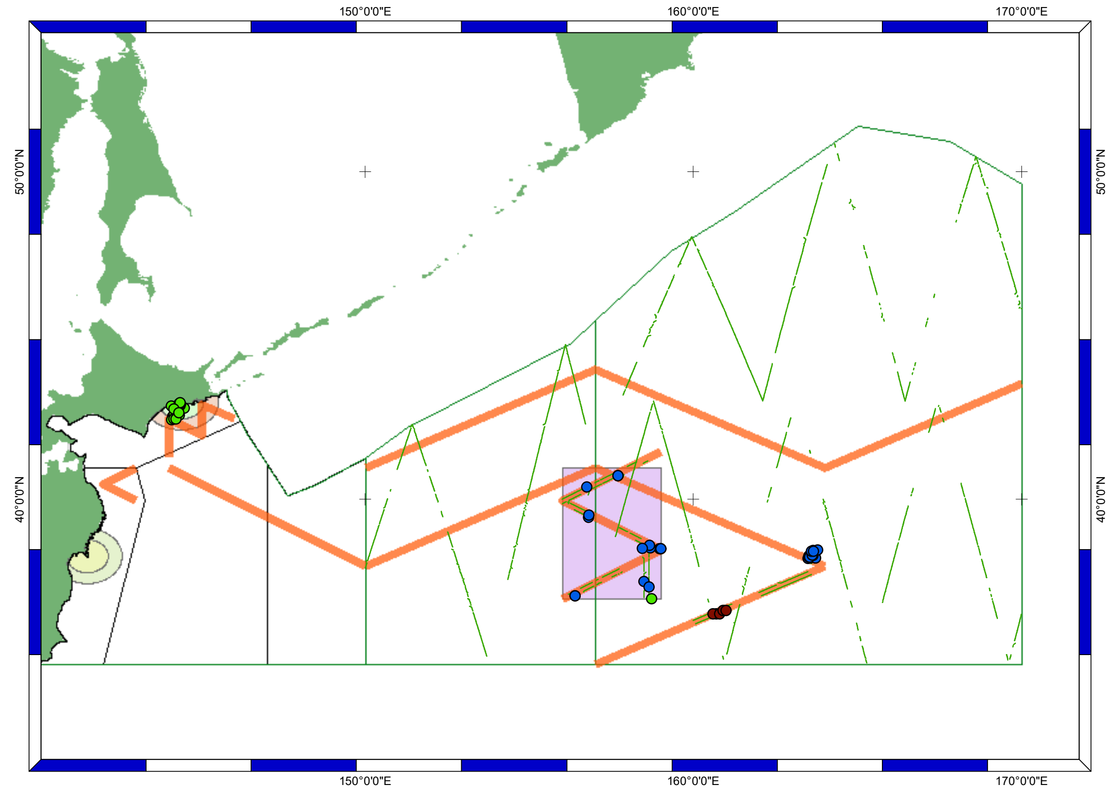

Figure 53. 2011 JARPNII in early season (April, May and June)

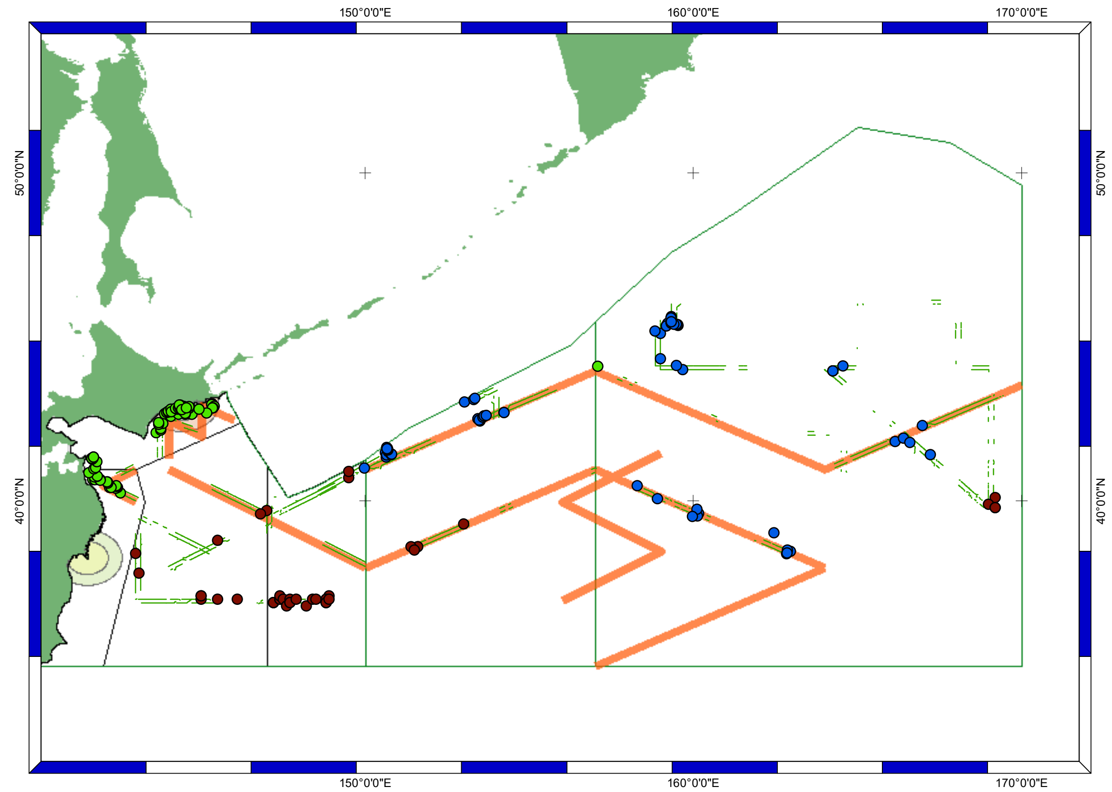

Figure 24. 2011 JARPNII in late season (July, August, September and October)

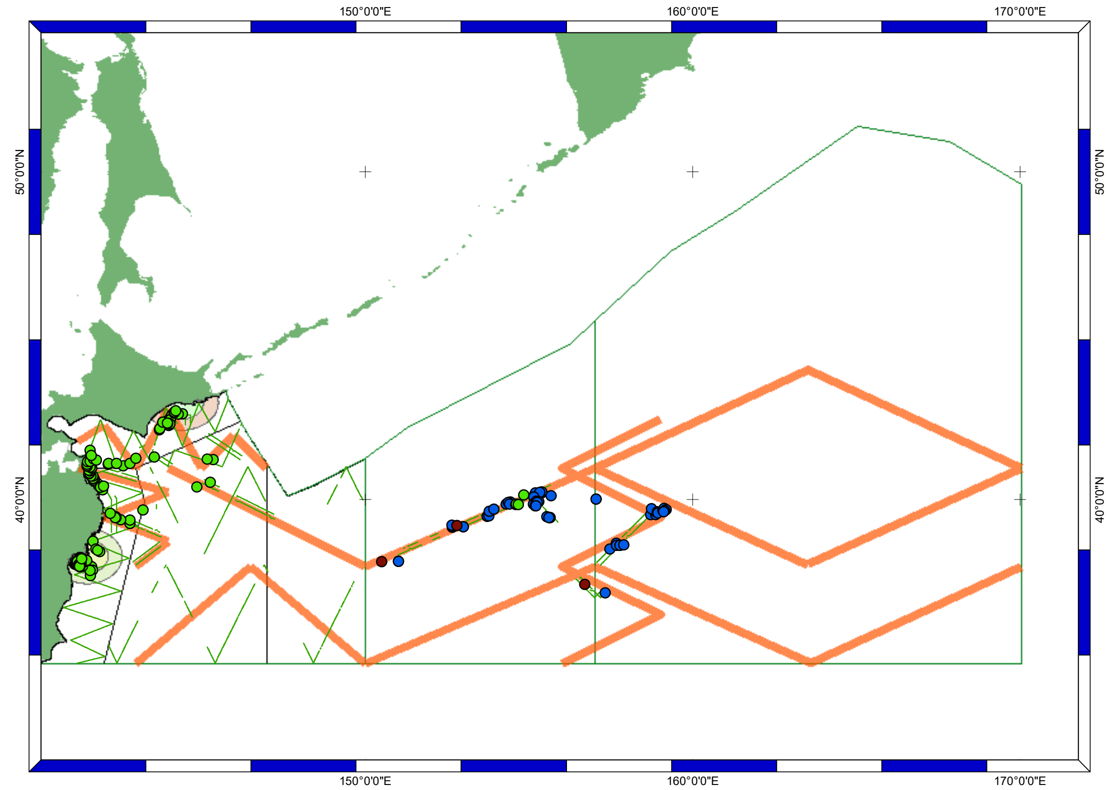

Figure 65. 2012 JARPNII in early season (April, May and June).

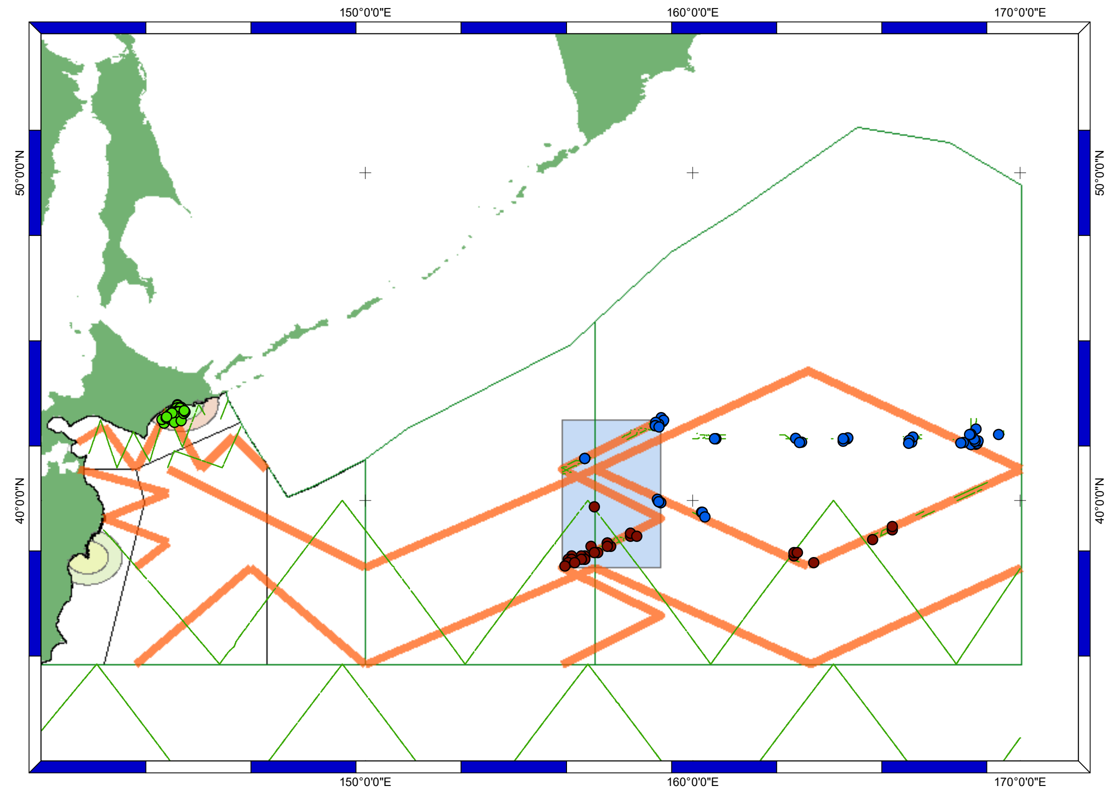

Figure 26. 2012 JARPNII in late season (July, August, September and October).

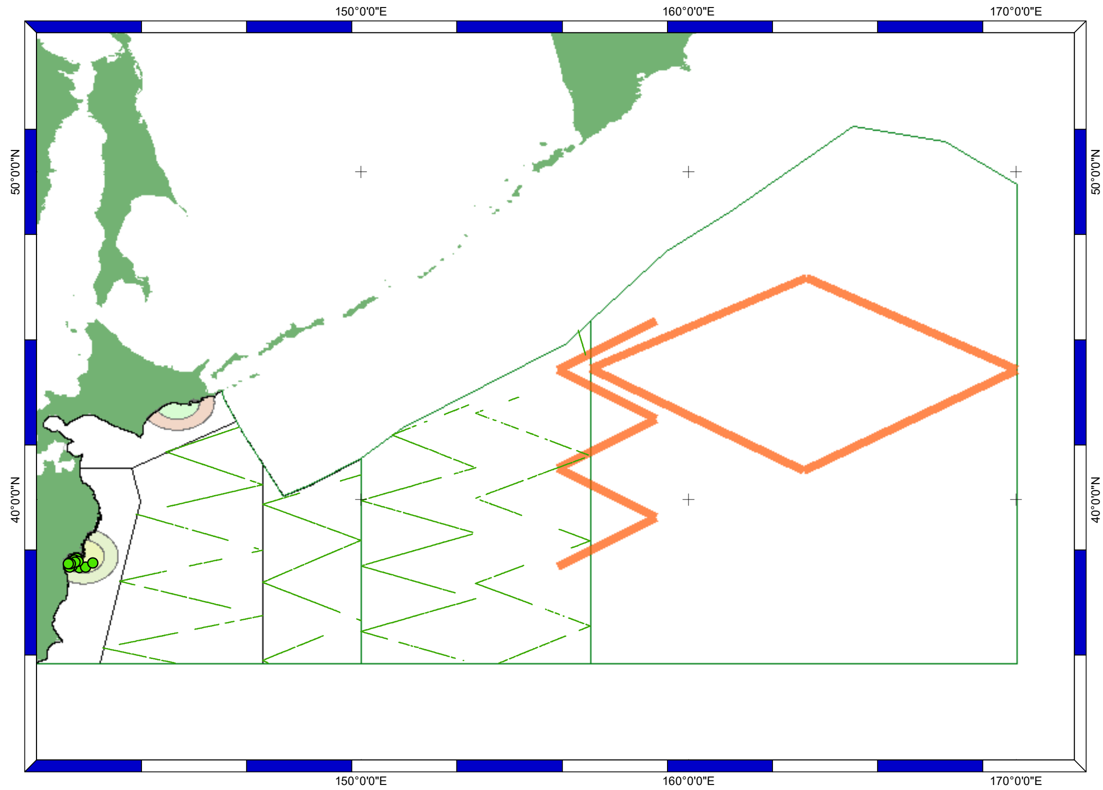

Figure 27. 2013 JARPNII in early season (April, May and June).

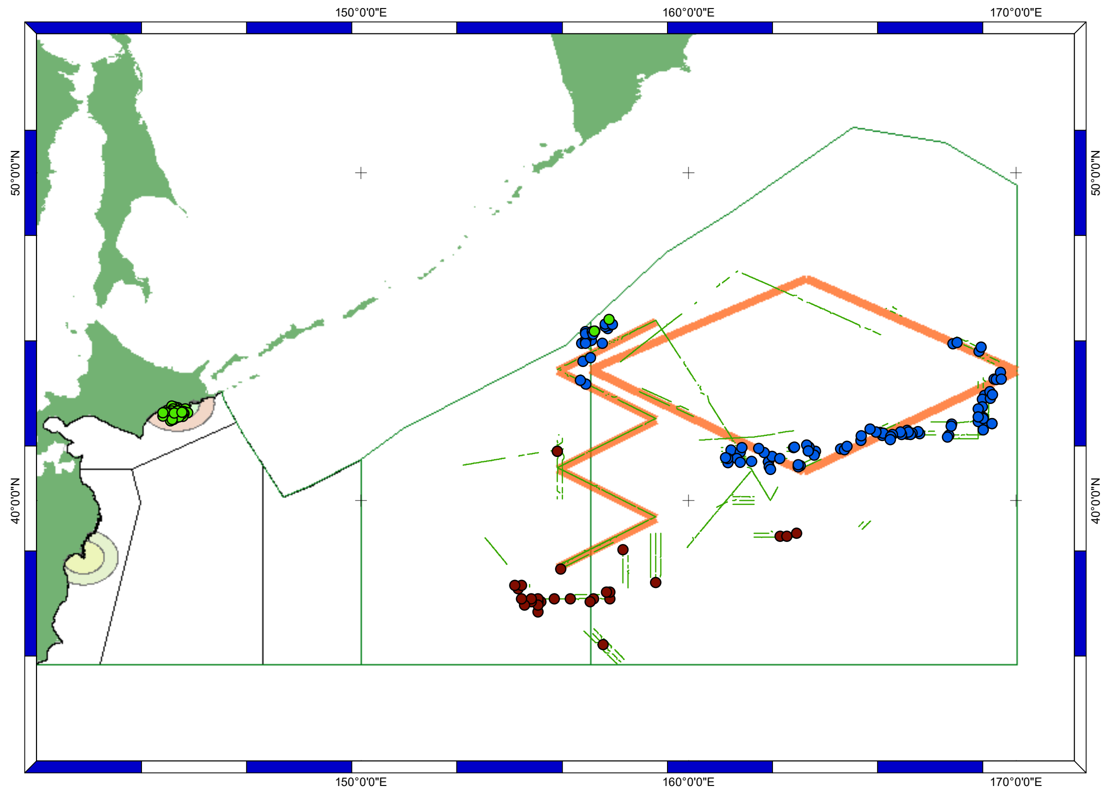

Figure 28. 2013 JARPNII in late season (July, August, September and October).

Annex G

Some suggestions for potential guidelines for an integrated final report from a special permit programme

It should be noted that several of the sections should easily be taken from the original proposal and any periodic reviews (e.g. Chapters 1-3 and early sections of Chapters 4). These guidelines are intended to assist proponents as well as reviewers. Electronic copies of the full report, its annexes and all listed peer-review papers and cited documents should be submitted to the Secretariat according to the timeline defined in Annex P.

1. EXECUTIVE SUMMARY

This should be short (usually no more than 3-4 pages) summary of the results of programme by Objective and Sub-objectives with an indication of any limitations and a short explanation of the contributions the programme in light of the topics covered by Annex P[7].

2. INTRODUCTION

This should include:

(a) identification of Objectives and Sub-objectives and any changes to these over the period of the programme;

(b) short background as to why they are important and why changes were made if they occurred.

3. STUDY AREA(S), SAMPLE SIZE AND SAMPLING DESIGN

This chapter should contain (a) a summary of the justification for sample sizes, design and sampling areas, including any changes to these over the period of the programme (this may include logistical as well as scientific considerations); and (b) a summary of how well the achieved sampling matched the proposed sampling (in terms of design and size).

For programmes with multiple objectives this should include:

(a) specification of the appropriate study areas to address each objective;
(b) specification of the quantities of interest that need to be determined to achieve each objective;
(c) specification of the sources of uncertainty in the estimation for each quantity of interest and which of these were functions of sample size;
(d) explanation of the calculations used to determine the optimal sampling design and sample size for each objective (including consideration of methods e.g. lethal and non-lethal techniques) and then how this was integrated into the final sampling design and sample size;
(e) an overview of how the achieved sampling followed the proposed design and numbers (and an explanation as to why if it did not); and
(f) An analysis of the effect of sample size changes (if they occurred during the programme) on the ability to meet objectives and sub-objectives.

Details should be provided as an Annex or Annexes as described in a later section.

[7] (1) assess the extent of the programme's scientific output, and whether this was appropriate in light of the stated research objectives and the time elapsed; (2) assess the degree to which the programme coordinated its activities with related research projects; this included assessment of whether the degree of coordination was sufficient to ensure that the field and analytical methods were appropriate and best practice to achieve the stated objectives and whether the degree of coordination was sufficient to avoid unnecessary duplication; (3) evaluate other contributions to important research and information needs that were not part of the original set of objectives of the research programme; (4) consider any other relevant matters as decided by the Scientific Committee; and (5) evaluate how well the initial, or revised, objectives of the research were met, and the extent to which results have led to demonstrated improvements in the conservation and management of whales, for broad categories of objectives 1 ('improve the conservation and management of whale stocks') and 2 ('improve the conservation and management of other living marine resources or the ecosystem of which the whale stocks are an integral part').

4. A CHAPTER FOR EACH OBJECTIVE CONTAINING:

These should be self-contained[8] to the extent possible and contain sufficient levels of detail (first with sections by sub-objective if appropriate and then integrated over the main objective) to allow a review of:

(a) the field methods (and difficulties encountered – any uncertainty arising from this should be covered under (c) below);

(b) the laboratory methods (and difficulties encountered any uncertainty arising from this should be covered under (c) below);

(c) use of data from other projects or programmes (and any uncertainty arising from this – which should also be covered under (c) below);

(d) the analytical methods (including an explanation of assumptions, key parameters, how uncertainty was accounted for);

(e) the results;

(f) a discussion of the importance of the results (including caveats about conclusions that can be drawn) and how these add to and/or compare with related research from other regions; and

(g) an evaluation (for the overall objective) of the results in light of the topics covered by Annex P[3].

5. ADDITIONAL RESEARCH

This chapter should contain a summary of any results and studies that were completed that used data from the programme but was not addressing the objectives of the programme itself.

6. CONCLUSIONS

This should include at least an evaluation for the programme as a whole in the light of the topics covered by Annex P[3] plus consideration of any other scientific issues that arose from the programme.

ANNEXES

The Final Report should include[9] a number of Annexes including the following.

(1) Field protocols (and if relevant how these compare with IWC guidelines).

(2) Laboratory protocols (and if relevant how these compare with IWC guidelines).

(3) A list of samples and data collected, and samples analysed by technique.

(4) Analytical details for new approaches or models (including formulae for estimating parameters of interest and how uncertainty was dealt with).

(5) For each year (and season if appropriate):

(a) the predetermined tracklines for sampling and sightings surveys and the rationale for those lines;

(b) the actual coverage of those tracklines and the rationale for any decisions taken to deviate from the predetermined lines including the rationale for any new lines developed; and

(c) an evaluation of how representative the realised samples may be of the study area and the biological populations involved.

(6) A list (by objective) of collaborating institutes, expert, projects or external data sources.

(7) A list (by objective, or for other research, topic) of published papers that use data from the programme (copies should be archived with the IWC Secretariat).

(8) A list (by objective, or for other research, topic) of working papers that use data from the programme that have been presented at international meetings, including the IWC Scientific Committee (copies should be archived with the IWC Secretariat).

---

[8] i.e. Contain a sufficient level of detail that the reader does not have to frequently consult other material to evaluate the work – similar to the level of detail provided in a published paper. If a programme has already published papers in peer-reviewed journals comprising all or most of its results these chapters can be made by the sum of these papers with a short introduction and an overall conclusion.

[9] It is assumed that the report will be in electronic format so (a) links can be given and (b) that much of this information will have been developed by the proponents at the start of the programme anyway (e.g. protocols).

Annex H

List of Publications arising out of JARPN II or using JARPN II data

Peer-reviewed production of JARPN II – Main objectives

1. Kanda, N., Goto, M. and Pastene, L.A. 2006. Genetic characteristics of western North Pacific sei whales, *Balaenoptera borealis,* as revealed by microsatellites. *Marine Biotechnology*8:86-93.
2. Kanda, N., Goto, M., Kato, H., McPhee, M.V. and Pastene, L.A. 2007. Population genetic structure of Bryde's whales (*Balaenoptera brydei*) at the inter-oceanic and trans-equatorial levels. *Conservation Genetics* 8:853-864.
3. Kim, E.Y., Iwata, H., Fujise, Y. and Tanabe, S. 2004. Searching for novel CYP members using cDNA library from a minke whale liver. *Mar. Environ. Res.* 58: 495-498.
4. Konishi, K. and Tamura, T. 2007. Occurrence of the minimal armhook squids *Berryteuthis anonychus* (Cephalopoda: Gonatidae) in the stomachs of common minke whales *Balaenoptera acutorostrata* in the western North Pacific. *Fisheries Science* 73: 1208-1210.
5. Konishi, K., Tamura T., Isoda, T. Okamoto, R., Hakamada, T., Kiwada, H. and Matsuoka, K. 2009. Feeding strategies and prey consumption of three baleen whale species within the Kushiro-Current Extension. *Journal of Northwest Atlantic Fishery Science* 42: 27-40.
6. Maeda, H., Kawamoto, T. and Kato, H. 2013. A study on the improvement of age estimation in common minke whales using the method of gelatinized extraction of earplug. *NAMMCO Scientific Publication* 10:17pp. **SC/F16/JR52**.
7. Maeda, H.and Kato, H. 2012. Technical improvements of the age character (earplug) collections in common minke whales. *Bull. Jpn. Soc. Fish. Oceanogr*. 76(2): 59-65 (in Japanese with English abstract).
8. Matsukura, R., Yasuma, H., Murase, H., Yonezaki, S., Funamoto, T., Honda, S. and Miyashita, K. 2009. Measurements of density contrast and sound-speed contrast for target strength estimation of *Neocalanus* copepods (*Neocalanus cristatus*) in the North Pacific Ocean. *Fish. Sci.* 75: 1377-87.
9. Matukura, R., Sawada, K., Abe, K., Minami, K., Nagashima, H., Yonezaki, S., Murase, H., Miyashita, K. 2013. Comparision of measurements and model calculations of target strength of juvenile sandeel in Sendai Bay. *Nippon Suisan Gakkaishi* 79: 638-48 (in Japanese with English abstract).
10. Murase, H., Hakamada, T., Matsuoka, K., Nishiwaki, S., Inagake, D., Okazaki, M., Toji, N. and Kitakado, T. 2014. Distribution of sei whales (*Balaenoptera borealis*) in the subarctic-sub-tropical transition area of the western North Pacific in relation to oceanic fronts. *Deep-Sea Research II* 107: 22-28. **SC/F16/JR8.**
11. Murase, H., Ichihara, M., Yasuma, H., Watanabe, H., Yonezaki, S., Nagashima, H., Kawahara, S. and Miyashita, T. 2009. Acoustic characterization of biological backscatterings in the Kuroshio-Oyashio inter-frontal zone and subarctic waters of the western North Pacific in spring. *Fisheries Oceanography* 18(6): 386-401.
12. Murase, H., Kawabata, A., Kubota, H., Nakagami, M., Amakasu, K., Abe, K., Miyashita, K. And Oozeki, Y. 2012. Basin-scale distribution pattern and biomass estimation of Japanese anchovy *Engraulis japonicas* in the western North Pacific. *Fish. Sci*. 78: 761-773. **SC/F16/JR18**.
13. Murase, H., Kawabata, A., Kubota, H., Nakagami, M., Amakasu, K., Abe, K., Miyashita, K. and Oozeki, Y. 2011. Effect of depth-dependent target strength on biomass estimation of Japanese anchovy. *Mar. Sci. Technol.* 19: 267-72.
14. Murase, H., Nagashima, H., Yonezaki, S., Matsukura, R. And Kitakado, T. 2009. Application of a generalized additive model (GAM) to reveal relationships between environmental factors and distributions of pelagic fish and krill: a case study in Sendai Bay, Japan. *ICES Journal of Marine Science* 66(6): 1417-24.
15. Murase, H., Tamura, T., Kiwada, H., Fujise, Y., Watanabe, H., Ohizumi, H., Yonezaki, S., Okamura, H. and Kawahara, S. 2007. Prey selection of common minke (*Balaenoptera acutorostrata*) and Bryde's (*Balaenoptera edeni*) whales in the western North Pacific in 2000 and 2001. *Fish. Oceanogr.* 16 (2): 186-201. **SC/F16/JR21**.
16. Murase, H., Tamura, T., Otani, S. and Nishiwaki, S. 2016. Satellite tracking of Bryde's whales *Balaenoptera edeni* in the offshore western North Pacific in summer 2006 and 2008. *Fish. Sci*. 82:35-45. **SC/F16/JR45**.
17. Nakamura, G., Kadowaki, I., Nagatuka, S., Fujise, Y., Kishiro, T. and Kato, H. 2014. Variation in a colour pattern of white patch on the flippers of North Pacific common minke whales: Potential application for their interoceanic difference. *La mer* 52: 31-47.
18. Niimi, S., Imoto, M., Kunisue, T, Watanabe, M.X., Kim, E., Nakayama, K., Yasunaga, G., Fujise, Y., Tanabe, S. and Iwada, H. 2014. Effects of persistent organochlorine exposure on the liver transcriptome of the common minke whale (*Balaenoptera acutorostrata*) from the North Pacific. *Ecotoxicology and Environmental Safety* 108: 95-105. **SC/F16/JR36**.
19. Niimi S., Kim E.-Y., Iwata, H., Watanabe, M.X., Yasunaga, G., Fujise, Y. and Tanabe, S. 2007. Identification and hepatic expression profiles of cytochrome P450 1-4 isozymes in common minke whales (*Balaenoptera acutorostrata*). *Comp. Biochem. Physiol. B Biochem. Mol. Biol.* 147(4):667-81.
20. Niimi, S., Watanabe, M.X., Kim, E.-Y., Iwata, H., Yasunaga, G., Fujise, Y. and Tanabe, S. 2005. Molecular cloning and mRNA expression of cytochrome P4501A1 and 1A2 in the liver of common minke whales (*Balaenoptera acutorostrata*). *Mar. Pollut. Bull.* 51(8-12):784-93.
21. Ohishi, K., Fujise, Y. and Maruyama, T. 2008. *Brucella* spp. in the western North Pacific and Antarctic cetaceans: a review. *J. Cetacean Res. Manage.* 10(1): 67-72.
22. Ohishi. K., Takishita, K., Kawato, M., Zenitani, R., Bando, T., Fujise, Y., Goto, Y., Yamamoto, S. and Maruyama, T. 2004. Molecular evidence of new variant *Brucella* in North Pacific common minke whales. *Microbes and Infection* 6: 1199-1204.
23. Ohishi, K., Takishita, K., Kawato, M., Zenitani, R, Bando, T., Fujise, Y., Goto, Y., Yamamoto, S. and Maruyama, T. 2005. Chimeric structure of omp2 of *Brucella* from Pacific common minke whales (*Balaenoptera acutorostrata*). *Microbiol. Immunol.* 49(8):789-93.

24. Ohishi, K., Maruyama, T., Ninomiya, A., Kida, H., Zenitani, R., Bando, T., Fujise, Y., Nakamatsu, K., Miyazaki, N. and Boltunov, A. N. 2006. Serologic investigation of influenza a virus infection in cetaceans from the western North Pacific and the Southern Oceans. *Mar. Mamm. Sci.* 22(1): 214-221.
25. Ohishi, K., Zenitani, R., Bando, T., Goto, Y., Uchida, K., Maruyama, T., Yamamoto, S., Miyazaki, N. and Fujise, Y. 2003. Pathological and serological evidence of Brucella-infection in baleen whales (Mysticeti) in the western North Pacific. *Comp. Immunol. Microbiol. Infect. Dis.* 26(2):125-36.
26. Sasaki, H., Murase, H., Kiwada, H., Matsuoka, K., Mitani, Y. and Saitoh, S. 2013. Habitat differentiation between sei (*Balaenoptera borealis*) and Bryde's whales (*B. brydei*) in the western North Pacific. *Fish. Oceanogr*. 22 (6): 496-508. **SC/F16/JR10.**
27. Shimizu, Y., Ohishi, K., Suzuki, R., Tajima, Y., Yamada, T., Kakizoe, Y., Bando, T., Fujise, Y., Taru, H., Murayama, T. and Maruyama, T. 2013. Amino acid sequence variations of signalling lymphocyte activation molecule and mortality caused by morbillivirus infection in cetaceans. *Microbiol. Immunol.* 57:624-32. **SC/F16/JR37.**
28. Shishido, R., Ohishi, K., Suzuki, R., Takishita, K., Ohtsu, D., Okutsu, K., Tokutake, K., Katsumata, E., Bando, T., Fujise, Y., Murayama, T. and Maruyama, T. 2010. Cetacean Toll-like receptor 4 and myeloid differentiation factor 2, and possible cetacean-specific responses against Gram-negative bacteria. *Comparative Immunology, Microbiology and Infectious Diseases.* 33(6): 89-98.
29. Tojo, N., Matsukura, R., Yasuma, H., Yonezaki, S., Watanabe, H., Kawahara, S., Murase, H., and Miyashita, K. 2010. Spatial analysis of isada krill (*Euphausia pacifica*) distribution in frontal environments in the North Pacific Ocean. GIS/spatial analyses in fisheries and aquatic science. *4th. International Fishery GIS Society* 115-38.
30. Watanabe, H., Okazaki, M., Tamura, T., Konishi, K., Inagake, D., Bando, T., Kiwada, H. and Miyashita, T. 2012. Habitat and prey selection of common minke, sei, and Bryde's whales in mesoscale during summer in the subarctic and transition regions of the western North Pacific. *Fish. Sci.* 78:557-67. **SC/F16/JR20**.
31. Zharikov, K., Fujise, Y., Tamura, T., Kiwada, H., Bando, T., Konishi, K. and Isoda, T. 2004. Distribution and feeding of large cetaceans based on the data of JARPN II - 2003 May, 17-July, 9. *Marine Mammals of the Holarctic* 2004: 207-210.

Peer-reviewed production of JARPN II – Others research fields

1. Bhuiyan, M.M.U., Suzuki, Y., Watanabe, H., Hirayama, H., Matsuoka, K., Fujise, Y., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2008. Attempts at *in vitro* fertilization and culture of *in vitro* matured oocytes in sei (*Balaenoptera borealis*) and Bryde's (*B. edeni*) whales. *Zygote* 16: DOI 10.1017/S0967199408004887.
2. Bhuiyan, M.M.U., Suzuki, Y., Watanabe, H., Lee, E., Hirayama, H., Matsuoka, K., Fujise, Y., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2010. Production of Sei Whale (*Balaenoptera borealis*) Cloned Embryos by Inter- and Intra-Species Somatic Cell Nuclear Transfer. *J. Reprod. Dev.* 56: 131-9.
3. Birukawa, N., Ando, H., Goto, M., Kanda, N., Pastene, L.A., Nakatsuji, H., Hata, H. and Urano, A. 2005. Plasma and Urine Levels of Electrolytes, Urea and Steroid Hormones Involved in Osmoregulation of Cetaceans. *Zool. Sci.* 22: 1245-1257.
4. Birukawa, N., Ando, H., Goto, M., Kanda, N., Pastene, L.A. and Urano, A. 2008. Molecular cloning of urea transporters from the kidneys of baleen and toothed whales. Comp. *Biochem. Physiol. Part B* 149: 227-35.
5. Fujita, H., Honda, K., Hamada, N., Yasunaga, G. and Fujise, Y. 2009. Validation of high-throughput measurement system with microwave-assisted extraction, fully automated sample preparation device, and gas chromatography-electron capture detector for determination of polychlorinated biphenyls in whale blubber. *Chemosphere* 74:1069-1078.
6. Fukui, Y., Iwayama, H., Matsuoka, T., Nagai, H., Koma, N., Mogoe, T., Ishikawa, H., Fujise, Y., Hirabayashi, M., Hochi, S., Kato, H. and Ohsumi, S. 2007. Attempt at Intracytoplasmic sperm injection of *in vitro* matured oocytes in common minke whales (*Balaenoptera acutorostrata*) captured during the Kushiro coast survey. *Journal of Reproduction and Development.* 53(4): 945-952.
7. Funasaka, N., Yoshioka, M. and Fujise, Y. 2010. Features of the ocular harderian gland in three Balaenopterid species based on anatomical, histological and histochemical observations. *Mammal Study* 35:9-15.
8. Glover, K.A., Kanda, N., Haug, T., Pastene, L.A., Oien, N., Goto, M., Seliussen, B.B. and Skaug, H.J. 2010. Migration of Antarctic minke whales to the Arctic. *Plos One* 5 (12):
9. Glover, K.A., Kanda, N., Haug, T., Pastene, L.A., Oien, N., Seliusen, B.B., Sorvik, A.G.E. and Skaug, H.J. 2013. Hybrids between common and Antarctic minke whales are fertile and can back-cross. *BMC Genetics* 14:25.
10. Hayashi, K., Nishida, S., Yoshida, H., Goto, M., Pastene, L.A. and Koike, H. 2003. Sequence variation of the DQB allele in the cetacean MHC. *Mammal Study* 28: 89-96.
11. Hiwasa, M., Suzuki, Y., Watanabe, H., Bhuiyan, M.M.U., Matsuoka, K., Fujise, Y., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2009. Effects of semen extenders and storage temperatures on characteristics of frozen-thawed Bryde's (*Balaenoptera edeni*) whale spermatozoa. *J. Reprod. Dev*. 55: 599-606.
12. Inoue, S., Kishiro, T., Fujise, Y., Nakamura, G. and Kato, H. 2014. Seasonal changes in the testis of the North Pacific common minke whale. *Nippon Suisan Gakkaishi* 80 (2): 185-90 (in Japanese with English abstract).
13. Iwanami, K., Mita, H., Yamamoto, Y., Fujise, Y., Yamada, T. and Suzuki, T. 2006. cDNA-derived amino acid sequences of myoglobins from nine species of whales and dolphins. *Comp. Biochem. Physiol. Part B Biochem. Mol. Biol.* 45:249-56.
14. Kitayama, C., Sasaki, M., Ishikawa, H., Mogoe, T., Ohsumi, S., Fukui, Y., Budipitojo, T., Kondoh, D. and Kitamura, N. 2015. Structure and functions of the placenta in common minke (*Balaenoptera acutorostrata*), Bryde's (*B. brydei*) and sei (*B. borealis*) whales. *Journal of Reproduction and Development* 61(5): 415-421.
15. Lee, E., Bhuiyan, M.M.U., Watanabe, H., Matsuoka, K., Fujise, Y., Ishikawa, H. and Fukui. Y. 2009. Production of cloned sei whale (*Balaenoptera borealis*) embryos by interspecies somatic cell nuclear transfer using enucleated pig oocytes. *J. Vet. Sci.* 10(4): 285-92.

16. Miyakawa, N. and Kato, H. 2015.Morphology of innominate bones (pelvic bones) of Bryde's whales *Balaenoptera edeni. Honyuurui Kagaku* 55(1):1-10 (in Japanese with English abstract).
17. Nakamura, G. and Kato, H. 2014. Developmental changes in the skull morphology of common minke whales *Balaenoptera acutorostrata*. *Journal of Morphology* doi:10.1002/jmor.20288.
18. Nakamura, G., Kato, H. and Fujise, Y. 2012. Relative Growth of the Skull of the Common Minke Whale *Balaenoptera acutorostrata* from the North Pacific in Comparison to Other Balaenoptera Species. *Mammal Study* 37(2): 105-112.
19. Nikaido, M., Hamilton, H., Makino, H., Sasaki, T., Takahashi, K., Goto, M., Kanda, N., Pastene, L.A. and Okada, N. 2006. Baleen whale phylogeny and a past extensive radiation event revealed by SINE insertion analysis. *Mol. Biol. Evol*. 23 (5):866-873.
20. Nishida, S., Pastene, L.A., Goto, M. and Kanda, N. 2003. SRY gene structure and phylogeny in the cetacean species. *Mammal Study* 28: 57-66.
21. Nishida, S., Goto, M., Pastene, L.A., Kanda, N. and Koike, H. 2007. Phylogenetic relationships among cetaceans revealed by Y-chromosome sequences. *Zoological Science* 24(7): 723-732.
22. Ogawa, G., Ishida, M., Kato, H., Fujise, Y. and Urano, N. 2010. Identification of facultative anaerobic bacteria isolated from the intestine of the minke whale *Balaenoptera acutorostrata* by 16S rRNA sequencing analysis. *Fish. Sci*. 76:177-181.
23. Pastene, L.A., Goto, M., Kanda, N., Zerbini, A.N., Kerem, D., Watanabe, K., Bessho, Y., Hasegawa, M., Nielsen, R., Larsen, F. and Palsboll, P.J. 2007. Radiation and speciation of pelagic organisms during periods of global warming: the case of the common minke whale, *Balaenoptera acutorostrata.Molecular Ecology*16 (7): 1481-1495.
24. Pastene, L.A., Acevedo, J., Goto, M., Zerbini, A.N., Acuna, P. and Aguayo-Lobo, A. 2010. Population structure and possible migratory links of common minke whales, *Balaenoptera acutorostrata*, in the Southern Hemisphere. *Conserv. Genet*. 11:1553-1558.
25. Sasaki, T., Nikaido, M., Hamilton, H., Goto, M., Kato, H., Kanda, N., Pastene, L.A., Cao, Y., Fordyce, R.E., Hasegawa, M. and Okada, N. 2005. Mitochondrial Phylogenetics and Evolution of Mysticete Whales. *Systematic Biology* 54(1): 77-90.
26. Suzuki, Y., Umatani, M., Bhuiyan, M.M.U., Watanabe, H., Mogoe, T., Matsuoka, K., Fujise, Y., Ishikawa, H., Ohsumi, S., Sasaki, M. and Fukui, Y. 2010. Effects of equilibration steps, type of sugars and addition of whale follicular fluid on viability and *in vitro* maturation of vitrified whale oocytes. *Japanese Journal of Zoo and Wildlife Medicine.* 15(2): 65-72.
27. Tsuji, K., Sato, A., Kaneko, H., Yasunaga, G., Fujise, Y. and Nomata, H. 2009. Comparison of physiologically significant imidazole dipeptides in cetaceans sampled in Japanese Whale research (short paper). *Sci. Rep. Hokkaido Fish. Exp. Stn*. 74: 25-8. 50
28. Urashima, T., Kobayashi, M., Asakuma, S., Uemura, Y., Arai, I., Fukuda, K., Saito, T., Mogoe, T., Ishikawa, H., Fukui, Y. 2007. Chemical characterization of the oligosaccharides in Bryde's whale (*Balaenoptera edeni*) and Sei whale (*Balaenoptera borealis*) milk. *Comparative Biochemistry and Physiology*, Part B 146: 153-159.
29. Watanabe, H., Mogoe, T., Asada, M., Hayashi, K., Fujise, Y., Ishikawa, H., Ohsumi, S., Miyamoto, A. and Fukui, Y. 2004. Relationship between serum sex hormone concentrations and histology of seminiferous tubules of captured baleen whales in the western North Pacific during the feeding season. *Journal of Reproduction and Development* 50(4): 419-427.
30. Watanabe, H., Tateno, H., Kusakabe, H., Matsuoka, T., Kamiguchi, Y., Fujise, Y., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2007. Fertilizability and chromosomal integrity of frozen-thawed Bryde's whale (*Balaenoptera edeni*) spermatozoa intracytoplasmically injected into mouse oocytes. *Zygote* 15: 9-14.

Annex I

A summary of samples/data collected by JARPN II (2000-2014)

Some samples and data obtained by JARPN II are not related to the main research objectives of JARPN II or to other main research need, and these items are not listed here but they are available for research collaboration with ICR under data access protocols of ICR (http://www.icrwhale.org/pdf/appendix2.pdf), outside the context of the IWC SC review workshop.

The tables below show the research items and sample sizes by each item for the period 2000-2014.

I-1. SIGHTING DATA-Offshore components (SV+SSV)

Data	Sample size
Weather data (no. observations)	85,219
Effort data (Searching distance (n. miles))	202,403
Sighting data (no. of school)	15,594
Angle and distance experiments	6,031
Photo-ID blue whales (no. of schools photographed)	107
Photo-ID humpback whales (no. of schools photographed)	65
Photo-ID North Pacific right whales (no. of schools photographed)	50

I-2. SIGHTING DATA-Coastal components (Sanriku)(SV)

Data	Sample size
Weather data (no. observations)	1,008
Effort data (Searching distance (n. miles))	3,048
Sighting data (no. of school)	110
Angle and distance experiments	88

I-3. SIGHTING DATA-Coastal component (Kushiro SV)

Data	Sample size
Weather data (no. observations)	2,150
Effort data (Searching distance (n. miles))	5,155
Sighting data (no. of school)	353
Angle and distance experiments	112

I-4. SIGHTING DATA-Coastal component (Sanriku)(SSV)

Data	Sample size
Weather data (no. observations)	4,769
Effort data (n. miles)	32,665
Sighting data (no. of school)	642

I-5. SIGHTING DATA-Coastal components (Kushiro)(SSV)

Data	Sample size
Weather data (no. observations)	4,847
Effort data (n. miles)	33,378
Sighting data (no. of school)	985

Note 1=Sighting data (no. of school) are on baleen, sperm, and killer whales.
Note 2=Sighting data of the coastal components surveyed by SSVs were not obtained by strict line transect surveys.
Note 3=Sighting data on sei and Bryde's whales obtained during IWC/POWER would be available depending on progress of data validation by the IWC Secretariat.

II-1. BIOLOGICAL DATA - Common minke whale (Offshore component)

Data and sample	Sample size		
	Male	Female	Total

Sampling date	861	121	982
Sampling location	861	121	982
Body length	861	121	982
Body proportion (19 measurements)	861	121	982
Skull (length and width)	847	119	966
Body scar record	861	121	982
Record of external body characters	861	121	982
Sex	861	121	982
Body weight	861	121	982
Organ weight	180	29	209
Blubber thickness (5 points)	861	121	982
Girth	861	121	982
Maturity stage	861	121	982
Corpora albicantia and lutea (presence/absence only)	-	15	15
Corpora albicantia and lutea (presence/absence and number)	-	106	106
Lactation condition	-	121	121
Testis weight	861	-	861
Stomach contents (IWS format)	861	121	982
Stomach contents weight	861	121	982
Main prey species in stomach contents	861	121	982
Freshness of stomach contents	861	121	982
Energy contents of prey species	-	-	16
Foetus number, sex, body length, body weight	-	-	51
Aspartic acid isomers ratios (lens of fetus)*			13
Age (from Ear plug)**	409	55	464
Total PCB concentrations (blubber)	546	0	546
Total Hg concentrations (muscle)	680	0	680
PCBs, DDTs, HCB, HCHs and CHLs concentrations (blubber)	5	0	5
I-131, Cs-134 and Cs-137 concentrations (muscle)	8	2	10
Mitochondrial DNA control region sequences	855	121	976
Nuclear DNA microsatellite (16 loci)	855	121	976

*: Analysis of samples is ongoing.
**: 2000-2013.

II-2. BIOLOGICAL DATA - Sei whale (Offshore component)

Data and sample	Sample size		
	Male	Female	Total
Sampling date	551	623	1,174
Sampling location	551	623	1,174
Body length	551	623	1,174
Body proportion (19 measurements)	551	623	1,174
Skull (length and width)	534	603	1,137
Sex	551	623	1,174
Body weight	551	623	1,174
Organ weight	77	104	181
Blubber thickness (5 points)	551	623	1,174
Girth	551	623	1,174
Maturity stage	551	623	1,174
Corpora albicantia and lutea (presence/absence only)	-	205	205
Corpora albicantia and lutea (presence/absence and number)	-	418	418
Lactation condition	-	623	623
Testis weight	551	-	551
Stomach contents (IWS format)	551	623	1,174
Stomach contents weight	551	623	1,174
Main prey species in stomach contents	551	623	1,174
Freshness of stomach contents	551	623	1,174
Energy contents of prey species	-	-	20
Prey species estimating by next generation sequencing (NGS)	8	2	10
Behavioral data using acoustic tags			2
Foetus number, sex, body length, body weight	-	-	366
Age (from Ear plug)*	335	348	683
Total Hg concentrations (muscle)	160	-	160
PCBs, DDTs, HCB, HCHs and CHLs concentrations (blubber)	5	0	5
I-131, Cs-134 and Cs-137 concentrations (muscle)	12	13	25
Mitochondrial DNA control region sequences	551	622	1,173
Nuclear DNA microsatellite (16 loci)	551	623	1,174

*: 2002-2013.

II-3. BIOLOGICAL DATA - Bryde's whale (Offshore component)

Data and sample	Sample size

	Male	Female	Total
Sampling date	289	391	680
Sampling location	289	391	680
Body length	289	391	680
Body proportion (19 measurements)	289	391	680
Skull (length and width)	278	375	653
Sex	289	391	680
Body weight	289	391	680
Organ weight	60	77	137
Blubber thickness (5 points)	289	391	680
Girth	289	391	680
Maturity stage	289	391	680
Corpora albicantia and lutea (presence/absence only)	-	87	87
Corpora albicantia and lutea (presence/absence and number)	-	304	304
Lactation condition	-	391	391
Testis weight	289	-	289
Stomach contents (IWS format)	289	391	680
Stomach contents weight	289	391	680
Main prey species in stomach contents	289	391	680
Freshness of stomach contents	289	391	680
Energy contents of prey species	-	-	13
Prey species estimating by next generation sequencing (NGS)	2	4	6
Foetus number, sex, body length, body weight	-	-	169
Total Hg concentrations (muscle)	49	0	49
PCBs, DDTs, HCB, HCHs and CHLs concentrations (blubber)	5	0	5
I-131, Cs-134 and Cs-137 concentrations (muscle)	6	7	13
Mitochondrial DNA control region sequences	284	387	671
Nuclear DNA microsatellite (16 loci)	289	391	680

II-4. BIOLOGICAL DATA - Sperm whale (Offshore component)

Data and sample	Sample size		
	Male	Female	Total
Sampling date	16	40	56
Sampling location	16	40	56
Body length	16	40	56
Body proportion (18 measurements)	16	40	56
Skull (length and width)	16	38	54
Sex	16	40	56
Body weight	16	40	56
Organ weight	10	26	36
Blubber thickness (11 points)	16	40	56
Girth	16	40	56
Maturity stage	13	40	53
Corpora albicantia and lutea (number)	-	40	40
Lactation condition	-	40	40
Testis weight	16	-	16
Stomach contents (IWS format)	16	40	56
Stomach contents weight	16	40	56
Main prey species in stomach contents	16	40	56
Freshness of stomach contents	16	40	56
Energy contents of prey species	-	-	10
Foetus number, sex, body length, body weight	-	-	10
Age (from tooth)*	4	19	23
Total Hg concentrations (muscle)	1	4	5
PCBs, DDTs, HCB, HCHs and CHLs concentrations (blubber)	1	2	3
I-131, Cs-134 and Cs-137 concentrations (muscle)	1	2	3
Mitochondrial DNA control region sequences	16	40	56
Nuclear DNA microsatellite (15 loci)	16	40	56

*: 2000-2013.

II-5. BIOLOGICAL DATA - Common minke whale (Coastal component-Sanriku)

Data and sample	Sample size		
	Male	Female	Total
Sampling date	221	295	516
Sampling location	221	295	516
Body length	221	295	516
Body proportion (19 measurements)	221	295	516
Skull (length and width)	215	286	501
Body scar record	221	295	516
Sex	221	295	516

Body weight	221	295	516
Organ weight	7	10	17
Blubber thickness (5 points)	221	295	516
Girth	221	295	516
Maturity stage	221	295	516
Corpora albicantia and lutea (number)	-	295	295
Lactation condition	-	295	295
Testis weight	219	-	219
Stomach contents (IWS format)	221	295	516
Stomach contents weight*	205	281	486
Main prey species in stomach contents	221	295	516
Freshness of stomach contents	221	295	516
Energy contents of prey species	-	-	3
Prey species estimating by next generation sequencing (NGS)	1	2	3
Foetus number, sex, body length, body weight	-	-	44
Age (from Ear plug)**	94	123	217
Aspartic acid isomers ratios (lens)***	46	48	94
Total Hg concentrations (muscle)	195	48	280
Total Hg concentrations (liver)	46	48	94
PCBs, DDTs, HCB, HCHs and CHLs concentrations (blubber)	5	0	5
I-131, Cs-134 and Cs-137 concentrations (muscle)	7	6	13
Mitochondrial DNA control region sequences	221	295	516
Nuclear DNA microsatellite (16 loci)	221	295	516

* : 2003-2013. Analysis of 2014 samples is ongoing.
**: 2003-2013.
***: Analysis of samples is ongoing.

II-6. BIOLOGICAL DATA - Common minke whale (Coastal component-Kushiro)

Data and sample	Sample size		
	Male	Female	Total
Sampling date	438	219	657
Sampling location	438	219	657
Body length	438	219	657
Body proportion (19 measurements)	438	219	657
Skull (length and width)	430	215	645
Body scar record	438	219	657
Sex	438	219	657
Body weight	438	219	657
Organ weight	17	8	25
Blubber thickness (5 points)	438	219	657
Girth	438	219	657
Maturity stage	438	219	657
Corpora albicantia and lutea (number)	-	219	211
Lactation condition	-	219	211
Testis weight	438	-	429
Stomach contents (IWS format)	438	219	657
Stomach contents weight*	403	203	606
Main prey species in stomach contents	438	219	657
Freshness of stomach contents	438	219	657
Energy contents of prey species	-	-	3
Prey species estimating by next generation sequencing (NGS)	3	3	6
Foetus number, sex, body length, body weight	-	-	14
Age (from Ear plug)**	172	78	250
Total Hg concentrations (muscle)	377	0	377
PCBs, DDTs, HCB, HCHs and CHLs concentrations (blubber)	5	0	5
I-131, Cs-134 and Cs-137 concentrations (muscle)	12	13	25
Mitochondrial DNA control region sequences	438	219	657
Nuclear DNA microsatellite (16 loci)	438	218	656

* : 2002-2013. Analysis of 2014 samples is ongoing.
**: 2002-2013.

III. POLLUTANT DATA (Environmental and prey species samples)-Offshore components

Data and sample	Sample size
Total Hg concentrations (krill)	8
Total Hg concentrations (fishes)	19

IV-1. OCEANOGRAPHIC DATA- Offshore components

Data and sample	Sample size
Temperature & salinity (XCTD survey)	47
Temperature & salinity (CTD survey)	761
Midwater trawl (# of hawls)	262
MOTH trawl (# of hawls)	16
MOCNESS (# of hawls)	36
IKMT (# of hawls)	34
NORPAC (# of hawls)	254
Other nets (VMPS, Ring, BONGO) (# of hawls)	36
Echo sounder (2002-2007: km)	12,838
Echo sounder (2008-2013: n.miles)	8,098

Others nets: VMPS 12, ring net 8, BONGO net 16
Note 4=2008 cruise: *Shunyo-Maru* and *Kaiko-Maru*; 2009, 2012, 2013 cruises: *Shunyo-Maru*; 2010, 2011 cruises: *Hokko-Maru*.

IV-2. OCEANOGRAPHIC DATA- Coastal components (Sanriku)

Data and sample	Sample size
Temperature & salinity (XCTD survey)	11
Temperature & salinity (CTD survey)	325
Midwater trawl (no. of hawls)	109
Bongo net (no. of hawls)	5
IKMT (no. of hawls)	17
Sampling by fishing (no. of stations)	2
Echo sounder (2005 and 2006 seasons: km)	277.5
Echo sounder (2008 and 2009 seasons: n.miles)	354.3

IV-3. OCEANOGRAPHIC DATA- Coastal components (Kushiro)

Data and sample	Sample size
Temperature & salinity (CTD survey)	109
Midwater trawl (no. of hawls)	133
IKMT (no. of hawls)	6

V-1. GENETIC DATA- North Pacific right whale

Data and sample	Sample size
Mitochondrial DNA sequences	20

Note 5= Data of some items for common minke whales are also available for the JARPN period (1994-1999), which were reviewed by the IWC SC in 2000 (IWC, 2001).

Note 6= Genetic data from other sources have been used to complement the previous genetic analyses on stock structure of baleen whales. These data would be also available for the review.