The Japanese Whale Research Program under Special Permit in the western North Pacific Phase-II (JARPN II): origin, objectives and research progress made in the period 2002-2007, including scientific considerations for the next research period

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ABSTRACT

The International Whaling Commission's Scientific Committee (IWC SC) will carry out a Workshop to review the progress made in the research conducted under the Japanese Whale Research Program under Special Permit in the North Pacific – Phase II (JARPN II) in its first six years (2002-2007). This review will follow the new protocol agreed by the IWC SC in 2008. A number of scientific papers are now available, which present JARPN II results for this period. The present paper has been prepared to facilitate the understanding of this large research program in a comprehensive way, which could not be possible by reading only the individual papers. We believe that this paper could be useful for the external reviewers, particularly for those that are not familiar with JARPN II. This paper includes an overview section focused to explain the origin, research objectives and characteristics of JARPN II and a section summarizing the progress made in research under the established objectives and other contributions to important research needs. Another section includes some scientific considerations for the next research period. The last section summarizes responses to the five TORs of the review Workshop defined by the IWC SC.

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1. GENERAL INTRODUCTION

Science as the basis for managing natural resources is a long-standing paradigm and fisheries science is recognized as crucial input to fisheries management world-wide. More than 60 years ago drafters of the 1946 International Convention for the Regulation of Whaling (ICRW) recognized this in the preamble and several Articles of the Convention: Article IV encourages studies and investigations and the collection of statistical information, Article V requires that regulations related to whales be based on scientific findings and, Article VIII provides for special permits authorizing the killing of whales for scientific research and recognizes that continuous collection and analysis of biological data in conjunction with whaling operations are "indispensable to sound and constructive management of the whale fisheries." This "science-based management" is the context within which Japan's whale research programs were developed.

The International Whaling Commission's Scientific Committee (IWC SC) will carry out a Workshop to review the progress made in the research conducted under the Japanese Whale Research Program under Special Permit in the North Pacific – Phase II (JARPN II) in its first six years (2002-2007). This review will follow the new protocol agreed by the IWC SC in 2008 (Annex P in IWC, in press). A number of scientific papers are now available, which present JARPN II results for this period.

The present paper has been prepared to facilitate the understanding of this large research program in a comprehensive way, which could not be possible by reading only the individual papers. We believe that this paper could be useful for the external reviewers, particularly for those that are not familiar with JARPN II.

This paper includes an overview section focused to explain the origin, research objectives and characteristics of JARPN II and a section summarizing the progress made in research under the established objectives and other contributions to important research needs. Another section includes some scientific considerations for the next research period. The last section summarizes responses to the five TORs of the review Workshop defined in Annex P (IWC, in press).

Details of the analyses conducted and results can be found in the individual papers. Annex 1 shows the list of documents prepared for the IWC SC JARPN II Review Workshop, and Annex 2 a list of sample/data produced by JARPN II.

2. OVERVIEW

2.1 The JARPN

The Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN) started in 1994. The main objective was to elucidate the stock structure of common minke whales in the Pacific side of Japan. In a management context stock structure is a key piece of information for the application of the Revised Management Procedure (RMP), a procedure adopted by the IWC in 1994 to calculate a catch limit for future commercial whaling.

One of the major components of the RMP is the '*Implementation Simulation Trials*' (*ISTs*), which are conducted to guarantee the performance of RMP prior to the actual application of RMP to calculate a commercial catch limit of whales. The main purpose of the *ISTs*, which are specific to species/areas, is to assure a sustainable exploitation of whale resources by avoiding depletion of individual stocks. Therefore the hypotheses on stock structure and their plausibility are important, and are the basis for the establishment of *Small Areas*, for which catch limits are calculated.

Regarding stock structure of western North Pacific common minke whales the IWC SC recognized in 1993 two stocks of common minke whales, the Okhotsk Sea/Western Pacific ('O' stock) and the Yellow Sea/East China Sea/Sea of Japan ('J' stock). It also proposed a complicated sub-stock scenario with several sub-stocks composing the 'J' and 'O' stocks and hypothesized a western stock ('W' stock) in offshore areas in the Pacific side of Japan (IWC, 1994) (see Figure 1 for the definition of sub-areas for management by the IWC SC).

The issue of stock structure was discussed again by the IWC SC in 1996. During that meeting the IWC SC discussed the new scientific information derived from JARPN and concluded that the sub-stock scenario proposed in 1993 was not plausible (IWC, 1997).

The IWC SC reviewed the final results of JARPN during a Workshop conducted in 2000. Based on the information presented, the Workshop did not discard the hypothesis of occurrence of 'W' stock in offshore areas in the Pacific side of Japan, at least in some years of the period of JARPN. The Workshop recommended that further research was necessary to examine the hypothesis of the 'W' stock (IWC, 2001a).

A second objective of JARPN, 'the feasibility study on the feeding ecology of minke whales in the research ground', was added in 1996. Previous studies based on commercial samples were basically qualitative descriptions of the prey species eaten by whales (e.g. Nemoto, 1959; Kasamatsu and Tanaka, 1992). For ecosystem modeling purposes, however, both qualitative and quantitative data on prey consumption are required.

Research under the feeding ecology objective of JARPN allowed scientists to collect information on both qualitative and quantitative aspects of stomach contents of common minke whales. JARPN research also showed that the distribution of minke whales overlapped with the area of operation of some important commercial fisheries in Japan. Furthermore the analysis of stomach contents demonstrated that this whale species feeds on several prey species, all of which are also the target of commercial fisheries in Japan. Therefore the first priority of the Second Phase of JARPN (JARPN II) was placed on feeding ecology and ecosystem studies in this 'hot spot' area for cetacean/fisheries interaction.

2.2 The JARPN II

2.2.1 Objectives

The objectives of JARPN II are the following:

a) Feeding ecology and ecosystem studies
- Prey consumption by cetaceans
- Prey preference of cetaceans
- Ecosystem modeling

b) Monitoring environmental pollutants in cetaceans and the marine ecosystem
- Pattern of accumulation of pollutants in cetaceans
- Bioaccumulation process of pollutants through the food chain
- Relationships between chemical pollutants and cetacean health

c) Stock structure of large whales
- Common minke whale (*Balaenoptera acutorostrata*)
- Bryde's whale (*B. edeni*)
- Sei whale (*B. borealis*)
- Sperm whale (*Physeter macrocephalus*)

2.2.2 Justifications of objectives

Feeding ecology and ecosystem studies
According to the White Paper issued by the Government of Japan (1999), while the fisheries have provided 40% of human consumed animal protein with a variety of fish products, the recent level of fisheries resources and catches has decreased. The catches by Japanese fisheries drastically decreased from 12.8 million tons in 1988 to 5.8 million tons in 2005. In 1999, therefore, the Fisheries Agency of Japan announced the principles of the fundamental policy on fisheries and an action program to implement the policy. In the policy, the first priority is given to science-based management and sustainable utilization of fisheries resources within Japan's EEZ. In investigating the reason of decreasing fish resources and fish catches, over-fishing and the changing of marine environment such as surface water temperature were recognized. However, the effect of consumption by marine mammals and other animals on fish resources can not be disregarded. To aid the recovery of the fish resources, investigations should be carried out taking into account the management and sustainable utilization of the whole ecosystem including marine mammals. In fact some initial ecosystem model analyses indicated possible competition between cetaceans and fisheries and that the ecosystem of the western North Pacific may be affected on a large scale by trophic interaction and changes of fishing (Government of Japan, 2002a).

There is a growing disillusion with the predictive capacity of single species assessment methods and the management approaches they support, and this has been the primary driver for the development of ecosystem-based approaches. The principle of multi-species management has been discussed by many international organizations.

In its 24th Session in 2001, COFI (FAO's Committee on Fisheries) unanimously agreed that the FAO should conduct studies on the interaction between fisheries and marine mammals. This agreement was endorsed by the

120th Session of the FAO Council and reaffirmed in the October 2001 Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem (FAO, 2001). The Reykjavik Declaration also affirmed that the incorporation of ecosystem considerations implies increased attention to predator-prey relationships and in Point 5 of the Declaration agreed that it is important, among other things:

a) 'To advance the scientific basis for developing and implementing management strategies that incorporate ecosystem considerations and which will ensure sustainable yields while conserving stocks and maintaining the integrity of ecosystems and habitats on which they depend;

b) Identify and describe the structure, components and functioning of relevant marine ecosystems, diet composition and food webs, species interactions and predator-prey relationships, the role of habitat and the biological, physical and oceanographic factors affecting ecosystem stability and resilience;

c) Build or enhance systematic monitoring of natural variability and its relations to ecosystem productivity' (FAO, 2001).

The FAO's current definition of ecosystem-based approach to management is the following: "An ecosystem approach to fisheries strives to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic, and human components of ecosystem and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries" (FAO Fisheries Department, 2003).

The IWC has recognized the importance of the study of competition between top predators and fisheries since 1999. In 2001 the IWC unanimously decided to make the study of interactions between whales and fish stocks a matter of priority (IWC, 2001b). Recognizing the importance of this topic the IWC SC in 2006 created a Working Group on Ecosystem Modeling where prototype ecosystem models from JARPN II were presented and discussed in 2007 (IWC, 2008a).

Under the new Japanese fisheries management regime an ecosystem-based approach plays an important role because marine living resources and habits around Japan are quite diversified and their interrelationships are very dynamic. Understanding of the marine ecosystem around Japan needs to be substantially strengthened in order to take, for example, the following factors into account in prescribing fisheries management measures:

a) A drastic decrease of Japan's fisheries catches from 12.8 million metric tons in 1988 to 5.8 million metric tons in 2005.
b) Introduction of the moratorium on commercial whaling since 1988 and resultant increase of whales around Japan.
c) Historical drastic fluctuation of the pelagic fisheries resources in a process so-called 'species replacement' in the western North Pacific.

JARPN II was designed to provide data to build ecosystem models that would be used to promote the understanding of the factors above. The ecosystem models are expected to provide insights to the relationships between different species in the marine ecosystem and the dynamics of the ecosystem. They are expected to provide information on the extent of the predation by the increased marine mammal populations, which will balance the need for the effective utilization of fisheries resources and the conservation of marine mammals (Government of Japan, 2002b). Therefore JARPN II research is entirely consistent with the Reykjavik Declaration (FAO, 2001).

The primary purpose of JARPN II is to study the interactions between fisheries and cetaceans in the marine ecosystem of the western North Pacific through ecosystem modeling. The output from this study can assist in the formulation of effective ecosystem-based management policies in the future. For this purpose multidiscipline, comprehensive surveys are required (See Figure 2 for the multidiscipline surveys designed by JARPN II).

Four large whale species were chosen for the study: the common minke, Bryde's, sei and sperm whales. These species were chosen because they occupy an important niche in the pelagic zone of the North Pacific and because their populations are relatively abundant.

Monitoring environmental pollutants

In 1992 the IWC decided to establish a regular agenda item for research on the effects of environmental change on cetaceans (IWC, 1993). At the 1994 IWC SC meeting, one of the items identified was pollution (IWC, 1995a). In particular, there is concern that pollutants have a negative effect on the health of cetaceans resulting in a decrease in the abundance of the stocks.

Pollutants such as organochlorines (OCs) and heavy metals are generally released from land and transported to coastal and pelagic waters in run-off as well as by atmospheric transportation and other ways. Higher trophic animals such as cetaceans generally accumulate organochlorines and toxic elements through the marine food web. The monitoring of pollutants in the marine environment through the examination of biological tissues of marine mammals is of importance since marine mammals can serve as useful biological indicators of environmental conditions. Large cetaceans are particularly useful as they are long-lived animals migrating long-distances. Therefore pollutants can be monitored in a wide area and pollutant burdens can be integrated over time. This monitoring can be done through JARPN II surveys.

Stock structure

The description of stock structure in a species is important for management and conservation purposes. The information on number and distribution of stocks is important because the abundance, abundance trends and catch quotas (in the case of harvested populations) should be estimated on the basis of individual stocks. If such information is not available there is the risk that small stocks could be depleted. The RMP has been applied to some of the whale species investigated by JARPN II (see Section 2.1) and others are being considered by the IWC SC for in-depth assessment (evaluation of stock status which considers information on stock structure, abundance, etc.). JARPN II has been collecting data and samples (genetics and non-genetics), which can be used for studies on stock structure in those species.

In this section the justification for the studies on stock structure is explained for each of the whale species investigated in JARPN II.

<u>Common minke whale</u>

There are two remaining issues on stock structure, which are important in the context of management under the RMP (see Section 2.1 for an explanation of RMP):

a) Systematic monitoring of the occurrence of J stock like animals in coastal areas of the Pacific side of Japan (sub-area 7, Figure 1) to determine the dynamics (spatial and temporal) of their occurrence.

Assignment of individuals to stocks is particularly important in situations of geographical overlap of stocks (animals of two or more stocks occupying a same geographical area). Furthermore individuals assigned to particular stocks by genetics analysis can be examined for other biological and ecological traits so that differences among stocks due to non-genetic markers can be investigated as well.

b) Plausibility of the stock structure hypotheses of the ‘O’ stock used by the IWC SC in 2003 (including the elucidation of the occurrence of the ‘W’ stock in offshore areas as mentioned earlier in Section 2.1).

The rational for the studies on stock structure of the ‘O’ stock of minke whale under the JARPN program (1994-1999) was given in Section 2.1.

Several meetings were conducted by the IWC SC in the context of the RMP’s *ISTs*, which were completed in 2003 (IWC, 2004; Table 1). Final hypotheses on stock structure were based on genetic analyses conducted using the past commercial samples and new samples collected in sub-areas 7, 8 and 9 by JARPN and JARPN II between 2000 and 2001 (e.g. Goto *et al*., 2002; Kanda *et al*., 2002; Taylor and Martien, 2002). The following four hypotheses on stock structure were used in the RMP’ *ISTs* (Figure 3):

Hypothesis A: three-stock scenario (‘J’, ‘O’, ‘W’) with the ‘W’ stock found only in part of sub-area 9 and only sporadically (Figure 3-AB); Hypothesis B: two stock scenario (‘J’ and ‘O’) with no W stock as a limiting case of Baseline A (Figure AB); Hypothesis C: four-stock scenario overall, with ‘O_W’, ‘O_E’ and ‘W’ to the east of Japan. Boundaries are fixed at 147°E and 157°E and there is no mixing between the stocks (Figure 3-C); Hypothesis D: three-stock scenario (‘J’, ‘O’, ‘W’), with ‘O’ and ‘W’ mixing over 147°E and 162°E, O being dominant to the west and W to the east (Figure 3-D).

In 2003 the IWC SC gave the same high plausibility to these four hypotheses (IWC, 2004). There was therefore a need to examine new samples (genetics and non-genetics) to evaluate the plausibility of these four stock structure hypotheses.

Bryde's whale
Several meetings were conducted by the IWC SC in the context of the RMP's *ISTs*, which were completed in 2007 (IWC, 2008b; Table 2). Final hypotheses on stock structure were based on genetic analyses conducted using the past commercial samples and new samples collected in sub-area 1 by JARPN II between 2000 and 2003 (Figure 4) (Pastene *et al*., 2004; Martien and Taylor, 2004). The following four hypotheses on stock structure were used in the RMP' *ISTs* (Figure 5):

Hypothesis 1: this is a single stock hypothesis under which only one stock of Bryde's whale is found in the area from 130°E and 160°W (excluding the area of distribution of the East China Sea Stock) and there are no sub-stocks (Figure 5-1); Hypothesis 2: this is a two-stock hypothesis under which Stock 1 is found in sub-area 1 and Stock 2 in sub-area 2. Sub-areas 1 and 2 are divided at 180° longitude. Under this hypothesis there are no sub-stocks (Figure 5-2); Hypothesis 3: this is a two-stock hypothesis under which Stock 1 is found in sub-areas 1 and 2 and Stock 2 only in sub-area 2. Under this hypothesis there are no sub-stocks (Figure 5-3); Hypothesis 4: this is a two-stock hypothesis under which Stock 1 is found in sub-area 1 and Stock 2 in sub-area 2. Stock 1 consists of two sub-stocks that mix in sub-area 1 (Figure 5-4).

The IWC SC gave different plausibility to these hypotheses as follow: Hypothesis 1: high; Hypothesis 2: high; Hypothesis 3: high; Hypothesis 4: medium (IWC, 2008b). There was therefore a need to collect and examine new samples to evaluate the plausibility of these four stock structure hypotheses, in particular to respond to remaining key questions on a) whether or not sub-stocks occur in sub-area 1 and b) whether or not a different stock occurs in sub-area 2. JARPN II attempted to respond to the first question.

Sei and sperm whales
These species are currently not being considered for RMP *Implementation*. The IWC SC is currently considering an in-depth assessment of these species in the North Pacific to investigate the current population status in this oceanic region. Estimations of abundance, biological parameters and examination of the catch history are conducted on the basis of individual stocks.

The past information on stock structure of sei whales was based on marking, catch distribution, sighting and morphology of baleen plates (Masaki, 1977), and isozymes (Wada and Numachi, 1991). The information is old and very limited, and it was considered as non conclusive by the IWC SC. Therefore there is the need to update sampling and analysis on stock structure for this species in the North Pacific.

In the past the management of sperm whales by the IWC was based on the assumption of two stocks, western and eastern stocks divided at 180º. The most recent information on stock structure was based on analysis of whaling operation data, movement of marked whales and sighting distribution (Kasuya and Miyashita, 1988). These authors suggested two latitudinal segregated sperm whale stocks in the western North Pacific. Therefore the information on stock structure of sperm whales in the North Pacific is old and very limited and there is the need to update sampling and analysis on stock structure for this species in the North Pacific.

2.2.3 Brief outline of the research area and general methodology

Research area
The research area is on the Pacific side of Japan and covers the IWC SC management sub-areas 7, 8 and 9 (Figure 1). The research area on the Pacific side of Japan (e.g. coast of Tohoku and southern Hokkaido) can be considered as Japan's richest fishing grounds and provided an ideal area to study the interaction between cetaceans and fisheries, and can be considered as a 'hot-spot' area for cetacean/fisheries interaction (see Annex 3 for more details of the research area).

For the main objective of JARPN II (feeding ecology and ecosystem studies), two components are considered: coastal and offshore. The coastal component involves two localities: the coast of Tohoku (off Sanriku) covered in spring and the coast of southern Hokkaido (off Kushiro) covered in fall (see SC/J09/JR3). This corresponds to a part of sub-area 7 (Figure 1). The offshore component is covered in spring-summer.

As mentioned above, the coastal waters off northern Japan can be considered as Japan's richest fishing grounds and provide an ideal area to study the interaction between cetaceans and fisheries. The offshore component involves sub-areas 7 (offshore), 8 and 9 (see SC/J09/JR4) (Figure 1). Although the interaction between fisheries and cetacean is less marked in offshore waters, an important amount of information for modeling purposes can be obtained from those waters, especially from large whales that feed on prey species widely distributed in both coastal and offshore waters.

In Section 3 progress in research for the first six years of JARPN II is presented separately for coastal and offshore components.

General methodology

<u>Feeding ecology and ecosystem studies</u>

In line with the conclusion from FAO (2008) and IWC (2008a) that there is no one single correct model, and that the greatest benefits are to be obtained by considering a number of models that may be of quite different forms, JARPN II is developing different kinds of models (see Figure 2).

For the coastal component a Bayesian Assessment Model (a practical MRM-type model) is being developed, basically to investigate the effect of consumption of sand lances by marine mammals.

For the offshore component two types of models were selected: Ecopath with Ecosim (Christensen *et al*., 2005) and MRM. The Ecopath with Ecosim represent a large range of species and interactions and address broad-scale questions related to the structure of the ecosystem. In the case of JARPN II the impact of common minke, Bryde's, sei and sperm whales whaling on Japan's fisheries resources such as anchovy, Pacific saury, mackerel, etc., is being evaluated. MRM considers the interaction among a smaller number of species by developing a multi-species model with a small number of predators. In the case of JARPN II the impact of common minke, Bryde's, sei and sperm whales whaling on Japan's fisheries resources such as anchovy, Pacific saury, mackerel, etc., is being evaluated together with suitable TACs for anchovy and Pacific saury. These models are being developed for the offshore sub-areas 7, 8 and 9.

It should be noted that at this stage, the progress level of the three ecosystem models used in JARPN II is different. More progress has been made for the Ecopath with Ecosim model.

Figure 2 shows a conceptual diagram on the relevant input data for these models. Several kinds of input data for ecosystem modeling exercise have been obtained through JARPN II research e.g. abundance and distribution of large whales (common minke, Bryde's, sei and sperm whales), distribution, abundance and habitat of whale's prey species (anchovy, Pacific saury, copepod, Euphausia), prey consumption by whales (common minke, Bryde's, sei and sperm whales) and whale's prey preference. In order to get these data JARPN II has conducted a variety of surveys:

- Dedicated sighting surveys and the application of the Line Transect Method for estimating the number of whales present in a particular area at a particular season (see SC/J09/JR2 for details of the methodology and procedure of the dedicated sighting surveys in the coastal and offshore components).
- Whale surveys on predetermined track-lines to investigate whale's prey consumption by examining qualitatively and quantitatively the stomach contents of whales sampled. In addition several other biological data and samples are collected from the whales sampled (these data and samples are used for the other two objectives of JARPN II) (see SC/J09/JR3 and SC/J09/JR4 for details of the methodology and survey procedure -with special emphasis on whale sampling procedure- in the coastal and offshore components, respectively). The target species are the common minke whale, Bryde's whale, sei whale and sperm whale. These species were chosen because they occupy an important niche in the pelagic zone of the North Pacific and because their populations are relatively abundant. Sample size was calculated for estimating their prey consumption with good precision (CV equal to, or less than 0.2). Estimated annual sample sizes were 220 minke whales. A total of 120 in the coastal component (60 in Sanriku in spring and 60 in Kushiro in fall) and 100 in the offshore component. A total of 50 Bryde's whales, 100 sei whales, and a maximum of ten sperm whales were planned to be sampled in the offshore component (see details in Annex 3).
- Concurrent whale and prey species surveys to investigate distribution and abundance of prey species (through echo-sounder and trawling surveys) and prey preference of whales through a comparison of whale stomach contents and prey availability in the area where whales were sampled (see SC/J09/JR5 and SC/J09/JR6 for details of the whale's preys surveys in the coastal component; SC/J09/JR7 for details of the methodology and procedures of concurrent whale and preys surveys in the offshore component). During these surveys detailed oceanographic information is also obtained using CTD and

XCTD so that distribution of whales and prey species can be studied together with the oceanographic information.

Other data for input to the ecosystem models related to other predators and prey species are obtained from the literature.

Monitoring environmental pollutant
The level of accumulation of pollutants is measured using standard analytical protocols: Cold Vapor Atomic Absorption Spectrophotometry (CV-AAS) for Hg in biological tissues of predators and prey species; Gas Chromatography-Mass Spectrometry (GC-MS) for PCB in atmospheric and sea water samples; Gas Chromatography Electron Capture Detector (GC-ECD) for PCB in biological tissues. In order to understand the accumulation characteristics of pollutants in whales, biological information such as sex and maturity stage of the animals are considered. In addition to whales, whale's preys and environmental samples are monitored. It is known that differences in the accumulation levels of some organochlorines are observed between baleen and toothed whales. These differences reflect the fact that their prey species are in different trophic level and/or have different contamination levels. Therefore JARPN II also investigated the pollution levels in prey species collected from the stomach contents of whales as well in seawater and air samples. This kind of analysis is important to understand the bioaccumulation process through the marine food chain.

In order to assess relationships between pollutant levels and effects in cetaceans, biomarkers are developed.

Stock structure
Monitoring of 'J' stock animals in sub-area 7 is addressed through the analysis of genetic variation at 16 microsatellite loci coupled with a Bayesian method implemented in the computer program STRUCTURE. Stock structure of 'O' stock of minke whales is addressed using genetics (hypothesis testing based on mtDNA control region sequences and microsatellites data) and non-genetics (morphometric). At this stage only genetic analyses have been conducted to investigate stock structure of Bryde's and sei whales.

2.2.4 Characteristics of JARPN II

The JARPN II is a comprehensive research program providing information potentially useful for the management of marine resources. The JARPN II has the following characteristics:

a) It is a comprehensive large-scale research project including both lethal and non-lethal surveys. It is the first time that data for all parts of ecosystem has been collected at the same time. Different disciplines working together to achieve comprehensive outcomes for fisheries management (Figure 2). A list of data and samples collected during the JARPN II is presented in Annex 2.
b) It is a research project that contributes to rational management of marine resources. The information obtained is useful for ecosystem modeling, which can assist in the formulation of effective ecosystem-based management policies (see Figure 2), as well as input data for the IWC's RMP, a single-species management procedure (e.g. through information on stock structure).
c) It is a long-term research project. This characteristic allows the study of fluctuations of biological processes over time. Further the research is conducted in the same areas in different years, which provide a good opportunity for continuous observations in a fixed area.

JARPN II has contributed substantially to science in a number of fields (Annex 4).

Data obtained in JARPN II have been available to the international scientific community under established data access protocols. Annex 5 shows the data access protocol of the Institute of Cetacean Research (ICR), which is also available at the following IWC web page:
http://www.iwcoffice.org/_documents/sci_com/DataAvailability/DAprotocolJapan.pdf.

3. PROGRESS IN JARPN II RESEARCH (2002-2007)

3.1 Feeding Ecology and Ecosystem Studies

Figure 2 shows a conceptual schematic representation of the different research components under this objective. A summary of results below are given according the flow order in this figure, and separately for coastal and offshore components.

Annex 1 shows a list of documents on which the research results summarized below are based.

3.1.1 Coastal component

Prey consumption by cetaceans

First the number of whales at a particular area and time is estimated. These figures are used for the estimation of prey consumption by whales (Figure 2).

- Abundance of whales

SC/J09/JR8 estimated the abundance of common minke whales in the coastal regions of Sanriku and Kushiro in order to estimate prey consumption by the common minke whales. Abundance is defined here as the number of whales present in a given area and at a particular time. These estimates could be used for input for ecosystem models in the JARPN II survey area as well. The estimated numbers off Kushiro are 601, 968, 368, 316, 241 and 142 in 2002-2007, respectively. The estimated numbers off Sanriku are 247 and 123 in 2005 and 2006, respectively. It should be noted that these numbers should not be used for assessment because they do not represent estimates of *stock* abundance of the common minke whale. This is because sighting surveys used for the estimation of the number of whales covered only a limited area of the stock distribution, during a particular time of its migration to northern feeding grounds. Futher, depending of changing environmental factors, the number of whales sighted in this limited area and time, could be different from year to year.

- Prey consumption and feeding habitat of common minke whale

The stomach contents of common minke whales sampled off Sanriku (April-May) and Kushiro (September-October) in 2002-2007 JARPN II were analyzed (SC/J09/JR9). In Sanriku region, the dominant prey species consisted of krill (*Euphausia pacifica*) and fishes (Japanese sand lance *Ammodytes personatus* and Japanese anchovy *Engraulis japonicus*). In the Kushiro region the dominant prey species consisted of krill (*E. pacifica*), fish (Japanese anchovy, Pacific saury *Cololabis saira* and walleye pollock *Theragra chalcogramma*) and squid (Japanese flying squid *Todarodes pacificus*). The total prey consumptions in the Sanriku region of Japanese sand lance, Japanese anchovy and krill were estimated as 683-1,616 tons, 150-194 tons and 1-109 tons, respectively (2005-2006). In Kushiro region the total prey consumption of Pacific saury, walleye pollock, Japanese flying squid and Japanese anchovy was estimated as 39-1,075 tons, 95-2,322 tons, 3-1,753 tons and 308-1,422 tons, respectively (2002-2007).

Prey preference of cetaceans

- Distribution and abundance of prey species, and prey preference of whales

Results of a prey preference study of common minke whales in the coastal waters of Sanriku are given in SC/J09/JR10. To estimate prey preference sampling surveys of common minke whales and their prey surveys were conducted in the same area at the same timing (April). A prey preference index, Manly's α, was used in the analysis. Minke whales fed on krill, Japanese anchovy and sand lance (adult). These are important species of local commercial fisheries. Minke whales showed preference for adult sand lance. As previously reported in other regions, krill was not a preferable prey for minke whales. Ecosystem modelling work (see SC/J09/JR14 below) suggested that change in functional form had substantial effect on predation impact on sand lance by minke whales. Functional response can be estimated if long term prey preference data are available.

Results of a prey preference study of common minke whale in the coastal waters of Kushiro are presented in SC/J09/JR11. Results suggest that the slope water region of less than 18°C SST is a rich prey environment in both the epi- and mesopelagic zones. Common minke whale might prefer the rich prey environment affected by the Oyashio not only in the continental shelf region where walleye pollock, Pacific saury, and euphausiids are distributed but also in the offshore region where Pacific saury and euphausiids are distributed. It is suggested that immature common minke whales prefer walleye pollock while mature animals prefer Pacific saury, although both frequently fed on Japanese anchovy in some years in the area within 50 nautical miles from Kushiro.

Other potential information for ecosystem modeling

Relationship between body size, maturity and feeding habit of common minke whales in Sanriku area in spring season was reported in SC/J09/JR12. The total number of whales examined was 227 (91 males and 136 females). Three species, krill, Japanese sand lance and Japanese anchovy were found in stomachs, of which sand lance was the most dominant prey species, followed by anchovy. All the whales but two were sighted in waters with a depth of 20-100m. No obvious difference was observed in their sighting positions between males and females, immature and mature animals, and the three prey species. Examination of the frequency of prey species consumed by whales of different lengths and by whales of different sexual maturity status showed little difference.

The relationship between body size, maturity and feeding habit of common minke whales in Kushiro area in autumn season was reported in SC/J09/JR13. The total number of whales examined was 254 (182 males and 72 females). Occurrence of prey species in stomachs differed significantly with maturity stage. Smaller and immature whales tend to feed on walleye pollock and krill whilst larger and mature whales tend to feed on Pacific saury. Japanese flying squid was consumed only by mature whales. Japanese anchovy was equally consumed by immature and mature whales. For the coastal waters off Kushiro in the fall season the results suggested that migration and prey preference of common minke whales differed with maturity stage and that on the continental shelf and slope regions immature whales showed a greater preference for walleye Pollock and krill than mature whales.

Ecosystem modelling

Progress has been made on the development of an ecosystem model for the coastal component off Sanriku as follow:

A Bayesian assessment model was developed (SC/J09/JR14) to investigate the effects of consumption by minke whales on sand lances in the coastal waters of Sanriku. The model allows for various uncertainties making use of time series data historically collected by fisheries and researches. The impact of predation was examined in terms of MSY. When linear functional response curve was used, the resultant impact was so great that the median value of MSY was increased by 154%. Whereas using the constant functional response, the impact was much smaller, only 17% increase in the median value of MSY. The estimation of functional response forms should therefore be important.

3.1.2 Offshore component

Prey consumption by cetaceans

Information in this section is structured in a similar format as to that in the coastal component. As noted above the whale survey of the offshore component involves sampling of four species of large whales.

- Distribution and abundance of whales

In order to estimate prey consumption by common minke, Bryde's, sei and sperm whales in the early and late feeding seasons, the numbers of the whales distributed in JARPN II survey area were estimated in SC/J09/JR15. The estimates were also intended as input for ecosystem models in the JARPN II survey area. It was suggested that the estimates were affected by migration patterns of the whales. Considering the migration pattern suggested by sighting survey data, the estimates are 7,338 in the early and 2,976 in the late season for the common minke, 7,744 in the early and 5,406 in the late season for the sei whales 1,677 in the early and 9,797 in the late season for the Bryde's whales and 15,929 in the early and 20,292 in the late season for the sperm whales. It should be noted that these estimates should not be used for assessment because the estimated figures represent only a part of the population considered.

- Prey consumption and feeding habitat of baleen whales

The stomach contents of common minke, sei and Bryde's whales sampled in the western North Pacific from May to September in 2000-2007 JARPN II, were analyzed in SC/J09/JR16. The main prey species of common minke whale consisted of one copepod, two krill, two squids and eight fish. The main prey species of sei whale consisted of two copepods, three krill and four fish. The main prey species of Bryde's whale consisted of five krill, one squid and four fish. There were seasonal and geographical changes of prey species. The total prey consumption by three baleen whales during the feeding season was estimated to be 1.6 million tons. The prey consumption of Japanese anchovy, mackerels and Pacific saury by three baleen whales were estimated as 739 thousands tons, 140 thousands tons and 43 thousands tons, respectively.

Prey consumption and feeding habitat of sperm whales

The stomach contents of sperm whales sampled in the western North Pacific from May to September each year from 2000 to 2007 were analyzed in SC/J09/JR17. Thirty-eight prey species consisting of 33 squids, 1 octopus and 4 fishes, were identified. Sperm whales fed mainly on various deep-sea squids. The most important prey species were 4 squids (*Taningia danae, Histioteuthis dofleini*, *Belonella pacifica borealis* and the eight armed squid *Gonatopsis borealis*). Sperm whales feed mainly on prey in the mesopelagic and/or bottom during daytime. The seasonal prey consumption (from May to September) by sperm whales in this region was calculated to be nearly 1.2 million tons. The consumption of neon flying squid *Ommastrephes bartrami* was estimated to be 30,000 tons. Estimated feeding contribution rates of the surface layer to predation by sperm whales in each sub-area were ranged from 4.7 to 11.4%. The influence on the surface layer of the marine ecosystem resulting from consumption by sperm whales can not be disregarded, because the biomass of sperm whales is large.

Prey preference of cetaceans

- Distribution and abundance of prey species, and prey preference of whales

Murase *et al*. (2007) (For Info 1) presented a study on prey selection of common minke and Bryde's whales in the western North Pacific based on data collected in the 2000 and 2001 summer seasons. 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. Bryde's whales showed selection for Japanese anchovy in August 2000 and July 2001, while they showed prey selection for krill in May and June in 2001.

Prey preferences of common minke, Bryde's and sei whales at meso scale were estimated (SC/J09/JR18) 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 prey species with large values of Manly's α indicates preference for it. 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 preys of three baleen whale species overlapped, Manly's α suggested their trophic niches were different from each other. Minke and sei whales coexisted in same survey blocks but their prey utilization patterns were different.

The prey preferences estimates in SC/J09/JR18 could be used as input parameters for a Minimum Realistic-based ecosystem model (see below).

Other potential information for ecosystem modeling

SC/J09/JR19 presented a model for density prediction of common minke, sei and Bryde's whales in the western North Pacific during the feeding season. Data used for the model were densities estimated from dedicated sighting survey data in JARPN II, and satellite information on surface temperature, surface height and chlorophyll. The predicted density distributions by the analysis suggested spatial distribution patterns of whales and differences in the pattern among whale species.

SC/J09/JR20 examined time trend of blubber thickness in common minke, sei and Bryde's whales, and the factors influencing the energy storage in these whales. Results suggested that the blubber thickness of minke whale has increased during the JARPN and JARPN II period; that of sei whales has increased during the 5-years of the JARPN II period, while that in Bryde's whales have decreased during 7 years. The feeding areas of

Bryde's and sei whales showed limited overlap, and their distribution is separated by sea surface temperature (SST). Further studies were suggested to assist in the interpretation of these results.

Ecosystem modeling

Information on the number of whales in the research area (SC/J09/JR15) and prey consumption by whales (SC/J09/JR16; SC/J09/JR17) was used to develop ecosystem models for the offshore component (see Figure 2). The MRM also considered information on prey preference of whales (SC/J09/JR18). Below is a summary of key results of the modeling work at this stage. As mentioned above at this stage the progress level of these models is different.

- Ecopath with Ecosim

SC/J09/JR21 presents the progress made on developing an ecosystem model based on Ecopath with Ecosim. The results suggest that in average terms: 1) when minke whales are the only species that are harvested by 4% of its biomass (catch of other species are kept constant at current catch rate), depending on the functional response form assumed for the species, it is not certain whether catch of some Japanese fisheries resources (e.g. anchovy, Pacific saury, skipjack tuna, mackerels) will increase or not; 2) when sei and Bryde's whales are each the only species that are harvested by 4% of their biomass, regardless of the functional response form assumed for the species, catch of anchovy, skipjack tuna, and mackerels may increase; 3) when minke, sei and Bryde's whales are all harvested by 4% of their biomass, a positive increase in catch is expected for most of the fish resources (i.e. anchovy, skipjack tuna and mackerels); and 4) when sperm whales are the only species that are harvested by 4% of its biomass, depending on the functional response form assumed for the species, catch of anchovy, Pacific saury, mackerels and skipjack tuna may decrease, but catch of neon-flying squid may increase.

- MRM (Stella)

SC/J09/JR22 presents the progress made on developing an ecosystem model based on MRM. The model is focused to assess the impact of common minke, Bryde's and sei whales whaling on two prey species with commercial importance, the Japanese anchovy and Pacific saury. It should be noted that this is an ongoing work and that the focus at this stage is on methodological issues.

3.2 Monitoring Environmental Pollutants in Cetaceans and the Marine Ecosystem

Pattern of accumulation of pollutants in cetaceans

PCBs and pesticides were measured in the blubber of sperm and sei whales collected from offshore waters of the western North Pacific in 2001 and 2002. PCBs and DDTs were the predominant contaminants in both species. Organochlorine residue levels in sei whales were one or two orders of magnitude lower than sperm whales and were the lowest reported in whales from the Northern Hemisphere. Compositions of CHL and DDT compounds also showed species-specific differences, with sperm whales retaining a higher percentage of p,p'- DDE and a lower percentage of oxychlordane compared with sei whales. These results suggest that the differences in feeding preferences and metabolic capabilities are the major contributing factors influencing the accumulation patterns of organochlorines, in different species of marine mammals. (Results from this study were presented to the First International Symposium on Environmental Behavior and Ecological Impact of Persistent Toxic Substances", Matsuyama, Japan March 18-20, 2004) (Abstract available).

To investigate temporal changes of Hg levels in the western North Pacific, total Hg concentrations in muscle samples from common minke, Bryde's and sei whales were measured (SC/J09/JR23). Total Hg levels were in the order: mature common minke whales (0.22±0.07 ppm wet wt.) > mature sei whales (0.052 ±0.009) = mature Bryde's whales (0.046±0.008). Yearly changes of total Hg levels in zooplankton and pelagic fishes were not observed in the period 1995-2007. Apart from common minke whales from sub-area 9, significant yearly changes of levels in whales were not observed. For minke whales in sub-area 9, levels decreased from 1994 to 1999 but increased from 2000 to 2007. Results of a multi linear regression analysis suggested that changes of Hg levels in sub-area 9 reflect changes in food habitat of minke whale rather than changes in accumulation levels in the environment.

SC/J09/JR24 presents information on PCB levels in blubber samples of common minke, Bryde's and sei whales from the western North Pacific. The range of levels in these species was 0.13-4.0, 0.04-0.21 and 0.03-0.47 ppm wet wt., respectively. Yearly changes of PCB levels were not observed in common minke, Bryde's and sei whales in the period 2002-2007. Results of previous studies suggested that PCB levels had been continually decreasing in this oceanic region (1980's-1990's). Results from JARPN II suggest that the level has been stabilized since 2002.

Bioaccumulation process of pollutants through the food chain

SC/J09/JR23 also examined total Hg level in prey samples of whales: two zooplanktons (krill *E. Pacifica*; copepods *Neocalanus spp.* and *Calanus sp.*), six pelagic fishes (Japanese anchovy; Pacific saury; walleye pollock; mackerels; Pacific pomfret). Total Hg levels in krill and copepods ranged from <0.001-0.013 and 0.003-0.010 ppm dry wt., respectively. Total Hg levels in the pelagic fishes were in the order: Pacific pomfret (0.232±0.027) > walleye pollock (0.045) = Pacific saury (0.039±0.016) =Japanese anchovy (adult) (0.037±0.025) > Japanese anchovy (larval fish) (0.005±0.003). No yearly changes of total Hg level were observed for krill and Japanese anchovy during the period 1995-2007. Variation of Hg levels in pelagic fishes from the western North Pacific was not related to sampling year.

SC/J09/JR24 also presented information on PCB level in air and surface seawaters from the western North Pacific. The range of levels was ND-22 pg/m3 for air samples and 1.5-11 ng/L for sea water samples. PCB levels in seawater decreased from coastal to offshore regions. The trend in level of air samples was not clear.

Relationships between chemical pollutants and cetacean health

To examine the CYP families, related to immune-toxicity of PCB and pesticides, full-length cDNA sequences of CYP1A1 and 1A2, in common minke whales were determined (Niimi *et al*., 2005; For Info 2). The deduced full-length amino acid sequence of CYP1A1 revealed higher identities with those of sheep (86%) and pig (87%), and that of CYP1A2 was most closely related to human (82%) and monkey CYP1A2 (82%) among species from which CYP1A2 has been isolated so far. Differences in certain conserved and functional amino acid residues of CYP1A1 and 1A2 between common minke whale and other mammalian species indicate the possibility of their specific metabolic function. Concentrations of organochlorine compounds (OCs) including PCBs and DDTs analyzed in common minke whale liver showed no significant correlation with hepatic mRNA expression levels of CYP1A1 and CYP1A2, indicating no induction of these enzymes by such OCs.

To investigate whether or not CYP expression levels are altered by organochlorine contaminants (OCs), mRNA levels of CYPs in the liver of common minke whales were measured (Niimi *et al*., 2007; For Info 3). The quantified mRNA levels were employed for the statistical analysis with the residue levels of OCs including PCBs, DDTs (p,p'-DDT, p,p'-DDD and p,p'-DDE), chlordanes (cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor and oxychlordane), HCHs (alpha-, beta- and gamma-isomers) and hexachlorobenzene that have already been reported elsewhere. Spearman's rank correlation analyses showed no significant correlation between CYP expression levels and each OC level in the common minke whale liver, implying that these environmental chemicals have no potential to alter the expression levels of these CYPs or the residue levels encountered in the whale livers may not reach their transcriptional regulation levels. This suggests that the expression of individual CYPs in the whale liver may be at basal level.

SC/J09/JR25 examined the accumulation characteristics of mercury, a toxic element, and selenium, an antagonist, as well as the inter-species difference of sensitivity to mercury toxicity. Total mercury (T-Hg), methyl mercury (MeHg) and selenium (Se) levels in the liver, kidneys and muscle were measured. T-Hg and MeHg levels were higher in the order of sperm whale > common minke whale > Bryde's whale. Se levels were higher in the order of sperm whale > Bryde's whale > common minke whale. The order of the T-Hg and Se levels in the tissues of the common minke and Bryde's whales was kidneys > liver > muscle, and that of MeHg was liver > muscle > kidneys. The order of the T-Hg and Se levels in the tissues of sperm whales was liver > kidneys > muscle.

3.3 Stock Structure
Common minke whale

<u>J-O stock research</u>

SC/J09/JR26 assigned minke whales into genetically distinct stocks using a combination of microsatellite analysis and a Bayesian clustering approach. Samples of 2,542 minke whales collected during the offshore component of JARPN and JARPNII from 1994 to 2007, during the coastal component of JARPNII from 2002 to

2007, and from bycatches in the set net fishery along the Japanese coast from 2001 to 2007, were analyzed using 16 microsatellite loci. Approximately 91% of the individuals were assigned into ‘J’ and ‘O’ stocks based on their high membership probability (>90%). It was also found that a) the ‘O’ stock individuals appeared to migrate, although rarely, to the Sea of Japan, b) the ‘J’ stock individuals migrated to sub-area 7W (Figure 1) of the North Pacific side and very rarely to further east, and c) the sub-area 2 (Figure 1) was mainly occupied by the J stock. Temporal distribution of the assigned bycatches collected from sub-area 7 (Figure 1) indicated seasonal movement of the whales with the number of the ‘O’ stock increased in spring.

SC/J09/JR27 investigated morphometric differences between ‘J’ and ‘O’ stock animals, as identified by the microsatellite analysis in SC/J09/JR26. Marked differences in morphometry were found between both stocks.

SC/J09/JR28 examined the status of scars on the skin of minke whales, and whether or not it is possible to identify the stock of the individual animal based on external morphological scars using samples of western North Pacific common minke whales collected by JARPNII. This study was assisted by the genetic assignment to stocks shown in SC/J09/JR26. Assignments of the number of scars were not a complete diagnostic for the minke whales samples for ‘J’ and ‘O’ stocks. However, at least there is a strong likelihood that animals which have no scars on the body were ‘J’ stock animals.

<u>Stock structure of ‘O’ stock of minke whale</u>

SC/J09/JR29 investigated genetic variation at mtDNA control region in samples of western North Pacific common minke whales to describe their stock structure, and then to examine the plausibility of four stock structure hypotheses adopted at the final stage of the *ISTs* process by IWC Scientific Committee in 2003 (Figure 3). It was found that a) whales from ‘J’ stock existed in sub-area 7W with low but large enough numbers to cause genetic heterogeneity observed in the 7W samples as well as between the 7W and other samples; b) after exclusion of the ‘J’ stock whales, the survey area was occupied mainly by ‘O’ stock, which provide support to hypothesis B; and c) the hypotheses C and D (Figure 3) were not supported.

SC/J09/JR30 investigated genetic variation at 16 hypervariable microsatellite DNA markers to describe stock structure in common minke whales, and then to examine the plausibility of four stock structure hypotheses adopted at the final stage of the *ISTs* process by IWC Scientific Committee in 2003 (Figure 3). It was found that a) whales from the ‘J’ stock existed in sub-area 7W with low but large enough numbers to cause genetic heterogeneity observed in the 7W samples as well as between the 7W and other samples, b) except the ‘J’ stock whales, the survey area was mainly occupied by ‘O’ stock, which provide support to hypothesis B, and c) the hypotheses C and D (Figure 3) were not supported because no other genetically distinct coastal stock was observed. Heterogeneity found for a single microsatellite locus in sub-area 9 should be further investigated in the context of hypothesis A.

SC/J09/JR27 conducted a morphometrics analysis of common minke whales in sub-areas 7, 8 and 9 to evaluate the plausibility of four stock structure hypotheses adopted by IWC in RMP *Implementation Simulation Trial*s in 2003 (Figure 3). Analysis of covariance (ANCOVA) using body length as a covariate is used to test if there are significant differences in morphometric measurements among groups compared. Apart from differences between ‘J’ and ‘O’ stocks animals no other significant geographic or temporal differences were found. Results of the analyses support hypothesis B and are inconsistent with hypotheses C and D (Figure 3).

Bryde’s whale

Kanda *et al*. (2007) (For Info 4) investigated the pattern of genetic stock structure in the Bryde’s whale at the inter-oceanic and trans-equatorial levels, using microsatellites (17 loci) and mtDNA control region sequences (299bp). Samples were available from the western North Pacific (JARPN II), South Pacific (historical) and Indian Ocean (historical). While no significant differentiation was found within the western North Pacific, marked genetic differentiation was found among oceans and between South and North Pacific.

SC/J09/JR31 examined genetic variations at 17 microsatellite loci and 299 bp of mitochondrial DNA (mtDNA) control region were analyzed to investigate the existence of genetically differentiated sub-stocks of Bryde’s whales in the sub-area 1 (stock hypothesis 4 in Figure 5). No evidence was found of genetic differentiation between the samples from the 1W and 1E (separated at 153ºE), indicating these JARPNII samples came from a genetically same group of Bryde’s whales. The same result was found when historical samples from the central western North Pacific and around Ogasawara Islands were incorporated into the analysis.

Sei whale

Kanda *et al*. (2006) (For Info 5) examined the genetic characteristics of sei whales inhabiting the western North Pacific based on 17 microsatellite loci in a total of 89 whales obtained by JARPN II from the area between 37ºN–45ºN and 147ºE–166ºE in 2002 (N = 39) and 2003 (N = 50). No evidence of genetic heterogeneity in allele frequencies was observed between sexes within samples as well as between the two temporally different samples, indicating a single population of sei whales inhabiting the western North Pacific.

SC/J09/JR32 examined genetic variation at 17 microsatellite loci and 487 bp of mitochondrial DNA (mtDNA) control region sequences in samples of sei whales in order to describe their stock structure in the western North Pacific. The samples used consisted of 489 whales collected during JARPNII (2002-2007) in the area between 143°E and 170°E. In order to explore their stock structure in a wider geographic area, a total of 301 whales (298 for the mtDNA analyses) collected from the 1972 and 1973 commercial whaling in the North Pacific from 165°E to 139°W were incorporated into the analysis. All the tests conducted found no evidence of genetic differences within as well as between the JARPNII and commercial whaling samples. This study indicated that the open water of the North Pacific was mainly occupied by individuals from a single stock.

Sperm whale

SC/J09/JR33 analyzed genetic variations at 15 microsatellite DNA loci and mitochondrial DNA (mtDNA) control region sequences in samples of sperm whales collected during JARPNII from 2000 to 2007 in order to examine the effectiveness of these genetic markers for stock structure study of the species. Analyses of mtDNA and microsatellite markers in the total of 45 sperm whales demonstrated that these genetic markers were variable enough to explore stock structure of sperm whales. 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 in the research area was found.

3.4 Other Results

Oceanographic features in the research area

SC/J09/JR34 examined oceanographic conditions in the offshore and the coastal (off Kushiro) components of JARPN II using output from an operational ocean prediction system (FRA-JCOPE). Oceanographic observations with CTD and XCTD were conducted in the cetacean prey surveys in JARPN II. These observations were incorporated into the prediction system. The survey covered from subarctic area to the adjacent area of the subtropical area where common minke, Bryde's and sei whales were found. The survey area was located between the Kuroshio Extension and the Subarctic Front, where the water mass was characterized by the subarctic water, subtropical water and mixed water. Understanding of the oceanographic conditions is fundamental for marine ecological study. The results of the oceanographic survey in this paper were used in other studies related to feeding ecology of whales (e.g. SC/J09/JR10, SC/J09/J11 and SC/J09J18).

Pattern of distribution of large whales

SC/J09/JR35 reported the Density Index (DI: individuals / 100 n.miles) and monthly distribution pattern of blue, fin, humpback and right whales from May to September in the western North Pacific based on JARPN (1994-1999) and JARPN II (2000-2007) sighting data. Among four species, fin whales were most frequently sighted, and next were blue, humpback and right whales in order. Northward migration pattern of whales were observed for these species. Additionally, sighting areas of these species were spread out compared to the previous information except for right whales.

Reproductive biology and physiology

Watanabe *et al*. (2004) (For Info 6) presents a study to obtain new information on relationships among serum testosterone (T), estradiol-17β (E_2), follicle-stimulating hormone (FSH), and luteinizing hormone (LH) concentrations and histology of seminiferous tubules in captured common minke and Bryde's whales during the feeding season. Results indicated that the low serum T concentrations reflect the inactivity of spermatogenesis in both baleen whales, and that it is not possible to assess gonadal activity in either species using serum sex hormone concentrations during the feeding season.

Watanabe *et al*. (2007) (For Info 7) investigated whether spermatozoa of Bryde's whale can retain the capacity for oocyte activation and pro nucleus formation as well as chromosomal integrity under cryopreservation by using intra cytoplasmic sperm injection (ICSI) into mouse oocytes. Results showed that motile Bryde's whale spermatozoa are competent to support embryonic development.

Urashima *et al*. (2007) (For Info 8) examined samples of milk from a Bryde's whale and a Sei whale. Milk samples of these species contained 2.7 g/100 mL and 1.7 g/100 mL of hexose, respectively. Both contained lactose as the dominant saccharide. The dominance of lactose in the carbohydrate of these milks is similar to that of minke whale milk and bottlenose dolphin colostrum, but the oligosaccharide patterns are different from those of these two species, illustrating the heterogeneity of milk oligosaccharides among the cetacea.

Fukui *et al*. (2007) (For Info 9) presents a study aimed at producing common minke whale embryos. The study was based on minke whale samples collected in the coastal research component off Kushiro. Results indicated that a 40 h IVM (*in vitro* maturation) culture produces significantly higher rates of in vitro maturation than a 30 h IVM culture for common minke whale oocytes. Following ISI (intracytoplasmatic sperm injection), some oocytes cleaved to the 16-cell stage, but no further development was observed.

Birukawa *et al*. (2008) (For Info 10) examined kidney samples of common minke, sei, Bryde's and sperm whales to determine the nucleotide sequences of mRNAs encoding UT (urea transporters). Urea transport in the kidney is important for the production of concentrated urine. It was speculated that different phosphorylation sites found in whale UT-A2s may result in the high concentrations of urinary urea in whales, by reflecting their urea permeability.

Genetics

Nishida *et al*. (2007) (For Info 11) reconstructed cetacean phylogeny using a 1.7-kbp fragment of the non-recombining Y chromosome (NRY), including the SRY gene and a flanking non-coding region. The topology of the Y-chromosome tree is robust to various methods of analysis and exhibits high branch-support values, possibly due to the absence of recombination, small effective population size, and low homoplasy. The Y-chromosome tree indicates monophyly of each suborder, Mysticeti and Odontoceti, with high branch support values.

Onbe *et al*. (2007) (For Info 12) examined the amino-acid sequences of the T-domain region of the *Tbx4* gene, which is required for hindlimb development. Cetaceans have lost most of their hindlimb structure, although hindlimb buds are present in very early cetacean embryos. They investigated whether the *Tbx4* gene has the same function in cetaceans as in other mammals. The study concluded that the *Tbx4* gene maintains it function in cetaceans, although full expression leading to hind limb development is suppressed.

4. SIGNIFICANCE OF KEY RESULTS

- JARPNII was developed as science-based management program. Continuous collection of the whale samples and thorough analysis of biological data provided useful information not only for sound and effective management of marine resources but also understanding of biological and ecological processes of species involved in marine ecosystem.

- A combination of lethal and non-lethal surveys in the comprehensive large-scale JARPNII allowed us to acquire an unbiased, widely collected, large data base from all parts of ecosystem that was not available from commercial catches.

- The long term research projects provided us a great opportunity to systematically monitor long-term natural variability of biotic and abiotic factors (prey species replacement, global climatic changes, persistence of predator species, etc.) in marine ecosystem. Data on pelagic fishes obtained from stomach contents of whales and from the prey surveys under JARPN II were provided to the National Research Institute of Fisheries Science and used for management of pelagic fishes. The data are particularly valuable since the current interactions between whales and fisheries are likely to be different from the situation prior to the moratorium because of the increase in cetacean populations.

Feeding ecology and ecosystem studies:

- Previous studies based on commercial samples were primarily qualitative descriptions of the prey species eaten by whales, which was inadequate to provide insights to the relationships between different species in the marine ecosystem and the dynamics of the ecosystem. JARPNII provided both qualitative and quantitative information that will allow us to conduct ecosystem-based, multi-species approaches.

- Decreasing fish resources and fish catches are thought to be partly due to the effect of consumption by large whales on fish resources. Concurrent whale and prey species surveys investigated distribution and abundance of the preys through echo-sounder and trawling surveys and prey preference of the whales through a comparison of whale stomach contents and prey availability. It was found that the whales fed on several prey species that support important commercial fisheries in Japan. These results indicate successful fisheries management of the area requires continued study of feeding ecology of whales. Of interest was the result that the smaller common minke whale has a more varied and flexible diet than larger whales such as Bryde's and sei whales. When these three baleen whales feed on a same fish species, the smaller common minke whale feed on the bigger fishes.

- A growing disillusion with the predictive capacity of single species assessment methods and the management approaches they support has driven us to apply ecosystem-based models. However, no single ecosystem model can project the complex nature of the marine ecosystem. The greatest benefits are obtained from a combined use of different types of models. JARPNII thus developed three different types of the ecosystem models: Ecopath with Ecosim and MRM for the offshore component and a Bayesian Assessment Model for the coastal component. The output from this study can assist in the formulation of effective ecosystem-based management policies in the future.

- The coastal research areas off Sanriku of Tohoku and off Kushiro of southern Hokkaido are rich fishing grounds and hotspot areas for the interaction between several kinds of fisheries and top predators such as cetaceans. Preliminary ecosystem modeling of the coastal area of Sanriku showed competition between fishery and minke whales for sandlance. The research at Japan's richest fishing grounds provided us a great opportunity to study the direct interaction between cetaceans and fisheries.

- JARPNII suggested that sperm whales have a large influence on the surface ecosystem and appear to consume a substantial amount of neon flying squid, one of the commercially important squids in Japan. Considering their large biomass together, we believe that the addition of these results are critical to design and improve the ability of our ecosystem models.

Monitoring environmental pollutants in cetaceans and the marine ecosystem:

- It is important to monitor environmental changes and the responses of whales to such changes especially under the circumstances of progressing climate change. Whales are suited as biological indicators of environmental conditions because they are long-lived animals with ability of long-distance migration. JARPNII investigated pollutant levels of the sampled baleen and toothed whales in relation to their sex and maturity. In addition, JARPN II investigated the pollution levels in prey species collected from the stomach contents of whales as well as in samples of seawater and air obtained from the research area at the same time. The results from these direct examinations on the several different types of biotic and abiotic sources provided us very important information to understand the bioaccumulation process through the marine food chain.

- IWC has raised a concern about the effects of environmental change, especially pollutants, on cetaceans because of the possibility that these pollutants negatively affect the whales' health resulting in a decrease in the abundance of the stocks. JARPN II conducted toxicological studies to assess the relationships between pollutant levels and their effects on cetaceans. Monitoring of the toxicological conditions of whales is an important part of the long-term management of whale stocks.

Stock structure:

- A concern about the past genetic studies of the North Pacific whales was the use of the genetic markers with relatively low genetic variation such as allozyme and mitochondrial DNA (mtDNA) restriction fragments length polymorphisms. No evidence of genetic heterogeneity in samples analyzed using these markers could indicate that only a single stock exists in the area or that the resolution power is low to detect slight genetic difference. In JARPNII, a system utilizing hypervariable microsatellite and mtDNA sequencing analyses has been developed that allows us to increase power to study whales' stock structure. Furthermore past geographical and temporal gaps in sampling were covered by JARPN II surveys.

- Description of stock structure is a key piece of information for the application of the RMP to calculate a catch limit for future commercial whaling. JARPNII investigated stock structure of the target species using both genetic and non-genetics analyses. The key for sound management is to gain understanding of genetics, biology, and ecology of the species.

- In a situation of geographical overlap of multiple stocks, stock identification at an individual base allows us to directly depict dynamics and patterns of temporal and spatial distribution of the stocks. Under JARPN II it was possible to distinguish the individuals in the samples into the J and O stocks by the combined use of the microsatellite analysis and Bayesian clustering approach. This will allow a continued monitoring of the occurrence of J stock in SA7 in the future to determine spatial and temporal dynamics of its occurrence.

- At the final stage of the *Implementation* process for the western North Pacific common minke whales during the 2003 Annual Meeting, the IWC SC adopted the four baseline stock scenarios for the O stock including the occurrence of the W stock in the offshore area. We examined the plausibility of these four baselines by analyzing JARPNII as well as JARPN samples of minke whales. Analysis of additional 923 minke whales collected widely from the survey area after the 2003 *Implementation* process allowed us to detect the J and W stocks, if they exist, in the area. It was found that the survey area was mainly occupied by O stock with the appearance of a low number of J stock whales along the coastal line and ruled out the possibility of a genetically distinct coastal stock other than the J and O. We believe that the results of this study improve our knowledge of the stock structure of minke whales in the western North Pacific and are quite informative for effective management of this species.

- Although it was initially agreed to place the sub-area 1 and 2 divided at 180° in the western North Pacific Stock of Bryde's whales, there was concern about making firm conclusions on their stock structure because of the very wide size of sub-area 1 with limited available information. JARPN II conducted genetic analyses on new samples collected as well as from past commercial whaling and showed that sub-area 1 was occupied exclusively by individuals from a single stock.

- In order to investigate the current status of whale stocks in given oceanic regions, the IWC SC conducts 'in-depth assessments' of the subject species. The IWC SC is considering conducting in-depth assessments of sei whales and sperm whales in the North Pacific in the near future. Among all of the required information, an understanding of stock structure in the region is essential for successful in-depth assessment. Genetic analyses of the sei whales samples from the JARPNII and past commercial whaling covering the wide area from 145°E to 139°W indicated that the open water of the North Pacific was mainly occupied by the individuals from a single stock of sei whales. Genetic analyses of the sperm whales from the JARPNII demonstrated that our genetic analysis system was very effective to explore genetic characteristics of sperm whales. Our findings will surely facilitate in-depth assessment of these the North Pacific whales.

5. THE NEXT PERIOD OF JARPN II

As shown in Section 3 and 4 above considerable progress has been made in the research conducted under JARPN II. However some issues remain unresolved and new questions have emerged. In this section the major scientific considerations for JARPN II in the next research period are presented.

a) Multidiscipline surveys

As explained in Sections 2.2.3 and 2.2.4, JARPN II conduct different surveys (whale sampling, dedicated sighting and prey species surveys) in a comprehensive way to address the main objective of JARPN II; feeding ecology and ecosystem studies (Figure 2). In order to achieve this objective there is the need to maintain these multidiscipline surveys in the future.

b) Importance of monitoring (see also c) below)

Monitoring is scientifically valuable as it provides time-series data on biological and ecological phenomena in the environment. It is important to monitor environmental changes and the responses of whales to such changes especially under the circumstances of progressing climate change. JARPN II has the potential to provide long time series data and therefore the potential for monitoring whales and their environment.

c) Study on the regime shift and response of whales to such event

It is recognized that both climatic and biological regime shifts have occurred in the North Pacific Ocean. Their effects on fisheries and ecosystems are actively being investigated by the North Pacific Marine Science Organization (PICES). Although there are many definitions of regime shift, the study group on regime shift under PICES defined regime shift as "a relative rapid change from one decadal-scale period of a persistent state to another decadal-scale period of persistent state" (King, 2005). In the western North Pacific, commercial catch histories of pelagic fishes (e.g. sardine, anchovy and mackerel) have shown drastic fluctuation and quasi-decadal species alterations so-called species replacement since the 1950's (Yatsu *et al.,* 2001). Species replacement is a form of biological regime shift. Climate indices such as the Pacific Decadal Oscillation (PDO) indicated that significant climatic regime shifts occurred around 1976, 1989 and 1998 in recent decades (Overland *et al.*, 2008). Responses of pelagic biological organisms to climatic regime shifts were reported for a number of species including copepods (Tadokoro *et al.*, 2005), Japanese anchovy, Japanese sardine, Pacific saury and mackerel (Takasuka *et al.*, 2008; Tian *et al.*, 2004; Yatsu *et al.*, 2008). Some analyses provided simple interpretation of the interaction between climatic and biological regime shifts based on spawning temperature optima theory (e.g. Takasuka *et al.*, 2008) but the interpretation is difficult in other cases because of complexity of interactions (Yatsu *et al.*, 2008). Stomach contents collected by commercial fisheries indicated that common minke whales switched their prey according to biological regime shifts of prey abundances (Kasamatsu and Tanaka, 1992). However, effects of both biological and climatic regime shifts on baleen whales in the western North Pacific are still largely open to question because of lack of data collected through systematic surveys. To detect the effects of regime shifts on cetaceans as well as the effect of predation by cetaceans on biological regime shifts, long term monitoring programs are essential.

d) Improvement of accuracy of ecosystem models

For minke and Bryde's whales, obtaining further diet composition data has improved the precision of the estimate of % increase in catch of Japan's fisheries resources (i.e. Pacific saury, anchovy, mackerels) calculated by the EwE model. This suggests that the JARPN II survey will likely contribute in improving the precision of the effect of whaling on Japan's fisheries resources, which is important for robust management of the fisheries resources in the western North Pacific.

Results of the ecosystem modeling studies using JARPNII data (SC/J09/JR14; SC/J09/JR21) suggested that functional response of predators (relationship between consumption rate by predator and prey availability) had strong impact on the outcome of the models. It was strongly recommended that effort be focused on appropriate data collection and/or experiments to develop the most appropriate functional response form to represent feeding behavior (Pláganyi, 2007). For fisheries management purpose, decades of long term data collection of both stomach contents and prey availability is required to estimate reliable functional responses of cetaceans. Functional response of cetaceans has not been estimated because of lack of long term data set obtained through systematic survey. For ecosystem models, estimation of a multi-species functional response is required though the parameterization could be potentially difficult (Matthiopoulos *et al.*, 2008). Decadal data collection through JARPN II will ensure the development of reliable ecosystem model.

e) Coastal research

The coastal research areas of Tohoku (off Sanriku) and southern Hokkaido (off Kushiro), are rich fishing grounds and hotspot areas for the interaction between several kinds of fisheries and predators such as cetaceans. Through JARPN II research it was found that the main preys of common minke whales in some particular coastal areas are bottom fish, such as sandlance and Pacific whiting. Preliminary results from ecosystem modeling of the coastal area of Sanriku (SC/J09/JR14) showed competition between the fishery and minke whales for sandlance. The coastal research component is effective in order to better understand the relationships between fisheries and whales in coastal waters through additional data and improved modeling.

f) Contribution to fisheries management

JARPN II has contributed important information on stock structure to the *Implementation* of the RMP. Future JARPN II surveys will provide additional useful information for example through the systematic monitoring of 'J' stock animals of common minke whales in the research area, particularly in sub-area 7. It is important to better understand the nature of interaction between J and O stocks both spatially and temporally. Systematic sighting surveys conducted under the JARPN II will provide information on whale abundance, which is also important for management under the RMP.

JARPN II will allow the collection of new information required to improve ecosystem models, which in turn will assist in the formulation of ecosystem or multi species-based management policies. As noted above the JARPN II research area is a hot spot for fisheries interaction and such ecosystem-based policies will be very important in future.

In general, ecosystem models are potentially important tools for providing wider scientific information on fisheries management such as impacts of the fishery on other ecosystem components and to take into account changes in the ecosystem other than those caused by fishing that may be impacting the fishery. Also,they can be used to simulate the implications and trade offs of alternative management actions and trade-offs for the different, conflicting stakeholders or objectives, and in this way, they can provide valuable information to managers in the search for optimal management measures and approaches (FAO, 2008). Moreover, ecosystem models can have an important role to play in Management Strategy Evaluation (MSE) or the Management Procedure (MP) approach, especially as Operating Models (OMs) which provide the basis for simulation testing to assess how well alternative candidate harvest rules achieve the objectives sought by the management authority (FAO, 2008).

g) Prospect of sperm whale sampling

A total of 45 specimens were collected during eight years of JARPNII (two-year feasibility study and six years of full JARPN II). At this stage results on the feeding ecology of sperm whale are of a qualitative nature for immature animals. Modeling suggested that sperm whales have a large influence on the surface ecosystem (SC/J09/JR21). Further, sperm whales appear to consume a considerable amount of neon flying squid, which is one of the commercially important squids in Japan (SC/J09/JR17). Therefore surveys of sperm whales have provided valuable qualitative information on feeding ecology for immature animals.

6. SUMMARY RESPONSE TO TORs OF THE JARPN II REVIEW WORKSHOP

Responses to the TORs of the JARPN II review workshop (IWC, in press) can be summarized as follows:

TOR 1

A summary of the research conducted under the three objectives of JARPN II was given in Sections 3.1, 3.2 and 3.3, respectively.

TOR 2

A summary of the research conducted under JARPN II related to other contributions to important research needs was given in Section 3.4

TOR 3

Relationship between JARPN II research and IWC scientific-related resolutions

In 2005, the JARPA Review Planning Steering Group examined IWC resolutions and produced a helpful report (Zeh *et al*., 2005). Resolutions were directed to Contracting Governments (CG), Government of Japan (GOJ) and/or the Scientific Committee (SC). None of three resolutions directed to the GOJ was related to JARPN II. After the JARPA Review Meeting no Resolution directed to JARPN II has been adopted by the IWC.

Here five resolutions directed to CG/SC and one to GOJ are considered.

- Resolution recommending non-lethal research

Resolution 1995-9 (IWC, 1996a) recommended CGs to use non-lethal methods and instructed the SC to review SP research. One of the main characteristics of JARPN II is the combination of both lethal and non-lethal surveys and analyses, which is important for achieving the main objective of the research program. Some of the biological information from whales can be obtained only through the lethal approach (see TOR 4 below).

- Encourage study of environmental change

Resolution 1994-13 (IWC, 1995b) encouraged CGs/SC to study environmental changes and impact on cetaceans. Resolution 1995-10 (IWC, 1996b) encouraged CGs to study the effects of pollutants on cetaceans as recommended by the Bergen workshop. Resolution 1997-7 (IWC, 1998a) encourages CGs to continue to provide information on environmental changes and potential effects on cetaceans. Resolution 1999-4 (IWC, 2000) request CGs to provide the SC with data on contaminants in cetaceans. As shown in section 3.2 JARPN II included a comprehensive monitoring and assessment of chemical pollutants in whales and their environment. Therefore JARPN II is investigating several of the topics mentioned in these Resolutions.

- Establishment of SWG-E

Resolution 1998-7 (IWC, 1999) invited the GOJ to take full advantage of the existing mechanisms for cooperation between national research programs and the SWG-E on environmental research. Japan accepted this invitation positively and will cooperate by providing the information on environmental research obtained in JARPN II (see section 3.2).

TOR 4

No specific paper was prepared for this Workshop regarding the utility of lethal versus non-lethal techniques to address the research objectives of JARPN II. General discussions on lethal versus non-lethal approaches in whale research under special permits have been discussed several times by the IWC SC in the past. Summaries of those discussions can be found in IWC (1998b; 2008c).

It should be noted here that JARPN II combines both lethal and non-lethal techniques for the study of large whales and the ecosystem, and that this combination is important for achieving the main objective of JARPN II on feeding ecology and ecosystem studies (see Figure 2). For example the abundance of whales and prey species in box 'Analysis step 1' in Figure 2 is investigated using non-lethal techniques (sighting surveys, echo-sounder/trawling surveys). However prey composition of whales in box 'Analysis step 1' and prey consumption of whales in box 'Analysis step 2' can not be investigated using non-lethal techniques. This is because for ecosystem modeling purposes, quantitative data on prey composition and consumption are required. This quantitative information is obtained by examining stomach contents.

To estimate prey preferences of cetaceans, examination of stomach contents data is the only way to identify prey species consumed and quantify preys consumption (e.g. SC/J09/JR9;16;17). Feeding ecology of baleen whales can be studied using several methods other than stomach contents. Barros and Clarke (2002) categorized those methods as follows: direct observation of feeding, traditional methods (analysis of vomit, scat, stomach and intestine contents), fatty acids, stable isotopes, genetic identification of scat and video taping of feeding behavior. In addition, telemetries such as satelltite tags and time and depth recorders (TDR) (e.g. Croll *et al*., 1998) were also used for feeding ecology studies in recent years. Direct observation of feeding is limited to above the sea surface or short duration of underwater observation by scuba survey. Given diversities and vertical distribution patterns of prey species of minke, Bryde's and sei whales direct observation method is not applicable to those species. Haug and Lindstrøm (2003) compared the traditional methods with the rest of the new methods and concluded that those new methods have not proven to provide detailed quantitative information on the diet of individual animals and must be supplemented with traditional methods especially with identifying and measuring items in gastrointestinal contents though the combinations of those methods can support the results of each.

Regarding environmental studies (objective 2) some pollutants are organ-specific and therefore studying different organs for different pollutants will provide valuable information. Furthermore studies on the effect of pollutants on the health of whales require examination of target organs. The level of some lipophilic pollutants can be measured from blubber samples obtained by biopsy sampling. However, biopsy sampling is a difficult method for collecting samples over the whole research period and area of JARPN II. This is because sampling efficiency is affected by wind force, the particular research area and the targeted school size. The difficulty of obtaining biopsy samples could be also different among whale species, according body size, swimming speed, pattern of movement.

In order to understand the pattern of accumulation of pollutants in whales, it is important to have access to some biological information of the whales under investigation such as sex, reproductive status, body length, weight of stomach contents, some of which can be obtained only by using the lethal approach. A previous study attempted to assess reproductive status by examining hormone metabolites in fecal samples of the right whale (Rolland *et al*., 2005). However there are practical difficulties for obtaining fecal samples.

Studies on stock structure under JARPN II (objective 3) are based on both genetic and non-genetics approaches. The non-genetic approach used in JARPN II (for common minke whale at this stage) is morphometrics, which requires accurate body measurements obtained from whales sampled. Genetic analysis on stock structure based on DNA can be carried out by using biopsy samples. As explained above, there are some practical problems with the use of biopsy sampling.

TOR 5

Evaluation of sample size

Sample sizes of minke, sei and Bryde's whales were set for estimating prey consumption with good precision (coefficient of variation, CV = 0.2), in the same way as in the case of the Norwegian research program (Government of Norway, 1992). The sample size of sperm whale was set as a minimum level necessary for obtaining qualitative information for a feasibility study.

Coefficient of Variation (CV) of stomach content weight of three baleen whales from the first six years of JARPN II can be summarized as follows (see Annex 6 for details):

a) Target CV was satisfactory in most cases for minke whales. This means that the sample sizes of minke whales for both offshore and coastal component seem to be appropriate.

b) CVs were larger than the target in most cases for sei whales. This means that the sample size was smaller than the appropriate number, which could reflect diversity of prey species.

c) CVs were not satisfactory in more than half of the cases for Bryde's whales. This means that the sample size might be a little bit smaller than the appropriate number.

Effect on the stocks in light of new knowledge on status of stocks

SC/J09/JR36 examined the effect of future JARPN II catches on the whale stocks in light of new information on stock structure and abundance obtained through JARPN II research. The effect was examined for the next 20 years using HITTER methodology. Results showed that, apart from the case of J stock in the scenario of low limit of 90CI in abundance and MSYR (+1)= 1% (scenario considered of low plausibility), all the minke, Bryde and sei whale stocks will continue to increase in the next 20 years, under all scenarios considered. Therefore future catches under JARPN II will not affect negatively the status of the stocks.

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Yatsu, A., Aydin, K. Y., King, J. R., McFarlane, G. A., Chiba, S., Tadokoro, K., Kaeriyama, M. and Watanabe, Y. 2008. Elucidating dynamic responses of North Pacific fish populations to climatic forcing: Influence of life-history strategy. *Prog. Oceanogr.* 77: 252-268.

Zeh, J., Brownell, R., Childerhouse, S., Fujise, Y., Gales, N., Hatanaka, H., Pastene, L.A. and Schweder, T. 2005. Progress report of the JARPA review planning steering group. Paper S/57/O2 presented to the IWC Scientific Committee, June 2005 (unpublished), 11pp.

Table 1: Contribution of JARPN and JARPN II to the management of common minke whales in the western North Pacific through the *Implementation Simulation Trials* of the Revised Management Procedure (RMP)

IWC SC meeting	JARPN-JARPN II data/**contribution**	References
1996 IWC SC annual meeting	JARPN 1994-95+past commercial data on mtDNA and allozyme data**,** conception date, length and sex composition, morphology, pollutant load. Contribution: **'It was agreed that the available data and information were generally inconsistent with there being substocks to the east of Japan characterized by different levels of latitudinal migration'.**	IWC (1997) pp208
2000 JARPN Review Workshop	JARPN 1994-99+past commercial data on mtDNA and allozyme, biological parameters, morphological and morphometric, pollutants, parasites, stable isotopes. Contribution: **'In the light of the results (*on mtDNA*) the Workshop agreed that the possibility of the existence of some group of minke whales to the east of Japan that differed from the 'O' stock could not be ruled out, but that the data nevertheless provided a basis to restrict the number of 'W' stock hypotheses that need to be considered in the RMP trials'.** Contribution: **'The Workshop agreed that it would be premature to draw conclusions on the extent of the possible presence of 'W' stock animals west of sub-area 9, prior the completion of further analyses…….Furthermore current hypotheses placing 'W' stock animals in sub-areas 7 and/or 8 could be then rejected'.**	IWC (2001a) pp385 IWC (2001a) pp386
2000 IWC SC annual meeting	Committee discussion on JARPN review workshop Contribution: **'With respect to the Commission's Resolution, it noted the Workshop's comments above on whether the information obtained was useful for management, i.e. information obtained during JARPN had been and will continue to be used in the refinements of *Implementation Simulations Trials* for North Pacific minke whales, and consequently was relevant to their management'.**	IWC (2001c) pp60
2002 Intersessional Workshop on North Pacific Minke Whale *Implementation Simulation Trials*	JARPN-JARPN II 1994-2001 data on mtDNA and microsatellites **Analyses of those data enabled the Workshop to establish four stock structure hypotheses for use in the *Implementation Simulation Trials* (see Figure 3).** JARPN 1996-1999+commercial data on mtDNA Contribution: **These data were used to estimate the 'J'-'O' mixing proportion in several sub-areas and month, some of those were used in trials conditioning (choosing population parameters for**	IWC (2003) pp458-459 IWC (2003) pp462 (Table 2)

	the trials compatible with data). JARPN 1994-1995 abundance data in sub-area 9; Contribution: **these data were used in trials conditioning.**	IWC (2003) pp456 (Table 1)

Table 2: Contribution of JARPN II to the management of Bryde's whales in the western North Pacific through the *Implementation Simulation Trials* of the Revised Management Procedure (RMP)

IWC SC meeting	JARPN II data/**contribution**	References
2004 IWC SC annual meeting	JARPN II 2000-2003+past commercial data on mtDNA and microsatellites Contribution: **'The Committee agreed that** **a) the limited genetic data from the Hawaiian islands do not suggest the occurrence of a small-form Bryde's whale in those waters** **b) there is no direct evidence to support the existence of more than one stock in sub-area 1; and** c) **there are too few samples in sub-area 2 to allow firm conclusions to be drawn on the basis of genetic data regarding stock structure there'.**	IWC (2005) pp10
2005 Workshop on the *pre-implementation assessment*	JARPN II 2000-2003 mtDNA and microsatellites data +past commercial genetics and non genetics data Contribution: **the Workshop established a set of 5 conceptual stock structure hypotheses that covers the entire plausible range.**	IWC (2006) pp343
2005 First Intersessional Workshop on *Implementation*	JARPN II 2000-2003 mtDNA and microsatellites data +past commercial genetics and non genetics data JARPN II 2000-05 catch distribution Contribution: **Refinement of the hypotheses on stock structure. A final 4 stock structure hypotheses were agreed (see Figure 5).**	IWC (2007) pp408-411
2006 IWC SC Annual Meeting	JARPN II 2000-2003 mtDNA, microsatellites; JARPN II 2000-2005 catch distribution+ past commercial genetic and non-genetics data Contribution: **the IWC SC assigned plausibility to the hypotheses on stock structure as follow (see Figure 5):** **Hypothesis 1: high** **Hypotheses 2, 3: high** **Hypothesis 4: medium**	IWC (2008b) pp94-95

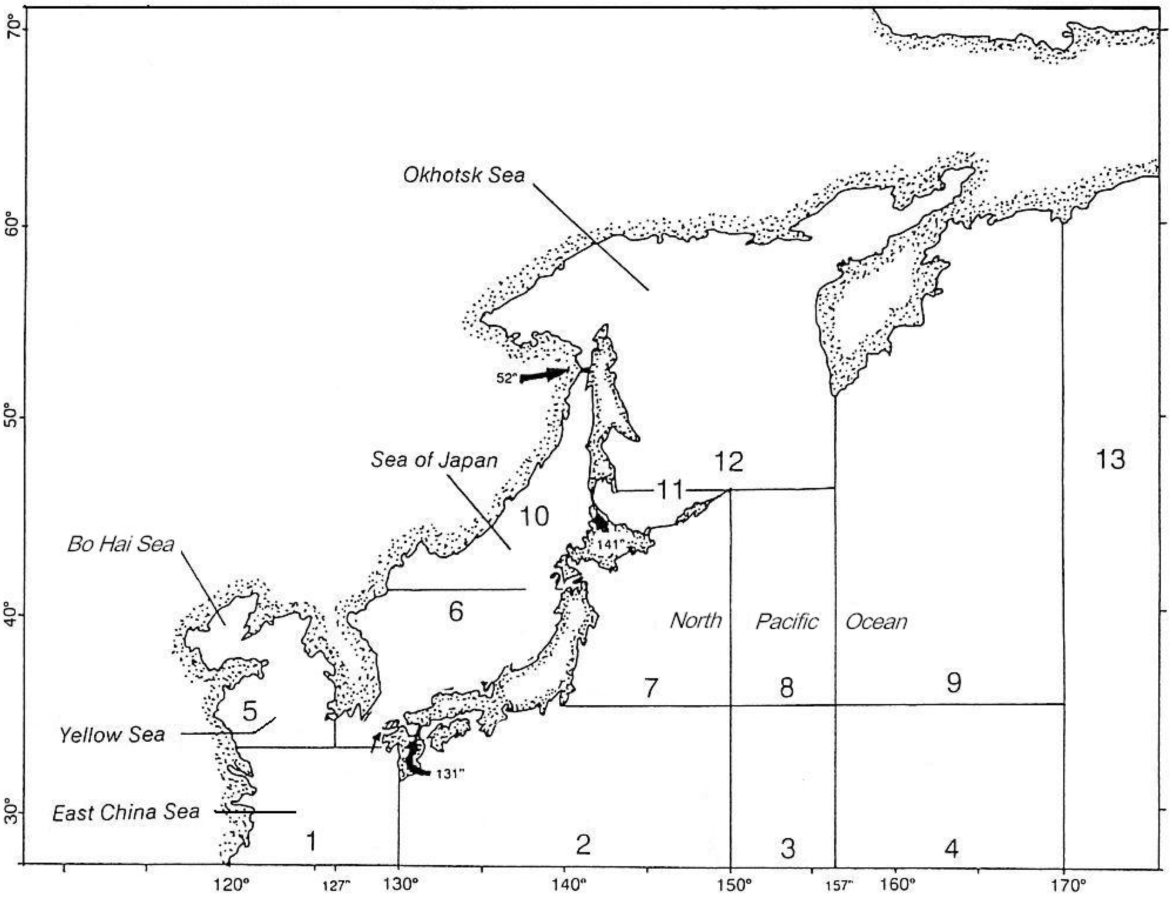
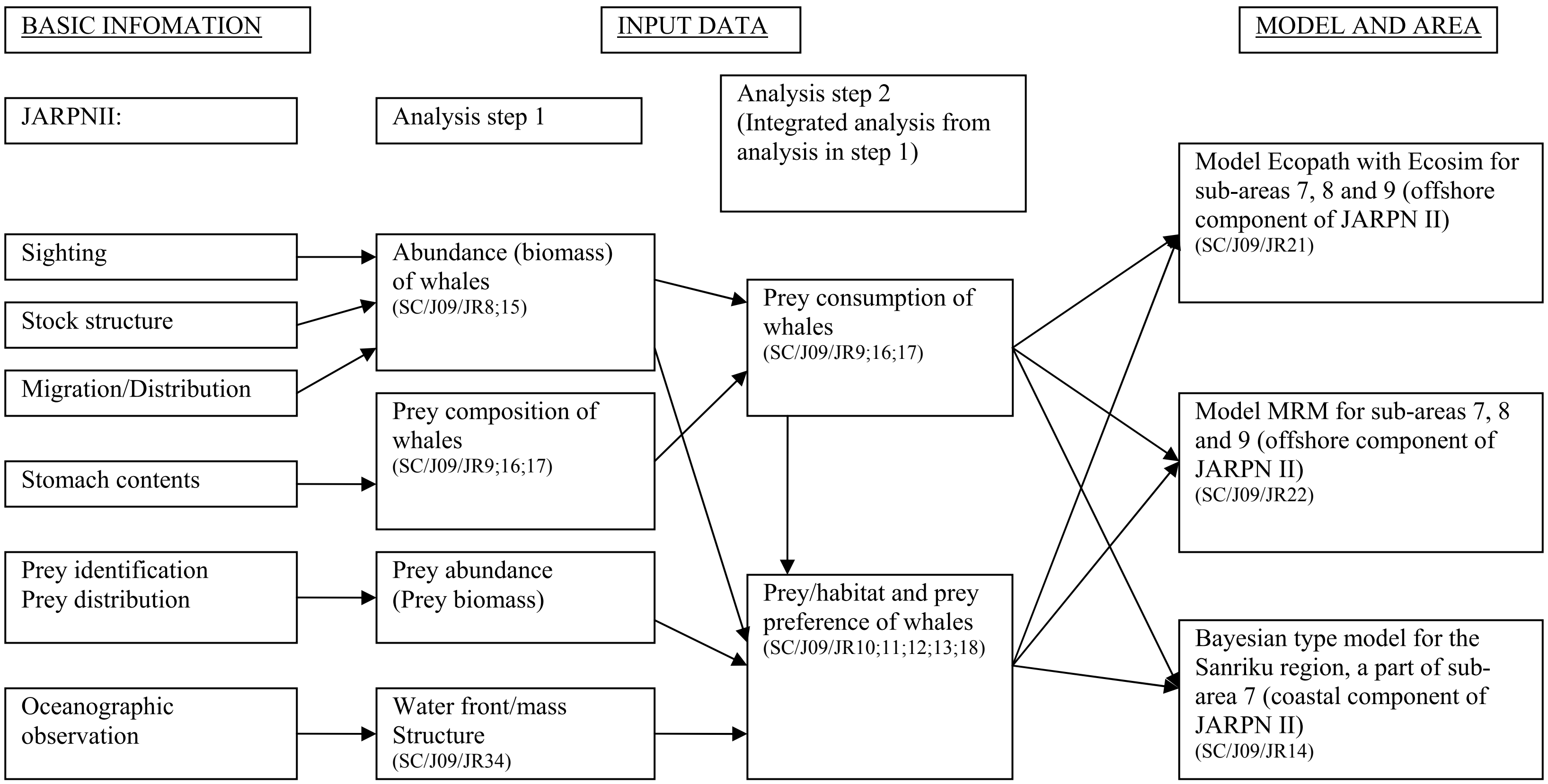
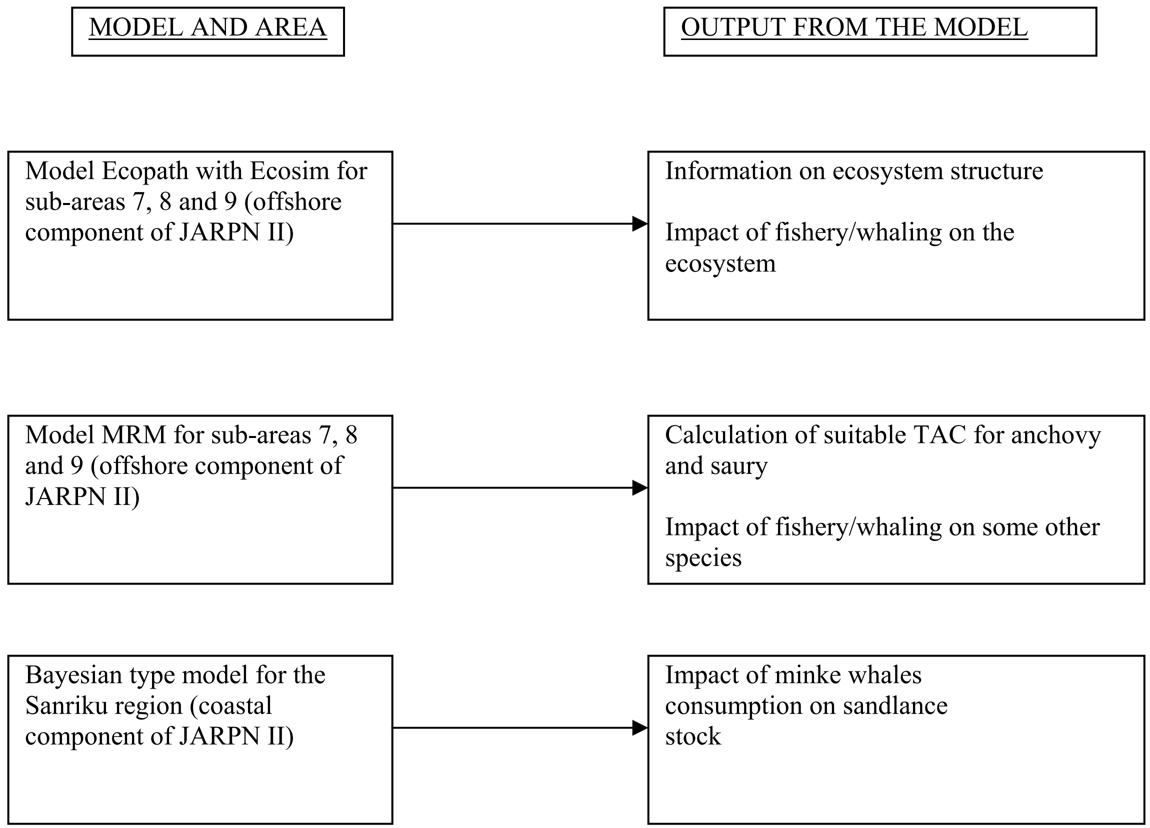


Figure 1: Sub-areas used by the IW SC for management purposes of the common minke whale. JARPN II research area involves sub-areas 7, 8 and 9.


BASIC INFOMATION
INPUT DATA
MODEL AND AREA
JARPNII:
Analysis step 1
Analysis step 2 (Integrated analysis from analysis in step 1)
Sighting
Stock structure
Migration/Distribution
Stomach contents
Prey identification
Prey distribution
Oceanographic observation
Abundance (biomass) of whales (SC/J09/JR8;15)
Prey composition of whales (SC/J09/JR9;16;17)
Prey abundance (Prey biomass)
Water front/mass Structure (SC/J09/JR34)
Prey consumption of whales (SC/J09/JR9;16;17)
Prey/habitat and prey preference of whales (SC/J09/JR10;11;12;13;18)
Model Ecopath with Ecosim for sub-areas 7, 8 and 9 (offshore component of JARPN II) (SC/J09/JR21)
Model MRM for sub-areas 7, 8 and 9 (offshore component of JARPN II) (SC/J09/JR22)
Bayesian type model for the Sanriku region, a part of sub-area 7 (coastal component of JARPN II) (SC/J09/JR14)

A)



B)

Figure 2: Conceptual diagram on the input data required for each ecosystem model (A) being developed in JARPN II and expected output from the models (B) (see text for more details).

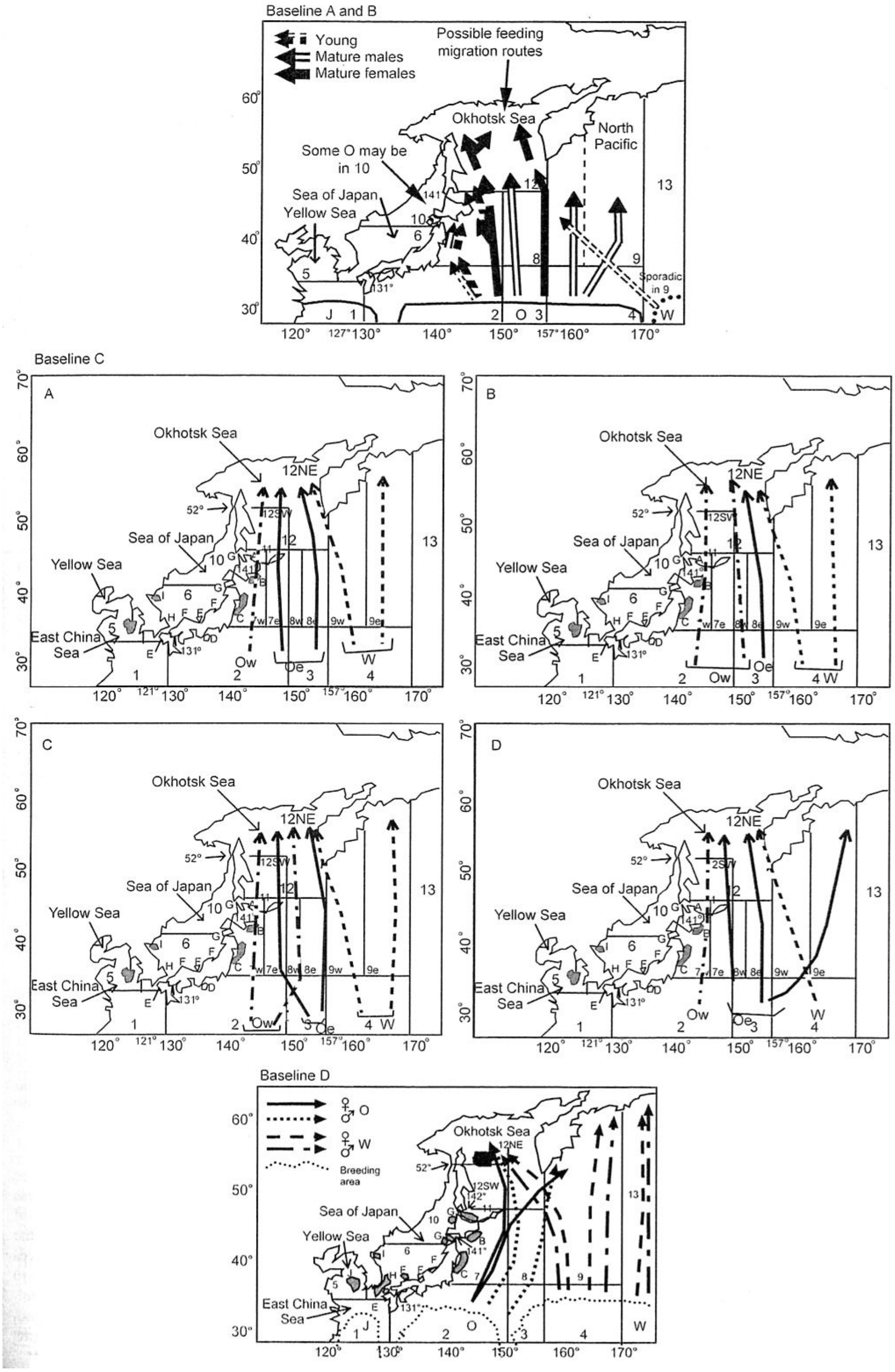


Figure 3: Hypotheses on stock structure of North Pacific common minke whale used in the *Implementation Simulation Trials* of the RMP (IWC, 2004). See text for details.

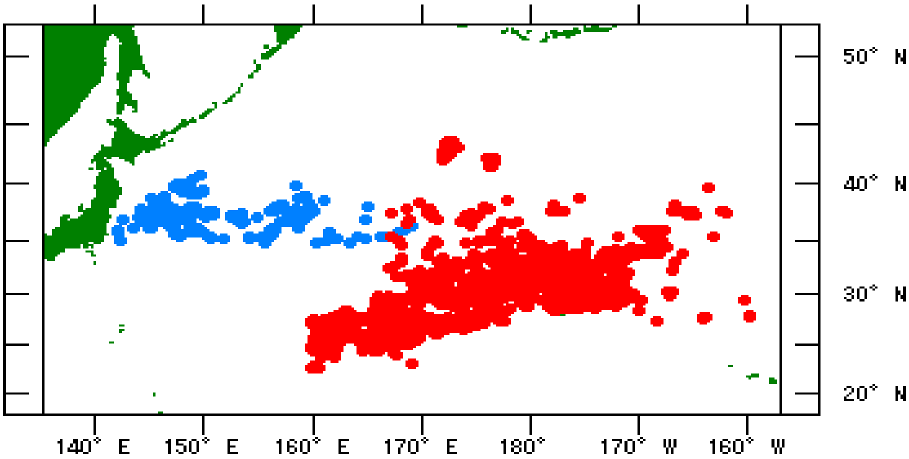


Figure 4: Catch distribution of Bryde's whales in the western North Pacific. Red corresponds to catch by pelagic whaling operations conducted between 1971 and 1979; blue corresponds to catch by JARPN II between 2000 and 2005. Note that sampling by JARPN II covered an important geographical gap.

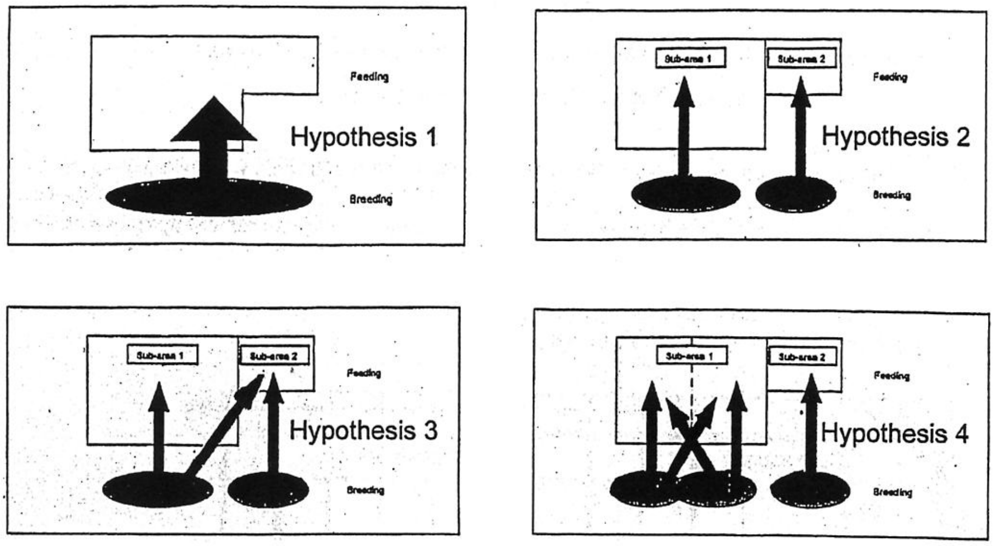


Figure 5: Hypotheses on stock structure of North Pacific Bryde's whale used in the *Implementation Simulation Trials* of the RMP (IWC, 2008b). See text for details.

Annex 1

List of documents presented to the IWC SC JARPN II Review Workshop

Primary papers

SC/J09/JR1. Pastene, L.A., Hatanaka, H., Fujise, Y., Kanda, N., Murase, H., Tamura, T., Miyashita, T. and Kato, H. The Japanese Whale Research Program under Special Permit in the western North Pacific Phase-II (JARPN II): origin, objectives and research progress made in the period 2002-2007, including scientific considerations for the next research period. 73pp.

SC/J09/JR2. Kiwada, H., Kumagai, S. and Matsuoka, K. Methodology and procedure of the dedicated sighting surveys in JARPN II –Offshore and coastal component of Sanriku and Kushiro-. 16pp.

SC/J09/JR3. Kishiro, T., Yoshida, H., Goto, M., Bando, T. and Kato, H. Methodology and survey procedure under the JARPN II – coastal component of Sanriku and Kushiro-, with special emphasis on whale sampling procedures. 27pp.

SC/J09/JR4. Tamura, T., Matsuoka, K. and Fujise, Y. Methodology and survey procedure under the JARPN II - offshore component- with special emphasis on whale sampling procedures. 16pp.

SC/J09/JR5. Yonezaki, S., Nagashima, H., Murase, H., Yoshida, H., Bando, T., Goto, M., Kawahara, S. and Kato, H. Methodology and procedures of surveys of prey of common minke whales JARPN II - Coastal component of Sanriku. 6pp.

SC/J09/JR6. Watanabe, H., Yonezaki, S., Kiwada, H., Kumagai, S., Kishiro, T., Yoshida, H. and Kawahara, S. Methodology and procedures of common minke whale's prey surveys in JARPN II –Coastal component of Kushiro-. 12pp.

SC/J09/JR7. Murase, H., Watanabe, H., Yonezaki, S., Tamura, T., Matsuoka, K., Fujise, Y. and Kawahara, S. Methodology and procedures of cetacean prey surveys in JARPN II –Offshore Component-. 11pp.

SC/J09/JR8. Hakamada, T., Matsuoka, K. and Miyashita, T. The number of western North Pacific common minke whales (*Balaenoptera acutorostrata*) distributed in JARPN II coastal survey areas. 12pp.

SC/J09/JR9. Tamura, T., Konishi, K., Goto, M., Bando, T., Kishiro, T., Yoshida, H., Okamoto, R. and Kato, H. Prey consumption and feeding habits of common minke whales in coastal areas off Sanriku and Kushiro. 18pp.

SC/J09/JR10. Murase, H., Kawahara, S., Nagashima, H., Onodera, K., Tamura, T., Okamoto, R., Yonezaki, S., Matsukura, R., Minami, K., Miyashita, K., Yoshida, H., Goto, M., Bando, T., Inagake, D., Okazaki, M., Okamura, H. and Kato, H. Estimation of prey preference of common minke whales (*Balaenoptera acutorostrata*) in a coastal component (off Sanriku) of JARPNII in 2005 and 2006 . 15pp.

SC/J09/JR11. Watanabe, H., Yonezaki, S., Kiwada, H., Kumagai, S., Kishiro, T., Yoshida, H. and Kawahara, S. Distribution and abundance of prey species and prey preference of common minke whale *Balaenoptera acutorostrata* in the coastal component of JARPN II off Kushiro from 2002 to 2007. 37pp.

SC/J09/JR12. Yoshida, H., Kishiro, T., Goto, M., Bando, T., Tamura, T., Konishi, K., Okamoto, R. and Kato, H. Relationship between body size, maturity, and feeding habit of common minke whales off Sanriku in spring season, from 2003-2007 whale sampling surveys under the JARPN II coastal component off Sanriku. 20pp.

SC/J09/JR13. Kishiro, T., Yoshida, H., Tamura, T., Konishi, K., Kanda, N., Okamoto, R. and Kato, H. Relationship between body size, maturity, and feeding habit of common minke whales off Kushiro in autumn season, from 2002-2007 whale sampling surveys under the JARPN II coastal components off Kushiro. 25pp.

SC/J09/JR14. Okamura, H., Nagashima, H. and Yonezaki, S. Preliminary assessment of impacts on the sandlance population by consumption of minke whales off Sanriku region. 20pp.

SC/J09/JR15. Hakamada, T., Matsuoka, K. and Miyashita, T. Distribution and the number of western North Pacific common minke, Bryde's, sei and sperm whales distributed in JARPN II Offshore component survey area. 18pp.

SC/J09/JR16. Tamura, T., Konishi, K., Isoda, T., Okamoto, R. and Bando, T. Prey consumption and feeding habits of common minke, sei and Bryde's whales in the western North Pacific. 36pp.

SC/J09/JR17. Tamura, T., Kubotera, T., Ohizumi, H., Konishi, K. and Isoda, T. Feeding habits of sperm whales and their impact on neon flying squid resources in the western North Pacific. 22pp.

SC/J09/JR18. 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. Prey preferences of common minke (*Balaenoptera acutorostrata*), Bryde's (*B. edeni*) and sei (*B. borealis*) whales in offshore component of JARPNII from 2002 to 2007. 31pp.

SC/J09/JR19. Konishi, K., Kiwada, H., Matsuoka, K., Hakamada, T. and Tamura, T. Density prediction modeling and mapping of common minke, sei and Bryde's whales distribution in the western North Pacific using JARPN II (2000-2007) data set. 20pp.

SC/J09/JR20. Konishi, K., Tamura, T., Goto, M., Bando, T., Kishiro, T., Yoshida, H. and Kato, H. Trend of blubber thickness in common minke, sei and Bryde's whales in the western North Pacific during JARPN and JARPN II periods. 4pp.

SC/J09/JR21. Mori, M., Watanabe, H., Hakamada, T., Tamura, T., Konishi, K., Murase, H. and Matsuoka, K. Development of an ecosystem model of the western North Pacific. 49pp.

SC/J09/JR22. Kawahara, S. A minimum realistic model in the JARPNII offshore survey area. 22pp.

SC/J09/JR23. Yasunaga, G. and Fujise, Y. Temporal trends and factors affecting mercury levels in common minke, Bryde's and sei whales and their prey species in the western North Pacific. 13pp.

SC/J09/JR24. Yasunaga, G. and Fujise, Y. Temporal trends and factors affecting PCB levels in baleen whales and environmental samples from the western North Pacific. 10pp.

SC/J09/JR25. Yasunaga, G. and Fujise, Y. Accumulation features of total and methyl mercury and selenium in tissues of common minke, Bryde's and sperm whales from the western North Pacific. 11pp.

SC/J09/JR26. Kanda, N., Goto, M., Kishiro, T., Yoshida, H., Kato, H. and Pastene, L.A. Individual identification and mixing of the J and O stocks around Japanese waters examined by microsatellite analysis. 9pp.

SC/J09/JR27. Hakamada, T. and Bando, T. Morphometric analysis on stock structure in the western North Pacific common minke whale (*Balaenoptera acutorostrata*) . 13pp.

SC/J09/JR28. Goto, M., Kanda, N., Pastene, L.A., Bando, T. and Hatanaka, H. Differences in cookie cutter shark-induced body scar marks between J and O stocks of common minke whales in the western North Pacific. 7pp.

SC/J09/JR29. Goto, M., Kanda, N., Kishiro, T., Yoshida, H., Kato, H. and Pastene, L.A. Mitochondrial DNA analysis on stock structure in the western North Pacific common minke whales. 10pp.

SC/J09/JR30. Kanda, N., Goto, M., Kishiro, T., Yoshida, H., Kato, H. and Pastene, L.A. Microsatellite analysis of minke whales in the western North Pacific. 14pp.

SC/J09/JR31. Kanda, N., Goto, M. and Pastene, L.A. Stock structure of Bryde's whales in the western North Pacific as revealed by microsatellite and mitochondrial DNA analyses. 8pp.

SC/J09/JR32. Kanda, N., Goto, M., Yoshida, H. and Pastene, L.A. Stock structure of sei whales in the North Pacific as revealed by microsatellite and mitochondrial DNA analyses. 14pp.

SC/J09/JR33. Kanda, N., Goto, M. and Pastene, L.A. Genetic characteristics of sperm whales sampled during JARPNII from 2000 to 2007 as revealed by mitochondrial DNA and microsatellite analyses. 5pp.

SC/J09/JR34. Okazaki, M., Inagake, D., Murase, H., Watanabe, H., Yonezaki, S., Nagashima H., Matsuoka, K., Kiwada, H. and Kawahara, S. Oceanographic conditions of the western North Pacific based on oceanographic data collected during the JARPN II. 13pp.

SC/J09/JR35. Matsuoka, K., Kiwada, H., Fujise, Y. and Miyashita, T. 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 sighting surveys (1994 to 2007) . 12pp.

SC/J09/JR36. Hakamada, T. Examination of the effects on whale stocks of future JARPN II catches. 51pp.

For Information papers

1- 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.

2- 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*). *Marine Pollution Bulletin* 51(2005): 784-793.

3- 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*). *Comparative Biochemistry and Physiology, Part B* 147 (2007): 667-681.

4- 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.

5- 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.

6- 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. *J. Reprod. Dev*. 50:419-427.

7- 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.

8- 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.

9- 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.

10- 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*, Part B 149:227-235.

11- Nishida, S., Goto, M., Pastene, L.A., Kanda, N. and Koike, H. 2007. Phylogenetic relationships among cetaceans revealed by Y-chromosome sequences. *Zoological Science* 24:723-732.

12- Onbe, K., Nishida, S., Sone, E., Kanda, N., Goto, M., Pastene, L.A., Tanabe, S. and Koike, H. 2007. Sequence variation in the *Tbx4* gene in marine mammals. *Zoological Science* 24:449-464.

Annex 2

List of sample/data produced by JARPN II (2000-2007)

*: Data-base completed

I SIGHTING DATA - Coastal and Offshore components

DB		Total sample size
	Angle and distance experiment data (no. of experiments)	3,807
*	Photo ID humpback whales (no. of schools photographed)	24
*	Photo ID right whales (no. of schools photographed)	22
*	Photo ID blue whales (no. of schools photographed)	65
*	Sighting data (no. of schools)	9,426
*	Effort data (n.miles)	439,047
	Weather data (no. observations)	66,260

Annex 2. Cont.

II-1. BIOLOGICAL DATA - COMMON MINKE WHALE - Offshore component

DB	Data and sample	Number of whales		
		Male	Female	Total
*	Sampling date	661	79	740
*	Sampling location	661	79	740
*	Body length	661	79	740
*	Body proportion	661	79	740
	Skull (length and breadth)	656	78	734
	Body scar record	661	79	740
	Parasites, external occurrence record	661	79	740
	Parasites, internal occurrence record	661	79	740
*	Sex	661	79	740
*	Body weight	661	79	740
*	Organ weights	158	23	181
*	Blubber thickness	661	79	740
*	Girth	661	79	740
*	Maturity stage	661	79	740
	Corpora albicantia and lutea (number)	-	79	79
*	Lactation condition	-	79	79
*	Testis weight	661	-	661
*	Stomach contents (IWS format)	661	79	740
*	Stomach contents weights	661	79	740
*	Main prey species in stomach contents	661	79	740
*	Freshness of stomach contents	661	79	740
	Foetus, number	-	79	79
	Foetus, sex	-	-	35
	Foetus, body length	-	-	35
	Foetus, body weight	-	-	35
	Ear plug	661	79	740
*	PCB concentrations (blubber)	347	-	347
*	Total Hg levels (liver)	77	-	77
*	Total Hg, methyl Hg and Se levels (liver)	35	5	40
*	Total Hg, methyl Hg and Se levels (kidney)	35	5	40
*	Total Hg, methyl Hg and Se levels (muscle)	35	5	40
*	Mitochondrial DNA control region sequences	655	79	734
*	Nuclear DNA microsatellite (16 loci)	654	79	733

Annex 2. Cont.

II-2. BIOLOGICAL DATA - SEI WHALE - Offshore component

DB	Data and sample	Number of whales		
		Male	Female	Total
*	Sampling date	238	251	489
*	Sampling location	238	251	489
*	Body length	238	251	489
*	Body proportion	238	251	489
	Skull (length and breadth)	232	243	475
	Body scar record	238	251	489
	Parasites, external occurrence record	238	251	489
	Parasites, internal occurrence record	238	251	489
*	Sex	238	251	489
*	Body weight	238	251	489
*	Organ weights	63	64	127
*	Blubber thickness	238	251	489
*	Girth	238	251	489
*	Maturity stage	238	251	489
	Corpora albicantia and lutea (number)	-	251	251
*	Lactation condition	-	251	251
*	Testis weight	238	-	238
*	Stomach contents (IWS format)	238	251	489
*	Stomach contents weights	238	251	489
*	Main prey species in stomach contents	238	251	489
*	Freshness of stomach contents	238	251	489
	Foetus, number	-	251	251
	Foetus, sex	-	-	115
	Foetus, body length	-	-	115
	Foetus, body weight	-	-	115
	Ear plug	238	251	489
*	PCB concentrations (blubber)	15	-	15
*	Total Hg levels (liver)	30	-	30
*	Total Hg, methyl Hg and Se levels (liver)	-	-	-
*	Total Hg, methyl Hg and Se levels (kidney)	-	-	-
*	Total Hg, methyl Hg and Se levels (muscle)	-	-	-
*	Mitochondrial DNA control region sequences	238	251	489
*	Nuclear DNA microsatellite (17 loci)	238	251	489

Annex 2. Cont.

II-3. BIOLOGICAL DATA - BRYDE'S WHALE - Offshore component

DB	Data and sample	Number of whales		
		Male	Female	Total
*	Sampling date	166	227	393
*	Sampling location	166	227	393
*	Body length	166	227	393
*	Body proportion	166	227	393
	Skull (length and breadth)	161	222	383
	Body scar record	166	227	393
	Parasites, external occurrence record	166	227	393
	Parasites, internal occurrence record	166	227	393
*	Sex	166	227	393
*	Body weight	166	227	393
*	Organ weights	56	71	127
*	Blubber thickness	166	227	393
*	Girth	166	227	393
*	Maturity stage	166	227	393
	Corpora albicantia and lutea (number)	-	227	227
*	Lactation condition	-	227	227
*	Testis weight	166	-	166
*	Stomach contents (IWS format)	166	227	393
*	Stomach contents weights	166	227	393
*	Main prey species in stomach contents	166	227	393
*	Freshness of stomach contents	166	227	393
	Foetus, number	-	227	227
	Foetus, sex	-	-	127
	Foetus, body length	-	-	127
	Foetus, body weight	-	-	127
	Ear plug	166	227	393
*	PCB concentrations (blubber)	15	-	15
*	Total Hg levels (liver)	20	-	20
*	Total Hg, methyl Hg and Se levels (liver)	21	22	43
*	Total Hg, methyl Hg and Se levels (kidney)	21	22	43
*	Total Hg, methyl Hg and Se levels (muscle)	21	22	43
*	Mitochondrial DNA control region sequences	166	227	393
*	Nuclear DNA microsatellite (17 loci)	166	227	393

Annex 2. Cont.

II-4. BIOLOGICAL DATA - SPERM WHALE - Offshore component

DB	Data and sample	Number of whales		
		Male	Female	Total
*	Sampling date	13	32	45
*	Sampling location	13	32	45
*	Body length	13	32	45
*	Body proportion	13	32	45
	Skull (length and breadth)	13	30	43
	Body scar record	13	32	45
	Parasites, external occurrence record	13	32	45
	Parasites, internal occurrence record	13	32	45
*	Sex	13	32	45
*	Body weight	13	32	45
*	Organ weights	8	22	30
*	Blubber thickness	13	32	45
*	Girth	13	32	45
*	Maturity stage	13	32	45
	Corpora albicantia and lutea (number)	-	32	32
*	Lactation condition	-	32	32
*	Testis weight	13	-	13
*	Stomach contents (IWS format)	13	32	45
*	Stomach contents weights	13	32	45
*	Main prey species in stomach contents	13	32	45
*	Freshness of stomach contents	13	32	45
	Foetus, number	-	32	32
	Foetus, sex	-	-	7
	Foetus, body length	-	-	7
	Foetus, body weight	-	-	7
	Ear plug	13	32	45
*	PCB concentrations (blubber)	-	-	-
*	Total Hg levels (liver)	-	-	-
*	Total Hg, methyl Hg and Se levels (liver)	3	2	5
*	Total Hg, methyl Hg and Se levels (kidney)	3	2	5
*	Total Hg, methyl Hg and Se levels (muscle)	3	2	5
*	Mitochondrial DNA control region sequences	13	32	45
*	Nuclear DNA microsatellite (15 loci)	13	32	45

Annex 2. Cont.

II-5. BIOLOGICAL DATA - COMMON MINKE WHALE - Coastal component off Kushiro

DB	Data and sample	Number of whales		
		Male	Female	Total
*	Sampling date	182	72	254
*	Sampling location	182	72	254
*	Body length	182	72	254
*	Body proportion	182	72	254
	Skull (length and breadth)	181	72	253
	Body scar record	182	72	254
	Parasites, external occurrence record	182	72	254
	Parasites, internal occurrence record	-	-	-
*	Sex	182	72	254
*	Body weight	182	72	254
*	Organ weights	11	3	14
*	Blubber thickness	182	72	254
*	Girth	182	72	254
*	Maturity stage	182	72	254
	Corpora albicantia and lutea (number)	-	72	72
*	Lactation condition	-	72	72
*	Testis weight	182	-	182
*	Stomach contents (IWS format)	182	72	254
*	Stomach contents weights	182	72	254
*	Main prey species in stomach contents	182	72	254
*	Freshness of stomach contents	182	72	254
	Foetus, number	-	72	72
	Foetus, sex	-	-	4
	Foetus, body length	-	-	4
	Foetus, body weight	-	-	4
	Ear plug	181	71	252
*	PCB concentrations (blubber)	-	-	-
*	Total Hg levels (liver)	46	-	46
*	Total Hg, methyl Hg and Se levels (liver)	-	-	-
*	Total Hg, methyl Hg and Se levels (kidney)	-	-	-
*	Total Hg, methyl Hg and Se levels (muscle)	-	-	-
*	Mitochondrial DNA control region sequences	181	72	253
*	Nuclear DNA microsatellite (16 loci)	182	71	253

Annex 2. Cont.

II-6. BIOLOGICAL DATA - COMMON MINKE WHALE - Coastal component off Sanriku

DB	Data and sample	Number of whales		
		Male	Female	Total
*	Sampling date	91	136	227
*	Sampling location	91	136	227
*	Body length	91	136	227
*	Body proportion	91	136	227
	Skull (length and breadth)	89	133	222
	Body scar record	91	136	227
	Parasites, external occurrence record	91	136	227
	Parasites, internal occurrence record	-	-	-
*	Sex	91	136	227
*	Body weight	91	136	227
*	Organ weights	4	5	9
*	Blubber thickness	91	136	227
*	Girth	91	136	227
*	Maturity stage	91	136	227
	Corpora albicantia and lutea (number)	-	135	135
*	Lactation condition	-	136	136
*	Testis weight	89	-	89
*	Stomach contents (IWS format)	91	136	227
*	Stomach contents weights	89	133	222
*	Main prey species in stomach contents	91	136	227
*	Freshness of stomach contents	91	136	227
	Foetus, number	-	135	135
	Foetus, sex	-	-	30
	Foetus, body length	-	-	30
	Foetus, body weight	-	-	30
	Ear plug	91	136	227
*	PCB concentrations (blubber)	-	-	-
*	Total Hg levels (liver)	29	-	29
*	Total Hg, methyl Hg and Se levels (liver)	-	-	-
*	Total Hg, methyl Hg and Se levels (kidney)	-	-	-
*	Total Hg, methyl Hg and Se levels (muscle)	-	-	-
*	Mitochondrial DNA control region sequences	91	136	227
*	Nuclear DNA microsatellite (16 loci)	91	136	227

Annex 2. Cont.

III. POLLUTANT DATA (Enviromental and prey species samples) - Offshore component

DB	Item	Number of samples
*	Organochlorine compounds (air)	6
*	Organochlorine compounds (sea water)	7
*	Total Hg compounds (copepods)	5
*	Total Hg compounds (Krill)	17
*	Total Hg compounds (Larval of anchovy)	6
*	Total Hg compounds (Adult of anchovy)	20
*	Total Hg compounds (Pacific saury)	41
*	Total Hg compounds (mackerels)	5
*	Total Hg compounds (Pacific pomfret)	3
*	Organochlorine compounds (walleye pollock)	2

IV-1. OCEANOGRAPHIC DATA - Offshore component

DB		Number of samples
	Marine debris (sighting survey, days)	56
*	Temperature & Salinity (XCTD survey: 2000-2007)	38
*	Temperature & Salinity (CTD survey: 2000-2007)	593
*	Midwater trawl (# of hawls)	141
*	MOCNESS (# of hawls)	24
*	IKMT (# of hawls)	30
*	NORPAC (# of hawls)	75
*	Echo sounder (km: 2002-2007)	12,838

IV-2. OCEANOGRAPHIC DATA - Coastal component off Sanriku

DB		Number of samples
*	Temperature & Salinity (XCTD survey: 2003-2007)	11
*	Temperature & Salinity (CTD survey: 2003-2007)	149
*	Midwater trawl (# of hawls)	57
*	Bongo net (# of hawls)	5
*	IKMT (# of hawls)	17
*	Sampling by fishing (# of stations)	2
*	Echo sounder (km; 2005 and 2006 seasons)	2,775

IV-3. OCEANOGRAPHIC DATA - Coastal component off Kushiro

DB	Item	Number of samples
*	Temperature & Salinity (CTD survey: 2002-2007)	109
*	Midwater trawl (no. tow)	133
*	MOCNESS survey (no. tow)	-
*	IKMT survey (no. tow)	6
*	NORPAC net survey (no. tow)	-

Annex 3

Details of research area, time frame, target species and rational for sample sizes in the whale survey component of JARPNII.

Research area of JARPN II
In the western North Pacific, there are numerous fronts and water masses (Figure 1). The Kuroshio Current, which is one of the strongest west-boundary currents of the subtropical gyre, flows northward from the offshore area of the Philippines to the waters off Japan with warm high-salinity water. It turns eastwards off the Pacific side of Japan as the Kuroshio Extension. On the other hand the Oyashio Current flows southward along the Kurile Islands with cold low-salinity water. It branches into two flows off northern Japan. The Kuroshio and the Oyashio flow eastward, and the area between the Kuroshio Extension and Oyashio east of Japan is usually called the Kuroshio-Oyashio Inter-frontal Zone or simply the Transition Zone. It is well-known that these areas have a high productivity and are feeding grounds for highly migratory species such as Pacific saury, skipjack tuna and baleen whales.

The research area of JARPN II covered the Kuroshio, the Oyashio and the Transition Zone (Figures 1). It also covers part of sub-areas 7, 8 and 9 used by the IWC for management purposes, see Figure 2).

The research area for the feeding ecology study in the full JARPN II was extended eastward to 170ºE to cover the geographical distribution of fisheries resources caught by Japanese fisheries. In particular, Pacific saury is distributed in sub-areas 8 and 9 in summer just before they are recruited to the fishery in autumn (Sugisaki and Kurita, 2004). The eastward extension of the research area was also important for more detailed studies on stock structure of the target species that allowed us to investigate additional structure in offshore waters.

Time frame of JARPN II
The full JARPN II research plan was designed as a long term research program of undetermined duration (Government of Japan, 2002a). The habitats of marine living resources around Japan are quite diversified and their relationships are very dynamics. The long term research is necessary to investigate these complex relationships and the fluctuations of biological processes in time so that ecosystem models can be adjusted for such fluctuations. Annual fluctuations in abundance, distribution, prey consumption, prey species, etc., are large. Therefore long-term monitoring of these and other environmental variables involved is necessary. In order to incorporate the results into the ongoing surveys, however, the research plan included a comprehensive review following completion of the first six years of the research. The time frame of JARPN II is as follows:

2000-2001: Feasibility study (Government of Japan, 2000; 2002b)
2002-2007: First full research period (Government of Japan, 2002a)
After 2007: Comprehensive review and output for fisheries resource management in the western North Pacific
2008-2013: Research plan of second period improved by taking into account results of the first period

Target whale species and rational for sample sizes in the whale survey component
The JARPN II started with two feasibility surveys in the spring/summer seasons of years 2000 and 2001. The research plan for the two-year feasibility study was presented to the 2000 Meeting of the IWC SC as Document SC/52/O1 (Government of Japan, 2000).

The target species and sample sizes for the feasibility study were the common minke whale (*Balaenoptera acutorostrata*, n=100), Bryde's whale (*B. edeni*, n=50) and the sperm whale (*Physeter macrocephalus*, n=10). These species were chosen for sampling because they occupy an important niche in the pelagic zone of the North Pacific and because their populations are relatively abundant (Government of Japan, 2000). Regarding the sperm whales previous reports showed that this species fed mainly on neon flying squids around the Joban area (sub-area 7) in winter (Okutani *et al*., 1976). The abundance of sperm whales was estimated to be 102,000 (Kato and Miyashita, 1998). Under the assumption that the neon flying squid was 5 % of their prey consumption, the total consumption was estimated to be eight hundred thousand tons, equivalent to roughly eight times the total estimated recent neon flying squid fisheries catch in the western North Pacific. There was therefore a need to collect more data on the food habits of sperm whales to investigate the role of this species in the ecosystem, in particular to evaluate the impact of their consumption on neon flying squids.

The two-year JARPN II feasibility surveys were conducted in order to make the full JARPN II successful by i) examining the performance and practicability of the concurrent whale and prey surveys using a total of six research vessels, and ii) assessing whether such concurrent surveys provide enough data to determine prey preferences. The feasibility study was also conducted to evaluate the performance of the whale survey under the situation when the number of target species increased from one in the JARPN to three in the JARPN II (Government of Japan, 2000). This evaluation was important given the practical and logistical problems involved when the number of target species is increased.

A comprehensive report of the results of the two-year feasibility study was presented to the 2002 IWC/SC Meeting as Document SC/54/O17 (Government of Japan, 2002b). The report of the feasibility study concluded that the concurrent prey and whale surveys were feasible and that information on feeding ecology of Bryde's and sperm whales could be obtained in the same way as it had been obtained for minke whales (Government of Japan, 2002b). Given these positive results the full 'Research Plan for Cetaceans Studies in the Western North Pacific under Special Permit (JARPN II) was implemented from 2002. The full research plan of JARPN II plan was presented to the IWC SC in 2002 as Document SC/54/O2 (Government of Japan, 2002a).

The target species and sample sizes for the full JARPN II were the common minke whale (n=100 pelagic; 50 coastal), Bryde's whale (n=50), sei whale (*B. borealis*, n=50) and the sperm whale (n=10).

This research plan involved two new components:

a) Sampling of 50 sei whales.
b) Sampling of 50 common minke whales by small type whaling catcher boats in coastal waters as a two-year feasibility study (50 whales to be sampled each in fall 2002 and spring 2003, respectively)

Abundance (biomass) and ecological niche in the western North Pacific were two criteria for choosing the sei whale as a target species of JARPN II. Their biomass is larger than those of the common minke and Bryde's whales, and the past information indicated that they feed on schooling fish and squid as well as krill in the JARPN II research area and on copepods in the Northern North Pacific (Government of Japan, 2002a).

The coastal component for common minke whales was necessary to cover the temporal (late autumn, early spring) and spatial gaps in sampling, which cannot be covered by the pelagic research base *Nisshin Maru* (Government of Japan, 2002a).

It should be noted that some elements of the full JARPN II were defined as feasibility studies e.g. sampling of minke whale under the coastal component in 2002 and 2003 to investigate the feasibility of sampling using small catcher boats. The sample size for minke whales in the coastal component was also considered as preliminary and further calculation should be made after new data were obtained in the two-year feasibility survey were accumulated. Also the sperm whale sampling to investigate the relationship and impact of sperm whales on the surface ecosystem was still considered as a feasibility study (Government of Japan, 2002a).

Considerations related to the feasibility components of the JARPN II were presented to the IWC SC Meeting in 2004 as Document SC/56/O2 (Government of Japan, 2004a). It was concluded that research surveys using small type whaling catcher boats was feasible. Furthermore geographical and/or temporal variations of prey species of the minke whales revealed during the feasibility coastal surveys were considered to re-calculate the sample sizes of minke whales for the coastal component of the research. Also data on stomach content of sei whales collected in the 2002 and 2003 surveys were used to calculate sample size of this species using the new information on stomach contents. Finally it was decided to keep the sampling of a small number of sperm whales, which was useful at least for qualitative studies on feeding ecology of this species (Government of Japan, 2004a).

Based on these considerations a revised research plan for cetacean studies in the western North Pacific under Special Permit was presented to the same meeting as Document SC/56/O1 (Government of Japan, 2004b). The objectives of the research were the same as specified in Government of Japan (2002b), but the following new research elements were added:

a) Sample size for the minke whale in the coastal component was increased to 120, with 60 each in spring and autumn, respectively (in 2004, 60 animals would be sampled in fall and from 2005, 60 each in spring and fall, respectively).
b) Sample size for sei whales was increased to 100.

Table 1 shows the planned sample sizes for the different whale species investigated in JARPN II.

Rational for sample size of common minke whales:
During the feasibility study (200-2001) the sample size was calculated for estimating their prey consumption with good precision (CV equal to, or less than 0.2) using the method developed by Norwegian scientists during their feeding ecology study of common minke whales in the North Atlantic (Government of Norway, 1992). Data on prey consumption obtained during the JARPN in sub-area 7 (Figure 2) was used. Data was divided into two, based on seasons - spring and summer. Two types of data were used for the calculation: number of whales feeding on each of the prey species (krill, Pacific saury and Japanese anchovy), and average stomach contents weight with its standard deviation. On the basis of these estimations a sample size of 100 animals for the total research area (sub-areas 7, 8 and 9, Figure 2) was determined (Government of Japan, 2000).

For the full JARPN II a similar procedure was used but this time using a larger data set. A sample size of 100 animals was determined for the offshore research area (Government of Japan, 2002a). The sample size for the coastal minke whale component was calculated using a similar procedure with and data obtained in the Sanriku region and coastal region of Hokkaido in 2000 and 2001. A sample size of 50 animals was determined for the inshore part of sub-area 7 (Government of Japan, 2002a).

Results of the 2002 (fall, Kushiro) and 2003 (spring, Sanriku) coastal surveys revealed geographical and temporal changes of prey species of minke whales. Required sample size was then recalculated with these data to secure statistical accuracy for constructing ecosystem models. Based on these results the revised JARPN II research plan concluded that the coastal survey component would be conducted twice a year and that 60 whales would be sampled in early and late seasons, respectively, beginning with the survey in the fall 2004 (Government of Japan, 2004a;2004b) .

Rational for sample size of Bryde's whales:
A similar procedure as that used for the minke whale was used to calculate the necessary sample size for Bryde's whales in order to obtain statistically reasonable results. Calculation for the feasibility study was based on data on prey consumption obtained during the period of commercial whaling. Preliminary sample size of 50 was determined (Government of Japan, 2000). During the full research plan recalculations were conducted based on data on consumption collected during the feasibility studies. A sample size of 50 was determined (Government of Japan, 2002a).

Rational for sample size of sei whales:
Calculation of sample size for this species in the full JARPN II was made using a similar procedure as above with data on prey consumption from the Bryde's whale. A sample size of 50 was determined. Given the scarcity of consumption data for this species, the calculation of sample size was considered as preliminary (Government of Japan, 2002a).

In the revised plan sample size was recalculated using data from the 2002 and 2003 surveys to secure statistical accuracy for constructing ecosystem models. New calculation of sample size for sei whales using data from these two surveys showed that at least 100 sei whales per year were required for estimating prey consumption with sufficient precision (C.V.=0.2). The sample size of sei whale increased because the study in 2002 and 2003 indicated that a wider variety of prey species was consumed by the sei whale than had been known in the past (Government of Japan, 2004a; 2004b).

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Table 1: Planned sample sizes for different whale species under investigation in JARPN, in the period 2000-2007. *= JARPN II feasibility survey; **= feasibility surveys for coastal component

Year	Species	Coastal		Offshore
		Spring (Sanriku)	Fall (Kushiro)	
2000*	Common minke			100
	Bryde			50
	Sperm			10
2001*	Common minke			100
	Bryde			50
	Sperm			10
2002	Common minke		50**	100
	Bryde			50
	Sei			50
	Sperm			10
2003	Common minke	50**		100
	Bryde			50
	Sei			50
	Sperm			10
2004	Common minke		60	100
	Bryde			50
	Sei			100
	Sperm			10
2005	Common minke	60	60	100
	Bryde			50
	Sei			100
	Sperm			10
2006	Common minke	60	60	100
	Bryde			50
	Sei			100
	Sperm			10
2007	Common minke	60	60	100
	Bryde			50
	Sei			100
	Sperm			10

*See text for the rational used in the change of sample sizes in the cases of common minke and sei whales.

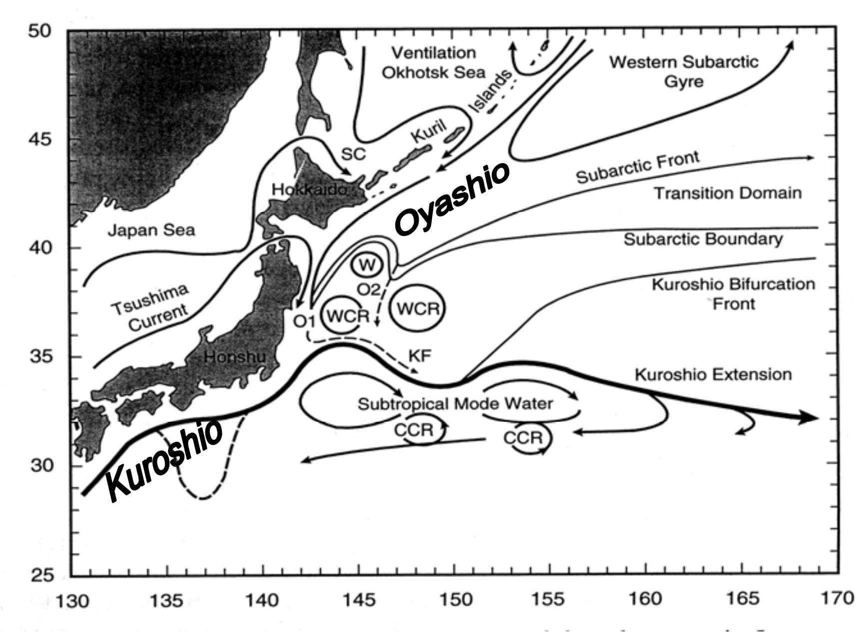

Figure 1: Schematic representation of the current and frontal systems in the western North Pacific (Yasuda *et al*., 1996; modified from Endo, 2000). SC: Soya Current, TW, O1: Oyashio first branch, O2: Oyashio second branch, WCR: warm core ring, CCR: cold core ring, KF: Kuroshio Front.

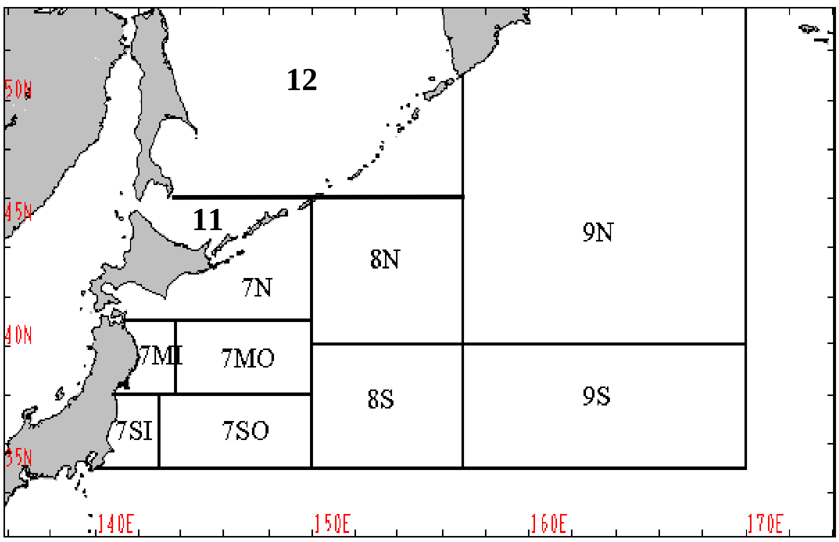

Figure 2: The research area and strata for the full-scale JARPN II surveys.

Annex 4

Scientific Contribution of JARPN/JARPN II

The following is a list of scientific papers based on data and samples collected by JARPN and JARPN II (peer-reviewed papers and unpublished documents submitted to the IWC/Scientific Committee). JARPN papers on stock structure are incorporated into JARPN II's Objective 3; JARPN papers on feeding ecology are incorporated into JARPN II' Objective 1. Asterisks indicate those papers published in peer reviewed journals.

Objective 1 (Feeding ecology and ecosystem studies)

*Hatanaka, H. and Miyashita, T. 1997. On the feeding migration of the Okhotsk Sea-West Pacific stock of minke whales, estimates based on length composition data. *Rep. int. Whal. Commn* 47: 557-564.

*Lindstrøm, U., Fujise, Y., Haug, T. and Tamura, T. 1998. Feeding habits of western North Pacific minke whales, Balaenoptera acutorostrata, as observed in July-September 1996. *Rep. int. Whal. Commn* 48:463-469.

*Tamura, T., Fujise, Y. and Shimazaki, K. 1998. Diet of minke whales *Balaenoptera acutorostrata* in the Northwestern part of the North Pacific in Summer 1994 and 1995. *Fisheries Science* 64(1): 71-76.

Mitani, Y., Bando, T., Takai, N. and Sakamoto, W. 2000. Diet records and stock structure of minke whales *Balaenoptera acutorostrata* around Japan examined by δ^{13} C and δ^{15} N analyses. Paper SC/F2K/J20 presented to the Workshop to Review the Japanese Whale Research Programme under Special Permit for North Pacific Minke Whales (JARPN), February 2000 (unpublished). 12pp.

Tamura, T. and Fujise, Y. 2000. Geographical and seasonal changes of prey species in the western North Pacific minke whale. Paper SC/F2K/J22 presented to the Workshop to Review the Japanese Whale Research Programme under Special Permit for North Pacific Minke Whales (JARPN), February 2000 (unpublished). 26pp.

Tamura, T. and Fujise, Y. 2000. Diurnal change in feeding activity in the western North Pacific minke whale. Paper SC/F2K/J23 presented to the Workshop to Review the Japanese Whale Research Programme under Special Permit for North Pacific Minke Whales (JARPN), February 2000 (unpublished). 16pp.

Tamura, T. and Fujise, Y. 2000. Daily and seasonal food consumption by the western North Pacific minke whale. Paper SC/F2K/J24 presented to the Workshop to Review the Japanese Whale Research Programme under Special Permit for North Pacific Minke Whales (JARPN), February 2000 (unpublished). 18pp.

Tamura, T. and Fujise, Y. 2000. Brief review of the studies of feeding ecology in the minke whale *Balaenoptera acutorostrata* from the western North Pacific prior to JARPN surveys. Paper SC/F2K/J31 presented to the Workshop to Review the Japanese Whale Research Programme under Special Permit for North Pacific Minke Whales (JARPN), February 2000 (unpublished). 6pp.

Tamura, T., Ohsumi, S. and Fujise Y. 2000. Some examinations on body fatness of the western North Pacific minke whales. Paper SC/F2K/J25 presented to the Workshop to Review the Japanese Whale Research Programme under Special Permit for North Pacific Minke Whales (JARPN), February 2000 (unpublished). 20pp.

Tamura, T. and Ohsumi, S. 2000. Regional assessments of prey consumption by marine cetaceans in the world. Paper SC/52/E6 presented to the IWC Scientific Committee, June 2000 (unpublished). 42pp.

*Ohsumi, S. and Tamura, T. 2002. Dietary studies on baleen whales in the North Pacific. *Fisheries Science* 68 (Supp.I): 260-263. (Proceedings of International Commemorative Symposium, 70th Anniversary of the Japanese Society of Fisheries Science).

*Tamura T. and Fujise Y. 2002. Geographical and seasonal changes of the prey species of minke whale in the Northwestern Pacific. *ICES Journal of Marine Science* 59(3): 516-528.

Tamura, T. 2003. Regional Assessments of prey consumption and competition by Marine cetaceans in the world. pp.143-170. *In*: Sinclair, M. and Valdimarsson, G. eds. *Responsible Fisheries in the Marine Ecosystem*. 426pp. CABI Publishing, Cambridge.

Kawahara, S., Kishiro, T., Tamura, T., Murase, H., Kiwada, H. and Nishiwaki, S. 2004. Preliminary estimation of prey selection of minke whales based on JARPN II coastal survey off the southeastern Hokkaido in September-October 2002. Paper SC/56/O18 presented to the IWC Scientific Committee, June 2004 (unpublished). 16pp.

Kawahara, S. and Hosho, T. 2004. Improvement and test runs Multspec-type ecosystem model for the western North Pacific. Paper SC/56/O24 presented to the IWC Scientific Committee, June 2004 (unpublished). 8pp.

Tamura, T., Konishi, K. and Fujise, Y. 2004. Preliminary analyses of prey consumption of three baleen whales and their interaction with fisheries in the western North Pacific. Paper SC/56/O15 presented to the IWC Scientific Committee, June 2004 (unpublished). 13pp.

Tamura, T., Konishi, K., Hakamada, T., Matsuoka, K., Murase, H., Miyashita, T., Kishiro, T., Ohizumi, H., Kato, H., Kawahara, S. and Fujise, Y. 2004. Preliminary analyses of interaction between common minke whales and fisheries off Kushiro region. Paper SC/56/O16 presented to the IWC Scientific Committee, June 2004 (unpublished). 16pp.

Tamura, T., Konishi, K., Miyashita, T., Yoshida, H., Kato, H. and Kawahara, S. 2004. Preliminary analyses of interaction between common minke whales and sand lance fisheries off Sanriku region. Paper SC/56/O17 presented to the IWC Scientific Committee, June 2004 (unpublished). 9pp.

*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.

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Annex 5

Protocol for access to samples/data from the Institute of Cetacean Research (ICR), Tokyo, Japan under Procedure B (JCRM 6 (suppl.): in press

INTRODUCTION

This protocol has been developed in the context of Procedure B of the IWC Scientific Committee's rules for data availability adopted at the 55th Annual Meeting (*Journal of Cetacean Research and Management* 6 (suppl.): in press). Procedure B applies to data required for analyses deemed important in providing advice to the Committee other than catch limits. Conditions for data recipients (repeated below) as specified in the rules for data availability are applicable.

It was agreed that the Committee shall specify the nature of the work and the data required during the meeting at which the recommendation is made, to the fullest extent possible in the time available at the meeting and in accord with the published protocol. Requests to the ICR for data under Procedure B of the Scientific Committee's rules for data availability shall be submitted by the Data Availability Group assisted by a nominated member of ICR.

It was also agreed that if the correct process is followed, the data owners will normally approve the applications within a 'specified time period'; in this case ICR agrees that it will respond within XXX weeks of receiving an application.

FORMAT OF THE APPLICATION

The format for the application is based on the revised application for catch-at-age analyses agreed by all members of the Scientific Committee at the end of the Scientific Committee meeting in 2003 (Annex G, Appendix 11).

(a) *Title* of the proposal, giving the broad subject of the proposed analyses.

(b) *Investigators:* the full name and affiliation of the principal investigator(s) and co-investigator(s) should be provided. This should include at least one scientist from ICR.

(c) *Objectives and rationale of the study* as specified by the by the Scientific Committee along with the appropriate reference to the report(s) of the Scientific Committee. This will include the reasons why the proposed analyses are important and how they fit into previous work.

(d) *Data to be used* will include a general description of all data to be used as well as data held by ICR. For the ICR-held data, the precise requirements will be given, including the level of disaggregation.

(e) *Description of the methods* likely to be used. The level of detail must be in accordance with the level of novelty of the proposed methods and the particular research questions they will address. References to similar analyses should be included where available.

(f) *Schedule of the work:* this should include estimated times for the various analyses to be carried out and an indication of which investigators will collaborate on individual components. If the project is a long-term project, annual progress reports will be required by ICR and the Scientific Committee.

(g) *Output of the research:* this will follow the rules for publication agreed at the Scientific Committee meeting and given below. ICR may consider requests for less stringent conditions (e.g. presentations at non-IWC scientific meetings, publications, etc.). Such requests should be detailed here.

CONSIDERATION OF THE PROPOSAL

If an application has been approved by the whole Scientific Committee at an annual meeting, it will normally be approved by ICR. However, the final decision will always remain the prerogative of ICR. ICR may request reviews by an internal review group and/or external experts. The following factors will be taken in to account by ICR when considering applications.

(a) *Priority:* highest priority for analysis/research of samples/data produced by Japan's Whale Research Programs under Special Permit, will be for the scientists that collected and obtained the data in any particular field.

(b) *Suitability of the requested data in the context of the proposed methods and the objectives of the research.*

(c) *Level of co-operation with ICR scientists.*

The response to an application for data will be communicated by the ICR's Director General to the Data Availability Group and may include requests for further information. If the research proposal is accepted, ICR will nominate a scientist, (normally one of the co-investigators) who shall be responsible for making the necessary arrangements to provide the required samples/data.

Agreed Scientific Committee conditions for data recipients
Applications deemed suitable under Procedure A or Procedure B below are granted under the following conditions:

(1) Data shall not be transmitted to third parties.
(2) Papers may only be submitted to a Committee meeting in accordance with the time restrictions given below. Such papers must not include the raw data or the data in a form in more detail than is necessary to understand the analysis.
(3) Papers must carry a restriction on citation except in the context of IWC meetings.
(4) Data owners are offered co-authorship.
(5) Publication rights remain strictly with the data owner.
(6) Data shall be returned, to the Secretariat or the data owner as appropriate, immediately after the meeting at which the paper is submitted and any copies destroyed, unless an extension is granted.
(7) Data requesters sign a form agreeing to the above conditions. Such forms will be held by the data owner and the Secretariat. In the case of Procedure B, the Data Availability Group will sign the agreement on the Committee's behalf and ensure that the conditions of any agreement are met by any individual scientists involved in the analysis.
(8) In the event of a breach of the conditions in (6), serious sanctions [to be determined] will apply.

Annex 6

Coefficient of Variation (CV) of stomach content weight

Offshore component

1) Common minke whales

2000	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sardine	Others
Avg.		9.09	40.90	4.45	1.90	40.37			
Std.		13.25	69.20	2.95	3.16	64.95			
C.V.		0.73	0.39	0.33	0.74	0.54			
N		4	19	4	5	9			

2001	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sardine	Others
Avg.		29.25	24.84	24.15		40.68			
Std.		44.29	21.40	21.61		50.69			
C.V.		0.38	0.16	0.14		0.39			
N		16	30	43		10			

2002	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sardine	Others
Avg.		14.50	16.21	34.86		20.80			
Std.		16.13	18.24	47.58					
C.V.		0.24	0.25	0.19					
N		22	21	50		1			

2003	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sardine	Others
Avg.		1.55	22.30	23.10					
Std.		1.86	29.96	28.79					
C.V.		0.49	0.19	0.20					
N		6	49	39					

2004	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sardine	Others
Avg.		0.10	13.54	29.62		0.40			
Std.			12.13	28.25					
C.V.			0.22	0.12					
N		1	17	63		1			

2005	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sardine	Others
Avg.	2.49	21.42	24.27	23.78	9.82	2.45			
Std.	2.00	25.72	34.10	20.63		3.11			
C.V.	0.46	0.26	0.28	0.17		0.45			
N	3	22	26	25	1	8			

2006	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sardine	Others
Avg.		5.40	19.89	18.97	30.27	11.53			
Std.		7.30	28.97	23.41		7.21			
C.V.		0.51	0.21	0.21		0.44			
N		7	48	35	1	2			

2007	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sardine	Others
Avg.	15.07	20.61	27.57	17.90	4.52	310.85			
Std.	19.54	29.14	28.05	15.59	5.95	544.40			
C.V.	0.75	0.38	0.13	0.25	0.76	0.78			
N	3	14	66	12	3	5			

2) Sei whales

2002	Krill	Copepoda	Anchovy	Saury	Mackerel
Avg.	71.17	31.53	163.88	13.46	
Std.	126.68	46.37	284.76	18.62	
C.V.	0.49	0.42	0.71	0.80	
N	13	12	6	3	

2003	Krill	Copepoda	Anchovy	Saury	Mackerel
Avg.	9.05	22.51	70.76	5.28	
Std.	10.08	22.79	122.95	4.71	
C.V.	0.56	0.23	0.43	0.45	
N	4	19	16	4	

2004	Krill	Copepoda	Anchovy	Saury	Mackerel
Avg.	62.15	20.64	265.58	64.16	51.98
Std.	53.26	37.43	372.26	74.94	91.22
C.V.	0.61	0.44	0.25	0.41	0.58
N	2	17	31	8	9

2005	Krill	Copepoda	Anchovy	Saury	Mackerel
Avg.	167.15	100.08		52.06	
Std.	154.65	128.60		64.50	
C.V.	0.14	0.22		0.41	
N	41	34		9	

2006	Krill	Copepoda	Anchovy	Saury	Mackerel
Avg.	91.71	20.91	235.10	9.41	
Std.	106.41	27.72	442.97	11.15	
C.V.	0.32	0.34	0.33	0.36	
N	13	15	33	11	

2007	Krill	Copepoda	Anchovy	Saury	Mackerel
Avg.	109.71	32.05	65.07	6.96	138.68
Std.	54.41	33.72	142.03	14.79	177.94
C.V.	0.35	0.17	0.49	0.61	0.29
N	2	39	20	12	20

3) Bryde's whales

2000	Krill	Anchovy	Mackerel
Avg.	93.71	355.48	
Std.	62.24	308.68	
C.V.	0.25	0.20	
N	7	19	0

2001	Krill	Anchovy	Mackerel
Avg.	74.88	6.35	107.15
Std.	91.15	4.81	
C.V.	0.23	0.44	
N	29	3	1

2002	Krill	Anchovy	Mackerel
Avg.		181.85	
Std.		218.84	
C.V.		0.18	
N		43	

2003	Krill	Anchovy	Mackerel
Avg.	86.07	114.04	123.19
Std.	113.37	102.75	
C.V.	0.27	0.28	
N	23	10	1

2004	Krill	Anchovy	Mackerel
Avg.	50.63	163.54	74.83
Std.	44.67	173.75	97.62
C.V.	0.62	0.19	0.36
N	2	32	13

2005	Krill	Anchovy	Mackerel
Avg.	52.29	379.30	150.91
Std.	51.20	312.28	242.01
C.V.	0.25	0.34	0.39
N	15	6	17

2006	Krill	Anchovy	Mackerel
Avg.	89.73	23.63	
Std.	102.14	28.03	
C.V.	0.27	0.40	
N	18	9	0

2007	Krill	Anchovy	Mackerel
Avg.	38.45	115.42	1.13
Std.	32.00	174.74	
C.V.	0.59	0.26	
N	2	35	1

Coastal component

1) Common minke whale (Kushiro)

2002	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sardine	Others
Avg.		42.42	13.08	47.57		27.77	87.10		
Std.		38.61	8.95	35.58		22.29	36.87		
C.V.		0.46	0.15	0.33		0.24	0.17		
N		4	21	5		11	6		

2004	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sardine	Others
Avg.		26.89	20.55	31.64		30.21			
Std.			14.61	27.50		25.20			
C.V.			0.12	0.20		0.59			
N		1	37	18		2			

2005	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sardine	Others
Avg.		22.42	9.62	24.32		130.33	126.14		
Std.		17.09	5.04			241.33			
C.V.		0.20	0.11			0.46			
N		14	22	1		16	1		

2006	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sardine	Others
Avg.		3.32	13.87	15.67		50.09	36.42		
Std.			14.89	6.02		71.80			
C.V.			0.21	0.22		0.83			
N		1	26	3		3	1		

2007	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sardine	Others
Avg.		9.26	48.79	36.09		39.26	192.15		
Std.		7.01	54.64	47.97		26.21			
C.V.		0.34	0.29	0.54		0.21			
N		5	15	6		10	1		

2) Common minke whale (Sanriku)

2003	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sand lance	Others
Avg.		48.78						35.20	
Std.		40.48						46.92	
C.V.		0.24						0.26	
N		12						26	

2005	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sand lance	Others
Avg.		52.39	43.29					35.21	
Std.		34.95	27.89					32.78	
C.V.		0.47	0.32					0.14	
N		2	4					44	

2006	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sand lance	Others
Avg.		1.24	17.35					28.20	
Std.			19.63					27.40	
C.V.			0.34					0.17	
N		1	11					32	

2007	Copepoda	Krill	Anchovy	Saury	Mackerel	Pollock	Squid	Sand lance	Others
Avg.			21.24					16.48	
Std.			21.80					21.78	
C.V.			0.28					0.26	
N			13					26	