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Response to SC 65b recommendation on Japans Whale Research Program under Special Permit in the Western North Pacific (JARPN II)

Government of Japan

INTERNATIONAL WHALING COMMISSION

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Fisheries Agency of Japan

1. Background

The Second Phase of Japan's Whale Research Program under Special Permit in the Western North Pacific (JARPN II) was designed in order to address important scientific questions raised at the Review Workshop of JARPN in February 2000. The research is aiming at contributing to conservation and sustainable utilization of marine living resources including cetaceans in the western North Pacific, particularly in the Japanese EEZ and its adjacent areas.

The first objective of JARPN II is to reveal prey consumption and preference by cetaceans and to establish ecosystem models taking into consideration feeding ecology of cetaceans and other marine species in the western North Pacific. Collecting information about feeding ecology of cetaceans and integrating this into comprehensive ecosystem models can play a central role in achieving the aim of this research program.

The second objective is to study stock structure of cetaceans in the western North Pacific. When JARPN II was initiated, existence of a W-stock of common minke whales (*Balaenoptera acutorostrata*) was proposed in addition to J- and O-stocks despite there being little scientific grounds. There were also concerns about insufficient knowledge about the stock structure of Bryde's (*B. edeni*) whales in the western North Pacific although a comprehensive assessment (CA) of this species was completed (IWC, 2000). Thus collecting genetic and non-genetic information for stock structure analyses became one of the objectives of this research program.

The third objective is to monitor environmental pollutants in cetaceans and the marine ecosystem. In this research program, monitoring pollutants in several whale species with different trophic levels is planned as well as monitoring pollutants in other marine species. Such a comprehensive monitoring can contribute to the conservation of the marine ecosystem in the western North Pacific (Government of Japan, 2000).

Under these objectives, feasibility study surveys for JARPN II were conducted in 2000 and 2001 with sample sizes of 100 minke whales, 50 Bryde's whales, and 10 sperm whales (*Physeter macrocephalus*). These species were identified as research targets because they were a dominant component of the biomass of large cetaceans in the research area and it was estimated that the lethal take would cause no harm to this abundant stock (Government of Japan, 2000).

Following the feasibility study, in 2002, the JARPN II program was revised considering preliminary results. Research objectives didn't change, but 50 sei (*B. borealis*) whales were added to the target species because the feasibility study indicated that sei whales play an important role in the marine ecosystem as well as minke whales and Bryde's whales. In addition, in order to study the competition for prey species between fisheries and cetaceans, Japan identified "hot spots" in the coastal area where such a competition is likely to take place at a large scale and introduced a research plan in the coastal components of Sanriku and Kushiro with sample sizes of 50 minke whales for each study area in order to detect and analyze the plausible competition (Government of Japan, 2002a).

In 2004, the research plan was again revised including re-calculation of sample sizes, taking account of research outcomes in 2002 and 2003. As a result, 220 minke whales (100 for the offshore component and 120 for the coastal component), 50 Bryde's whales, 100 sei whales and 10 sperm whales were set as target sample sizes in the research plan (Government of Japan, 2002a, 2002b).

At the expert panel review workshop in 2009 which was supposed to review the research outcomes from the first 6-

year period of JARPN II, the panel reported that "the Panel appreciates the notable amount of effort undertaken and the generally high quality of the sampling programme, resultant data and information from JARPN II studies on whale food habits and prey preferences. The sampling programme was generally well-coordinated across a wide range of vessels and platforms, and the degree of concurrently collected multi-disciplinary data was laudable. These efforts have resulted in valuable datasets that have great potential for concerted analytical work on a broad range of topics, not all directly related to the JARPN II programme objectives" (IWC, 2010a). Discussion was made based on the review panel report at the SC meeting in 2010, and Japan didn't revise the target or sample sizes partly because an ecosystem model which is one of the main goals of JARPN II was still being developed (IWC, 2010b).

The Judgment of the International Court of Justice (ICJ) in the case Whaling in the Antarctic (Australia v. Japan: New Zealand intervening) was issued on March 31, 2014. In the ICJ Judgment, the court states "[it is] expected that Japan will take account of the reasoning and conclusions contained in this judgment as it evaluates the possibility of granting any future permits under Article VIII, paragraph 1, of the Convention" (paragraph 246).
While JARPN II was not the direct subject of the ICJ case, as the Judgment showed an expectation as to research permits under Article VIII in general, the Government of Japan voluntarily reviewed the JARPN II program in response to the Judgment, prioritized research objectives, re-calculated sample sizes, and allocated a part of the samples required to non-lethal methods.

At the SC65b meeting, the delegation of Japan explained the actions taken by Japan after the ICJ judgment was issued. In response to the explanation, the Scientific Committee recommended as follows: (See P.73-74, SC report IWC/65/Rep1)

"In discussion, the Committee recommends that the proponents of JARPN II develop a more comprehensive document for review at the 2015 Annual Meeting that details how the above recalculations of sample size and changes in allotments of lethal versus non-lethal methods fit with achieving the overarching programmatic objectives. This recommendation is made because the written information available to the Committee was not sufficient to evaluate whether the numbers of animals to be taken had been adequately justified in relation to the specific objectives of the research."

This document responds to the recommendation above.

2. Japan's voluntary action

(1) Overview

The Judgment of the International Court of Justice (ICJ) in the case Whaling in the Antarctic (Australia v. Japan: New Zealand intervening) was issued on March 31, 2014. In the ICJ Judgment, the court states "[it is] expected that Japan will take account of the reasoning and conclusions contained in this judgment as it evaluates the possibility of granting any future permits under Article VIII, paragraph 1, of the Convention" (paragraph 246).

While JARPN II was not the direct subject of the ICJ case, because the Judgment expressed the expectation as to research permits under Article VIII in general, the Government of Japan voluntarily reviewed the JARPN II program in response to the Judgment, prioritized research objectives, re-calculated sample sizes, and allocated a part of required samples to non-lethal methods.

The main purpose of these adjustments is to conduct comparative studies between lethal and non-lethal research methods in response to the ICJ Judgment. In designing the comparative studies, a priority was placed on the first objective of JARPN II; to reveal prey consumption and preference by cetaceans and to establish ecosystem models. This is because scientific data from lethal research methods is aimed at contributing to this objective and, therefore, studying the feasibility, usefulness, and efficiency of non-lethal methods for this objective will be most effective in responding to the ICJ Judgment. Accordingly sample sizes were re-calculated based on the latest data on stomach contents of whales as explained in detail in the following sections of this document. Re-calculation is also responding to one of the points raised by the ICJ Judgment that not enough details were provided in calculating the sample sizes for JARPA II. Then a part of the required sample was allocated to non-lethal methods. If non-lethal methods are comparable to lethal research methods in contributing to the JARPN II objective, these adjustments will not affect the achievement of the overarching JARPN II objectives. If non-lethal methods can't produce comparable scientific information, the achievement of the objectives will be compromised.

JARPN II is subject to IWC review under Annex P in 2016. As stated by Japan at the 2014 SC meeting, it is planned to propose a new research plan to succeed JARPN II taking account of the results of the 2016 review and the results of the comparative studies explained above.

As the primary purpose of JARPN II is to study the interactions between fisheries and cetacean in the marine ecosystem of the western North Pacific through ecosystem modeling (Government of Japan 2002), during the three year period of the adjusted JARPN II, the Government of Japan decided to place priority on estimating prey consumption which could be valuable information for the development of ecosystem models and for fishery resource management.

Taking account of that decision, target species for lethal sampling until the implementation of a new research plan were identified and sample sizes were re-calculated for these target species as explained in detail below and in Appendix 1 using a preliminary data set (up to and including 2010 for the coastal components: up to and including 2012 for the off-shore component at the time of 2014 Scientific Committee).

- Minke whales in the costal component remained as a target because competition for prey between coastal fisheries and this species has been strongly indicated from the past research (IWC 2010a)
- Sei whales and Bryde's whales remained as targets because the past studies revealed that these species are dominant in the research area and play an important role in the pelagic marine ecosystem of the western North Pacific (Konishi *et al*, 2009).
- Minke whales in the offshore component were set excluded from the target species because from sighting surveys the distribution of this species in the research area appears to be shifting (Matsuoka *et al*., 2012, 2013; Kanaji *et al*., 2012) and therefore it was thought to be better to suspend the sampling and reconsider how to deal with this species in the new research plan.
- Sperm whales were excluded from the target species because its consumption of neon flying squid which is a fishery target has been rarely observed in our past research since 2008 (Tamura et al., 2009, 2012; Bando et al., 2010, 2013, 2014; Yasunaga et al., 2011).

(2) Re-calculation of sample sizes

Sample sizes were re-calculated for these target species based on the same idea as previous in JARPN II using a preliminary data set (up to and including 2010 for the coastal components: up to and including 2012 for the off-shore component at the time of 2014 Scientific Committee) . Sample sizes of target species necessary for the estimation of food consumption by cetaceans were calculated with the method employed under the Norwegian research (Government of Norway, 1992) taking into account the following information derived from its past researches:

i) Composition of prey species (%)
ii) Average weight of each prey species in the stomach contents (kg)
iii) S.D. and C.V. of the compositions and weights

Sample sizes were calculated with a condition that the stomach contents of a target prey species be estimated with C.V. =0.2, for each year. This C.V. level is consistent with the target level employed by the Norwegian research referenced above and also the level achieved in another study (Winship and Trites, 2003).

With the sample sizes, early changes in main prey consumption by cetaceans can be estimated with a fixed high accuracy. Such scientific knowledge can contribute to developing ecosystem models that take account of changes in prey consumption.

(3) Comparative evaluation of lethal and non-lethal research methods

The following four aspects are to be evaluated in comparing lethal and non-lethal research methods;

(i) whether a tissue and other samples can be obtained by a non-lethal method (*e.g*. biopsy sampling, feces collection);
(ii) whether enough number of samples can be obtained by the non-lethal method;
(iii) whether the sample obtained by the non-lethal method can produce scientific information compatible to that produced by a lethal sampling method; and
(iv) whether the cost for obtaining the sample/producing scientific information is reasonable.

The third aspect, in particular, requires an evaluation regarding whether prey consumption can be estimated at a certain high accuracy in species composition and its quantity.

(4) Research target species and re-estimation of sample sizes

Sampling of sperm whale

When the feasibility research was planned in 2000, it was known that sperm whales have a large biomass in the research area and consume fishery resources such as neon flying squids and bottom fish such as rock fishes and cod, as well as deep-sea squids (Kawakami, 1980). Moreover, in the research plan it was important to monitor several cetacean species with different feeding ecologies (Government of Japan, 2000). For these reasons, it was considered necessary to conduct research on sperm whales for developing ecosystem models and this species was added to the research targets in 2002 and 2003.

Based on the outcome of the feasibility research, we assessed appropriate research targets for JARPN II using Ecopath with Ecosim in 2004. Test-run results showed that the consumption by sperm whales exerted an impact on its prey species, which was a similar outcome as minke whales (Okamura *et al.*, 2002). Moreover, little knowledge was available about the niche of deep-sea squids which is one of sperm whales' prey species and a role of sperm whales in the pelagic ecosystem. Also, as high as 5 % of fishery-targeted neon flying squids appear to be consumed by sperm whales. For these reasons, sperm whales remained as a research target in JARPN II research plan (Government of Japan, 2004a, 2004b).

At the expert review panel workshop in 2009, the proponents presented a preliminary assessment that neon flying squids accounted for 30,000 tons of the sperm whales' total consumption of 1.2 million tons. They suggested that this result, taking into consideration a large biomass of sperm whales in the research area, indicates sperm whales have a huge impact on pelagic ecosystem. They also presented the results of pollution in this species such as mercury and PCB and suggested that sperm whales are important as a target species for monitoring pollutants. Although the review panels expressed a concern about an insufficient number of samples and their representativeness of the whole population (IWC, 2010a), the proponents kept sperm whales as a research target because a continuous collection of samples was an important factor in the research (IWC, 2010b).

From a recent consumption analysis, however, little knowledge has been added about the consumption of neon flying squid by sperm whales since 2009. Also, analysis shows that sperm whales have a strong predator-prey interaction with deep-sea squids which are not a fishery target, rather than with species in the pelagic ecosystem (Tamura *et al*., 2009, 2012; Bando *et al*., 2010, 2013, 2014; Yasunaga *et al*., 2011). For these reasons, sperm whales were regarded as a lower priority species and therefore excluded from the target species.

Sampling of minke whale（Offshore component）

Common minke whales in the offshore component have been a target since JARPN and the species is still important for studies on ecosystem modeling and stock structure. However, the number of sightings of this species has been decreasing recently, indicating that its distribution in the western North Pacific is changing over time (Matsuoka *et al*., 2012, 2013; Kanaji *et al*., 2012). Past research revealed that this species mainly consumes anchovy earlier in the research period (May-June) and Pacific saury later in the period (July-September) offshore (Konishi *et al*., 2009), but both of the prey species are known to recently be distributed less within the research area. For example, while the stock of anchovy was estimated 1-2 million tons in 2003, its stock was estimated 630 thousand tons in 2013. Distribution of anchovy is getting limited, which could have been reflected by the drastic decrease in the stock estimates（http://www.jfa.maff.go.jp/j/press/sigen/pdf/141222-03.pdf: in Japanese）. Similarly, while the stock of Pacific saury was estimated to be 5 million tons in 2003, its stock was only estimated at 1.8 million tons in 2013. In particular, a decrease was reported to be obvious in the area west of 170E（http://www.jfa.maff.go.jp/j/press/sigen/pdf/140731-01.pdf: in Japanese）. Thus the decrease in number of sightings and the limited distribution of prey species can change the distribution of minke whales offshore in the western North Pacific. A possible explanation is that a large-scale change in the marine ecosystem such as a regime shift drives these changes. However, because the main reasons are still unknown, we decided to suspend the sampling of this species and reconsider how this species should be treated in the future research program rather than continuing lethal take of this species in the offshore area.

Sampling of minke whale（Coastal component- Sanriku and Kushiro）

Minke whales in the costal component remained as a target because a competition for prey between coastal fisheries and this species has been strongly indicated from the past research (IWC 2010a). Sample size for Sanriku component was recalculated focusing on the main prey species (juvenile sand lance), using a preliminary data set (up to and including 2010), i.e. we calculated sample sizes necessary to detect stomach content with an accuracy of CV=0.2. The result of re-calculation varied from 29 to 78 samples depending on the year the data was obtained. We employed an average of those numbers 57 samples as a targeted sample size. Of the 57 samples, six samples (10% of the

original sample size) were allocated to the feasibility evaluation of non-lethal methods. This allocation was based on the logic stated above in section 2. Ten percent was selected by the government as a practical target.
Sample size for Kushiro component was recalculated focusing on the main prey species (Japanese anchovy and walleye pollock), using a preliminary data set (up to and including 2010), i.e. we calculated sample sizes necessary to detect stomach content with an accuracy of CV=0.2. The result of re-calculation varied from 27 to 109 samples depending on the year the data was obtained. We employed an average of those numbers 57 samples as a targeted sample size. Of the 57 samples, six samples (10% of the original sample size) were allocated to non-lethal methods. This allocation was based on the logic stated above in section 2. Ten percent was selected by the government as a practical target.

Sampling of sei whale (Offshore component)
Sei whales remained as a target because the past studies revealed that this species is dominant in the research area and plays an important role in the pelagic marine ecosystem of the western North Pacific. Sample size for this species was recalculated, using a preliminary data set (up to and including 2012) with a focus on prey species in the stomach content. Prey species in the stomach were diverse, such as copepods, krill, Japanese anchovy, and mackerel. The result of re-calculation varied from 69 to 215 samples depending on the year the data was obtained. We calculated an average of those numbers to be 135 samples.
The sample sizes were, however, maintained at 100 since recalculation for those species showed the need for substantial increases of sample sizes. Such increases were considered to be regarded as revisions of the program and therefore should be examined after the due process including review of results that is planned in 2016 for the 2nd period of JARPN II (2008-2013).
Of the 100 samples, 10 samples (10% of the original sample size) were allocated to non-lethal methods. This allocation was based on the logic stated above in section 2. Ten percent was selected by the government as a practical target.

Sampling of Bryde's whale (Offshore component)
Bryde's whales remained as a target for the same reason as sei whales. Sample size for this species was recalculated, using a preliminary data set (up to and including 2012) with a focus on main prey species (krill and Japanese anchovy) in the stomach content. The result of re-calculation varied from 36 to 148 samples depending on the year the data was obtained. We calculated an average of those numbers to be 75 samples. However, the original sample size was maintained (i.e. 50 samples) for Bryde's whales for the same reason as sei whales. Of the 50 samples, 25 samples (50% of the original sample size) were allocated to non-lethal methods. A priority was placed on one of the research objectives, prey consumption and preference. We have a higher level of interests in building ecosystem models covering the interactions between whales, i.e. minke whales and sei whales, and coastal fisheries. Therefore 50 percent of the sample size was allocated to non-lethal samples of Bryde's whales.

3. Conclusion
The main purpose of the adjustments in sample sizes and their allocations to lethal and non-lethal methods is to provide a more detailed and updated basis for calculating sample sizes and to conduct comparative studies between lethal and non-lethal research methods in response to the ICJ Judgment. For this purpose, a priority was placed on one of the research objectives, prey consumption and preference, under JARPN II during 2014-2016. If non-lethal methods can't produce comparable scientific information to that from lethal methods, the achievement of the JARPN II research objectives will be compromized. The results of the 2014-2016 research program will be duly utilized for the establishment of the new research plan.

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Appendix 1. The method of calculation of sample size

To calculate necessary sample size of minke whale, Bryde's and sei whale, we used the data of the stomach contents from JARPN II survey and the following formulas (The Government of Norway, 1992).

Consider I types of prey indexed i = 1,…, I ; J sampling seasons indexed j = 1,…, J.
Set n ($n = n_1 + \ldots + n_j$) for the total sample size of a year.
To focus on a particular period, let for a randomly sampled whale:
X = amount of food in forestomach
T = a type of food
For simplicity, we assume that no forestomach contents is mixed type, so that T is a single species:

(1) $$P(T = i) = P_i ; i = 1, \ldots . I$$

Then, from the amount of forestomach contents, we calculate the mean and the variance:

(2) $$E(X|T = i) = \mu_i$$

(3) $$Var(X|T = i) = \sigma_i^2$$

If n numbers of whales are sampled in the season, N_i of these will have prey type i in their forestomachs. Let the quantities be $X_{i1},\ldots, X_{iNi}$, then μ_i and σ_i are estimated:

(4) $$\hat{P}_i = N_i / n$$

(5) $$\hat{\mu}_i = 1 / N_i \sum_{K=1}^{Ni} X_{ik}$$

Then, the estimated mean amount of prey type i in forestomach of a random whale is

(6) $$\hat{P}_i \hat{\mu}_i = 1 / n \sum_{K=1}^{Ni} X_{ik}$$

If W numbers of whales are in the area over the season, the estimated consumption of prey type i is

(7) $$\overline{C}_i = W \hat{P}_i \hat{\mu}_i$$

For simplicity, we disregard uncertainly in W. Then, the mean and variance of C_i is

(8) $$E(\overline{C}_i) = W P_i \mu_i$$

(9) $$Var(\overline{C}_i) = W^2 \frac{1}{n} P_i (\sigma_i^2 + (1 - P_i)\mu_i^2)$$

Similarly, the estimated total consumption of prey type i in season j is

(10) $$\overline{C}_{ij} = W_j \hat{P}_{ij} \hat{\mu}_{ij}$$

The total consumption of prey type i over all sampling seasons is

(11) $$T\hat{C}_i = \sum_J \overline{C}_{ij}$$

By independence between feeding seasons of minke whales, the mean and variance of TC_i is

$$E(\hat{TC}_i) = \sum_{j=1}^{J} W_j P_{ij} \mu_{ij} \quad (12)$$

$$Var(\hat{TC}_i) = \sum_{j=1}^{J} W_j^2 \frac{1}{n_j} P_{ij}(\sigma_{ij}^2 + (1 - P_{ij})\mu_{ij}^2) \quad (13)$$

Therefore, the coefficient of variance of TC_i is

$$c.v.^2(\hat{TC}_i) = \frac{1}{n}[\sum_{j=1}^{J} \Pi_j^{-1} W_j^2 P_{ij}(\sigma_{ij}^2 + (1 - P_{ij})\mu_{ij}^2)][\sum_{j=1}^{J} W_j P_{ij} \mu_{ij}]^{-2} \quad (14)$$

$$= \frac{1}{n} C_i^2$$

where

$$\Pi_j = W_j / \sum_{j=1}^{J} W_k \quad (15)$$

$$W_j = W_j \sqrt{\sum_{i=1}^{I} P_{ij}(\sigma_{ij}^2 + (1 - P_{ij})\mu_{ij}^2)} \quad (16)$$

To determine n, the criterion is to choose n as small as possible.

(17) $n \geqq c_i^2 / \alpha^2 \quad i = 1,\ldots,I$

A value of

$\alpha = 0.2$

It seems to be a reasonable choice to achieve a level of precision appropriate for inputs to some ecosystem models so that they provide reliable results.

Sample size n is determined by solving inequality (17), then the way to allocate n to sampling seasons so as to minimize the variance of TC_i is determined and n_j's are

(18) $n_j = n\Pi_j \quad (j=1,\ldots,J)$

Appendix 2. The results of re-calculation of sample size (C.V.=0.2)

Year	Offshore				Coastal			
	Bryde's		Sei		Minke (Sanriku)		Minke (Kushiro)	
	Dominant prey	Re-calculation of sample size	Dominant prey	Re-calculation of sample size	Dominant prey	Re-calculation of sample size	Dominant prey	Re-calculation of sample size
2000	Anchovy	36	-	-	-	-	-	-
2001	Krill	47	-	-	-	-	-	-
2002	Anchovy	39	Krill	210	-	-	Anchovy	58
2003	Krill	104	Copepods	85	Sand lance	77	-	-
2004	Anchovy	39	Anchovy	121	-	-	Anchovy	34
2005	Krill	66	Krill	69	Sand lance	29	Anchovy	54
2006	Krill	91	Anchovy	215	Sand lance	42	Anchovy	51
2007	Anchovy	64	Copepods	73	Sand lance	78	Walleye pollock	109
2008	Anchovy	148	Anchovy	76	Sand lance	43	Anchovy	52
2009	Anchovy	86	Anchovy	187	Sand lance	59	Krill	73
2010	Anchovy	71	Copepods	135	Sand lance	72	Walleye pollock	27
2011	Krill	41	Copepods	176				
2012	Anchovy	138	Copepods	142				
Avg.		75		135		57		57