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An overview of the research programs on large whales conducted by the Institute of Cetacean Research

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ABSTRACT

This paper summarizes the research programs and related activities conducted by scientists of the Institute of Cetacean Research (ICR). ICR conducts biological and ecological research of whales and their ecosystem through different research programs: special permit scientific programs involving lethal and non-lethal techniques; dedicated sighting survey programs; DNA register for large whales and market molecular monitoring programs; and cetacean stranding record programs. This paper summarizes those research programs, including their objectives and methodologies. Outputs of specific studies based on data collected will be published in the annual series of the Technical Reports of ICR (TEREP-ICR).

INTRODUCTION

The Institute of Cetacean Research (ICR) was founded in 1987 as a foundational juridical person whose legal status is authorized by the Minister of Agriculture, Forestry and Fisheries of the Government of Japan. ICR has the purpose of contributing to the appropriate management and utilization of marine resources by conducting research on marine mammals centered on whales, and investigations of the international situation concerning large whales.

The Survey and Research Division of ICR is in charge of the biological and ecological research of whales and their ecosystem. The division has well-equipped laboratories to study whale biology, environmental pollutants and molecular ecology, and includes a number of national and international scientists, who conduct specific studies in the context of the objectives of the research programs conducted by the institute.

Outputs of the research are available in a substantial number of peer-reviewed publications and scientific documents presented to national and international meetings, mainly to meetings of scientific committees of international organizations in charge of the conservation and management of marine resources including large whales, for example working groups of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) and the Scientific Committee (SC) of the International Whaling Commission (IWC).

The Technical Reports of the ICR (TEREP-ICR) will publish outputs of specific studies conducted by ICR scientists. As an introduction to such outputs, this paper summarizes the research programs conducted by the institute, including their objectives and methodologies.

RESEARCH PROGRAMS

Special permit scientific research

ICR has been in charge of implementing some special permit research programs under Article VIII of the International Convention for the Regulation of Whaling (ICRW). These research programs involve both lethal and non-lethal components. Among the former component, a limited number of whales have been taken. The research plans have been presented and commented on by the IWC SC, and data and results obtained have been reviewed by workshops of specialists sponsored by the IWC SC and by the IWC SC itself.

Antarctic

The first program was the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA), which was conducted between the austral summer seasons of 1987/88 and 2004/05. The JARPA had four main objectives: a) estimation of biological parameters to improve the stock management of the Southern Hemisphere minke whale; b) elucidation of the role of whales in the Antarctic marine ecosystem; c) elucidation of the effect of environmental changes on cetaceans; and d) elucidation of the stock structure of Southern Hemisphere minke whales to improve stock management. The second phase of JARPA, JARPAII, started with two feasibility surveys in

the seasons 2005/06 and 2006/07. The first full survey started in the 2007/08 season. The objectives of the JARPAII were the following: a) monitoring the Antarctic ecosystem (whale abundance trends and biological parameters; krill abundance and the feeding ecology of whales; effects of contaminants on cetaceans; and cetacean habitat); b) modeling competition among whale species and future management objectives (constructing a model of competition among whale species; and new management objectives including the restoration of the cetacean ecosystem); c) elucidation of temporal and spatial changes in stock structure; and d) improving the management procedure for Antarctic minke whale stocks. See details of the objectives, methodology and outputs from JARPAII in Pastene *et al*. (2014).

The current New Scientific Whale Research Program in the Antarctic Ocean (NEWREP-A), started in the austral summer season 2015/16 as a 12-year long research program. NEWREP-A has two main objectives: a) improvement in the precision of biological and ecological information for the application of the Revised Management Procedure (RMP) to the Antarctic minke whales; and b) investigation of the structure and dynamics of the Antarctic marine ecosystem through building ecosystem models. In order to attain the first objective, four sub-objectives were set: (i) abundance estimates for Antarctic minke whales taking into account of $g(0)$ and additional variance; (ii) improvement of precision of biological and ecological parameters; (iii) refinement of stock structure hypotheses of Antarctic minke whale in Areas III–VI for the implementation of the RMP; and (iv) specification of RMP *Implementation Simulation Trials* (*ISTs*) for the Antarctic minke whales (GOJ, 2015). In order to attain the second objective, four sub-objectives were set: (i) ecological research (krill abundance estimate and oceanographic observation); (ii) abundance estimate of some cetacean species as input data for ecosystem modelling; (iii) estimation of prey consumption by the Antarctic minke whale and its nutritional condition; (iv) ecosystem modelling (spatial interaction among baleen whales and consideration of predators-prey system and allometric reasoning). See details of the objectives and methodology of NEWREP-A in GOJ (2015).

An outline of the research area, survey methodology and data being obtained by NEWREP-A are given below.

Research area

The research area of NEWREP-A is shown in Figure 1. The research area comprises the Indian and western South Pacific regions of the Antarctic, which involves IWC Management Areas III, IV, V and VI.

Research activities in the field based on lethal techniques

The lethal part of NEWREP-A involves the sampling of a limited number of Antarctic minke whales (n=333 whales annually).

Sampling methodology

Track-lines for sighting and sampling of Antarctic minke whales are generally designed south of 60°S. Survey courses are established in offshore and ice edge waters of the research area by the line transect method. Two or three sampling and sighting vessels advance along parallel track-lines 7n. miles apart, at a standard speed of 11.5 knots. Basically, each of the sampling and sighting vessels change the track-line order every day to avoid possible sighting bias produced by fixed positions. The starting point each day is set at the most advanced position where one of the vessels ended the surveys on the previous day. A maximum of two Antarctic minke whales per school sighted is sampled randomly.

All whales are taken using explosive grenades to attain instantaneous death in line with existing norms of whale killing methods. If instantaneous death is not achieved by the primary killing method, a suitable secondary method, such as a large caliber rifle or another grenade is chosen,

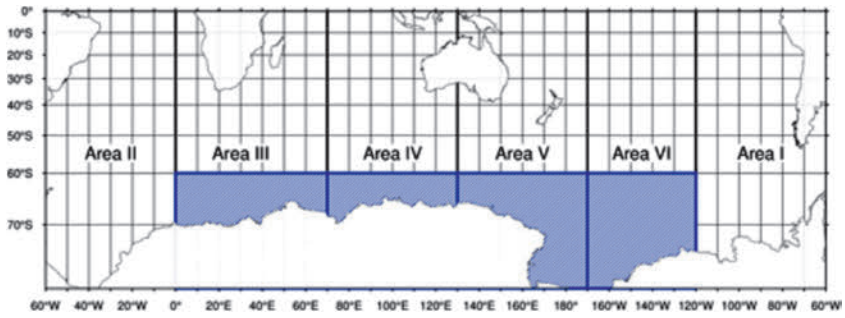

Figure 1. Research area of NEWREP-A.

Figure 2. Biological survey of Antarctic minke whale under the NEWREP-A.

depending on the condition of the whale.

Biological surveys

Sampled whales are immediately transported to the research base vessel, where biological measurements and sampling are carried out in a systematic manner by researchers (Figure 2). The following main data/samples are obtained on board for each whale sampled (see also Table 1). Samples and data collected are required for the analyses related to the main objectives and sub-objectives of NEWREP-A.

1. Morphometrics for studies on stock structure.
2. Body weight, blubber thickness and total fat weight measurements for nutritional studies.
3. Reproductive organs (testis and ovaries) for determination of sexual maturity.
4. Earplugs for age determination.
5. Stomach contents (qualitative and quantitative) for studies on feeding ecology.
6. Other biological samples such as ocular lenses for age determination and tissues for genetic studies on stock structure.

Research activities in the field based on non-lethal techniques

Dedicated sighting surveys

Data collected by these surveys are required for the abundance estimation of whales. Sighting surveys are conducted by the Line Transect Method. Survey protocols follow the IWC SC's Requirements and Guidelines for Conducting Surveys and Analyzing Data within the Revised Management Scheme (IWC, 2012) and are conducted under the oversight of the IWC SC. Sighting protocols are the same as those in the former International Decade for Cetacean Research/Southern Ocean Whale and Ecosystem Research (IDCR/SOWER) (Matsuoka *et al*., 2003).

In general, the sighting surveys cover areas south of 60°S. Surveys are planned to cover one IWC Management Area (one of the Areas III to VI) in a year. Cruise tracks are designed systematically in accordance with mathematical and scientific calculation in the research area. The sighting survey is conducted using (1) Closing mode and (2) Passing with Independent Observer mode. Both survey modes follow the protocol already endorsed for the IDCR/SOWER surveys. Primary search effort is conducted only when weather conditions are acceptable (see details in Matsuoka *et al*., 2003) (Figure 3).

Biopsy and photo-ID (Figures 4 and 5)

Biopsy and photo-ID experiments are conducted routinely for large whales such as blue, fin, humpback, southern right and killer whales. Feasibility studies of biopsy sampling and telemetry for Antarctic minke whales are also conducted. Photo-ID and DNA data obtained from biopsy samples are useful for studies of distribution, movement and stock structure of whales.

Figure 3. Sighting activity by the dedicated sighting vessels.

Figure 4. Humpback whale biopsy sampling by the dedicated sighting vessel.

Krill survey (Figure 6)

The main objective of the krill surveys is to estimate the relative abundance of Antarctic krill acoustically, and to obtain the length frequency distribution and maturity stage of Antarctic krill in the survey area. Information on krill distribution and abundance is important as input data for the development of ecosystem modelling. Acoustic data using quantitative echosounders EK80 and EK60 are recorded continuously. Net samplings using a small ring net and an Isaacs-Kidd Midwater Trawl (IKMT) are carried out to identify species and size compositions of plankton echo signs. See details in GOJ (2015).

Oceanographic observations (Figure 7)

The conductivity-temperature-depth profilers (CTD) are used to obtain water temperature and salinity data. Oceanographic data are important to understand the physical environment in which whales live. Changes in oceanographic conditions determine the distribution of krill, which is the main prey species of large baleen whales.

Marine debris (Figure 8)

The observation and collection of debris, both in the environment and in the stomachs of the whales sampled provide valuable information on the surrounding environment of whales. Such information is collected systematically during the sampling and sighting surveys.

Data and analyses

Table 1 shows the kinds of data and samples being collected by NEWREP-A. These data are analyzed in the context of the objectives and sub-objectives of the program, with some of the analyses of temporal trends incorporating data from the previous research programs JARPA and JARPAII (see details of the data and samples collected by JARPA and JARPAII in IWC, 2008 and IWC, 2015, respectively).

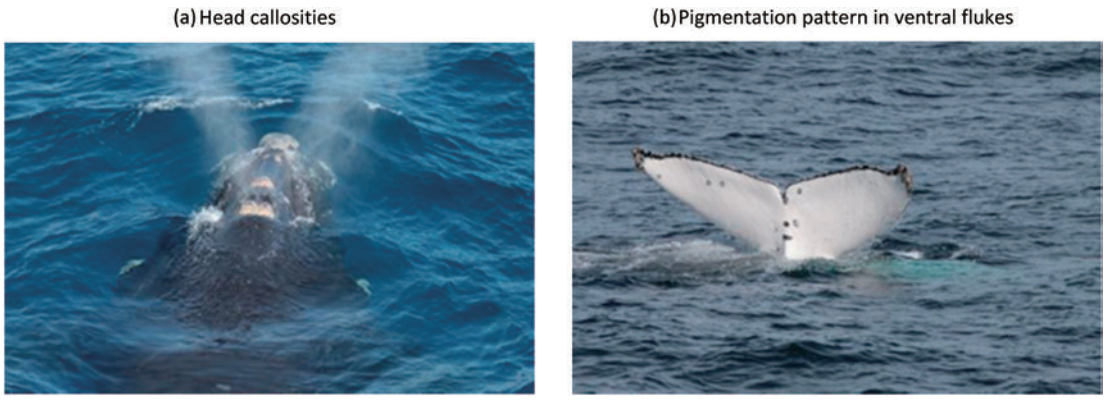

Figure 5. Morphological characteristics used for individual identification in southern right (a) and humpback (b) whales.

Figure 6. Small ring net (left) and an Isaacs-Kidd Midwater Trawl (IKMT) net (right).

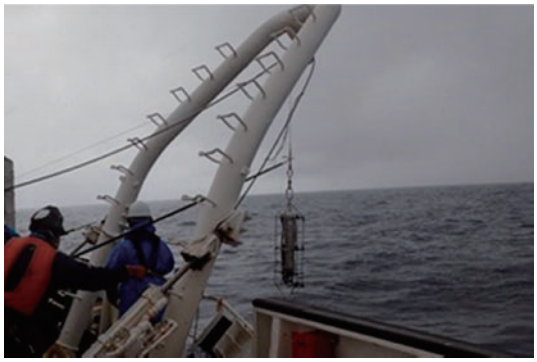

Figure 7. Oceanographic survey by CTD.

Figure 8. Rope found in the stomach contents of an Antarctic minke whale.

Research outputs

As in the cases of JARPA and JARPAII, the scientific outputs from NEWREP-A will be summarized as a) scientific reports to be presented to international meetings, mainly to the IWC SC meetings; and b) as peer-reviewed publications. In the case of the previous JARPA, results were presented to the IWC SC review workshops conducted in 1997 (mid-term review) (IWC, 1998) and 2006 (final review) (IWC, 2008). The results of the JARPAII were presented to the IWC SC review workshops conducted in 2014 (IWC, 2015). Peer-reviewed publications based on JARPA and JARPAII are presented in this issue of TEREP-ICR.

Western North Pacific

The first program was the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN), which was conducted in the spring-autumn seasons between 1994 and 1999. The main objective was to elucidate the stock structure of common minke whales in the Pacific side of Japan. A second objective, 'the feasibility study on the feeding ecology of minke whales in the research ground,' was added in 1996. The second phase of JARPN, JARPNII, started with two feasibility surveys in 2000 and 2001. The first full survey started in 2002. The objectives of the JARPNII were the following: a) feeding ecology and ecosystem studies; b) monitoring environmental pollutants in cetaceans and the marine ecosystem; and c) stock structure of large whales. See details of the objectives, methodologies and outputs from JARPNII in Tamura *et al.* (2016).

The current New Scientific Whale Research Program in the western North Pacific (NEWREP-NP) started in 2017 as a 12-year long research program. NEWREP-NP has two main objectives: a) contribution to optimizing the establishment of a sustainable catch limit for common minke whales in the coastal waters of Japan; and b) contribution to the RMP/IST for North Pacific sei whales. In order to attain the first objective, four secondary objectives are set: (i) investigate the spatial and temporal occurrence of J stock common minke whales around Japan, by sex, age and reproductive status; (ii) estimate the abundance of the J and O stocks in coastal waters of Japan; (iii) verify that there is no structure in the O stock common minke whales in the Pacific side of Japan; and (iv) improve RMP trials by incorporating age data in their conditioning. In order to attain the second objective, four secondary objectives are set: (i) abundance estimates for North Pacific sei whales taking account additional variance; (ii) estimation of biological and ecological parameters in North Pacific sei whales for RMP *Implementation*; (iii) study of the pattern of movement of whales of the 'pelagic stock' within the feeding grounds and between feeding and

Table 1
Data and samples collected under the NEWREP-A (from GOJ, 2015).

Data	Sample
Abundance estimate	
*# Weather data	
*# Effort data	
*# Sighting record of whales	
*# Angle and distance experiments	
*# Ice edge line	
Environmental data	
# Temp. Salin. (CTD)	
# Echo sound (krill distribution/abundance)	
Marine debris (sea surface)	
Antarctic minke whale	
*# Catching date and location	# Prey species in stomach for feeding ecology
Photographic record of external character	# Feces and colon contents for feeding ecology
Record of internal and external parasites	*# Testis for reproductive study
*# Sex and body length	*# Ovary for corpora counting and reproductive study
* Body proportion for stock structure	Mammary grand and endometrium for reproductive study
* Skull measurements (length and breadth) for stock structure	*# Earplug for age determination
* Satellite tracking for stock structure	*# Ocular lens for age determination
# Body weight for feeding ecology	*# Baleen plates for age determination
# Organ weight including fat weight for feeding ecology	*# Tissue samples for genetic study
# Diatom film record for feeding ecology	*# Tissue and organ samples for chemical study
# Blubber thickness for feeding ecology	# Tissue and plasma samples for physiological study
# Stomach content : freshness and weight for feeding ecology	Vertebral epiphyses for physical maturity
# Diving behaviour for feeding ecology	
*# Testis weight for reproductive study	
Mammary grand : lactation status and measurement for reproductive study	
Fetal number, sex, length and weight for reproductive study	
Marine debris (stomach)	
Gross pathological observation and sampling	
Other large whales	
Photo-ID	Skin sample (biopsy)

*: Data or samples to be used for Main Objective I; # : Data or samples to be used for Main Objective II (other items will be used for other research purposes)

breeding grounds; and (iv) specification of RMP *ISTs* for North Pacific sei whales. See details of the objectives and methodology of NEWREP-NP in GOJ (2017).

An outline of the research area, survey methodologies and data being obtained by NEWREP-NP are given below.

Research area

The research area of NEWREP-NP is shown in Figures 9a and 9b. The research area for lethal sampling comprises the Pacific side and the Okhotsk Sea side of Japan, which involves IWC Management Sub-areas 7, 8, 9 and 11 (Figure 10). The research area for the sighting surveys comprises the Pacific side, the Sea of Japan side and the Okhotsk Sea side of Japan, which involves IWC Management Sub-areas 6, 7, 8, 9, 10 and 11.

Research activities in the field based on lethal techniques

The lethal part involves the sampling of a limited number of common minke whales (n=80 whales annually in sub areas 7CS and 7CN; n=47 whales annually in sub area 11; and n=43 whales annually in sub areas 7WR, 7E, 8 and 9), and of sei whales (n=134 whales annually in sub areas 7WR, 7E, 8 and 9).

Sampling methodology (offshore component)

Survey courses are established in the research area by the Line Transect Method. Two sampling and sighting vessels advance along parallel track-lines 7n. miles apart, at a standard speed of 10.5 knots. All common minke and sei whales sighted as primary and secondary sightings, excluding cow and calf pairs, are targeted for sampling. When a sighting consists of more than one animal, the first targeted animal is selected using tables of random sampling numbers (TRS).

All whales are taken using explosive grenades to attain instantaneous death in line with existing norms of whale killing methods. If instantaneous death is not achieved by the primary killing method, a suitable secondary method, such as a large caliber rifle or another grenade is chosen, depending on the condition of the whale.

Sampling methodology (coastal component)

A land-based operation system which takes into account operational capacity, ability, and arrangements of the small boats is applied, and thus is different from the sampling procedures adopted by the offshore component. A predetermined course (direction from the port) at an angle of regular intervals (usually 10–15 degree intervals) is set up by the head office, and allocated to the respective boats. The boats depart the port with their respective course, and start searching at a survey speed of 10–11 knots. All common minke whales sighted as primary and secondary sightings, excluding cow and calf pairs, are targeted for sampling. When a sighting consists of more than one animal, the first targeted animal is selected using tables of random sampling numbers (TRS). All whales are taken using explosive grenades to attain instantaneous death in line with existing norms of whale killing methods. If instantaneous death is not achieved by the primary killing method, another grenade is chosen as a suitable secondary method.

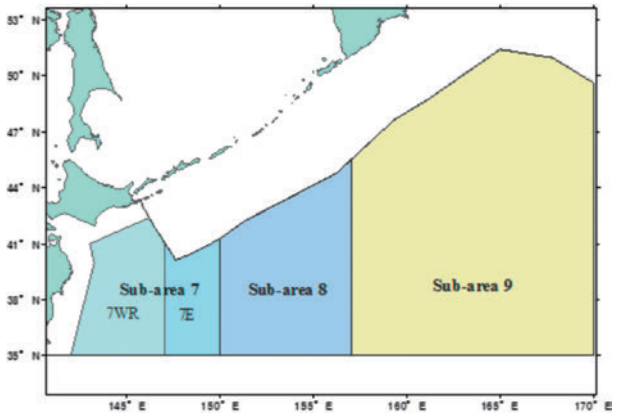

Figure 9a. Research area of NEWREP-NP for lethal sampling (offshore component).

Biological surveys

Sampled whales are immediately transported to the research base vessel (offshore component) or land base (coastal component), where biological measurements and sampling are carried out in a systematic manner by researchers (Figure 11). The kind of data and biological sampling is similar to those in NEWREP-A.

Research activities in the field based on non-lethal techniques

Dedicated sighting surveys

Sighting surveys are conducted by the Line Transect Method and the survey protocols are the same as in the Antarctic dedicated sighting surveys.

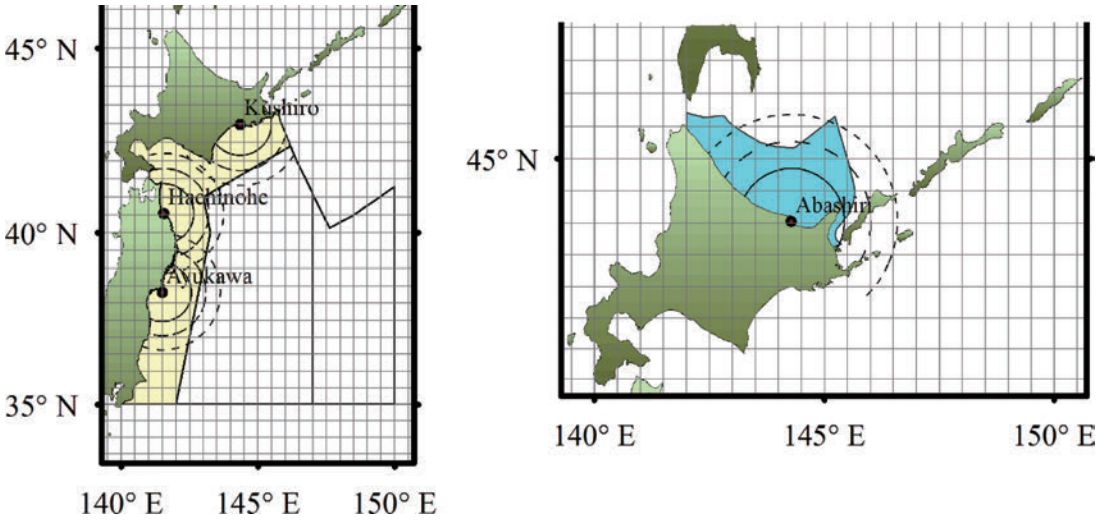

Figure 9b. Research area of NEWREP-NP for lethal sampling (coastal component).

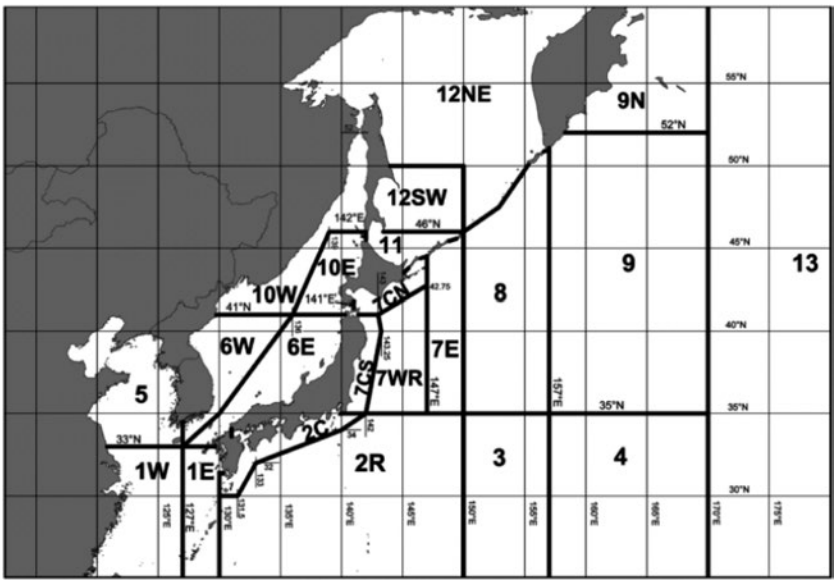

Figure 10. Sub-areas to be covered by the dedicated sighting surveys under the NEWREP-NP (Sub-areas 6E, 10E, 11, 7CS, 7CN, 7WR, 7E, 8 and 9).

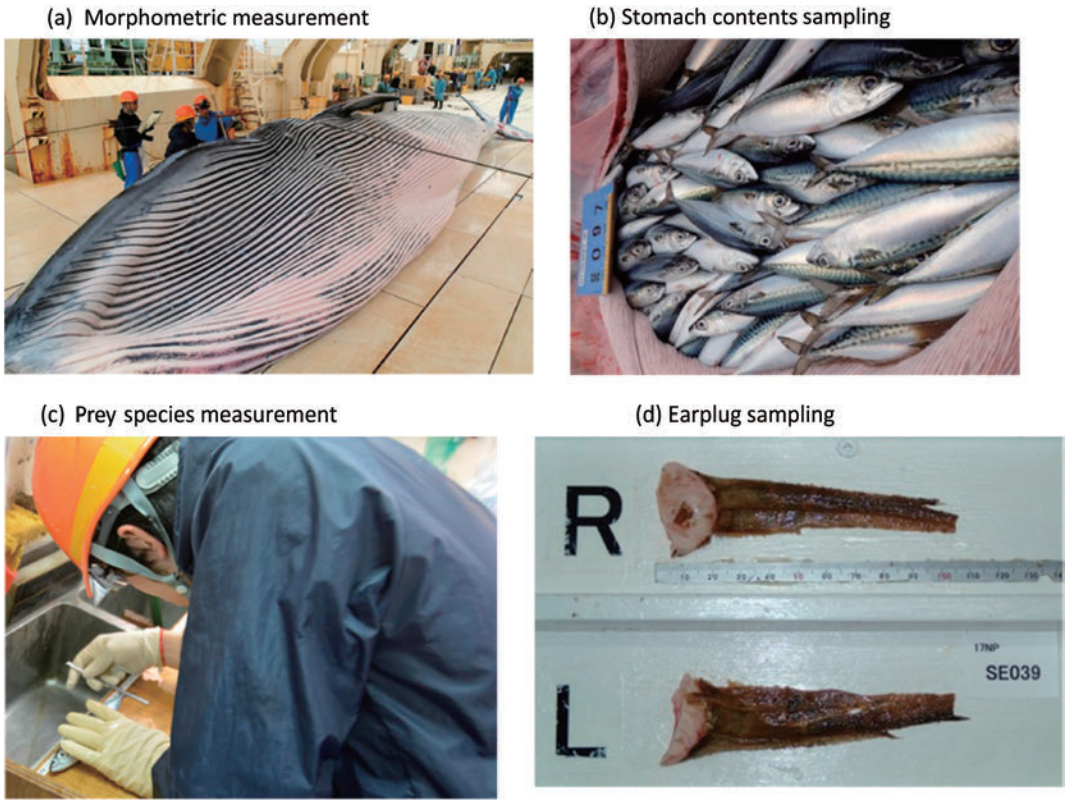

Figure 11. Biological surveys of sei whales under the NEWREP-NP.

Provided that two dedicated sighting vessels are available, surveys are planned to cover sub-areas 7, 8 and 9 in summer once in three years. Sub-areas 6E, 10E and 11 would be surveyed once in the other three years (Figure 10).

Biopsy and photo-ID

Biopsy and photo-ID experiments are conducted routinely for large whales such as blue, fin, humpback, North Pacific right, gray and killer whales. Feasibility studies of biopsy sampling for common minke whales are also conducted. As in the Antarctic, photo-ID and DNA data obtained from biopsy samples are useful for studies of distribution, movement and stock structure of these whales (Figure 12).

Figure 12. Biopsy sampling of a sei whale under the NEWREP-NP.

Figure 13. Satellite tagging of sei whales under the NEWREP-NP.

Satellite tagging

Satellite tagging experiments are conducted for common minke and sei whales to elucidate movement within the feeding grounds and the location of breeding grounds (Figure 13).

Oceanographic observations

In the offshore component of NEWREP-NP, oceanographic conditions are investigated using data collected by ocean circulation models such as FRA-ROMS (Okazaki *et al*., 2016). In the Sanriku region, the oceanographic surveys are conducted using a trawler-type R/V, '*Miyashio*' (199 GT) by the Miyagi Prefecture Fisheries Technology Institute. Vertical oceanographic observations are conducted using CTD. Subsurface (approximately 5 m water depth) temperature, salinity and chlorophyll-*a* index are recorded every minute along the track-lines.

Marine debris

As noted above, the observation and collection of debris, both in the environment and in the stomachs of the whales sampled, provide valuable information on the surrounding environment of whales. Such information is collected systematically during the sampling and sighting surveys of NEWREP-NP (Figure 14).

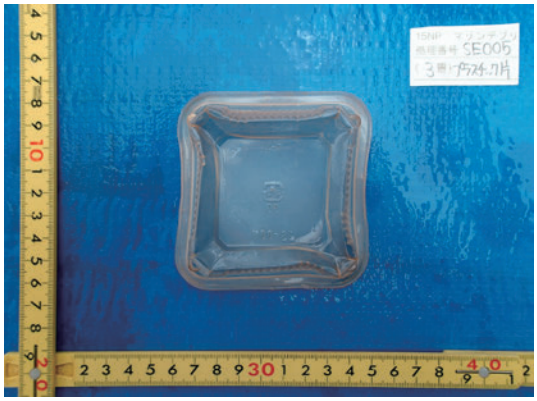

Figure 14. Plastic bowl found in the stomach of a sei whale.

Data and analyses

Table 2 shows the kinds of data and samples being collected by NEWREP-NP. These data are analyzed in the context of the objectives and sub-objectives of the program, with some of the analyses on temporal trends incorporating data from the previous research programs JARPN and JARPNII (see details of the data and samples collected by JARPN and JARPNII in IWC, 2001 and IWC, 2016a, respectively).

Research outputs

As in the cases of JARPN and JARPNII, the scientific output from NEWREP-NP is summarized as a) scientific reports to be presented to international meetings, mainly to the IWC SC meetings; and b) as peer-reviewed publications. The results of the JARPN were presented to the IWC SC review workshop conducted in 1999 (IWC, 2001). In the case of the JARPNII, results were presented to the IWC SC review workshops conducted in 2009 (mid-term review) (IWC, 2010) and 2016 (final review) (IWC, 2016a). Peer-reviewed publications based on JARPN and JARPNII are presented in this issue of TEREP-ICR.

International dedicated sighting surveys

One example of international sighting surveys in which ICR scientists participate is the IWC-Pacific Ocean Whale and Ecosystem Research (POWER) program. The IWC-POWER program is an international effort coordinated by the IWC and designed by the IWC SC with special partnership of the Japanese Government. The vessel is provided by the Government of Japan. The IWC-POWER surveys in the North Pacific follow the series of IWC IDCR/SOWER surveys that were conducted in the Antarctic since 1978. The IWC POWER program has the following main objectives: (a) provide information for the proposed future *in-depth assessment* of sei whales in terms of both abundance and stock structure; (b) provide information relevant to the

Table 2
Data and samples collected under NEWREP-NP, by research objective (from GOJ, 2017).

Data		Sample	
Abundance estimate			
1,2,3	Weather data		
1,2,3	Effort data		
1,2,3	Sighting record of whales		
1,2,3	Angle and distance experiments		
Common minke whale/sei whale			
1,2,3,4	Catching date and location	1,2,3,4	Testis
1	Photographic record of external character	1,2,3,4	Ovary
1,2,3,4	Sex and body length	1,2,4	Earplug
1,2,3	Satellite tracking	1,2,4	Ocular lens
3,4	Body weight	1,2,3,4	Baleen plates
3,4	Blubber thickness and nutrition condition	1,2,4	Tissue samples for genetic study (including fetus)
3,4	Stomach content: freshness and weight	1,2,3,4	Tissue and organ samples for chemical study
1,2,3,4	Testis weight	4	Tissue and plasma samples for physiological study
1,2	Fetal number, sex, length and weight	3,4	Prey species in stomach
4	Marine debris (in stomach)		
Other large whales			
5	Photo ID	3,5	Skin sample (biopsy)

[1]: Data or samples to be used for Primary Objective I. [2]: Data or samples to be used for Primary Objective II. [3]: Data or samples to be used for Ancillary Objective I. [4]: Data or samples to be used for Ancillary Objective II. [5]: Data or samples to be used for Ancillary Objective III

Implementation Reviews of whales in terms of both abundance and stock structure; (c) provide baseline information on distribution and abundance for a poorly known area for several large whale species/populations (including those that were known to have been depleted in the past, but whose status is unclear); (d) provide biopsy samples and photo-identification data to contribute to discussions of stock structure for several large whale species/populations and (e) provide essential information for the intersessional workshop to plan for a medium to long term international research programme in the North Pacific (IWC, 2016b).

Research area

The research area was set north of 20°N, south of the Aleutian Islands, between 170°E and 135°W in the period 2010–2016 (Figure 15). The research area for the 2017–19 period and agreed by the IWC SC is shown in Figure 16.

Research activities

Dedicated sighting surveys

Survey methodology is similar to that described above for the dedicated sighting surveys in the Antarctic.

Other surveys

Photo-ID and biopsy experiments are conducted for North Pacific right, blue, fin, sei, Bryde's, gray, humpback, sperm and killer whales. Marine debris information is collected systematically. Acoustic studies using sonobuoys

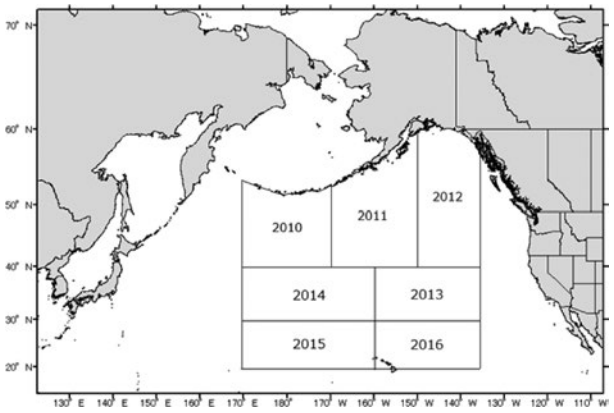

Figure 15. Research area of the IWC POWER program in 2010–2016.

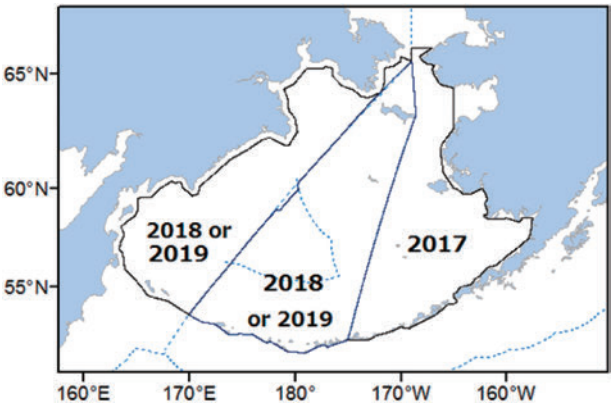

Figure 16. Research area of the IWC POWER program in 2017–2019.

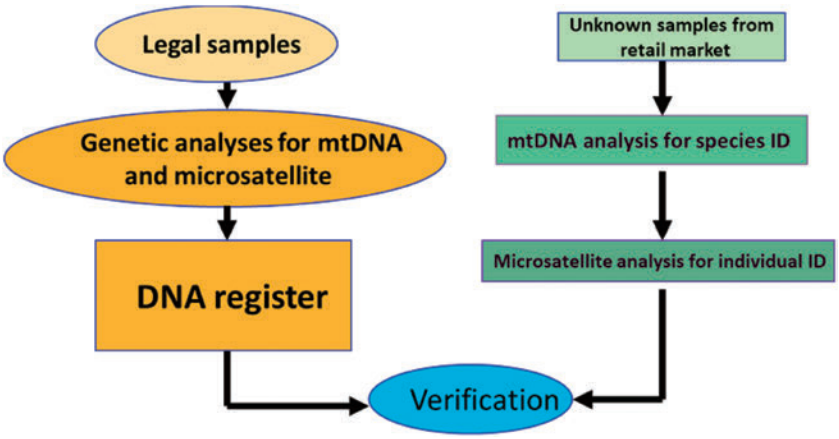

Figure 17. Flow chart of the DNA monitoring system for regulation of whale products in the market in Japan.

have also been conducted since 2017.

Data and analyses

The data and samples collected are analyzed in the context of the objectives of the program (see details of the data and samples collected by IWC-POWER in Matsuoka *et al.*, 2011, 2012, 2013, 2014, 2015, 2016 and 2017). Results of analyses are presented to the annual meetings of the IWC SC and/or published in peer-reviewed journals (e.g. Kanda *et al.*, 2013; 2015; Hakamada *et al.*, 2017).

DNA register and market monitoring

Background

The basic position of the Government of Japan is that matters related to regulation of the market for whale products are outside the jurisdiction of the IWC. Therefore management and regulation of whale products in Japan is carried out by the Government.

As in the case of Norway and Iceland, Japan is using a DNA-based system for tracking whale products in the market, and this task has been assigned to the ICR. The system involves two main components: establishment and maintenance of a diagnostic DNA register for large whales and molecular market monitoring through systematic surveys in the retail market (Figure 17).

Technical details of the DNA register for large whales

Source of tissue samples

In Japan there are two main sources of tissue samples of large whales: 1) special permit scientific whaling in the North Pacific (JARPN/JARPNII and NEWREP-NP) and the Antarctic (JARPA/JARPAII and NEWREP-A), and 2) coastal by-catches in set nets.

In the case of special permit scientific whaling, samples for genetic analysis are collected from each whale by researchers. These involve skin samples (two or three pieces of 5×5×5 mm kept in 99% ethanol). A large amount of information of each whale sampled is collected using established protocols including species name, catch date and location (longitude, latitude), body length and sex.

The Japanese regulation on by-catches (established from 1 July 2001) requires that all animals should be DNA-registered before whale meat can be sold in the market. Details of the regulation and procedure can be found in the following web page: http://www.icrwhale.org/pdf/higekujira.pdf.

Skin or muscle samples (5×5×5 cm) are taken by the fisherman and sent to the laboratory at the ICR (as frozen samples). Together with these samples, the fishermen should provide information following an established protocol including: species, date and location of the by-catch, type of set net, body length and sex.

Genetic markers

The Japanese DNA register for large whales is composed of three parts: a) an approximately 500 bp fragment of the 5′-end of the mitochondrial DNA control region, which is used for the purpose of species identification of unknown whale products, based on phylogenetic analyses; b) a set of nuclear DNA markers (microsatellites: 13–17 loci in each species), which is used for the purpose of individual identification; and c) data from Y chromosome DNA, which is used for the purpose of sex identification. See details in Pastene and Goto (2006).

Technical details of the market monitoring

Sampling procedure

One or two technicians, who are familiar with market operations, are appointed to carry out the sampling of whale products in the retail market. In each year, a total of 350 samples have been collected between September and December, involving around 19 cities or towns. Table 3 shows

Table 3
The number of whale products by sampling localities and tissue type purchased in the 2016 survey.

City/Town	Meat	Blubber	Ventral grooves	Total
Sapporo	15	2	13	30
Sendai	25	3	7	35
Niigata	4	12	4	20
Kanazawa	4	2	1	7
Noto	4	5	1	10
Anamizu	1	0	0	1
Nanao	1	1	0	2
Toyama	4	0	2	6
Himi	2	6	1	9
Nagoya	13	0	4	17
Kochi	8	9	8	25
Kobe	13	5	6	24
Osaka	14	7	7	28
Taiji	3	6	1	10
Nachikatsuura	4	4	3	11
Hiroshima	18	0	3	21
Shimonoseki	15	8	9	32
Fukuoka	13	6	11	30
Nagasaki	12	7	13	32
Total	173	83	94	350

an example of cities and whales products sampled in the 2016 survey. The sampling attempts to cover the entire Japanese archipelago but the method of sampling is not a random procedure. The following information is collected for each whale product sample: kind of whale product, sampling locality, date, and price. Once sampled, the products are sent to the laboratory at the ICR for genetic analysis.

Genetic markers

The laboratory work for the whale product samples involves the same genetic markers used for the DNA register, which were explained above.

Outputs

Results of the comparisons between 'test' (sequences and genotype of whale's products) and 'type' (sequences and genotype in the register) samples are summarized in an annual report to the Fishery Agency of the Government of Japan. An example of analyses is available in Goto and Pastene (2000).

Stranding record

Background

The ICR has been recording strandings of marine mammals on the Japanese coast since 1986, with the purpose of obtaining information on their migration and distribution through the record and analysis of samples collected from the stranded animal.

Record procedure

The ICR compiles information on stranding received from researchers, government officials or the general public who send the information following a protocol and record sheet developed and distributed by the ICR among Japanese coastal prefectures, or from other sources such as newspapers. See details on the protocol and data sheet in the following link: (http://www.icrwhale.org/pdf/stranding.pdf).

Together with the stranding record sheet, people are requested to send skin or muscle samples for genetic analysis in pieces of 5×5×5 mm kept frozen or in 99% ethanol. The ICR corroborates species identity by DNA analysis.

Outputs

Information on stranding of large cetacean has been reported to the IWC SC annual meetings on a voluntary base as Progress Reports on Cetacean Research. Stranding records since 1996 are available in the following link: (http://www.icrwhale.org/zasho2.html).

Data and samples from strandings are available to interested scientists under the data access protocol of the ICR.

RESEARCH COLLABORATION

Several aspects of the research programs described above are conducted as research collaboration between the ICR scientists and several Japanese and international research organizations. Within Japan in particular the ICR conducts research collaboration with the National Research Institute of Far Seas Fisheries and with the Tokyo University of Marine Science and Technology. A list of peer-reviewed publications derived from research collaborations is included in the relevant section of this issue of the TEREP-ICR. Protocols for data access and research proposals are available at the ICR Home Page.

FINAL REMARKS

The ICR has been heavily involved in the design and implementation of several research programs on large whales and the ecosystem. The ICR will maintain this effort by continuing the ongoing surveys. A unique and valuable data base of whale biology and whale's environment has become available. Analyses of these data have contributed and will continue contributing to the understanding of whale biology and ecology, and to the

management of whaling on a sustainable basis.

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