ICR

TEREP-ICR

TECHNICAL REPORTS OF THE INSTITUTE OF CETACEAN RESEARCH

No. 8

December 2024

TEREP-ICR is published annually by the Institute of Cetacean Research.
ISSN: 2433-6084

Citation

Entire issue:

Institute of Cetacean Research. 2024. *Technical Reports of the Institute of Cetacean Research (TEREP-ICR)* No. 8. The Institute of Cetacean Research, Tokyo, Japan, 00 pp.

Individual reports:

'Author Name'. 2024. 'Report title'. *Technical Reports of the Institute of Cetacean Research (TEREP-ICR)* No. 8: 'pp'-'pp'.

Editorial correspondence should be sent to:
Editor, TEREP-ICR
The Institute of Cetacean Research,
4-5 Toyomi-cho, Chuo-ku, Tokyo 104-0055, Japan
Phone: +81(3) 3536 6521
Fax: +81(3) 3536 6522
E-mail: webmaster@icrwhale.org
TEREP-ICR is available online at www.icrwhale.org/TEREP-ICR.html

Cover photo: A German scientist working at the former genetic laboratory of ICR-Tokyo Office (top). Instrument Juno, EP1 used for single nucleotide polymorphisms (SNPs) analyses at the genetic laboratory of ICR-Taiji Office (middle). A Chilean scientist participating in the 2023/24 JASS-A survey in Antarctic Area IV (bottom).

Copyright © 2024, The Institute of Cetacean Research (ICR).

TECHNICAL REPORTS OF THE INSTITUTE OF CETACEAN RESEARCH

TEREP-ICR
No. 8

The Institute of Cetacean Research (ICR)
Tokyo, 2024

Foreword

It is a pleasure for me to introduce the eighth issue of the Technical Reports of the Institute of Cetacean Research (TEREP-ICR-8). TEREP-ICR describes and reports on the process, progress, and results of technical or scientific research on whales and their environment, as well as the field activities and state of current research surveys conducted by the ICR, both in the North Pacific and the Antarctic Oceans.

The definitive return of the in-person mode of work in the post-pandemic period facilitated the research activities carried out in 2024, including field surveys, laboratory work and analyses, writing of papers and participation in national and international meetings. This, in turn, enabled the ICR to make a significant contribution to whale science during this year as shown in this issue of TEREP-ICR.

To facilitate the research work on cetaceans, the ICR has undergone reorganization in 2024 and now has two Research Departments under the Survey and Research Division. The first department deals with studies directly relevant for assessment and management, while the second department deals with studies on biological and ecological topics which can be used as indicators of the health, condition and role of whales in the ecosystem. Furthermore, the ICR in 2024 expanded into two offices, Tokyo Office and Taiji Office. All laboratories dedicated to aspects of biology, genetics, feeding ecology, and chemicals of cetaceans are located at the Taiji Office. I trust that this new organizational structure at the ICR will allow more comprehensive and innovative research on cetaceans with a focus on their conservation and management.

I would like to highlight three of ICR′s activities in 2024 that involved international research collaboration. Firstly, in March 2024, a German researcher completed a successful one-year post-doctoral stay at the ICR which was the first experience of this kind for our institute. The main objective of the post-doctoral stay was the development and establishment of a new genetic marker (Single Nucleotide Polymorphism or SNP), which is now available for the use in studies on population genomic structure in baleen whale species by the ICR genetic team (see a report of the post-doctoral research in this issue). Secondly, in February 2024 a training course for the SNP genetic marker was carried out by a German researcher at the ICR Taiji Office′s genetic laboratory. This activity was accompanied by a successful international workshop on the use of genetic data for whales′ stock identification purposes, with the participation of international experts from Norway, Iceland, Germany and Japan. Finally, a Chilean scientist participated successfully in the 2023/24 survey of the JASS-A program in the Antarctic Ocean enabling a path for further research collaboration on whales between his institute in Chile and ICR (see commentary article in this issue). I hope that activities involving international research collaboration will increase in the future.

The previous TEREP-ICR-7 was widely distributed both in Japan and other countries. There is good evidence that TEREP-ICR is on course towards achieving its objectives. At the same time, TEREP-ICR has been providing valuable opportunities for our scientists to compile and summarize their research conducted over the years, as a precursor to submitting their works for publication in peer-reviewed journals (see some examples of publications in the list of peer-reviewed papers in this TEREP issue).

It is my sincere hope that this eighth issue of the TEREP-ICR will contribute further to an increased understanding among national and international scientific communities of the technical and research activities on whales and their ecosystem conducted by the ICR.

Dr. Yoshihiro Fujise
Director General
Institute of Cetacean Research
Tokyo, December 2024

Editorial

Welcome to the eighth issue of the Technical Reports of the Institute of Cetacean Research (TEREP-ICR-8).

This issue contains six technical reports and one commentary article. Takahashi and Pastene presented a summary of their published study on the use of mathematical models to investigate close kin in the southern right whale of the Indian sector of the Antarctic. The analysis was based on genetic data from biopsy samples obtained from several Japanese and International Whaling Commission (IWC) whale research surveys in the Antarctic. Kiemel and colleagues explained the development and implementation of Single Nucleotide Polymorphism (SNPs) markers for whale's population genomics research at the ICR. Katsumata and Isoda presented an overview of the studies on individual identification and photogrammetry of Antarctic blue whales based on drone surveys conducted by the ICR in the Antarctic.

Results of three important dedicated sighting surveys were presented in this issue: Isoda and colleagues summarized the results of the 2023/24 austral summer season survey of the Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A) conducted in a Indian sector of the Antarctic; Kim and colleagues summarized the results of sighting surveys conducted in the North Pacific in 2023; and Murase and Yoshimura presented an overview of the results of the 2023 IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER) survey conducted in the eastern North Pacific.

In the commentary article, Pastene described two successful cases of international research collaborations by the ICR in 2023/24 highlighting the importance of international research collaboration in the study of cetaceans by the ICR.

TEREP-ICR-8 issue also included sections that outline the contribution of ICR scientists to international and national meetings in 2024, as well as their contribution in terms of peer-reviewed publications up to December 2024.

We trust that you will find this eighth TEREP-ICR issue informative and useful.

Dr. Luis A. Pastene
Dr. Mutsuo Goto
Editorial Team, TEREP-ICR
Tokyo, December 2024

Contents

Technical Reports of the Institute of Cetacean Research (2024) pp. 1–7

Technical Report (not peer reviewed)

A method to investigate close kin in wildlife populations: the case of the southern right whale *(Eubalaena australis)* in the Indian sector of the Antarctic Ocean

Megumi TAKAHASHI* and Luis A. PASTENE

Institute of Cetacean Research, 4–5 Toyomi-cho, Chuo-ku, Tokyo 104–0055, Japan

**Contact e-mail: takahashi@cetacean.jp*

ABSTRACT

This paper describes a method for investigating close kin in wildlife species, which is based on LOD (Logarithm of the odds) score—a relatedness index for a pair of genotypes. The method was applied to study the distribution of close kin in southern right whales in the feeding grounds of the Indo-Pacific sector of the Antarctic Ocean, using biopsy samples of 183 individual whales collected during Japanese and International Whaling Commission's whale surveys in the Antarctic. The description of the method and results for southern right whales in this paper are based on a recently published paper derived from a research collaboration between scientists of the Institute of Cetacean Research and the University of Bergen, Norway.

INTRODUCTION

The genetic determination of close kin pairs has been proposed as a general framework for estimating key population parameters, such as population size and growth rate in wild animals (Bravington *et al.*, 2016). Also, kinship information can assist the interpretation of movement and social and population structure in whales (Skaug *et al.*, 2010). Therefore, information on close kin has the potential to contribute to the conservation of whale species through the monitoring of important population parameters. See Taguchi (2020) for a review of genetic methods to infer kinship inferences in whales.

A commonly used test statistic for close kin inference is the LOD (Logarithm of the odds) score, which is readily calculated from a pair of DNA profiles (Meagher, 1986; Skaug, 2001). Two individuals may be classified as related, with no further specification of the type of relationship if their LOD score exceeds a predefined critical value.

The objective of this paper is to present a brief outline of the analytical methodology of close kinship inference based on LOD. This paper also presents the results of the application of this methodology on southern right whales in the feeding grounds of the Indo-Pacific sector of the Antarctic. The description of the method and results for southern right whales in this paper are based on a recently published

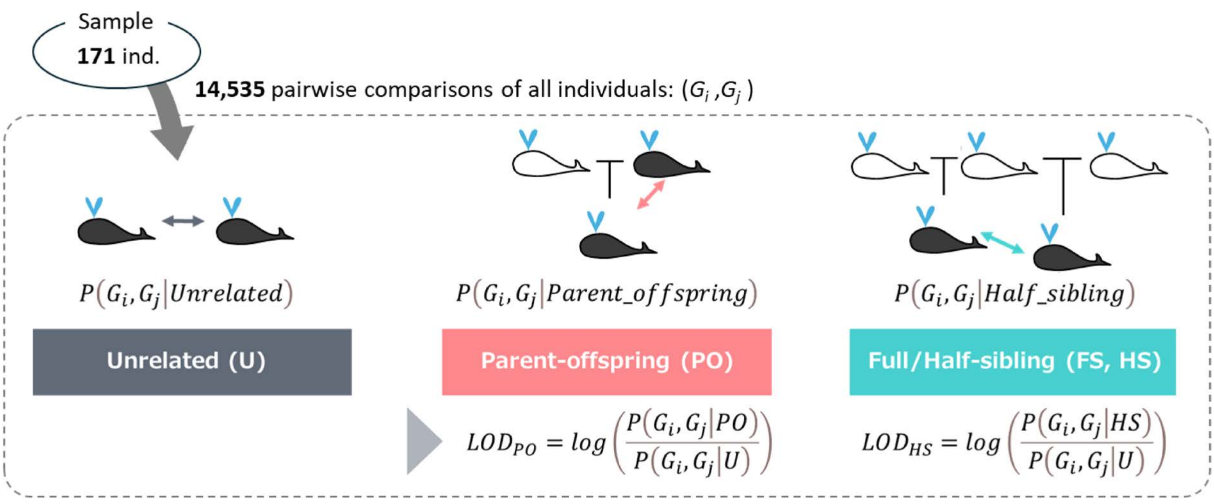


Figure 1. Examples of relatedness index for a pair of genotype for a case of 171 individuals analyzed.

paper derived from a research collaboration between scientists of the Institute of Cetacean Research (ICR) and the University of Bergen, Norway (Takahashi *et al.*, 2024).

ANALYTICAL PROCEDURES

LOD score analysis

The LOD is defined as the log-likelihood ratio of the probability of an observed genotype pair when they share a certain relationship, e.g., parent-offspring, relative to the probability of the genotype pair when they are unrelated. For the parent-offspring relationship (PO), this amounts to

$$LOD_{PO}(i,j) = \ln\left(\frac{P(G_i, G_j \mid Parent - offspring)}{P(G_i, G_j \mid Unrelated)}\right).$$

Here, G_i and G_j are the observed genotypes for two specimens, *i* and *j*. LOD scores for other kinship categories are defined similarly (Figure 1).

The observed genotypes may contain genotyping errors. To address this, a simple error model with a constant and independent per-allele error rate can be used. For a parent-offspring pair and self/monozygotic relationships, an error model ensures that the LOD score is well defined for all genotype pairs. Otherwise, the LOD score would be undefined for all pairs containing loci with no compatible alleles.

The second-degree relationships of half-siblings (HS), grandparents, and full aunts and uncles all have the same LOD score and cannot be distinguished on the basis of genotypes. We refer to this as the LOD_{HS} (half-sibling LOD score). It should be kept in mind that LOD_{HS} does not necessarily refer to only half-siblings. We define the maximum likelihood kinship for a genotype pair as the kinship category that gives the highest probability for the observed genotype, i.e., the relationship with the highest $P(G_i,G_j \mid \text{Kinship})$. This is equivalent to selecting the kinship category with the highest LOD score, since its denominator is the same for all kinship categories.

APPLICATION OF THE METHOD TO THE SOUTHERN RIGHT WHALE

Background of the southern right whale

Southern right whales (*Eubalaena australis*) are widely distributed across the three ocean basins in the Southern Hemisphere: South Atlantic, Indian Ocean, and South Pacific, mainly between latitudes 16°S and 65°S. Southern right whales approach the continental coasts and some islands for breeding, calving and resting during the austral winter and early spring. The primary breeding grounds of this species are located in the waters off South Africa, South West Australia, mainland New Zealand, New Zealand Sub-Antarctic and Argentina (Figure 2) (Carroll *et al.*, 2014; 2016; Cranswick, 2022; IWC, 2001; 2013). Also, southern right whales occur in winter in coastal areas of

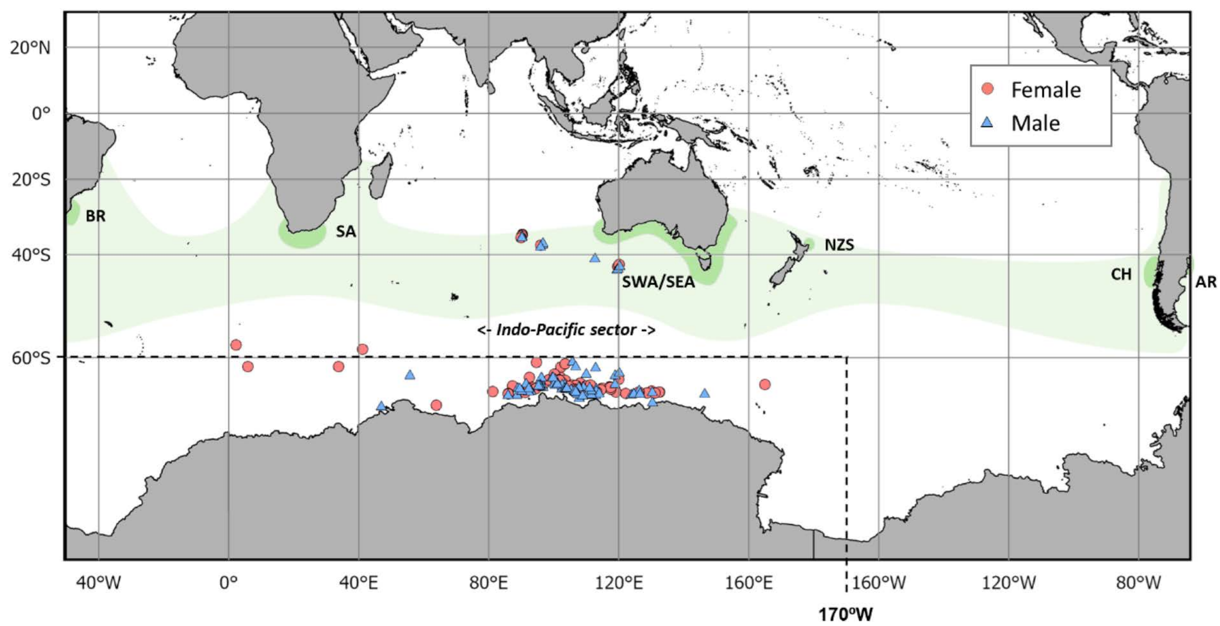


Figure 2. Historical distribution and primary calving grounds of southern right whales. The geographical positions of the sampled whales for this study are shown by sex. Surveys were conducted in the austral summer seasons (December to March) from 1993/94 to 2018/19. The map was obtained in the R statistical environment (R core Team, 2023) using '*rnaturalearth*' package (Massicotte and South, 2023), and the world vector map data was obtained from Natural Earth (public domain): http://www.naturalearthdata.com.

South Eastern Australia, Chile and Brazil.

Previous studies on distribution and movement based on photo-id matches (Bannister, 1999), historical whaling data and sighting surveys (Bannister, 2001) showed that whales in the Indian sector of the Antarctic (85°–135°E) are associated with breeding grounds in the Australasian regions. Also, a previous study on mtDNA analysis supported a close relationship between whales in the Antarctic Indian sector and whales in the Southwestern Australia breeding ground (Pastene *et al.*, 2018).

Biopsy samples

A total of 183 skin/blubber biopsy samples were obtained opportunistically from free-ranging southern right whales along the sighting surveys of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA/JARPAII), the International Whaling Commission-International Decade for Cetacean Research/Southern Ocean Whale and Ecosystem Research (IWC-IDCR/SOWER) programs, and the New Scientific Whale Research Program in the Antarctic Ocean (NEWREP-A) in the Antarctic Ocean from 60°W to 170°W across the 180° meridian, south of 35°S during the austral summer seasons (December to March) 1993/94 to 2018/19.

Most of the samples were taken in the Antarctic Indian sector (85°–135°E), south of 60°S from 1993/94 to 2015/16. Figure 2 shows the geographical distribution of the southern right whales sampled. For each sample, sampling date and geographical location were available. In some cases, visually estimated measurements of body lengths of the animals sampled were recorded in conjunction with other ancillary information such as the presence of calf. Visual estimates of body length were made from the vessels by experienced scientists and crew members. This additional non-genetic information assisted the interpretation of the results of close kinship inferences.

DNA profile preparation

Microsatellite DNA (msDNA) genotypes were the primary data used for estimating close kinship. Also, the sex information and mitochondrial DNA (mtDNA) haplotypes were used only to assist the interpretation of close kinship inferences. The DNA samples were genotyped using 14 microsatellite loci: EV1Pm, EV14Pm, EV21Pm, EV37Mn, EV94Mn (Valsecchi and Amos, 1996), GT023, GT211, GT310 (Bérubé *et al.*, 2009), GATA028 (Palsbøll *et al.*, 1997), DlrFCB17 (Buchanan *et al.*, 1996), TR3G2, TR2G5, TR2F2, and TR3F3 (Frasier *et al.*, 2006). The SRY locus located on the *Y* chromosome was also used for sex determination following the method of Abe *et al.* (2001) with a slight modification described in Pastene *et al.* (2022).

Also, the first 470 base pairs (bp) at the 5′ end of the mtDNA control region was sequenced. The mtDNA haplotypes were used for interpretation purposes.

Results of the close kinship inference

Determination of the cut-off point value

Figure 3 shows the LOD score distributions (LOD_{PO}) for simulated and observed data sets. There was an overlap between the three distributions simulated from different kinship categories (Figure 3, left). Table 1 shows the number of detected close kin dyads at various levels of the cut-off point of LOD score, as well as the expected number of false positives from unrelated pairs. The challenge is to find a way to determine the value of the cut-off point that will maximize the number of correctly inferred pairs of related individuals, while keeping the number of pairs incorrectly inferred as close relatives to a reason-

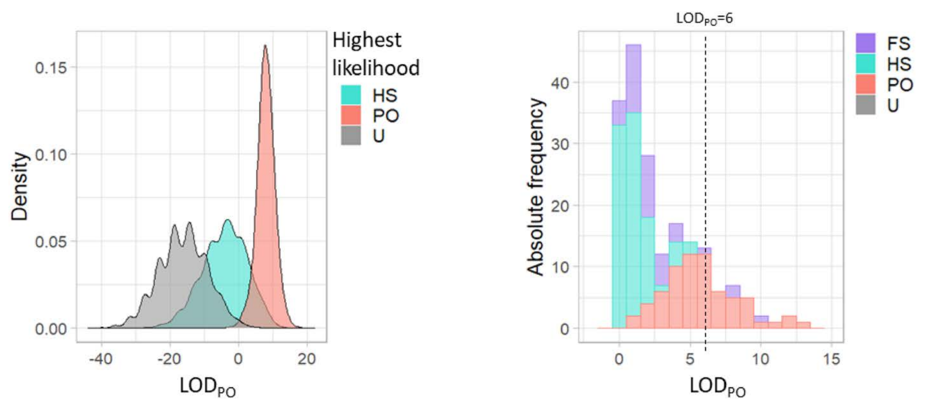


Figure 3. Simulated (left) and observed (right) distribution of the LOD_{PO} scores. For the three simulated datasets (HS, PO, U) normalized densities (unit area) are shown, while for the real data the absolute frequency of each relationship category, as assigned by the maximum likelihood, is displayed.

Table 1
Number of related pairs by different (maximum probability) kinship category (PO/HS/FS) for LOD_{PO} score, for different cut-off LOD values.

Kinship categories for LOD score	Cut-off point	# highest likelihood (# expected FP)						# expected FN on category "PO"
		FS		HS		PO		
HS	8	1	—	—	—	2	—	—
	7	1	—	—	—	4	(0.01)	—
	6	2	(0.09)	—	(0.16)	8	(0.19)	—
	5	5	(1.00)	6	(1.00)	15	(0.97)	—
	4	9	(4.00)	14	(8.00)	25	(4.00)	—
	3	28	(18.00)	41	(49.00)	43	(12.00)	—
PO	8	2	(0.07)	—	—	13	(0.60)	15
	7	3	(0.16)	—	—	18	(1.00)	11
	6	3	(0.29)	—	(0.01)	25	(4.00)	8
	5	4	(0.74)	1	(0.31)	39	(9.00)	6
	4	6	(1.00)	4	(1.00)	51	(16.00)	4
	3	9	(3.00)	7	(4.00)	58	(23.00)	3

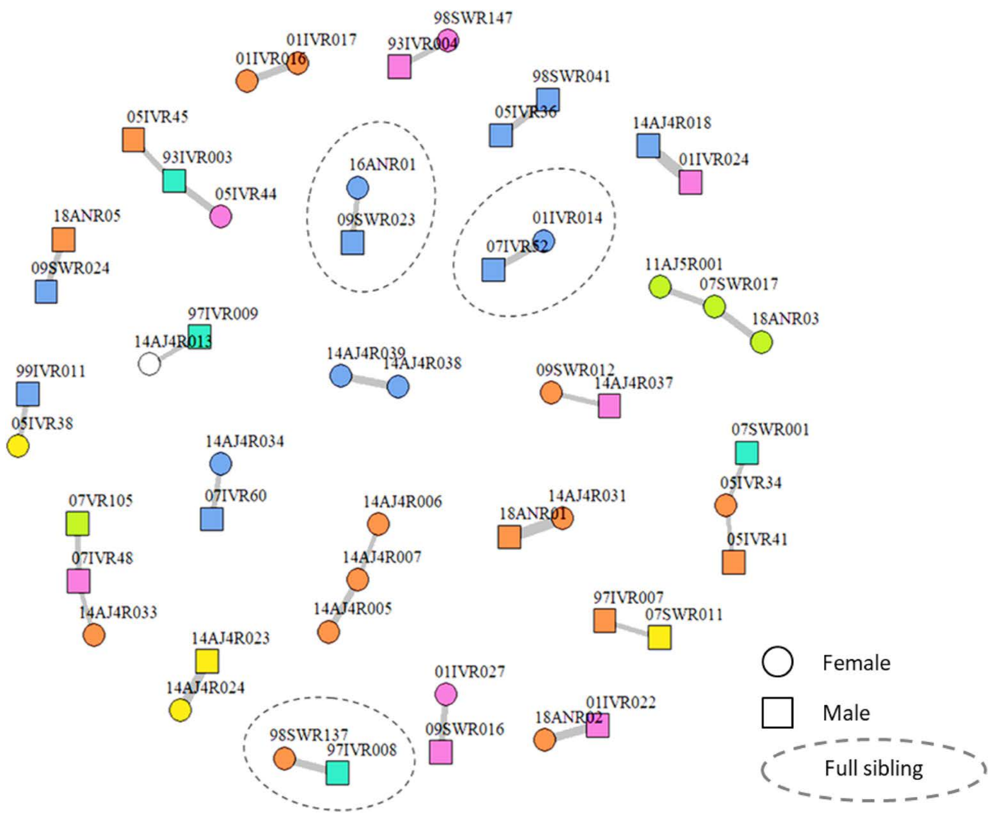


Figure 4. Schematic representation of the dyads and triads in Table 1 (LOD_{PO}>6). The strength of evidence (LOD_{PO}) is indicated by the width of the line connecting related individuals. Mitochondrial DNA haplotypes are shown by color: circles denote females and squares denote males. The dashed circles show dyads inferred as full-sibling pairs by maximum likelihood.

able minimum. In this case, the best cut-off point under this criterion was LOD_{PO}>6.

Identification of close kin dyads

Figure 4 provides a schematic representation of the information of the 28 dyads with LOD_{PO}>6. They consist of a total of 25 possible PO pairs and three possible full-sibling (FS) pairs, as determined by maximum likelihood classification. Some additional genetic (mtDNA haplotype) and biological (body length and sex) information can assist in the interpretation of close kinship categories. Triad relationships in this figure result from one individual occurring in more than one dyad. Dyads encircled by a dashed line show possible FS pairs. There were two triads comprising only female animals, and there were three triads comprising two males and one female.

The triad 93IVR003 (male), 05IVR45 (male) and 05IVR44 (female) was one of the strongly supported triads and also a case in which the biological data contributed to the interpretating of close kin inference. Male 93IVR003 had a dyad with a male 05IVR45 and another dyad with female 05IVR44. The two pairwise LOD scores were LOD_{PO}=7.73 and LOD_{PO}=8.69, respectively. The fact that 93IVR003 had reached 13.7 m in body length in 1993 indicates that it was sexually mature. This supports the possibility that the other two animals in the triad (05IVR45 and 05IVR44) are the son and daughter of male 93IVR003, respectively.

Geographical connections for inferred dyads

Figure 5 shows the geographical locations and connections for the 28 dyads with LOD_{PO}>6. Six of these dyads were individuals sampled at low and high latitudes; the high-latitude individuals of these dyads were mostly concentrated between 85°E and 110°E. Within the Antarctic, parent-offspring relationships were concentrated within the Antarctic Indian sector. There was a single connection between the inner and outer Indo-Pacific sectorsfor one possible full-sibling relationship. In addition, there were no close kin relationships identified between individuals distributed west and east of 85°E.

Interpretation of results

Close kinship information from this study strongly supported the view that whales in the Indian sector of the Antarctic belong to a stock related to Southwestern Australia, as most of the dyads were found within the sector 85°–135°E (within and between austral summer seasons), and between this Antarctic sector and whales in lower latitudes off Southwestern Australia (between different austral summer seasons). Also, results of this study supported the hypothesis that fidelity to feeding areas is

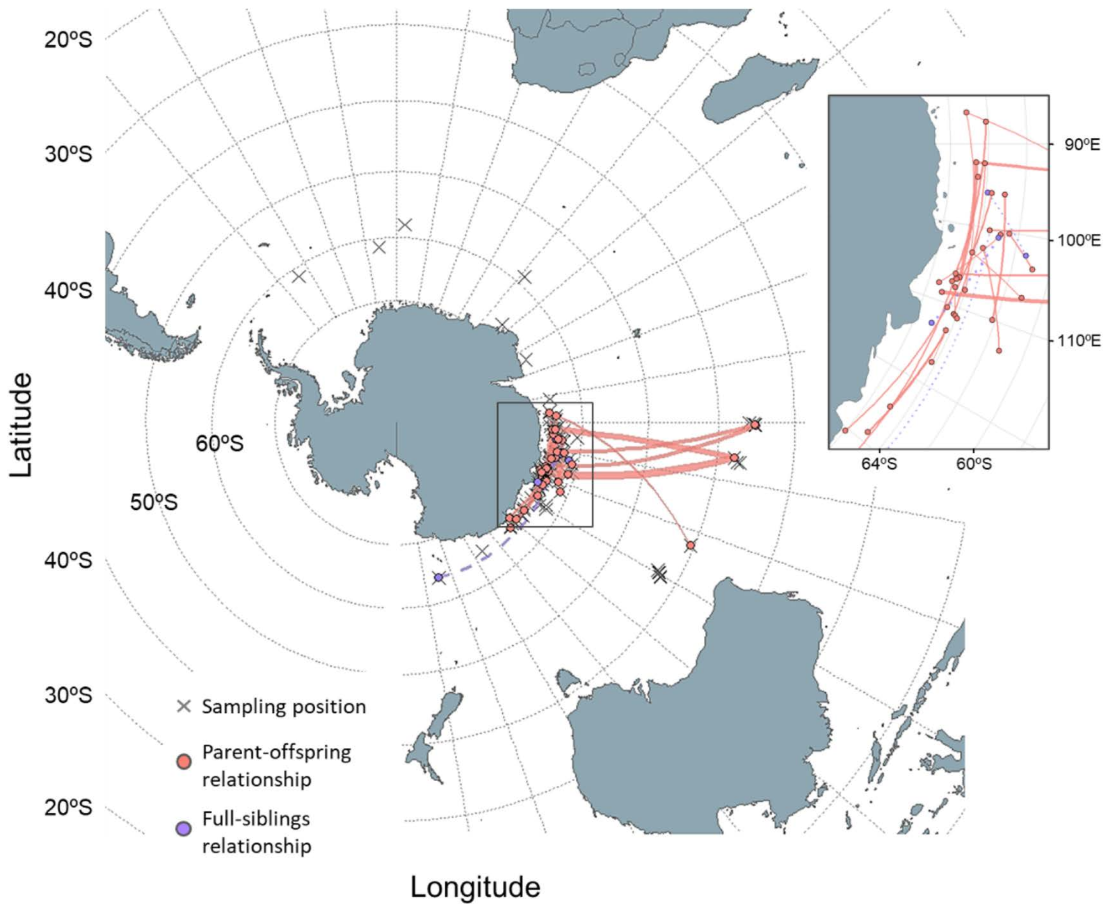


Figure 5. Geographical connections for dyads with LOD_{PO}>6 indicating the degree of strength of the connection. The inset shows a map focusing on the Indian sector of the Antarctic where most of the observations are concentrated. Maps were obtained by R (R core Team, 2023) using '*rnaturalearth*' package (Massicotte and South, 2023).

inherited from mother to offspring (Carroll *et al.*, 2015; Valenzuela *et al.*, 2009), given that most of the maternally related parent offspring pairs occurred in a similar sector in the Antarctic (85°–135°E) or represented connections between low and high latitude waters in this longitudinal sector.

As previously mentioned, however, a possible full-sibling pair was found between the Antarctic Indian sector and the outer Amtarctic Indian sector (between 160° and 170°E). This could be explained by the sporadic dispersion of close kin whales of the Southwest Australia stock in the core longitudinal sector (85°–135°E) into a more eastern longitude. An alternative explanation could be that whales from different breeding grounds, for example, Southwest Australia and New Zealand, breed (Patenaude *et al.*, 2007) and their 'hybrid' offspring migrate to different sectors of the Antarctic. However, currently there is no evidence of monogamy, so full-siblings can be expected to be rare. A third interpretation is the possibility of a false-positive dyad for this particular case. The first interpretation of sporadic longitudinal dispersion of possible full siblings is considered more plausible.

The uncertainties for the inference of close kin dyads are related mainly to the amount of information in the DNA profiles, and also to genotyping error. In the present study, a simple error model with a constant and independent per-allele error rate was based on genotyping error information from the North Pacific right whale. Uncertainty associated with the analytical approach used in this study could be reduced by the use of other genetic markers, as well as biological information such as age of the individuals.

POTENTIAL USE OF CLOSE KINSHIP INFORMATION

Close kinship data from this study can be used for estimating the abundance of the stock using close-kin mark-recapture (CKMR) method (Bravington *et al.*, 2016). The CKMR method is an extension of classical mark-recapture methods. In previous applications of this method to fish species, age data have been available, which simplified the calculation of kinship recapture probabilities. No age data is available for southern right whales. Therefore if the CKMR method is applied to this species in the future, some modification of the method that addresses the lack of age data, will be required (e.g., Skaug, 2001).

As mentioned earlier, close kin information are potentially useful for estimating some demographic parameters, which should be monitored for conservation purposes. Furthermore, the information on close kinship in this study could also be informative about inbreeding in this species.

However, when using feeding ground data, if the aim is to estimate the size of a breeding population, then the question of which population size is being estimated requires careful consideration, and further methodological developments are also needed.

See Takahashi *et al.* (2024) for details of the close kinship inference using LOD score, and application and results for southern right whales.

ACKNOWLEDGEMENTS

The document Takahashi *et al.* (2024) resulted from a research collaboration from ICR and the University of Bergen, Norway, represented by Prof. H.J. Skaug. We thank B. Føland, University of Bergen, for his assistance in the application of the analytical approach. This study was based mainly on genetic data published previously by Pastene *et al.* (2021) as well on new genetic data obtained in more recent years. The data were obtained from biopsy samples collected in different dedicated sighting surveys. We thank cruise leaders, captains, crew members, and researchers who participated in Japanese and IWC-sponsored surveys in the Antarctic for their effort in collecting biopsy samples and ancillary data of the southern right whales. We also thank M. Taguchi and other members of the ICR genetic team for producing the genetic data used in this study. Finally we thank the TEREP editorial team for their editorial check.

REFERENCES

Abe, H., Goto, M., Pastene, L.A., Dewa, K. and Naito, E. 2001. Practical use of multiplex fluorescent PCR for Cetacean sex identification. *Mar. Mam. Sci.* 17: 657–664.

Bannister, J. 2001. Status of southern right whales (*Eubalaena australis*) off Australia. *J. Cetacean Res. Manage.* 3: 103–110.

Bannister, J.L., Pastene, L.A. and Burnell, S.R. 1999. First record of movement of a southern right whale (*Eubalaena australis*) between warm water breeding grounds and the Antarctic Ocean, South of 60°S. *Mar. Mam. Sci.* 15(4): 1337–1342.

Bérubé, M., Jørgensen, H., McEwing, R. and Palsbøll, P.J. 2000. Polymorphic di-nucleotide microsatellite loci isolated from the humpback whale, *Megaptera novaeangliae*. *Mol. Ecol.* 9(12): 2181–2183.

Buchanan, F.C., Friesen, M.K., Littlejohn, R.P. and Clayton, J.W. 1996. Microsatellites from the beluga whale *Delphinapterus leucas*. *Mol. Ecol.* 5(4): 571–575.

Bravington, M.V., Skaug, H.J. and Anderson, E.C. 2016. Close-Kin Mark-Recapture. *Statistical Science* 31(2): 259–274.

Carroll, E.L., Rayment, W.J., Alexander, A.M., Baker C.S., Patenaude, N.J., Steel, D., Constantine, R., Cole, R., Boren, L.J.

and Childerhouse, S. 2014. Reestablishment of former wintering grounds by New Zealand southern right whales. *Mar. Mam. Sci.* 30(1): 206–220.

Carroll, E.L., Baker, C.S., Watson, M., Alderman, R., Bannister, J., Gaggiotti, O.E., Gröcke, D.R., Patenaude, N. and Harcourt, R. 2015. Cultural traditions across a migratory network shape the genetic structure of southern right whales around Australia and New Zealand. *Sci. Rep.* 5: 16182.

Carroll, E.L., Fewster, R.M., Childerhouse, S.J., Patenaude, N.J., Boren, L. and Baker, C.S. 2016. First direct evidence for natal wintering ground fidelity and estimate of juvenile survival in the New Zealand southern right whale *Eubalaena australis*. *PLoS One.* 11(1): e0146590.

Cranswick, A. 2022. New Zealand Southern Right Whale *Eubalaena australis*—Foraging Ecology and Distribution. The University of Auckland, 2022, Master thesis.

Frasier, T., Rastogi, T., Brown, M., Hamilton, P., Kraus, S. and White, B. 2006. Characterization of tetranucleotide microsatellite loci and development and validation of multiplex reactions for the study of right whale species (genus *Eubalaena*). *Mol. Ecol. Notes* 6: 1025–1029.

International Whaling Commission. 2001. Report of the workshop on the comprehensive assessment of right whales: A worldwide comparison. *J. Cetacean Res. Manage*. (Suppl.) 2: 1–35.

International Whaling Commission. 2013. Report of the IWC workshop on the assessment of southern right whales. *J. Cetacean Res. Manage*. (Suppl.) 14: 437–462.

Massicotte, P., South A. and Hufkens, K. 2023. *rnaturalearth*: World Map Data from Natural Earth. https://docs.ropensci.org/rnaturalearth/, https://github.com/ropensci/rnaturalearth.

Palsbøll, P.J., Bérubé, M., Larsen, A.H. and Jorgensen, H. 1997. Primers for the amplification of tri- and tetramer microsatellite loci in baleen whales. *Mol. Ecol.* 6(9): 893–895.

Pastene, L.A., Goto, M., Acuña, P., Taguchi, M., Hakamada, T. and Matsuoka, K. 2018. Population identity, site-fidelity, movement ranges and preliminary estimates of abundance of southern right whales in the Antarctic Indian sector inferred from genetic markers. Paper WG-EMM-18/18 presented to the CCAMLR WG-EMM, July 2018 (unpublished). 13 pp. [Available from https://meetings.ccamlr.org/en/wg-emm-18].

Pastene, L.A., Goto, M., Taguchi, M. and Matsuoka, K. 2021. Genetic matches of southern right whales in the Indian sector of the Antarctic: a contribution towards understanding their movement and site-fidelity. *Cetacean Population Studies* 3: 129–138.

Pastene, L.A., Taguchi, M., Lang, A., Goto, M. and Matsuoka, K. 2022. Population genetic structure of North Pacific right whales. *Mar. Mam. Sci.* 38(3): 1249–1261.

Patenaude, N.J., Portway, V.A., Schaeff, C.M., Bannister, J.L., Best, P.B., Payne, R.S., Rowntree, V.J., Rivarola, M. and Baker, C.S. 2007. Mitochondrial DNA diversity and population structure among southern right whales (*Eubalaena australis*). *J Hered.* 98(2): 147–157.

R Core Team. 2023. R: A Language and Environment for Statistical Computing Austria, Vienna: R Foundation for Statistical Computing. Available from: https://www.R-project.org/.

Skaug, H.J. 2001. Allele-sharing methods for estimation of population size, *Biometrics* 57(3): 750–756.

Skaug, H.J, Bérubé, M. and Palsbøll, P.J. 2010. Detecting dyads of related individuals in large collections of DNA-profiles by controlling the false discovery rate. *Mol. Ecol. Resour.* 10(4): 693–700.

Taguchi, M. 2020. Genetic tagging technique: basic concept and a case study by the Institute of Cetacean Research. *Tecnhical Reports of the Institute of Cetacean Research (TEREP-ICR)* No.4: 35–40.

Takahashi, M, Føland, B., Pastene, L.A. and Skaug, H.J. 2024. Geographical distribution of close kin in southern rigjht whales on feeding grounds. *PLoS One.* https://doi.org/10.1371/journal.pone.0301588.

Valenzuela, L.O., Sironi, M., Rowntree, V.J. and Seger, J. 2009. Isotopic and genetic evidence for culturally inherited site fidelity to feeding grounds in southern right whales (*Eubalaena australis*). *Mol. Ecol.* 18(5): 782–791.

Valsecchi, E. and Amos, W. 1996. Microsatellite markers for the study of cetacean populations. *Mol. Ecol.* 5(1): 151–156.

Technical Reports of the Institute of Cetacean Research (2024) pp. 8–14

Technical Report (not peer reviewed)

Development and implementation of SNP markers for whale research at the Institute of Cetacean Research's genetic laboratory based on ddRAD technique

Katrin Kiemel[1, *], Mioko Taguchi[1], Ralph Tiedemann[2] and Luis A. Pastene[1]

[1] *Institute of Cetacean Research, 4–5 Toyomi-cho, Chuo-ku, Tokyo 104–0055, Japan*

[2] *Unit of Evolutionary Biology/Systematic Zoology, Institute for Biochemistry and Biology, University of Potsdam, Karl-Liebknecht Straße 24-25, 14476 Potsdam, Germany*

[*] *Contact e-mail: kiemel.katrin@gmail.com*

ABSTRACT

The inference of population structure and species determination has relied on the availability of molecular information. This information was traditionally gained through markers such as microsatellite DNA, single mitochondrial gene sequencing or Restriction Fragment Length Polymorphisms (RFLPs). However, with the advent of high throughput genomics, which began more than two decades ago with the development of next generation sequencing (NGS), there has been a significant shift in methodology. The increasing cost efficiency of NGS has led to a rapid increase in publications utilizing genome-wide single nucleotide polymorphisms (SNPs) to determine species, study population structure and allow to examine the related adaptations shaping the observed population structure. The use of SNPs allows for a more comprehensive analysis of genetic variation across entire genomes, often providing a more detailed and accurate understanding of fine scale population structure and species relationships than traditionally used markers. Furthermore, SNP assays (i.e., a defined number of informative SNPs) allow the screening of large numbers of samples with the added benefit of between-laboratory comparability. Currently, the Institute of Cetacean Research (ICR) employs traditional markers. However, the advantages of SNPs strongly support the need for a transition to this method. To facilitate the transition, a SNP pipeline has been established that allows the ICR to (i) identify SNPs from double digest Restriction-site Associated DNA (ddRAD) sequencing data and quality filter SNPs depending on different datasets, (ii) conduct the SNP analysis and (iii) select a SNP assay which facilitates further processing of unprocessed samples not subject to ddRAD sequencing or DNA samples of low quality.

INTRODUCTION

To accurately identify species and assess their population structure, molecular information is essential. Before the advent of high throughput technologies, scientists relied on methods such as Restriction Fragment Length Polymorphisms (RFLPs), microsatellite DNA and single gene sequencing, often focusing on the mitochondrial DNA (mtDNA), to study species and their population structures. However, using these markers, often resulted in unresolved fine scale population structures. The emergence of next generation sequencing (NGS) and its various methods to process DNA prior to sequencing, including double digest Restriction-enzyme Associated DNA (ddRAD) and Genotyping by Random Amplicon Sequencing-Direct (GRAS-Di), has introduced the high throughput era, enabling the transition from population genetics to population genomics (Hemmer-Hansen *et al.*, 2014; Hohenlohe *et al.*, 2021).

The analysis of Single Nucleotide Polymorphisms (SNPs) or entire genomes offers significant advantages by overcoming the resolution limitations of traditional population genetics often encountered in highly mobile species/groups such as cetaceans (Lah *et al.*, 2016). This approach leverages a vastly increased number of loci, often ranging from hundreds to several thousands, providing comprehensive genomic coverage that includes both coding and non-coding regions, which in turn allowing the identification of signs of selection and the investigation of adaptations that shape the observed population structures (e.g., Autenrieth *et al.*, 2024; Celemín *et al.*, 2023).

SNP assays, also referred to as panels (i.e., a fixed number of informative SNPs), have become particularly valuable for their ability to enable a high comparability of population genetics conducted in different laboratories without the need for prior calibration, as is required for microsatellites (Ellis *et al.*, 2011). Technologies such as microfluidics (e.g., the Fluidigm System, Standard BioTools as shown in Figure 1), facilitate the high throughput processing of SNP assays through integrated fluidic circuits (IFCs), which can perform multiple PCRs simultaneously. This method allows semi-automated screening of large numbers of samples and SNPs, thereby significantly enhancing efficiency and consistency in genetic analysis (Fabbri *et al.*, 2012; Kraus *et al.*, 2014; Holman *et al.*, 2015).

Blue whales (*Balaenoptera musculus*), a highly mobile marine species, have been significantly depleted in the 19th and 20th century due to commercial whaling and are currently listed as an endangered species (IUCN, 2024). They have attracted considerable scientific interest, with population structure being studied using traditional markers such as the mtDNA control region, microsatellite DNA (e.g., LeDuc *et al.*, 2007; 2016; Torres-Lorez *et al.*, 2014), but also SNPs (Attard *et al.*, 2024). These studies have revealed pronounced genetic differentiation among ocean regions (*i.e.*, North Pacific, South Pacific, Southern Ocean and Indian Ocean). The combination of results based on genetics (LeDuc *et al.*, 2007; 2016; Torres-Lorez *et al.*, 2014), morphometrics (i.e., Branch *et al.*, 2007; Pastene *et al.*, 2020) and acoustics (McDonald *et al.*, 2006), suggest the existence of five subspecies (i.e., *B. m. musculus*, *B. m. intermedia*, *B. m. indica*, *B. m. brevicauda*, *B. m. unnamed subspecies*, aka Chilean blue whale).

To facilitate the transition from population genetics to population genomics for the investigation of cetaceans at the ICR, this study established a SNP panel pipeline, using blue whales as an example, which will allow the processing of data generated from ddRAD sequencing. The aim was to develop a pipeline which can (i) identify and quality filter SNPs, (ii) perform SNP analysis, and (iii) design a SNP panel allowing for species/population assessment and kinship analysis for subsequent use on the Fluidigm system available at the ICR.

SAMPLE SELECTION, DNA EXTRACTION AND ddRAD SEQUENCING

Samples (n=314) of the subspecies *Balaenoptera m. musculus*, *B. m. intermedia* (Antarctic blue whale), *B. m. brevicauda* (pygmy blue whale) *and B. m. unnamed subspecies* (aka) Chilean Blue whale were used for the development of SNP genotyping techniques at the ICR. These samples were biopsied under various surveys including the International Whaling Commission Pacific Ocean Whale and Ecosystem Research (IWC POWER), Japanese Whale Research Program under Special Permit in the western North Pacific, Phases II (JARPNII), New Scientific Whale Research Program in the North Pacific (NEWREP-NP), Japanese dedicated sighting surveys, IWC International Decade for Cetacean Research-Southern Ocean Whale and Ecosystem Research (IWC IDCR-SOWER), Japanese Whale Research Program under Special Permit in the Antarctic, Phases I and II (JARPA and JARPAII), New Scientific Whale Research Program in the Antarctic (NEWREP-A) and Japanese Abundance and Stock-structure Surveys in the Antarctic (JASS-A).

Samples were selected to cover global distribution from the following regions with sample sizes as indicated: Indian Ocean (IO) n=21, Southern Ocean (SO) n=224, eastern South Pacific (ESP) n=17, eastern North Pacific (ENP) n=10, western North Pacific (WNP) n=42. Total genomic DNA was extracted from approximately 0.05 g of

Figure 1. Fluidigm system consisting of (A) the IFC available in different sizes 24×96, 48×48 and 96×96, (B) JUNO to conduct PCRs and (C) EP1 to visualize results. Example of a result output is shown in (D). Each column is a sample while each row is a SNP. Red dots represent a homozygous call for allele (X/X), green dots represent a homozygous call for allele (Y/Y), blue dots represent a heterozygous call (X/Y), and grey dots indicate unsuccessful amplification. Figures (A), (B) and (C) are from Standard BioTools (2024).

tissue sample (i.e., skin, muscle or blubber), using either the phenol-chloroform method (Sambrook *et al.*, 1989) or the Gentra Puregene kit (QUIAGEN), following the manufacturer's protocol for animal tissue. The extracted DNA was stored in TE buffer at 4°C until further processing.

To retrieve ddRAD sequences, 25 µL of extracted DNA (5–10 ng/µL) was sent to the Giken Biotechnology Lab for sequencing. For genomic library preparation, 100 ng of DNA was treated with the restriction enzymes MspI and EcoRI for 3 hours at 37°C. The DNA was then cleaned using DNA Clean Beads (MGI Tech CO Ltd) and ligated for 16 hours using T4-DNA-Ligase (TaKaRa), followed by another cleaning with DNA Clean Beads. The library was amplified using PCR, and a size selection performed with a size range of 240–400 bp. Libraries were quantified using the Qubit dsDNA HS Assay kit and enriched with DNA Clean beads. Final libraries were checked with the Agilent 2100 Bioanalyzer and the High sensitivity DNA Kit (Agilent technology). Libraries were circularized using the MGIEasy Circularization kit (MGI Tech Co Ltd) as per the manufacturer's protocol. Paired-end reads of 100 bp or 200 bp were sequenced on a DNBSEQ G400 with a sequencing depth of 1–3 million read pairs, respectively. The company provided demultiplexed reads.

SNP IDENTIFICATION

To identify SNPs, demultiplexed reads were processed using radtags to check for intact barcodes and restriction enzyme cutting sites. Adapters were trimmed at the 3'-end and filtered for the mean quality using the program fastp (Chen, 2023). The reads were then mapped against the indexed reference genome of *B. m. musculus* (NCBI Accession number: GCA_009873245.3) using BWA-MEM (Li, 2013), and bam files were indexed using samtools index. SNPs were called using STACKS version 2.2 (Rochette *et al.*, 2019) and freebayes version 1.3.6 (Garrison & Marth, 2012). Info tags derived from freebayes were combined with the SNPs called by STACKS using bcftools annotate (Li *et al.*, 2011). SNPs were filtered based on a modified pipeline described by O'Leary *et al.* (2018) using vcftools version 0.1.19 (Danecek *et al.*, 2011), bcftools version 1.13 (Li *et al.*, 2011) and plink version 1.9 (Purcell *et al.*, 2007).

First, SNPs located on non-autosomal chromosomes (i.e., sex-determining chromosomes and mtDNA) were removed, as they can bias subsequent population genetic analysis. To ensure that only high quality SNPs being retained, several filter steps were included to remove low confidence SNPs, as described in O'Leary *et al.* (2018). SNPs were filtered for minor allele frequency (MAF≥0.05), quality score (QUAL≥20), minimum genotype read depth (minDP≥5), minimum mean read depth per locus (minmeanDP≥15) and minor allele count (MAC≥3). Next, SNPs were filtered iteratively by genotype call rate (geno) and individual missing data (imiss) to minimize missing data: step 1: geno≥50%, imiss≤90%; step 2: geno≥60%, imiss≤70%; step 3: geno≥70%, imiss≤50%. After adjusting the SNP dataset, only biallelic SNPs were retained and filtered using the info tags to ensure a high confidence SNP set by the removal of additional putative low confidence SNPs. SNPs were filtered for allele balance (AB: 0.2–0.8), quality/depth ratio (QUAL/DPB>0.2), mapping quality (MQM/MQMR 0.25–1.75) and properly paired status. A final filtering step was done based on genotype call rate and individual missing data (4: geno≥85%, imiss≤25%). Only unlinked SNPs and those in Hardy-Weinberg Equilibrium were kept for further analysis.

IDENTIFICATION OF DUPLICATED INDIVIDUALS AND POPULATION GENETIC ANALYSIS

Before conducting the population genetic analysis, the remaining individuals were checked for duplicates. Samples were derived from biopsy sampling, thus enabling the possibility of repeated sampling. To identify duplicates, the R package *sequoia* v. 2.11.2 (Huisman, 2017) was used. Duplicate individuals, as well as parent offspring pairs (PO) sampled at the same location and time, were removed to ensure the criteria of random sampling. Population genetic analysis was conducted based on the remaining Individuals and SNPs. All analyses were conducted using R version 4.2.2 (R Core Team, 2021) and plink. The population structure was examined through PCA/DAPC and ADMIXTURE. PCA was performed using plink, while DAPC utilized the R package *adegenet* v. 2.1.10 (Jombart, 2008). The program ADMIXTURE (Alexander *et al.*, 2009) was used to infer clusters and the genetic identity of each sample. The optimal K value (range: 1–12) was determined and evaluated via cross validation. All figures were visualized in R using ggplot2 v. 3.5.1 (Wickham, 2016).

SNP PANEL DESIGN AND TESTING

The most informative SNPs from the full SNP set were selected using two approaches: (i) For cluster assignment: 96 SNPs were selected using the program TRES (Kavakiotis *et al.*, 2015), based on maximized F_{ST} across clusters and subspecies, (ii) For kinship and duplicate identification: 96 SNPs with a F_{ST} of 0 and a heterozygosity close to 0.5 were selected. The selected SNP panels were then dry lab tested for cluster assignment by PCA and ADMIXTURE and for kinship/duplicate assessment using the R package *sequoia* v. 2.11.2. Both SNP panels were designed and ordered with the D3 Assay Design tool provided by Standard BioTools and wet lab tested on the JUNO and EP1 system using the Integrated Preamp SNP Type Genotyping Kit suitable for 96 SNPs and 96 samples (Standard BioTools) following the manufacturer's protocol. SNP panels were wet lab tested on a test set of 95 individuals. The set was chosen to cover all clusters and subspecies, including ddRAD-processed samples, unanalysed samples, low quality samples (≤5.0 ng/μL) that were removed during SNP filtering, duplicates (n=5) and PO pairs (n=6). After they were run on the Fluidigm and EP1, SNP panels were analysed using the Fluidigm SNP Genotyping Analysis Software (Standard BioTools) and subsequently processed in R.

RESULTS OF SNP POPULATION GENETICS AND SNP PANEL DESIGN

After filtering, 12,131 unlinked and Hardy-Weinberg Equilibrium (HWE)-compliant SNPs and 297 individuals were retained from the initial 1,656,931 SNPs for cluster assignment. Kinship and duplicate analysis using *sequoia* identified 49 duplicates which were removed. Additionally, 11 PO pairs, sampled on the same day and location, were excluded to ensure the random sampling criteria. PCA revealed three main clusters corresponding to the ocean basins, supported by ADMIXTURE which suggested a cross-validated K of 3 (Figure 2). Based on these results, a population/cluster SNP panel was designed with 48 SNPs to maximize difference between clusters (F_{ST}: 0.31–0.43) and 48 SNPs to differentiate between subspecies (F_{ST}: 0.39–0.46). For identifying duplicates and assessing kinship status, 96 SNPs with heterozygosity in a range of 0.50–0.54 and an F_{ST} of 0 were selected to ensure that SNPs are present in all clusters.

Wet lab SNP panel validation, based on the 95 individual test set, was run successfully at the ICR, Taiji Office, with an average processing time of 4.5 hours per SNP panel. Wet lab validation revealed that from the 96 selected SNPs in the cluster panel, 90 were amplified with a

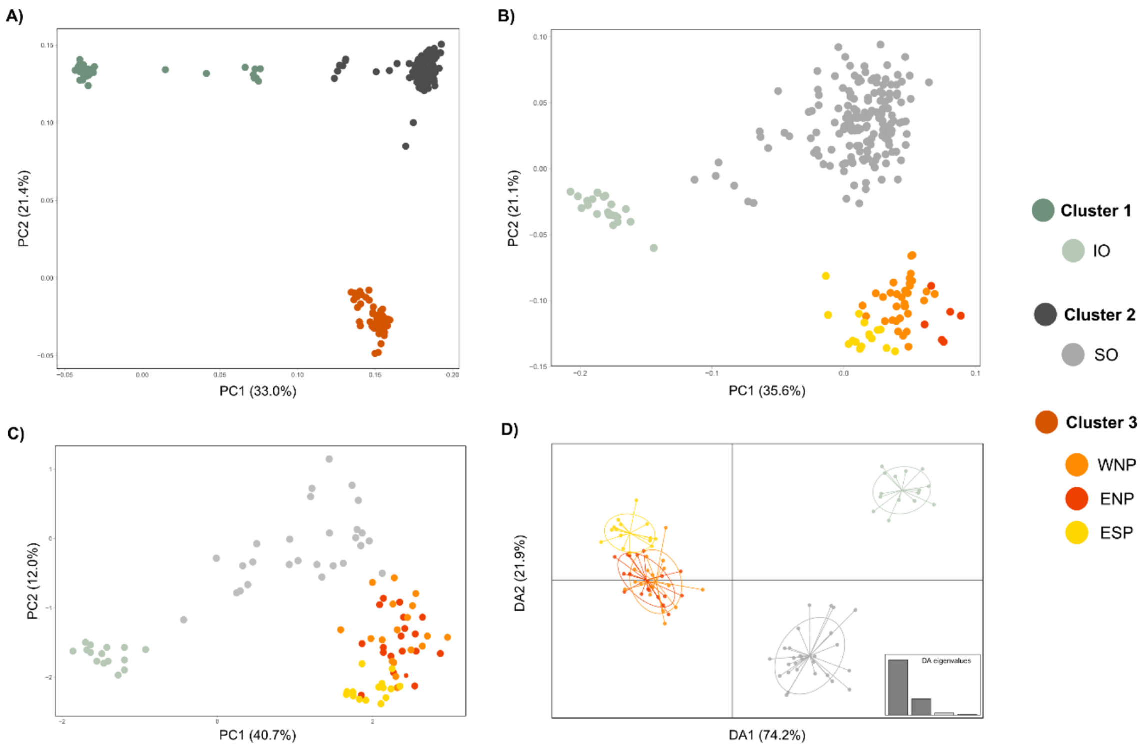


Figure 2. Clustering methods of analysed SNPs. **A)** PCA clustering based on 237 individuals and 12,131 SNPs. Colour code is assigned based on highest ADMIXTURE assignment probability to respective cluster (i.e., Cluster 1—green, Cluster 2—dark grey, Cluster 3—dark orange. **B)** PCA based on 96 most informative SNPs of the population in the SNP panel dry lab tested on 237 individuals. Colours represent subpopulations/ regions. **C)** PCA based on 96 SNPs of the population in the SNP panel and the test set of 95 individuals run on the Fluidigm. **D)** DAPC conducted to increase genetic distance between clusters and subpopulations/ regions. IO=Indian Ocean; SO=Southern Ocean; WNP=Western North Pacific; ENP=Eastern North Pacific; ESP=Eastern South Pacific.

call rate of ≥85% in 93 individuals. For the kinship panel 88 of the 96 selected SNPs were amplified with a call rate of ≥85% in 93 individuals. The inclusion of low quality samples (≤5.0 ng/µL) and samples which were originally excluded during SNP filtering, resulted in successful amplification in both SNP panels. Cluster assignment of the test set was consistent with previous results based on 237 individuals. Although genetic distance appeared reduced, this could be improved using a DAPC as shown in Figure 2. Kinship analysis and duplicate assignment were conducted and showed a consistency in the identification of all five duplicates which were included. On the other hand, the power to detect PO pairs decreased, as none of the six pairs were detected. Two PO pairs were misclassified as duplicates, likely due to missing data.

DISCUSSION AND FUTURE WORK

The pipeline established and introduced in this work opens a new chapter for the ICR, facilitating the transition to the era of high throughput analysis. This advancement will foster the application of the Fluidigm system in the future for population/cluster assignment, kinship analysis and duplicate detection. The aim of this study was to design a pipeline in a way that it can be readily modified depending on the cetacean species of interest. The established pipeline includes (i) the identification of SNPs from ddRAD data but also is adjustable for GRAS-DI data, including SNP filtering which can be adjusted according to data availability and quality, (ii) population genetics and kinship/duplicate analysis based on SNPs, (iii) SNP

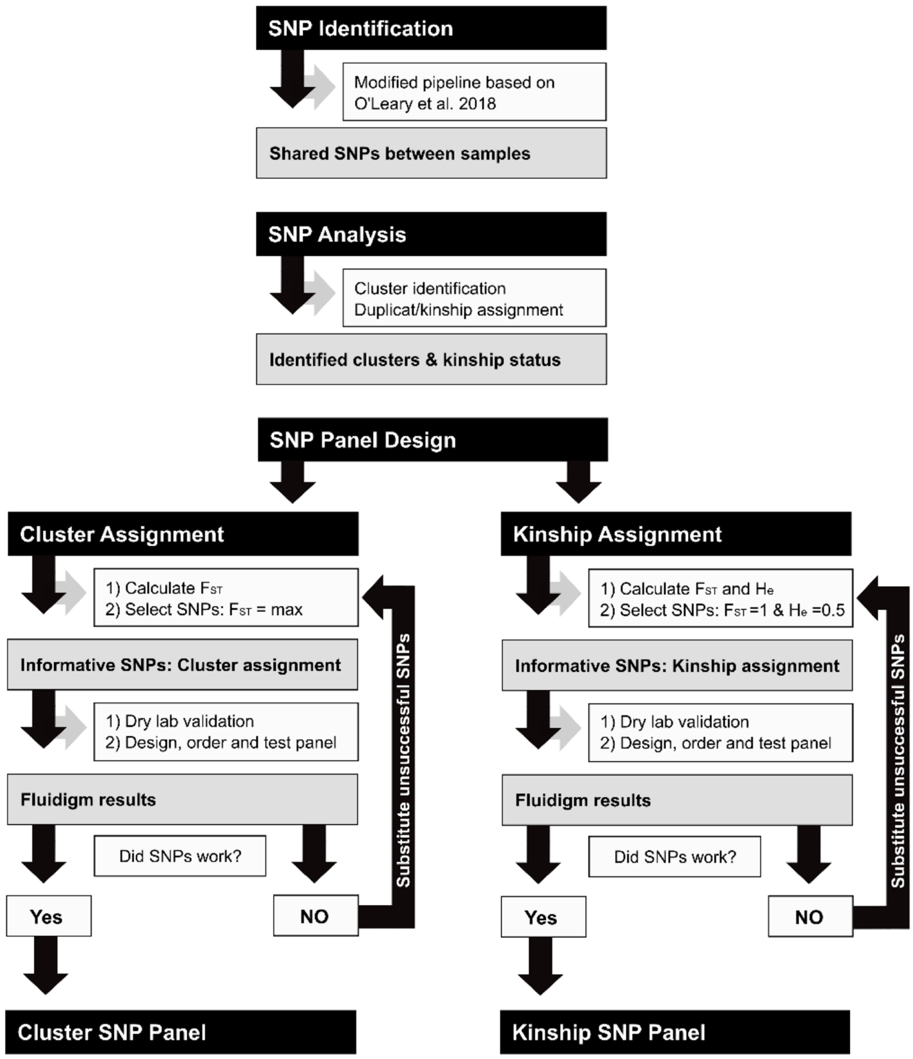


Figure 3. Developed SNP Panel pipeline at the ICR. Pipeline consists of (i) SNP identification based on ddRAD data including a modified filtering scheme described by O'Leary *et al.* (2018), (ii) subsequent SNP analysis to identify genetic clusters, kinship and duplicates and (iii) SNP panel design pipeline that includes the steps to design a SNP panel for cluster assignment, duplicate identification and kinship assessment as well as dry and wet lab testing procedures.

selection and SNP panel design (i.e., F_{ST} outlier, F_{ST} max or heterozygosity) and the establishment of SNP panel wet lab testing at the ICR's Taiji Office (Figure 3).

The results based on the test set of 95 blue whale samples have shown that the designed SNP panels work for low quality samples, which were originally excluded in the SNP filtering process. This makes the SNP panels particularly valuable for stranding samples, which often have a higher level of DNA degradation (Autenrieth *et al.*, 2024), and for non-invasive collected samples such as feces (Thaden *et al.*, 2020; Thavornkanlapachai *et al.*, 2024). Even though most of the SNPs were amplified successfully, some currently unamplified SNPs (six SNPs in cluster SNP panel and eight in the kinship SNP panel) should be substituted in the future to enhance the information provided by each SNP panel. This is particularly important for the kinship SNP panel, as it may enhance the power of PO pair assignments, which was reduced compared to the full 12,131 SNP set, likely due to missing data. A more stringent application of loci exclusion in the analysis may lead to more precise predictions of PO pairs.

While this study has demonstrated that SNPs can be used to assign specimens to clusters and to assess duplicates and potentially kinship status, the potential use of SNP panels are not limited to these applications. Other studies have successfully used SNP panels to assign species (Ciezarek *et al.*, 2022), hybrid status (Thaden *et al.*, 2020; Jarausch *et al.*, 2023), and even sex (Talenti *et al.*, 2018) to screened individuals. With the newly established pipeline and the workshops held recently in Taiji on this topic, such applications can now be explored at the ICR.

ACKNOWLEDGEMENTS

We thank all participating crew members and researchers who contributed to the collection of the samples, as well as the technicians for their support in the laboratory work at the ICR. In addition, we thank the editorial team of TEREP-ICR for editorial checking.

REFERENCES

Alexander, D.H., Novembre, J. and Lange, K. 2009. Fast model-based estimation of ancestry in unrelated individuals. *Genome Res*. 19(9): 1655–1664.

Attard, C.R.M., Sandoval-Castillo, J., Lang, A.R., Vernazzani, B.G., Torres, L.G., Baldwin, R., Jenner, K.C.S., Gill, P.C., Burton, C.L.K., Barcelo, A., Sironi, M., Jenner, M.-N.M., Morrice, M.G., Beheregaray, L.B. and Moller, L.M. 2024. Global conservation genomics of blue whales calls into question subspecies taxonomy and refines knowledge of population structure. *Anim. Conserv.* DOI: 10.1111/acv.12935.

Autenrieth, M., Havenstein, K., De Cahsan, B., Canitz, J., Benke, H., Roos, A., Pampoulie, C., Sigurosson, G.M., Siebert, U., Olsen, M.T., Biard, V., Heide-Guojon, M.P., Ozturk, A.A., Ozturk, B., Lawson, J.W. and Tiedeman, R. 2024. Genome-wide analysis of the harbour porpoise (*Phocoena phocoena*) indicates isolation-by-distance across the North Atlantic and potential local adaptation in adjacent waters. *Conserv. Genet.* 25(2): 563–584.

Branch, T.A., Abubaker, E.M.N., Mkango, S. and Butterworth, D.S. 2007. Separating Southern Blue Whale Subspecies based on length frequencies of sexually mature females. *Mar. Mam. Sci.* 23(4): 803–833.

Celemín, E., Autenrieth, M., Roos, A., Pawliczka, I., Quintela, M., Lindstrøm, U., Benke, H., Siebert, U., Lockyer, C., Berggren, P., Ozturk, A.A., Ozturk, B., Lesage, V. and Tiedemann, R. 2023. Evolutionary history and seascape genomics of Harbour porpoises (*Phocoena phocoena*) across environmental gradients in the North Atlantic and adjacent waters. *Mol. Ecol. Resour.* 00: 1–18. DOI: 10.1111/1755-0998.13860.

Chen, S. 2023. Ultrafast one-pass FASTQ data preprocessing, quality control, and deduplication using fastp. *IMeta* 2(2): e107. DOI: 10.1002/imt2.107.

Ciezarek, A., Ford, A.G.P., Etherington, G.J., Kasozi, N., Malinsky, M., Mehta, T.K., Penso-Dolfin, L., Ngatunga, B.P., Shechonge, A., Tamatamah, R., Haerty, W., Di Palma, F., Genner, M.J. and Turner G.F. 2022. Whole genome resequencing data enables a targeted SNP panel for conservation and aquaculture of Oreochromis cichlid fishes. *Aquaculture* 548: 737637. DOI: 10.1016/j.aquaculture.2021.737637.

Danecek, P., Auton, A., Abecasis, G., Albers, C.A., Banks, E., DePristo, M.A., Handsaker, R.E., Lunter, G., Marth, G.T., Sherry, S.T., McVean, G., Durbin, R. and 1000 Genomes Project Analysis Group. 2011. The variant call format and VCFtools. *Bioinformatics* 27(15): 2156–2158.

Ellis, J.S., Gilbey, J., Armstrong, A., Balstad, T., Cauwelier, E., Cherbonnel, C., Consuegra, S., Coughlan, J., Cross, T.F., Crozier, W., Dillane, E., Ensing, D., Garcia de Leaniz, C., Garcia-Vazquez, E., Griffiths, A.M., Hindar, K., Hjorleifsdottir, S., Knox, D., Machado-Schiaffino, G., McGinnity, P., Meldrup, D., Nielsen, E.E., Olafsson, K., Primmer, C.R., Prodohl, P., Stradmeyer, L., Vaha, J.-P., Verspoor, E., Wennevik, V. and Stevens, J.R. 2011. Microsatellite standardization and evaluation of genotyping error in a large multi-partner research programme for conservation of Atlantic salmon (*Salmo salar* L.). *Genetica* 139(3): 353–367.

Fabbri, E., Caniglia, R., Mucci, N., Thomsen, H. P., Krag, K., Pertoldi, C., Loeschcke, V. and Randi, E. 2012. Comparison of single nucleotide polymorphisms and microsatellites in non-invasive genetic monitoring of a wolf population. *Arch. Boil. Sci.* 64(1): 321–335.

Garrison, E. and Marth, G. 2012. Haplotype-based variant detection from short-read sequencing. *arXiv preprint* *arXiv:1207.3907*.

Hemmer-Hansen, J., Therkildsen, N.O. and Pujolar, J.M. 2014. Population genomics of marine fishes: Next-generation prospects and challenges. *Biol. Bull.* 227(2): 117–132.

Hohenlohe, P.A., Funk, W.C. and Rajora, O.P. 2021. Population genomics for wildlife conservation and management. *Mol. Ecol.* 30(1): 62–82.

Holman, L.E., La Garcia de serrana, D., Onoufriou, A., Hillestad, B. and Johnston, I.A. 2017. A workflow used to design low density SNP panels for parentage assignment and traceability in aquaculture species and its validation in Atlantic salmon. *Aquaculture* 476: 59–64.

Huisman, J. 2017. Pedigree reconstruction from SNP data: Parentage assignment, sibship clustering and beyond. *Mol. Ecol. Resour.* 17(5): 1009–1024.

Jarausch, A., Thaden, A., Sin, T., Corradini, A., Pop, M. I., Chiriac, S., Gazzola, A. and Nowak, C. 2023. Assessment of genetic diversity, population structure and wolf-dog hybridisation in the Eastern Romanian Carpathian wolf population. *Sci. Rep.* 13: 22574. DOI: 10.1038/s41598-023-48741-x.

Jombart, T. 2008. adegenet: A R package for the multivariate analysis of genetic markers. *Bioinformatics* 24(11): 1403–1405.

Kraus, R. H., Vonholdt, B., Cocchiararo, B., Harms, V., Bayerl, H., Kühn, R., Forster, D.W., Fickel, J., Roos, C. and Nowak, C. 2015. A single-nucleotide polymorphism-based approach for rapid and cost-effective genetic wolf monitoring in Europe based on noninvasively collected samples. *Mol. Ecol. Resour.* 15(2): 295–305.

Lah, L., Trense, D., Benke, H., Berggren, P., Gunnlaugsson, Þ., Lockyer, C., Öztürk, A., Öztürk, B., Pawliczka, I., Roos, A., Siebert, U., Skóra, K., Víkingsson, G. and Tiedemann, R. 2016. Spatially Explicit Analysis of Genome-Wide SNPs Detects Subtle Population Structure in a Mobile Marine Mammal, the Harbor Porpoise. *PloS One* 11(10): e0162792. DOI: 10.1371/journal.pone.0162792.

LeDuc, R.G., Dizon, A.E., Goto, M., Pastene, L.A., Kato, H., Nishiwaki, S. LeDuc, C.A. and Brownell, R.L. 2007. Patterns of genetic variation in Southern Hemisphere blue whales and the use of assignment test to detect mixing on the feeding grounds. *J. Cetacean Res. Manage*. 9(1): 73–80.

LeDuc, R.G., Archer, F.I., Lang, A.R., Martien, K.K., Hancock-Hanser, B., Torres-Florez, J.P., Hucke-Gaete, R., Rosenbaum, H.C., van Waerebeek, K., Brownell, R.L. Jr. and Taylor, B.L. 2017. Genetic variation in blue whales in the eastern pacific: Implication for taxonomy and use of common wintering grounds. *Mol. Ecol.* 26(3): 740–751.

Li, H. 2011. A statistical framework for SNP calling, mutation discovery, association mapping and population genetical parameter estimation from sequencing data. *Bioinformatics* 27(21): 2987–2993.

Li, H. 2013. Aligning sequence reads, clone sequences and assembly contigs with BWA-MEM. *arXiv preprint arXiv: 1303.3997*.

McDonald, M.A., Mesnick, S.L. and Hildebrand, J.A. 2006. Biogeographic characterization of blue whale song worldwide: Using song to identify populations. *J. Cetacean Res. Manage*. 8(1): 55–65.

O′Leary, S.J., Puritz, J.B., Willis, S.C., Hollenbeck, C.M. and Portnoy, D.S. 2018. These aren′t the loci you′e looking for: Principles of effective SNP filtering for molecular ecologists. *Mol. Ecol.* 27: 3193–3206.

Pastene, L.A., Acevedo, J. and Branch, T.A. 2020. Morphometric analysis of Chilean blue whales and implications for their taxonomy. *Mar. Mam. Sci.* 36(1): 116–135.

Purcell, S., Neale, B., Todd-Brown, K., Thomas, L., Ferreira, M.A.R., Bender, D., Maller, J., Sklar, P., de Bakker, P.I.W., Daly, M.J. and Sham, P.C. 2007. PLINK: A tool set for whole-genome association and population-based linkage analyses. *Am. J. Human Genet.* 81(3): 559–575.

Rochette, N.C., Rivera-Colón, A.G., Catchen, J.M. 2019. Stacks 2: Analytical methods for paired-end sequencing improve RADseq-based population genomics. *Mol. Ecol.* 28(21): 4737–4754.

Talenti, A., Palhière, I., Tortereau, F., Pagnacco, G., Stella, A., Nicolazzi, E.L., Crepaldi, P., Tosser-Klopp, G. and Consortium, A. 2018. Functional SNP panel for parentage assessment and assignment in worldwide goat breeds. *Genet. Sel. Evol.* 50: 55. DOI: 10.1186/s12711-018-0423-9.

Thaden, A., Nowak, C., Tiesmeyer, A., Reiners, T.E., Alves, P.C., Lyons, L.A., Mattucci, F., Randi, E., Cragnolini, M., Galián, J., Hegyeli, Z., Kitchener, A.C., Lambinet, C., Lucas, J.M., Mölich, T., Ramos, L., Schockert, V. and Cocchiararo, B. 2020. Applying genomic data in wildlife monitoring: Development guidelines for genotyping degraded samples with reduced single nucleotide polymorphism panels. *Mol. Ecol. Resour.* 20(3): 662–680.

Thavornkanlapachai, R., Armstrong, K.N., Knuckey, C., Huntley, B., Hanrahan, N. and Ottewell, K. 2024. Species-specific SNP arrays for non-invasive genetic monitoring of a vulnerable bat. *Sci. Rep.* 14(1): 1847.

Torres-Florez, J.P., Hucke-Gaete, R., LeDuc, R., Lang, A., Taylor, B., Pimper, L.E., Bedrinana-Romano, L., Rosenbaum, H.C. and Figueroa, C.C. 2014. Blue whale population structure along the eastern South Pacific Ocean: Evidence of more than one population. *Mol. Ecol.* 23(24): 5998–6010.

Wickham, H. and Wickham, H. 2016. Getting Started with ggplot2. *ggplot2: Elegant Graphics for Data Analysis* 11–31.

Technical Reports of the Institute of Cetacean Research (2024) pp. 15–25

Technical Report (not peer reviewed)

Report and highlights of the dedicated sighting survey under the Japanese Abundance and Stock structure in the Antarctic (JASS-A) in the 2023/24 austral summer season

Tatsuya ISODA[1,*], Takashi YOSHIDA[1], Yujin KIM[1], Claudio A. MORAGA[2] and Koji MATSUOKA[1]

[1] *Institute of Cetacean Research, 4–5 Toyomi-cho, Chuo-ku, Tokyo 104–0055, Japan*

[2] *Centro de Estudios del Cuaternario de Fuego-Patagonia y Antártica (CEQUA), Punta Arenas, Chile*

**Contact e-mail: isoda@cetacean.jp*

ABSTRACT

The results of the sighting survey of the Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A) in the 2023/24 austral summer season are reported. Two dedicated sighting vessels were engaged in the line transect method survey in a part of Antarctic Area IV (70°E–100°E) for 36 days, from 7 January to 11 February 2024. For the survey, the research area was divided into northern and southern strata and Prydz Bay. In addition, surveys were conducted in the coastal ice-free waters in the Davis Sea. The total searching distance in the research area was 3,278.3 n.miles (6,071.4 km). Four baleen whale species and at least two toothed whale species were sighted in the research area. Other research activities such as biopsy sampling, photo-ID, satellite tagging, and oceanographic observations were also conducted. The data and samples collected are required for the main and secondary research objectives of JASS-A program.

INTRODUCTION

Long-term systematic surveys on whales and the ecosystem in the Antarctic, such as the JARPA/JARPAII[1], NEWREP-A[2] and IWC IDCR/SOWER[3], obtained important data pertaining to the study of abundance and abundance trends of large whales and their biology as well as the role of whales in the Antarctic ecosystem. All these research programs have been terminated. The last NEWREP-A survey was carried out in the 2018/19 austral summer season.

The Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A) commenced in the 2019/20 austral summer season because it was considered important to continue with the whale and ecosystem surveys in the Indo-Pacific region of the Antarctic Ocean through dedicated sighting surveys and other non-lethal research techniques. JASS-A has two main research objectives, i) the study of the abundance and abundance trends of large whale species, and ii) the study of the distribution, movement and stock structure of large whale species. JASS-A also has several secondary research objectives related to oceanography, marine debris, genetic data to estimate abundance, whale biology and study on the utility of Unmanned Aerial Vehicle (UAV). The JASS-A program was presented to the 2019 meeting of IWC SC[4] (GOJ, 2019a), the 2019 meeting of CCAMLR-EMM[5] (GOJ, 2019b) and the 2019 meeting of NAMMCO SC[6] (GOJ, 2019c).

The approach of JASS-A is systematic vessel-based sighting surveys utilizing the line transect method. Surveys are designed and conducted following the protocols included in the 'Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme' (IWC, 2012). Sighting protocols are the same as those used in the former IDCR/SOWER surveys (Matsuoka *et al.*, 2003; IWC, 2008). The JASS-A surveys are conducted alternatively in IWC Management

[1] Japanese Whale Research Programs under Special Permit in the Antarctic, Phases I and II

[2] New Scientific Whale Research Program in the Antarctic Ocean

[3] International Decade for Cetacean Research/Southern Ocean Whale and Ecosystem Research

[4] International Whaling Commission-Scientific Committee

[5] Commission for the Conservation of Antarctic Marine Living Resources-Working Group on Ecosystem Monitoring and Management

[6] North Atlantic Marine Mammal Commission-Scientific Committee

Areas III, IV, V and VI by one or two specialized vessels, over a tentative period of eight austral summer seasons.

The first to fourth JASS-A surveys were carried out in the 2019/20, 2020/21, 2021/22 and 2022/23 austral summer seasons, respectively, and covered the sector 000°–035°E of Antarctic Area III West and 145°W–120°W of Antarctic Area VI East.

The fifth JASS-A survey was carried out in the 2023/24 season and covered the sector 70°E–100°E of Antarctic Area IV. This paper presents a summary of the 2023/24 JASS-A survey results.

SURVEY DESIGN

Research area

The research area of JASS-A is comprised of IWC Management Areas III, IV, V and VI, south of 60°S (Figure 1). The research area in the 2023/24 season was a part of Antarctic Area IV (70°E–100°E), south of 60°S (Figure 1). The area was divided into northern and southern strata. The boundary between these strata was defined by a line 45 n.miles from the northern edge of the pack-ice (Figure 2). In addition, an area in the coastal ice-free waters south of 65°30'S, which was formed at the Davis Sea, an area of the sea along the coast between the West Ice Shelf and the Shackleton Ice Shelf (89°E–95°E). A polynya was formed in mid-January, which could be surveyed only in late in January when ice-free waters were formed. Details of the ice configuration are shown in Figure 3.

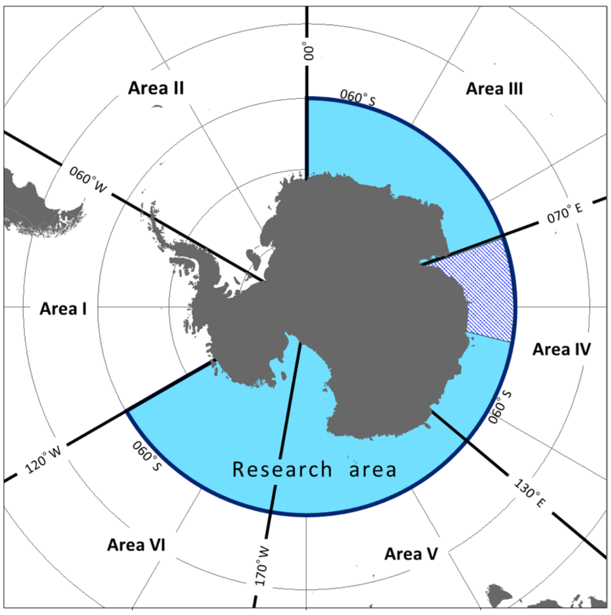


Figure 1. Research area of JASS-A. The shaded area (70°E–100°E) indicates the surveyed area in the 2023/24 austral summer season.

Research vessel

The dedicated sighting vessels *Yushin-Maru* No. 3 (*YS3*) and *Yushin-Maru* No. 2 (*YS2*) were engaged in the survey. The specifications for both vessels are the same and are shown in Figure 4. Eight researchers participated in the survey, five in *YS3* and three in *YS2*. They had experience in conducting line transect surveys, biopsy sampling, photo-identification (photo-ID), satellite tagging and oceanographic survey through the previous JARPA/JARPAII, NEWREP-A, previous JASS-A surveys or other research programs.

Sighting procedures and experiments

The procedures for sighting and experiments were the same as in previous JASS-A surveys. See Isoda *et al.* (2024) for details of the procedures used for sighting surveys and other research activities such as sighting distance and angle experiment, photo-ID, biopsy sampling, satellite tagging, oceanographic survey, marine debris observation, and survey using UAV.

RESULTS OF THE SURVEY

Narrative of the survey

Table 1 shows the itinerary of the survey. The duration of this cruise was 99 days. The *YS3* and *YS2* departed Japan on 8 December 2023. They arrived at the home port on 20 December. The *YS3* and *YS2* started the sighting survey in Antarctic Area IV at 62°57'S; 99°55'E on 7 January, and at 62°03'S; 100°00'E on 7 January 2024, respectively. The *YS3* and *YS2* completed the surveys at position 60°06'N; 84°45'E on 11 February and 62°40'S; 95°36'E on 11 February, respectively. The *YS3* and *YS2* arrived at the home port on 29 February, and finally in Japan on 15 March.

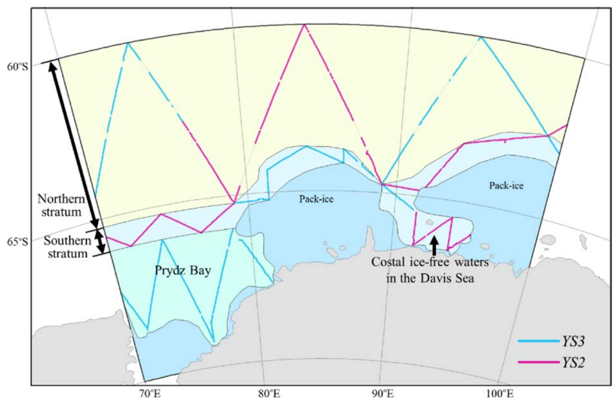


Figure 2. Research area (70°E–100°E) indicating northern, southern strata, Prydz Bay and the coastal ice-free waters searching efforts (blue and red lines for *Yushin-Maru* No. 3 (*YS3*) and *Yushin-Maru* No. 2 (*YS2*), respectively) of the JASS-A survey in the 2023/24 austral summer season.

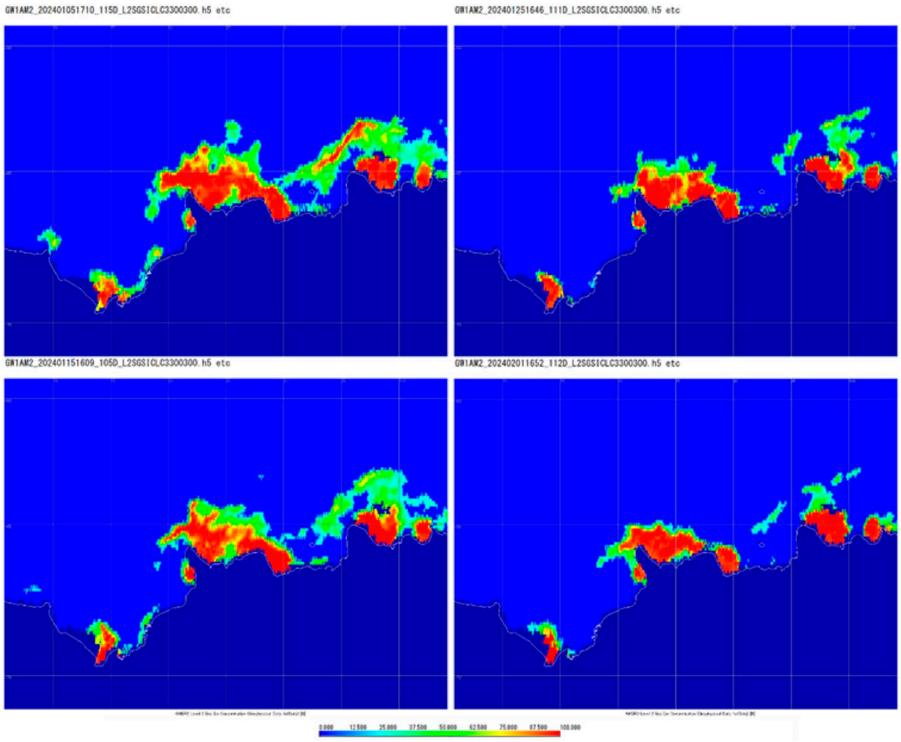


Figure 3. Maps of the pack-ice distributions in the research area for dates 5 January (upper left), 15 January (lower left), 25 January (upper right) and 1 February (lower right) 2024, constructed by Japan Aerospace Exploration Agency (JAXA), based on observational data acquired by the Advanced Microwave Scanning Radiometer 2 (AMSR2). Note that the ice-free waters became accessible to the vessel in late January.

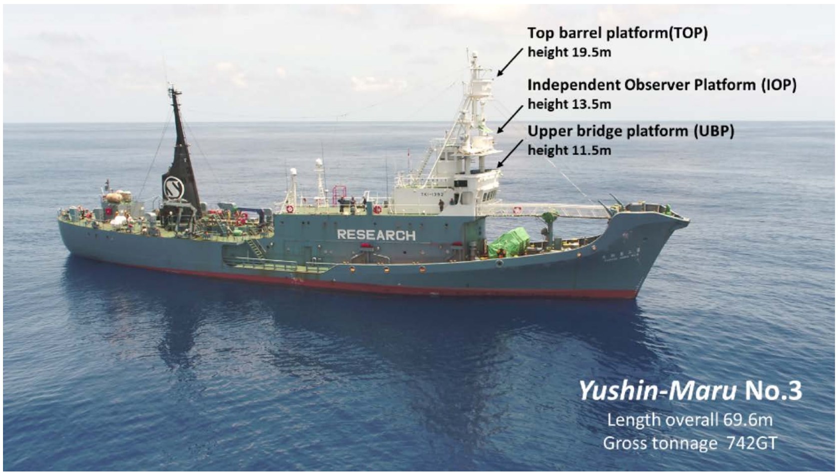


Figure 4. Specifications of the dedicated sighting vessel *Yushin-Maru* No. 3.

Research effort in the research area

Table 2 shows a summary of the searching effort spent during the survey. Both vessels, *YS3* and *YS2* were engaged in the research for 36 days. The total searching effort of both vessels was 3,278.3 n.miles (6,071.4 km); 1,595.0 n.miles in NSP mode during 149 hours 24 minutes of research and 1,683.3 n.miles in IO mode during 155 hours 11 minutes of research.

In the northern stratum, the total searching effort was 1,374.2 n.miles (NSP: 680.2 n.miles; IO: 694.0 n.miles), and the searching effort coverage was 74%. In the southern stratum, the total searching effort was 927.0 n.miles (NSP: 429.2 n.miles; IO: 497.8 n.miles), and the searching effort coverage was 93%. In Prydz Bay, the total searching effort was 682.3 n.miles (NSP: 332.5 n.miles; IO: 349.8 n.miles), and the searching effort coverage was 89%. In the coastal ice-free waters in the Davis Sea, the total searching effort was 294.7 n.miles (NSP: 152.9 n.miles; IO: 141.8 n.miles), and the searching effort coverage was 89%.

Therefore, a good distribution of effort within all strata

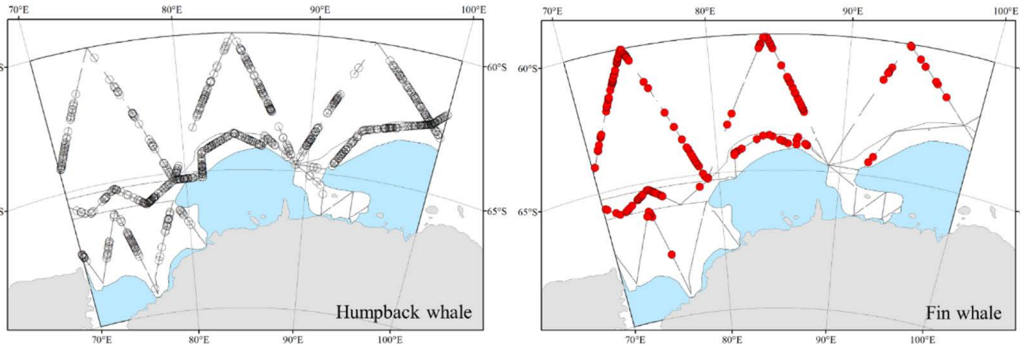


Figure 4a. Geographical distribution of primary sightings of humpback and fin whales during the 2023/24 JASS-A survey.

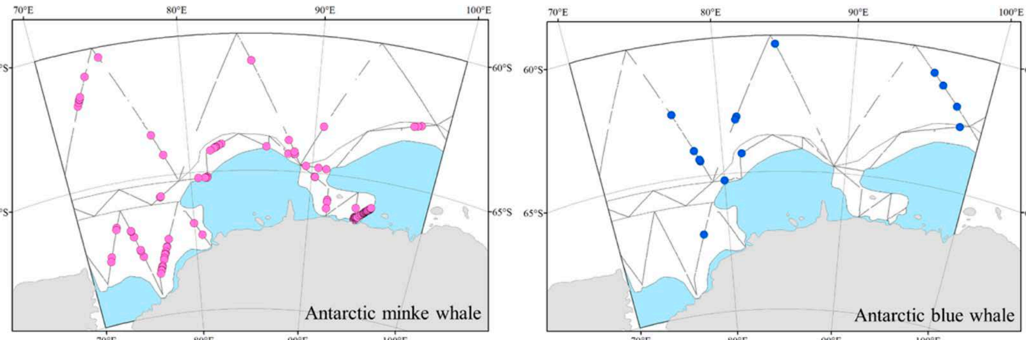


Figure 4b. Geographical distribution of primary sightings of Antarctic minke and Antarctic blue whales during the 2023/24 JASS-A survey.

Table 1
Itinerary of the 2023/24 JASS-A dedicated sighting survey.

Date (y/m/d)	Event
2023/11/13	Planning meeting held at Tokyo, Japan
2023/12/7	Pre-cruise meeting held at Shiogama, Japan
2023/12/8	*YS3* and *YS2* departed Shiogama, Japan
2023/12/10	*YS3* and *YS2* started transit surveys at 29°29′N; 139°23′E and at 29°15′N; 139°35′E, respectively
2023/12/20	*YS3* and *YS2* arrived in the home port (Surabaya, Indonesia)
2024/1/6	*YS3* and *YS2* finished transit surveys at 62°55′S; 99°49′E and at 61°00′N; 99°35′E, respectively
2024/1/7	*YS3* and *YS2* started surveys in the research area at 62°57′S; 99°55′E and at 62°03′S; 100°00′E, respectively
2024/2/11	*YS3* and *YS2* completed surveys in the research area at 60°06′S; 84°45′E and at 62°40′S; 95°36′E, respectively and started transit surveys
2024/2/29	*YS3 and YS2* arrived in the home port (Dili, East Timor)
2024/3/12	*YS3* and *YS2* finished transit surveys at 30°48′N; 131°48′E and at 32°13′N; 139°36′E, respectively
2024/3/15	*YS3* and *YS2* arrived in Japan and post cruise meeting at Setoda and Shiogama, Japan, respectively.

and survey mode was achieved. The total experimental time for photo-ID, biopsy sampling, tagging and distance and angle experiment was 37 hours 03 minutes.

Whale sightings in the research area

Four baleen whale species and at least two toothed whale species were identified in the research area. The dominant whale species sighted in the research area was the humpback whale (874 schools/1,706 individuals) followed by the fin whale (200/467). Sightings of other species were as follows; Antarctic minke (111/178), sperm (42/43), killer (19/263, including Type A, Type B, Type C and undetermined type) whales, Ziphiidae (19/26) and Antarctic blue whale (15/18) (Table 3).

Humpback whales

Humpback whale was distributed in all research areas excepting the south part of coastal ice-free waters in

Table 2

Summary of searching effort and time spent by *YS3* and *YS2* during the 2023/24 JASS-A survey.

Vessel: *YS3* Survey Sections	Date and time Start	End	Searching effort (distance [n.miles] and time [hours: minutes: seconds]) NSP		IO		Experiments time Photo-ID, Biopsy, Satellite tag experiment	Estimated angle and distance training/experiment
Transit survey (Japan–Entering foreign countries EEZ)	2023/12/10 7:25	2023/12/14 16:48	334.7	28:59:41	—	—	0:00:00	0:00:00
Transit survey (Leaving foreign countries EEZ–Research area)	2023/12/26 6:05	2024/1/6 18:00	820.8	71:14:03	—	—	3:17:13	0:00:00
Research area (Area IV 70°E–100°E)	2024/1/7 6:00	2024/1/16 8:43	195.2	18:11:38	220.1	20:11:36	2:54:46	2:11:54
Coastal ice-free waters in the Davis Sea	2024/1/16 9:15	2024/1/16 17:38	38.3	3:27:56	28.9	2:56:56	0:00:00	0:00:00
Transit in the research area	2024/1/16 17:39	2024/1/19 18:00	—	—	—	—	0:00:00	0:00:00
Research area (Area IV 70°E–100°E)	2024/1/20 6:00	2024/1/24 14:44	117.2	11:34:45	206.1	19:48:56	1:49:16	0:00:00
Transit in the research area	2024/1/24 14:45	2024/1/27 9:36	—	—	—	—	0:00:00	0:00:00
Prydz Bay	2024/1/27 9:37	2024/2/4 15:03	332.6	31:02:48	349.7	31:17:26	5:20:34	0:00:00
Transit in the research area	2024/2/4 15:04	2024/2/5 7:18	—	—	—	—	0:00:00	0:00:00
Research area (Area IV 70°E–100°E)	2024/2/5 7:19	2024/2/11 11:59	158.6	14:36:48	178.8	16:16:42	6:23:52	4:26:28
Transit survey (Research area–Entering foreign countries EEZ)	2024/2/11 12:00	2024/2/26 12:43	918.1	82:46:56	—	—	0:00:00	0:00:00
Transit survey (Leaving foreign countries EEZ–Japan)	2024/3/8 7:40	2024/3/12 17:15	214.6	18:26:34	—	—	0:00:00	0:00:00
Total			3,130.0	280:21:09	983.5	90:31:36	19:45:41	6:38:22

Vessel: *YS2* Survey Sections	Date and time Start	End	Searching effort (distance [n.miles] and time [hours: minutes: seconds]) NSP		IO		Experiments time Photo-ID, Biopsy, Satellite tag experiment	Estimated angle and distance training/experiment
Transit survey (Japan–Entering foreign countries EEZ)	2023/12/10 7:25	2023/12/14 17:00	289.1	24:40:52	—	—	0:00:00	0:00:00
Transit survey (Leaving foreign countries EEZ–Research area)	2023/12/26 6:05	2024/1/6 18:00	884.1	77:07:07	—	—	0:53:23	0:00:00
Research area (Area IV 70°E–100°E)	2024/1/7 6:00	2024/1/29 14:17	504.6	47:17:58	457.0	42:17:05	8:20:07	2:29:15
Transit in the research area	2024/1/29 14:18	2024/1/30 17:24	—	—	—	—	1:14:33	0:00:00
Research area (Area IV 70°E–100°E)	2024/1/30 17:25	2024/2/2 16:33	134.0	12:06:43	129.7	11:52:09	1:53:08	0:00:00
Transit in the research area	2024/2/2 16:34	2024/2/5 7:29	—	—	—	—	0:00:00	0:00:00
Coastal ice-free waters in the Davis Sea	2024/2/5 7:30	2024/2/11 11:59	114.5	11:05:39	113.0	10:31:00	0:00:00	0:00:00
Transit survey (Research Area–Entering foreign countries EEZ)	2024/2/11 12:00	2024/2/25 14:45	781.4	67:53:24	—	—	0:00:00	4:35:52
Transit survey (Leaving foreign countries EEZ–Japan)	2024/3/7 8:11	2024/3/12 16:45	225.2	18:37:47	—	—	0:00:00	0:00:00
Total			2,932.9	258:49:30	699.7	64:40:14	12:21:11	7:05:07

Table 3
Number of sightings made during the 2023/24 JASS-A survey in the research area, by stratum and species.

Species	Area IV (70°E–100°E)																					
	Southern stratum				Northern stratum				Prydz Bay				Costal ice-free waters in the Davis Sea				Sub-total				Total	
	Prim.		Second.		Prim.		Second.		Prim.		Second.		Prim.		Second.		Prim.		Second.			
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Antarctic blue whale	3	4	0	0	11	13	0	0	1	1	0	0	0	0	0	0	15	18	0	0	15	18
Fin whale	58	127	0	0	129	314	6	10	7	16	0	0	0	0	0	0	194	457	6	10	200	467
Like fin whale	5	11	0	0	2	2	0	0	0	0	0	0	0	0	0	0	7	13	0	0	7	13
Antarctic minke whale	21	28	0	0	14	20	3	3	26	43	1	1	44	81	2	2	105	172	6	6	111	178
Like Antarctic minke whlae	2	2	0	0	0	0	0	0	2	2	1	1	0	0	1	1	4	4	2	2	6	6
Humpback whale	385	740	8	9	363	721	20	35	89	188	3	5	6	8	0	0	843	1,657	31	49	874	1,706
Like humpback whale	6	7	0	0	13	18	0	0	1	1	0	0	1	1	0	0	21	27	0	0	21	27
Baleen whales	3	3	1	1	9	9	1	2	0	0	0	0	0	0	0	0	12	12	2	3	14	15
Sperm whale	22	23	1	1	6	6	0	0	5	5	1	1	7	7	0	0	40	41	2	2	42	43
Southern bottlenose whale	8	18	1	1	2	3	1	2	0	0	0	0	0	0	0	0	10	21	2	3	12	24
Mesoplodon	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	1	3
Killer whale (Undetermined)	3	50	1	5	2	21	0	0	1	2	0	0	5	56	0	0	11	129	1	5	12	134
Killer whale (Type A)	1	17	0	0	0	0	0	0	2	11	0	0	0	0	0	0	3	28	0	0	3	28
Killer whale (Type B)	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	1	4
Killer whale (Type C)	0	0	0	0	0	0	0	0	3	97	0	0	0	0	0	0	3	97	0	0	3	97
Ziphiidae	6	10	0	0	11	14	1	1	0	0	0	0	1	1	0	0	18	25	1	1	19	26
Unidentified whales	5	5	0	0	11	14	0	0	2	3	0	0	3	3	0	0	21	25	0	0	21	25

Prim.: primary sighting, Second.: secondary sighting, Sch.: schools, Ind.: indisivuals

the Davis Sea (Figure 4a). According to previous surveys (Kasamatsu *et al.*, 1989; Ensor *et al.*, 1999; Matsuoka *et al.*, 2015), humpback whales were mainly distributed in the northern stratum in late 1990′s and were distributed in the entire research area after 2010′s, especially in the southern stratum and Prydz Bay. In Areas IV, both estimates of annual rate of increase of humpback whales, 13.6% (95% CI=8.4–18.7%), and estimates of abundance for humpback whales may suggest that are close to the carrying capacity of the population (Hakamada and Matsuoka, 2014). The study of spatial distribution in this area suggested humpback whales expanded their habitat closer to the shelf break (800 m isobath), where Antarctic minke whales are mainly distributed, as their abundance rebounded and humpback whales were rarely distributed on the shelf (Murase *et al.*, 2014). Our results indicate that the habitat of humpback whales extended further south of this area, encompassing Prydz Bay.

Fin whales

Fin whale was mainly distributed in the northern and southern strata (Figure 4a). The compared density between previous surveys (Kasamatsu *et al.*, 1989; Ensor *et al.*, 1999; Matsuoka *et al.*, 2015) and the present survey showed that there was not only a clear and rapid increase in the northern stratum but also in the southern stratum and Prydz Bay in later seasons. The increase in the density of this species in the survey area is thought to reflect its population recovery, as it has recently expanded its distribution area to the whole research area.

Antarctic minke whales

Antarctic minke whale was mainly distributed in the southern part of the research area (Figure 4b) with higher concentrations observed in the southernmost part of coastal ice-free waters in the Davis Sea. In particular, the high-density distribution observed in the coastal ice-free waters in the Davis Sea could be indicative that remarkable changes in the main distribution have occurred. It is thought that is caused by the geographical expansion of fin and humpback whales as mentioned above, which was confirmed in this survey. This result is similar with the interpretation of Fujise and Pastene (2021) that a large proportion of Antarctic minke whale population could have been moving into in polynias within sea ice fields in recent years, reflecting perhaps a response of this species to the geographical expansion of humpback and fin whales to the south.

The spatial distributions of Antarctic minke, humpback and fin whales in this survey showed remarkable changes regarding previous surveys. The current hypothesis of cascading distribution effects borrows from the interference prediction of competition among these whale species. In this way humpback whales may be expanding their range southward due to the recovery of the fin whale population, and the expansion of fin whales′ distribution range, as well as reaching their own carrying capacity, may lead to further localization of Antarctic minke whales′ distribution range.

Antarctic blue whales

Antarctic blue whale was sighted in the northern, southern stratum and Prydz Bay (Figure 4b), however it was mainly distributed in the northern stratum. The density of the present survey was higher than the density of previous surveys, suggesting that the Antarctic blue whale population recovery has continued in recent years.

Duplicate sightings

Duplicates sightings were those sightings made concurrently by both the IOP and TOP barrel observers during the IO mode survey. These data will be used to estimate $g(0)$, which in turn will be used to adjust estimates of abundance. There was a total of 148 duplicates involving several whale species.

Other research activities

Table 4 shows a summary of results of different experiments.

Sighting distance and angle experiment

The sighting distance and angle experiment was conducted in order to evaluate the accuracy of sighting distance and angle provided by primary observers. The results of this experiment will be used for the calculation of abundance estimates. The actual experiments were successfully completed on 6 February for 128 trials in *YS3*, and on 17 February for 144 trials in *YS2*.

Photo-ID

Photo-ID data is used for individual matching exercise to investigate distribution and movement of large whales. A total of 16 Antarctic blue, 94 humpback, 5 southern right and 84 killer whales were successfully photo-identified during the entire survey. These data will be registered into the Institute of Cetacean Research (ICR) database (see Matsuoka and Pastene, 2014).

Biopsy sampling for whales

Biopsy samples are used for genetic studies on stock structure of large whales and for other feasibility studies related to the specific objectives of the JASS-A. For the entire survey, a total of 54 biopsy samples were collected from 8 Antarctic blue, 9 fin, 3 Antarctic minke, 24 humpback, 3 sei, 4 southern right and 3 killer whales, using the Larsen system (Larsen, 1998). Biopsy samples were stored at −20°C.

Satellite tagging

Satellite tagging is used for the study of movement, distribution and stock structure of whales. The satellite-monitored tags (SPOT and SPLASH-types, Wildlife Computers, Redmond, Washington, USA) were deployed with the Air Rocket Transmitter System (ARTS) (LK-ARTS, Skutvik, Norway). The detail of deployment system, protocols and research results to date were described in Konishi *et al.* (2020). During the whole survey, 6 fin, 2 Antarctic minke and 3 humpback whales were tagged.

Oceanographic survey

Oceanographic observations are important to understand the relationship of whales and the physical environment. The vertical distribution of water temperature and salinity were recorded from sea surface to 1,850 m water depth using XCTD system (eXpendable Conductivity, Temperature and Depth profiler, Tsurumi-Seiki Co., Ltd., Yokohama, Japan; probe type: XCTD-4N) with Digital Converter MK-150N (*YS3*) and MK-150P (*YS2*) at 148 stations (Figure 5).

Marine debris observation

Studies on marine debris in the Antarctic are very scarce. It is important to continue with this kind of survey in order to monitor future trends in the occurrence of marine debris. One fishing buoy was observed in the research area. These data will be registered into the ICR database and reported in the future (e.g. Isoda *et al.*, 2021).

Feasibility study on the utility of UAV

The VTOL-UAV ASUKA conducted a successful autonomous flight of a total distance of 297.5 n.miles (551 km) and collected aerial images related to whale sighting surveys and basic data on improving UAV ASUKA′s performance for long-distance autonomous flights in the polar region.

Sighting survey in low-middle latitude area

Sighting surveys in low-mid latitude areas have the potential to collect data on seasonal movement and possible breeding grounds of whale species. JASS-A has been collecting information on cetaceans by conducting sighting surveys in the low-middle latitude area using the opportunity of a round-trip cruise to the Antarctic, excluding waters of foreign countries EEZs.

Table 4
Summary of the results of experiments conducted during the 2023/24 JASS-A survey.

Experiments	Results and descriptions
Sighting distance and angle experiment	272 trials completed
Photo-ID	Obtained from 16 Antarctic blue, 94 humpback, 5 southern right and 84 killer whales
Biopsy sampling	Collected from 8 Antarctic blue, 9 fin, 3 Antarctic minke, 24 humpback, 3 Sei, 4 southern right and 3 killer whales
Satellite tagging	Deployed on 6 fin, 2 Antarctic minke and 3 humpback whales
Oceanographic survey	148 XCTD casts
Marine debris observation	1 fishing buoy was observed in the research area
UAV autonomous flight and collected aerial images	297.5 n.miles flew with 13 autonomous flights

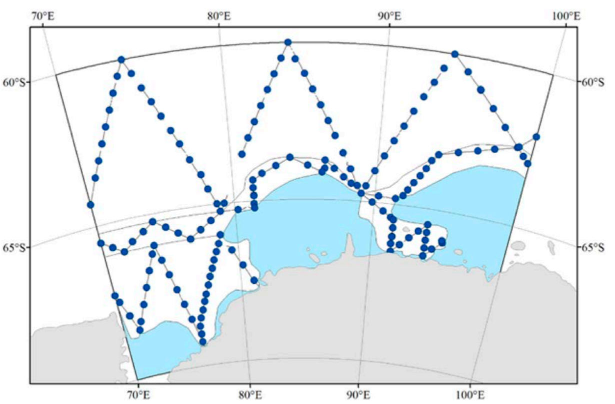


Figure 5. Oceanographic stations (XCTD casting points) at the 2023/24 JASS-A survey.

In transit from homeport in Japan to boundary of the foreign countries EEZ, sighting survey was conducted by both vessels from 10 to 14 December (Table 2). The total searching effort of both vessels was 623.8 n.miles (Table 2) and sperm whale (16/31) were sighted.

In transit from the boundary of the foreign countries EEZ to the starting position in the Antarctic research area, sighting survey was conducted by both vessels from 26 December to 6 January (Table 2). The total searching effort of both vessels was 1,704.9 n.miles (Table 2). Total sightings included blue (1/1), fin (1/1), Antarctic minke (1/1), humpback (2/3), southern right (4/5), sei (14/24), sperm (1/1), Ziphiidae (2/6) and *Mesoplodon* (2/9) whales. Biopsy sample was collected from 4 southern right and 3 sei whales.

In transit from the ending position in the Antarctic research area to the boundary of the foreign countries EEZ, sighting survey was conducted by *YS3* from 11 to 26 February and *YS2* from 11 to 25 February (Table 2). The searching effort was 1,699.5 n.miles (Table 2) and the total sightings included fin (1/1), sperm (14/24), killer (3/10), Ziphiidae (4/8) and *Mesoplodon* (6/16) whales.

In transit from the foreign countries EEZ to homeport in Japan, sighting survey was conducted by *YS3* from 8 to 12 March and *YS2* from 7 to 12 March (Table 2). The total searching effort of both vessels was 439.8 n.miles and the total sightings included Bryde′s (2/2) and killer (1/3) whales.

A total of experimental time in transit survey for photo-ID, biopsy sampling, satellite tagging and estimated angle and distance experiment was 8 hour 46 minutes (Table 2).

HIGHLIGHTS OF THE SURVEY

The 2023/24 JASS-A survey covered a portion of Area IV (70°E–100°E) and was successful in collecting sighting data required for cetacean abundance estimation of in this area. The survey conducted in Prydz Bay and the coastal ice-free waters in the Davis Sea, in addition to the northern and southern strata, was of particular importance in understanding the current distribution of large baleen whales. Several other data necessary for understanding stock structure, movement and the environment of whales were collected during the survey. The data collected through the JASS-A will be analysed in conjunction with the data collected by the previous JARPA/JARPA, NEWREP-A and IDCR/SOWER surveys in the same region so that the analyses can be based on a long and consistent data set, enabling a thorough and unique understanding of long-term population dynamics.

ACKNOWLEDGEMENTS

We thank the captains, crew members and researchers who participated in the 2023/24 JASS-A survey for their effort in the collection of data and samples. We also thank the Fisheries Agency of Japan for the funding and logistic support for the JASS-A program. We appreciate Y. Fujise, T. Tamura (ICR), H. Murase (Tokyo University of Marine Science and Technology), T. Hakamada, M. Taguchi, T. Katsumata (ICR) and the steering group of JASS-A for their guidance in the design and implementation of the research, E.P. Acuña Gómez (CEQUA) for support participation of CEQUA's scientist in the field survey. Kyodo Senpaku Co. Ltd. is acknowledged for their arrangements and support for this cruise. ICR colleagues for support survey activity and K. Konishi (ICR) for preparation of satellite tags. We are grateful to L.A. Pastene (ICR) for his assistance in preparing this report and to the TEREP editorial team for editorial check.

REFERENCES

Ensor, P., Sekiguchi, K., Doherty, J., Kleivane, L., Ljungblad, D., Marques, F., Matsuoka, K., Narita, H., Pitman, R. and Sakai, K. 1999. 1998–99 IWC-Southern Ocean Whale and Ecosystem Research (IWC-SOWER) Antarctic cruise, Areas III and IV. Paper SC/51/CAWS6 presented to the IWC Scientific Committee, May 1999 (unpublished). 61 pp. [Available from the IWC Secretariat].

Fujise, Y. and Pastene, L.A. 2021. Whales as Indicators of Historical and Current Changes in the Marine Ecosystem of the Indo-Pacific Sector of the Antarctic. *Glaciers and Polar Environment.* IntechOpen. 19 pp. DOI: http://dx.doi.org/10.5772/intechopen.94323.

Government of Japan. 2019a. Outline of a research program to investigate the abundance, abundance trends and stock structure of large whales in the Indo-Pacific region of the Antarctic, including a survey plan for the 2019/20 austral summer season. Paper SC/68a/ASI8 presented to the IWC Scientific Committee, May 2019 (unpublished). 16 pp. [Available from the IWC Secretariat].

Government of Japan. 2019b. Outline of a research program to investigate the abundance, abundance trends and stock structure of large whales in the Indo-Pacific region of the Antarctic, including a survey plan for the 2019/20 austral summer season. Paper WG-EMM-2019/68 presented to CCAMLR meeting of Working Group on Ecosystem Monitoring and Management, June–July 2019 (unpublished). 16 pp.

Government of Japan. 2019c. Outline of a research program to investigate the abundance, abundance trends and stock structure of large whales in the Indo-Pacific region of the Antarctic, including a survey plan for the 2019/20 austral summer season (revised version of document SC/68a/ASI08 presented to the IWC SC 2019 meeting). Paper SC/26/NPR-JP presented to the 26th meeting of the NAMMCO Scientific Committee, October–November 2019 (unpublished). 16 pp.

Hakamada, T. and Matsuoka, K. 2014. Estimates of abundance and abundance trend of the humpback whale in Areas IIIE-VIW, south of 60°S, based on JARPA and JARPAII sighting data (1989/90–2008/09). Paper SC/F14/J4 presented to the IWC/SC Review Workshop of the Japanese Whale Research Program under Special Permit in the Antarctic-Phase II (JARPAII), February 2014 (unpublished). 41 pp. [Available from the IWC Secretariat].

International Whaling Commission. 2008. IWC SOWER Cruise 2008/09, Information for Researchers. http://iwcoffice.org/_documents/sci_com/SOWER/Guide%20%20for%20Researchers%202008-09.pdf. [Available from the IWC Secretariat].

International Whaling Commission. 2012. Requirements and guidelines for conducting surveys and analysing data within the Revised Management Scheme. *J. Cetacean Res. Manage.* (Suppl.) 13: 507–517.

Isoda, T., Matsuoka, K., Tamura, T. and Pastene, L.A. 2021. Spatial and temporal distribution of floating marine macro debris in the Indo-Pacific region of the Antarctic. *Cetacean Population Studies* 3: 198–211.

Isoda, T., Yoshida, T., Yoshimura, I., Kim, Y., Moraga, C.A., Ueta, E., Higashi, M., Kawajiri, K., Ohkoshi, C., Abe, N. and Matsuoka, K. 2024. Results of the Japanese Abundance and Stock structure Survey in the Antarctic (JASS-A) during the 2023/2024 austral summer season. Paper SC/69B/ASI/04 presented to the IWC Scientific Committee, April–May 2024 (unpublished). 31 pp. [Available from the IWC Secretariat].

Kasamatsu, F., Ensor, P., Mermoz, J., Shigemune, H., Nakanishi, S., Zorin, A., Da silva, V., Newcomer, M. and Ohwada, A. 1989. Report of the 1988/89 IWC/IDCR Southern Hemisphere Minke Whale Assessment Cruise, Area IV. Paper SC/41/SHMi7 presented to the IWC Scientific Committee, May–June 1989 (unpublished). 19 pp. [Available from the IWC Secretariat].

Konishi, K., Isoda, T., Bando, T., Minamikawa, S. and Kleivane, L. 2020. Antarctic minke whales find ice gaps along the ice edge in foraging grounds of the Indo-Pacific sector (60°E and 140°E) of the Southern Ocean. *Polar Biology*. 43(4): 343–357.

Larsen, F. 1998. Development of a biopsy system primarily for use on large cetaceans. Paper SC/50/O15 presented to the IWC Scientific Committee, May 1998 (unpublished). 8 pp. [Available from the IWC Secretariat].

Matsuoka, K., Ensor, P., Hakamada, T., Shimada, H., Nishiwaki, S., Kasamatsu, F. and Kato, H. 2003. Overview of minke whale sightings surveys conducted on IWC/IDCR and SOWER Antarctic cruises from 1978/79 to 2000/01. *J. Cetacean Res. Manage.* 5(2): 173–201.

Matsuoka, K. and Pastene, L.A. 2014. Summary of photo-identification information of blue, southern right and humpback whales collected by JARPA/JARPAII. Paper SC/F14/J34 presented to the IWC Scientific Committee, February 2014 (unpublished). 11 pp. [Available from the IWC Secretariat].

Matsuoka, K., Tsunekawa, M., Yamaguchi, F., Honma, H., Ohkoshi, C. and Abe, N. 2015. Cruise report of the 2014/15 Japanese dedicated whale sighting survey in the Antarctic in Area IV. Paper SC/66a/IA7 presented to the IWC Scientific Committee, May–June 2015 (unpublished). 21 pp. [Available from the IWC Secretariat].

Murase, H., Matsuoka, K., Hakamada, T. and Kitakado, T. 2014. Preliminary analysis of changes in spatial distribution of Antarctic minke and humpback whales in Area IV during the period of JARPA and JARPAII from 1989 to 2006. Paper SC/F14/J18 presented to the IWC Scientific Committee, February 2014 (unpublished). 17 pp. [Available from the IWC Secretariat].

Appendix 1.

Photographs from the 2023/24 JASS-A survey in Antarctic Area IV

Photo 1. Antarctic blue whale.

Photo 2. Antarctic blue whale mother and calf (calf on far side).

Photo 3. Fin whale blow.

Photo 4. Antarctic minke whales.

Photo 5. Breaching humpback whale.

Photo 6. Diving humpback whale.

Photo 7. Southern right whale sighted during the low-middle latitude area survey.

Photo 8. Killer whales (type A).

Photo 9. VTOL-UAV ASUKA taking off from onboard.

Photo 10. Photo shooting humpback whales for individual identification.

Photo 11. Sighting survey in the iceberg belt.

Photo 12. Biopsy specimen of a humpback whale.

Technical Report (not peer reviewed)

Report and highlights of the Japanese dedicated sighting surveys in the North Pacific in 2023

Yujin KIM, Taiki KATSUMATA*, Tatsuya ISODA and Koji MATSUOKA

Institute of Cetacean Research, 4–5 Toyomi-cho, Chuo-ku, Tokyo 104–0055, Japan

Contact e-mail: katsumata@cetacean.jp

ABSTRACT

This paper presents the results of vessel-based sighting surveys conducted in 2023 by the Institute of Cetacean Research in the North Pacific. The research area was set between 20°N–50°N and 140°E–160°W. The surveys were conducted between 6 April and 6 November involving three seasons: spring, summer and autumn. The spring and summer surveys were conducted to examine the distribution and abundance of whales. Part of spring and autumn surveys were conducted to investigate the migration of whales using satellite tags. The research vessels *Yushin-Maru, Yushin-Maru* No.2 and *Kaiyo-Maru* No.7 were engaged in the surveys. A total of 10,778.7 n.miles were searched in the research area. Coverage of the searching efforts on the planned cruise track line was 81.3%. In total, eight large whale species, including blue (30 schools/34 individuals), fin (268/450), sei (160/243), Bryde′s (75/84), common minke (72/84), humpback (55/77), North Pacific right (1/1) and sperm (78/172) whales were sighted during the whole research. Photo-ID images were collected from blue (n=28), humpback (n=18), North Pacific right (n=1) and killer (n=66) whales. Biopsy skin samples using a Larsen system were collected from blue (n=4), fin (n=27), sei (n=47), common minke (n=1) and North Pacific right (n=1) whales. Satellite tags were attached on fin (n=22) and sei (n=44) whales. Data collected during these surveys will be used in studies on abundance, distribution, movement, and stock structure of several whale species.

INTRODUCTION

Dedicated cetacean sighting surveys in the western North Pacific were conducted in the late summer season since 1995 as a part of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN/JARPNII) and the New Scientific Whale Research Program in the western North Pacific (NEWREP-NP) based on the survey procedures of the International Whaling Commission/Southern Ocean Whale and Ecosystem Research (IWC/SOWER) (IWC, 2008). Based on the collected data, the distribution patterns of large whales such as blue, fin, sei, Bryde′s, common minke, humpback, North Pacific right and sperm whales, and abundance estimates of common minke, sei and Bryde′s whales were investigated and reported to the IWC SC (IWC, 2001; 2010; 2016; Hakamada *et al.*, 2009; Murase *et al.*, 2009; Pastene *et al.*, 2009; Matsuoka *et al.*, 2014; 2015).

The Fisheries Resources Institute (FRI) has also conducted dedicated sighting surveys for cetaceans in the North Pacific since the 1980s (Buckland *et al.*, 1992; Miyashita *et al.*, 1995; Miyashita and Kato, 2004; 2005; Shimada, 2004; Kanaji *et al.*, 2012). In 2019 the Government of Japan decided to continue the sighting surveys in the North Pacific (IWC, 2019) under the rational that the collection of sighting data to estimate abundance and biopsy/photo-identification data to examine stock structure have contributed in the past to the work on management and conservation of large whales by the IWC SC (IWC, 2016).

This paper reports the results of the Japanese dedicated sighting surveys conducted during 6 April and 6 November 2023 involving three seasons: spring, summer and autumn.

SURVEY DESIGN

Research period and area

In 2023, the surveys were conducted in three seasons: spring, summer and autumn. The objective of spring and summer surveys was the study of distribution and abundance of large whales from poorly documented seasons. The surveys during part of spring and autumn were designed to study the movement and migration of fin, sei and common minke whales using satellite tags. Figure 1

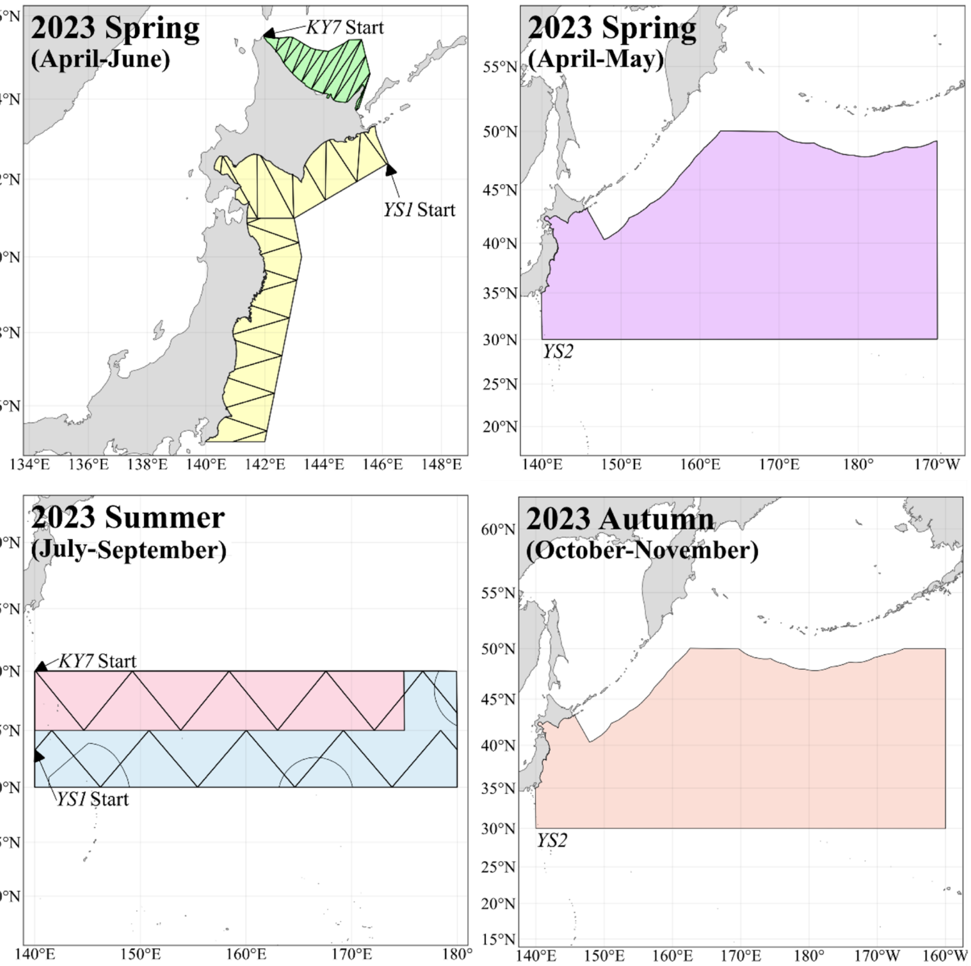


Figure 1. Research areas covered by the 2023 dedicated sighting surveys in each season. Upper left: spring survey. *Kaiyo-Maru* No.7 (*KY7*) covered the green area, and *Yushin-Maru* (*YS1*) covered the yellow area. Upper right: spring survey. *Yushin-Maru* No.2 (*YS2*) covered the purple area. Lower left: summer survey. *KY7* covered the pink area, and *YS1* covered the blue area. Lower right: autumn survey. *YS2* covered the orange area. The spring and autumn surveys conducted by *YS2* did not have a pre-determined track line.

illustrates the research areas covered in each season.

In the spring (April to June), the research area was set up between 30°N–50°N and 140°E–170°W; in the summer (July to September), between 20°N–30°N and 140°E–180°; and in the autumn (October to November), between 30°N–50°N and 140°E–160°W.

Research vessels

The sighting surveys in 2023 were conducted by the research vessels *Yushin-Maru* (*YS1*), *Yushin-Maru* No.2 (*YS2*) and *Kaiyo-Maru* No.7 (*KY7*). The vessels were equipped with a top barrel platform (TOP), IO barrel platform (IOP) and upper bridge (Figure 2).

Track line design

The pre-determined track lines in the spring and summer surveys are shown in Figure 1. The start points of the track lines were decided randomly using the 'Distance program ver. 7.3' (Thomas *et al.*, 2010) and the number of the line (width in the longitude) was decided by the research schedule based on the IWC survey guidelines (IWC, 2012). The spring and autumn surveys conducted by *YS2* did not set track lines because the objective was not to estimate abundance but to satellite tag of whales.

Sighting procedure

The sighting surveys were conducted using (1) Normal Passing mode (NSP), (2) Normal Closing mode (ASP) and (3) Passing with Independent Observer mode (IO). The latter mode was conducted to estimate whale abundance considering estimated $g(0)$. The survey modes adopted for each survey are shown in Table 1. The three survey modes followed the protocol endorsed for the SOWER surveys (e.g. Matsuoka *et al.*, 2003; IWC, 2008; 2012). As data from summer surveys are used to estimate the abundance of large whales, the IO mode was also adopt-

Figure 2. Research vessels participating in the 2023 dedicated sighting surveys: *Yushin-Maru* (*YS1*) (upper left), *Yushin-Maru* No.2 (*YS2*) (upper right) and *Kaiyo-Maru* No.7 (*KY7*) (lower left).

Table 1
Summary of the survey modes and searching conditions by each seasonal survey during the 2023 dedicated sighting surveys.

Season	Vessel	Survey mode	Searching conditions		
			Visibility (n.miles)	Wind speed (kt)	Searching speed (kt)
Spring	*KY7, YS1*	Normal Passing mode	≥2.0	17.0>	10.0
	YS2	Normal Closing mode	≥2.0	17.0>	11.5
Summer	*KY7, YS1*	Normal Passing mode Passing with Independent Observer mode	≥2.0	21.0>	10.5
Autumn	*YS2*	Normal Closing mode	≥2.0	21.0>	11.5

ed for this survey, as this survey can provide important data to calculate $g(0)$.

For NSP and ASP mode, there were two primary observers in the top barrel (TOP) and two in the upper bridge (captain and helmsman). All primary observers conducted searching for cetaceans by using angle board and scaled binoculars (7x).

For IO mode, there were two primary observers on the TOP and two in the independent observer platform (IOP). These observers conducted searching for cetaceans by using angle board and scaled binoculars (7x). There was no open communication between the IOP and the TOP. The observers and researchers on the upper bridge communicated to the TOP (or IOP) independently, only to clarify information and did not distract the top-men from their normal searching procedure. These primary observers report sighting-information to researchers and other observers on the upper bridge for data recording.

The survey effort began 60 minutes after sunrise and ended 60 minutes before sunset, with a maximum of 12 hours per day (maximum 06:00–19:00, including 30 minutes for mealtime for lunch and supper, when surveying in IO mode) when the weather conditions were acceptable for observations. Detailed search conditions for each survey are shown in Table 1.

Experiments

Table 2 describes the details of the planned experiments for each survey. Distance and angle experiments were conducted in the middle of the survey period. The experiment was conducted to evaluate measurement error and followed the protocol of the IWC/SOWER and IWC-POWER surveys (IWC, 2012).

When large cetaceans such as blue and humpback whales were found, photo-id images were obtained using Canon EOS R6 Mark II (with 100–500 mm lens) from the

Table 2
Experiments planned in each seasonal survey during the 2023 dedicated sighting surveys.

Season	Vessel	Planned experiments
Spring	*KY7, YS1*	Photo-ID, biopsy, satellite tagging, distance and angle experiments
	YS2	Photo-ID, biopsy, satellite tagging
Summer	*KY7, YS1*	Photo-ID, biopsy, distance and angle experiments
Autumn	*YS2*	Photo-ID, biopsy, satellite tagging

bow or upper deck. Further, biopsy skin sampling using the Larsen system (Larsen, 1998) was conducted when blue, fin, sei and common minke whales were sighted. The satellite tagging experiment using the Air Rocket Transmitter System (LK-ARTS) was also conducted for fin, sei and common minke whales.

RESULTS

Brief narrative of the surveys

Spring (April–June)

KY7 departed Hakodate, Hokkaido, Japan on 6 April, and started the survey in the research area on 8 April. *KY7* paused the survey on 2 May for a scheduled port call, and entered Otaru, Hokkaido, Japan, on 5 May for refueling and disembarkation of researchers. On 8 May, *KY7* departed Otaru, and resumed the survey on 9 May. The survey was completed on 3 June. *KY7* arrived in Kushiro, Hokkaido, Japan on 6 June.

YS1 and *YS2* departed Shiogama, Miyagi, Japan on 7 April and 12 April, respectively. *YS1* started the survey in the research area on 9 April and completed it on 20 May. On 13 April, *YS2* started the survey, which was completed on 29 May. *YS1* and *YS2* arrived in Shiogama on 22 May and 31 May, respectively.

Summer (July–September)

KY7 departed Kurihama, Kanagawa, Japan on 29 July and began the survey on 31 July. *KY7* suspended the survey on 25 August and entered Shiogama for refueling on 1 September. *KY7* departed Shiogama on 4 September and resumed the survey on 9 September. *KY7* completed the survey on 24 September and arrived in Kushiro on 5 October.

YS1 departed Shimonoseki, Yamaguchi, Japan on 28 July. *YS1* started the survey on 31 July and paused the survey on 21 August for refueling and disembarkation

Table 3
Summary of the survey periods and searching effort by each seasonal survey in the 2023 dedicated sighting surveys.

Season	Vessel	Research period	Planned cruise track (n.miles)	Searching effort NSP (n.miles)	Searching effort IO (n.miles)	Searching effort Total (n.miles)	Coverage of effort
Spring	*KY7**	2023/04/08–05/02	1,019.2	820.8	—	820.8	80.5%
		2023/05/09–06/03	1,019.2	794.2	—	794.2	77.9%
	YS1	2023/04/09–05/20	1,648.0	1,242.2	—	1,242.2	75.4%
	YS2	2023/04/13–05/29	—	1,678.9**	—	1,678.9	—
	Sub total	—	3,686.4	4,536.1	—	4,536.1	77.5%
Summer	*KY7*	2023/07/31–08/25	1,868.7	901.9	941.7	1,843.6	98.7%
		2023/09/09–09/24	1,076.6	551.0	514.9	1,065.9	99.0%
	YS1	2023/07/31–08/21	1,706.7	624.0	650.7	1,274.7	74.7%
		2023/09/04–09/21	2,121.0	735.2	712.2	1,447.4	68.2%
	Sub total	—	6,773.0	2,812.1	2,819.5	5,631.6	83.1%
Autumn	*YS2*	2023/10/12–11/05	—	611.0**	—	611.0	—
Total		—	10,459.4	7,959.2	2,819.5	10,778.7	81.3%

* The pre-determined track line was surveyed twice at different times.

** Searching effort ASP (n.miles).

of researchers, and entered Sendai, Miyagi, Japan on 26 August. *YS1* restarted the survey on 4 September and completed it on 21 September. *YS1* arrived in Shiogama on 2 October.

Autumn (October–November)

YS2 departed Shiogama on 12 October and began the survey on 12 October. The vessel completed the survey on 5 November and arrived in Shiogama on 6 November.

Searching effort

A summary of searching effort and coverage in each seasonal survey is shown in Table 3. A total of 10,778.7 n. miles (19,962.2 km) were searched in all seasonal surveys.

Sightings

Spring

Tables 4a and 4b show the total sightings for large and small cetacean species, respectively, made in the spring season. The sighting locations of each species are shown in Figure 3a and 3b together with sea surface temperature (SST).

Blue whale

A total of 28 schools (32 individuals two mother and calf pairs) were sighted in this season (Figure 3a, 3b). The range of SST in the sighting positions was 15.8°C–21.0°C (mean SST 17.0°C), and the mean school size was 1.14. The Density Index (DI: schools of primary sighted/100 n. miles searching distance) of *YS1* was 0.08. A total of 26

Table 4a

Total number of sightings of large whales made in the spring season 2023, by research vessel and species.

Season	Species	*KY7* (Apr.)		*KY7* (May)		*YS1*		*YS2*		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Spring	Blue whale	0	0	0	0	1	1	27	31	28	32
	Fin whale	62	90	152	289	4	5	15	17	233	401
	Sei whale	0	0	0	0	0	0	93	155	93	155
	Bryde's whale	0	0	0	0	11	14	8	8	19	22
	Common minke whale	31	41	36	38	3	3	2	2	72	84
	Humpback whale	2	2	1	1	26	37	5	8	34	48
	North Pacific right whale	0	0	0	0	1	1	0	0	1	1
	Sperm whale	0	0	3	3	19	61	8	19	30	83

Table 4b

Total number of sightings of small cetaceans made in the spring season 2023, by research vessel and species.

Season	Species	*KY7* (Apr.)		*KY7* (May)		*YS1*		*YS2*		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Spring	Baird's beaked whale	8	33	12	45	2	11	0	0	22	89
	Bottlenose dolphin	0	0	0	0	1	8	0	0	1	8
	Striped dolphin	0	0	0	0	1	11	0	0	1	11
	Common dolphin	0	0	0	0	0	0	4	104	4	104
	Pacific white sided dolphin	0	0	0	0	3	40	0	0	3	40
	Risso's dolphin	0	0	0	0	7	74	3	13	10	87
	Southern form short-finned pilot whale	0	0	0	0	1	2	0	0	1	2
	Northern form short-finned pilot whale	0	0	0	0	1	35	0	0	1	35
	Killer whale	13	51	15	135	6	17	3	11	37	214
	Harbour porpoise	3	6	3	3	0	0	0	0	6	9
	Truei type Dall's porpoise	0	0	0	0	9	68	0	0	9	68
	Dalli type Dall's porpoise	0	0	2	7	1	44	0	0	3	51
	Unidentified type Dall's porpoise	0	0	4	10	3	20	0	0	7	30
	Black type Dall's porpoise	0	0	1	3	0	0	0	0	1	3
	Ziphiidae	0	0	0	0	0	0	8	16	8	16
	Mesoplodon	0	0	0	0	1	4	0	0	1	4

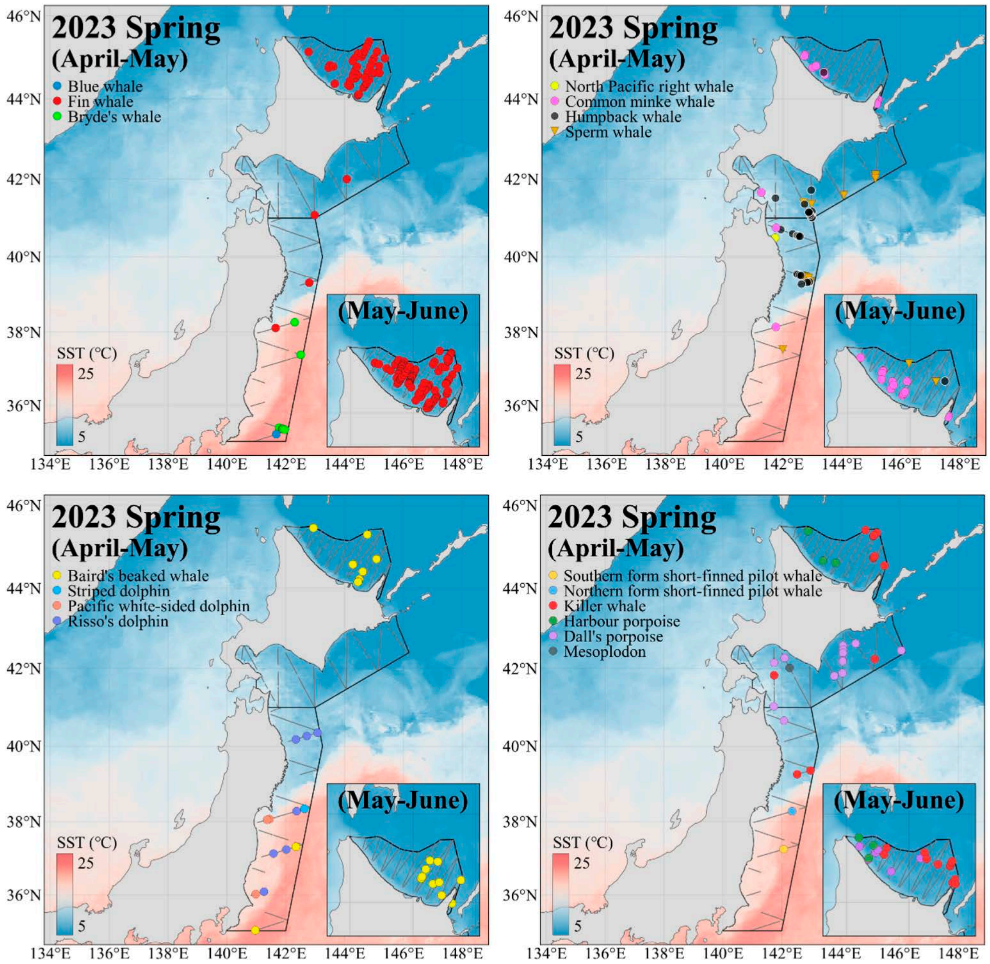


Figure 3a. The locations of large and small cetaceans sighted by *YS1* and *KY7* during the spring season 2023. Rolling 32 days average sea surface temperature data from 23 April to 24 May and 1 May to 1 June 2023 obtained by MODIS-Aqua (Original data: Ocean color web, from https://oceancolor.gsfc.nasa.gov/, accessed on 2024-04-01), are also shown.

individuals were photographed and four biopsy samples were collected.

Fin whale

This species was the most frequently sighted species in the spring season (233 schools and 401 individuals) (Figure 3a, 3b). No mother and calf pairs were sighted. The range of SST in the sighting positions was 0.6°C–18.1°C (mean SST 6.4°C), and the mean school size was 1.72. The DIs differed considerably between the seasonal surveys, 5.24 for *KY7* in April, 16.1 for *KY7* in May and 0.32 for *YS1*. A total of 11 biopsy samples were collected and seven satellite tags were attached to seven individuals.

Sei whale

A total of 93 schools (155 individuals including 8 mother and calf pairs) were sighted (Figure 3a, 3b). The mean SST at the sighting position was 16.6°C (14.7°C–19.9°C). The mean school size was 1.67. A total of 47 biopsy samples were collected and satellite tag were attached to 44 individuals.

Bryde's whale

A total of 19 schools (22 individuals with no mother and calf pair) were sighted (Figure 3a, 3b). The range of SST at the sighting positions was 10.5°C–21.0°C (mean SST 19.3°C). Observed mean school size was 1.15. The DI was 0.72 for *YS1*.

Common minke whale

A total of 72 schools (84 individuals with no mother and calf pair) were sighted (Figure 3a, 3b). The mean school size was 1.17 and the range of SST at the sighting positions was 1.9°C–16.9°C (mean SST 8.4°C). The DIs of *KY7* in April and May were 1.34 and 1.89, respectively. The DI of *YS1* was 0.24. One biopsy sample was collected.

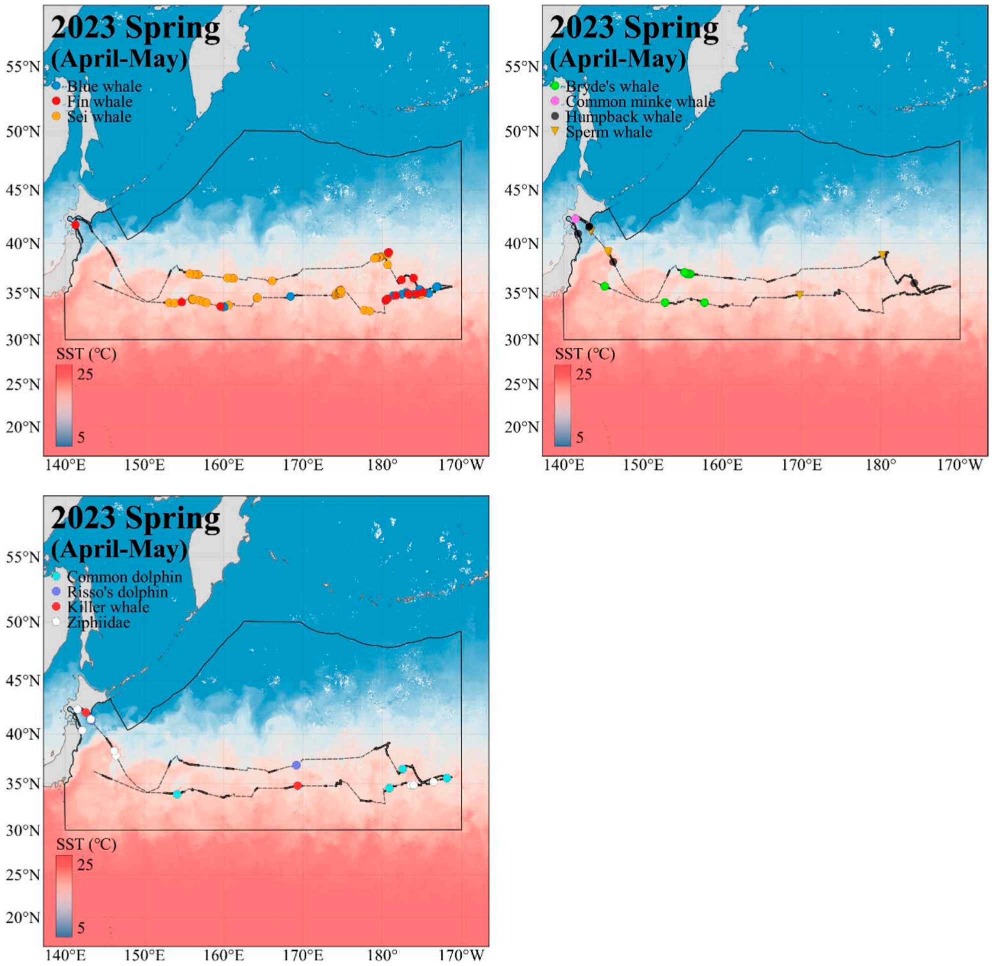


Figure 3b. The locations of large and small cetaceans sighted by *YS2* during the spring season 2023. Rolling 32 days average sea surface temperature data from 23 April to 24 May 2023 obtained by MODIS-Aqua (Original data: Ocean color web, from https://oceancolor.gsfc.nasa.gov/, accessed on 2024-04-01), are also shown.

Humpback whale

A total of 34 schools (48 individuals including two mother and calf pairs) were sighted (Figure 3a, 3b). The observed mean school size was 1.41. The range of SST in the sighting positions was 3.1°C–20.6°C (mean SST 8.4°C). The DIs of *KY7* in April, May and *YS1* were 0.12, 0.13 and 1.85, respectively. Photo-ID images were collected from nine individuals.

North Pacific right whale

One school (one individual) of estimated body length of 13.7 m was sighted at 40°30′N, 141°44′E (Figures 3a and 4). The SST at the sighting position was 9.4°C. This individual was photographed, and a biopsy sample was obtained. As the whale was sighted secondarily, not during a search, no DI was calculated for this species.

Sperm whale

A total of 30 schools (83 individuals) were sighted (Figure 3a, 3b). The range of SST in the sighting positions was 2.1°C–21.7°C (mean SST 9.9°C). Because the opportunity to approach the schools was limited, there was little information on school size, body length and calves. The mean school size was 2.77 when the school size was confirmed. The DIs were 0.38 for *KY7* in May and 1.45 for *YS1*.

Figure 4. A North Pacific right whale sighted in the spring (16 May) during the 2023 dedicated sighting surveys.

Small cetaceans

In the spring season, eight species of the family Delphinidae, five species of the family Phocoenidae and three species of the family Ziphiidae were sighted (Table 4b). The most common species sighted was the killer whale (37 schools/214 individuals), followed by Baird's beaked whale (22/89). Killer whales and Baird's beaked whales were primarily sighted north of 44°N, but were also sighted at 35°N, the southernmost point of the seasonal research area (Figures 3a, 3b).

Summer

Tables 5a and 5b show the total sightings for large and small cetacean species, respectively, made in the summer season. The sighting locations of each species are shown in Figure 5 together with SSTs.

Bryde's whale

Bryde's whales were the only baleen whales sighted in the summer season. A total of 32 schools (33 individuals with no mother and calf pair) were sighted (Figure 5). The observed mean school size was 1.03. The range of SST at the sighting positions was 27.4°C–30.6°C (mean SST 28.8°C). The DIs were 0.52 and 0.62 for *KY7* and *YS1*, respectively.

Sperm whale

A total of 26 schools (54 individuals) were sighted (Figure 5). This species was not sighted east of 160°E. Mean school size was 2.08. The range of the SST at the sighting position was 27.5°C–31.5°C (mean SST 29.4°C). The DIs were 0.58 for *KY7* and 0.33 for *YS1*.

Small cetaceans

In this season, eight species of the family Delphinidae, two species of the family Ziphiidae and one species of the family Kogiidae were sighted (Table 5b). Species of the family Ziphiidae were the most common species sighted (20 schools/44 individuals) and were mainly sighted north of 25°N (Figure 5). One school of killer whale was sighted at 28°46′N, 148°06′E.

Duplicate sightings

A total of 16 and 14 re-sightings of large whales were recorded in IO mode during this season in *KY7* and *YS1*, respectively.

Autumn

Tables 6a and 6b show the total sightings for large and small cetacean species, made in the autumn season. The sighting locations of each species are shown in Figure 6

Table 5a

Total number of sightings of large whales made in the summer season 2023, by research vessel and species.

Season	Species	*KY7*		*YS1*		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Summer	Bryde's whale	15	15	17	18	32	33
	Sperm whale	17	40	9	14	26	54

Table 5b

Total number of sightings of small cetaceans made in the summer season 2023, by research vessel and species.

Season	Species	*KY7*		*YS1*		Total	
		Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Summer	Bottlenose dolphin	1	60	0	0	1	60
	Spotted dolphin	2	50	1	45	3	95
	Striped dolphin	2	88	0	0	2	88
	Fraser's dolphin	1	43	1	70	2	113
	Risso's dolphin	1	7	3	60	4	67
	False killer whale	2	6	1	25	3	31
	Melon-headed whale	0	0	1	540	1	540
	Killer whale	1	2	0	0	1	2
	Ziphiidae	8	12	3	7	11	19
	Mesoplodon	9	25	0	0	9	25
	Kogia	2	4	0	0	2	4

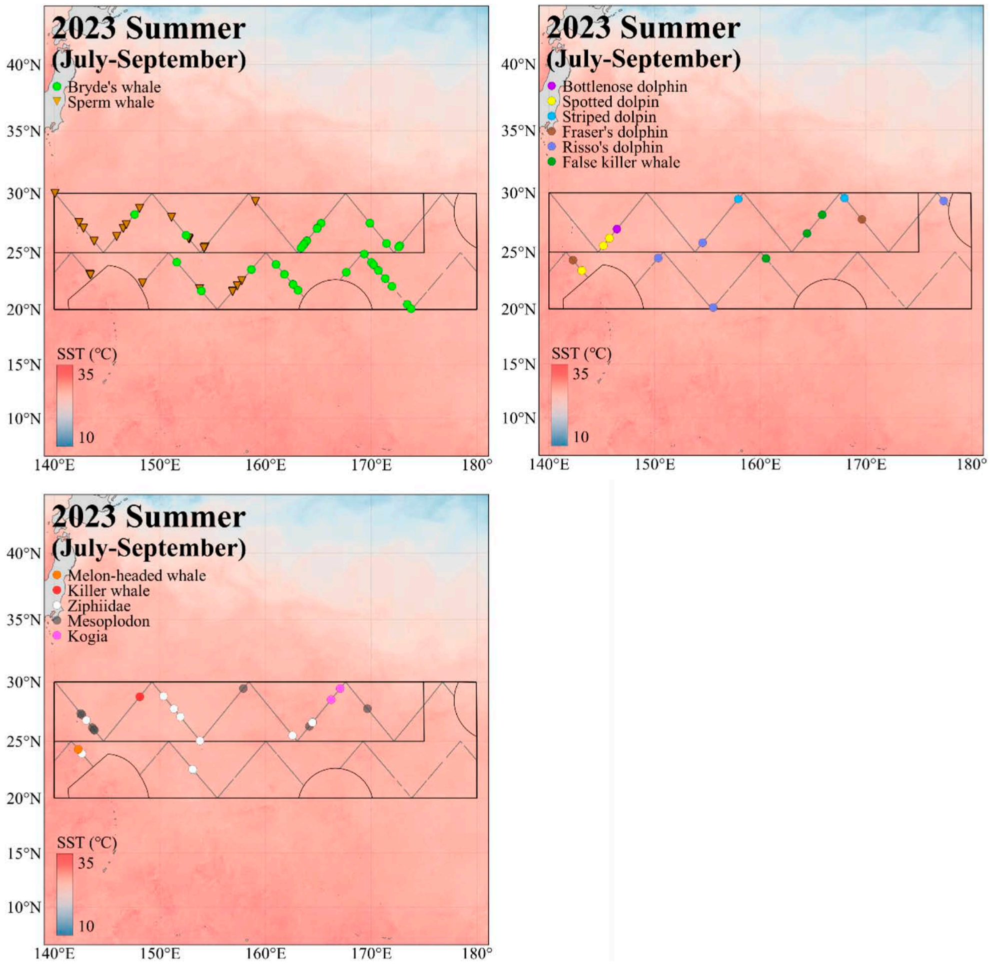


Figure 5. The locations of large and small cetaceans sighted during the summer season 2023. Rolling 32 days average sea surface temperature data from 21 August to 21 September 2023 obtained by MODIS-Aqua (Original data: Ocean color web, from https://oceancolor.gsfc.nasa.gov/, accessed 2024-04-01), are also shown.

together with SSTs.

Blue whale

Two schools (two individuals) with estimated body lengths of 18.4 m and 20.1 m were sighted (Figure 6). The range of SST was 14.0°C–15.7°C (mean SST 14.9°C). Photo-ID images were collected from two individuals.

Fin whale

A total of 35 schools (49 individuals with no mother and calf pair) were sighted (Figure 6). This species was mainly sighted north of 40°N and west of 150°E. Observed mean school size was 1.40. The mean SST at the sighting positions was 14.2°C (9.9°C–17.9°C). A total of 16 biopsy samples were collected, and satellite tags were attached on 15 individuals.

Sei whale

Sei whales were the most common species sighted during the autumn season. A total of 67 schools (88 individuals with no mother and calf pair) were sighted (Figure 6). Mean school size was 1.31. The range of SST at the sighting positions was 9.9°C–18.2°C (mean SST 11.4°C). This species was sighted in high densities east of 150°E.

Bryde's whale

A total of 24 schools (29 individuals) were sighted (Figure 6). A mother and calf pair was sighted at 41°50′N, 143°58′E. This species was the only baleen whale species sighted south of 40°N. The range of SST at the sighting positions was 13.8°C–24.5°C (mean 16.2°C) and mean school size was 1.21.

Humpback whale

A total of 21 schools (29 individuals including two mother and calf pairs) were sighted (Figure 6). The mean SST at the sighting position was 14.3°C (11.8°C–16.3°C). The observed mean school size was 1.38. Nine individuals were photographed.

Table 6a
Total number of sightings of large whales made in the autumn season 2023, by research vessel and species.

Season	Species	*YS2*	
		Sch.	Ind.
Autumn	Blue whale	2	2
	Fin whale	35	49
	Sei whale	67	88
	Bryde's whale	24	29
	Humpback whale	21	29
	Sperm whale	22	35

Table 6b
Total number of sightings of small cetaceans made in autumn season 2023, by research vessel and species.

Season	Species	*YS2*	
		Sch.	Ind.
Autumn	Baird's beaked whale	2	12
	Common dolphin	4	102
	Pacific white sided dolphin	2	93
	Northern right whale dolphin	2	19
	Risso's dolphin	1	8
	Killer whale	3	17
	Truei type Dall's porpoise	5	45
	Unidentified type Dall's porpoise	5	20
	Ziphiidae	3	6

Sperm whale

In total, 22 schools (35 individuals) were sighted (Figure 6). Mean school size was 2.45. The range of SST was 9.6°C–17.8°C (mean SST 13.2°C).

Small cetaceans

In this season, five species of the family Delphinidae, two species of the family Phocoenidae and two species of the family Ziphiidae were sighted (Table 6b). Dall's porpoises were sighted primarily in the 42°–44°N latitudinal band.

Experiments

Sighting distance and angle experiment

In the spring, the Estimated Angle and Distance Experiment was conducted by *KY7* on 29 April. It was conducted on 18 May by *YS1*. In the summer, the experiment was conducted on 27 August by *KY7* and on 25 September by *YS1*. The results of this experiment will be used for calibrating the sighting distances and angle data used for the calculation of abundance estimates.

Photo-ID

The number of individuals photographed by species is shown in Table 7. All photographs were stored in the Institute of Cetacean Research (ICR) catalogs and will be used for investigating the stock structure and movement of those cetacean species in the future.

Biopsy sampling

A total of 80 biopsy samples were collected during the 2023 dedicated sighting surveys. Table 8 shows the number of biopsy samples, by seasonal survey, research vessels and species. All samples were stored at the ICR laboratory and will be used in genetic analyses for investigating the stock structure of those species in the future.

Satellite tagging

Satellite tags were deployed in the spring and autumn surveys and deployment was successful in both seasons. The number of individuals tagged is shown in Table 9, by seasonal survey, research vessel and species. A total of 22 and 44 satellite tags were deployed for fin and sei whales, respectively. All the deployments to sei whales taken place in the spring. These were evenly deployed among the sightings (Figure 7). Tracking data obtained from satellite tags will contribute to the elucidation of the movement of whales in each season and the timing of the start of migration between high latitude feeding areas and low latitude breeding areas.

HIGHLIGHTS OF THE SURVEY

The sighting surveys conducted in 2023 were completed successfully. They provided unique data obtained not only in the summer, but also in the spring and autumn seasons for which information on cetacean distribution and abundance have been very scarce. Some main characteristics of the surveys are summarized below.

A large number of blue and sei whales were sighted during the spring season. Blue whales were more densely distributed east of 180°, while sei whales were distributed throughout the pelagic area (outside the Japanese EEZ). Sei whales are known to migrate north from the breeding areas in January and February, reaching feeding areas around 30°N by March, and reaching feeding areas north of 35°N by May and early June (Mizroch *et al.*, 2016; Konishi *et al.*, 2024). This species was also concentrated around 35°N, between April and June 2023. Although no direct feeding behaviour of this species was observed during these surveys, many patches of prey species such as small fish were observed at the sighting positions. These numerous sightings of sei whales and

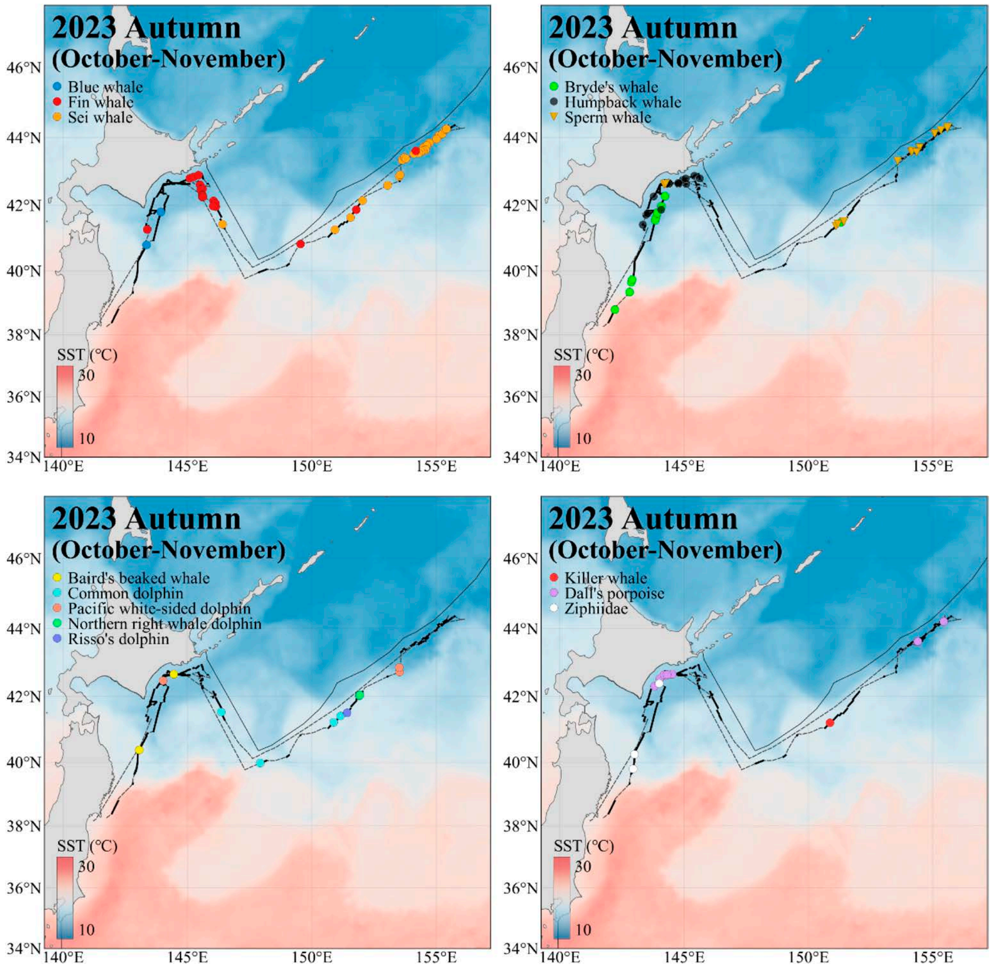


Figure 6. The locations of large and small cetaceans sighted during the autumn season 2023. Rolling 32-days average sea surface temperature data from 8 October to 8 November 2023 obtained by MODIS-Aqua (Original data: Ocean color web, from https://oceancolor.gsfc.nasa.gov/, accessed on 2024-04-01), are also shown.

Table 7
Number of individuals photographed during the 2023 dedicated sighting surveys, by seasonal survey, research vessel and species.

Species	Spring				Summer		Autumn	Total
	KY7 (Apr.)	*KY7* (May)	*YS1*	*YS2*	*KY7*	*YS1*	*YS2*	
Blue whale	0	0	1	25	0	0	2	28
Humpback whale	0	0	1	8	0	0	9	18
North Pacific right whale	0	0	1	0	0	0	0	1
Killer whale	3	39	13	9	2	0	0	66
Total	3	39	16	42	2	0	11	113

observations of prey species support the migration pattern to feeding areas around 35°N during the spring season suggested by previous studies (Mizroch *et al.*, 2016; Konishi *et al.*, 2024).

In April–June, fin and common minke whales were distributed in high densities on the Japanese side of the Sea of Okhotsk. Compared to previous surveys conducted during the same seasons and in the same research area (Kim *et al.*, 2023), sightings in April confirmed that fin whales were distributed east of 144°E, the same as in 2022, but in May the distribution extended further west of 144°E. Common minke whales were distributed west of 144°E and east of the Shiretoko Peninsula, the same as in 2022. Based on the results of the previous surveys, these two species had separate distributions in the Sea of Okhotsk during the spring feeding season from April to June (Kim *et al.*, 2023), but in 2023 they were mixed in one area (west of 144°E). One of the reasons for the

Table 8
Number of biopsy samples collected during the 2023 dedicated sighting surveys, by seasonal survey, research vessel and species.

Species	Spring				Summer		Autumn	Total
	KY7 (Apr.)	*KY7* (May)	*YS1*	*YS2*	*KY7*	*YS1*	*YS2*	
Blue whale	0	0	0	4	0	0	0	4
Fin whale	0	0	2	9	0	0	16	27
Sei whale	0	0	0	47	0	0	0	47
Common minke whale	0	0	0	1	0	0	0	1
North Pacific right whale	0	0	1	0	0	0	0	1
Total	0	0	3	61	0	0	16	80

Table 9
Number of individuals attached with satellite tags, by each season and research vessel in 2023.

Species	Spring		Autumn	Total
	YS1	*YS2*	*YS2*	
Fin whale	1	6	15	22
Sei whale	0	44	0	44
Total	1	50	15	66

westward expansion of the distribution of fin whales may be that the number of whales visiting this area during the same period has increased compared to previous surveys. The number of sightings of this species between April and June more than doubled compared to 2022 (Kim *et al.*, 2023). Further research is needed to determine what is driving the increase in number of whales visiting this area during the spring season.

A large number of humpback whales were sighted in the coastal area (within the Japanese EEZ) from April to June. Most of these sightings were between 39°N and 42°N. Compared to previous surveys (Kim *et al.*, 2023), large numbers of this species were sighted south of 40°N in 2022, while whales were sighted further north in 2023. This suggests that the northward migration of humpback whales started earlier in 2023 than in 2022. In the spring seasons, Bryde′s whales were distributed in south of the coastal area and west of the pelagic area, with a concentration of sightings around 35°N and 142°E in the coastal area and 37°N and 156°E in the pelagic area.

The summer survey covered the North Pacific between 20°N–30°N and 140°E–180° and provided important summer sighting data for Bryde′s and sperm whales. In the previous survey in 2014, a total of 56 schools (72 individuals) including 9 mother and calf pairs of Bryde′s whales were sighted in this area (Matsuoka *et al.*, 2015), while no mother and calf pair was sighted in 2023. The monthly mean SST in 2023 was lower than 30°C (Figure 5), but in 2014, the monthly mean SST in this area was higher than 30°C. Changes in SST in this area could be a contributing factor to changes in the distribution trend of Bryde′s whales. However, SST at the sighting positions averaged 29.1°C (range 27.8°C–30.1°C) in 2014 (Matsuoka *et al.*, 2015) and 28.8°C (range 27.4°C–30.6°C) in 2023, indicating that there was no significant difference in SST between the two years. The distribution trend of this species needs to be analyzed in more detail, considering other information such as prey species. No sperm whales were sighted east of 160°E during this season. However, this species was sighted further east than 160°E during previous surveys in 2014 (Matsuoka *et al.*, 2015). The mean SST at the sighting position in the previous survey in 2014 was 28.5°C (range 26.8°C–29.7°C) (Matsuoka *et al.*, 2015), lower than in 2023.

In October–November, most of the baleen whales (blue, fin, Bryde′s and humpback whales) were distributed on the Japanese side of the North Pacific, particularly off Kushiro. In contrast, sei whales were distributed in high densities further east than 150°E. These trends in the distribution of baleen whales also differed in SST. The mean SST at the sighting positions where blue, fin, Bryde′s and humpback whales were sighted was higher than 14°C, while for sei whales it was lower at 11.4°C. During this season, feeding behaviours such as multiple defecations by fin and Bryde′s whales and a single prey chase by sei whales have been observed. These behaviours indicate that these waters are one of the whales′ feeding grounds for this season.

Satellite tags were deployed during the part of spring and autumn surveys to study the movements and migrations of fin, sei and common minke whales. In the spring survey, 7 and 44 satellite tags were successfully deployed on fin and sei whales, respectively. In the autumn survey, 15 satellite tags were deployed on fin whales. Common minke whales were not tagged in either the spring or autumn surveys due to the low number of sightings.

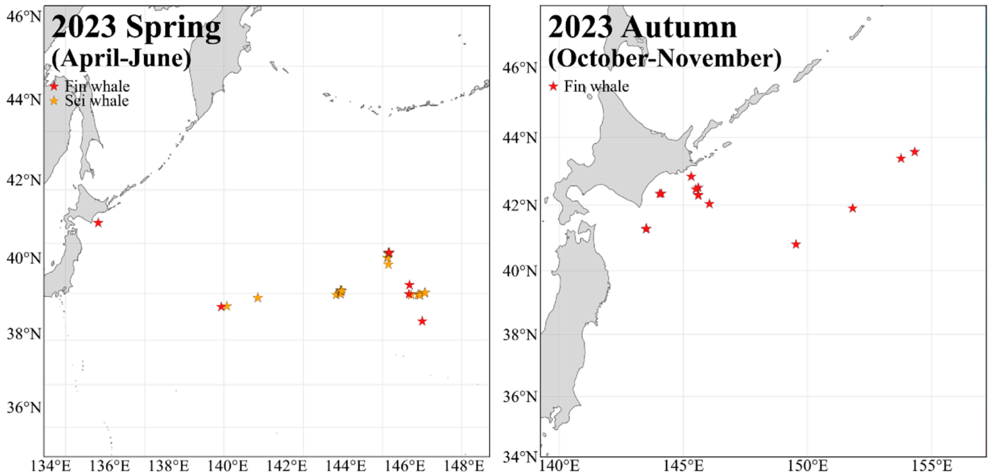


Figure 7. The locations of tagged fin and sei whales during the 2023 dedicated sighting surveys. Locations were obtained from photographs taken at the time of the tagging.

Tracking data from satellite tags deployed during sighting surveys conducted between 2017 and 2023 were used to study the seasonal migration patterns of sei whales between feeding and breeding areas (Konishi *et al.*, 2024). These studies of the migration using satellite tags will contribute to resource management by assisting the interpretation of the genetic analyses of stock structure of sei and other large whales.

As in the previous surveys, the 2023 surveys collected data on small cetaceans in the same way as large cetaceans. The analyses of these data will provide valuable information on the distribution and abundance of small cetaceans in different seasons.

ACKNOWLEDGEMENTS

We acknowledge the Government of Japan's assistance in providing the research permits and funding for these cruises. We also thank the captains H. Kasai, C. Ohkoshi, Y. Sasaki, and researchers T. Kuno, M. Kawasaki, M. Higashi, S. Kawabe, E. Ueta, M. Yamazaki, S. Teruya, A. Arito, as well as the officers and crew of the *Yushin-Maru*, *Yushin-Maru* No.2 and *Kaiyo-Maru* No.7 for their hard work and dedication that led to the successful execution of these surveys. We express our deep gratitude to T. Hakamada and M. Takahashi of ICR for expert support in planning survey design. We thank Y. Fujise and T. Tamura and the staff of ICR and Kyodo Senpaku Co. Ltd. for their assistance with arrangements and support for the cruise. We also thank K. Konishi of ICR for satellite tagging and M. Taguchi of ICR for biopsy sample management. Finally, we thank L.A. Pastene for his assistance in preparing this report and to the TEREP Editorial Team for editorial check.

REFERENCES

Buckland, S.T., Cattanach, K.L. and Miyashita, T. 1992. Minke whale abundance in the northwest Pacific and the Okhotsk Sea, estimated from 1989 and 1990 sighting surveys. *Rep. int. Whal. Commn.* 42: 387–392.

Hakamada, T., Matsuoka, K. and Miyashita, T. 2009. Distribution and the number of western North Pacific common minke, Bryde's, sei and sperm whales distributed in JARPNII Offshore component survey area. Paper SC/J09/JR15 presented to the IWC Scientific Committee Expert Workshop to review the JARPNII Programme, January 2009 (unpublished). 18 pp. [Available from the IWC Secretariat].

International Whaling Commission. 2001. Report of the Workshop to Review the Japanese Whale Research Program under Special Permit for North Pacific Minke whales (JARPN). *J. Cetacean Res. Manage.* (Suppl.) 3: 377–413.

International Whaling Commission. 2008. IWC SOWER Cruise 2008/09, Information for Researchers. https://iwc.int/private/downloads/-m4RVc06JhBVw3ymd3oPcw/Guide%20%20for%20Researchers%202008-09.pdf. [Available from the IWC Secretariat].

International Whaling Commission. 2010. The Report of the Expert Workshop to review the Ongoing JARPNII Programme. *J. Cetacean Res. Manage.* (Suppl.) 11(2): 405–450.

International Whaling Commission. 2012. Requirements and guidelines for conducting surveys and analyzing data within the revised management scheme. *J. Cetacean Res. Manage.* (Suppl.) 13: 509–517.

International Whaling Commission. 2016. Report of the Expert Panel of the final review on the western North Pacific Japanese Special Permit Programme (JARPNII). Paper SC/66b/REP/06 presented to the IWC Scientific Committee, June 2016 (unpublished). 96 pp. [Available from the IWC Secretariat].

International Whaling Commission. 2019. Report of the

Scientific Committee. Annex Q. *J. Cetacean Res. Manage*. (Suppl.) 20: 394–412.

Kanaji, Y., Iwasaki, T., Kishiro, T. and Miyashita, T. 2012. Cruise report of the sighting and satellite tagging survey for common minke whales in the sub-area 7 in 2011. Paper SC/64/O9 presented to the IWC Scientific Committee, June 2012 (unpublished). 10 pp. [Available from the IWC Secretariat].

Kim, Y., Katsumata, T., Isoda, T. and Matsuoka, K. 2023. Report and highlights of the Japanese dedicated sighting surveys in the North Pacific in 2022. *Technical Reports of the Institute of Cetacean Research* (*TEREP-ICR*) No.7: 34–46.

Konishi, K., Minamikawa, S., Kleivane, L. and Takahashi, M. 2024. Annual phenology and migration routes to breeding grounds in western-central North Pacific sei whales. *Sci. Rep.* 14(1): 1–14.

Larsen, F. 1998. Development of a biopsy system primarily for use on large cetaceans. Paper SC/50/O15 presented to the IWC Scientific Committee, May 1998 (unpublished). 8 pp. [Available from the IWC Secretariat].

Matsuoka, K., Ensor, P., Hakamada, T., Shimada, H., Nishiwaki, S., Kasamatsu, F. and Kato, H. 2003. Overview of minke whale sightings surveys conducted on IWC/IDCR and SOWER Antarctic cruises from 1978/79 to 2000/01. *J. Cetacean Res. Manage*. 5(2): 173–201.

Matsuoka, K., Hakamada, T. and Miyashita, T. 2014. Recent sightings of the North Pacific right (*Eubalaena japonica*) whales in the western North Pacific based on JARPN and JARPNII surveys (1994 to 2013). Paper SC/65b/BRG11 presented to the IWC Scientific Committee, May 2014 (unpublished). 8 pp. [Available from the IWC Secretariat].

Matsuoka, K., Yamaguchi, F., Honma, H., Ohkoshi, C., Maki, K. and Miyashita, T. 2015. Cruise report of the Japanese dedicated cetacean sighting survey in the western North Pacific in 2014. Paper SC/66A/IA6 presented to the IWC Scientific Committee, May 2015 (unpublished) 11 pp. [Available from the IWC Secretariat].

Miyashita, T., Kato, H. and Kasuya, T. 1995. *Worldwide Map of Cetacean Distribution based on Japanese Sighting Data (Volume 1)*. National Research Institute of Far Seas Fisheries, Shimizu, Shizuoka, Japan. 140 pp.

Miyashita, T. and Kato, H. 2004. Plan for the North Pacific minke whale sighting surveys in 2004. Paper SC/56/RMP3 presented to the IWC Scientific Committee, June 2004 (unpublished). 3 pp. [Available from the IWC Secretariat].

Miyashita, T. and Kato, H. 2005. Plan for the minke whale sighting surveys in the North Pacific in 2005. Paper SC/57/NPM2 presented to the IWC Scientific Committee, June 2005 (unpublished). 5 pp. [Available from the IWC Secretariat].

Mizroch, S.A., Conn, P.B. and Rice, D.W. 2016. The mysterious sei whale: Its distribution, movements and population decline in the North Pacific revealed by whaling data and recoveries of Discovery-type marks. Paper SC/66b/IA20 Presented to the IWC Scientific Committee, June 2016 (unpublished). 129 pp. [Available from the IWC Secretariat].

Murase, H., Hakamada, T., Kiwada, H., Inagake, D., Okazaki, M., Tojyo, N. and Matsuoka, K. 2009. Preliminary results of estimation of sei whale (*Balaenoptera borealis*) distribution and abundance in the whole North Pacific basin. Appendix 2. 11 pp. *In*: Hakamada, T., Examination of the effects on whale stocks of future JARPNII catches. Paper SC/J09/JR36 presented to the IWC Scientific Committee Expert Workshop to review the JARPNII Programme, January 2009 (unpublished) 56 pp. [Available from the IWC Secretariat].

Pastene, L.A., Hatanaka, H., Fujise, Y., Kanda, N., Murase, H., Tamura, T., Miyashita, T. and Kato, H., 2009. The Japanese Whale Research Program under Special Permit in the western North Pacific Phase-II (JARPNII): Origin, objectives and research progress made in the period 2002–2007, including scientific considerations for the next research period. Paper SC/J09/JR1 (Rev 1) presented to the IWC Scientific Committee Expert Workshop to review the JARPNII Programme, January 2009 (unpublished). 73 pp. [Available from the IWC Secretariat].

Shimada, H. 2004. Abundance estimate of the western North Pacific stock of Bryde's whales using sighting data from 1998 to 2002. Paper SC/56/PFI6 presented to the IWC Scientific Committee, June 2004 (unpublished). 8 pp. [Available from the IWC Secretariat].

Thomas, L., Buckland, S.T., Rexstad, E.A., Laake, J.L., Strindberg, S., Hedley, S.L., Bishop, J.R.B., Marques, T.A. and Burnham, K.P. 2010. Distance software: Design and analysis of distance sampling surveys for estimating population size. *J. Appl. Ecol*. 47(1): 5–14.

Technical Report (not peer reviewed)

Results of the IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER) dedicated sighting survey in 2023 —An overview—

Hiroto MURASE[1, *] and Isamu YOSHIMURA[2]

[1] *Laboratory of Cetacean Biology, Tokyo University of Marine Science and Technology, 4–5–7 Konan, Minato-ku, Tokyo 108–8477, Japan*

[2] *Kyodo Senpaku Co. Ltd., 4–5 Toyomi-cho, Chuo-ku, Tokyo 104–0055, Japan*

Contact e-mail: hmuras0@kaiyodai.ac.jp

ABSTRACT

This paper outlines the main results of the 2023 dedicated sighting survey of the International Whaling Commission-Pacific Ocean Whale and Ecosystem Research (IWC-POWER). The IWC-POWER surveys are designed and implemented by the IWC Scientific Committee, in special partnership with the Government of Japan. The surveys have been conducted since 2010 as the first phase with the long-term objective: 'provide information to allow determination of the status of populations (and thus stock structure is inherently important) of large whales that are found in the North Pacific waters and provide the necessary scientific background for appropriate conservation and management actions'. The 2023 survey was conducted successfully between 28 July and 5 October 2023 in the eastern North Pacific by the Japanese R/V *Yushin-Maru* No. 2. The following whale species were sighted in the survey area: blue (9 schools/9 individual), fin (70/109), sei (63/82), humpback (1/1), sperm (25/26) and killer (3/5) whales. North Pacific right whales (4/5) were also sighted during the transit from the research area to Dutch Harbor. Photo-identification data were collected from 4 right, 7 blue, 30 fin and 9 sei whales. A total of 19 biopsy samples were collected from 4 blue, 8 fin and 7 sei whales. A total of 146 sonobuoys were deployed, of which 143 were successful, for a total of over 538.28 monitoring hours. A total of four SPOT 177S satellite tags were deployed on four blue whales. Five SPLASH-f-333 satellite tags each were deployed on fin and sei whales. Two drifting buoy recorders (Long-term Drifting Buoy Recorder, LT-DBR) were deployed during the cruise. A seabird sighting survey was conducted as a feasibility study and a total of 115 survey blocks along tracklines up to 15 minutes long was covered with sightings of 27 species of seabirds. Data collected during this survey will be used mainly for abundance estimation and stock structure purposes.

INTRODUCTION

The International Whaling Commission-Pacific Ocean Whale and Ecosystem Research (IWC-POWER) program is an international research effort in the North Pacific coordinated by the IWC and designed by the IWC Scientific Committee (SC) in special partnership with the Government of Japan. Scientists from the Institute of Cetacean Research (ICR) and the cooperative institutes such as Tokyo University of Marine Science and Technology participate regularly in the IWC-POWER program, both in designing and implementing the surveys. The IWC-POWER surveys in the North Pacific follow the series of IWC International Decade for Cetacean Research/Southern Ocean Whale and Ecosystem Research (IDCR/SOWER) surveys that have been conducted in the Antarctic since 1978 (Matsuoka *et al.*, 2003).

The long-term objective of the IWC-POWER is to 'provide information to allow determination of the status of populations (and thus stock structure is inherently important) of large whales that are found in the North Pacific waters and provide the necessary scientific background for appropriate conservation and management actions'. The first survey of this program was conducted in 2010 and the most recent one in 2023 as Phase I (IWC, 2024a). The Phase I survey would be completed in 2025 and the IWC SC is preparing for the next phase related to medium and long-term priorities, based on the results of the first phase (IWC, 2024b).

The objective of this document is to present an overview of the 2023 IWC-POWER focusing on the results within the survey area. The details are provided in Murase *et al.* (2024). For a general background of the IWC-POWER including objectives, research area and general methodology are described in Matsuoka (2020).

Table 1
The 2023 IWC-POWER survey itinerary.

Date (ship's time)	Event
27-Jul-2023	Pre-cruise meeting held at Shiogama
28-Jul	Vessel departed from Shiogama
5-Aug	Vessel arrived at Dutch Harbor
7-Aug	Vessel departed from Dutch Harbor
7-Aug	Pre-cruise meeting held on YS2 off Dutch Harbor
9-Aug	Vessel started the survey in the research area
13-Sep	Vessel completed the survey in the research area
22-Sep	Vessel arrived at Dutch Harbor
24-Sep	Post-cruise meeting held at Dutch Harbor
25-Sep	Vessel departed from Dutch Harbor
5-Oct	Vessel arrived at Shiogama
6-Oct	Post-cruise meeting held at Shiogama

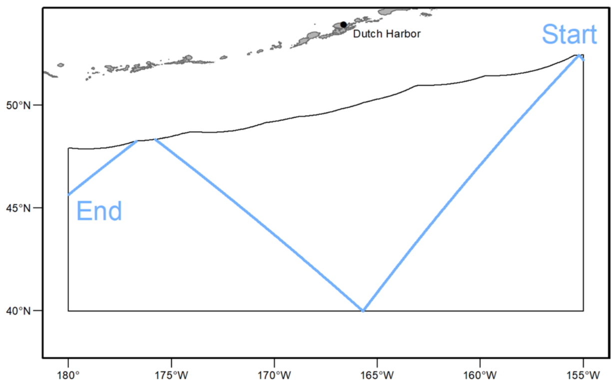


Figure 1. Research area (thin black line) and survey track lines (blue line) with start and end points for the 2023 IWC-POWER survey.

OVERVIEW OF RESULTS OF THE 2023 IWC-POWER SURVEY

Itinerary

The survey was conducted between 28 July and 5 October 2023 by the Japanese R/V *Yushin-Maru* No. 2. The itinerary is shown in Table 1.

Research area

The research area for IWC-POWER 2023 was off the southern Aleutian Islands bounded by 40°00′N, the US exclusive economic zone (EEZ) boundary to the north, 180°00′ and 155°00′W, comprised entirely of the high seas (Figure 1). As a part of the transit survey, a small-scale opportunistic sighting survey mainly targeting North Pacific right whale was conducted south of the Alaska Peninsula between 155°00.0′W and 157°24.0′W (all within the US EEZ) from 17 to 20 September.

Table 2
Specifications of the R/V *Yushin-Maru* No. 2.

Call sign	JPPV
Length overall [m]	69.61
Molded breadth [m]	11.5
Gross tonnage (GT)	747
Barrel height [m]	19.5
IO barrel height [m]	13.5
Upper bridge height [m]	11.5
Bow height [m]	6.5
Engine power [PS/kW]	5,303/3,900

Research vessel and scientific personnel

The R/V *Yushin-Maru* No. 2 was used for this survey. The specifications of the vessel are given in Table 2.

Four international researchers were nominated by the IWC SC for this survey:

Hiroto Murase (Japan): Cruise Leader (CL)
Jessica Crance (USA): Acoustics and photo-ID
Bernardo Alps (USA): Photo-ID data management and seabird sighting
Isamu Yoshimura (Japan): sighting data, marine debris and biopsy sample management

Searching effort

The survey was conducted using methods based on the guidelines of the IWC SC. Survey trackline coverage in the research area was 84.6% (1,476.57 n.miles of a planned distance of 1,745.00 n.miles), with a total of 742.29 n.miles in Normal Passing with abeam closing mode (NSP) and 734.18 n.miles in Independent Observer passing mode (IO) (Table 3). Additionally, 172.80 n.miles were surveyed during transit between Japan to and from Dutch Harbor, and Dutch Harbor to and from the research area.

Summary of the sightings

During the survey in the research area, sightings of blue (9 schools/9 individuals), fin (70/109), sei (63/82), humpback (1/1), sperm (25/26) and killer (3/5) whales were observed (Table 4). North Pacific right whales (4/5) were also observed during the small-scale opportunistic sighting survey conducted as a part of the transit survey from the research area to Dutch Harbor. These data will be mainly used to estimate abundance of several species.

Geographical distribution by species

Blue whale (Balaenoptera musculus)

Blue whales were mainly distributed in the northern part of the area to the west of 165°W (Figure 2). Sea surface

Table 3
Summary of the searching effort (time and distance) and experimental time (hours) in the survey area of the 2023 IWC-POWER. NSP: Normal Passing with abeam closing mode, IO: Independent Observer mode.

Area	Area Code	Leg No.	Start	End	NSP		IO		NSP+IO		Photo-ID, Biopsy, TDR tag	Estimated angle and distance training/ experiment
		Start / End	Date / Time	Date / Time	Time	Dist. (n.m.)	Time	Dist. (n.m.)	Time	Dist. (n.m.)	Time	Time
Research Area (Leg 101–132)	88 (All High Sea)	101 / 127	9-Aug. / 6:00	13-Sep. / 13:38	64:27:50	742.29	63:25:17	734.28	127:53:07	1476.57	16:29:19	10:12:30

Table 4
Number of sightings for all species observed in the research area during the 2023 IWC-POWER survey (original tracklines), by effort mode. NSP: Normal Passing with abeam closing mode, IO: Independent Observer mode, OE: Top down (TD) and drifting (DR), Sch.: schools, Ind.: individuals. Numbers of Individuals include the number of calves.

Species	NSP			IO			OE			Total		
	Sch.	Ind.	Calf	Sch.	Ind.	Calf	Sch.	Ind.	Calf	Sch.	Ind.	Calf
Blue whale	1	1	0	8	8	0	0	0	0	9	9	0
Fin whale	28	44	3	39	57	2	3	8	0	70	109	5
Like fin whale	0	0	0	2	3	0	0	0	0	2	3	0
Sei whale	34	49	0	27	31	0	2	2	0	63	82	0
Like sei whale	1	2	0	1	1	0	0	0	0	2	3	0
Common minke whale	2	2	0	0	0	0	0	0	0	2	2	0
Humpback whale	0	0	0	1	1	0	0	0	0	1	1	0
Sperm whale	12	13	0	12	12	0	1	1	0	25	26	0
Like sperm whale	0	0	0	1	1	0	0	0	0	1	1	0
Mesoplodon	0	0	0	1	3	0	0	0	0	1	3	0
Ziphiidae	3	8	0	4	4	0	0	0	0	7	12	0
Killer whale	3	5	0	0	0	0	0	0	0	3	5	0
Risso′s dolphin	1	13	0	0	0	0	0	0	0	1	13	0
Common dolphin	3	143	13	1	66	3	0	0	0	4	209	16
Pacific white-sided dolphin	5	250	11	1	19	1	0	0	0	6	269	12
Northern right whale dolphin	2	72	4	1	13	1	0	0	0	3	85	5
Dalli type Dall′s porpoise	4	22	1	7	22	0	1	4	0	12	48	1
Unid. type Dall′s porpoise	6	24	0	2	5	0	0	0	0	8	29	0
Unid. large baleen whale	5	5	0	14	14	0	1	1	0	20	20	0
Unid. dolphin	2	35	0	1	4	0	0	0	0	3	39	0
Unid. large cetacean	2	2	0	4	4	0	0	0	0	6	6	0
Unid. small cetacean	0	0	0	2	2	0	0	0	0	2	2	0
Unid. cetacean	2	2	0	4	4	0	0	0	0	6	6	0

temperatures of the sighting positions were between 12.9 and 18.5°C.

Fin whale (Balaenoptera physalus)
Fin whales were primarily observed in the northern part of the research area (Figure 3). Sea temperatures ranged from 11.6 to 23.1°C.

Sei whale (Balaenoptera borealis)
Sei whales were mainly distributed in the northern part of the area (Figure 4). Sea surface temperatures ranged from 11.3 to 17.4°C.

Humpback whale (Megaptera novaeangliae)
One school (one individual) of humpback whale was observed (Figure 5). Sea temperature at the sighting posi-

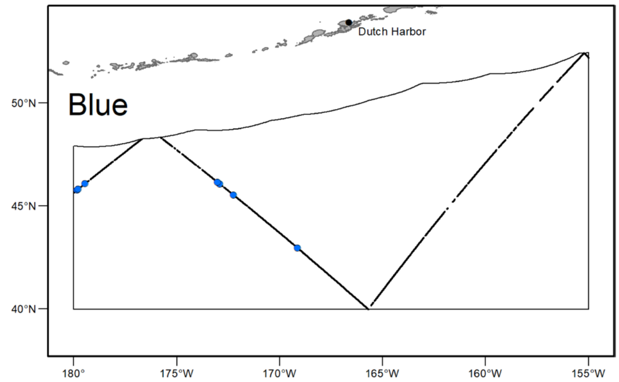


Figure 2. The searching effort (black lines) and sighting positions (blue circles) of blue whales during the 2023 IWC-POWER survey.

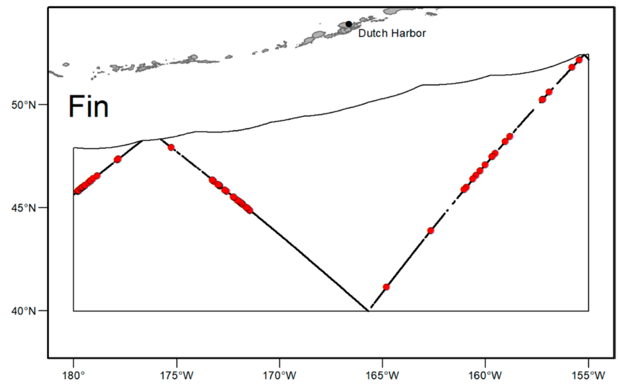


Figure 3. The searching effort (black lines) and sighting positions (red circles) of fin whales during the 2023 IWC-POWER survey.

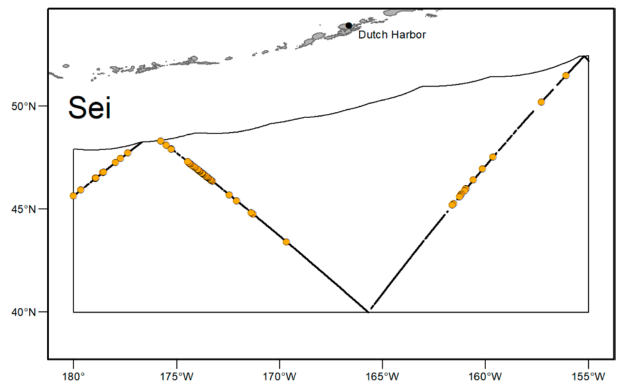


Figure 4. The searching effort (black lines) and sighting positions (orange circles) of sei whales during the 2023 IWC-POWER survey.

tion was 12.9°C.

Sperm (Physeter macrocephalus)

Sperm whales were widely distributed throughout the research area (Figure 6). Sperm whales were recorded in waters with sea surface temperatures (SSTs) ranging from 11.6 to 23.3°C.

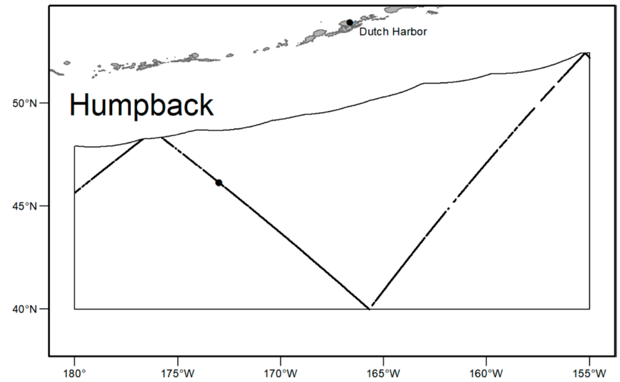


Figure 5. The searching effort (black lines) and the sighting position (black circle) of humpback whale during the 2023 IWC-POWER survey.

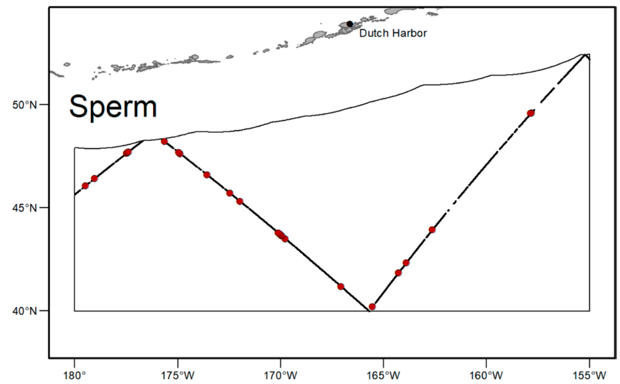


Figure 6. The searching effort (black lines) and sighting positions of sperm whales (brown circles) during the 2023 IWC-POWER survey.

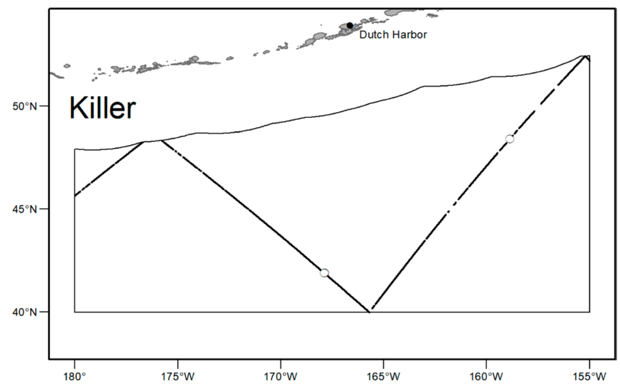


Figure 7. The searching effort (black lines) and sighting positions of killer whales (white circles) during the 2023 IWC-POWER survey.

Killer whale (Orcinus orca)

A total of 3 schools (5 individuals) were sighted (Figure 7). Killer whales were recorded in waters with SSTs ranging from 11.8 to 20.7°C.

Identification of duplicated sightings

Resight data were recorded for a total of 117 sightings

Table 5
Summary of the Photo-ID'd experiments, by each species conducted during the entire 2023 IWC-POWER.

Photo-ID	Right	Blue	Fin	Sei	Total
Entire 2023 IWC-POWER	4	7	30	9	50

Table 6
Summary of the number of species-specific biopsy samples collected in the 2023 IWC-POWER research area.

Biopsy samples	Blue	Fin	Sei	Total
Entire 2023 IWC-POWER	4	8	7	19

during IO Mode involving several baleen whale species. These data will be used to estimate *g*(0), which in turn will be used to correct abundance estimates.

Photo-ID experiments
Photo-ID data were obtained from a total of 50 individuals: North Pacific right (4 individuals), blue (7), fin (30), sei (9) whales (Table 5). Images collected during the survey were uploaded to the IWC master photographic database in Adobe Lightroom (LR) Classic. Photo-ID data will be used to study movement, distribution and stock structure of the species involved.

Biopsy sampling
Biopsy samples were collected during the entire cruise including transits for 19 individual whales: 4 blue, 8 fin and 7 sei whales (Table 6). Every biopsy sampling was documented photographically. All biopsy samples were catalogued and stored on the vessel in cryo-vials frozen at a temperature of −30°C. These samples will be used for molecular genetics analyses on stock identification.

Sonobuoys
A total of 146 sonobuoys were deployed during the cruise. Of these, 143 transmitted successfully, for a total of over 538.28 monitoring hours. The most common species detected were sperm and fin whales, detected on 107 (74.8%) and 81 (56.6%) buoys, respectively. Killer whales were the next most common detected on 53 buoys (37.1%), followed by blue whales (33, 23.1%), common dolphins (10, 6.9%), humpback whales (8, 5.6%), North Pacific right whales (7, 4.9%), Pacific white-sided dolphins (6, 4.2%), and sei whales (4, 2.8%).

Estimated Angle and Distance Experiment
The Estimated Angle and Distance Experiment was conducted on 22 September for 6 hours 33 minutes whilst in the research area. A total of 84 trials were conducted for each platform (TOP and IO barrels and upper bridge). The data will be used to calibrate observed angle and distance based on known angle and distance.

Marine macro debris observation
A total of 95 marine debris objects were observed. 56 items were recorded 'on effort' (i.e., during the first 15 minutes of each hour) and 39 items were recorded during 'off effort'.

Satellite tagging studies
Two types of satellite tags were deployed during the cruise: SPOT 177S for monitoring the horizontal movement and SPLASH-f-333 for recording dive data with assumption that those data could be used to estimate availability bias (both types were manufactured by Wildlife Computers Inc., US). A total of four SPOT 177S satellite tags were deployed on four blue whales. Five SPLASH-f-333 satellite tags each were deployed on fin and sei whales.

Deployment of Long-term Drifting Buoy Recorder (LT-DBR)
Two drifting buoy recorders (Long-term Drifting Buoy Recorder, LT-DBR) were deployed during the cruise on behalf of Jay Barlow (US) to record acoustic data from beaked whales in the central North Pacific. LT-DBRs can record higher frequency sounds and remain deployed for considerably longer (months vs hours) than sonobuoys.

Feasibility study of seabird sighting survey
A feasibility study of seabird sighting survey was conducted along with cetacean sighting survey. The researcher wrote down the summary of species and approximate numbers seen within 300 m from the vessel, from 0° to 90° on the starboard side for the first 15 minutes of each effort hour (except during off-effort) in a similar manner to marine debris. The seabird sighting survey was conducted only in the research area. This was the first attempt to conduct a seabird sighting survey within the framework of POWER programme. A total of 115 survey blocks along tracklines up to 15 minutes long was covered with sightings of 27 species of seabirds.

HIGHLIGHTS OF THE SURVEY

It is concluded that the 2023 IWC-POWER survey was completed successfully by a group of international scientists and crews (Figure 8), and that valuable data were collected for several cetacean species. Such data will allow studies on distribution, abundance and stock structure in this particular area of the North Pacific.

Figure 8. Researchers and crew of the 2023 IWC-POWER survey with the *Yushin-Maru* No. 2 in the background. The picture was taken at the end of the cruise in Dutch Harbor.

There are three aspects of this survey that should be highlighted. The first aspect is a seasonal change in distribution of baleen whales. The research area for 2023 cruise was surveyed in 2010 and 2011, but these surveys were conducted from mid-July to mid-August while the 2023 survey was conducted from mid-August to mid-September. As the results, it appeared that the distributions of baleen whales were shifted northward. Such a change will be investigated in a future study.

The second aspect is sightings of North Pacific right whales during the transit between the research area and Dutch Harbor. The obtained data are worthwhile examining for conservation and management of this endangered species, although the survey was opportunistically conducted within a limited time frame.

The third aspect is conducting three new experiments (satellite tagging for horizontal movement study of blue whale, deployment of LT-DBR and a feasibility study of seabird sighting survey) in the history of the IWC-POWER. They were accomplished through the cooperation of the crews and researchers.

ACKNOWLEDGEMENTS

We acknowledge the Governments of the US (NOAA Fisheries) and Japan (Fisheries Agency of Japan) for their assistance in the research permit and funding for this cruise and Iain Staniland and Secretariat of the IWC for their support and funding for this cruise. We also acknowledge the steering group of this cruise, and the Technical Advisory Group (TAG), and Mioko Taguchi and other staff of the Institute of Cetacean Research as well as the staff of Kyodo Senpaku Co. LTD., for their arrangements and support for this cruise. We also thank the crew of the R/V *Yushin-Maru* No.2 for their hard work and dedication. Finally, we thank the TEREP Editorial Team for the editorial check.

REFERENCES

International Whaling Commission. 2024a. Report of the IWC-POWER Planning Meeting, 6–10 September 2022, Tokyo, Japan. *J. Cetacean Res. Manage.* (Suppl.) 25: 195–207.

International Whaling Commission. 2024b. Report of the Technical Advisory Group Workshop on Planning for the Medium-Long Term IWC-POWER Programme. Paper SC/69B/REP/01B presented to the IWC Scientific Committee, April-May 2024, (unpublished). 28 pp. [Available from the IWC Secretariat].

Matsuoka, K. 2020. An outline of the IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER) including results of the 2019 survey. *Technical Reports of the Institute of Cetacean Research (TEREP-ICR)* No. 4: 23–34.

Matsuoka, K., Ensor, P., Hakamada, T., Shimada, H., Nishiwaki, S., Kasamatsu, F. and Kato, H. 2003. Overview of minke whale sightings surveys conducted on IWC/IDCR and SOWER Antarctic cruises from 1978/79 to 2000/01. *J. Cetacean Res. Manage.* 5: 173–201.

Murase, H., Crance, J., Alps, B., Yoshimura, I. and Okoshi, C. 2024. Cruise report of the 2023 IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER). Paper SC/69B/ASI/05 presented to the IWC Scientific Committee, April-May 2024 (unpublished). 58 pp. [Available from the IWC Secretariat].

Technical Report-Note (not peer reviewed)

An overview of studies at the Institute of Cetacean Research on individual identification and photogrammetry of Antarctic blue whales based on drone surveys

Taiki KATSUMATA* and Tatsuya ISODA

Institute of Cetacean Research, 4–5 Toyomi-cho, Chuo-ku, Tokyo 104–0055, Japan

**Contact e-mail: katsumata@cetacean.jp*

In recent years, the use of small drones has become prevalent in marine mammal surveys, establishing them as a standard tool in the fields of morphology and animal behavior studies (Fiori *et al.*, 2017). The Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A) conducted by the Institute of Cetacean Research (ICR) (Isoda *et al.*, 2020) has also introduced drone technology for the study of large whales in the Antarctic. This paper reports progress in the use of drone technology for i) the identification of individual blue whales based on aerial photography, and ii) measurements of blue whales′ body length and body condition using photogrammetry.

In JASS-A, Phantom Pro 4 (DJI China) and Inspire 2 (DJI China) drones have been used primarily for photographing Antarctic blue whales, *Balaenoptera musculus intermedia*. The Drone Inspire 2 was equipped with a laser rangefinder SF11/C (LightWare LiDAR LLC, U.S.), which allowed estimating the distance to the sea surface using LiDAR (Light Detection and Ranging) technology. It also had a Global Positioning System (GPS) receiver EM506 (Globalsat, Taiwan) and an Inertial Measurement Unit (IMU) MiniIMU-9 v5 (Pololu Corporation, U.S.). Each data was recorded every second on a logger and were used for photogrammetry study. This altitude measuring system is identical to that used by Dawson *et al.* (2017) in their study on southern right whales, *Eubalaena australis*, in Auckland Islands and has proven useful in reducing observation error. Furthermore, it enables the attainment of accurate morphometric measurements and comparison with data from other individuals and populations (Bierlich *et al.*, 2021a).

The equipment used and the number of individuals photographed by year are summarized in Table 1. Figure 1 shows photographs of the drone in flight. A more detailed video of the drone flight in the Antarctic Ocean can be seen at the following URL:

https://www.youtube.com/watch?v=mjj-0OdolDE&t=27s

Individual identification

Blue whales possess unique mottled pigmentation, which allows for individual identification from clear photographs captured from a vessel (Sears *et al.*, 1990). The research vessels used in the JASS-A program are relatively large (700 GT) (Isoda *et al.*, 2020). When the vessels approach blue whales, the whales tend to swim away at increased speeds. This makes it difficult to capture clear dorsal/lateral images, as splashing often obscures the pigmentation patterns. In contrast, drones capture clear images of whales swimming undisturbed. This aerial perspective provides a unique view of the whale's dorsal/lateral parts.

From Figure 2, examination of photographs of two individuals taken by drone Phantom Pro 4 demonstrated that each individual has an identifiable mottling pattern behind the blowhole. Additionally, large white scars, likely resulting from contact with pack ice, were also use-

Table 1
Austral summer season, survey areas, type of drones used and the number of Antarctic blue whales photographed during the past four JASS-A surveys.

Season Survey Area	2019/20 Area IIIW: 000°–015°E	2020/21 Area IIIW: 015°E–035°E	2021/22 Area VIE: 130°W–120°W	2022/23 Area VIE: 145°W–130°W	Total
Drone	Phantom Pro 4	Phantom Pro 4	Inspire 2 with altitude measuring system	Inspire 2 with altitude measuring system	
Number of photographed Antarctic blue whales	2	10	2	7	21

Figure 1. A drone Phantom Pro 4 flying over an Antarctic blue whale during the 2020/2021 JASS-A survey (left). Scene of retrieving the drone Inspire 2 at the bow deck of the research vessel *Yushin-Maru* No.2 during the 2021/2022 JASS-A survey (right). When retrieving, the drone is caught by hand. For safety, the person catching the drone uses a full-face helmet and cut-resistant gloves.

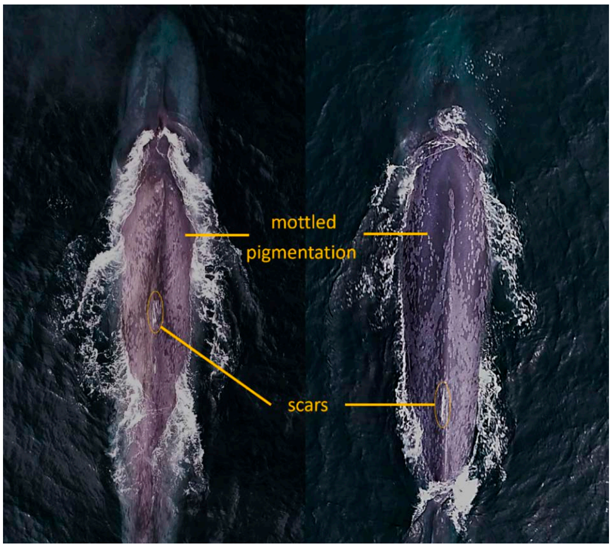


Figure 2. Individual identification of Antarctic blue whales by differentiated mottled pigmentations photographed by Phantom Pro 4. The mottling pattern on the dorsal is clearly visible and easily identifiable. The white scar is also a clue for individual identification.

ful for identifying individuals. Sears *et al.* (1990) reported that such large scars remained unchanged over an eight-year period. However, smaller scars tend to disappear within two years, necessitating caution when identifying individuals across different seasons. Our comparison of drone-captured images of two individuals indicates that these dorsal mottling patterns allow for easy and reliable individual identification.

In the application of photo identification using aerial imagery by drones, it is essential to cross-reference these images with existing catalogs of dorsal/lateral mottling photographs. Due to the significant difference in photographic angles between pictures taken from drones and pictures taken from vessels, the same mottled patterns may appear different. To investigate this, we obtained lateral pictures obtained from vessels and aerial pictures taken from drones from the same individuals. A future task is to conduct comparative analyses of both types of photographs to determine whether the same individuals can be reliably identified using both methods.

Photogrammetry

The use of drones has enabled non-lethal measurement of whale body length (BL), leading to a surge in research on body length and body condition since the 2010s (e.g., Durban *et al.*, 2015; Christiansen *et al.*, 2016). Body condition is a crucial indicator reflecting an animal's survival strategy, adaptive capacity and prey availability (Stevenson and Woods, 2006; Konishi *et al.*, 2008; Solvang *et al.*, 2017). Drone-based studies have introduced various indices for body condition. For example, the Body Area Index (BAI) (Burnett *et al.*, 2019), which standardizes the whale's dorsal surface area by dividing it by BL, and the Body Condition Index (BCI) (Christiansen *et al.*, 2018), which calculates the body volume. BAI, calculated using Equation 1, is a relative indicator where higher values indicate better body condition. Due to its low uncertainty and high precision, BAI is used for comparisons between individuals and populations (Bierlich *et al.*, 2021b).

$$\mathrm{BAI} = [\mathrm{SA}/(\mathrm{HT} \times \mathrm{BL})^2] \times 100 \qquad \text{Equation 1}$$

Where:
SA=Surface area (m^2) (the area shown in white in Figure 3)
HT=Head-tail range (proportion of total length used, typically 0.7 for 20–90% in blue whales)
BL=Body length (m)

The surface area (SA) was estimated by approximating the whale's body as a series of trapezoids between 20% and 90% of the total body length and obtaining the sum

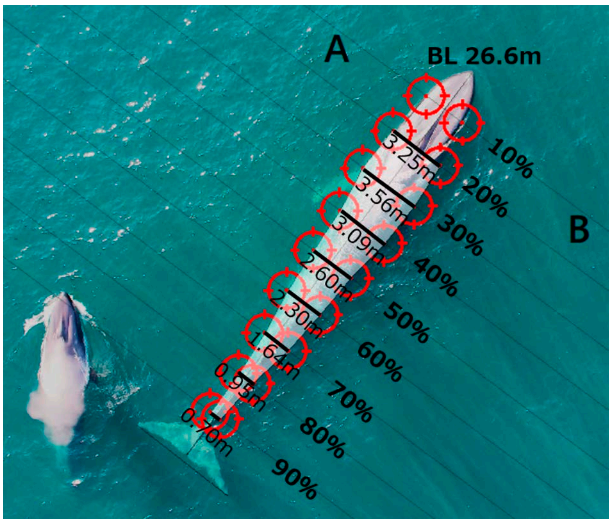


Figure 3. A lens-distortion corrected photograph used for measuring body length (BL) and width at 10% intervals of the BL (black thick lines) using MorphoMetriX (Ver.2.1.2). The red circles indicate the endpoints for measuring the body width. The flight altitude at the time of capture was 52.5 m. Letters A and B indicate the mirror sides. The measurements for this individual were based on the body width from side A edge to side B edge. MorphoMetriX (Ver.2.1.2) can handle one-sided measurements (from the edge of one side to the center) when the edge of one side of the whale is obstructed, e.g., by waves, glare and other factors.

of those areas. The drone Inspire 2 with altitude measuring system was used for the photogrammetry study.

In this study, we preliminary calculated BAI for a mother Antarctic blue whale photographed by drone Inspire 2 on 16 January 2023. The BL and width at each 10% interval of the body length were measured using MorphoMetriX (Ver.2.1.2) (Torres *et al.*, 2020). The measurements required the flight altitude at the time of capture, focal length, sensor size, and the number of pixels from the tip of the rostrum to the notch of the fluke for BL. Figure 3 shows the entire body immediately after breathing. This was extracted using a VLC media player (Ver. 3.0.8.0). Based on the time and position at the time of extraction, the distance from the sea surface measured by LiDAR and the tilt of the aircraft were obtained. After correcting for the tilt, the flight altitude was calculated to be 52.5 m. The focal length was fixed at 14 mm during the flight to capture 4K video (3840×2160 pixels). The onboard camera was the ZENMUSE X5S (DJI, China), equipped with a MICRO 4/3 sensor, and the lens was the Olympus M. ZUIKO DIGITAL 14–42 mm 1 : 3.5–5.6 (Olympus, Japan). The wide-angle lens caused distortion in the images, which was corrected using the video editing software Defishr (Ver.1.0) to prevent interference with accurate measurements. From the corrected images, the number of pixels from the tip of the rostrum to the notch of the fluke and from the edge of the body to the other edge was counted.

The BL of this individual was estimated to be 26.6 m. Commercial whaling data for Antarctic blue whale showed sexually mature females averaged 25.59 m in length (range: 23.4–28.2 m) (Mackintosh and Wheeler, 1929; Pastene *et al.*, 2019). This suggested that the estimated body length of this individual was within that range. The BAI of this animal was measured at 12.35. Barlow *et al.* (2023) used Monte Carlo ANOVA to analyze BAI values for three blue whale populations on the feeding ground. They reported the following results: Eastern North Pacific (ENP) blue whales had a BAI of 13.02 (95% CI: 12.74–13.33), New Zealand pygmy blue whales 14.36 (95% CI: 13.84–14.77), and Chilean blue whales 12.67 (95% CI: 12.21–13.23). The Antarctic blue whale mother in our study showed the lowest value which was closest to that of the Chilean blue whales.

It is generally observed that the body condition of mother whales deteriorates when accompanied by calves (the case of our study) due to energy allocation for nursing (Christiansen *et al.*, 2016). Barlow *et al.* (2023) provided valuable insights into blue whale body condition across different ecosystems. Of particular interest is their observation that New Zealand pygmy blue whales, which do not migrate seasonally, showed the best body condition. This finding offers an important point of comparison for understanding the body condition of the Antarctic blue whales in our study. Antarctic blue whales, which undergo seasonal migration, may be more vulnerable to changes in the distribution and abundance of prey caused by climate change. The relatively low BAI value we observed in our study individual aligns with this hypothesis. Furthermore, the record low sea ice extent observed in February 2023 (Purich and Doddridge, 2023) (year in which the picture was taken) and the predicted rapid ocean warming (Naughten *et al.*, 2023) could significantly impact the feeding environment of Antarctic blue whales. Under these circumstances, monitoring body condition, in addition to abundance, has become increasingly important for resource management.

However, due to the difficulty of accessing the Antarctic Ocean, collecting sampling data on the body condition of baleen whales in this region remains challenging. The utilization of drones in the JASS-A program serves as a valuable data sampling platform and provides a globally significant research opportunity. Given that this study focused on a mother with a calf, which is a special case, and the limited number of data points, we will move to conducting measurements of other individuals collected in JASS-A and analyze the body condition of Antarctic blue whale populations. It is also crucial to accumulate data on various whale species, not limited to Antarctic blue whales. This will enable us to assess the body condition of whales and evaluate whether the changing Antarctic Ocean continues to function as a healthy feeding ground.

ACKNOWLEDGEMENTS

We thank Y. Fujise, K. Matsuoka, T. Tamura and T. Hakamada (ICR) for their support in conducting the experiments and the preliminary analyses. We also thank Captains C. Ohkoshi, H. Kasai, N. Abe and crew members (Kyodo Senpaku) as well as the researchers who participated in JASS-A surveys and worked on the drone experiment. We also acknowledge H. Murase (Tokyo University of Marine Science and Technology) for his advice on photo identification. We are grateful to L.A. Pastene (ICR) for his assistance in preparing this report and the TEREP editorial team for editorial checking.

REFERENCES

Barlow, D.R., Bierlich, K.C., Oestreich, W.K., Chiang, G., Durban, J.W., Goldbogen, J.A., Johnston, D.W., Leslie, M.S., Moore, M.J., Ryan, J.P. and Torres, L.G. 2023. Shaped by their environment: Variation in blue whale morphology across three productive coastal ecosystems. *Integr. Org. Biol.* 5(1): obad039.

Bierlich, K.C., Schick, R.S., Hewitt, J., Dale, J., Goldbogen, J.A., Friedlaender, A.S. and Johnston, D.W. 2021a. Bayesian approach for predicting photogrammetric uncertainty in morphometric measurements derived from drones. *Mar. Ecol.: Prog. Ser.* 673: 193–210.

Bierlich, K.C., Hewitt, J., Bird, C.N., Schick, R.S., Friedlaender, A., Torres, L.G., Dale, J., Goldbogen, J., Read, A.J., Calambokidis, J. and Johnston, D.W. 2021b. Comparing uncertainty associated with 1-, 2-, and 3D aerial photogrammetry-based body condition measurements of baleen whales. *Front. Mar. Sci*. 8 : 749943.

Burnett, J.D., Lemos, L., Barlow, D., Wing, M.G., Chandler, T. and Torres, L.G. 2019. Estimating morphometric attributes of baleen whales with photogrammetry from small UASs: A case study with blue and gray whales. *Mar. Mamm. Sci.* 35(1): 108–139.

Christiansen, F., Dujon, A.M., Sprogis, K.R., Arnould, J.P. and Bejder, L. 2016. Noninvasive unmanned aerial vehicle provides estimates of the energetic cost of reproduction in humpback whales. *Ecosphere* 7(10): e01468.

Christiansen, F., Vivier, F., Charlton, C., Ward, R., Amerson, A., Burnell, S. and Bejder, L. 2018. Maternal body size and condition determine calf growth rates in southern right whales. *Mar. Ecol. Prog. Ser.* 592: 267–281.

Dawson, S.M., Bowman, M.H., Leunissen, E. and Sirguey, P. 2017. Inexpensive aerial photogrammetry for studies of whales and large marine animals. *Front. Mar. Sci.* 4(366).

Durban, J.W., Fearnbach, H., Barrett-Lennard, L.G., Perryman, W.L. and Leroi, D.J. 2015. Photogrammetry of killer whales using a small hexacopter launched at sea. *J. Unmanned Veh. Syst*. 3(3): 131–135.

Fiori, L., Doshi, A., Martinez, E., Orams, M.B. and Bollard-Breen, B. 2017. The use of unmanned aerial systems in marine mammal research. *Remote Sens*. 9(6): 543.

Isoda, T., Katsumata, T., Tamura, T., Matsuoka, K. and Pastene, L.A. 2020. An outline of the Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A) including results of the first survey under this new research program. *Technical Reports of the Institute of Cetacean Research (TEREP-ICR)* No. 4: 12–22.

Konishi, K., Tamura, T., Zenitani, R., Bando, T., Kato, H. and Walløe, L. 2008. Decline in energy storage in the Antarctic minke whale (*Balaenoptera bonaerensis*) in the Southern Ocean. *Polar Biol*. 31: 1509–1520.

Mackintosh, N.A. and Wheeler, J.F.G. 1929. Southern blue and fin whales. *Discovery Reports* 1: 257–540.

Naughten, K.A., Holland, P.R. and De Rydt, J. 2023. Unavoidable future increase in West Antarctic ice-shelf melting over the twenty-first century. *Nat. Clim. Chang*. 13: 1222–1228.

Pastene, L.A., Acevedo, J. and Branch, T.A. 2019. Morphometric analysis of Chilean blue whales and implications for their taxonomy. *Mar. Mamm. Sci.* 36: 116–135.

Purich, A. and Doddridge, E.W. 2023. Record low Antarctic sea ice coverage indicates a new sea ice state. *Commun. Earth Environ*. 4: 314.

Sears, R., Williamson, M., Wenzel, F., Bérubé, M., Gendron, D. and Jones, P. 1990. Photographic identification of the blue whale (*Balaenoptera musculus*) in the Gulf of St. Lawrence, Canada. *Rep. int. Whal. Commn* (Special issue 12): 335–342.

Solvang, H.K., Yanagihara, H., Øien, N. and Haug, T. 2017. Temporal and geographical variation in body condition of common minke whales (*Balaenoptera acutorostrata acutorostrata*) in the Northeast Atlantic. *Polar Biol*. 40: 667–683.

Stevenson, R.D. and Woods, W.A. 2006. Condition indices for conservation: new uses for evolving tools. *Integr. Comp. Biol.* 46(6): 1169–1190.

Torres, W. and Bierlich, K. 2020. MorphoMetriX: a photogrammetric measurement GUI for morphometric analysis of megafauna. *J. Open Source Softw*. 5(45): 1825.

Commentary

The views expressed here are those of the author and do not necessarily reflect the views of the Institute of Cetacean Research

Implementing international collaboration in the study of cetaceans at the Institute of Cetacean Research

Luis A. Pastene

Institute of Cetacean Research, 4–5 Toyomi-cho, Chuo-ku, Tokyo 104–0055, Japan

The importance of international collaboration in the study of cetaceans was commented on and discussed in a previous TEREP′s commentary article (Pastene, 2021). According to the article, one of the advantages of international research collaboration is that it 'facilitates the access to, and interchange of, field, laboratory and analytical techniques'. This article describes and comments on two recent examples of research collaborations resulting in valuable exchange of field, laboratory and analytical techniques. One example is a German scientist′s one-year post-doctoral stay at the Institute of Cetacean Research (ICR) with the focus on population genomics of large whales. Another example is a Chilean scientist′s participation in the fieldwork during the 2023/24 season of the Japanese Abundance and Stock-structure Survey (JASS-A) cruise in the Antarctic.

Post-doctoral stay of a German scientist

Dr. Katrin Kiemel is an evolutionary biologist with a special interest in the field of molecular ecology. She has been working in Germany on a wide spectrum of organisms, ranging from large mammals such as the North Atlantic common minke whale to smaller amphibians and microscopic invertebrates such as zooplankton.

After completing her Ph.D. in the field of evolutionary biology at the University of Potsdam, Germany in February 2023, Dr. Kiemel applied for a post-doctoral research position at the ICR, Tokyo, Japan. This position was approved for a period of one year (March 2023–February 2024). The primary research objective of the post-doctoral stay was to develop and implement a new genetic marker, Single Nucleotide Polymorphism (SNPs), at the genetic laboratory of the ICR to enable the study of population genomics of cetaceans. Technical details of this marker and its development are outlined in an article by Dr. Kiemel in this issue of TEREP. Figure 1 shows Dr. Kiemel working at the former genetic laboratory of the ICR in Tokyo.

Population genetics studies of large whales at the ICR, as well as in many other research institutions worldwide, have traditional relied on two genetic markers: sequencing analyses of a segment of the maternal inherited mitochondrial DNA (mtDNA) control region and genotyping based on multiple loci of bi-parental inherited microsatellite DNA (msDNA). However, SNPs offer several advantages over msDNA. As Dr. Kiemel explains in her article, the primary advantages of SNPs are i) they can overcome the resolution limitations often encountered in traditional population genetics, particularly in highly mobile species like cetaceans; and ii) they allow for a greater comparability of population genetics studies across different laboratories without requiring prior calibration, which is necessary for microsatellites (Kiemel *et al.*, this issue).

During her research stay at the ICR, Dr. Kiemel implemented the SNPs marker in the study of blue whales worldwide, aiming to answer questions on population structure and kinship assessment (paper in preparation). As a main output of Dr. Kiemel′s work at ICR, the

Figure 1. Dr. Kiemel working at the ICR′s former genetic laboratory in Tokyo.

Figure 2. Dr. Moraga engaged in sighting activities during the 2023/24 JASS-A survey.

SNPs markers are now available not only for the study of population genomics of blue whales, but also for the pipeline that allows population genomic studies on other baleen whale species by the ICR genetic team. At the end of her stay, Dr. Kiemel conducted a training course on SNP genetic markers in February 2024 at the ICR Taiji Office's genetic laboratory. She also contributed a related lecture at the international workshop in Taiji, which focused on the use of genetic data for whale stock identification. The workshop included participation from international experts representing Norway, Iceland, Germany and Japan.

In conclusion, Dr. Kiemel's post-doctoral research stay at the ICR was very successful for several reasons. Firstly, the research objective of developing and implementing SNPs at the ICR was achieved. This was possible not only because Dr. Kiemel's high laboratory and analytical skills but also because of her efficient organization of work activities and highly productive use of her time. Additionally, she developed strong communication ties with ICR scientists, particularly members of the genetic team, both professionally and socially. These interactions facilitated an exchange of information between scientists from different scientific and cultural backgrounds. Moreover, Dr. Kiemel showed keen interest in Japanese culture, dedicating her limited free time to exploring and learning from traditional locations in Japan.

After completing her post-doctoral work in ICR, Dr. Kiemel moved to the Department of Evolutionary and Integrative Ecology of the Leibniz Institute of Freshwater Ecology in Berlin, Germany.

Participation of a Chilean scientist in a JASS-A survey

Dr. Claudio Moraga, DVM, Ph.D.(c), is a Chilean veterinarian and ecologist with experience in wildlife ecology studies of land and marine mammals. At present, he works at the 'Centro de Estudios del Cuaternario de Fuego-Patagonia y Antartica Chilena' (CEQUA). He is also an associate researcher of the microbiome international project which is being implemented in the Magellan Strait by CEQUA in collaboration with scientists from several countries including Japan, Mexico, Germany, Ecuador and Chile. His experience covers handling and sampling of wildlife species to methods for estimation of wildlife abundance. He has experience with biological sampling of subantarctic penguins, South American sea lions and large whales inhabiting the southernmost Chilean Patagonia. In addition, he has field and analytical experience working with the Line Transect Method in studies of land mammals in Chile. Recently he has overseen the use of drones for the observation of animal counts and behavior in this southern region of Chile.

Under the framework of a Memorandum of Understanding (MOU) between the ICR and CEQUA, Dr. Moraga applied for a position as a field researcher in the 2023/24 JASS-A survey in a part of Area IV, in the Indian sector of the Antarctic. After acceptance by the ICR, he carried out the logistic preparation for his participation with assistance from several colleagues from the ICR. For instance, several introductory and organizational online meetings were carried out in which Dr. Moraga participated together with Dr. Matsuoka (director of ICR), Mr. Isoda (cruise leader of the 2023/24 JASS-A survey) and the author of this article.

The objectives of Dr. Moraga's participation in the JASS-A survey were the following: i) to contribute to the field work of JASS-A survey; ii) to learn on the cetacean application of the Line Transect Method as well biopsy sampling, photo-id, drone survey and oceanographic survey; iii) to exchange information of the common field techniques that are used in both JASS-A surveys and CEQUA surveys in the Patagonia; iv) to contribute to a study based on samples obtained during the JASS-A survey; and v) to disseminate information in Chile about the JASS-A survey, including technical and cultural aspects.

The JASS-A survey was held between 23 December 2023 to 29 February 2024 (port-to-port period) (see details of this survey in Isoda *et al.*, this issue). After a long flight from Chile to Surabaya, Indonesia, Dr. Moraga met Japanese scientists and crew members. He then participated in a pre-cruise meeting and boarded one of the vessels to start transit to the Antarctic research area. After completing the survey in the Antarctic, the vessels returned to Dili, East Timor on 29 February 2024. After participating in a post-cruise meeting Dr. Moraga returned to Chile.

According to the cruise leader and other scientists participating in the 2023/24 JASS-A survey, Dr. Moraga participated actively and enthusiastically in all research activities assigned to him (see Figure 2) and adapted quickly to the life on the Japanese vessel. According to them, Dr. Moraga communicated well not only with the scientists on board but also with the captain and crew members. In summary Dr. Moraga made an excellent contribution to the fieldwork of the JASS-A survey.

Based on the comments from the cruise leader and other scientists summarized above, I believe that the participation of Dr. Moraga in the 2023/24 JASS-A survey was a success and that all objectives were or are being fulfilled. He contributed to the field work of JASS-survey and learnt about different techniques used, which will be applied back in Chile during CEQUA field surveys in the Patagonia (objectives i–iii above). Some of the biopsy samples collected from humpback whales are being used in a collaborative study on microbiota between ICR and CEQUA (objective iv above). Finally, Dr. Moraga is preparing a paper for publication in a local journal in Chile about his experience working on a Japanese research vessel in the Antarctic, including technical and cultural aspects (objective v above).

The successful participation of Dr. Moraga in the 2023/24 JASS-A survey enabled a path for further research collaboration on whales between his institute in Chile and the ICR. For instance, a new collaborative research project between the two research institutions has just started. It deals with Whole Genome Sequencing (WGS) of humpback whales from the JASS-A research area and those in the Chilean Patagonia and Antarctic Peninsula.

Concluding remarks

The two experiences described briefly in this article confirm the view that international collaboration in the study of large whales is important for the access and interchange of laboratory, field and analytical techniques among research institutions from different regions and countries. Further, these two experiences demonstrated that international research collaboration promotes the exchange of ideas and modes of working among scientists from different countries. This in turn should facilitate the understanding of the different cultures involved. Ignoring such differences may result in misunderstandings during international scientific debates or research collaborations (Pastene, 2021).

REFERENCES

Pastene, L.A. 2021. Importance of international collaboration in the study of cetaceans: experiences of the Institute of Cetacean Research. *Technical Reports of the Institute of Cetacean Research (TEREP-ICR)* No. 5: 68–71.

National meetings

Participation of scientists from the Institute of Cetacean Research in National Meetings in 2024

The 38th International Symposium on the Okhotsk Sea and Polar Oceans

The Sea Ice Research Laboratory of Hokkaido University was established in 1965. This laboratory has been organizing the International Symposium on the Okhotsk Sea and Polar Oceans since 1986. Originally, the subjects of the symposium were related mainly to sea ice physics, engineering for oil development in the sea ice, and biology of marine resources and fishery. Recently the subjects covered marine environments, global warming, and the Arctic Sea Routes (northern passage into the Arctic Ocean).

The 38th International Symposium on the Okhotsk Sea and Polar Oceans was held from 21 to 28 February 2024 at several venues in Mombetsu, Hokkaido. Tamura and Bando from the Institute of Cetacean Research (ICR) participated in the symposium by presenting the study 'Stable isotope ratios in minke whale baleen in the Sea of Okhotsk'.

Mombetsu Municipal Museum, Mombetsu, Hokkaido, Japan.

The 2024 meeting of the Japanese Society of Fisheries Science (JSFS)

The Japanese Society of Fisheries Science (JSFS) was established in 1932. It is a non-profit, registered society dedicated to the promotion of all aspects of fisheries science. The society fulfills its global commitment by promoting science, striving to achieve sustainable development in the field of fisheries, while recognizing the crucial need to preserve the natural aquatic resources. It also strives to forge relationships with the fishing industry, comprising both capture and culture fisheries. The main events organized by the society are the biannual meetings held in spring and autumn in one of the main cities of Japan. This forum is where members present their research activities, exchange information, and foster collaborative research in areas of common interest.

The 2024 spring meeting of the JSFS was held from 27 to 30 March at Tokyo University of Marine Science and Technology (TUMSAT). Matsuoka, Hakamada and Katsumata from the ICR participated in the meeting as co-authors of the study titled 'Preliminary estimation of availability bias in North Pacific sei whale using satellite tagging data'.

The Tokyo University of Marine Science and Technology, Tokyo, Japan, venue of the 2024 spring meeting of the JSFS.

International meetings

Participation of scientists from the Institute of Cetacean Research in International Meetings in 2024

International workshop on the use of genetic data for whale's stock identification purposes

This international workshop organized by the Institute of Cetacean Research (ICR) was held from 18 to 22 February 2024 in Taiji, Wakayama Prefecture, with two main objectives: (1) to interchange information on genetic techniques —laboratory and analytical— used on large whale's stock structure studies in institutes in Germany, Iceland, Norway, and Japan, and (2) to identify future collaborative research topics on population genetic structure of baleen whales.

The objective (1) was implemented through the following activities: (i) training course in the use of the Single Nucleotide Polymorphism (SNP) technique by an experienced German scientist; (ii) visit and advice from experienced foreign scientists to the recently established ICR, Taiji Office, including the genetic laboratory; and (iii) oral presentations on population genetic studies on whales conducted in each country. Activities (i) and (ii) above were carried out at the ICR Taiji Office, and activity (iii) including discussions on future research collaborations, i.e., objective (2), were carried out at the Taiji Whale Museum.

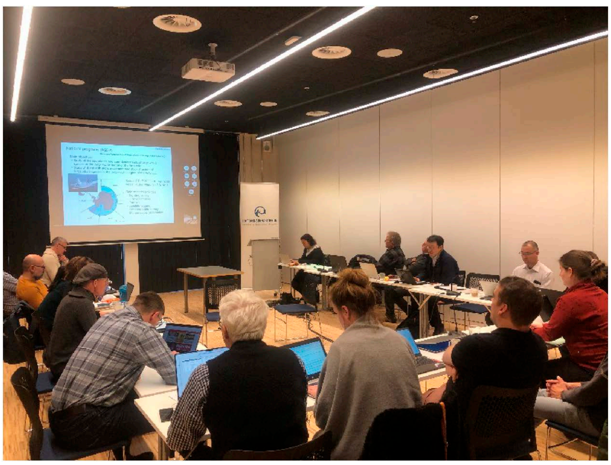
Six scientists from ICR participated in the workshop, and they presented population genetics studies on North Pacific common minke and southern humpback whales (Goto), southern right whales (Katayama), blue whales (Kiemel), Antarctic minke whales (Pastene), North Pacific fin whales (Taguchi), and North Pacific Bryde's whales (Sugimoto). The history of laboratory genetic techniques which have been implemented in ICR through time and the on-going development of SNP genotyping techniques at ICR were introduced by Pastene and Kiemel, respectively. Based on the three activities above, several topics for future international research collaborations were identified. Details can be found in the proceedings of the workshop (Geiken-Sosho No.17).

Annual meeting of the North Atlantic Marine Mammal Commission (NAMMCO) Scientific Committee (SC)

The North Atlantic Marine Mammal Commission (NAMMCO) is an international body for cooperation on the conservation, management and study of marine mammals in the North Atlantic. The NAMMCO Agreement was signed in Nuuk, Greenland on 9 April 1992 by Norway, Iceland, Greenland and the Faroe Islands, and entered into force on 8 July 1992. The agreement focuses on modern approaches to the study of the marine ecosystem, and to better understanding the role of marine mammals in the ecosystem. NAMMCO has a Scientific Committee (SC), which meets annually.

The 2024 NAMMCO SC (SC30) meeting was held from 22 to 26 January 2024 in Hafnarfjörður, Iceland. Four scientists from ICR participated in the meeting (Pastene, Tamura, Konishi and Sugimoto) as observers from Japan.

Participants of the workshop on the use of genetic data for whale's stock identification purposes held in Taiji, Wakayama Prefecture, Japan.



A session of the 2024 NAMMCO SC meeting (SC30) at the Marine & Freshwater Research Institute, Hafnarfjörður, Iceland.

They presented the following documents: the 2022–2023 Japan progress report on large cetacean research, the 2021–2022 Japan progress report on small cetacean research, a proposal for starting a collaborative study to further understand the role of baleen whales in the western North Pacific ecosystem and the 2022–2023 report on satellite tagging experiments at the ICR. The report of the meeting can be found on the website of NAMMCO (https://nammco.no/wp-content/uploads/2024/02/Report_SC30_rev08042024.pdf).

NAMMCO-Japan MINTAG project meetings

NAMMCO and Japan have agreed on a collaborative project to develop a new satellite tag suited for use on fast swimming rorquals (fin, sei, Bryde's, blue and minke whales) and pilot whales, which are of most interest to NAMMCO countries and Japan. The project is called MINTAG project. The project started in 2022 and will run for five years. The project is divided into phases: development phase, testing phase, deployment-data collection-analyses phase, and publication-final reporting-workshop phase. The project is led by a Steering Group composed of scientists from NAMMCO countries and Japan, the Secretariat of NAMMCO, and the Fisheries Agency of Japan (FAJ). Yearly reports are available at https://mintag-project.com/about-us/#reports.

An in-person MINTAG Steering Group meeting was held from 21 to 22 January 2024 in Hafnarfjörður, Iceland, with participation of a scientist from the ICR (Konishi). A second Steering Group meeting was held online on 17 April 2024, with participation of two scientists from the ICR (Pastene and Konishi). The main topics of this second meeting were the evaluation of tests in 2023, a web blog, and the test schedule for the project in 2024 (https://mintag-project.com/follow-the-whales/).

NAMMCO genetic working group (WG) meeting

The first genetic working group meeting of NAMMCO was held in-person from 8 to 9 October 2024 in Copenhagen, Denmark with participation of a scientist from the ICR (Taguchi). During the meeting, discussions primarily focused on the genetic population structure of the North Atlantic long-finned pilot whales, narwhals, and belugas, based on the priorities assigned to this WG by NAMMCO SC/30. Additionally, previous findings on the population structure of the white-beaked and Atlantic white-sided dolphins were reviewed, and data collection and analytical approaches to be standardized across all member countries were discussed. Based on these discussions, several recommendations were made to the member

Participants of the NAMMCO genetic working group meeting held in Copenhagen, Denmark.

countries. The content of this meeting will be reported to and approved by the upcoming NAMMCO SC meeting.

Annual meeting of the International Whaling Commission Scientific Committee (IWC SC)

The International Whaling Commission (IWC) is an international body set up by the terms of the International Convention for the Regulation of Whaling (ICRW), which was signed in Washington, D.C., United States, on 2 December 1946, to 'provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry'. One of the important subsidiary bodies of the IWC is its Scientific Committee (SC), which meets bi-annually.

The 2024 meeting of the IWC SC (SC69B) was held from 22 April to 3 May 2024 in Bled, Slovenia. Three scientists from the ICR participated in the meeting (Matsuoka, Isoda and Kim) as observers from Japan. They presented a total

A session of the IWC SC meeting (69B) in Riki Balance Hotel, Bled, Slovenia.

of 10 documents: six documents at the Standing Working Group on Abundance Estimates, Stock Status and International Cruises (ASI), one document at the Working Group on Stock Definition and DNA testing (SDDNA), one document at the Sub-Committee on Conservation Management Plans (CMP) and two general documents (O: PICES Observer Report and Japan's Scientific Progress Reports).

The next meeting of the IWC SC (SC70) will be held in 2026.

The report of the IWC SC meeting can be found on the website of the IWC https://archive.iwc.int/pages/view.php?ref=22181&k=).

Annual meeting of the Convention on the Conservation of Antarctic Marine Living Resources-Working Group on Ecosystem Monitoring and Management (CCAMLR-EMM)

The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) is part of the Antarctic Treaty System. The Convention was opened for signature on 1 August 1980 and entered into force on 7 April 1982, thereby establishing the Commission for the Conservation of Antarctic Marine Living Resources. Its goal is to preserve marine life and environmental integrity in and near Antarctica. It was established in large part in response to concerns that an increase in krill catches in the Southern Ocean could have a serious impact on populations of other marine life, which are dependent upon krill for food. The CCAMLR has a Scientific Committee and several Working Groups. One of these groups is the Working Group on Ecosystem Monitoring and Management (EMM), which meets annually.

The 2024 meeting of the EMM Working Group was held from 1 to 12 July 2024 in Leeuwarden, Netherlands. The main topics for discussions were krill fishery management, spatial management and ecosystem monitoring. Under the spatial overlap analysis approach, several papers on monitoring of krill-dependent predators including whales in western Antarctic were presented. Isoda, Kim and Matsuoka were co-authors of a report presented to the meeting titled 'Summary of the dedicated sighting survey for large whale species under the Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A) during the 2023/24 austral summer season'.

The report of the meeting can be found on the website of the CCAMLR (https://meetings.ccamlr.org/en/wg-emm-2024).

The 6th International Conference of *D*-Amino Acid Research (IDAR2024)

The Joint 6th International Conference of *D*-Amino Research (IDAR2024) and 18th Conference of the *D*-Amino Acid Research Society of Japan was held at Kanazawa University from 21 to 24 August 2024. This is a unique international interdisciplinary conference that deepens comprehensive research findings and exchanges among scientists doing research on *D*-amino acids in the fields of biology, chemistry, medicine, pharmacology, engineering, and agriculture.

A scientist from ICR (Yasunaga) participated in the conference as invited speaker and presented the study titled 'Age estimation of baleen whales based on aspartic acid racemization technique using UPLC-MS/MS measurement combined with deuterium-chloride hydrolysis'.

Scientists participating in the dinner of the IDAR2024 and 18th Conference of the *D*-Amino Acid Research Society of Japan in Kanazawa University, Kanazawa, Japan.

Annual meeting of the North Pacific Marine Science Organization (PICES)

The North Pacific Marine Science Organization (PICES) is an intergovernmental science organization established in 1992. It aims to promote and coordinate marine scientific research in the North Pacific Ocean and its adjacent seas, and to provide a mechanism for information and data exchange among scientists in its member countries. Its present members are Canada, Japan, People's Republic of China, Republic of Korea, the Russian Federation, and the United States of America.

The 2024 meeting of the PICES was held in Honolulu, Hawaii, USA. The business meeting of the Marine Bird and Mammals (S-MBM) section was held on 26 Octo-

A session of the 2024 PICES meeting in Honolulu, Hawaii, USA.

ber. One scientist from ICR participated in this meeting (Tamura) introducing the observer report of the 2024 IWC SC meeting. Under the topic ʻSocial, economic and ecological implications of recoveries, range expansions and shifting distributions of marine birds, mammals and fishʼ discussed on 31 October, Tamura, Kato Konishi and Isoda from the ICR presented the study titled ʻTemporal changes in distribution and prey species of common minke whales in Sendai Bay off the Pacific coast of Japanʼ. Under the same topic, Katsumata and Kato from the ICR were co-authors of a study presented at the meeting titled ʻNew wintering ground for humpback whales that have appeared around Hachijyojima Island (33°06ʹN, 139°47ʹE), Tokyo Metropolis, Japan since 2015: Their ecology and positive impact on the local tourismʼ. The report of the PICES meeting can be found on the website of PICES (https://meetings.pices.int/).

25th Biennial Conference on the Biology of Marine Mammals

The Society for Marine Mammalogy (SMM) was founded in 1981 and is the largest international association of marine mammal scientists in the world. The mission of the SMM is to promote the global advancement of marine mammal science and contribute to its relevance and impact in education, conservation and management. The SMM holds conferences every two years.

The 25th biennial conference of the SMM was held in Perth, Western Australia, Australia, from 11 to 15 November 2024. This was the first time the conference was held in Australia. Katsumata, Isoda, Hakamada and Matsuoka from the ICR presented the study titled ʻAbundance and distribution of southern right whales in the eastern Indian Ocean sector (70°–130°E) of the Antarctic, south of 60°Sʼ.

A poster session of the 25th Biennial Conference on the Biology of Marine Mammals held in Perth, Western Australia, Australia.

Peer-reviewed publications

List of peer-reviewed publications based on the Institute of Cetacean Research (ICR)'s surveys up to 2024

This section presents a list of peer-reviewed publications based on data collected by surveys conducted under former special scientific permit programs (JARPA/JARPAII/NEWREP-A and JARPN/JARPNII/NEWREP-NP), including both lethal and non-lethal techniques. Peer-reviewed publications based on these surveys are focused mainly on topics related to assessment and management of large whales. However samples and data collected by the surveys have also been useful to carry out studies of a more academic-oriented nature. Publications based on such studies are also listed here.

This section also includes a list of peer-reviewed publications resulting from other surveys and research activities, different from special scientific permit surveys.

Publications having as a first author a non-ICR scientist commonly followed a data request or collaboration research agreement with ICR. In a few cases, external scientists used published data from ICR surveys in their analyses and publications, without a formal agreement with ICR. These cases are indicated by an asterisk (*).

JARPA/JARPAII/NEWREP-A surveys

1989 (2)

Kato, H., Hiroyama, H., Fujise, Y. and Ono, K. 1989. Preliminary report of the 1987/88 Japanese feasibility study of the special permit proposal for Southern Hemisphere minke whales. *Rep. int. Whal. Commn* 39: 235–248.

Nakamura, T., Ohnishi, S. and Matsumiya, Y. 1989. A Bayesian cohort model for catch-at-age data obtained from research takes of whales. *Rep. int. Whal. Commn* 39: 375–382.

1990 (8)

Butterworth, D.S. and Punt, A.E. 1990. Some preliminary examinations of the potential information content of age-structure data from Antarctic minke whale research catches. *Rep. int. Whal. Commn* 40: 301–315.

Ichii, T. 1990. Distribution of Antarctic krill concentrations exploited by Japanese krill trawlers and minke whales. *Proc. NIPR Symp. Polar Biol* 3: 36–56.

Itoh, S., Takenaga, F. and Tsuyuki, H. 1990. Studies on lipids of the Antarctic minke whale. I. The fatty acid compositions of the minke whale blubber oils caught on 1987/88 season. *Yukagaku* 39 (7): 486–490 (in Japanese).

Kasamatsu, F., Kishino, H. and Hiroyama, H. 1990. Estimation of the number of minke whale (*Balaenoptera acutorostrata*) schools and individuals based on the 1987/88 Japanese feasibility study data. *Rep. int. Whal. Commn* 40: 239–247.

Kato, H., Fujise, Y., Yoshida, H., Nakagawa, S., Ishida, M. and Tanifuji, S. 1990. Cruise report and preliminary analysis of the 1988/89 Japanese feasibility study of the special permit proposal for southern hemisphere minke whales. *Rep. int. Whal. Commn* 40: 289–300.

Kato, H., Kishino, H. and Fujise, Y. 1990. Some analyses on age composition and segregation of southern minke whales using samples obtained by the Japanese feasibility study in 1987/88. *Rep. int. Whal. Commn* 40: 249–256.

Nagasaki, F. 1990. The Case for Scientific Whaling. *Nature* 334: 189–190.

Tanaka, S. 1990. Estimation of natural mortality coefficient of whales from the estimates of abundance and age composition data obtained from research catches. *Rep. int. Whal. Commn* 40: 531–536.

1991 (9)

Bergh, M.O., Butterworth, D.S. and Punt, A.E. 1991. Further examination of the potential information content of age-structure data from Antarctic minke whale research catches. *Rep. int. Whal. Commn* 41: 349–361.

Ichii, T. and Kato, H. 1991. Food and daily food consumption of southern minke whales in the Antarctic. *Polar Biol* 11 (7): 479–487.

Kasamatsu, F., Kishino, H. and Taga, Y. 1991. Estimation of southern minke whale abundance and school size composition based on the 1988/89 Japanese feasibility study data. *Rep. int. Whal. Commn* 41: 293–301.

Kato, H., Fujise, Y. and Kishino, H. 1991. Age structure and segregation of southern minke whales by the data obtained during Japanese research take in 1988/89. *Rep. int. Whal. Commn* 41: 287–292.

Kato, H. and Miyashita, T. 1991. Migration strategy of southern minke whales in relation to reproductive cycles estimated from foetal lengths. *Rep. int. Whal. Commn* 41: 363–369.

Kato, H., Zenitani, R. and Nakamura, T. 1991. Inter-reader calibration in age readings of earplugs from southern minke whale, with some notes of age readability. *Rep. int. Whal. Commn* 41: 339–343.

Kishino, H., Kato, H., Kasamatsu, F. and Fujise, Y. 1991. Detection of heterogeneity and estimation of population characteristics from the field survey data: 1987/88 Japanese feasibility study of the Southern Hemisphere minke whales. *Ann. Inst. Statist. Math.* 43 (3): 435–453.

Nakamura, T. 1991. A new look at a Bayesian cohort model for time-series data obtained from research takes of whales. *Rep. int. Whal. Commn* 41: 345–348.

Wada, S., Kobayashi, T. and Numachi, K. 1991. Genetic variability and differentiation of mitochondrial DNA in minke whales. *Rep. int. Whal. Commn* (special issue) 13: 203–215.

1992 (2)

Nakamura, T. 1992. Simulation trials of a Bayesian cohort model for time-series data obtained from research takes of whales. *Rep. int. Whal. Commn* 42: 421–427.

Tanaka, S., Kasamatsu, F. and Fujise, Y. 1992. Likely precision of estimates of natural mortality rates from Japanese research data for Southern Hemisphere minke whales. *Rep. int. Whal. Commn* 42: 413–420.

1993 (7)

Fujise, Y., Ishikawa, H., Saino, S., Nagano, M., Ishii, K., Kawaguchi, S., Tanifuji, S., Kawashima, S. and Miyakoshi H. 1993. Cruise report of the 1991/92 Japanese research in Area IV under the special permit for Southern Hemisphere minke whales. *Rep. int. Whal. Commn* 43: 357–371.

Hasunuma, R., Ogawa, T., Fujise, Y. and Kawanishi, Y. 1993. Analysis of selenium metabolites in urine samples of minke whale (*Balaenoptera acutorostrata*) using ion exchange chromatography. *Comp. Biochem. Physiol.* 104C (1): 87–89.

Itoh, S., Takenaga, F. and Tsuyuki, H. 1993. Studies on lipids of the Antarctic minke whale. II. The fatty acid compositions of the blubber oils of minke whale and dwarf minke whale caught on 1988/89 and 1989/90 seasons. *Yukagaku* 42 (12): 1007–1011 (in Japanese).

Iwata, H., Tanabe, S., Sakai, N. and Tatsukawa, R. 1993. Distribution of persistent organochlorines in the oceanic air and surface seawater and the role of ocean on their global transport and fate. *Environ. Sci. Technol.* 27: 1080–1098.

Kasamatsu, F., Yamamoto, Y., Zenitani, R., Ishikawa, H., Ishibashi, T., Sato, H., Takashima, K. and Tanifuji, S. 1993. Report of the 1990/91 southern minke whale research cruise under scientific permit in Area V. *Rep. int. Whal. Commn* 43: 505–522.

Nakamura, T. 1993. Two-stage Bayesian cohort model for time-series data to reduce bias in the estimate of mean natural mortality rate. *Rep. int. Whal. Commn* 43: 343–348.

Pastene, L.A., Kobayashi, T., Fujise, Y. and Numachi, K. 1993. Mitochondrial DNA differentiation in Antarctic minke whales. *Rep. int. Whal. Commn* 43: 349–355.

1994 (3)

Kimoto, H., Endo, Y. and Fujimoto, K. 1994. Influence of interesterification on the oxidative stability of marine oil triacylglycerols. *JAOCS* 71 (5): 469–473.

Pastene, L.A., Fujise, Y. and Numachi, K. 1994. Differentiation of mitochondrial DNA between ordinary and dwarf forms of southern minke whale. *Rep. int. Whal. Commn* 44: 277–281.

Yoshioka, M., Okumura, T., Aida, K. and Fujise, Y. 1994. A proposed technique for quantifying muscle progesterone content in the minke whales (*Balaenoptera acutorostrata*). *Can. J. Zool.* 72 (2): 368–370.

1995 (3)

Fukui, Y., Mogoe, T., Terawaki, Y., Ishikawa, H., Fujise, Y. and Ohsumi, S. 1995. Relationship between physiological status and serum constituent values in minke whales (*Balaenoptera acutorostrata*). *Journal of Reproduction and Development* 41 (3): 203–208.

Ishikawa, H. and Amasaki, H. 1995. Development and physiological degradation of tooth buds and development of rudiment of baleen plate in Southern minke whale, *Balaenoptera acutorostrata*. *J. Vet. Med. Sci.* 57 (4): 665–670.

Kasamatsu, F., Nishiwaki, S. and Ishikawa, H. 1995. Breeding areas and southbound migrations of southern minke whales *Balaenoptera acutorostrata*. *Mar. Ecol. Prog. Ser.* 119: 1–10.

1996 (7)

Bakke, I., Johansen, S., Bakke, O. and El-Gewely, M.R. 1996. Lack of population subdivision among the minke whales (*Balaenoptera acutorostrata*) from Icelandic and Norwegian waters based on mitochondrial DNA sequences. *Marine Biology* 125: 1–9.

Butterworth, D.S. and Geromont, H.F. 1996. On the provision of advice on the effect on stock(s) of scientific permit catches, with particular reference to proposed research catches of minke whales from Antarctic Area IV. *Rep. int. Whal. Commn* 46: 653–655.

Butterworth, D.S., Punt, A.E., Geromont, H.F., Kato, H. and

Miyashita, T. 1996. An ADAPT approach to the analysis of catch-at-age information for Southern Hemisphere minke whales. *Rep. int. Whal. Commn* 46: 349–359.

Fukui, Y., Mogoe, T., Jung, Y.G., Terawaki, Y., Miyamoto, A., Ishikawa, H., Fujise, Y. and Ohsumi, S. 1996. Relationships among morphological status, steroid hormones, and post-thawing viability of frozen spermatozoa of male minke whales (*Balaenoptera acutorostrata*). *Marine Mammal Science* 12 (1): 28–37.

Iga, K., Fukui, Y., Miyamoto, A., Ishikawa, H. and Ohsumi, S. 1996. Endocrinological observations of female minke whales (*Balaenoptera acutorostrata*). *Marine Mammal Science* 12 (2): 296–301.

Matsuoka, K., Fujise, Y. and Pastene, L.A. 1996. A sighting of a large school of the pygmy right whale, *Caperea marginata* in the southeast Indian Ocean. *Marine Mammal Science* 12 (4): 594–597.

Pastene, L.A., Goto, M., Itoh, S. and Numachi, K. 1996. Spatial and temporal patterns of mitochondrial DNA variation in minke whale from Antarctic Areas IV and V. *Rep. int. Whal. Commn* 46: 305–314.

1997 (3)

Aono, S., Tanabe, S., Fujise, Y., Kato, H. and Tatsukawa, R. 1997. Persistent organochlorines in minke whale (*Balaenoptera acutorostrata*) and their prey species from the Antarctic and the North Pacific. *Environmental Pollution* 98: 81–89.

Fukui, Y., Mogoe, T., Ishikawa, H. and Ohsumi, S. 1997a. Factors affecting *in vitro* maturation of minke whale (*Balaenoptera acutorostrata*) follicular oocytes. *Biology of Reproduction* 56: 523–528.

Fukui, Y., Mogoe, T., Ishikawa, H. and Ohsumi, S. 1997b. *In vitro* fertilization of *in vitro* matured minke whale (*Balaenoptera acutorostrata*) follicular oocytes. *Marine Mammal Science* 13 (3): 395–404.

1998 (7)

Ichii, T., Shinohara, N., Fujise, Y., Nishiwaki, S. and Matsuoka, K. 1998. Interannual changes in body fat condition index of minke whales in the Antarctic. *Mar. Ecol. Prog. Ser.* 175: 1–12.

Ito, S., Takenaga, F. and Tsuyuki, H. 1998. Lipids in Antarctic minke whales III. Site and sexual differences of muscle lipids. *J. Jpn. Oil Chem. Soc.* 47 (2): 191–194 (in Japanese).

Kida, M.Y. 1998. Morphology of the tracheobronchial tree and the route of the pulmonary artery in the fetal minke whale (*Balaenoptera acutorostrata*). *Okajimas Folia Anat. Jpn.*75 (5): 251–258.

Mogoe, T., Fukui, Y., Ishikawa, H. and Ohsumi, S. 1998a. Morphological observations of frozen-thawed spermatozoa of Southern minke whales (*Balaenoptera acutorostrata*). *Journal of Reproduction and Development* 44 (1): 95–100.

Mogoe, T., Fukui, Y., Ishikawa, H. and Ohsumi, S. 1998b. Effects of diluent composition and temperature on motility and viability after liquid storage and cryopreservation of minke whale (*Balaenoptera acutorostrata*) spermatozoa. *Marine Mammal Science* 14 (4): 854–860.

Nagasawa, K., Yamada, T.K. and Ishikawa, H. 1998. Measurements of the skeleton of a minke whale (*Balaenoptera acutorostrata*) from the Antarctic Ocean. *Bulletin of the Yamagata Prefectural Museum* 20: 1–19.

Terabayashi, T. and Kawanishi, Y. 1998. Naturally occurring ganglioside lactones in minke whale brain. *Carbohydrate Research* 307 (3): 281–290.

1999 (4)

Bannister, J.L., Pastene, L.A. and Burnell, S.R. 1999. First record of movement of a southern right whale (*Eubalaena australis*) between warm water breeding grounds and the Antarctic Ocean, South of 60°S. *Marine Mammal Science* 15 (4): 1337–1342.

Butterworth, D.S., Punt, A.E. Geromont, H.F., Kato, H. and Fujise, Y. 1999. Inferences on the dynamics of Southern Hemisphere minke whales from ADAPT analyses of catch-at-age information. *J. Cetacean Res. Manage.* 1 (1): 11–32.

Ishikawa, H., Amasaki, H., Dohguchi, H., Furuya, A. and Suzuki, K. 1999. Immunohistological distributions of fibronectin, tenascin, type I, III and IV collagens, and laminin during tooth development and degeneration in fetuses of minke whale, *Balaenoptera acutorostrata*. *J. Vet. Med. Sci.* 61 (3): 227–232.

Thomson, R.B., Butterworth, D.S. and Kato, H. 1999. Has the age at transition of southern hemisphere minke whales declined over recent decades? *Marine Mammal Science* 15 (3): 661–682.

2000 (5)

Asada, M., Horii, M., Mogoe, T., Fukui, Y., Ishikawa, H. and Ohsumi, S. 2000. *In vitro* maturation and ultrastructural observation of cryopreserved minke whale (*Balaenoptera acutorostrata*) follicular oocytes. *Biology of Reproduction* 62 (2): 253–259.

Kasamatsu, F., Matsuoka, K. and Hakamada, T. 2000. Interspecific relationships in density among the whale community in the Antarctic. *Polar Biol* 23 (7): 466–473.

Mogoe, T., Suzuki, T., Asada, M., Fukui, Y., Ishikawa, H. and Ohsumi, S. 2000. Functional reduction of the Southern minke whale (*Balaenoptera acutorostrata*) testis during the feeding season. *Marine Mammal Science* 16 (3): 559–569.

Rosenbaum, H.C., Brownell, R.L., Brown, M.W., Schaeff, C., Portway, V., White, B.N., Malik, S., Pastene, L.A., Pateneude, N.J., Baker, C.S., Goto, M., Best, P.B., Clapham, P.J., Hamilton, P., Moore, M., Payne, R., Rowntree, V., Tynan, C.T., Bannister, J.L. and DeSalle, R. 2000. World-wide genetic differentiation of *Eubalaena*: questioning the number of right whale species. *Molecular Ecology* 9: 1793–1802.

Wei, H. and Fukui, Y. 2000. Fertilizability of ovine, bovine or minke whale (*Balaenoptera acutorostrata*) spermatozoa intracytoplasmically injected into bovine oocytes. *Zygote* 8 (3): 267–274.

2001 (3)

Asada, M., Tetsuka, M., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2001. Improvement on *in vitro* maturation, fertilization and development of minke whale (*Balaenoptera acutorostrata*) oocytes. *Theriogenology* 56 (4): 521–533.

Asada, M., Wei, H., Nagayama, R., Tetsuka, M., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2001. An attempt at intracytoplasmic sperm injection of frozen-thawed minke whale (*Balaenoptera bonaerensis*) oocytes. *Zygote* 9 (3): 299–307.

Suzuki, T., Mogoe, T., Asada, M., Miyamoto, A., Tetsuka, M., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2001. Plasma and pituitary concentrations of gonadotropins (FSH and LH) in minke whales (*Balaenoptera acutorostrata*) during the feeding season. *Theriogenology* 55 (5): 1127–1141.

2002 (6)

Abe, H. and Goto, M. 2002. The application of microsatellite DNA for determining population structure of minke whale. pp. 109–113. *In*: A. Nishimura (Ed.). *Technical Reports of the Hokkaido National Fisheries Research Institute No.5*. Hokkaido National Fisheries Research Institute, Hokkaido.

Kunito, T., Watanabe, I., Yasunaga, G., Fujise, Y. and Tanabe, S. 2002. Using trace elements in skin to discriminate the populations of minke whale in southern hemisphere. *Marine Environmental Research* 53: 175–197.

Murase, H., Matsuoka, K., Ichii, T. and Nishiwaki, S. 2002. Relationship between the distribution of euphausiids and baleen whales in the Antarctic (35°E–145°W). *Polar Biol* 25 (2): 135–145.

Pastene, L.A., Goto, M. and Kanda, N. 2002. The utility of DNA analysis for the management and conservation of large whales. *Fish Sci* 68 (Suppl. I): 286–289.

Suzuki, M., Ishikawa, H., Otani, S., Tobayama, T., Katsumata, E., Ueda, K., Uchida, S., Yoshioka, M. and Aida, K. 2002. The characteristics of adrenal glands and its hormones in cetacean. *Fish Sci* 68 (Suppl. I): 272–275.

Urashima, T., Sato, H., Munakata, J., Nakamura, T., Arai, I., Saito, T., Tetsuka, M., Fukui, Y., Ishikawa, H., Lyndersen, C. and Kovacs, K.M. 2002. Chemical characterization of the oligosaccharides in beluga (*Delphinapterus leucas*) and minke whale (*Balaenoptera acutorostrata*) milk. *Comparative Biochemistry and Physiology, Part B* 132: 611–624.

2003 (5)

Hayashi, K., Nishida, S., Yoshida, H., Goto, M., Pastene, L.A. and Koike, H. 2003. Sequence variation of the *DQB* allele in the cetacean MHC. *Mammal Study* 28 (2): 89–96.

Matsuoka, K., Watanabe, T., Ichii, T., Shimada, H. and Nishiwaki, S. 2003. Large whale distributions (south of 60°S, 35°E–130°E) in relation to the Southern Boundary of the Antarctic Circumpolar Current. pp. 26–30. *In*: *Antarctic Biology in a Global Context.* Proceedings of the VIIIth SCAR International Biology Symposium, 27 August-1 September 2001. Vriji Universiteit, Amsterdam, The Netherlands, Backhuys Publisheres, Leiden.

Nishida, S., Hayashi, K., Pastene, L.A., Goto, M., Kanda, N. and Koike, H. 2003. Polymorphic analysis of cetacean MHC—A case study on the minke whales—. *Mammalian Science* (Suppl.) 3: 75–78 (in Japanese).

Nishida, S., Pastene, L.A., Goto, M. and Kanda, N. 2003. SRY gene structure and phylogeny in the cetacean species. *Mammal Study* 28 (1): 57–66.

Ohishi, K., Zenitani, R., Bando, T., Goto, Y., Uchida, K., Maruyama, T., Yamamoto, S., Miyazaki, N. and Fujise, Y. 2003. Pathological and serological evidence of *Brucella*-infection in baleen whales (Mysticeti) in the western North Pacific. *Comp. Immun. Microbiol. Infect. Dis.* 26 (2): 125–136.

2004 (8)

Amemiya, K., Iwanami, Y., Kobayashi, T., Terao, T., Fukui, Y., Ishikawa, H., Ohsumi, S., Hirabayashi, M. and Hochi, S. 2004. Acquirement of oocyte-activating factor in Antarctic minke whale (*Balaenoptera bonaerensis*) spermatogenic cells, assessed by meiosis resumption of microinseminated mouse oocytes. *J. Mamm. Ova*

Res. 21: 149–156.

Branch, T.A., Matsuoka, K. and Miyashita, T. 2004. Evidence for increase in Antarctic blue whales based on Bayesian modeling. *Marine Mammal Science* 20 (4): 726–754.

Fujihira, T., Kinoshita, M., Sasaki, M., Ohnishi, M., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2004. Comparative studies on lipid analysis and ultrastructure in porcine and southern minke whale (*Balaenoptera bonaerensis*) oocytes. *Journal of Reproduction and Development* 50 (5): 525–532.

Fukui, Y., Togawa, M., Abe, N., Takano, Y., Asada, M., Okada, A., Iida, K., Ishikawa, H. and Ohsumi, S. 2004. Validation of the sperm quality analyzer and the hypo-osmotic swelling test for frozen-thawed ram and minke whale (*Balaenoptera bonarensis*) spermatozoa. *Journal of Reproduction and Development* 50 (1): 147–154.

Ikumi, S., Sawai, K., Takeuchi, Y., Iwayama, H., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2004. Interspecies somatic cell nuclear transfer for *in vitro* production of Antarctic minke Whale (*Balaenoptera bonaerensis*) Embryos. *Cloning and Stem Cells* 6 (3): 284–293.

Iwayama, H., Hochi, S., Kato, M., Hirabayashi, M., Kuwayama, M., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2004. Effects of cryodevice type and donor′s sexual maturity on vitrification of minke whale (*Balaenoptera bonaerensis*) oocytes at germinal vesicle-stage. *Zygote* 12 (4): 333–338.

Muranishi, Y., Sasaki, M., Hayashi, K., Abe, N., Fujihira, T., Ishikawa, H., Ohsumi, S., Miyamoto, A. and Fukui, Y. 2004. Relationship between the appearance of preantral follicles in the fetal ovary of Antarctic minke whales (*Balaenoptera bonaerensis*) and hormone concentrations in the fetal heart, umbilical cord and maternal blood. *Zygote* 12 (2): 125–132.

Tetsuka, M., Asada, M., Mogoe, T., Fukui, Y., Ishikawa, H. and Ohsumi, S. 2004. The pattern of ovarian development in the prepubertal Antarctic minke whale (*Balaenoptera bonaerensis*). *Journal of Reproduction and Development* 50 (4): 381–389.

2005 (6)

Ishikawa, H. and Shigemune, H. 2005. Improvements in more humane killing methods of Antarctic minke whales, *Balaenoptera bonaerensis*, in the Japanese Whale Research Program under Special Permit in the Antarctic Sea (JARPA). *Jpn. J. Zoo Wildl. Med.* 10 (1): 27–34.

Iwayama, H., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2005. Attempt at *in vitro* maturation of minke whale (*Balaenoptera bonaerensis*) oocytes using a portable CO_2 incubator. *Journal of Reproduction and Development* 51 (1): 69–75.

Matsuoka, K., Pitman, R. and Marques, F. 2005. A note on a pigmy right whale (*Caperea marginata*) sighting in the southwestern Pacific Ocean. *J. Cetacean Res. Manage.* 7(1): 71–73.

Matsuoka, K., Hakamada, T., Kiwada, H., Murase, H. and Nishiwaki, S. 2005. Abundance increases of large baleen whales in the Antarctic based on the sighting survey during Japanese Whale Research Program (JARPA). *Global Environmental Research* 9 (2): 105–115.

Nikaido, M., Sasaki, T., Makino, H., Goto, M., Kanda, N., Pastene, L.A. and Okada, N. 2005. Phylogenetic reconstruction of baleen whales and detection of their past extensive radiation event by the SINE insertion analysis. *Fossils* 77: 22–28 (in Japanese).

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

2006 (9)

Fujihira, T., Kobayashi, M., Hochi, S., Hirabayashi, M., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2006. Developmental capacity of Antarctic minke whale (*Balaenoptera bonaerensis*) vitrified oocytes following *in vitro* maturation, and parthenogenetic activation or intracytoplasmic sperm injection. *Zygote* 14 (2): 89–95.

Honda, K., Aoki, M. and Fujise, Y. 2006. Echochemical approach using mercury accumulation of Antarctic minke whale, *Balaenoptera bonaerensis*, as tracer of historical change of Antarctic marine ecosystem during 1980–1999. *Bull. Environ. Contam. Toxicol.* 76: 140–147.

Iwanami, K., Mita, H., Yamamoto, Y., Fujise, Y., Yamada, T. and Suzuki, T. 2006. cDNA-derived amino acid sequences of myoglobins from nine species of whales and dolphins. *Comparative Biochemistry and Physiology, Part B* 145: 249–256.

Kobayashi, T., Amemiya, K., Takeuchi, K., Tsujioka, T., Tominaga, K., Hirabayashi, M., Ishikawa, H., Fukui, Y. and Hochi, S. 2006. Contribution of spermatozoal centrosomes to the microtubule-organizing centre in Antarctic minke whale (*Balaenoptera bonaerensis*). *Zygote* 14 (1): 45–51.

Konishi, K. 2006. Characteristics of blubber distribution and body condition indicators for Antarctic minke whale (*Balaenoptera bonaerensis*). *Mammal Study* 31 (1): 15–22.

Mori, M. and Butterworth, D.S. 2006. A first step towards modelling the krill–predator dynamics of the Antarctic ecosystem. *CCAMLR Science* 13: 217–277.

Nikaido, M., Hamilton, H., Makino, H., Sasaki, T., Takahashi, K., Goto, M., Kanda, N., Pastene, L.A. and Okada, N. 2006. Baleen whale phylogeny and a past extensive radiation event revealed by SINE insertion analysis. *Mol. Biol. Evol.* 23 (5): 866–873.

Rock, J., Pastene, L.A., Kaufman, G., Forestell, P., Matsuoka, K. and Allen, J. 2006. A note on East Australia Group V Stock humpback whale movement between feeding and breeding areas based on photo-identification. *J. Cetacean Res. Manage.* 8 (3): 301–305.

Yabuki, T., Suga, T., Hanawa, K., Matsuoka, K., Kiwada, H. and Watanabe, T. 2006. Possible source of the Antarctic bottom water in the Prydz Bay Region. *Journal of Oceanography* 62 (5): 649–655.

2007 (7)

Asada, M., Tetsuka, M., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2007. Ultrastructural changes during maturation and cryopreservation of follicular oocytes of Antarctic minke whales (*Balaenoptera bonaerensis*). *Jpn. J. Zoo. Wildl. Med.* 12 (1): 51–66.

Branch, T.A., Stafford, K.M., Palacios, D.M., Allison, C., Bannister, J.L., Burton, C.L.K., Cabrera, E., Carlson, C.A., Galletti Vernazzani, B., Gill, P.C., Hucke-Gaete, R., Jenner, K.C.S., Jenner, Mn. M., Matsuoka, K., Mikhalev, Y.A., Miyashita, T., Morrice, M.G., Nishiwaki, S., Sturrock, V.J., Tormosov, D., Anderson, R.C., Baker, A.N., Best, P.B., Borsa, P., Brownell Jr, R.L., Childerhouse, S., Findlay, K.P., Gerrodette, T., Ilangakoon, A.D., Joergensen, M., Kahn, B., Ljungblad, D.K., Maughan, B., Mccauley, R.D., Mckay, S., Norris, T.F., Oman Whale and Dolphin Research Group, Rankin, S., Samaran, F., Thiele, D., Van Waerebeek, K. and Warneke, R.M. 2007. Past and present distribution, densities and movements of blue whales in the Southern Hemisphere and adjacent waters. *Mammal Rev.* 37 (2): 116–175.

LeDuc, R.G., Dizon, A.E., Goto, M., Pastene, L.A., Kato, H., Nishiwaki, S. and Brownell, R.L. 2007. Patterns of genetic variation in southern hemisphere blue whales, and the use of assignment test to detect mixing on the feeding grounds. *J. Cetacean Res. Manage.* 9 (1): 73–80.

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

Nishida, S., Goto, M., Pastene, L.A., Kanda, N. and Koike, H. 2007. Phylogenetic relationships among cetaceans revealed by Y-chromosome sequences. *Zoological Science* 24 (7): 723–732.

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 (5): 449–464.

Pastene, L.A., Goto, M., Kanda, N., Zerbini, A.N., Kerem, D., Watanabe, K., Bessho, Y., Hasegawa, M., Nielsen, R., Larsen, F. and Palsbøll, P.J. 2007. Radiation and speciation of pelagic organisms during periods of global warming: the case of the common minke whale, *Balaenoptera acutorostrata. Molecular Ecology* 16: 1481–1495.

2008 (4)

Ishikawa, H. and Shigemune, H. 2008. Comparative experiment of whaling grenades in the Japanese Whale Research Program under Special Permit (JARPA and JARPN). *Jpn. J. Zoo Wildl. Med.* 13 (1): 21–28.

Konishi, K., Tamura, T., Zenitani, R., Bando, T., Kato, H. and Walløe, L. 2008. Decline in energy storage in the Antarctic minke whale (*Balaenoptera bonaerensis*) in the Southern Ocean. *Polar Biol* 31 (2): 1509–1520.

Ohishi, K., Fujise, Y. and Maruyama, T. 2008. *Brucella* spp. in the western North Pacific and Antarctic cetaceans: a review. *J. Cetacean Res. Manage.* 10 (1): 67–72.

Yunoki, K., Ishikawa, H., Fukui, Y. and Ohnishi, M. 2008. Chemical properties of epidermal lipids, especially sphingolipids, of the Antarctic minke whale. *Lipids* 43 (2): 151–159.

2009 (2)

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

Tamura, T. and Konishi, K. 2009. Feeding habits and prey consumption of Antarctic minke whale (*Balaenoptera bonaerensis*) in the Southern Ocean. *J. Northw. Atl. Fish. Sci.* 42: 13–25.

2010 (15)

Fujise, Y., Nishiwaki, S. and Ishikawa, S. 2010. Overview of the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA). *Bull. Jpn. Soc. Fish. Oceanogr.* 74: 43–44 (in Japanese).

Fujise, Y., Hatanaka, H. and Ohsumi, S. 2010. Changes in the Antarctic marine ecosystem as revealed by the JARPA research: What has happened to the Antarctic minke whale stocks? *Ottar* (Tromsø Museum) 280: 29–34 (in Norwegian).

Glover, K.A., Kanda, N., Haug, T., Pastene, L.A., Øien, N., Goto, M., Seliussen, B.B. and Skaug, H.J. Migration of Antarctic minke whales to the Arctic. *PLoS ONE* 5 (12): e15197.

Ishikawa, H. 2010. Animal Welfare—Introduction—. *Jpn. J. Zoo. Wildl. Med.* 15 (1): 1–3 (in Japanese).

Ishikawa, H. 2010. Lethal Research for Wildlife. *Jpn. J. Zoo. Wildl. Med.* 15 (1): 9–14 (in Japanese).

Kokubun, N., Yasuma, H., Murase, H. and Naganobu, M. 2010. Distribution of seabirds in the Ross Sea, Antarctica. *Bull. Jpn. Soc. Fish. Oceanogr.* 74: 42–43 (in Japanese).

Matsuoka, K., Kiwada, K., Murase, H. and Nishiwaki, S. 2010. Whale species composition and their distribution patterns in the Ross Sea, Antarctica. *Bull. Jpn. Soc. Fish. Oceanogr.* 74: 44–45 (in Japanese).

Murase, H., Matsuoka, K., Hakamada, T., Nishiwaki, S., Naganobu, M. and Kitakado, T. 2010. Estimation of spatial distribution pattern of cetacean using environmental covariates in the Ross Sea, Antarctica. *Bull. Jpn. Soc. Fish. Oceanogr.* 74: 47–48 (in Japanese).

Naganobu, M. and Murase, H. 2010. Ecological linkage between oceanographic environment and distribution of top predators and their preys in the Ross Sea region. *Bull. Jpn. Soc. Fish. Oceanogr.* 74: 48–49 (in Japanese).

Naganobu, M., Murase, H., Nishiwaki, S., Yasuma, H., Matsukura, R., Takao, Y., Taki, K., Hayashi, T., Watanabe, Y., Yabuki, T., Yoda, Y., Noiri, Y., Kuga, M., Yoshikawa, K., Kokubun, N., Iwami, T., K., Itoh, K., Goto, M., Isoda, T., Matsuoka, K., Tamura, T. and Fujise, Y. 2010. Structure of marine ecosystem of the Ross Sea, Antarctica—overview and synthesis of the results of the Japanese multidisciplinary study by *Kaiyo-Maru* and JARPA—. *Bull. Jpn. Soc. Fish. Oceanogr.* 74: 1–12.

Naganobu, M., Nishiwaki, S., Nagai, N. and Tohyama, D. 2010. Multidisciplinary ecological survey by the R/V *Kaiyo Maru* and JARPA in the Ross Sea, Antarctica. *Bull. Jpn. Soc. Fish. Oceanogr.* 74: 34–35 (in Japanese).

Pastene, L. A., Acevedo, J., Goto, M., Zerbini, A.N., Acuna, P. and Aguayo-Lobo, A. 2010. Population structure and possible migratory links of common minke whales, *Balaenoptera acutorostrata*, in the Southern Hemisphere. *Conserv Genet* 11 (4): 1553–1558.

Tamura, T., Konishi, K., Nishiwaki, S., Taki, K., Hayashi, T. and Naganobu, M. 2010. Feeding ecology of the Antarctic minke whales in the Ross Sea, Antarctica. *Bull. Jpn. Soc. Fish. Oceanogr.* 74: 46–47 (in Japanese).

Yabuki, T., Noiri,Y., Murase, H., Kiwada, H., Matsuoka, K. and Naganobu, M. 2010. Physical and chemical study of hydrographic feature based on the R/V *Kaiyo Maru* cruise and JARPA in the Ross Sea, Antarctica. *Bull. Jpn. Soc. Fish. Oceanogr.* 74: 35–36 (in Japanese).

Zenitani, R. and Kato, H. 2010. The growth of baleen plates in Antarctic minke whales, with special reference to the V-shape notch appearing at the outer edge of the plates. *Nippon Suisan Gakkaishi* 76 (5): 870–876 (in Japanese with English abstract).

2011 (1)

Matsuoka, K., Hakamada, T., Kiwada, H., Murase, H. and Nishiwaki, S. 2011. Abundance estimates and trends for humpback whales (*Megaptera novaeangliae*) in Antarctic Areas IV and V based on JARPA sighting data. *J. Cetacean Res. Manage.* (special issue) 3: 75–94.

2012 (1)

*Sremba, A.L., Hancock-Hanser, B., Branch, T.A., LeDuc, R.L. and Baker, C.S. 2012. Circumpolar diversity and geographic differentiation of mtDNA in the critically endangered Antarctic blue whale (*Balaenoptera musculus intermedia*). *PLoS ONE* 7 (3): e32579.

2013 (6)

Glover, K.A., Kanda, N., Haug, T., Pastene, L.A., Øien, N., Seliussen, B.B., Sørvik, A.G.E. and Skaug, H.J. 2013. Hybrids between common and Antarctic minke whales are fertile and can back-cross. *BMC Genetics* 14: 25.

Hakamada, T., Matsuoka, K., Nishiwaki, S. and Kitakado, T. 2013. Abundance estimates and trends for Antarctic minke whales (*Balaenoptera bonaerensis*) in Antarctic Areas IV and V for the period 1989/90–2004/05. *J. Cetacean Res. Manage.* 13 (2): 123–151.

Kitakado, T., Lockyer, C. and Punt, A.E. 2013. A statistical model for quantifying age-reading errors and its application to the Antarctic minke whales. *J. Cetacean Res. Manage.* 13 (3): 181–190.

Murase, H., Kitakado, T., Hakamada, T., Matsuoka, K., Nishiwaki, S. and Naganobu, M. 2013. Spatial distribution of Antarctic minke whales (*Balaenoptera bonaerensis*) in relation to spatial distributions of krill in the Ross Sea, Antarctica. *Fish. Oceanogr.* 22 (3): 154–173.

Sasaki, M., Amano, Y., Hayakawa, D., Tsubota, T., Ishikawa, H., Mogoe, T., Ohsumi, S., Tetsuka, M., Miyamoto, A., Fukui, Y., Budipitojo, T. and Kitamura, N. 2013. Structure and steroidogenesis of the placenta in the Antarctic minke whale (*Balaenoptera bonaerensis*). *Journal of Reproduction and Development* 59 (2): 159–167.

Shibata, Y., Matsuishi, T., Murase, H., Matsuoka, K., Hakamada, T., Kitakado, T. and Matsuda, H. 2013. Effects of stratification and misspecification of covariates on species distribution models for abundance estimation from virtual line transect survey data. *Fish Sci* 79 (4): 559–568.

2014 (4)

Konishi, K., Hakamada, T., Kiwada, H., Kitakado, T. and Walløe, L. 2014. Decrease in stomach contents in the Antarctic minke whale (*Balaenoptera bonaerensis*) in the Southern Ocean. *Polar Biol* 37 (2): 205–215.

Punt, A.E. 2014. A summary history of the application of statistical catch-at-age analysis (SCAA) to Antarctic minke whales. *J. Cetacean Res. Manage.* 14: 81–92.

Punt, A.E., Hakamada, T., Bando, T. and Kitakado, T. 2014. Assessment of Antarctic minke whales using statistical catch-at-age analysis (SCAA). *J. Cetacean Res. Manage.* 14: 93–116.

Sasaki, M., Amano, Y., Hayakawa, D., Tsubota, T., Ishikawa, H., Mogoe, T., Ohsumi, S., Tetsuka, M., Miyamoto, A., Fukui, Y., Budipitojo, T. and Kitamura, N. 2014. Areolae of the placenta in the Antarctic minke whale (*Balaenoptera bonaerensis*). *Journal of Reproduction and Development* 60 (1): 62–67.

2015 (2)

Konishi, K. and Walløe, L. 2015. Substantial decline in energy storage and stomach fullness in Antarctic minke whales (*Balaenoptera bonaerensis*) during the 1990's. *J. Cetacean Res. Manage.* 15: 77–92.

Yasunaga, G., Fujise, Y., Zenitani, R., Tanabe, S. and Kato, H. 2015. Spatial and temporal variation of PCBs and organochlorine pesticides in the Antarctic minke whales, *Balaenoptera bonaerensis*, in the period 1987–2005. *Chemosphere* 126: 11–17.

2016 (2)

Pastene, L.A. and Goto, M. 2016. Genetic characterization and population genetic structure of the Antarctic minke whale *Balaenoptera bonaerensis* in the Indo-Pacific region of the Southern Ocean. *Fish Sci* 82 (6): 873–886.

Wada, N., Yamanaka, S., Shibato, J., Rakwal, R., Hirako, S., Iizuka, Y., Kim, H., Matsumoto, A., Kimura, A., Takenoya, F., Yasunaga, G. and Shioda, S. 2016. Behavioral and omics analyses study on potential involvement of dipeptide balenine through supplementation in diet of senescence-accelerated mouse prone 8. *Genomics Data* 10: 38–50.

2017 (3)

Isoda, T. and Tamura, T. 2017. Report of a White Adélie Penguin *Pygoscelis adeliae* in the Antarctic Ocean. *J. Yamashina Inst. Ornithol.* 48 (2): 74–77.

*Leduc, R.G., Archer, F.I., Lang, A.R., Martien, K.K., Hancock-Hanser, B., Torres-Florez, J.P., Hucke-Gaete, R., Rosenbaum, H.C., VanWaerebeek, Bownell, R.L. and Taylor, B.L. 2017. Genetic variation in blue whales in the eastern pacific: implications for taxonomy and use of common wintering grounds. *Molecular Ecology* 26: 740–751.

Yasunaga, G., Pastene, L.A., Bando, T., Hakamada, T. and Fujise, Y. 2017. Age estimation of Antarctic minke whales *Balaenoptera bonaerensis* based on aspartic acid racemization technique. *Fish Sci* 86 (6): 947–954.

2019 (1)

Inoue, S., Yasunaga, G. and Pastene, L.A. 2019. Comparison of progesterone concentrations in blubber and plasma among female Antarctic minke whales of known reproductive status. *Fish Sci* 85 (6): 971–977.

2020 (6)

Cunen, C., Walløe, L. and Hjort, N.L. 2020. Focused model selection for linear mixed models with an application to whale ecology. *Ann. Appl. Stat.* 14 (2): 872–904.

Goto, M., Kitakado, T. and Pastene, L.A. 2020. A preliminary study of epigenetic estimation of age of the Antarctic minke whale *Balaenoptera bonaerensis*. *Cetacean Population Studies* 2: 5–14.

Konishi, K., Isoda, T., Bando, T., Minamikawa, S. and Kleivane, L. 2020. Antarctic minke whales find ice gaps along the ice edge in foraging grounds of the Indo-Pacific sector (60°E and 140°E) of the Southern Ocean. *Polar Biol* 43 (4): 343–357.

Matsuoka, K. and Hakamada, T. 2020. Density distribution of several major whale species in the Indo-Pacific region of Antarctic using JARPA and JARPAII sighting data obtained through 1987/88–2008/09 seasons. *Cetacean Population Studies* 2: 15–38.

Murase, H., Palka, D., Punt, A.E., Pastene, L.A., Kitakado, T., Matsuoka, K., Hakamada, T., Okamura, H., Bando, T., Tamura, T., Konishi, K., Yasunaga, G., Isoda, T. and Kato, H. 2020. Review of the assessment of two stocks of Antarctic minke whales (eastern Indian Ocean and western South Pacific). *J. Cetacean Res. Manage.* 21: 95–122.

Tanabe, A., Shimizu, R., Osawa, Y., Suzuki, M., Ito, S., Goto, M., Pastene, L.A., Fujise, Y. and Sahara, H. 2020. Age estimation by DNA methylation in Antarctic minke whales. *Fish Sci* 86 (1): 35–41.

2021 (13)

Cunen, C., Walløe, L., Konishi, K. and Hjort, N.L. 2021. Decline in body condition in the Antarctic minke whale (*Balaenoptera bonaerensis*) in the Southern Ocean during the 1990s. *Polar Biol* 44 (2): 259–273.

Fujise, Y. and Pastene, L.A. 2021. Whales as indicators of historical and current changes in the marine ecosystem of the Indo-Pacific sector of the Antarctic. pp. 85–103. *In*: M. Kanao, D. Godone and N. Dematteis (Eds.). *Glaciers and Polar Environment.* IntechOpen, London. 200 pp.

Isoda, T., Matsuoka, K., Tamura, T. and Pastene, L.A. 2021. Spatial and temporal distribution of floating marine macro debris in the Indo-Pacific region of the Antarctic. *Cetacean Population Studies* 3: 198–211.

Isoda, T., Tamura, T. and Pastene, L.A. 2021. Ingestion of marine debris and evidence of entanglements involving Antarctic minke whales (*Balaenoptera bonaerensis*) sampled in the Indo-Pacific sector of the Antarctic. *Cetacean Population Studies* 3: 286–294.

Kato, H., Fujise, Y., Nakamura, G., Hakamada, T., Pastene, L.A. and Best, P.B. 2021. Dwarf minke whales: morphology, growth and life history based on samples collected from the higher latitudes in the Southern Hemisphere. *Cetacean Population Studies* 3: 93–128.

Kim, Y., Nishimura, F., Bando, T., Fujise, Y., Nakamura, G., Murase, H. and Kato, H. 2021. Fetal development in tail flukes of the Antarctic minke whale. *Cetacean Population Studies* 3: 231–238.

Konishi, K. and Tamura, T. 2021. Preliminary use of near-infrared spectroscopy to estimate the biochemical components of the muscles of the Antarctic minke whale *Balaenoptera bonaerensis*. *Cetacean Population Studies* 3: 281–285.

Nakamura, G., Zenitani, R., Bando, T., Fujise, Y., Yamamoto, R., Nishimura, F., Hirose, A., Kim, Y. and Kato, H. 2021. Skeletal measurements on some large cetacean species done by scientists of TUMSAT and ICR. *Cetacean Population Studies* 3: 215–230.

Nishimura, F., Kim, Y., Bando, T., Fujise, Y., Nakamura, G., Murase, H. and Kato, H. 2021. Morphological differences in skulls and feeding apparatuses between Antarctic (*Balaenoptera bonaerensis*) and common (*Balaenoptera acutorostrata*) minke whales, and the implication for their feeding ecology. *Can. J. Zool.* 99 (12): 1067–1079.

Ohashi, Y., Goto, M., Taguchi, M., Pastene, L.A. and Kitakado, T. 2021. Evaluation of a paternity method based on microsatellite DNA genotypes for estimating the abundance of Antarctic minke whales (*Balaenoptera bonaerensis*) in the Indo-Pacific region of the Antarctic. *Cetacean Population Studies* 3: 139–151.

Pastene, L.A., Goto, M., Taguchi, M. and Matsuoka, K. 2021. Genetic matches of southern right whales in the Indian sector of the Antarctic: a contribution towards understanding their movement and site-fidelity. *Cetacean Population Studies* 3: 129–138.

Uchida, M., Suzuki, I., Ito, K., Ishizuka, M., Ikenaka, Y., Nakayama, S.M.M., Tamura, T., Konishi, K., Bando, T. and Mitani, Y. 2021. Estimation of the feeding record of pregnant Antarctic minke whales (*Balaenoptera bonaerensis*) using carbon and nitrogen stable isotope analysis of baleen plates. *Polar Biol* 44 (3): 621–629.

*Yamazaki, K., Aoki, S., Katsumata, K., Hirano, D. and Nakayama, Y. 2021. Multidecadal poleward shift of the southern boundary of the Antarctic Circumpolar Current off East Antarctica. *Sci. Adv.* 7 (24): eabf8755.

2022 (3)

Ishikawa, H., Otsuki, M., Tamura, T., Konishi, K., Bando, T., Ishizuka, M., Ikenaka, Y., Nakayama, S.M.M. and Mitani, Y. 2022. Foraging ecology of mature male Antarctic minke whales (*Balaenoptera bonaerensis*) revealed by stable isotope analysis of baleen plates. *Polar Science* 31: 100785.

Pastene, L.A., Goto, M., Taguchi, M. and Fujise, Y. 2022. Phylogeny and population genetic structure of minke whales worldwide: a review of recent studies. pp. 11–37. *In*: H.A.E. Kaoud (Ed.). *Marine Mammals*. IntechOpen, London. 126 pp.

Ten, S., Konishi, K., Raga, J.A., Pastene, L.A. and Aznar, F.J. 2022. Epibiotic fauna of the Antarctic minke whale as a reliable indicator of seasonal movements. *Sci. Rep*. 12: 22214.

2023 (3)

Hamabe, K., Matsuoka, K. and Kitakado, T. 2023. Estimation of abundance and population dynamics of the Antarctic blue whale in the Antarctic Ocean south of 60°S, from 70°E to 170°W. *Marine Mammal Science* 39 (2): 671–687.

Yasunaga, G., Inoue, S., Bando, T., Hakamada, T. and Fujise, Y. 2023. Aspartic acid enantiomer quantification using ultraperformance liquid chromatography–tandem mass spectroscopy combined with deuterium-chloride hydrolysis to improve age estimation in Antarctic minke whale *Balaenoptera bonaerensis*. *Marine Mammal Science* 39 (2): 368–386.

Yasunaga, G., Inoue, S., Bando, T., Hakamada, T. and Fujise, Y. 2023. Yasunaga *et al.* (2022) meets the ethics code of Marine Mammal Science, and the journal's decision to publish the paper is correct. *Marine Mammal Science* 39 (2): 709–711.

2024 (1)

Takahashi, M., Førland, B., Pastene, L.A. and Skaug, H.J. 2024. Geographical distribution of close kin in southern right whales on feeding grounds. *PLoS ONE* 19 (4): e0301588. https://doi.org/10.1371/journal.pone.0301588

JARPN/JARPNII/NEWREP-NP surveys

1996 (3)

Butterworth, D.S., Geromont H.F. and Wada S. 1996. Further analysis of allele frequency data to provide estimates of the extent of mixing between the various North Pacific minke whale stocks, and their implications for the status of the "O"stock. *Rep. int. Whal. Commn* 46: 443–451.

Kuramochi, T., Machida, M., Araki, J., Uchida, A., Kishiro, T. and Nagasawa, K. 1996. Minke whales (*Balaenoptera acutorostrata*) are one of the major final hosts of *Anisakis simplex* (Nematoda: Anisakidae) in the Northwestern North Pacific Ocean. *Rep. int. Whal. Commn* 46: 415–419.

Miyashita, T. and Fujise, Y. 1996. Abundance estimate of the western North Pacific minke whale in sub-area 9 with notes on the results of dedicated surveys. *Rep. int. Whal. Commn* 47: 543–551.

1997 (6)

Aono, S., Tanabe, S., Fujise, Y., Kato, H. and Tatsukawa, R. 1997. Persistent organochlorines in minke whale (*Balaenoptera acutorostrata*) and their prey species from the Antarctic and the North Pacific. *Environmental Pollution* 98: 81–89.

Araki, J., Kuramochi, T., Machida, M., Nagasawa, K. and Uchida, A. 1997. A note on the parasite fauna of the western North Pacific minke whale (*Balaenoptera acutorostrata*). *Rep. int. Whal. Commn* 47: 565–567.

Goto, M. and Pastene, L.A. 1997. Population structure of western North Pacific minke whale based on an RFLP analysis of mtDNA control region. *Rep. int. Whal. Commn* 47: 531–537.

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.

Hatanaka, H. 1997. A short review of hypotheses on minke whale stock structure in the Northwestern part of the North Pacific. *Rep. int. Whal. Commn* 47: 553–555.

Pastene, L.A., Goto, M., Itoh, S., Wada, S. and Kato, H. 1997. Intra- and inter-oceanic patterns of mitochondrial DNA variation in the Bryde's whale, *Balaenoptera edeni*. *Rep. int. Whal. Commn* 47: 569–574.

1998 (4)

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.

Pastene, L.A., Goto, M. and Kishino, H. 1998. An estimate of mixing proportion of 'J' and 'O' stocks minke whales in sub-area 11 based on mitochondrial DNA haplotype data. *Rep. int. Whal. Commn* 48: 471–474.

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. *Fish Sci* 64 (1): 71–76.

Uchida, A., Kawakami, Y., Yuzu, S., Kishikawa, S., Kuramochi, T., Araki, J., Machida, M. and Nagasawa, K. 1998. Prevalence of parasites and histopathology of parasitisation in minke whales (*Balaenoptera acutorostrata*) from the western North Pacific Ocean and Southern Sea of Okhotsk. *Rep. int. Whal. Commn* 48: 475–479.

1999 (2)

Le, T.H.L., Takahashi, S., Saeki, K., Nakatani, N., Tanabe, S., Miyazaki, N. and Fujise, Y. 1999. High percentage of butyltin residues in total tin in the livers of cetaceans from Japanese coastal waters. *Environmental Science & Technology* 33 (11): 1781–1786.

Martinez, I. and Pastene, L.A. 1999. RAPD-typing of central and eastern North Atlantic and western North Pacific minke whales, *Balaenoptera acutorostrata*. *ICES Journal of Marine Science* 56 (5): 640–651.

2000 (2)

Punt, A.E., Butterworth, D.S. and Wada, S. 2000. On the use of allele frequency data within a Bayesian framework: evaluation of relative probabilities of alternative stock structure hypotheses for North Pacific minke whales. *J. Cetacean Res. Manage.* 2 (2): 151–158.

Uchida, A. and Araki, J. 2000. The ectoparasites and endoparasites in the minke whale, *Balaenoptera acutorostrata* from the western North Pacific Ocean. *J. Jpn. Vet. Med. Assoc.* 53 (2): 85–88 (in Japanese).

2001 (1)

Okamura, H., Matsuoka, K., Hakamada, T., Okazaki, M. and Miyashita, T. 2001. Spatial and temporal structure of the western North Pacific minke whale distribution inferred from JARPN sightings data. *J. Cetacean Res. Manage.* 3 (2): 193–200.

2002 (5)

Abe, H. and Goto, M. 2002. The application of microsatellite DNA for determining population structure of minke whale. pp. 109–113. *In*: A. Nishimura (Ed.). *Technical Reports of the Hokkaido National Fisheries Research Institute No.5*. Hokkaido National Fisheries Research Institute, Hokkaido.

Cui, G., Punt, A.E., Pastene, L. A. and Goto, M. 2002. Bayes and Empirical Bayes approaches to addressing stock structure questions using mtDNA data, with an illustrative application to North Pacific minke whales. *J. Cetacean Res. Manage.* 4 (2): 123–134.

Ohsumi, S. and Tamura, T. 2002. Dietary studies on baleen whales in the North Pacific. *Fish Sci* 68 (Suppl. I): 260–263.

Pastene, L.A., Goto, M. and Kanda, N. 2002. The utility of DNA analysis for the management and conservation of large whales. *Fish Sci* 68 (Suppl. I): 286–289.

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.

2003 (4)

Hayashi, K., Nishida, S., Yoshida, H., Goto, M., Pastene, L.A. and Koike, H. 2003. Sequence variation of the *DQB* allele in the cetacean MHC. *Mammal Study* 28 (2): 89–96.

Nishida, S., Pastene, L.A., Goto, M. and Kanda, N. 2003. *SRY* gene structure and phylogeny in the cetacean species. *Mammal Study* 28 (1): 57–66.

Nishida, S., Hayashi, K., Pastene, L.A., Goto, M., Kanda, N. and Koike, H. 2003. Polymorphic analysis of cetacean MHC—A case study on the minke whales—. *Mammalian Science* (Suppl.) 3: 75–78 (in Japanese).

Ohishi, K., Zenitani, R., Bando, T., Goto, Y., Uchida, K., Maruyama, T., Yamamoto, S., Miyazaki, N. and Fujise, Y. 2003. Pathological and serological evidence of Brucella-infection in baleen whales (Mysticeti) in the western North Pacific. *Comp. Immun. Microbiol. Infect. Dis* 26 (2): 125–136.

2004 (5)

Kim, E.Y., Iwata, H., Fujise, Y. and Tanabe, S. 2004. Searching for novel CYP members using cDNA library from a minke whale liver. *Marine Environmental Research* 58: 495–498.

Ohishi. K., Takishita, K., Kawato, M., Zenitani, R., Bando, T., Fujise, Y., Goto, Y., Yamamoto, S. and Maruyama, T. 2004. Molecular evidence of new variant *Brucella* in North Pacific common minke whales. *Microbes and Infection* 6: 1199–1204.

Ohishi, K., Takishita, K., Kawato, M., Maruyama, T., Zenitani, R., Bando, T., Fujise, Y., Goto, Y. and Yamamoto, S. 2004. Molecular characterization of *Brucella* from North Pacific common minke whale. *Oceans'04*: 499–504.

Watanabe, H., Mogoe, T., Asada, M., Hayashi, K., Fujise, Y., Ishikawa, H., Ohsumi, S., Miyamoto, A. and Fukui, Y. 2004. Relationship between serum sex hormone concentrations and histology of seminiferous tubules of captured baleen whales in the western North Pacific during the feeding season. *Journal of Reproduction and Development* 50 (4): 419–427.

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.

2005 (5)

Birukawa, N., Ando, H., Goto, M., Kanda, N., Pastene, L.A., Nakatsuji, H., Hata, H. and Urano, A. 2005. Plasma and urine levels of electrolytes, urea and steroid hormones involved in osmoregulation of cetaceans. *Zoological Science* 22 (11): 1245–1257.

Nikaido, M., Sasaki, T., Makino, H., Goto, M., Kanda, N., Pastene, L.A. and Okada, N. 2005. Phylogenetic reconstruction of baleen whales and detection of their past extensive radiation event by the SINE insertion analysis. *Fossils* 77: 22–28 (in Japanese).

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 (8): 784–793.

Ohishi, K., Takishita, K., Kawato, M., Zenitani, R., Bando, T., Fujise, Y., Goto, Y., Yamamoto, S. and Maruyama,

T. 2005. Chimeric structure of *omp2* of *Brucella* from North Pacific common minke whales (*Balaenoptera acutorostrata*). *Microbiol. Immunol.* 49 (8): 789–793.

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

2006 (5)

Iwanami, K., Mita, H., Yamamoto, Y., Fujise, Y., Yamada, T. and Suzuki, T. 2006. cDNA-derived amino acid sequences of myoglobins from nine species of whales and dolphins. *Comparative Biochemistry and Physiology, Part B* 145: 249–256.

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.

Mitani, Y., Bando., T., Takai., N. and Sakamoto, W. 2006. Patterns of stable carbon and nitrogen isotopes in the baleens of common minke whale *Balaenoptera acutorostrata* from the western North Pacific. *Fish Sci* 72 (1): 69–76.

Nikaido, M., Hamilton, H., Makino, H., Sasaki, T., Takahashi, K., Goto, M., Kanda, N., Pastene, L.A. and Okada, N. 2006. Baleen whale phylogeny and a past extensive radiation event revealed by SINE insertion analysis. *Molecular Biology and Evolution* 23 (5): 866–873.

Ohishi, K., Maruyama, T., Ninomiya, A., Kida, H., Zenitani, R., Bando, T., Fujise, Y., Nakamatsu, K., Miyazaki, N. and Boltunov, A.N. 2006. Serologic investigation of influenza a virus infection in cetaceans from the western North Pacific and the Southern Oceans. *Marine Mammal Science* 22 (1): 214–221.

2007 (11)

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.

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 (4): 853–864.

Konishi, K. and Tamura, T. 2007. Occurrence of the minimal armhook squids *Berryteuthis anonychus* (Cephalopoda: Gonatidae) in the stomachs of common minke whales *Balaenoptera acutorostrata* in the western North Pacific. *Fish Sci* 73 (5): 1208–1210.

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.

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: 667–681.

Nishida, S., Goto, M., Pastene, L.A., Kanda, N. and Koike, H. 2007. Phylogenetic relationships among cetaceans revealed by Y-chromosome sequences. *Zoological Science* 24 (7): 723–732.

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 (5): 449–464.

Pastene, L.A., Goto, M., Kanda, N., Zerbini, A.N., Kerem, D., Watanabe, K., Bessho, Y., Hasegawa, M., Nielsen, R., Larsen, F. and Palsbøll, P.J. 2007. Radiation and speciation of pelagic organisms during periods of global warming: the case of the common minke whale, *Balaenoptera acutorostrata*. *Molecular Ecology* 16: 1481–1495.

Urashima, T., Kobayashi, M., Asakuma, S., Uemura, Y., Arai, I., Fukuda, K., Saito, T., Mogoe, T., Ishikawa, H. and 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.

Watanabe, H., Tateno, H., Kusakabe, H., 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. *Reproduction, Fertility and Development* 19 (1): 306.

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 (1): 9–14.

2008 (3)

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.

Ishikawa, H. and Shigemune, H. 2008. Comparative experiment of whaling grenades in the Japanese Whale Research Program under Special Permit (JARPA and JARPN). *Jpn. J. Zoo Wildl. Med.* 13 (1): 21–28.

Ohishi, K., Fujise, Y. and Maruyama, T. 2008. *Brucella* spp. in the western North Pacific and Antarctic cetaceans: a review. *J. Cetacean Res. Manage.* 10 (1): 67–72.

2009 (9)

Bhuiyan, M.M.U., Suzuki, Y., Watanabe, H., Hirayama, H., Matsuoka, K., Fujise, Y., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2009. Attempts at in vitro fertilization and culture of in vitro matured oocytes in sei *(Balaenoptera borealis*) and Bryde′s (*B. edeni*) whales. *Zygote* 17 (1): 19–28.

Fujita, H., Honda, K., Hamada, N., Yasunaga, G and Fujise, Y. 2009. Validation of high-throughput measurement system with microwave-assisted extraction, fully automated sample preparation device, and gas chromatography-electron capture detector for determination of polychlorinated biphenyls in whale blubber. *Chemosphere* 74: 1069–1078.

Hiwasa, M., Suzuki, Y., Watanabe, H., Bhuiyan, M.M.U., Matsuoka, K., Fujise, Y., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2009. Effects of semen extenders and storage temperatures on characteristics of frozen-thawed Bryde′s (*Balaenoptera edeni*) whale spermatozoa. *Journal of Reproduction and Development* 55: 599–606.

Konishi, K., Tamura T., Isoda, T. Okamoto, R., Hakamada, T., Kiwada, H. and Matsuoka, K. 2009. Feeding strategies and prey consumption of three baleen whale species within the Kushiro-Current Extension. *J. Northw. Atl. Fish. Sci.* 42: 27–40.

Lee, E., Bhuiyan, M.M.U., Watanabe, H., Matsuoka, K., Fujise, Y., Ishikawa, H. and Fukui. Y. 2009. Production of cloned sei whale (*Balaenoptera borealis*) embryos by interspecies somatic cell nuclear transfer using enucleated pig oocytes. *J. Vet. Sci.* 10 (4): 285–292.

Matsukura, R., Yasuma, H., Murase, H., Yonezaki, S., Funamoto, T., Honda, S. and Miyashita, K. 2009. Measurements of density contrast and sound-speed contrast for target strength estimation of Neocalanus copepods (*Neocalanus cristatus*) in the North Pacific Ocean. *Fish Sci* 75 (6): 1377–1387.

Murase, H., Ichihara, M., Yasuma, H., Watanabe, H., Yonezaki, S., Nagashima, H., Kawahara, S. and Miyashita, T. 2009. Acoustic characterization of biological backscatterings in the Kuroshio-Oyashio inter-frontal zone and subarctic waters of the western North Pacific in spring. *Fish. Oceanogr.* 18 (6): 386–401.

Murase, H., Nagashima, H., Yonezaki, S., Matsukura, R. and Kitakado, T. 2009. Application of a generalized additive model (GAM) to reveal relationships between environmental factors and distributions of pelagic fish and krill: a case study in Sendai Bay, Japan. *ICES Journal of Marine Science* 66 (6): 1417–1424.

Tsuki, K., Sato, A., Kaneko, H., Yasunaga, G., Fujise, Y. and Nomata, H. 2009. Comparison of physiologically significant imidazole dipeptides in cetaceans sampled in Japanese whale research (short paper). *Sci. Rep. Hokkaido Fish. Exp. Stn.* 74: 25–28 (in Japanese).

2010 (7)

Bhuiyan, M.M.U., Suzuki, Y., Watanabe, H., Lee, E., Hirayama, H., Matsuoka, K., Fujise, Y., Ishikawa, H., Ohsumi, S. and Fukui, Y. 2010. Production of sei whale (*Balaenoptera borealis)* cloned embryos by inter- and intra-species somatic cell nuclear transfer. *Journal of Reproduction and Development* 56: 131–139.

Funakasa, N., Yoshioka, M. and Fujise, Y. 2010. Features of the Ocular Harderian Gland in three Balaenopterid species based on anatomical, histological and histochemical observations. *Mammal Study* 35 (1): 9–15.

Ogawa, G., Ishida, M., Kato, H., Fujise, H. and Urano, N. 2010. Identification of facultative anaerobic bacteria isolated from the intestine of the minke whale *Balaenoptera acutorostrata* by 16S rRNA sequencing analysis. *Fish Sci* 76 (2): 177–181.

Pastene, L.A., Fujise, Y. and Hatanaka, H. 2010. JARPNII: a challenging multidiscipline research program focused on whales in the western North Pacific. *Ottar* (Tromsø Museum) 280: 23–28 (in Norwegian).

Shishido, R., Ohishi, K., Suzuki, R., Takishita, K., Ohtsu, D., Okutsu, K., Tokutake, K., Katsumata, E., Bando, T., Fujise, Y., Murayama, T. and Maruyama, T. 2010. Cetacean Toll-like receptor 4 and myeloid differentiation factor 2, and possible cetacean-specific responses against Gram-negative bacteria. *Comp. Immun. Microbiol. Infect. Dis.* 33 (6): 89–98.

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

Tojo, N., Matsukura, R., Yasuma, H., Yonezaki, S., Watanabe, H., Kawahara, S., Murase, H. and Miyashita, K. 2010. Spatial analysis of isada krill (*Euphausia pacifica*) distribution in frontal environments in the North Pacific Ocean. *GIS/spatial analyses in fisheries and aquatic science*. 4. International Fishery GIS Society: 115–138.

2011 (20)

Hakamada, T. and Matsuoka, K. 2011. Abundance estimate for common minke, Bryde′s and sei whales in the offshore region of the western North Pacific. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 173–174 (in Japanese).

Kanda, N., Goto, M. and Pastene, L. A. 2011. Genetic stock structure of baleen whales. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 191 (in Japanese).

Kato, H. and Fujise, Y. 2011. General discussion: Symposium on "Marine ecosystem of the western North Pacific with special interest in cetaceans." *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 194–195 (in Japanese).

Kishiro, T., Yoshida, H., Tamura, T., Konishi, K., Kanda, N., Okamoto, R. and Kato, H. 2011. Relationship between maturity and feeding ecology of common minke whales off Kushiro in autumn. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 175–176 (in Japanese).

Maehara, T., Aoki, I., Yonezaki, S., Watanabe, H., Murase, H. and Yamaguchi, A. 2011. Feeding ecology of the Japanese anchovy in the offshore area east of Honshu, Japan in summer. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 187 (in Japanese).

Matsuoka, K., Kiwada, H., Fujise, Y. and Miyashita, T. 2011. Distribution of baleen whales in the western North Pacific based on the JARPN and JARPN II sighting surveys (1994 to 2007). *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 178–179 (in Japanese).

Miyashita, K., Matsukura, R., Tojo, N., Minami, K., Yasuma, H., Nagashima, H., Onodera, K., Watanabe, H., Yonezaki, S. and Murase, H. 2011. Monitoring of prey of cetaceans by using quantitative echosounders. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 183–184 (in Japanese).

Mori, M., Watanabe, H., Hakamada, T., Tamura, T., Konishi, K., Murase, H. and Matsuoka, K. 2011. Development of an ecosystem model of western North Pacific using Ecopath with Ecosim. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 189 (in Japanese).

Murase, H., Kawabata, A., Kubota, H., Nakagami, M., Amakasu, K., Abe, K., Miyashita, K. and Oozeki, Y. 2011. Effect of depth-dependent target strength on biomass estimation of Japanese anchovy. *Journal of Marine Science and Technology* 19: 267–272.

Murase, H., Tamura, T., Isoda, T., Okamoto, R., Kato, H., Yonezaki, S., Watanabe, H., Tojo, N. Matsukura, R., Miyashita, K., Kiwada, H., Matsuoka, K., Nishiwaki, S., Inagake, D., Okazaki, M., Okamura, H. and Fujise, Y. 2011. Prey selection of common minke, Bryde′s and sei whales in the offshore region of the western North Pacific. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 180–181 (in Japanese).

Nishiwaki, S., Otani, S. and Tamura, T. 2011. The satellite tracking of the western North Pacific. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 193–194 (in Japanese).

Onodera, K., Nagashima, H., Matsukura, R., Miyashita, K., Yonezaki, S. and Murase, H. 2011. Cetacean prey species and oceanographic surveys in Sendai Bay. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 184–185 (in Japanese).

Pastene, L.A., Hatanaka, H., Fujise, Y., Kanda, N., Murase, H., Tamura, T., Miyashita, T. and Kato, H. 2011. Whale research program under special permit in the western North Pacific—Phase II (JARPNII): origin and objectives. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 172–173 (in Japanese).

Pastene, L.A., Hatanaka, H., Fujise, Y., Kanda, N., Murase, H., Tamura, T., Yasunaga, G., Kishiro, T., Yoshida, H., Miyashita, T. and Kato, H. 2011. The Japanese Whale Research Program under Special Permit in the western North Pacific Phase-II (JARPNII): origin, objectives and research progress made in the first six years period (2002–2007), including scientific considerations for the next research period. *Aquabiology* 33 (2): 171–185 (in Japanese).

Sasaki, Y., Saito, S., Matsuoka, K., Murase, H. and Kiwada., H. 2011. Spatial distribution patterns of sei and Bryde′s whales. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 179–180 (in Japanese).

Tamura, T., Konishi, K., Isoda, T., Hakamada, T., Kiwada, H., Okamoto, R. and Matsuoka, K. 2011. The food habitat, relation of habitat factor and prey consumption of three baleen whale species in the offshore region of the western North Pacific. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 174–175 (in Japanese).

Watanabe, H., Kiwada, H., Kumagai, S., Yonezaki, S., Kishiro, T., Konishi., K. and Yoshida, H. 2011. Habitat and prey selection of common minke whale off Kushiro in autumn—Estimation of distribution and migration of common minke whale using environmental information—. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 182–183 (in Japanese).

Yamaguchi, A., Hanamiya, Y., Murase, H. and Watanabe, H. 2011. Vertical flux of materials by diel vertical migration of macrozooplankton. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 185–186 (in Japanese).

Yasunaga, G. and Fujise, Y. 2011. Monitoring of pollutants in the baleen whales and their prey species in the western North Pacific. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 190 (in Japanese).

Yoshida, H., Kishiro, T., Goto, M., Bando, T., Tamura, T., Konishi, K., Okamoto, R. and Kato, H. 2011. Feeding ecology of common minke whales in coastal waters off Sanriku in spring. *Bull. Jpn. Soc. Fish. Oceanogr.* 75 (3): 177–178 (in Japanese).

2012 (4)

Maeda, H. and Kato, H. 2012. Technical improvements of the age character (earplug) collections in common minke whales. *Bull. Jpn. Soc. Fish. Oceanogr.* 76 (2): 59–65 (in Japanese).

Murase, H., Kawabata, A., Kubota, H., Nakagami, M., Amakasu, K., Abe, K., Miyashita, K. and Oozeki, Y. 2012. Basin-scale distribution patterns and biomass estimation of Japanese anchovy *Engraulis japonicus* in the western North Pacific. *Fish Sci* 78 (4): 761–773.

Nakamura, G., Kato, H. and Fujise, Y. 2012. Relative growth of the skull of the common minke whale *Balaenoptera acutorostrata* from the North Pacific in comparison to other *Balaenoptera* species. *Mammal Study* 37 (2): 105–112.

Watanabe, H, Okazaki, M., Tamura, T., Konishi, K., Inagake, D., Bando, T., Kiwada, H. and Miyashita, T. 2012. Habitat and prey selection of common minke, sei, and Bryde′s whale in mesoscale during summer in the sub-arctic and transition regions of the western North Pacific. *Fish Sci* 78 (3): 557–567.

2013 (5)

*Kershaw, F., Leslie, M.S., Collins, T., Mansur, R.M., Smith, B.D., Minton, G., Baldwin, R., LeDuc, R.G., Anderson, R.C., Brownell, R.L. and Rosenbaum, H.C. 2013. Population differentiation of 2 forms of Bryde′s whales in the Indian and Pacific Oceans. *Journal of Heredity* 104 (6): 755–764.

Maeda, H., Kawamoto, T. and Kato, H. 2013. A study on the improvement of age estimation in common minke whales using the method of gelatinized extraction of earplug. NAMMCO *Scientific Publications* 10: 17 pp.

Matsukura, R., Sawada, K., Abe, K., Minami, K., Nagashima, H., Yonezaki, S., Murase, H. and Miyashita, K. 2013. Comparison of measurements and model calculations of target strength of juvenile sandeel in Sendai Bay. *Nippon Suisan Gakkaishi* 79 (4): 638–648 (in Japanese).

Sasaki, H., Murase, H., Kiwada, H., Matsuoka, K., Mitani, Y. and Saitoh, S. 2013. Habitat differentiation between sei (*Balaenoptera borealis*) and Bryde′s whales (*B. brydei*) in the western North Pacific. *Fish. Oceanogr.* 22 (6): 496–508.

Shimizu, Y., Ohishi, K., Suzuki, R., Tajima, Y., Yamada, T., Kakizoe, Y., Bando, T., Fujise, Y., Taru, H., Murayama, T. and Maruyama, T. 2013. Amino acid sequence variations of signaling lymphocyte activation molecule and mortality caused by morbillivirus infection in cetaceans. *Microbiol Immunol* 57: 624–632.

2014 (6)

Inoue, S., Kishiro, T., Fujise, Y., Nakamura, G. and Kato, H. 2014. Seasonal changes in the testis of the North Pacific common minke whale. *Nippon Suisan Gakkaishi* 80 (2): 185–190 (in Japanese).

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

Nakamura, G., Kadowaki, I., Nagatsuka, S., Fujise, Y., Kishiro, T. and Kato, H. 2014. Variation in a color pattern of white patch on the flippers of North Pacific common minke whales: potential application for their interoceanic difference. *La mer* 52: 31–47.

Nakamura, G. and Kato, H. 2014. Developmental changes in the skull morphology of common minke whales *Balaenoptera acutorostrata. Journal of Morphology* 275: 1113–1121.

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

*Rosel, P.E. and Wilcox, L.A. 2014. Genetic evidence reveals a unique lineage of Bryde′s whales in the northern Gulf of Mexico. *Endang Species Res.* 25 : 19–34.

2015 (1)

Kitayama, C., Sasaki, M., Ishikawa, H., Mogoe, T., Ohsumi, S., Fukui, Y., Budipitojo, T., Kondoh, D. and Kitamura, N. 2015. Structure and functions of the placenta in common minke (*Balaenoptera acutorostrata*), Bryde′s (*B.*

brydei) and sei (*B. borealis*) whales. *Journal of Reproduction and Development* 61 (5): 415–421.

2016 (6)

Hirako, S., Suzuki, M., Kim, H., Iizuka, Y., Matsumoto, A., Wada, N., Okabe, M., Takenoya, F., Yasunaga, G., Yamanaka, S., Miyazaki, A. and Shioda, S. 2016. Hepatic lipid accumulation is ameliorated in obese KK mice by dietary sei whale oil. *Fish Sci* 82 (3): 509–517.

Miyakawa, N., Kishiro, T., Fujise, Y., Nakamura, G. and Kato, H. 2016. Sexual dimorphism in pelvic bone shape of the North Pacific common minke whales (*Balaenoptera acutorostrata*). *Open Journal of Animal Sciences* 6: 131–136.

Murase, H., Tamura, T., Otani, S. and Nishiwaki, S. 2016. Satellite tracking of Bryde's whales *Balaenoptera edeni* in the offshore western North Pacific in summer 2006 and 2008. *Fish Sci* 82 (1): 35–45.

Nakamura, G., Kadowaki, I., Nagatsuka, S., Hayashi, R., Kanda, N., Goto, M., Pastene, L.A. and Kato, H. 2016. White patch on the fore-flipper of common minke whale, as a potential morphological index to identify stocks. *Open Journal of Animal Sciences* 6: 116–122.

Nakamura, G., Takahashi, M., Hirose, A., Hayashi, R., Fujise, Y., Miyakawa, N., Inoue, S. and Kato, H. 2016. Presence of an interparietal bone and morphological variation in the vertex of the skull in North Pacific common minke whale. *La mer* 54 (1): 1–10.

Ohishi, K., Bando, T., Abe, E., Kawai, Y., Fujise, Y. and Maruyama, T. 2016. Long-term and large-scale epidemiology of *Brucella* infection in baleen whales and sperm whales in the western North Pacific and Antarctic Oceans. *J. Vet. Med. Sci.* 78 (9): 1457–1464.

2017 (3)

Bando, T., Nakamura, G., Fujise, Y. and Kato, H. 2017. Developmental changes in the morphology of western North Pacific Bryde's whales (*Balaenoptera edeni*). *Open Journal of Animal Sciences* 7: 344–355.

Ishii, M., Murase, H., Fukuda, Y., Sawada, K., Sasakura, T., Tamura, T., Bando, T., Matsuoka, K., Shinohara, A., Nakatsuka, S., Katsumata, N., Okazaki, M., Miyashita, K. and Mitani, Y. 2017. Diving behavior of sei whales *Balaenoptera borealis* relative to the vertical distribution of their potential prey. *Mammal Study* 42 (4): 191–199.

Maeda, H., Fujise, Y., Kishiro, T. and Kato, H. 2017. Utility of the transition phase in earplugs of the North Pacific common minke whale as an indicator of age at sexual maturity. *Open Journal of Animal Sciences* 7: 414–424.

2018 (3)

Hirose, A., Kishida, T. and Nakamura, G. 2018. Nasal mucosa resembling an olfactory system in the common minke whale (*Balaenoptera acutorostrata*). *Cetacean Population Studies* 1: 25–28.

Huijser, L.A.E., Bérubé, M., Cabrera, A.A., Prieto, R., Silva, M.A., Robbins, J., Kanda, N., Pastene, L.A., Goto, M., Yoshida, H., Vikingsson, G.A. and Palsbøll, P.J. 2018. Population structure of North Atlantic and North Pacific sei whales (*Balaenoptera borealis*) inferred from mitochondrial control region DNA sequences and microsatellite genotypes. *Conserv Genet* 19: 1007–1024.

Nakamura, G., Ryeng, K.A., Kadowaki, I., Hayashi, R., Nagatsuka, S., Hirose, A., Fujise, Y. and Haug, T. 2018. Comparison of shapes of the white flipper patch between two sub-species of common minke whales (*Balaenoptera acutorostrata*). *Cetacean Population Studies* 1: 15–24.

2019 (1)

Watari, S., Murase, H., Yonezaki, S., Okazaki, M., Kiyofuji, H., Tamura, T., Hakamada, T., Kanaji, Y. and Kitakado, T. 2019. Ecosystem modeling in the western North Pacific using Ecopath, with a focus on small pelagic fishes. *Mar Ecol Prog Ser* 617–618: 295–305.

2020 (1)

Yasunaga, G. and Fujise, Y. 2020. Concentration of persistent organic pollutants (POPs) in three species of baleen whales in the western North Pacific. *Cetacean Population Studies* 2: 39–53.

2021 (8)

Bando, T. 2021. Improved estimates of some life-history parameters of the pelagic subspecies of Bryde's whale in the western North Pacific. *Cetacean Population Studies* 3: 239–245.

Gomes, T.L., Quiazon, K.M., Kotake, M., Fujise, Y., Ohizumi, H., Itoh, N. and Yoshinaga, T. 2021. *Anisakis* spp. in toothed and baleen whales from Japanese waters with notes on their potential role as biological tags. *Parasitology International* 80: 102228.

Maeda, H. and Kato, H. 2021. Seasonal changes in the earplug germinal layers of North Pacific common minke whales. *Cetacean Population Studies* 3: 246–251.

Matsuoka, K., Hakamada, T. and Miyashita, T. 2021. A note on recent surveys for right whales *Eubalaena japonica* in the western North Pacific. *Cetacean Population Studies* 3: 252–257.

Nakamura, G., Zenitani, R., Bando, T., Fujise, Y., Yamamoto, R., Nishimura, F., Hirose, A., Kim, Y. and Kato, H. 2021. Skeletal measurements on some large cetacean species done by scientists of TUMSAT and ICR. *Cetacean Population Studies* 3: 215–230.

Nishimura, F., Kim, Y., Bando, T., Fujise, Y., Nakamura, G., Murase, H. and Kato, H. 2021. Morphological differences in skulls and feeding apparatuses between Antarctic (*Balaenoptera bonaerensis*) and common (*Balaenoptera acutorostrata*) minke whales, and the implication for their feeding ecology. *Can. J. Zool.* 99 (12): 1067–1079.

Suyama, S., Yanagimoto, T., Nakai, K., Tamura, T., Shiozaki, K., Ohshimo, S. and Chow, S. 2021. A taxonomic revision of *Pennella* Oken, 1815 based on morphology and genetics (Copepoda: Siphonostomatoida: Pennellidae). *Journal of Crustacean Biology* 41 (3): ruab040.

Taguchi, M., Goto, M., Milmann, L., Siciliano, S., Tiedemann, R. and Pastene, L.A. 2021. New insights into the genetic structure of sei whales (*Balaenoptera borealis*) at the inter-oceanic scale. *Cetacean Population Studies* 3: 152–163.

2022 (3)

Pastene, L.A., Goto, M., Taguchi, M. and Fujise, Y. 2022. Phylogeny and population genetic structure of minke whales worldwide: a review of recent studies. pp. 11–37. *In*: H.A.E. Kaoud (Ed.). *Marine Mammals*. IntechOpen, London. 126 pp.

Takahashi, M., Tamura, T., Bando, T. and Konishi, K. 2022. Feeding habits of Bryde′s and sei whales in the western North Pacific inferred from stomach contents and skin stable isotope ratios. *Journal of Sea Research* 184: 102204.

Zhu, Y., Mizutani, K., Minami, K., Shirakawa, H., Kawauchi, Y., Shao, H., Tomiyasu, M., Iwahara, Y., Tamura, T., Ogawa, M., Tatsuyama, K. and Miyashita, K. 2022. Target strength measurements of free-swimming sandeel species, *Ammodytes* spp., in a large indoor experimental aquarium. *Journal of Marine Science and Engineering* 10 (7): 966.

2023 (3)

Murase, H., Matsuoka, K. and Watanabe, K. 2023. Effect of sea surface temperature on the distribution of common minke whales off southeastern Hokkaido, Japan, between 2002 and 2006, with notes on the formation of Pacific saury fishing grounds. *Cetacean Population Studies* 4: 7–18.

Saito, R., Bando, T., Kotaniguchi, M., Tamura, T., Kuno, T., Watanabe, K., Mizukami, Y., Kitamura, S. and Kadokawa, H. 2023. Ethanolamine plasmalogens derived from whale brain stimulate both follicle-stimulating hormone and luteinizing hormone secretion by bovine gonadotrophs. *Animal Science Journal* 94 (1): e13839.

Taguchi, M., Goto, M., Matsuoka, K., Tiedemann, R. and Pastene, L.A. 2023. Population genetic structure of Bryde′s whales (*Balaenoptera brydei*) on the central and western North Pacific feeding grounds. *Can. J. Fish. Aquat. Sci* 80: 142–155.

2024 (3)

Goto, M., Tamura, T., Bando, T. and Yasunaga, G. 2024. Genetically identified J-stock common minke whales: an overview of their biological and ecological features in waters around Japan. *Cetacean Population Studies*. https://doi.org/10.34331/cpops.2022-Re-001

Konishi, K., Minamikawa, M., Kleivane, L. and Takahashi, M. 2024. Annual phenology and migration routes to breeding grounds in western-central North Pacific sei whales. *Scientific Reports*. 14: 11212. https://doi.org/10.1038/s41598-024-61831-8

Sekine, A., Yasunaga, G., Kumamoto, S., Fujibayashi, S., Munirah, I., Bai, L., Tani, T., Sugano, E., Tomita, H., Ozaki, T., Kiyono, T., Inoue-Murayama, M. and Fukuda, T. 2024. Characterization of common minke whale (*Balaenoptera acutorostrata*) cell lines immortalized with the expression of cell cycle regulators. *Advanced Biology* 8 (3): e2300227. doi: 10.1002/adbi.202300227.

Other surveys

1993 (2)

Fujise, Y., Ishikawa, H., Saino, S. and Kawasaki, M. 1993. Catch and struck-and-lost rate in the Japanese Dall′s porpoise hand-harpoon fishery. *Rep. int. Whal. Commn* 43: 453–457.

Taga, Y. 1993. Generalization of HT strategy and its application. *Yokohama Mathematical Journal* 40 (2): 163–173.

1995 (1)

Shimada, H. and Pastene, L.A. 1995. Report of a sightings survey off the Solomon Islands with comments on Bryde′s whale distribution. *Rep. int. Whal. Commn* 45: 413–418.

1997 (4)

Kimura, T., Ozawa, T. and Pastene, L.A. 1997. Sample preparation and analysis of mitochondrial DNA from whale baleen plates. *Marine Mammal Science* 13 (3): 495–498.

Ljungblad, D.K., Stafford, K.M., Shimada, H. and Matsuoka, K. 1997. Sounds attributed to blue whales recorded off the southwest coast of Australia in December 1995. *Rep. int. Whal. Commn* 47: 435–439.

Ohmagari, K. and Berkes, F. 1997. Transmission of indigenous knowledge and bush skills among the Western James Bay Cree Women of Subarctic Canada. *Human Ecology* 25 (2): 197–222.

Shimamura, M., Yasue, H., Ohshima, K., Abe, H., Kato, H., Kishiro, T., Goto, M., Munechika, I. and Okada, N. 1997. Molecular evidence from retroposons that whales form a clade within even-toed ungulates. *Nature* 388: 666–670.

1998 (2)

Miyazaki, N., Fujise, Y. and Iwata, K. 1998. Biological analysis of a mass stranding of melon-headed whales (*Peponocephala electra*) at Aoshima. *Japan. Bull. Natn. Sci. Mus.*, Tokyo, Ser. A 24 (1): 31–60.

Otani, S., Naito, Y., Kawamura, A., Kawasaki, M., Nishiwaki, S. and Kato, A. 1998. Diving behavior and performance of harbor porpoises, *Phocoena phocoena*, in Fukuoka bay, Hokkaido, Japan. *Marine Mammal Science* 14 (2): 209–220.

1999 (5)

Corkeron, P.J., Ensor, P. and Matsuoka, K. 1999. Observations of blue whales feeding in Antarctic waters. *Polar Biol* 22 (3): 213–215.

Iino, Y. 1999. Treaty Implementation: the 1946 International Convention for the Regulation of Whaling. System Compliance in Ocean Management. Southeast Asian Programme in Ocean Law. *Policy and Management*: 189–193.

Pastene, L.A. and Shimada, H. 1999. Report of a sighting survey in Chile's Exclusive Economic Zone with comments on sei whale distribution. *Anales Instituto Patagonia, Serie Cs. Nat.* 27: 51–62.

Shimamura, M., Abe, H., Nikaido, M., Ohshima, K. and Okada, N. 1999. Genealogy of families of SINEs in cetaceans and artiodactyls: the presence of a huge superfamily of tRNAGlu-derived families of SINEs. *Mol. Biol. Evol.* 16 (8): 1046–1060.

Yoshida, H. and Kato, H. 1999. Phylogenetic relationships of Bryde's whales in the western North Pacific and adjacent waters inferred from mitochondrial DNA sequences. *Marine Mammal Science* 15 (4): 1269–1286.

2000 (3)

Goto, M. and Ohsumi, S. 2000. Response to "Scientific Whaling Source of illegal Products for Market" By Baker *et al. Science* 290: 1695–1696.

Otani, S., Naito, Y., Kato, A. and Kawamura, A. 2000. Diving behavior and swimming speed of a free-ranging harbor porpoise, *Phocoena phocoena. Marine Mammal Science* 16 (4): 811–814.

Takahashi, S., Le, L.T.H., Saeki, H., Nakatani, N., Tanabe, S., Miyazaki, N. and Fujise, Y. 2000. Accumulation of butyltin compounds and total tin in marine mammals. *Water Science and Technology* 42 (7–8): 97–108.

2001 (2)

Abe, H., Goto, M., Pastene, L.A., Dewa, K. and Naito, E. 2001. Practical use of multiplex fluorescent PCR for cetacean sex identification. *Marine Mammal Science* 17 (3): 657–664.

Yoshida, H., Yoshioka, M., Shirakihara, M. and Chow, S. 2001. Population structure of finless porpoises (*Neophocaena phocaenoides*) in coastal waters of Japan based on mitochondrial DNA sequences. *Journal of Mammalogy* 82 (1): 123–130.

2002 (1)

Konishi, K. and Sakurai, Y. 2002. Geographical variations in infection by larval *Anisakis simplex* and *Contracaecum osculatum* (Nematoda, Anisakidae) in walleye pollock *Theragra chalcogramma* stocks off Hokkaido, Japan. *Fish Sci* 68 (3): 534–542.

2003 (1)

Matsuoka, K., Ensor, P., Hakamada, T., Shimada, H., Nishiwaki, S., Kasamatsu, F. and Kato, H. 2003. Overview of the minke whale sighting survey in IWC/IDCR and SOWER cruises from 1978/79 to 2000/01. *J. Cetacean Res. Manage.* 5 (2): 173–201.

2004 (5)

Branch, T.A., Matsuoka, K. and Miyashita, T. 2004. Evidence for increases in Antarctic blue whales based on Bayesian modelling. *Marine Mammal Science* 20 (4): 726–754.

Escorza-Trevino, S., Pastene, L.A. and Dizon, A.E. 2004. Molecular analyses of the Truei and Dalli morphotypes of Dall's porpoise (*Phocoenoides dalli*). *Journal of Mammalogy* 85 (2): 347–355.

Ikemoto, T., Kunito, T., Watanabe, I., Yasunaga, G., Baba, N., Miyazaki, N., Petrov, E.A. and Tanabe, S. 2004. Comparison of trace element accumulation in Baikal seals (*Pusa sibirica*), Caspian seals (*Pusa caspica*) and northern fur seals (*Callorhinus ursinus*). *Environmental*

Pollution 127: 83–97.

Murase, H., Matsuoka, K., Nishiwaki, S., Hakamada, T. and Mori, M. 2004. Effect of observed covariates (school size, sighting cue, latitude and sea state) on the Antarctic minke whale abundance estimation parameters in the IWC/IDCR-SOWER surveys. *J. Cetacean Res. Manage.* 6 (3): 283–292.

Yanagimoto, T. and Konishi, K. 2004. *Acanthochondria priacanthi* (Copepoda: Chondracanthidae) as a biological indicator for stock identification of sandfish *Arctoscopus japonicus* (Steindachner). *Fish Sci* 70 (2): 336–338.

2005 (5)

Agusa, T., Matsumoto, T., Ikemoto, T., Anan, Y., Kubota, R., Yasunaga, G., Kunito, T., Tanabe, S., Ogi, H. and Shibata, Y. 2005. Body distribution of trace elements in black-tailed gulls from Rishiri Island, Japan: age-dependent accumulation and transfer to feathers and eggs. *Environ. Toxicol. Chem.* 24 (9): 2107–2120.

Agusa, T., Kunito, T., Yasunaga, G., Iwata, H., Subramanian, A., Ismail, A. and Tanabe, S. 2005. Concentrations of trace elements in marine fish and its risk assessment in Malaysia. *Marine Pollution Bulletin* 51 (8–12): 896–911.

Fukui, Y., Ishikawa, H. and Ohsumi, S. 2005. Difficulties in publishing research results from scientific whaling. *Marine Mammal Science* 21 (4): 781–783.

Prudente, M., Tanabe, S., Kunisue, T., Yasunaga, G., Watanabe, I. and Miyazaki, N. 2005. Accumulation of trace elements and persistent organochlorines in resident and migratory waders from Calatagan Bay, Philippines. *Coastal Marine Science* 29 (2): 133–140.

Sanino, G.P., Waerebeek, K.V., Van Bressem, M. and Pastene, L.A. 2005. A preliminary note on population structure in eastern South Pacific common bottlenose dolphins, *Tursiops truncatus. J. Cetacean Res. Manage.* 7 (1): 65–70.

2006 (6)

Acevedo, J., Aguayo-Lobo, A. and Pastene, L.A. 2006. Filopatria de la ballena jorobada (*Megaptera novaeangliae* Borowski, 1781), al area de alimentacion del Estrecho de Magallanes. *Revista de Biologia Marina y Oceanografia* 41 (1): 11–19.

Acevedo, J., Aguayo-Lobo, A., Acuna, P. and Pastene, L.A. 2006. A note on the first record of the dwarf minke whale (*Balaenoptera acutorostrata*) in Chilean waters. *J. Cetacean Res. Manage.* 8 (3): 293–296.

Hayashi, K., Yoshida, H., Nishida, S., Goto, M., Pastene, L.A., Kanda, N., Baba, H. and Koike, H. 2006. Genetic Variation of the MHC DQB locus in the finless porpoise (*Neophocaena phocaenoides*). *Zoological Science* 23 (2): 147–153.

Mori, M. and Butterworth, D.S. 2006. A first step towards modelling the krill–predator dynamics of the Antarctic ecosystem. *CCAMLR Science* 13: 217–277.

Sekiguchi, K., Olavarria, C., Morse, P., Olson, P., Ensor, P., Matsuoka, K., Pitman, R., Findlay, K. and Gorter, U. 2006. The spectacled porpoise (*Phocoena dioptrica*) in Antarctic waters. *J. Cetacean Res. Manage.* 8 (3): 265–271.

Takahashi, Y., Ohwada, S., Watanabe, K., Ropert-Coudert, Y., Zenitani, R., Naito, Y. and Yamaguchi, T. 2006. Does elastin contribute to the persistence of corpora albicantia in the ovary of the common dolphin (*Delphinus delphis*). *Marine Mammal Science* 22 (4): 819–830.

2007 (2)

Acevedo, J., Rasmussen, K., Felix, F., Castro, C., Llano, M., Secchi, E., Saborio, M.T., Aguayo-Lobo, A., Haase, B., Scheidat, M., Dalla-Rosa, L., Olavarria, C., Fosestell, P., Acuna, P., Kaufman, G. and Pastene, L.A. 2007. Migratory destinations of humpback whales from the Magellan Strait feeding ground, Southeast Pacific. *Marine Mammal Science* 23 (2): 453–463.

Branch, T.A., Stafford, K.M., Palacios, D.M., Allison, C., Bannister, J.L., Burton, C.L.K., Cabrera, E., Carlson, C.A., Galletti Vernazzani, B., Gill, P.C., Hucke-Gaete, R., Jenner, K.C.S., Jenner, Mn. M., Matsuoka, K., Mikhalev, Y.A., Miyashita, T., Morrice, M.G., Nishiwaki, S., Sturrock, V.J., Tormosov, D., Anderson, R.C., Baker, A.N., Best, P.B., Borsa, P., Brownell Jr, R.L., Childerhouse, S., Findlay, K.P., Gerrodette, T., Ilangakoon, A.D., Joergensen, M., Kahn, B., Ljungblad, D.K., Maughan, B., Mccauley, R.D., Mckay, S., Norris, T.F., Oman Whale and Dolphin Research Group, Rankin, S., Samaran, F., Thiele, D., Van Waerebeek, K. and Warneke, R.M. 2007. Past and present distribution, densities and movements of blue whales in the Southern Hemisphere and adjacent waters. *Mammal Rev.* 37 (2): 116–175.

2009 (1)

Nambu, H., Tokutake, K., Ishikawa, H., Ohta, M., Fujita, K. and Yamada, T.K. 2009. Observation of a gray whale, *Eschrichtius robustus*, in Tokyo Bay in 2005. *Japan Cetology* 19: 17–22 (in Japanese).

2010 (3)

Nambu, H., Ishikawa, H. and Yamada, T. 2010. Records of the western gray whale *Eschrichtius robustus*: its distribution and migration. *Japan Cetology* 20: 21–29 (in Japanese).

Pastene, L.A. and Quiroz, D. 2010. An Outline of the History of Whaling in Chile. pp. 73–98. *In*: International Center for Folk Culture Studies (Ed.). *Human Culture from the Perspective of Traditional Maritime Communities, International Symposium Report No. 1*. Kanagawa Shimbun Press, Kanagawa. 199 pp.

Taguchi, M., Ishikawa, H. and Matsuishi, T. 2010. Seasonal distribution of harbour porpoise (*Phocoena phocoena*) in Japanese waters inferred from stranding and bycatch records. *Mammal Study* 35 (2) : 133–138.

2011 (2)

Acevedo, J., Olavarría, C., Plana, J., Aguayo-Lobo, A., Larrea, A. and Pastene, L.A. 2011. Occurrence of dwarf minke whales (*Balaenoptera acutorostrata* subsp.) around the Antarctic Peninsula. *Polar Biol* 34 (2): 313–318.

Acevedo, J., Plana, J., Aguayo-Lobo, A. and Pastene, L.A. 2011. Surface feeding behavior of humpback whales in the Magellan Strait. *Revista de Biologia Marina y Oceanografia*. 46 (3): 483–490.

2013 (4)

Acevedo J., Haro D., Dalla R.L., Aguayo-Lobo A., Hucke-Gaete R., Secchi E., Plana J. and Pastene L.A. 2013. Evidence of spatial structuring of eastern South Pacific humpback whale feeding grounds. *Endang Species Res* 22 (1): 33–38.

Kitamura, S., Matsuishi, T., Yamada, K., Tajima, Y., Ishikawa, H., Tanabe, S., Nakagawa, H., Uni, Y. and Abe, S. 2013. Two genetically distinct stocks in Baird's beaked whale (Cetacea: Ziphiidae). *Marine Mammal Science* 29 (4): 755–766.

Murase, H., Temoai, I., Kirata, T., Finkaso, S., Yasunaga, G. and Pastene, L.A. 2013. A note on cetaceans off Kiribati and Tuvalu from a research cruise in October 2010. *J. Cetacean Res. Manage.* 13 (2): 153–158.

Sugino, T., Yasunaga, G. and Fukuda, M. 2013. Effect of whale meat extract on fatigue induced by physical load and by daily activities in humans. *Jpn. Pharmacol. Ther* 41 (9): 879–893 (in Japanese).

2014 (3)

Pastene, L.A. 2014. Macaya Hermanos y Compania. Notas sobre las actividades de la empresa ballenera de más larga historia en Chile. Colección Mocha Dick pp 255–274.

Quiroz, D. and Pastene, L.A. 2014. Norwegian whaling in Chile in the 20th Century and its influence on Chilean local communities. pp. 61–70. *In*: J.E. Ringstad (Ed.). *Whaling and History IV*. Commander Chr. Christensen's Whaling Museum, part of Vestfoldmuseene IKA, Sandefjord. 192 pp.

Quintela, M., Skaug, H.J., Øien, N., Haug, T., Seliussen, B.B., Solvang, H.K., Pampoulie, C., Kanda, N., Pastene, L.A. and Glover, K.A. 2014. Investigating population genetic structure in a highly mobile marine organism: the minke whale *Balaenoptera acutorostrata acutorostrata* in the North East Atlantic. *PLoS ONE* 9 (9): e108640.

2015 (3)

Funasaka, N., Kirihata, T., Kato, H. and Ohsumi, S. 2015. The first record of a true albino common bottlenose dolphin *Tursiops truncatus* from Japan. *Mammal Study* 40 (1): 19–22.

Pastene, L.A., Acevedo, J., Siciliano, S., Sholl, T.G.C., de Moura, J.F., Ott, P.H. and Aguayo-Lobo, Anelio. 2015. Population genetic structure of the South American Bryde's whale. *Revista de Biologia Marina y Oceanografia* 50 (3): 453–464.

Sakamoto, M., Itai, T., Yasutake, A., Iwasaki, T., Yasunaga, G., Fujise, Y., Nakamura, M., Murata, K., Chan, H.M., Domingog, J.L. and Marumoto, M. 2015. Mercury speciation and selenium in toothed-whale muscles. *Environmental Research* 143: 55–61.

2017 (3)

Funasaka, N., Kirihata, T., Hosono, M., Kato, K. and Ohsumi, S. 2017. Three Cases of Anomalously White Risso's Dolphins *Grampus griseus* in Japan. *Mammal Study* 42 (3): 173–178.

Hakamada, T., Matsuoka, K., Murase, H. and Kitakado, T. 2017. Estimation of the abundance of the sei whale *Balaenoptera borealis* in the central and eastern North Pacific in summer using sighting data from 2010 to 2012. *Fish Sci* 83 (6): 887–895.

Malde, K., Seliussen, B.B., Quintela, M., Dahle, G., Besnier, F., Skaug, H.J., Øien, N., Solvang, H.K., Haug, T., Skern-Mauritzen, R., Kanda, N., Pastene, L.A., Jonassen, I. and Glover, K.A. 2017. Whole genome resequencing reveals diagnostic markers for investigating global migration and hybridization between minke whale species. *BMC Genomics* 18: 76.

2019 (1)

Takahashi, M., Kato, H. and Kitakado, T. 2019. Sex prediction by machine learning methods for small sample sizes: a case study of cranial measurements of killer whales (*Orcinus orca*). *Mammalian Science* 59 (1): 67–78 (in Japanese).

2020 (2)

Kawasaki, K., Mikami, M., Goto, M., Shindo, J., Amano, M. and Ishiyama, M. 2020. The evolution of unusually small amelogenin genes in cetaceans; pseudogenization, X–Y gene conversion, and feeding strategy. *Journal of Molecular Evolution* 88 (2): 122–135.

Pastene, L.A., Acevedo, J. and Branch, T.A. 2020. Morphometric analysis of Chilean blue whales and implications for their taxonomy. *Marine Mammal Science* 36 (1): 116–135.

2021 (4)

Diallo, S.T., Sane, A., Nelson, T., Katsumata, T. and Hakamada, T. 2021. Cetaceans off Gabon based on a 2011 sighting survey, with a preliminary density estimate of the humpback whale *Megaptera novaeangliae*. *Cetacean Population Studies* 3: 258–264.

Katsumata, T., Hirose, A., Nakajo, K., Shibata, C., Murata, H., Yamakoshi, T., Nakamura, G. and Kato, H. 2021. Evidence of winter migration of humpback whales to the Hachijo island, Izu Archipelago off the southern coast of Tokyo, Japan. *Cetacean Population Studies* 3: 164–174.

Milmann, L., Taguchi, M., Siciliano, S., Baumgarten, J.E., Oliveira, L.R., Valiati, V.H., Goto, M., Ott, P.H. and Pastene, L.A. 2021. New genetic evidences for distinct populations of the common minke whale (*Balaenoptera acutorostrata*) in the Southern Hemisphere. *Polar Biol* 44 (8): 1575–1589.

Takahashi, M., Nakamura, G. and Kato, H. 2021. Growth-related changes in the cranium of killer whales in the western North Pacific. *Cetacean Population Studies* 3: 175–188.

2022 (6)

Cabrera, A.A., Schall, E., Bérubé, M., Anderwald, P., Bachmann, L., Berrow, S., Best, P.B., Clapham, P.J., Cunha, H.A., Dalla Rosa, L., Dias, C., Findlay, K.P., Haug, T., Heide-Jørgensen, M.P., Hoelzel, R., Kovacs, K.M., Landry, S., Larsen, F., Moreira Lopes, X., Lydersen, C., Mattila, D.K., Oosting, T., Pace III, R.M., Papetti, C., Paspati, A., Pastene, L.A., Prieto, R., Ramp, C., Robbins, J., Sears, R., Secchi, E.R., Silva, M.A., Simon, M., Víkingsson, G., Wiig, Ø., Øien, N. and Palsbøll, P.J. 2022. Strong and lasting impacts of past global warming on baleen whales and their prey. *Global Change Biology* 28 (8): 2657–2677.

Dolar, L., Barbieri, M., Crespo, E.A., Palacios, D.M., Pastene, L.A., Ponnampalam, L.S., Rajamani, L., Reyes, J.C., Rojas-Bracho, L., Secchi, E., Segniagbeto, G.H., Siciliano, S., Sutaria, D.N., Urbán, J., Wang, J.Y., Yamada, T.K. and Van Waerebeek, K. 2022. William Fergus Perrin—a marine mammalogist ʻfor all seasonsʼ: 20 August 1938–11 July 2022. *Latin American Journal of Aquatic Mammals* 17 (2): 133–141.

Hirose, A., Kodera, R., Uekusa, Y., Katsumata, H., Katsumata, E., Nakamura, G. and Kato, H. 2022. Comparative anatomy of and around the posterior nasofrontal sac of a beluga whale. *Marine Mammal Science* 38 (3): 1272–1285.

Matsuoka, K., Crance, J.L., Taylor, J.K.D., Yoshimura, I., James, A. and An, Y.-R. 2022. North Pacific right whale (*Eubalaena japonica*) sightings in the Gulf of Alaska and the Bering Sea during IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER) surveys. *Marine Mammal Science* 38 (2): 822–834.

Pastene, L.A., Taguchi, M., Lang, A., Goto, M. and Matsuoka, K. 2022. Population genetic structure of North Pacific right whales. *Marine Mammal Science* 38 (3): 1249–1261.

Ponganis, P.J., Fujise, Y. and Miyazaki, N. 2022. Morphology and physiology in some small pelagic cetaceans: is Dallʼs porpoise a deep diver and a thoroughbred of the sea? *Marine Mammal Science* 38 (4): 1442–1469.

2023 (4)

Inamori, D., Yoshioka, M. and Kato, H. 2023. Second occurrence of a dolphin with fin-shaped hind appendages from waters off Taiji, the Pacific coast of Japan. *Cetacean Population Studies* 4: 43–44.

Katsumata, T., Isoda, T., Matsuno, K., Murase, H. and Matsuoka, K. 2023. Observation of fin whale (*Balaenoptera physalus*) feeding behavior in the Austral summer southern hemisphere mid-latitudes. *Cetacean Population Studies* 4: 34–39.

Katsumata, T. and Yoshida, T. 2023. Development progress of a long-range vertical takeoff and landing UAV for the improvement of ship-based cetacean sighting surveys. *Cetacean Population Studies* 4: 45–47.

Nakamura, G., Al-Zaidan, A., Behbehani, M. and Kato, H. 2023. Preliminary report on the cranial measurements of a Brydeʼs whale stranded in Failaka Island, Kuwait in 2014. *Cetacean Population Studies* 4: 21–26.

2024 (4)

Best, P.B., Ohsumi, S., Kato, H. and Donovan, G.P. 2024. The SOWER programme in the Antarctic: Background, aims and objectives. *J. Cetacean Res. Manage*. (special issue) 4: 1–11.

Kato, H., Matsuoka, K., Nakamura, G. and Best, P.B. 2024. Sightings of dwarf minke whales in the Southern Hemisphere during the SOWER cruises. *J. Cetacean Res. Manage*. (special issue) 4: 63–68.

Pastene, L.A. 2024. A review of biopsy sampling experiments and studies of stock structure, phylogeny and taxonomy of large whales based on samples obtained on SOWER cruises. *J. Cetacean Res. Manage*. (special issue) 4: 43–62.

Shabangu, F.W., Stafford, K.M., Findlay, K.P., Rankin, S., Ljungblad, D., Tsuda, Y., Morse, L., Clark, C.W., Kato, H., and Ensor, P. 2024. Overview of the SOWER cruise circumpolar acoustic survey data and analyses of Antarctic blue whale calls. A special issue focusing on the analysis of data gathered during the IWC SOWER cruises which ran from 1978/79 to 2008/09. *J. Cetacean Res. Manage*. (special issue) 4: 21–41.

TEREP-ICR
The Institute of Cetacean Research,
4-5 Toyomi-cho, Chuo-ku, Tokyo 104-0055, Japan
www.icrwhale.org/TEREP-ICR.html