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Cover photo:

An external view of the International Cetacean Center (ICC) in Taiji, Wakayama Prefecture where the Institute of Cetacean Research (ICR) Taiji Office is situated (top). Chemical laboratory of the ICR Taiji Office (middle). Central hall of the ICC (bottom).

TECHNICAL REPORTS OF THE INSTITUTE OF CETACEAN RESEARCH

TEREP-ICR
No. 9

The Institute of Cetacean Research (ICR)
Tokyo, 2025

Foreword

It is a pleasure for me to introduce the ninth issue of the Technical Reports of the Institute of Cetacean Research (TEREP-ICR-9). 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 central-western North Pacific and the Antarctic Ocean.

In 2025 the ICR continued its research activities 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. I would like to highlight here the Japanese Abundance and Stock structure Surveys (JASS-A) mid-term review (MTR) workshop, which was carried out successfully in Tokyo between 20 and 22 October. The JASS-A is a research program designed and implemented by the ICR and authorized by the Government of Japan (GOJ) in the Antarctic. A total of 28 scientific documents derived from the JASS-A program was discussed between Japanese scientists and invited participants from Norway, United Kingdom, Germany and South Africa. The scientific outputs from the JASS-A program were well evaluated and useful suggestions and recommendations were provided by the MTR workshop, which will improve the ICR′s Antarctic research in the future.

I would also like to highlight the visits of international scientists to the new ICR Taiji Office. Firstly, the Executive Director (Dr. Paola Acuña) and Scientific Director (Dr. Jorge Acevedo) of CEQUA, a research institute located in Punta Arenas, Chile dedicated to the biological and ecological research in the Chilean Patagonia, visited ICR Taiji Office on 3-6 October. They were accompanied of a doctoral research student (Aida Murillo) of the Universidad Nacional Autónoma de México (UNAM). They offered lectures to the public of Taiji on the research activities of CEQUA including specific research activities on whales. Furthermore, they and ICR scientists participated in a mini workshop on the feasibility of implementing microbiota research in the ICR. Apart from a productive scientific interchange, they interacted with the Taji community in a warm atmosphere. Then, Dr. Martin Biuw of the Institute of Marine Research (IMR) in Norway visited ICR Taiji Office between 23 and 26 October to offer a lecture on whale and ecosystem research in Norway, and to carry out discussions with ICR scientists on future research collaborations on whales. Furthermore, the International Whaling Commission Scientific Committee (IWC SC)′s Technical Advisory Group (TAG) workshop was held in ICR Taiji Office in December to discuss matters related to the IWC-Pacific Ocean Whale and Ecosystem Research (POWER) program. Japanese and IWC SC scientists participated in the workshop.

I hope that activities involving international research collaborations and new visits to ICR Taiji Office will increase in the future.

The previous TEREP-ICR No. 8 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 ninth 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 2025

Editorial

Welcome to the ninth issue of the Technical Reports of the Institute of Cetacean Research (TEREP-ICR-9).

This issue contains seven technical reports and two commentary articles. In the first report, Pastene and colleagues presented a review of the studies on phylogenetic relationship and taxonomy of minke whale worldwide conducted by -or in collaboration with- ICR. The review involved both genetic and non-genetic studies. In the second report, Yamada and Katsumata presented the results of a pilot study on the use of passive acoustic monitoring to investigate the presence of the fin whale in northern Japan during winter. In the third report, Inoue and colleagues outlined the two feasibility studies targeting small cetacean species in Taiji, Wakayama Prefecture: investigation of the school structure and movement of small cetaceans targeted by the drive fisheries in Taiji and developing of bycatch prevention devices for fisheries set nets. In the fourth report, Taguchi summarized the progress made in the studies on stock structure in western North Pacific common minke whales.

Results of three important dedicated sighting surveys were presented in the following three reports: Katsumata and colleagues summarized the results of the 2024/25 austral summer season survey of the Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A) conducted in the eastern part of Antarctic Area IV; Katsumata and colleagues summarized the results of sighting surveys conducted in the North Pacific in 2024; and Murase and Yoshimura presented an overview of the results of the 2024 International Whaling Commission-Pacific Ocean Whale and Ecosystem Research (IWC-POWER) survey conducted in the eastern North Pacific.

In the first commentary article, Ikeda and colleagues explained the background and plan to move forward of the new research facility of the ICR in Taiji, the ICR Taiji Office. In the second commentary article, Miyashita described the objectives and the history of the Japan-Russian Federation's research collaboration in the Sea of Okhotsk highlighting the importance of such collaboration for investigating the distribution and abundance of some species of cetaceans in this oceanic basin.

TEREP-ICR-9 issue also included sections that outline the contribution of ICR scientists to international and national meetings in 2025, as well as their contribution in terms of peer-reviewed publications up to December 2025.

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

Dr. Luis A. Pastene
Dr. Mutsuo Goto

Editorial Team, TEREP-ICR
Tokyo, December 2025

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Contribution of the Institute of Cetacean Research to the understanding of minke whale's phylogeny and taxonomy

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ABSTRACT

In 1998 and based on early morphological and initial Japanese DNA studies in the 1990's, two species of minke whales were re-specified, the Antarctic minke whale *Balaenoptera bonaerensis*, which is restricted to the Southern Hemisphere and the common minke whale *B. acutorostrata*, which is distributed globally. Furthermore, three sub-species of the common minke whale were recognized, one in the North Pacific, one in the North Atlantic and one in the Southern Hemisphere (dwarf minke whale). This paper summarizes the genetic and non-genetic studies conducted post 1998 by or in collaboration with the Institute of Cetacean Research, which were focused to confirm and/or refine the taxonomic classification proposed in 1998. As shown in this paper, results of those studies were consistent with the 1998 classification, which was the basis for the taxonomic status of minke whales currently agreed by the Committee of Taxonomy of the Society for Marine Mammalogy.

INTRODUCTION

Until the early 1980's, only one species of minke whale was thought to exist, *Balaenoptera acutorostrata* Lacèpéde, 1804. This, despite early morphological studies that provided evidence of the existence of at least two species, one each in the Southern and Northern Hemisphere (e.g. Williamson, 1959; van Utrecht and van der Spoel, 1962; Kasuya and Ichihara, 1965; Omura, 1975).

From the start of the 1990's comparative studies of minke whales were carried out based on genetic, morphology and ecological aspects, and on available samples from different oceanic basins (e.g. North Pacific, North Atlantic and Southern Hemisphere). This research effort was motivated in part by the reports in the mid 1980's of a new 'form' of minke whales in the Southern Hemisphere which was called as 'dwarf' and 'diminutive' minke whales that were different morphologically from the more abundant 'ordinary form' minke whale distributed in the Southern Hemisphere (Best, 1985; Arnold, 1987).

Samples and data collected by the Institute of Cetacean Research (ICR) from different oceanic basins and southern 'forms' of minke whale played an important role in the different analyses. Particularly, sixteen samples of the dwarf minke whale collected during early JARPA (Japanese Whale Research Program under Special Permit in the Antarctic) surveys contributed importantly in most of the genetic and non-genetic analyses of minke whale worldwide.

In the first half of the 1990's results of some pioneering DNA studies confirmed the differentiation between the Southern and Northern Hemispheres minke whales suggested by historical morphological and morphometric studies. Furthermore, these genetic studies provided some highlights on the genetic diversity and differentiation of the southern 'dwarf form'. Wada *et al.* (1991) analyzed restriction fragment length polymorphism (RFLP) of mitochondrial DNA (mtDNA) in minke whales from the North Pacific and the Antarctic. The Antarctic sample included a single individual of the 'dwarf form', which had been sampled during early JARPA surveys. North Pacific, southern 'ordinary form' and southern 'dwarf forms' were all genetically different. Furthermore, they found that the southern 'dwarf form' and minke whales from the North Pacific were more similar to each other than they were to the southern 'ordinary form'. Pastene *et al.* (1994) expanded Wada *et al.* (1991) study to incorporate a larger number of the 'dwarf form' sampled during JARPA (n=11). In addition to confirming the main results of Wada *et al.* (1991), for the first time they provided information on the level of mtDNA diversity of the southern 'dwarf form'.

Rice (1998) reviewed the early morphological studies cited above and the initial DNA studies in the 1990's described in the previous paragraph, and re-specified two species, the Antarctic minke whale *B. bonaerensis*, which is restricted to the Southern Hemisphere (called previously as southern 'ordinary form'), and the common minke whale *B. acutorostrata*, which is distributed globally. Furthermore, he recognized three sub-species of the common minke whale, one in the North Pacific, one in the North Atlantic and one in the Southern Hemisphere. The latter was called previously as southern 'dwarf form'. Rice's proposed minke whale species and sub-species are shown in Figure 1.

This paper summarizes the genetic and non-genetic studies conducted post-1998 by or in collaboration with the ICR, which were focused to confirm and/or refine the taxonomic classification proposed by Rice (1998).

GENETIC STUDIES

Genetic studies were expanded from the late 2000's by using different genetic markers and additional minke

Figure 1. Species and sub-species of minke whales proposed by Rice (1998). From top to bottom: Antarctic minke whale, North Pacific common minke whale, North Atlantic common minke whale and Southern Hemisphere common minke whale (dwarf minke whale).

whale samples from different oceanic basins. Details of those studies can be found in Pastene *et al.* (2022) and a summary is presented below.

Phylogeny, speciation and radiation

The first study in the 2000's that involved samples of the minke whale worldwide was focused on understanding the radiation and speciation of minke whale in the context of climate changes (Pastene *et al.*, 2007). The study was based on mtDNA control region sequences (340 bp) in samples from the Antarctic minke whales (previously labeled as 'ordinary form') (n=180), North Atlantic (n=102), North Pacific (n=161) and Southern Hemisphere (previously labeled as 'dwarf form') (n=23) common minke whales. A total of 187 haplotypes (unique sequences) were determined in the total sample, several phylogenetic and population genetic analyses were conducted. The study provided evidence for phylogenetic differentiation not only between the two species of minke whales but also among North Atlantic, North Pacific and Southern Hemisphere common minke whales. The study estimated that the two species of minke whales diverged in the Southern Hemisphere less than 5 Ma, and that the current sub-species of the common minke whales diverged after the Pliocene some 1.5 Ma. Furthermore, based on their analyses in the minke whales, the authors proposed the hypothesis that prolonged periods of global warming facilitate speciation in pelagic marine species that depend on upwelling.

The next study (Pastene *et al.*, 2010) used mtDNA control region sequences (327 bp) and a similar sample set as that used in Pastene *et al.* (2007) but this time the study was focused to elucidate the population genetic structure of the Southern Hemisphere common minke whales (dwarf minke whales) using samples from western South Atlantic (WSA, n=12-Brazilian-Chilean samples) and western South Pacific (WSP, n=17-JARPA samples) (Figure 2).

Phylogenetic inferences derived from different methods were consistent, and similar to the inferences obtained in the previous study by Pastene *et al.* (2007). WSA common minke whale haplotypes (except one), clustered in a single clade, which nested within the North Atlantic common minke whale clade. On the other hand, WSP common minke whale haplotypes were clustered in a different clade. The study showed that haplotypes from the WSA whales share a more recent common ancestors with the North Atlantic minke whales than they do with the WSP minke whales. The analysis suggested a very low number of migrants by generation between WSA and WSP, which suggest that the WSA single haplotype in the

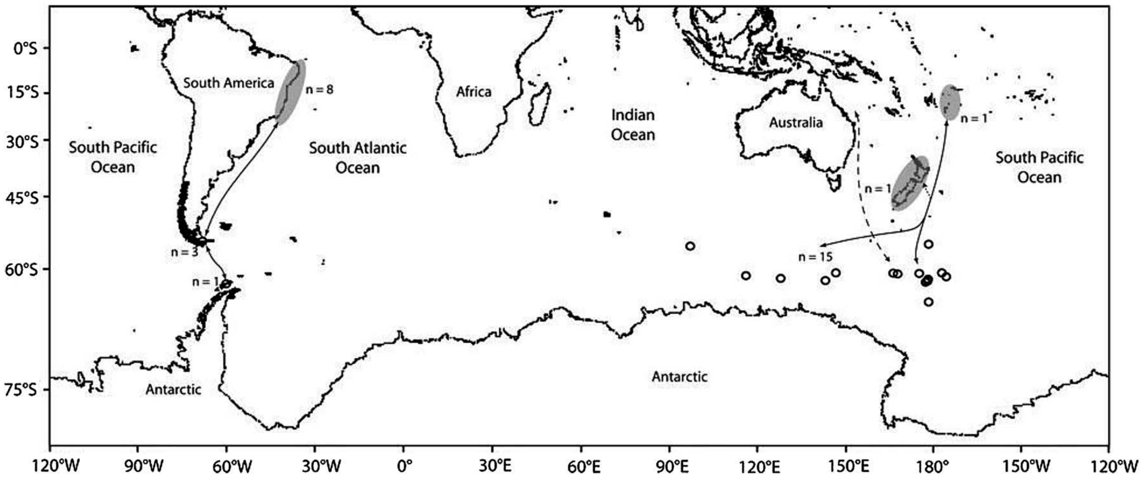

Figure 2. Geographic position of Southern Hemisphere common minke whale (dwarf minke whale) samples used in Pastene *et al.* (2010). Solid and dashed lines indicate possible migratory routes and possible connections, respectively (modified from Pastene *et al.*, 2010).

WSP clade was unlikely to be a result of migration but rather due to incomplete lineage sorting.

A more recent genetic analysis on minke whales worldwide conducted in cooperation with ICR was based on mtDNA control region sequences (313 bp) and microsatellite DNA (msDNA) (11 loci) (Milmann *et al.*, 2021). The sample set for the mtDNA analysis was similar to those in previous studies but the samples of the Southern Hemisphere common minke whales were increased (WSP, n=17; WSA, n=30), and msDNA was used in addition to mtDNA. A total of 148 haplotypes were determined in the total sample. The genealogy of the mtDNA haplotypes was estimated using several methods. These methods provided similar results, and they were consistent with previous phylogenetic inferences. Results from the Bayesian inference method are shown in Figure 3. This figure shows two main clades, one corresponding to Antarctic minke whale and the other to common minke whales. Furthermore, within the common minke whale clade, North Pacific, North Atlantic and Southern Hemisphere common minke whales clustered in different sub-clades.

Figure 3 shows that WSA and WSP common minke whales in the Southern Hemisphere clustered in different sub-clades (except the single WSA haplotype mentioned previously that clustered within the WSP sub-clade), and that the WSA haplotypes fell with the North Atlantic sub-clade. This study also estimated the net nucleotide substitutions (d_A) (Nei, 1987) between species and subspecies of minke whales. The d_A between Antarctic and common minke whales was high (0.08 in average). The value among common minke whales from different oceanic basins averaged 0.026. The d_A between Southern Hemisphere WSP and WSA was 0.027 and that between Sea of Japan and western North Pacific was 0.007.

The msDNA analysis in Milmann *et al.* (2021) involved samples from three localities only: North Pacific and Southern Hemisphere (WSA and WSP) common minke whales. Unfortunately, no samples from the North Atlantic common minke whales were available for this analysis. The pattern of msDNA differentiation was investigated by two indexes F_{ST} and D_{SW}. All pairwise comparisons among North Pacific, WSA and WSP yielded statistically significant differences, and the values estimated between WSA and WSP were smaller than the values between each of these populations and North Pacific common minke whales. Therefore, North Pacific, Southern Hemisphere WSA and WSP not only were separated phylogenetically in their mtDNA but they differed significantly in their msDNA as well.

In a cooperative study with ICR, Glover *et al.* (2013) provided information on genetic differentiation between Antarctic and common minke whales species as well as among common minke whales from different oceanic basins. The study was based on mtDNA control region sequences (287 bp) and msDNA (11 loci), and samples from the Antarctic minke whale (n=91), North Atlantic (n=91), North Pacific (n=95) and Southern Hemisphere (WSP) (n=9) common minke whales. The genealogy of the mtDNA haplotype was similar to the previous studies. The msDNA F_{ST} estimates were calculated, and Bayesian cluster analysis was also performed using the program *STRUCTURE* (Pritchard *et al.*, 2000). Pairwise F_{ST} estimates revealed that the Antarctic minke whales, North Atlantic, North Pacific and Southern Hemisphere (WSP) common minke whales were genetically distinct from each other.

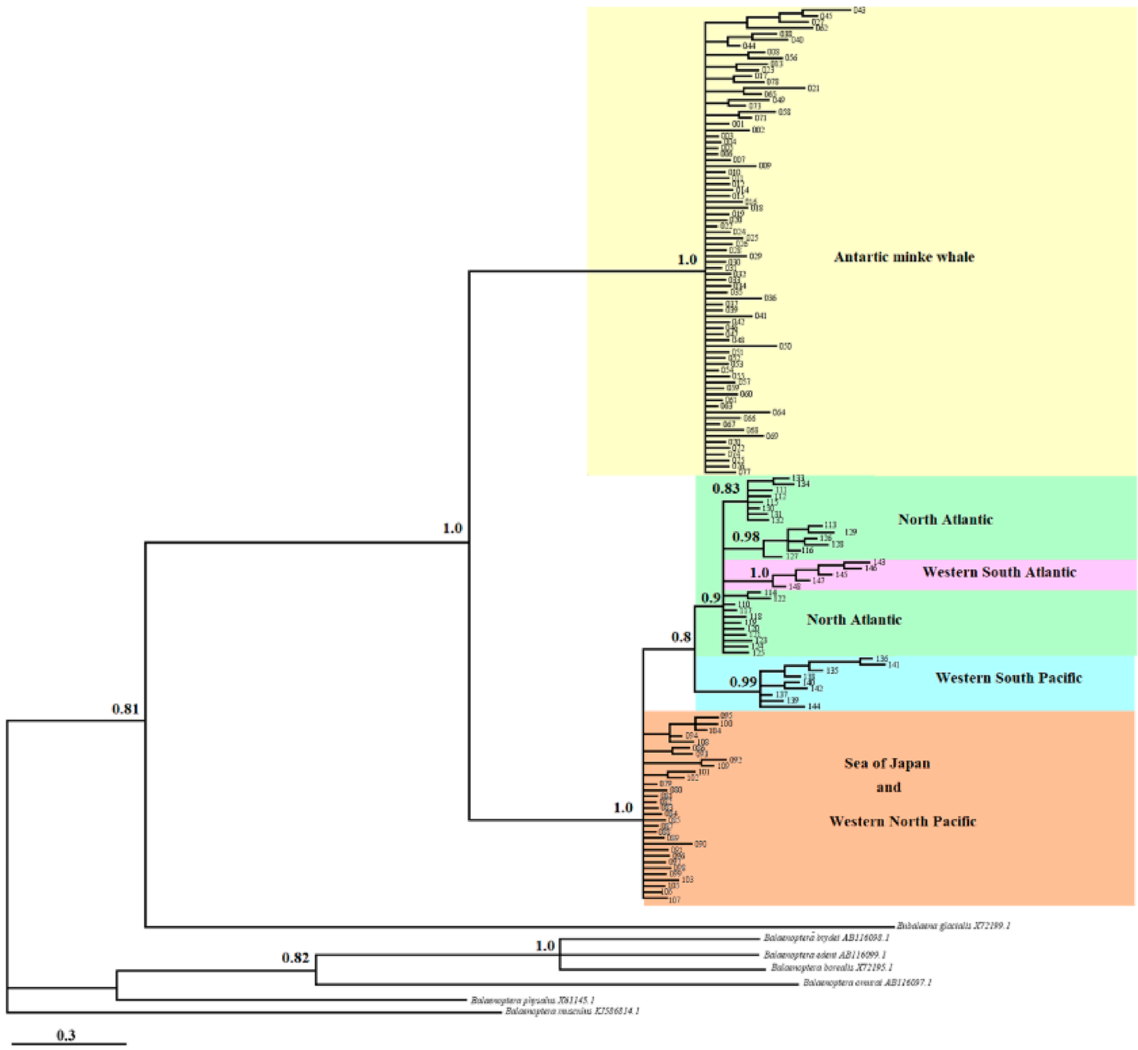

Figure 3. Bayesian phylogenetic tree of minke whale mtDNA haplotypes. Values indicate support for each node according to the maximum posterior probabilities>80%. Scale bar represents substitutions per nucleotide site (modified from Milmann *et al.*, 2021).

Also, the Bayesian cluster analysis supported the results based upon F_{ST} exhibiting large genetic differences between Antarctic and common minke whales as well as among common minke whales from North Atlantic, North Pacific and Southern Hemisphere (WSP).

Minke whale hybridization and unusual migration event

A genetic study based on both mtDNA (287 bp) control region sequences and msDNA (13 loci) conducted in cooperation with ICR, reported the migration of an Antarctic minke whale into the Arctic Northeast Atlantic in 1996 (Glover *et al.*, 2010). The same study reported the occurrence of a hybrid whale in the North Atlantic in 2007. The latter used a genetic baseline consisting of the three minke whale species and sub-species which had large sample size (Southern Hemisphere common minke whales were excluded due to their small sample size). The 2007 hybrid was demonstrated to consist of maternal contribution from Antarctic minke whale and most likely paternal contribution from North Atlantic common minke whale. Another case of hybrid was identified using the same analytical procedures. It was a pregnant female captured in 2010 (Glover *et al.*, 2013). In this case, the genetic analyses by both markers confirmed that the mother was a hybrid displaying maternal and paternal contribution from North Atlantic common and Antarctic minke whales, respectively. This study demonstrated for the first time that hybrids between minke whale species may be fertile, and that they can backcross.

It is very possible that the migrations from Antarctic to North Atlantic informed above were random events, which may or may not represent a scouting behavior having occurred over many years. The Northeast Atlantic does not appear to be a major destination of Antarctic minke whale migration outside its previously documented distribution (Glover *et al.*, 2010). However, it is possible that unusual migration patterns e.g. Southern-Northern Hemispheres migrations, could increase in the future as an effect of climate changes, particularly global warming which is making possible new migration routes.

NON-GENETIC STUDIES

The most comprehensive study focused on investigating differences in morphology, growth and life history of Southern Hemisphere common minke whales (dwarf minke whales) in relation to minke whales from different oceanic basins was carried out by Kato *et al.* (2021). This study was based on the examination of 16 dwarf minke whales, three males and 13 females, sampled by JARPA in the Indo-Pacific sector of the Antarctic (called as WSP in the genetic analyses) between 1987/88 and 1992/93 austral summer seasons. Kato *et al.* (2021) examined several aspects of their biology and life history, some of which were compared with those in Antarctic minke whales, North Pacific and North Atlantic common minke whales. Relevant results of their analyses are summarized below.

Body size and growth: female dwarf minke whales were significantly smaller in body length than Antarctic and North Pacific common minke whales through all age-classes. The mean asymptotic lengths indicated that fully grown females dwarf minke whales (physical maturity) was reached at 7.16 m, about 2.0 m and 1.5 m shorter than Antarctic minke North Pacific common minke whales, respectively.

Body length-weight relationship: this analysis suggested that dwarf minke whales tended to be stockier than Antarctic minke whales.

External appearance: the pattern of dark throat extension, shoulder flipper pigmentation and thorax blaze/patches pattern distinguished clearly dwarf minke whales from Antarctic and North Pacific minke whales. In particular, the dwarf minke whale possesses a distinct white flipper mark that is characteristic of the species in the Northern Hemisphere and absent in the Antarctic minke whale. The difference with the Northern Hemisphere whales is that the white flipper extends onto the shoulder in the dwarf minke whale (see Figure 1).

Baleen plate coloration: the external view of a baleen plate series of dwarf minke whales is mostly bilaterally symmetrical in coloration with a creamy white anterior portion that extends for almost half of the entire length of the baleen plates. The Antarctic minke whale in contrast has a bilaterally asymmetric baleen plate coloration. On the other hand, North Pacific common minke whale has usually all creamy white baleen plates.

Skeletal features: there were longer rostrum, deeply curved mandible and narrower nasal bone in dwarf minke whales in comparison with Antarctic and Northern Hemisphere common minke whales.

Morphometry: ANCOV analyses revealed significant differences in both external body and skull morphology among dwarf, Antarctic and Northern Hemisphere common minke whales. A cluster analyses of the skull morphology showed differentiation between dwarf minke whale and Antarctic and Northern Hemisphere common minke whales. Interesting, dwarf minke whales were more closely related to North Atlantic common minke whales, which coincide with the results of some of the genetic analyses shown above.

Life history: length at sexual maturity in female dwarf minke whales was estimated around 6.0–6.5 m, which was 1.0–2.0 m smaller than Antarctic and Northern Hemisphere common minke whales. The maximum life span in female dwarf minke whales was estimated at 47 years, which was similar to Antarctic minke whale (50 years) and North Pacific common minke whale (48 years).

Nakamura *et al.* (2018) examined morphological differences of the white patch on the flipper between North Pacific and North Atlantic common minke whales. There were statistical significant differences between common minke whales from the two oceanic basins in two measurements: the length between the tip of flipper to the proximal border of white patch relative to the total flipper length, which was larger in the North Atlantic (74.3%) than in North Pacific (63.6%), and in the mean angle between the proximal boundary line of the white patch and the longitudinal axis of the flipper, 70.1% and 92.3% in North Atlantic and North Pacific common minke whales, respectively.

From the practical point of view, the two species in the Southern Hemisphere have not been confused during the sighting surveys conducted using closing mode because of the distinctive morphological features of the two species. According to the descriptions for identification on the two species by Kato *et al.* (2015), the two species can be clearly distinguished from the vessels by the presence of white patch overspread on the shoulder-flipper portion in dwarf minke whales in contrast to Antarctic minke whales which lack them. The Antarctic minke whale can be distinguished in the field by its larger size and by a dorsal fin that is set farther back on the body. The dwarf minke whale has a very distinctive white patch on its flipper, unlike the light gray flipper of the Antarctic minke whale.

CURRENT TAXONOMIC STATUS OF MINKE WHALES

All post-1998 studies described above are consistent with the classification proposed by Rice (1998) and therefore these studies have contributed to the current taxonomic classification of minke whale by the Committee of Taxonomy of the Society for Marine Mammalogy, which is based largely on the classification by Rice (1998). The Committee listed the following species and sub-species of minke whale (Committee of Taxonomy, 2025):

(1) *Balaenoptera acutorostrata* Lacèpéde, 1804. Common minke whale
  (a) *B. a. acutorostrata* Lacèpéde, 1804. North Atlantic minke whale
  (b) *B. a. scammoni* Deméré, 1986. North Pacific minke whale

(2) *Balaenoptera bonaerensis* Burmeister, 1867. Antarctic minke whale.

The Committee also presents a 'List of proposed unnamed Taxa', which includes:

Balaenoptera acutorostrata un-named subsp. Dwarf minke whales (Rice, 1998).

It should be noted that the analyses summarized above suggested that common minke whales from the WSP and WSA in the Southern Hemisphere are phylogenetically separated, which could have taxonomic implications that should be further examined in the future. As demonstrated above, the genetic and non-genetic analyses conducted by or in collaboration with the ICR contributed largely to advance in the clarification of the taxonomic status of minke whales agreed currently by the international scientific community and in addition, evidenced new scientific challenges that should be addressed in future.

ONGOING AND FUTURE STUDIES

Further genetic analyses of minke whales from different oceanic basins should be conducted based on mitochondrial sequences and nuclear markers (microsatellite DNA), with emphasis on the southern common minke whales. While samples of this sub-species from the WSP (mainly JARPA samples) and WSA (Brazilian and Chilean samples) have been analyzed suggesting phylogenetic differentiation between the two oceanic basins, further analyses from other localities, e.g. South Africa should be conducted. On this regard, some few samples from the South African common minke whale are being analyzed currently. These genetic analyses should be complemented with additional morphological and morphometric analyses based on available data from the North Atlantic and Brazilian common minke whales. New genetic approaches such as Whole Genome Sequencing (WGS) should be used to investigate minke whale differentiation and genes responsible for local adaptation.

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Technical Reports of the Institute of Cetacean Research (2025) pp. 8–13

Technical Report (not peer reviewed)

Overview of the acoustic studies on large whales conducted by the Institute of Cetacean Research: Case study of fin whales off northern Japan

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ABSTRACT

The Institute of Cetacean Research (ICR) initiated passive acoustic monitoring (PAM) as a pilot study to address observational gaps of large whales in northern Japan during boreal winter months when weather conditions constrain visual surveys from specialized vessels. This paper presents the results of a pilot study focused on fin whale (*Balaenoptera physalus*). The occurrence of this species in northern Japan was investigated using autonomous acoustic recorders deployed in Ōhata, Aomori Prefecture, from 26 November to 25 December 2024. A total of 4,567 fin whale calls were detected, showing pronounced nighttime activity (18:00–08:00). The results of this pilot study demonstrated PAM's effectiveness for detecting the occurrence of large whales in winter in northern Japan. Further studies are planned to evaluate the feasibility of this approach to estimate whale density.

INTRODUCTION

The Institute of Cetacean Research (ICR) has been conducting long-term monitoring of cetacean populations in the North Pacific Ocean to contribute to the scientific understanding and resource management of the large baleen whale species (Tamura *et al.*, 2017). Dedicated sighting surveys by specialized vessels are valuable for estimating abundance and investigating their distribution. However, visual survey faces significant limitations during autumn and winter months in the North Pacific due to adverse weather conditions, limited daylight hours, and sea state constraints (Katsumata and Matsuoka, 2021). To address these observational gaps and enhance the temporal coverage of the large baleen whale species monitoring, the ICR has initiated passive acoustic monitoring (PAM) as a pilot study to investigate the feasibility of this approach to complement the routine visual surveys by research vessels.

Previous PAM studies in Japanese coastal waters have demonstrated the potential of this approach for acoustic detection of baleen whales. For example, low-frequency fin whale calls have been detected by seafloor cabled seismic networks and regional broadband sensors (Nishida *et al.*, 2016; Sugioka *et al.*, 2015), including areas near the Pacific coast of northern Japan. While these systems offer high temporal resolution and sensitivity in low-frequency bands, they are primarily designed for geophysical monitoring and thus lack the species-specific detection capabilities, deployment flexibility, and data accessibility needed for targeted ecological studies. To complement the long-term monitoring of baleen whale species by visual surveys, the ICR conducted a pilot passive acoustic monitoring survey in Ōhata, Aomori Prefecture, Japan, from late November to late December 2024. In this paper, we report on the results of the pilot study.

The pilot study was focused on fin whales (*Balaenoptera physalus*). This species produces a distinctive vocal repertoire that includes low-frequency (~20 Hz) downswept pulses and occasional mid-frequency (~130 Hz) upsweep calls. The 20-Hz pulses—often referred to as "20-Hz calls" or "notes"—are short (typically <1 s) and highly stereotyped, occurring in regular sequences that can propagate over tens to hundreds of kilometers in the ocean due to their low-frequency nature and high source levels (Širović *et al.*, 2007; Watkins, 1981; Watkins *et al.*, 1987). These calls are commonly made by males and are considered to play a role in reproductive and long-range communication(Clark and Ellison, 2004; Croll *et al.*, 2002; Watkins *et al.*, 1987). Their detectability and consistency make fin whales particularly well-suited for PAM studies. Accordingly, in the North Pacific, PAM-based studies have successfully documented fin whale vocal activity in remote or harsh environments such as the Bering Sea, Gulf of Alaska, and southern Chukchi Sea (Delarue *et al.*, 2009; Furumaki *et al.*, 2021; Stafford *et al.*, 2007; Tsujii *et al.*, 2016), and more broadly in the Southern Ocean(Leroy *et al.*, 2016).

MATERIALS AND METHODS

Data Collection

Between 26 November and 25 December 2024, we deployed a passive acoustic recorder (AUSOMS-mini Plus, model AQM-0007; AquaSound Inc., Japan) in the coastal waters off Ōhata, Aomori Prefecture, Japan, to monitor the vocal activity of fin whales. The hydrophone was installed on the continental shelf at a depth of 29.2 meters, and its location (41°34′55.92″N, 141°13′4.08″E) is shown in Figure 1.

The deployment procedure and the acoustic recorder unit are illustrated in Figures 2 and 3, respectively. The recording system was deployed using a subsurface mooring configuration arranged by a commercial contractor. The system was designed to ensure recording stability and minimize flow noise during the observation period. The AUSOMS-mini Plus operated in continuous mono recording mode at a sampling rate of 48 kHz. The hydrophone featured a frequency response range of 10 Hz to 20 kHz and a receiving sensitivity of −193 dB re 1 V/μPa. Calibration was performed prior to deployment in accordance with the manufacturer's specifications.

The recording was conducted in two consecutive phases. The first phase lasted from 26 November to 25 December 2024, totaling 339 hours, 29 minutes, and 57 seconds. The second phase spanned from 10 to 25 December 2024, totaling 363 hours, 33 minutes, and 29 seconds. A hydrophone replacement was carried out between the two phases, resulting in a recording gap of approximately two hours. The procedure was performed to minimize interruption of acoustic data acquisition. All recordings were successfully retrieved for subsequent analysis.

The collected acoustic data were processed with a focus on the low-frequency components, characteristic of fin whale vocalizations. As part of the preprocessing, the data were downsampled to 500 Hz and subjected to a band-pass filter at 15 Hz to 40 Hz that eliminated low and middle frequency background noise. Subsequent analyses aimed to detect ~20 Hz pulses (approximately 17–30 Hz) as previously described by Watkins *et al.* (1987) and Širović *et al.* (2007).

Data analysis

Spectral analysis was conducted in a two-step process to effectively identify and characterize fin whale vocaliza-

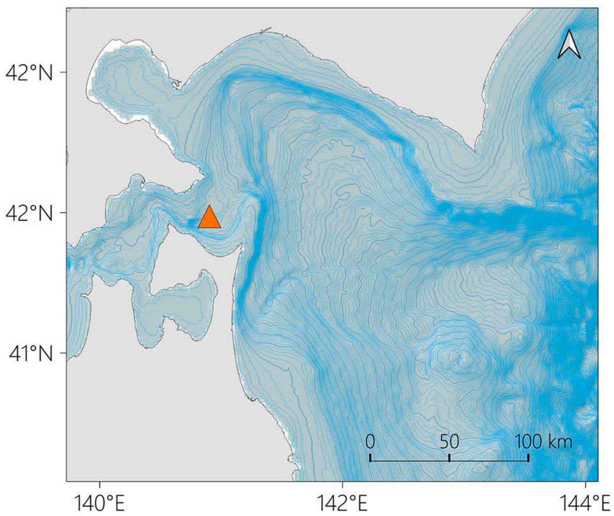

Figure 1. Map of the study area showing the deployment location of the passive acoustic recorder (AUSOMS-mini Plus, model AQM-0007; AquaSound Inc., Japan) in the coast of Ōhata, northern Japan. The recorder was moored at a depth of 29.2 meters on the continental shelf (41°34′55.92″N, 141°13′4.08″E), as indicated by the orange triangle.

Figure 2. Deployment of the AUSOMS-mini Plus passive acoustic recorder in Ōhata, Aomori Prefecture, Japan. The recorder was lowered from a research vessel and installed at a depth of 29.2 meters using a mooring configuration.

Figure 3. Close-up view of the AUSOMS-mini Plus recorder before deployment. The unit is enclosed in a protective frame and equipped for subsurface mooring.

tions. First, long-term spectral averages (LTSAs) were generated using TRITON, a custom MATLAB-based software developed by Scripps Institution of Oceanography, CA, US (Wiggins and Hildebrand, 2007). These LTSAs provided an overview of the temporal distribution and frequency ranges of prominent acoustic signals over multi-hour to multi-day time scales, enabling efficient identification of time windows likely to contain fin whale calls. Based on the LTSA results, segments containing potential vocalizations were subjected to detailed analysis using Avisoft-SASLab Pro (ver. 5.2.09; Avisoft Bioacoustics, Berlin, Germany). Prior to analysis, a band-limited filter was applied to isolate the frequency range of interest (typically 17–30 Hz for fin whale 20 Hz calls). The detection threshold was set to −14 dB relative to the maximum, with a minimum hold time of 20 ms, ensuring consistent element separation and reducing false detections.

For each detected pulse, spectral parameters such as peak frequency, minimum and maximum frequency, bandwidth, and peak amplitude were automatically extracted. Temporal parameters including element duration and inter-call interval were also computed.

Spectrograms were computed using a 1024-point fast Fourier transform (FFT) with a Hamming window and 87.5% overlap, yielding a frequency resolution of 1 Hz and temporal resolution of approximately 10.7 milliseconds. This configuration was selected to optimize detection of short-duration low-frequency signals. The temporal distribution of calls was visualized as heatmaps using Python (JupyterLab v4.3.1) and the ggplot2 package (Gómez-Rubio, 2017), allowing for the identification of diel and day-scale variability in vocal activity.

RESULTS

Acoustic identification of fin whale calls

Representative spectrograms extracted from the dataset (Figure 4) displayed repeated low-frequency pulses around 20 Hz occurring at regular intervals—an acoustic pattern widely recognized as characteristic of fin whale vocalizations (e.g., Moore *et al.*, 1998; Širović *et al.*, 2007). Although the spectrogram alone does not conclusively determine species identity, the observed regularity in both frequency and temporal spacing provided preliminary evidence supporting classification as fin whale calls.

To validate this interpretation, we conducted quantitative analyses of the detected signals′ acoustic features. First, the distribution of peak frequencies was tightly clustered around 18.7 Hz, with most values falling between 15 and 25 Hz, matching the well-documented spectral characteristics of fin whale calls reported in earlier studies (e.g., Moore *et al.*, 1998; Širović *et al.*, 2007; Tsujii *et al.*, 2016). This distribution is visualized in Figure 5a. In addition, the calls exhibited short durations, with a median of approximately 0.7 seconds, and a strongly right-skewed distribution (range: 0.2–2.0 s). This duration profile was well-approximated by a Weibull probability density function, as shown in Figure 5b, consistent with previously reported pulse durations for fin whale signals. Furthermore, the inter-call intervals (ICIs) ranged from 10 to 60 seconds, with a mode near 15 seconds, and a long-tailed distribution pattern. This structure is shown in Figure 5c, and it reflects the rhythmic repetition that is characteristic of fin whale stereotyped song sequences.

The results of the acoustic survey were corroborated by visual confirmation of fin whale presence in the same region during a ship-based sighting survey conducted in the autumn of 2019 (October–November), as reported by Katsumata and Matsuoka (2021). This independent visual record serves as external validation for attributing the recorded vocalizations to fin whales. In addition to the strong agreement of acoustic features—such as frequency, duration, and inter-call interval—with established characteristics of fin whale calls, the spectrograph-

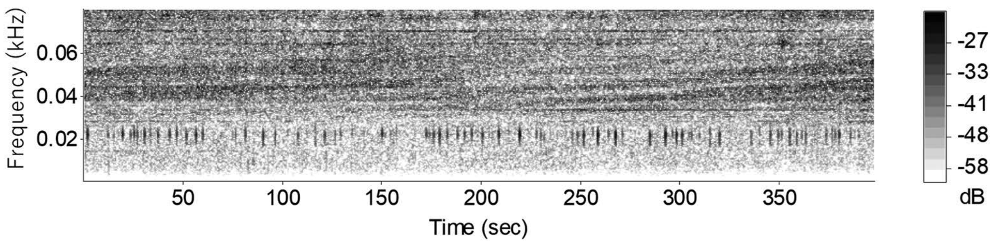

Figure 4. Long-duration spectrogram of fin whale calls recorded off Ōhata, Aomori Prefecture, Japan, in winter 2024. Spectral analysis was performed using a 1024-point Fast Fourier Transform (FFT) with a Hamming window, 75% overlap, and a frame advance of 100 samples. Repeated low-frequency pulses (~20 Hz) with regular spacing are visible throughout the 6-minute segment, characteristic of fin whale stereotyped song patterns.

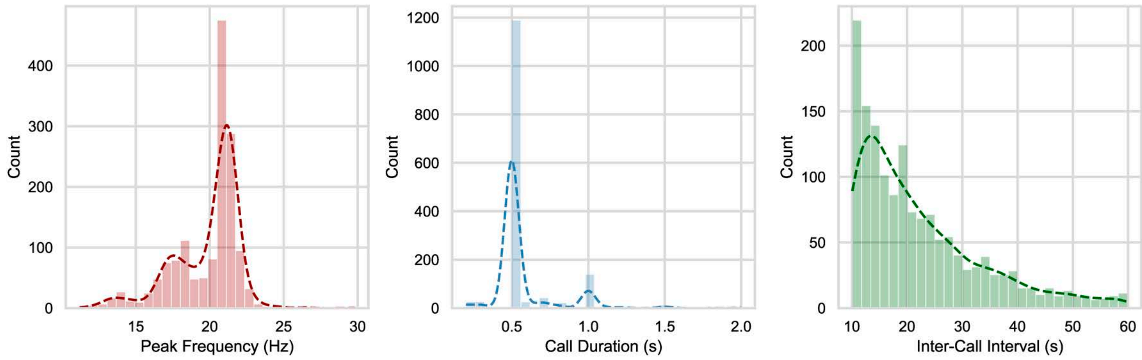

Figure 5. Distributions of acoustic parameters for detected fin whale 20 Hz pulses. (a) Peak frequency (Hz): the majority of calls exhibited peak frequencies clustered around 18.7 Hz, consistent with known fin whale vocalizations; (b) Call duration (s): most pulses were short in duration, with a median of 0.7 s and values typically falling between 0.2 and 2.0 s; (c) Inter-call interval (s): temporal spacing between calls ranged from 10 to 60 s, with a mode near 15 s, reflecting stereotyped rhythmic sequences. All histograms are overlaid with kernel density estimation (KDE) curves to illustrate overall distribution shape.

ic analysis and corresponding visual observations further reinforce this conclusion, providing robust evidence for identifying the detected vocalizations as those produced by fin whales.

Temporal distribution of fin whale calls

During the initial recording period from 26 November to 25 December 2024, a total of 4,567 fin whale calls were detected, revealing pronounced diel variability in vocal activity. Hourly detection counts indicated discrete periods of heightened acoustic activity, with particularly elevated call rates (>300 detections per hour) observed during the evening to early morning hours (18:00–08:00) on 7, 9, 10 and 11 December (Figure 6). These nocturnally concentrated call bouts may reflect diel patterns in behavioral states such as social interaction or foraging, or alternatively, improved acoustic transmission conditions during nighttime. Transient daytime peaks detected on 4 and 5 December further suggest that vocal activity was not strictly restricted to nocturnal periods.

DISCUSSION

Acoustic monitoring as a complementary approach to visual surveys

A total of 4,567 fin whale calls were detected between 26 November and 25 December 2024, providing robust acoustic evidence of the species′ presence in the coastal waters off northern Japan during the boreal winter. This finding is further supported by ship-based visual sightings recorded in the same region during the autumn of 2019 (October–November), as reported by Katsumata and Matsuoka (2021). Their results indicate that fin whales utilized the coastal waters of northern Japan during the autumn season, lending additional support to the interpretation that this area serves as an important seasonal habitat for the species.

Our observations also recorded vocalizations from species other than fin whales and advancing species identification represents a future challenge. Long-term monitoring through PAM has been widely applied to investigate the seasonal and diel distribution patterns, migratory routes, population structure, and reproductive and social behaviors of cetaceans (Delarue *et al.*, 2009; Leroy *et al.*, 2016; Stafford *et al.*, 2007). Around the coast of Japan, it is necessary to increase the number of observation sites and conduct monitoring of species whose migration patterns are poorly understood.

In recent years, methods have been developed to adapt PAM to distance sampling for density estimation (Marques *et al.*, 2013). To advance from a qualitative presence/absence assessment of fin whales to a quantitative estimation of their population density, several technical challenges must be addressed: i) the source level distribution of 20-Hz pulses produced by fin whales in Japanese waters remains poorly characterized. Acoustic tagging efforts (e.g., Stimpert *et al.*, 2015; Watkins *et al.*, 1987) are expected to provide essential baseline data to address this gap; ii) converting detected calls into individual whale counts requires reliable estimates of how frequently a single whale produces vocalizations (e.g., Marques *et al.*, 2013); and iii) accurate modeling of sound attenuation in shallow environments such as continental shelves and slopes is crucial for estimating the effective detection range and probability of calls (e.g., Mellinger *et al.*, 2007).

To address the components above, the ICR is testing the development and deployment of archival acoustic tags. Figs. 7 and 8 show the designed acoustic tag and its

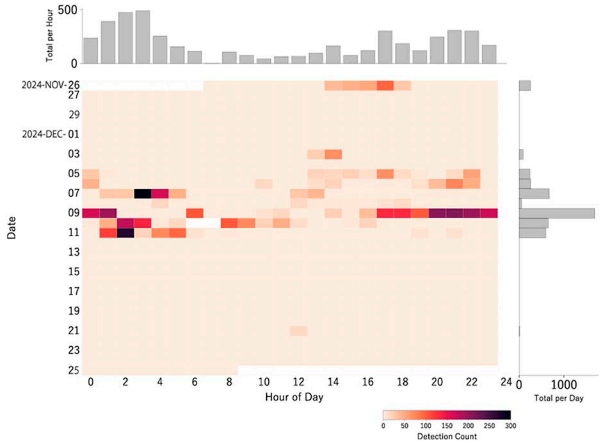

Figure 6. Hourly heatmap of fin whale call detections recorded in Ōhata, Aomori Prefecture, Japan, from 26 November to 25 December 2024. The x-axis indicates the hour of day (0–24), and the y-axis represents the calendar date. Color intensity reflects the number of detections per hour, with a notable concentration of vocal activity during nighttime hours. The bar plots above and to the right of the heatmap show the total number of detections per hour and per day, respectively. White gaps in the heatmap indicate periods of recorder replacement or data loss.

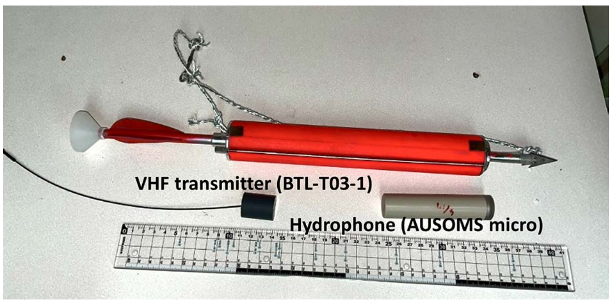

Figure 7. The acoustic tag designed and developed by the ICR. A VHF transmitter (BTL-T03-1, Circuit Design Inc.) is mounted for recovery purposes. The hydrophone uses AquaSound Inc.'s AUSOMS micro.

Figure 8. Acoustic tag deployment on a fin whale off Abashiri, May 2024. The tag was recovered 2 hours post-attachment.

deployment to fin whales. Once source-level estimation and calling rate quantification are established through acoustic tag deployment, distance sampling-based density estimation can be implemented. Another promising approach is the Spatially Explicit Capture–Recapture (SECR) method, which estimates animal density by modeling the spatial distribution of detections relative to sensor locations, and we plan to work on density estimation using this method in the future.

Temporal clustering and behavioral inference

Hourly detection trends revealed a pronounced diel rhythm in fin-whale vocal activity. Call counts were strongly concentrated during the night–early-morning period (18:00–08:00), and on 7, 9, 10 and 11 December hourly detections exceeded 300 calls. Similar nocturnal predominance has been reported elsewhere in the North Pacific (Širović *et al.*, 2015; Watkins *et al.*, 1987). Three non-mutually exclusive mechanisms may underline this pattern: i) endogenous behavioural rhythms associated with nocturnal foraging or social communication; ii) enhanced low-frequency propagation after sunset owing to changes in the sound-speed profile or reduced background noise; and iii) acoustic preference or timing of intra-specific information exchange restricted to specific hours.

Daytime detection bursts on 4 and 5 December indicate that calling is not exclusively nocturnal. Such unequal temporal distribution could also reflect transient aggregations of migrating animals or local environmental variability—e.g. prey density, water-column temperature structure or tidal flow. Because the present time series is relatively short and call samples are limited, a quantitative assessment of the ecological drivers is therefore premature.

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Technical Reports of the Institute of Cetacean Research (2025) pp. 14–17

Technical Report (not peer reviewed)

Research activities on small cetaceans in the Taiji Office of the Institute of Cetacean Research in the 2024/25 season

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ABSTRACT

In the spring of 2024, the Institute of Cetacean Research (ICR) established a new facility in Taiji, Wakayama Prefecture, to replace its Ayukawa laboratory, Miyagi Prefecture, which had been forced to cease operations due to the Great East Japan Earthquake. Following the establishment of a new research facility in Taiji, a locality with a longstanding historical affiliation with whaling, the ICR initiated a series of feasibility studies targeting small cetacean species. This report presents two major initiatives conducted during the 2024/25 season as part of the feasibility studies undertaken at the newly established facility. The first study investigated the school structure and movement of small cetaceans targeted by the drive fisheries in Taiji. Comprehensive data collection included measurements, biopsy sampling, photo-identification, tagging, and satellite telemetry, which provided insights into short-term movements. These efforts aim to clarify small cetaceans′ school cohesion, reproductive status, and ecological traits for improved resource management. The second study focused on developing bycatch prevention devices for set nets. Using captive dolphins, visual, tactile, and acoustic deterrents were tested. While some effectiveness was observed, rapid habituation underscored the need for refinement. These studies highlight the Taiji Office of the ICR′s role in advancing scientific understanding and practical tools to promote sustainable management of small cetacean populations and coexistence with coastal fisheries.

INTRODUCTION

The Institute of Cetacean Research (ICR), established in 1987, is a non-profit organization that conducts scientific research on whales and other marine mammals to support proper resource management. The background to the establishment of the ICR was the moratorium on commercial whaling adopted by the International Whaling Commission (IWC) in 1982. The Moratorium was adopted by the IWC to address concerns regarding the lack of scientific knowledge at the time, and it was stated that further scientific research on cetaceans was necessary before commercial whaling could resume. Therefore, ICR had implemented several whale research programs under special permit in the Antarctic Ocean and the western North Pacific Ocean, as planned by the Japanese government. Since the resumption of commercial whaling in 2019, the ICR has expanded its activities beyond resource management research to include efforts aimed at improving the efficiency of Japan′s whaling industry and increasing the added value of whale meat products.

Under these circumstances, ICR established a new facility in Taiji, Wakayama Prefecture, in the spring of 2024 to replace its Ayukawa laboratory, Miyagi Prefecture, which had been forced to cease operations following the Great East Japan Earthquake. The Taiji Office is on the International Cetacean Center (a two-story steel-frame building with a total floor area of 1,880 m^2), developed by Taiji Town. As a research facility, it is equipped with laboratories and facilities for genetics, chemistry, biochemistry, biology, ecology and other fields, and possesses much of what is necessary for land-based research contributing to resource management. The laboratories for genetics, chemistry, biochemistry and biology that were already in place at the Tokyo office were relocated to the Taiji office upon its opening, where experimental activities have begun.

The operations of the Taiji Office can be broadly categorized into two primary domains. The first encompasses research activities conducted under the institutional objectives of the ICR, which have traditionally been carried out at the Tokyo Office. These activities are particularly focused on laboratory-based investigations and include the Genetic Laboratory, the Biochemistry Laboratory, and the Cetacean Biology Laboratory. Additionally, certain components of the Population Dynamics Laboratory, which incorporate field surveys, are also included. Ancillary functions such as library management and public outreach are likewise part of this domain. In addition to these Tokyo-based research initiatives, the Taiji Office has recently commenced new projects that reflect its unique geographical and cultural context. Situated in Taiji Town, a region historically and economically linked to cetaceans, the office has begun addressing emerging issues related to the management of small cetacean resources and their interactions with local fisheries. This report aims to introduce and outline these newly initiated research themes at the Taiji Office.

Here, we introduce the two research activities on small cetaceans (a study on small cetacean school structure and movement, and the development of bycatch prevention devices) conducted over the past two years since the establishment of this new research facility.

Study on small cetacean school structure and movement in Taiji

Drive fisheries targeting dolphins in Taiji Town are conducted under the authorization of the Governor of Wakayama Prefecture and encompass nine species of small cetaceans. Many of these species form large schools ranging from tens to over a thousand individuals in offshore waters. Biological investigations have been conducted on specimens obtained through drive fisheries, alongside sighting surveys using research vessels to estimate abundance. In recent years, non-lethal methodologies such as satellite tagging and biopsy sampling have been increasingly employed to investigate movement ecology, stock structure, and reproductive cycle. Regarding small cetacean school composition, previous studies have shown that in striped dolphins (*Stenella coeruleoalba*), school structure varies according to sex, growth, and sexual conditions (Miyazaki and Nishiwaki, 1978). However, comprehensive research on school composition, social associations, and life history traits remains limited, particularly in the context of collective behavior and social structure. For gregarious small cetacean species, information on school structure and social bonds is critically important from the perspective of resource management and conservation.

The primary objective of this study was to establish a methodological framework for collecting biologically and ecologically relevant data from entire dolphin schools captured in drive fisheries, to contribute to the future management of small cetacean populations. Specifically, the study focused on implementing a comprehensive data collection protocol that included attaching identification tags to all individuals within a dolphin school, external observation for body length measurement and sex determination, biopsy sampling of blubber and skin tissues, photographic identification for natural markings, and the deployment of satellite telemetry devices to monitor post-release movements.

In the 2024/25 season, a total of 98 individuals from four schools of three small cetacean species— Risso's dolphins (*Grampus griseus*), Rough-toothed dolphins (*Steno bredanensis*), and pantropical spotted dolphins (*Stenella attenuata*)—which had been driven by dolphin fishing operations in Taiji, were subjected to the following procedures: body length measurement, sex determination, photographic identification of natural markings, biopsy sampling, and attachment of identification tags (Figure 1).

In addition, satellite tags (Figure 2) were also attached to two individuals to collect geolocation data. After these procedures, all individuals were released offshore. All procedures were conducted under the supervision of a licensed veterinarian. Location data were obtained from satellite tags deployed on one Risso's dolphin and one pantropical spotted dolphin, and tracking signals were received over 10 and 9 days, respectively (Figure 3).

In the future, genetic and stable isotope analysis

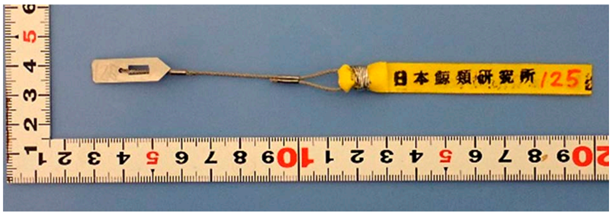

Figure 1. Identification tag for dolphins.

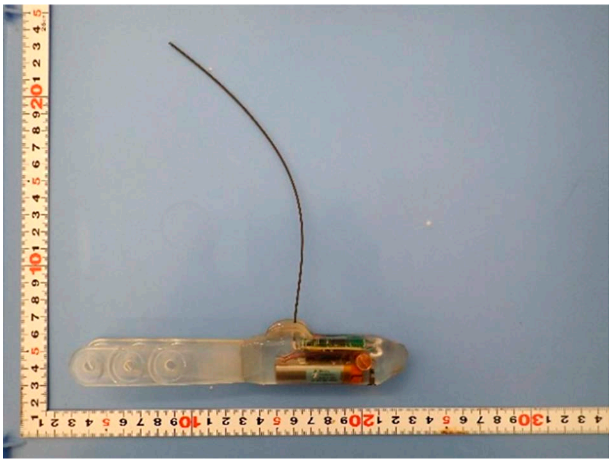

Figure 2. Satellite tag (SPOT-399, Wildlife Computers Inc.) used for dolphin tracking research.

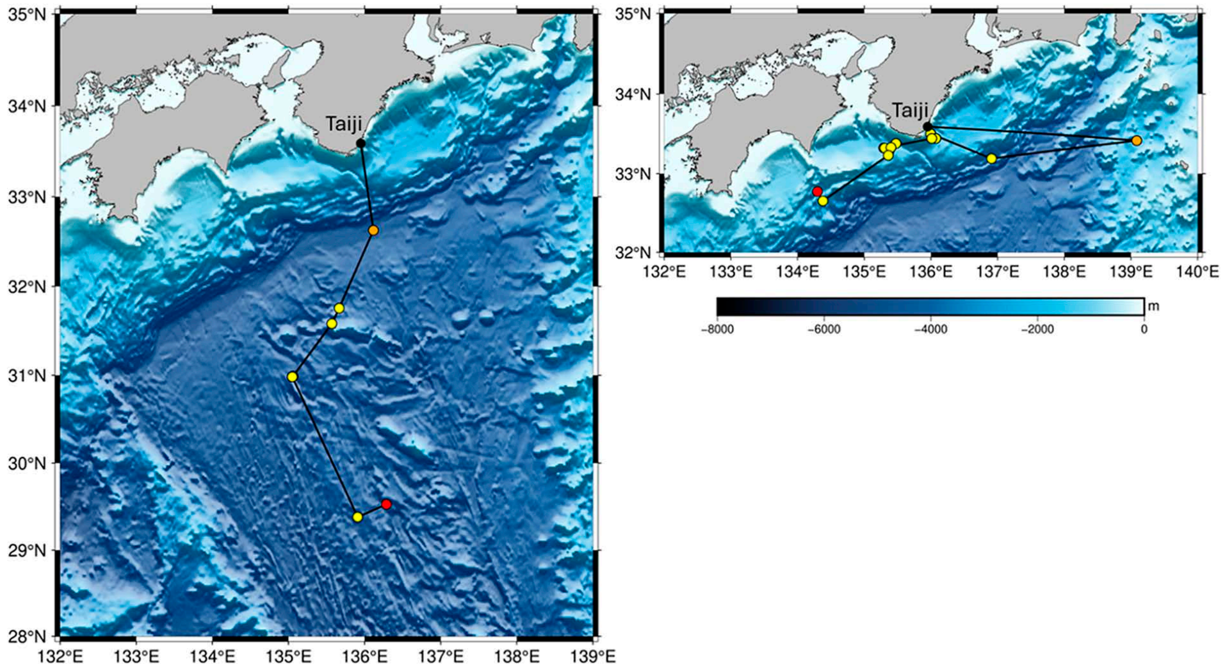

Figure 3. Locations and tracking data obtained by satellite tags of a Risso's dolphin (left: 10 days) and a pantropical spotted dolphin (right: 9 days) released from Taiji Port in the 2024/25 survey. The orange circle indicates the first signal location, red indicates the final signal location, and yellow indicates the position between orange and red.

will be conducted to identify stocks and clarify parent-offspring relationships, and diet. Also, sex hormones will be analyzed to determine sexual maturity and seasonality of breeding for understanding the reproductive status and school structure of individuals. If tagged individuals are recaptured after release, biological information on the school will be collected to clarify the school's cohesion and social structure. Furthermore, the relationship between location and movement data from satellite tags and oceanographic data such as sea surface temperature will be analyzed to deeply understand the ecology of these small cetaceans. Continuing these surveys can be expected to deepen our understanding of the life cycle of small cetaceans migrating off Taiji and contribute to improving resource management strategies.

Development of bycatch prevention devices

In recent years, there have been frequent incidents of cetaceans straying into set nets, causing disruptions to fisheries operations. Once inside the nets, these animals damage the catch and cause physical harm to the fishing gear. In particular, the damage caused by the intruding animals eating the catch results in severe economic losses. To address this problem, efforts have been made to develop fishing gear that prevents cetaceans from approaching or entering nets, as well as to design deterrent devices using firecracker sounds (Iwasaki, 2009), however, neither approach has proven to be a sufficient solution. Accordingly, this study conducted experiments to develop a deterrent device that affects cetaceans' vision, touch, and hearing (acoustics), with the aim of reducing bycatch by preventing their entry into set nets. The experiments were carried out using captive small cetaceans, six bottlenose dolphins (*Tursiops truncatus*) and three Risso's dolphins, kept in Moriura Bay, Taiji.

An experimental platform was constructed to evaluate the effectiveness of the deterrent devices (Figure 4). The platform connected the rearing and feeding pens (each 12 m square), with a net stitched between the rearing and feeding pens, and weights were used to open and close a passageway that allowed small cetaceans to move between the pens. The deterrent devices were installed in this passageway, and cetacean movements during feeding times, as well as the frequency of their entries into the feeding areas were observed. For comparison, control experiments were also conducted without the deterrent devices.

Three types of deterrent devices were tested: (1) a light-reflecting spiral-type blind, (2) a spiked-type blind designed to provide visual and tactile deterrence, and (3) five types of acoustic stimuli delivered through an underwater speaker (Figure 5). Each trial lasted 30 minutes and was repeated for up to five consecutive days. These experiments investigated whether the cetaceans

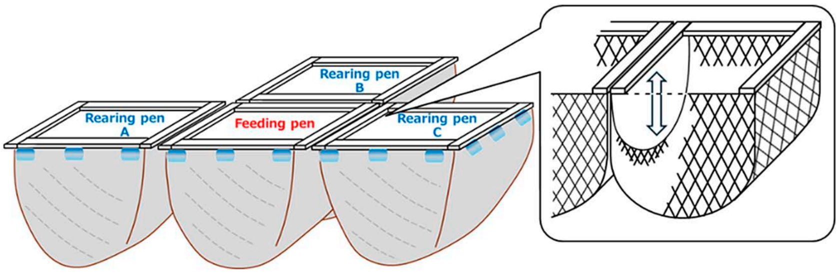

Figure 4. The experimental platform used to evaluate the effectiveness of the deterrent devices. It was configured to allow controlled opening and closing between the rearing and feeding pens via a rope equipped with a weight.

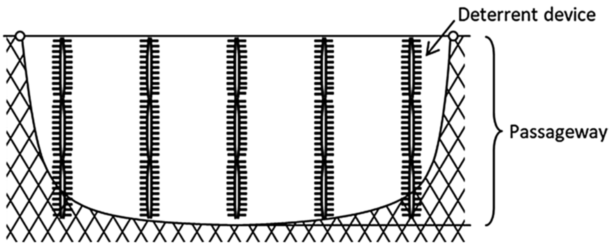

Figure 5. Schematic diagram of a deterrent device (spiked-type blind) installed on the passageway of the experimental platform used to evaluate the effectiveness of the deterrent devices.

exhibited aversion behavior toward each deterrent device and whether they became habituated to them. All experiments were conducted under the supervision of a veterinarian.

The results of the 2024/25 experiments showed that each type of deterrent device demonstrated some effectiveness. Compared with trials without deterrent devices, the number of passages through the spiked-type blind device was lower than through the spiral-type blind (52% vs. 86% of control levels). Similarly, the number of passages decreased by 68% when the acoustic deterrents were used compared with no sound. However, habituation occurred rapidly, in several cases, cetaceans initially avoided the deterrent device but passed through the gate without hesitation on the following day. These findings indicate that further refinement and improvement of deterrent devices are necessary. Future experiments will continue to use the established experimental platform to advance the development of effective bycatch prevention technologies.

CONCLUDING REMARKS

Following the establishment of a new ICR office in Taiji, a town with a long historical association with cetaceans, two new research initiatives on small cetaceans have been launched: school structure and movement of small cetaceans targeted by the drive fisheries and development of bycatch prevention devices for set nets. Although these initiatives are still in their preliminary phases, further investigation is being planned. These efforts are consistent with the ICR's longstanding commitment to contributing to the sustainable management of cetacean populations. The ICR will continue to actively address future research needs and respond to emerging issues.

ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to the Taiji Fisheries Cooperative, the Isana Union, and the Taiji Municipal Development Corporation for their generous cooperation in the surveys and experiments. We also extend our appreciation to the members of the Taiji Office and the staff of the ICR for their participation and support during the experimental procedures. We thank Luis A. Pastene (ICR) for his assistance in preparing this document and the Editorial Team of TEREP-ICR for editorial work.

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Technical Report (not peer reviewed)

Recent progress in studies of the stock structure of western North Pacific common minke whales

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ABSTRACT

This paper outlines recent progress in studies of the stock structure of western North Pacific common minke whales (*Balaenoptera acutorostrata*), focusing on analyses based on the GENELAND framework. The motivation to focus on GENELAND is that results of this approach in 2019 suggested a new stock structure hypothesis different from those currently accepted by the IWC Scientific Committee (a J stock primarily west of Japan and an O stock primarily east of Japan, with spatial mixing along the Pacific coast of Japan and the southern coastal Okhotsk Sea) as having high plausibility. This new hypothesis included an additional coastal stock (P stock) in those coastal regions, which consists of two genetic clusters inferred by GENELAND. Results from recent analyses suggest that inferences from GENELAND under a spatial model are not very robust for ICR's dataset. These results also indicate that the inference of the existence of a P stock likely resulted from over-splitting the mixing zone (i.e., sub-areas 2C, 7CS, 7CN, and 11), which is known for spatial mixture between two distinct stocks (the J and O stocks), into more coastal (and primarily J) and more offshore (and primarily O) components. These components would represent J-affiliated and O-affiliated genetic groups rather than a single distinct population.

INTRODUCTION

In the western North Pacific, at least two stocks of the common minke whale have been recognized: (1) the Okhotsk Sea–West Pacific (known as the O stock), and (2) the Sea of Japan–Yellow Sea–East China Sea (known as the J stock). They are distinguished morphologically and reproductively (e.g., Omura and Sakiura, 1956; Kato, 1992), and genetically (e.g., Wada and Numachi, 1991; Goto and Pastene, 1997). In the context of management, many genetic analyses have been conducted, as reviewed by Pastene *et al.* (2022). Figure 1 shows the International Whaling Commission Scientific Committee (IWC SC)'s management sub-areas for western North Pacific common minke whales.

In 2019, the IWC SC reviewed the available genetic and non-genetic information and proposed three stock structure hypotheses for western North Pacific common minke whales (IWC, 2020):

Hypothesis A: there is a single J stock distributed in sub-areas 1W, 1E, 2C, 5, 6W, 6E, 7CS, 7CN, 10W, 10E, 11 and 12SW, and a single O stock in sub-areas 2C, 2R, 3, 4, 7CS, 7CN, 7WR, 7E, 8, 9, 9N, 10E, 11, 12SW, 12NE and 13;

Hypothesis B: as for hypothesis A, but there is a third stock (Y) that resides in sub-area 1W, 5 and 6W and overlaps with J stock in the southern part of sub-area 6W; and

Hypothesis E: there are four stocks, referred to Y, J, P, and O, two of which (Y and J) occur to the west of Japan, and only three of which (J, P, and O) are found to the east of Japan and in the

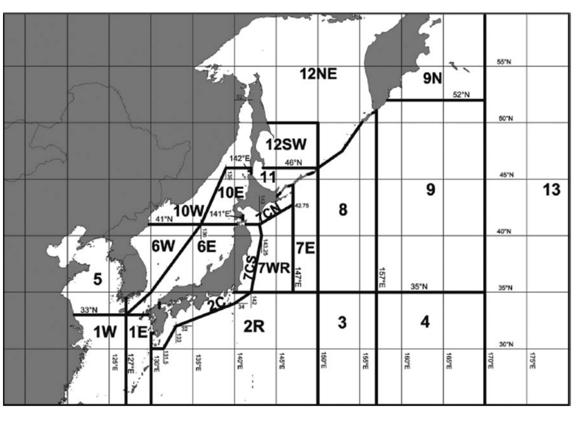

Figure 1. Management sub-area defined by IWC SC for western North Pacific common minke whales (IWC, 2020).

Okhotsk Sea. Stock P is a coastal stock.

The IWC SC assigned high plausibility to Hypotheses A and B. However, it agreed that the plausibility of Hypothesis E could not be evaluated until the results of the conditioning process (fitting the associated population model to the time series of abundance and related demographic data available) became available and simultaneously recommended several further analyses before plausibility could be assigned to this hypothesis (IWC, 2020).

Hypothesis E was based on preliminary genetic analyses (de Jong and Hoelzel, 2019) using the spatially explicit Bayesian clustering program GENELAND (Guillot *et al.*, 2005), which divides the study area into K geographically coherent clusters and assigns each individual whale to one of them, based on multilocus genotypes and spatial coordinates. This analysis identified four genetic clusters in western north Pacific common minke whale (i.e., green, red, blue, and orange), and subsequent discussions led to the integration of the red and blue clusters into a single group termed purple (currently referred to as the P stock) (IWC, 2020). However, as noted above, the plausibility of Hypothesis E, which assumes the existence of the P stock, has not yet been evaluated, and further analyses were recommended (IWC, 2020).

In this report, I present an outline of recent progress in stock structure analyses of western North Pacific common minke whales, focusing on the GENELAND framework. The analysis presented here uses the same dataset as de Jong and Hoelzel (2019), which comprises microsatellite genotypes at 16 loci from 4,656 whales collected between 1994 and 2016. Hereafter referred to as the 'ICR's data set'.

ANALYTICAL PROCEDURES AND RESULTS

GENELAND results varied according to parameter settings

To explore the performance of the spatial model in GENELAND, which incorporates geographic coordinates into the clustering process, when applied to the ICR's dataset, one spatial baseline and several spatial and non-spatial variant analyses were performed, each with 5 or 10 replicates. The non-spatial model has been tested here for the first time. Table 1 summarizes the parameter settings and outcomes of each analysis. The spatial baseline run converged in only three out of ten replicates at K=4, where K denotes the number of clusters. Spatial variants (SpVar and SpFix series) showed similarly unstable con-

Table 1. Summary of GENELAND parameter settings and outcomes: 'npopmin'=lower bound of the number-of-clusters (K) search range; 'npopinit'=initial K value at the start of MCMC iterations; 'npopmax'=upper bound of the K search range; 'spatial'=whether spatial coordinates were used (TRUE) or not (FALSE); 'varnpop'=parameter specifying whether the K value is fixed (FALSE) or estimated by GENELAND (TRUE); 'seed'=random number seed used for each run; 'rep'=number of replicate runs; 'conv.'=number of converged runs; 'bestK'=most frequently supported K. The baseline parameter settings followed de Jong and Hoelzel (2019). Series highlighted were used in the subsequent analyses shown in Figures 2, 3, 5 and 6, and Figure 4, respectively: the blue series to examine the reproducibility and robustness of GENELAND results of de Jong and Hoelzel (2019), and the orange series to evaluate the influence of spatial information on the inference.

Series	npopmin	npopinit	npopmax	spatial model	varnpop	seed	rep	conv.	bestK
Baseline	1	7	7	TRUE	TRUE	101-110	10	3	4
SpVar1-5	1	1	7	TRUE	TRUE	101-105	5	2	2
SpVar3-5	1	3	7	TRUE	TRUE	101-105	5	5	3
SpVar5-5	1	5	7	TRUE	TRUE	101-105	5	2	4
SpVar7-5	1	7	7	TRUE	TRUE	101-105	5	2	4
SpFix2-10	2	2	2	TRUE	FALSE	101-110	10	4	—
SpFix3-10	3	3	3	TRUE	FALSE	101-110	10	7	—
SpFix4-10	4	4	4	TRUE	FALSE	101-110	10	5	—
NoSpVar7-10	1	7	7	FALSE	TRUE	101-110	10	10	7
NoSpVar2-10	1	2	7	FALSE	TRUE	101-110	10	10	2
NoSpVar3-10	1	3	7	FALSE	TRUE	101-110	10	10	3
NoSpFix2-10	2	2	2	FALSE	FALSE	101-110	10	10	—
NoSpFix3-10	3	3	3	FALSE	FALSE	101-110	10	10	—
NoSpFix4-10	4	4	4	FALSE	FALSE	101-110	10	10	—

vergence, and when GENELAND estimated K (vernpop= TRUE), the inferred values were inconsistent among runs and replicates, ranging from 2 to 4. In contrast, the non-spatial variants (NoSpVar and NoSpFix series) consistently converged in all runs and replicates, but the K search often remained fixed at the initial value (npopinit). These results indicate that the GENELAND analyses are sensitive to parameter settings, particularly under the spatial model, for the ICR's dataset.

Partial reproduction of the four GENELAND clusters by the baseline

The three converged spatial baseline replicates reproduced the four GENELAND clusters (Figure 2: red, green,

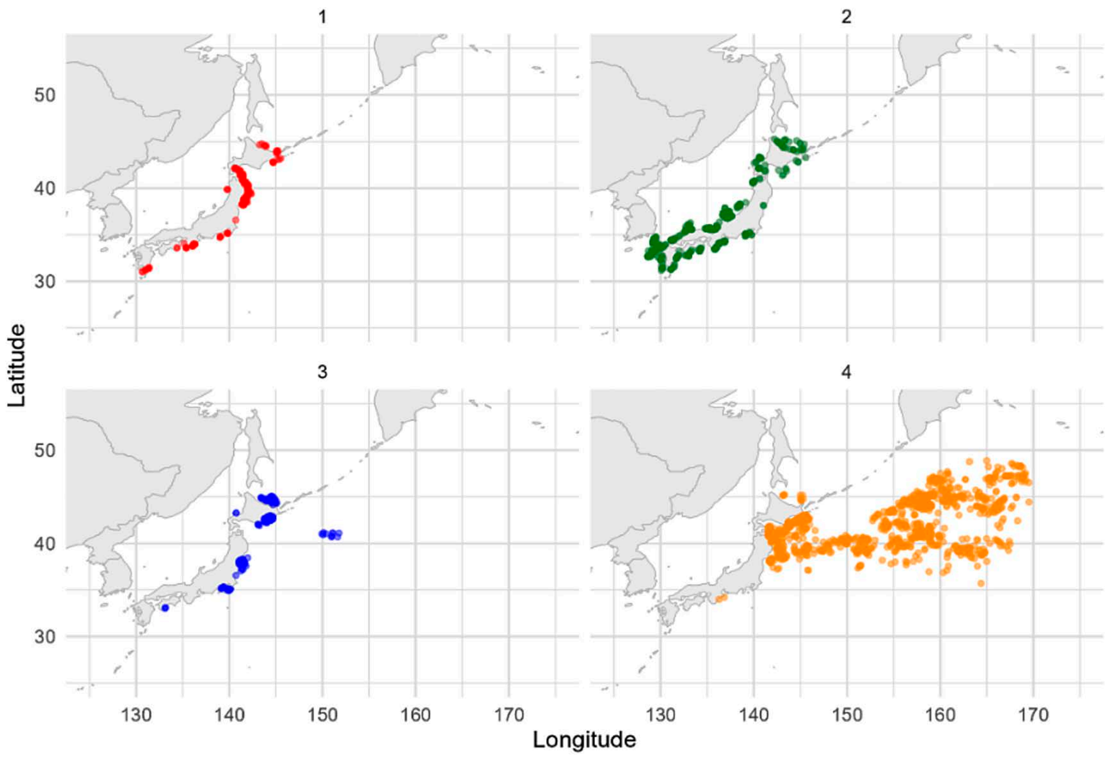

Figure 2. Geographic distributions of GENELAND clusters derived from the consensus *q* (average posterior assignment probability), defined as the average posterior assignment probability, across the three converged spatial baseline replicates.

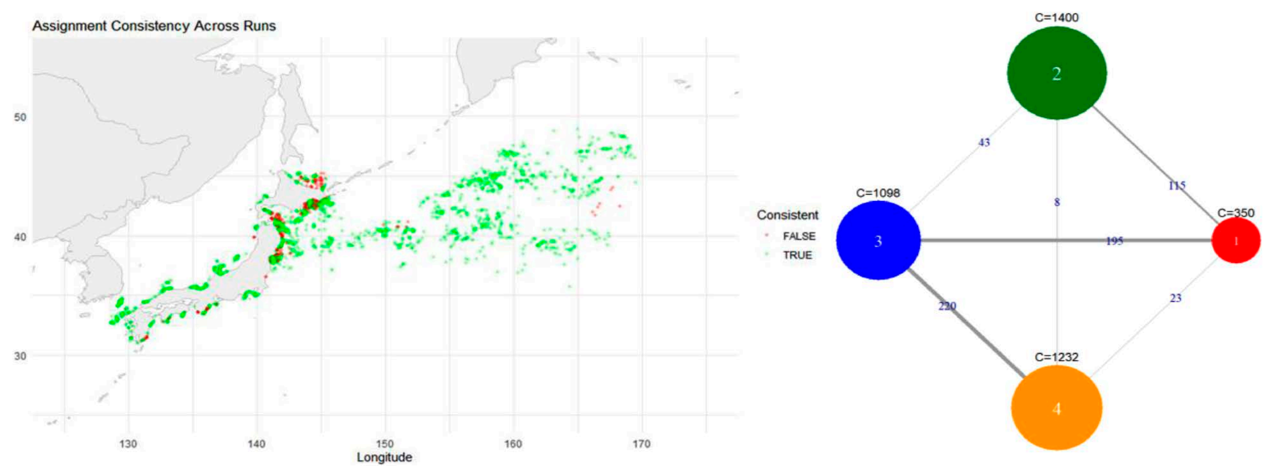

Figure 3. Cluster assignment agreement among the three converged spatial baseline replicates. In the network diagram, node indicates GENELAND clusters, and node size represents the number of consistently assigned to the respective cluster (C) across the replicates, and edge width and labels indicate the number of cross-assignments between clusters. Note that orange and green correspond O and J stocks, respectively.

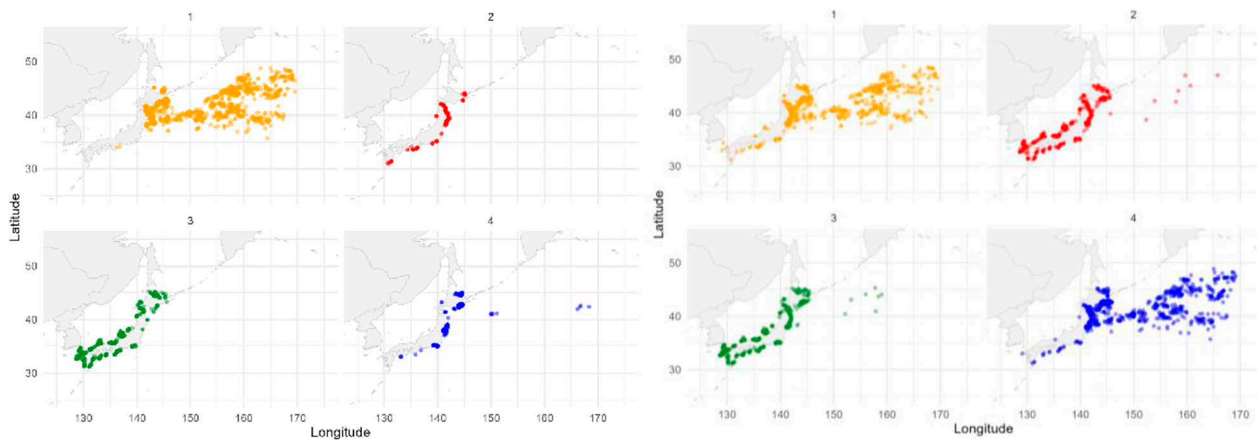

Figure 4. Geographic distributions of GENELAND clusters derived from the consensus *q* (average posterior assignment probability) across the converged spatial (SpFix4-10; left) and non-spatial (NoSpFix4-10; right) replicates, with K fixed at 4.

blue, orange) reported by de Jong and Hoelzel (2019), with the green and orange clusters corresponding to the J and O stocks, respectively.

Spatially structured disagreement in GENELAND cluster assignments

Figure 3 shows disagreements in cluster assignment across the three converged baseline replicates, which were concentrated in sub-areas 2C, 7CS, 7CN, and 11, where spatial mixtures of the J and O stocks are known to occur (hereafter referred to as the mixing zone). The network diagram showed that inconsistent assignments occurred mainly between specific clusters (i.e., between orange and blue, blue and red, or green and red). These results indicate that the observed disagreements are not random misassignments but rather reflect high uncertainty in the red and blue clusters.

Effect of spatial prior information on GENELAND clustering

Figure 4 shows geographic distribution patterns of clusters derived from spatial and non-spatial GENELAND variants when K was fixed at 4. Only the spatial model recovered red and blue clusters in the mixing zone, whereas the non-spatial model merged them into the J/O structure. Therefore, red and blue clusters appear to arise from spatial modeling assumptions rather than any strong genetic signal.

Over-partitioning of the J–O genetic axis

To examine whether the GENELAND K=4 clusters can be explained solely by the J–O genetic axis, Discriminant Analysis of Principal Components (DAPC; Jombart *et al.*, 2010) was performed (Figure 5). The red and blue clusters showed bimodal distributions along the first discriminant axis (DA1), each having a main peak overlapping with the J-like green and O-like orange clusters, respectively. This pattern likely resulted from over-partitioning of the continuous J/O mosaic structure, separating it into more coastal J-dominated (red) and more offshore O-dominated (blue) mixing zones.

No additional genetic structure beyond the J–O axis

To explore potential axes beyond the J–O genetic axis, a Factorial Correspondence Analysis (FCA) was conducted (Figure 6). Scree and scatter plots showed that Axis 1 explained the largest proportion of genetic variance and clearly separated the J-like green and O-like orange components. Red and blue clusters completely overlapped with the J-like green and O-like orange clusters, indicating no evidence of additional genetic structure beyond the main J–O axis.

NON-GENETIC ANALYSES

Various non-genetic data (e.g., body length, flipper coloration, conception date) were also analyzed to evaluate the four GENELAND clusters (Taguchi *et al.*, 2019). However, none of these analyses supported the inference that the red and blue clusters represent a resident stock in the mixing zone. Among them, body length distribution provided particularly important implications for stock assessment. Additionally, the trend in the number of sightings per unit effort in part of the mixing zone under the P stock scenario is being analyzed, and preliminary results indicate no drastic decline, which would be expected under a scenario of a coastal isolated stock.

Lack of mature females in the P stock

Figure 7 shows body length distribution among sub-area

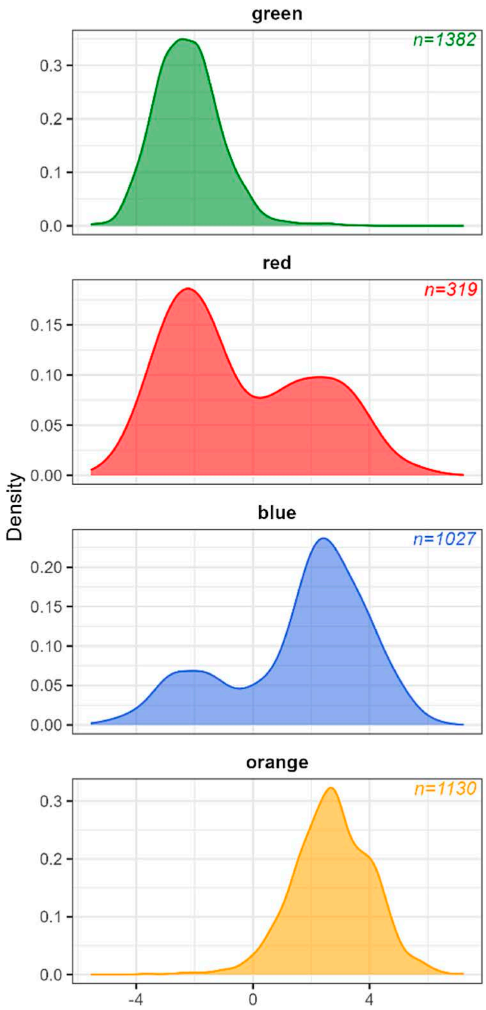

Figure 5. Density plot along the first discriminant axis (DA1) from DAPC. DAPC was trained using individuals from pure J (sub-areas 6E and 10E) and O (sub-areas 8 and 9) zones with consensus *q* (average posterior assignment probability)>0.9 across five STRUCTURE (K=2; Pritchard *et al.*, 2000) replicates. All individuals were then projected onto the STRUCTURE (K=2)-trained DA1 and colored according to the four GENELAND clusters, using assignments with consensus *q*>0.9 only.

by GENELAND cluster and sex. The red and blue clusters showed that most females did not reach the body length at sexual maturity. The absence of mature females in these clusters is biologically and demographically difficult to explain if the P-stock is assumed to be a resident stock. The J-like green cluster also consists mostly of immature whales; however, J stock whales are not considered resident in the study area. The apparent lack of immature males in the O-like orange cluster likely reflects misassignment of immature O stock whales distributed in the mixing area (Hatanaka and Miyashita, 1997) to the blue cluster.

CONCLUDING REMARKS

Evidence supporting the existence of the P stock under hypothesis E has been put forward from the GENELAND analysis only. However, the limited robustness of this inference indicates that even the GENELAND analysis provides only limited support for the P stock as a single, distinct stock. The software is based on a spatial Bayesian clustering model that assumes each individual belongs to one of K discrete populations and integrates genetic and geographic information to identify spatially coherent clusters. In the ICR's dataset, the genetic composition changes gradually along the spatial gradient from J-dominated to O-dominated waters (e.g., JJJJJ [pure J zone: sub-areas 1E, 6E and 10E] – JJJJO [coastal part of mixing zone] – JJOOO [offshore part of mixing zone] – OOOOO [pure O zone: sub-areas 8 and 9]). The spatial model in GENELAND tends to impose discrete population borders even across gradual genetic transitions, leading to over-partitioning within not only the mixing zones but also between the mixing and adjacent pure zones. This behavior likely explains the artificial genetic clusters (i.e., red and blue). In summary, these analyses do not support the existence of an additional coastal P stock along the

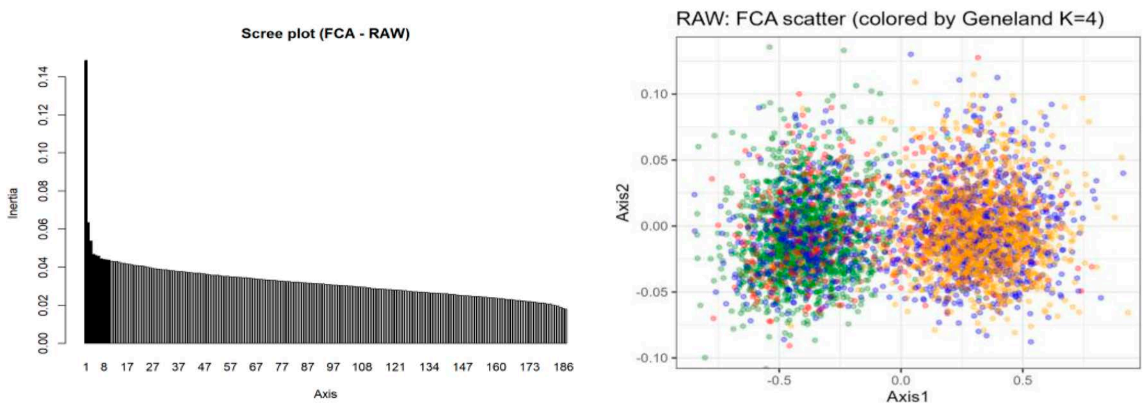

Figure 6. Scree plot and scatter plot of FCA analysis with GENELAND K=4 cluster colors.

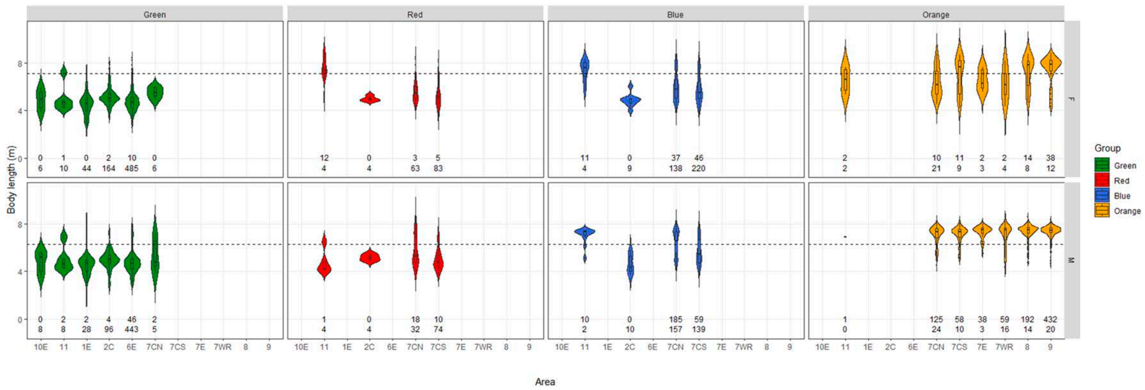

Figure 7. Body length distribution across sub-areas, grouped by sex and the four GENELAND clusters, using only individuals with consensus *q* (average posterior assignment probability) > 0.9. The dashed lines indicate the estimated body length at sexual maturity for western North Pacific common minke whales (7.1 m for females and 6.3 m for males; Kato, 1992). The values shown above the x-axis represent the number of mature (top) and immature (bottom) individuals, classified based on bodylength criteria.

Pacific coast of Japan and the southern coastal Okhotsk Sea (and not beyond those waters).

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Technical Report (not peer reviewed)

Results of the dedicated sighting survey under the Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A) in Area IV-East in the 2024/2025 austral summer season

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ABSTRACT

The results of the sighting survey of the Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A) in the 2024/2025 austral summer season are reported. Two dedicated sighting vessels were engaged in the line transect method survey in a part of Antarctic Area IV East (100°E–130°E) for 39 days, from 2 January to 9 February 2025. For the survey, the research area was divided into northern and southern strata. The total searching distance in the research area was 2,491.5 n.miles (4,614.3 km). Five baleen whale species and at least three 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.

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 2018/2019 austral summer season.

The Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A) commenced in the 2019/2020 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 (MO): i) the study of the abundance and abundance trends of large whale species (MO1), and ii) the study of the distribution, movement and stock structure of large whale species (MO2). JASS-A also has five secondary research objectives (SO) related to oceanography (SO1), marine debris (SO2), genetic data to estimate abundance (SO3), whale biology (SO4) and study on the utility of Unmanned Aerial Vehicle (UAV) (SO5). 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 ʻRequirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Schemeʼ (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 Areas III, IV, V and VI by one or two specialized vessels, over a tentative period of eight austral sum-

[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

mer seasons from 2019/20 to 2026/27. The first to fifth JASS-A surveys were carried out between 2019/20 and 2023/24 and covered the sector 000°–035°E of Antarctic Area III West, 145°W–120°W of Antarctic Area VI East, and 70°E–100°E of Antarctic Area IV West.

The sixth JASS-A survey was carried out in the 2024/2025 season and covered the sector 100°E–130°E (Antarctic Area IV East). This paper presents a summary of the 2024/2025 JASS-A survey results.

SURVEY DESIGN

Research period and area

The research area of JASS-A comprises IWC Management Areas III, IV, V and VI, south of 60°S (Figure 1). The research area in the 2024/2025 season was Area IV-East (100°E–130°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 north of the pack ice edge (Figure 2). The northern and southern strata were surveyed simultaneously to avoid a temporal gap.

Research vessels

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

Sighting procedures and experiments

The procedures for sighting and experiments were the same as in previous JASS-A surveys. See Katsumata *et al.* (2025) 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.

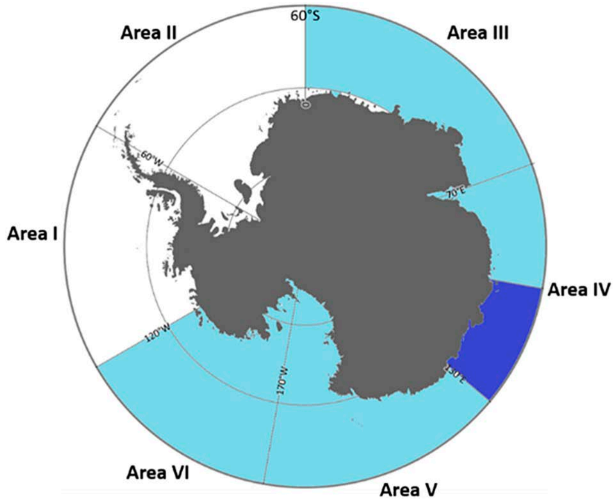

Figure 1. Research area of JASS-A. The blue colored area (100°E–130°E) indicates the surveyed area in the 2024/25 austral summer season.

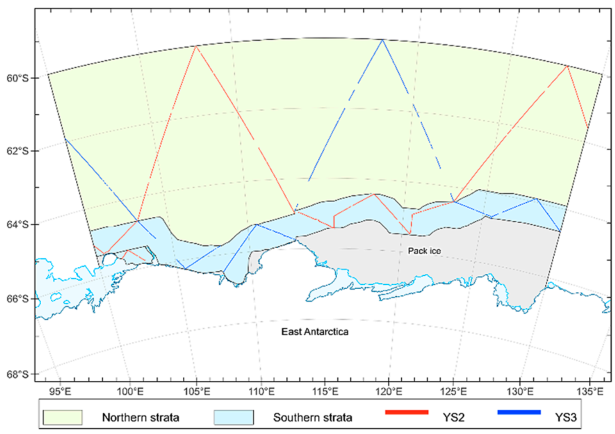

Figure 2. Research area (100°E–130°E) indicating northern, southern strata of the JASS-A survey in the 2024/25 austral summer season.

Figure 3. Research vessels participating in the JASS-A 2024/25 cruise.

RESULTS OF THE SURVEY

Narrative of the survey
Table 1 shows the itinerary of the survey. The duration of this cruise was 99 days for both *YS2* and *YS3*. The *YS2* and *YS3* departed Japan on 6 December 2024. They arrived at Benoa, Indonesia on 17 December. The *YS2* and *YS3* started the sighting survey in Antarctic Area IV East at 61°37′S; 130°00′E on 2 January, and at 64°39′S; 130°00′E on 3 January 2025, respectively. The *YS2* and *YS3* completed the survey on 9 February and left the research area at positions 60°00′S; 101°55′E and 60°00′S; 101°25′E respectively, on 10 February. The *YS2* and *YS3* arrived at Kota Kinabalu, Malaysia on 3 March and finally arrived at Japan on 14 March.

Research effort in the research area
Table 2 shows a summary of the searching effort spent during the survey. The *YS2* and *YS3* were engaged in the research for 39 days and 38 days, respectively. The total searching effort of both vessels was 2,491.5 n.miles (4,614.3 km); 1,230.8 n.miles in NSP mode and 1,260.8 n.miles in IO mode.

In the northern stratum, the total searching effort was 1,566.8 n.miles and the searching effort coverage was 84%. In the southern stratum, the total searching effort was 924.7 n.miles and the searching effort coverage was 85%. Therefore, a good distribution of effort within all strata and survey mode was achieved. The total experimental time for photo-ID, biopsy sampling, tagging and distance and angle experiment was 64 hours 06 minutes.

Whale sightings in the research area
Five baleen whale species and at least three toothed whale species were sighted in the research area. The dominant whale species in the research area was the humpback whale (850 schools/1,514 individuals) followed by the Antarctic minke whale (148/332). Sightings of other species were as follows: fin (28/72), Antarctic blue (19/25), southern bottlenose (12/22), killer including Type A, Type B, Type C and undetermined type (9/234), southern right (3/3), and sperm (3/3) whales (Table 3).

Antarctic minke whales
Antarctic minke whales were mainly distributed in the southern part of the research area (Figure 4), with higher concentrations observed in the northern part of Vincennes Bay (110°E–115°E). As in previous surveys, no mother and calf pair of the Antarctic minke whale was observed. The mean school size of the primary sighting was 2.4, and the density index (DI) in the research area was 5.09. The DI decreased from 6.51 to 5.09 compared to the 2014/15 and 2015/16 surveys (Table 4). In the present survey, a polynya was formed further south of the pack ice near 120°E (Figure 5), however, the research vessel could not enter this area. In contrast, in the 2015/16 survey the research vessel entered into this type of polynya, where a high density of Antarctic minke whales was confirmed (Isoda *et al.*, 2016). These findings indicate that

Table 1
Itinerary of the JASS-A 2024/25 cruise.

Date (y/m/d)	Event
2024/11/20	Planning meeting was held at Tokyo, Japan
2024/12/5	Pre-cruise meeting was held at Shiogama, Japan
2024/12/6	*YS3* and *YS2* departed Shiogama, Japan
2024/12/8	*YS3* and *YS2* started transit survey at 29°–13′N; 139°–14′E, and at 29°–12′N; 139°–29′E, respectively
2024/12/17	*YS3* and *YS2* arrived in the homeport Benoa, Indonesia (8°–45′S, 115°–13′E)
2024/12/21	*YS3* and *YS2* resumed transit survey at 12°–10S; 113°–41′E, and at 12°–28′S, 113°–45′E, respectively
2025/1/2	*YS2* started survey in the research area at 61°–37′S; 130°–00′E
2025/1/3	*YS3* started survey in the research area at 64°–39′S; 130°–00′E
2025/2/9	*YS3* and *YS2* completed the survey in the research area and started the transit survey.
2025/2/21	*YS3* interrupted transit survey at 10°–11′S; 101°–27′E
2025/2/22	*YS2* interrupted transit survey at 08°–35′S; 102°–16′E
2025/2/28	*YS3* and *YS2* arrived in the homeport Kota Kinabalu, Malaysia
2025/3/9	*YS3* and *YS2* resumed transit survey at 23°–12′N; 127°–23′E, and at 22°–58′N; 127°–30′E, respectively
2025/3/12	*YS3* and *YS2* finished transit survey at 35°–01′N; 140°–30′E, and at 35°–02′N; 140°–31′E, respectively
2025/3/14	*YS3* and *YS2* arrived and post cruise meeting a Shiogama, Japan.

Table 2
Summary of searching effort and time spent by *YS3* and *YS2* during the 2024/25 JASS-A cruise.

Vessel	Survey Sections	Date and time		Searching effort (distance [n.miles] and time)				Experiments time	
		Start	End	NSP		IO		Photo-ID, Biopsy, Satellite tag experiment	Estimated angle and distance training/experiment
YS2	Transit survey (Japan–Entering Philippines EEZ)	2024/12/08 07:25	2024/12/11 16:50	65.6	04:51:54	—	—	00:00:00	0:00:00
	Transit survey (Leavening Indonesia EEZ–Research area)	2024/12/21 07:00	2025/1/2 07:42	499.3	43:35:03	—	—	00:56:56	0:00:00
	Research area (Area IVE 100°E–130°E)	2025/1/2 07:42	2025/2/9 15:40	693.8	64:37:10	733.3	67:07:21	30:50:20	5:00:44
	Transit survey (Research area - Entering Indonesia EEZ)	2025/2/9 15:40	2025/2/21 18:00	444.5	37:50:52	—	—	0:00:00	0:00:00
	Transit survey (Leaving Philippines EEZ–Japan)	2025/3/9 07:45	2025/3/12 16:40	124.1	10:14:04	—	—	0:00:00	0:00:00
	Total			1827.3	161:09:03	733.3	67:07:21	31:47:16	5:00:44
YS3	Transit survey (Japan - Entering Philippines EEZ)	2024/12/8 07:25	2024/12/11 16:50	64.4	04:52:21	—	—	00:00:00	0:00:00
	Transit survey (Leavening Indonesia EEZ–Research area)	2024/12/21 07:00	2025/1/2 18:00	502.1	44:50:02	—	—	00:09:49	0:00:00
	Research area (Area IVE 100°E–130°E)	2025/1/3 06:00	2025/2/9 12:32	537.0	49:38:48	527.5	48:23:49	32:09:50	6:02:21
	Transit survey (Research area–Entering Indonesia EEZ)	2025/2/9 12:32	2025/2/21 18:00	413.0	36:26:52	—	—	0:00:00	0:00:00
	Transit survey (Leaving Philippines EEZ–Japan)	2025/3/9 07:50	2025/3/12 16:40	146.6	12:11:45	—	—	00:00:00	0:00:00
	Total			1663.1	147:59:48	527.5	48:23:49	32:19:39	6:02:21

the number of sightings of Antarctic minke whales exhibit fluctuations on an annual basis, contingent on the melting of sea ice and accessibility to preferred feeding areas.

Fin whales
Fin whales were mainly sighted in the northern stratum (Figure 6). Mother and calf pairs were not observed. The mean school size was 2.00. The DI in this survey was 0.72. Comparison with previous surveys shows consistently low densities in Area IV East (Table 5). In contrast, the adjacent Area IV West showed a much higher DI of 5.92 in the 2023/24 survey (Isoda *et al.*, 2024), approximately 8 times higher than the present survey. These results potentially indicate that Area IV East is not a major distribution area for this species.

Humpback whales
Humpback whales were distributed south of 62°00’S, and high-density areas were encountered between 63°S and 65°S (Figure 7). 4 mother and calf pairs were observed. The mean school size for primary sighting was 1.77. The DI in the research area was 32.43. Compared to the DI obtained from past surveys conducted with a similar design, the present survey recorded the highest value (Table 5). Area IV East is used as a feeding ground by both Stock D and E, with both stocks recovering towards pre-whaling resource levels (IWC, 2015). Stock E was estimated to be 24,545 individuals in the breeding grounds in 2015 representing 94% of the carrying capacity (Noad *et al.*, 2019). The present survey results suggest that the population size of this species in Area IV East may have continued to increase since 2015. Future work should focus on detailed abundance estimation using distance sampling methods and conducting trend analysis for Stocks D and E separately. In the present survey, 52 biopsy samples were collected from this species, from which the estimation of mixing rates based on genetic data can be calculated.

Antarctic blue whales
Antarctic blue whales were sighted in the northern and southern strata (Figure 8). Mother and calf pairs were not observed. The mean school size was 1.50. The DI in the research area was 0.48. Comparison with previous surveys shows relatively stable density levels: 0.09 (2005/06), 0.05 (2007/08), 0.50 (2014/15+15/16), and 0.48 (2024/25) (Table 4), suggesting a steady but slow recovery pattern consistent with this species′ long generation time and conservative reproductive strategy.

Table 3
Number of sightings made during the 2024/25 JASS-A survey in the research area, by stratum and species.

Species	Area IVE (100°E–130°E)								Sub-total				Total	
	Southern stratum Area code 42				Northern stratum Area code 44									
	Prim.		Second.		Prim.		Second.		Prim.		Second.			
	sch.	Ind.	sch.	Ind.	sch.	Ind.	sch.	Ind.	sch.	Ind.	sch.	Ind.	sch.	Ind.
Antarctic blue whale	6	10	5	5	6	8	2	2	12	18	7	7	19	25
Fin whale	7	19	0	0	11	17	10	36	18	36	10	36	28	72
Antarctic minke whale	100	265	14	24	27	36	7	7	127	301	21	31	148	332
Dwarf minke whale	0	0	0	0	1	1	4	4	1	1	4	4	5	5
Like minke	8	10	0	0	5	5	0	0	13	15	0	0	13	15
Humpback whale	409	710	10	20	399	725	32	59	808	1435	42	79	850	1514
Southern right whale	0	0	1	1	2	2	0	0	2	2	1	1	3	3
Baleen whale	5	6	0	0	0	0	0	0	5	6	0	0	5	6
Sperm whale	1	1	0	0	2	2	0	0	3	3	0	0	3	3
Southern bottlenose whale	4	7	0	0	8	15	0	0	12	22	0	0	12	22
Killer whale (Undetermined)	3	55	0	0	0	0	0	0	3	55	0	0	3	55
Killer whale (Type A)	0	0	1	17	0	0	0	0	0	0	1	17	1	17
Killer whale (Type B)	1	5	1	11	0	0	1	40	1	5	2	51	3	56
Killer whale (Type C)	2	106	0	0	0	0	0	0	2	106	0	0	2	106
Hourglass dolphin	0	0	0	0	2	17	0	0	2	17	0	0	2	17
Long-finned pilot whale	2	41	0	0	2	65	0	0	4	106	0	0	4	106
Ziphiidae	2	3	0	0	10	19	0	0	12	22	0	0	12	22
Spectacled porpoise	0	0	0	0	1	1	0	0	1	1	0	0	1	1
Unidentified whale	7	7	0	0	6	6	1	2	13	13	1	2	14	15

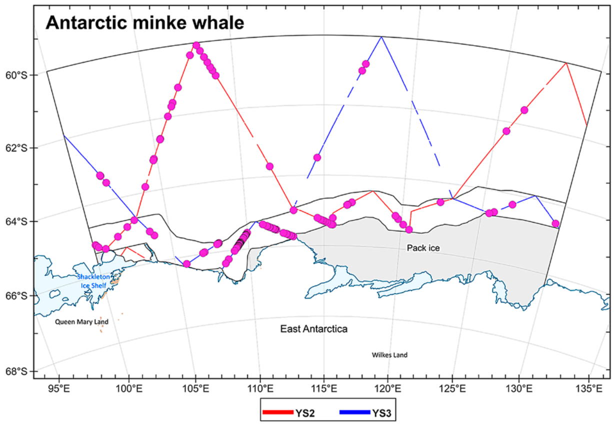

Figure 4. Geographical distribution of primary sightings of Antarctic minke whales during the 2024/25 JASS-A survey.

Southern right whales
Southern right whales (SRW) were sighted in the western part of the northern stratum (Figure 9). Mother and calf pairs were not observed. The mean school size was 1.00. The DI in the research area was 0.08 and decreased remarkably compared to the previous survey (Table 4). SRWs migrating Area IV East belong to the Southwest Australian population (Bannister, 2001), and this population migrate to feeding areas in mid-latitude areas without reaching Antarctic waters (Mackay *et al.*, 2020). Although southern right whales show slowed growth rates (O'Shannessy *et al.*, 2025; Grundlehner *et al.*, 2025), it is unlikely that the population has declined. Instead, these figures could reflect different numbers of whales from this population migrating into the Antarctic.

Rare species observations
Rare species sightings included a dwarf minke whale and a spectacled porpoise (Figure 10). The dwarf minke whale (Figure 11) was sighted as primary sighting at 60°30'S, 128°40'E in the northern stratum. This sighting location coincides with one of the high-density regions of this species identified by Kato *et al.* (2021). The spectacled porpoise (Figure 12) was observed in the northern stratum, representing a valuable record of this poorly known small cetacean species in Antarctic waters.

Other research activities
Table 5 shows a summary of results of different experi-

Table 4
Comparison of density indices (DI, number of schools per 100 n.miles) and mean school size (MSS) of baleen whales from primary sightings in Area IVE (100°E–130°E) between the present survey and previous surveys.

Species	Antarctic blue		Fin		Antarctic minke		Humpback		Southern right		Reference
Survey year	DI	MSS	DI	MSS	DI	MSS	DI	MSS	DI	MSS	
2005/06	0.09	1.50	3.60	2.51	5.20	2.08	28.21	1.82	1.08	1.32	Nishiwaki *et al.*, 2006
2007/08	0.05	3.00	0.04	1.00	0.78	2.41	7.57	1.87	2.09	1.33	Ishikawa *et al.*, 2008
2014/15+15/16	0.50	1.77	0.68	2.66	6.51	2.75	26.53	2.23	0.84	1.68	Matsuoka *et al.*, 2015 Isoda *et al.*, 2016
2024/25	**0.48**	**1.50**	**0.72**	**2.00**	**5.09**	**2.37**	**32.43**	**1.77**	**0.08**	**1.00**	**The present survey**

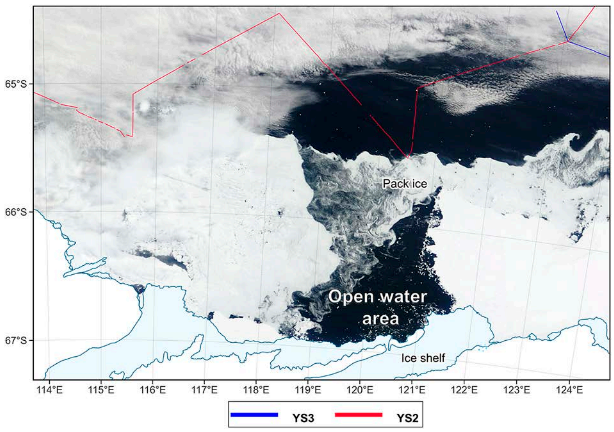

Figure 5. Satellite image of a polynya (open water area) formed near 120°E in the research area on January 13, 2025. The image shows thick pack ice (labeled) to the north of the open water area. The red line indicates survey tracks where research vessels (*YS2*) attempted to access the polynya but were unable to proceed due to sea ice conditions. This image was obtained from NASA Global Imagery Browse Services for EOSDIS WMS.

ments.

Sighting distance and angle experiment

The sighting distance and angle experiment was conducted to evaluate the accuracy of sighting distance and angle provided by primary observers. The results of this experiment will be used for the calibration of abundance estimates. The actual experiments were successfully completed on 26 January for 3 hours 17 minutes (128 trials) in *YS2*, and on 27 and 31 January for a total of 6 hours 2 minutes (136 trials) in *YS3*.

Photo-ID

Photo-ID data are used for individual matching exercises to investigate distribution and movement of large whales. A total of 24 Antarctic blue, 36 humpback, 3 southern right and 15 killer whales were successfully photo-

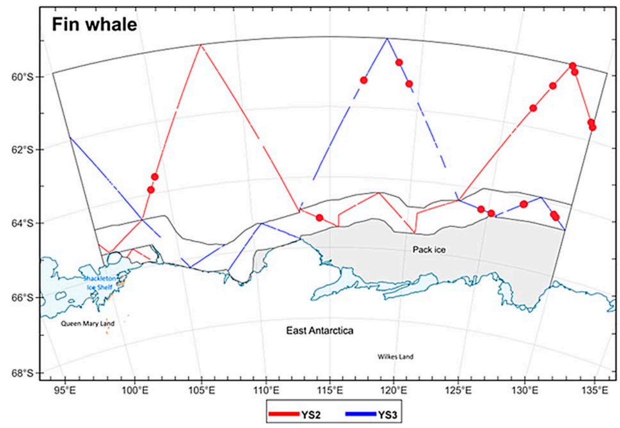

Figure 6. Geographical distribution of primary sightings of fin whales during the 2024/25 JASS-A survey.

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

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 128 biopsy samples were collected from 12 Antarctic blue, 18 fin, 35 Antarctic minke, 52 humpback, 3 southern right, 5 killer, one long-finned pilot whale, and one spectacled porpoise, 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 details of deployment system, protocols and research results to date were described in Konishi *et al.* (2020). During the whole survey, 10 fin, 25 Antarctic minke, and 2 humpback whales were tagged.

Table 5
Summary of the results of experiments conducted during the 2024/25 JASS-A survey.

Experiments	Results and descriptions
Sighting distance and angle experiment	264 trials completed (*YS2*: 128 trials, *YS3*: 136 trials)
Photo-ID	Obtained from 24 Antarctic blue, 36 humpback, 3 southern right and 15 killer whales
Biopsy sampling	Collected from 12 Antarctic blue, 18 fin, 35 Antarctic minke, 52 humpback, 3 southern right, 5 killer, 1 long-finned pilot whale, and 1 spectacled porpoise
Satellite tagging	Deployed on 10 fin, 25 Antarctic minke, and 2 humpback whales
Oceanographic survey	164 XCTD casts
Marine debris observation	1 plastic bottle was observed in the research area

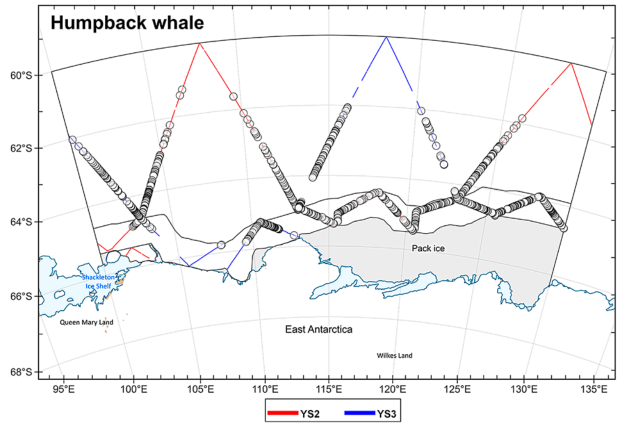

Figure 7. Geographical distribution of primary sightings of humpback whales during the 2024/25 JASS-A survey.

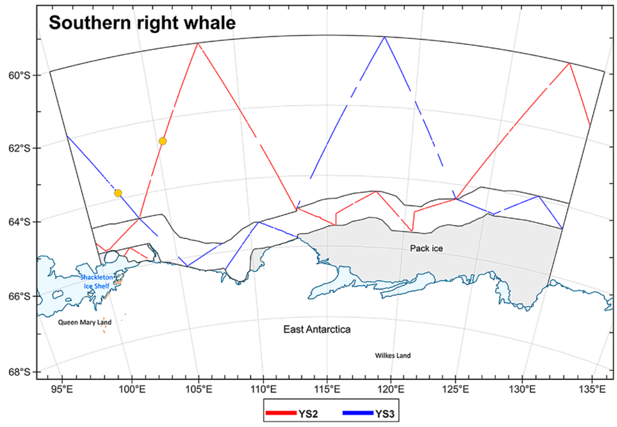

Figure 9. Geographical distribution of primary sightings of southern right whales during the 2024/25 JASS-A survey.

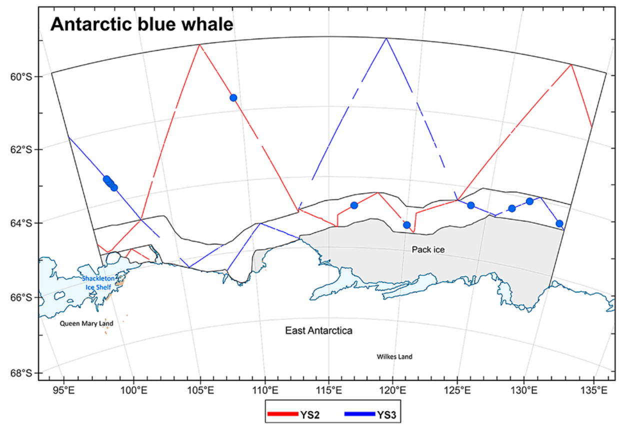

Figure 8. Geographical distribution of primary sightings of Antarctic blue whales during the 2024/25 JASS-A survey.

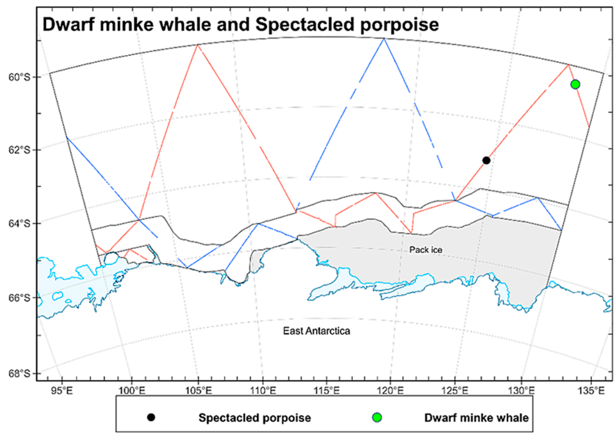

Figure 10. Geographical distribution of primary sightings of dwarf minke whale and spectacled porpoise during the 2024/25 JASS-A survey.

Oceanographic survey

Oceanographic observations are important to understand the relationship between 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-150P (*YS2*) and MK-150N (*YS3*) at 164 stations (Figure 13).

The mean temperature from the surface to 200 m depth (MTEM200) was calculated using XCTD data

Figure 11. Dwarf minke whale sighted at 60°30′S, 128°40′E on 2 January 2025. The white blaze can be confirmed to spread from the pectoral fin to the shoulder area. Photographed by Minato Kawasaki of *YS2*.

Figure 12. Spectacled porpoise sighted at 63°09′S, 124°35′E on 7 January 2025. Photographed by Minato Kawasaki of *YS2*.

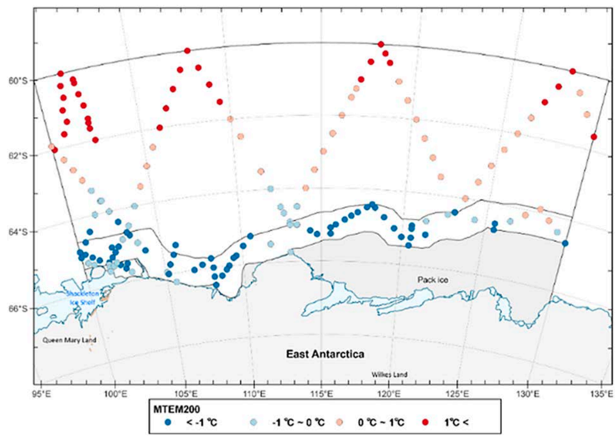

Figure 13. Oceanographic observation stations (XCTD casting points) in the 2024/2025 JASS-A survey. The mean temperature from the surface to 200 m depth (MTEM200) was calculated using XCTD data collected at these stations.

(Figure 13). The MTEM200 provides a useful overview of water mass structure, and temperatures ranging from 0°C to 1°C indicate the distribution around the SBACC (Southern Boundary of the Antarctic Circumpolar Current) zone (Naganobu *et al.*, 2010). Oceanographic data will be analysed to study the oceanographic structure of the research area and the relationship with whale distribution.

Marine debris observation

Studies on marine debris in the Antarctic are very scarce. It is therefore important to continue with this kind of survey to monitor future trends in the occurrence of marine debris. One plastic bottle 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).

HIGHLIGHTS OF THE SURVEY

The 2024/2025 JASS-A survey covered Area IV East (100°E–130°E) and succeeded in collecting sighting data following the same protocol as the past survey, necessary for the abundance estimation of cetaceans in this area. Several other data necessary for understanding stock structure, movement and the environment of whales were collected during the survey. The data collected through JASS-A will be analysed in conjunction with the data collected by the previous JARPA/JARPAII, NEWREP-A and IDCR/SOWER surveys in the same region so that the analyses can be based on a long and consistent data set.

ACKNOWLEDGEMENTS

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Technical Report (not peer reviewed)

Report and highlights of the Japanese dedicated sighting surveys in the North Pacific in 2024

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ABSTRACT

This paper presents the results of vessel-based sighting surveys conducted in 2024 by the Institute of Cetacean Research in the North Pacific. The research area was set between 39°N–46°N and 136°E–147°E for the spring survey, 35°N–51.5°N and 153°E–170°E for the summer survey, and around Hachijojima Island (33°N, 139°E) for the winter survey. The surveys were conducted between April 2024 and March 2025 involving three seasons. The research vessels *Yushin-Maru* and *Yushin-Maru* No.2 were engaged in the spring survey, *Yushin-Maru* and *Kaiyo-Maru* No.7 in the summer survey, and *Aki-Maru* in the winter survey. A total of 7,272.1 n.miles was searched in the North Pacific with an additional 106.0 n.miles around Hachijojima Island. Coverage of the searching efforts on the planned cruise track line was 77.9%. In total, seven large whale species, including blue (22 schools/23 individuals), fin (72/102), sei (80/96), Bryde′s (63/84), common minke (41/47), humpback (47/65 and 279/428 at Hachijojima island) and sperm (130/290) whales were sighted during the surveys. Photo-ID images were collected from 159 individuals across all seasons. Biopsy skin samples were collected from 21 individuals (common minke n=10, fin n=11). Satellite tags were attached to 17 whales (common minke n=13, fin n=4). The first record of a North Pacific right whale was made at Hachijojima Island. 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).

In 2024, the Institute of Cetacean Research (ICR) conducted sighting surveys with three seasonal components: spring surveys focusing on common minke whale migration and stock structure in the western North Pacific, summer surveys for abundance estimation across a broader scale, and a new winter survey component focusing on photo-identification of humpback whales around Hachijojima Island. The winter survey represents an important expansion, as humpback whales have been migrating to Hachijojima Island waters since 2015 (Katsumata *et al.*, 2021), providing a unique opportunity to monitor this species during their breeding season.

This paper reports the results of the Japanese dedicated sighting surveys conducted during April–October 2024 in the North Pacific and December 2024–March 2025 around Hachijojima Island, involving three seasons: spring, summer and winter.

SURVEY DESIGN

Spring and summer surveys

Research period and area

The spring survey (April–May) focused on common minke whales as the primary target species, with objectives to collect information on whale migration, movement patterns and stock structure, as well as abundance estimation. The summer survey (August–September) aimed to estimate abundance of large whales and study their distribution, migration and stock structure through various experiments. Figure 1 illustrates the research areas covered in the North Pacific.

In the spring, the research area was set up between 39°N–46°N and 136°E–147°E, excluding foreign Exclusive Economic Zones (EEZs); in the summer, between 35°N–51°30′N and 153°E–170°E for the main survey area, with an additional transit survey area between 35°N–43°N and 140°E–153°E, excluding foreign EEZs.

Research vessels

The sighting surveys in spring and summer seasons 2024 were conducted by research vessels *Yushin-Maru* (*YS1*),

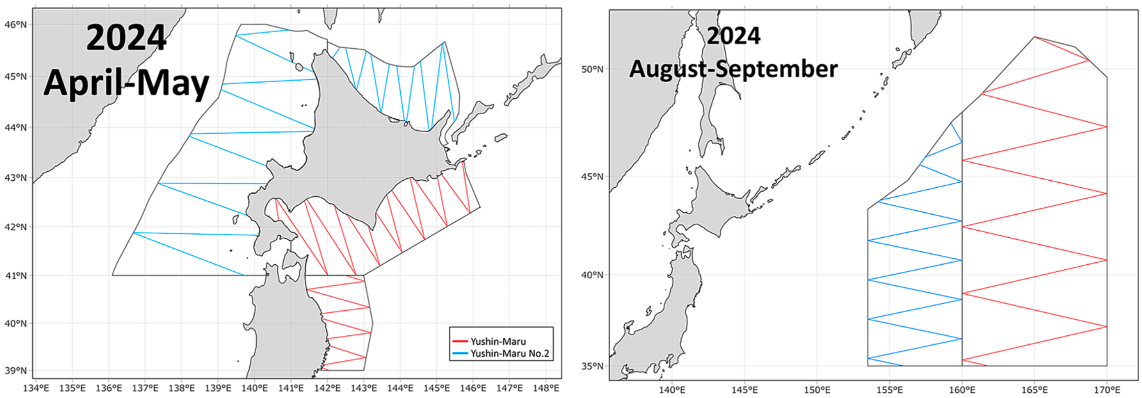

Figure 1. Research areas covered by the 2024 dedicated sighting surveys in each season. Left: spring survey. *Yushin-Maru* (*YS1*) surveyed blue line, and *Yushin-Maru* No.2 (*YS2*) covered red line. Right: summer survey. *Yushin-Maru* (*YS1*) covered the red line. *Kaiyo-Maru* No.7 (*YS7*) surveyed blue line.

Figure 2. Research vessels participating in the 2024 dedicated sighting surveys: *Yushin-Maru* (*YS1*) (upper left), *Yushin-Maru* No.2 (*YS2*) (upper right) and *Kaiyo-Maru* No.7 (*KY7*) (lower left).

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.

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 R package 'dssd' (Marshall, 2023), and the number of the line (width in the longitude) was decided by the research schedule based on the IWC survey guidelines (IWC, 2012).

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 in the summer survey to estimate whale abundance considering estimated $g(0)$. The survey modes adopted for each survey are shown in Table 1.

For spring surveys, the searching conditions followed traditional minke whale survey protocols (visibility ≥2.0 n. miles, wind speed <17 knots) with a searching speed of 8.5 knots. For summer surveys, different protocols were applied based on latitude: north of 43°N followed minke whale protocols, while south of 43°N used standard line transect protocols (visibility ≥2.0 n.miles, wind speed <21 knots) with searching speeds of 11.5 knots for *YS1* and 10.5 knots for *KY7*.

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 1

Summary of the survey modes and searching conditions by each seasonal survey during the 2024 dedicated sighting surveys.

Season	Vessel	Survey mode	Searching conditions		
			Visibility (n.miles)	Wind speed (kt)	Searching speed (kt)
Spring	*YS1, YS2*	Normal Passing mode	≥2.0	<17.0	8.5
Summer	*KY7, YS1*	Normal Passing mode Passing with Independent Observer mode	≥2.0	<21.0	10.5–11.5

Table 2

Experiments planned in each seasonal survey during the 2024 dedicated sighting surveys.

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

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 and common minke whales.

Hachijojima Island Survey

Research area and period

A new winter survey was conducted around Hachijojima Island (Figure 3) from December 2024 to March 2025. The primary objective was to collect photo-identification data of humpback whales in their breeding area for abundance estimation based on mark-recapture methods. The survey area primarily covered waters shallower than 200 m on the southeastern and southwestern sides of the island, located approximately 287 km south of Tokyo.

Research vessels and methodology

The survey employed a combination of dedicated systematic surveys using a chartered vessel *Aki-Maru* (12GT) (Figure 4) for 14 days, and opportunistic surveys using a commercial whale watching vessel for 15 days.

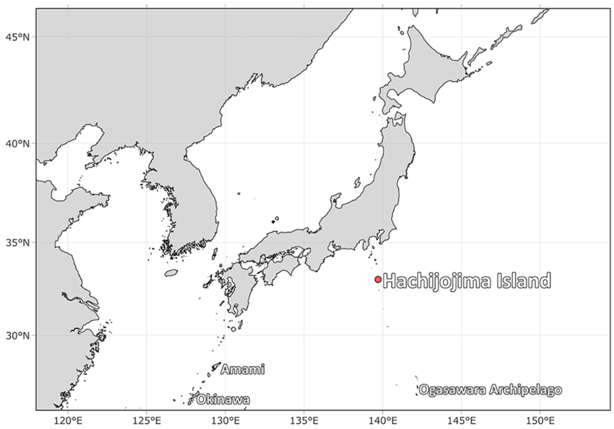

Figure 3. Location of Hachiojima island.

Figure 4. Research vessel *Aki-maru*.

Data collection

The primary focus was on collecting photo-identification images of humpback whale flukes using Canon EOS R6 Mark II cameras. A total of 29 survey days (14 dedicated + 15 opportunistic) were conducted, though weather conditions reduced the dedicated survey effort to 58% of the planned schedule.

Additionally, photo-identification images were provided by Nature Kikaku Co. from whale watching operations conducted outside of the scheduled survey periods.

RESULTS

Brief narrative of the surveys

Spring survey (April–June)

YS1 departed Shimonoseki, Yamaguchi, Japan on 20 April, and started the survey in the research area on 24 April. The survey was completed on 31 May. *YS1* arrived in Shiogama, Miyagi, Japan on 6 June.

YS2 departed Shiogama, Miyagi, Japan on 12 April, and started the survey in the research area on 15 April. The survey was completed on 25 May. *YS2* arrived in Shiogama on 29 May.

Summer survey (July–October)

KY7 departed Otaru, Hokkaido, Japan on 26 July and started the survey in the research area on 6 August. *KY7* suspended the survey on 4 September and entered Kushiro for port call on 7 September. *KY7* departed Kushiro on 8 September and resumed the survey in the research area on 10 September. The survey was completed on 4 October and *KY7* arrived in Shiogama on 11 October.

YS1 departed Shiogama on 2 August and started the survey on 8 August. *YS1* completed it on 25 September. *YS1* arrived in Hachinohe, Aomori, Japan on 30 September.

Although the survey was originally planned to cover waters down to 35°N, rough weather conditions caused delays in progress, and the survey area was limited to 38°N. The remaining area will be surveyed during the same period in 2025.

Winter survey (December–March, Hachijojima island)

Aki-Maru conducted dedicated surveys around Hachijojima Island in six periods between December 2024 and March 2025. In this study, daily surveys were conducted during each 4-day survey period, with the research vessel departing from either Yaene Port or Borawazawa fishery port or Kaminato port at 09:00 and returning at 15:00. Due to meteorological conditions, 14 out of 24 planned survey days were completed. Surveys were conducted on 6 January, 20–23 January, 3–4 and 17–20 February, 6 and

10–12 March 2025.

In addition, opportunistic surveys were conducted aboard commercial whale watching vessels operated by Nature Kikaku Co. Ltd. between December 2024 and March 2025, completing 15 survey days. These supplemented the dedicated surveys to maintain continuous monitoring throughout the winter season.

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 4 shows the total sightings for large and small cetacean species, made in the spring season. The sighting locations of each species are shown in Figure 5.

Fin whale

A total of 33 schools (53 individuals) were sighted (Figure 5). No mother and calf pairs were observed. The mean school size was 1.61. SST at sighting positions

Table 3

Summary of the survey periods and searching effort by each seasonal survey in the 2024 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	*YS1*	2024/04/24–05/31	1,585.4	1,466.7	—	1,466.7	92.5%
	YS2	2024/04/15–05/25	1,837.0	1,062.3	—	1,062.3	57.8%
	Sub total	—	3,422.4	2,529.0	—	2,529.0	73.9%
Summer	*KY7*	2024/08/17–09/04, 09/10–10/04	7,190.0*	2,377.6	2,365.6	4,743.2**	66.0%
	YS1	2024/08/08–09/25					
Total	—	—	10,612.4	4,906.6	2,365.6	7,272.2	68.5%

* Planned distance up to 35°N

** Actual surveyed distance up to 38°N

Table 4

Total number of sightings of large and small cetacean species made in the spring season 2024, by research vessel and species.

Species	*YS1*				*YS2*				Total			
	Prim.		Sec.		Prim.		Sec.		Prim.		Sec.	
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Fin whale	6	6	0	0	19	29	8	18	25	35	8	18
Common minke whale	12	13	0	0	17	21	6	7	29	34	6	7
Bryde′s whale	8	9	0	0	0	0	0	0	8	9	0	0
Humpback whale	36	50	7	10	0	0	0	0	36	50	7	10
Sperm whale	15	46	1	1	0	0	0	0	15	46	1	1
Like minke	0	0	1	1	1	1	1	1	1	1	2	2
Like fin	0	0	0	0	1	1	4	5	1	1	4	5
Unidentified large baleen whale	0	0	1	1	0	0	0	0	0	0	1	1
Unidentified large cetacean	1	1	0	0	3	3	0	0	4	4	0	0
Killer whale	6	30	0	0	8	40	0	0	14	70	0	0
Pacific white-sided dolphin	13	226	0	0	2	22	0	0	15	248	0	0
Striped dolphin	1	48	0	0	0	0	0	0	1	48	0	0
Risso′s dolphin	6	42	0	0	0	0	0	0	6	42	0	0
Northern form short-finned pilot whale	1	14	0	0	0	0	0	0	1	14	0	0
Harbour porpoise	1	3	0	0	1	2	0	0	2	5	0	0
Dall′s porpoise	44	344	0	0	48	150	0	0	92	494	0	0
Ziphiidae	2	4	0	0	5	13	0	0	7	17	0	0

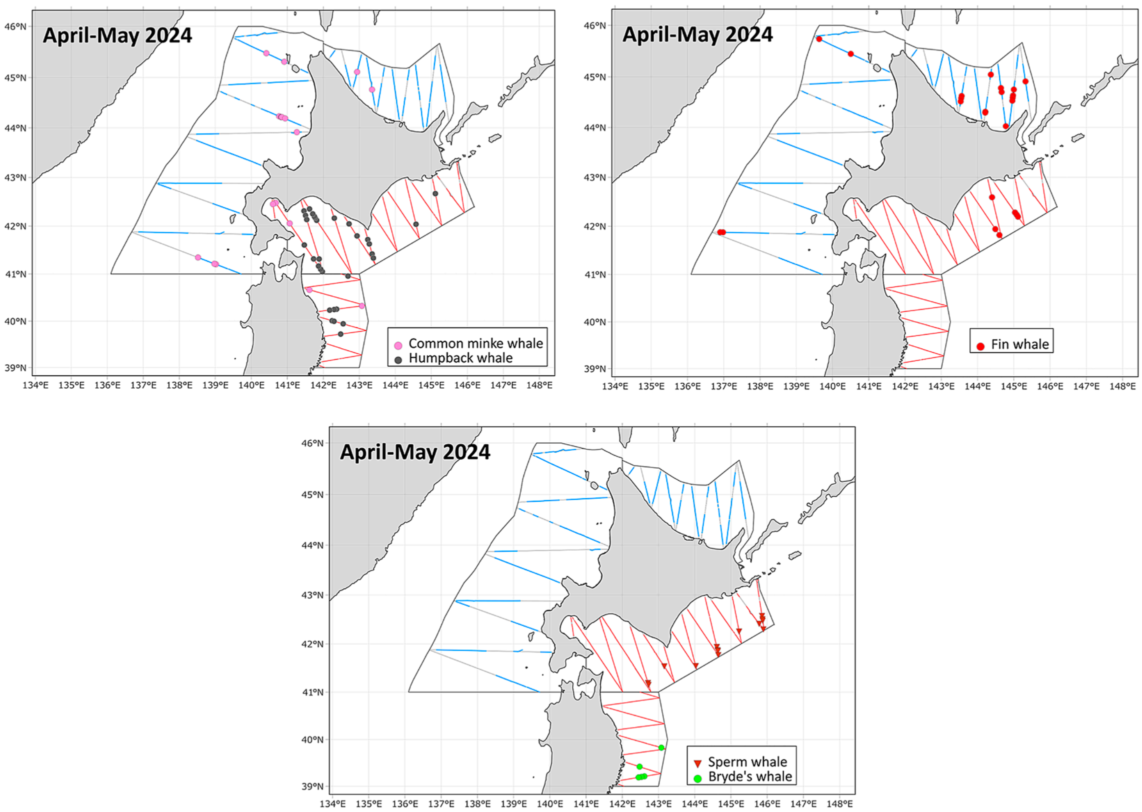

Figure 5. The locations of large cetaceans sighted by *YS1* (blue track lines) and *YS2* (red track lines) during the spring 2024. Upper left: Common minke whale (pink circles) and humpback whale (black circles) sightings. Upper right: Fin whale sightings (red circles). Lower: Sperm whale (purple triangles) and Bryde's whale (green circles) sightings.

ranged from 10.8°C–12.3°C (mean 11.6°C) for *YS1* and 4.8°C–10.8°C (mean 7.5°C) for *YS2*. A total of 5 biopsy samples were collected (1 by *YS1*, 4 by *YS2*) and 2 acoustic tags were attached to fin whales by *YS2* in the Okhotsk Sea.

<u>Bryde's whale</u>

A total of 8 schools (9 individuals) were sighted by *YS1* in the Pacific coastal waters south of 40°N (Figure 5). No mother and calf pairs were observed. The range of SST at sighting positions was 17.3°C–20.1°C (mean SST 18.7°C), and the mean school size was 1.13.

<u>Common minke whale</u>

A total of 35 schools (41 individuals including 1 mother and calf pair) were sighted (Figure 5). The mean school size was 1.17. SST at sighting positions ranged from 11.0°C–16.7°C (mean 14.2°C) for *YS1* in the Pacific side and 4.8°C–13.5°C (mean 9.8°C) for *YS2* in the Okhotsk Sea and Sea of Japan. A total of 10 biopsy samples were collected (4 by *YS1*, 6 by *YS2*) and 13 satellite tags were attached (6 by *YS1*, 7 by *YS2*).

<u>Humpback whale</u>

A total of 43 schools (60 individuals including 2 mother and calf pairs) were sighted by *YS1* only (Figure 5). The range of SST at sighting positions was 10.5°C–18.3°C (mean SST 15.2°C), and the mean school size was 1.40. Photo-ID images were collected from 5 individuals.

<u>Sperm whale</u>

A total of 16 schools (47 individuals) were sighted by *YS1* (Figure 5). The range of SST at sighting positions was 11.0°C–17.3°C (mean SST 14.8°C). The mean school size was 2.94.

Summer

Tables 5 shows the total sightings for large and small cetacean species, made in the summer season. The sighting locations of large cetacean species are shown in Figure 6.

<u>Blue whale</u>

A total of 22 schools (23 individuals) were sighted primarily by *YS1*, concentrated north of 50°N. No mother and calf pairs were observed. The range of SST at sighting positions was 9.5°C–14.8°C (mean 11.2°C), and the mean school size was 1.05. Photo-ID images were collected from 1 individual by *KY7*.

<u>Fin whale</u>

A total of 39 schools (49 individuals) were sighted, with 36 schools by *YS1* in the east of 160°E. No mother and

Table 5
Total number of sightings of large whales made in the summer season 2024, by research vessel and species.

Species	*KY7*				*YS1*				Total			
	Prim.		Sec.		Prim.		Sec.		Prim.		Sec.	
	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.	Sch.	Ind.
Blue whale	3	3	0	0	19	20	1	2	22	23	1	2
Fin whale	3	3	0	0	36	46	0	0	39	49	0	0
Sei whale	15	17	0	0	65	79	2	2	80	96	2	2
Common minke whale	3	3	0	0	3	3	0	0	6	6	0	0
Bryde's whale	35	55	0	0	20	20	1	1	55	75	1	1
Humpback whale	0	0	0	0	4	5	2	2	4	5	2	2
Sperm whale	63	161	0	0	51	82	0	0	114	243	0	0
Like fin	7	8	0	0	11	12	0	0	18	20	0	0
Like minke	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified large baleen whale	1	1	0	0	3	3	0	0	4	4	0	0
Baird's beaked whale	2	6	0	0	0	0	0	0	2	6	0	0
Killer whale	6	31	0	0	11	73	0	0	17	104	0	0
Common dolphin	8	188	0	0	2	41	0	0	10	229	0	0
Pacific white-sided dolphin	3	119	0	0	0	0	0	0	3	119	0	0
Northern right whale dolphin	0	0	0	0	1	26	0	0	1	26	0	0
Striped dolphin	1	12	0	0	1	23	0	0	2	35	0	0
Risso's dolphin	1	6	0	0	5	114	0	0	6	120	0	0
Southern form short-finned pilot whale	1	24	0	0	0	0	0	0	1	24	0	0
Dall's porpoise	3	14	0	0	7	44	0	0	10	58	0	0
Ziphiidae	7	16	0	0	7	10	0	0	14	26	0	0
Mesoplodon spp.	1	1	0	0	0	0	0	0	1	1	0	0

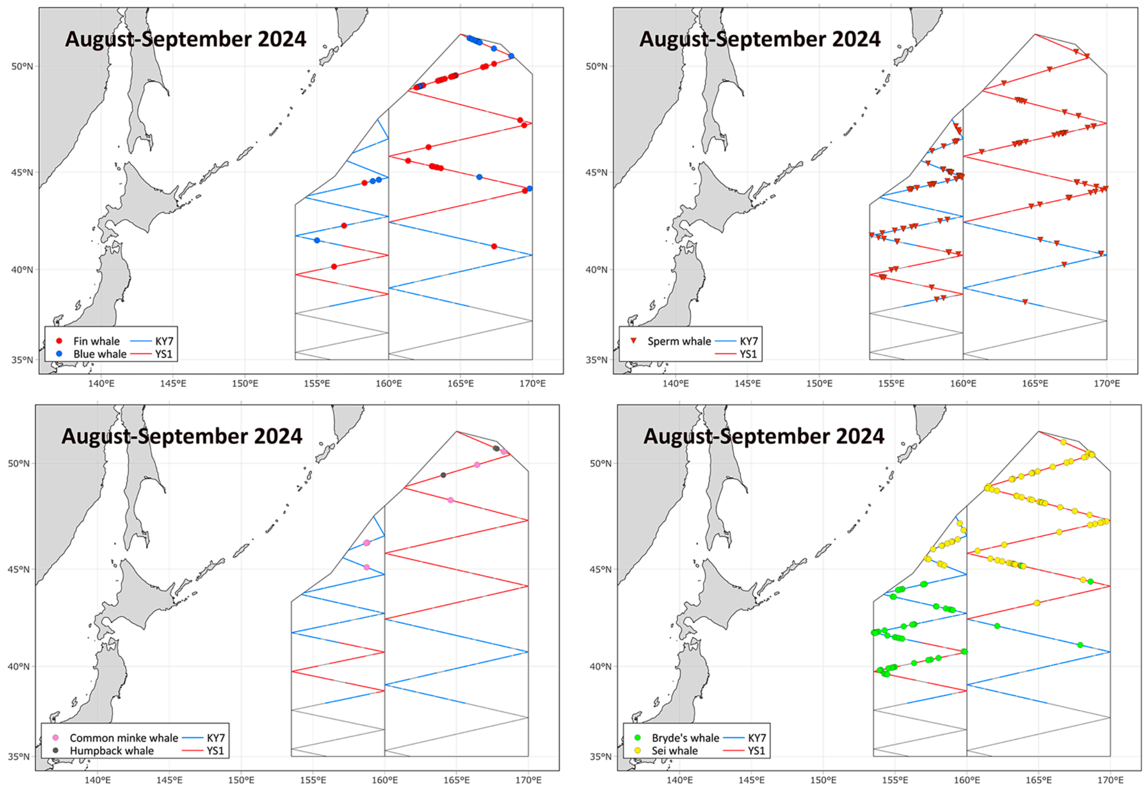

Figure 6. Sighting locations of large cetaceans by *KY7* (blue track lines) and *YS1* (red track lines) during the summer 2024. Upper left: fin whale (red circles) and blue whale (blue circles). Upper right: sperm whale (brown circles). Lower left: common minke whale (pink circles) and humpback whale (black circles). Lower right: Bryde's whale (green circles) and sei whale (yellow circles).

calf pairs were observed. The range of SST at sighting positions was 9.5°C–15.3°C (mean 11.8°C), and the mean school size was 1.26. A total of 6 biopsy samples were collected and 4 satellite tags and 1 MINTAG were deployed by *YS1*.

<u>Sei whale</u>

The most abundant baleen whale with 80 schools (96 individuals) sighted. No mother and calf pairs were observed. The range of SST at sighting positions was 9.5°C–16.8°C (mean 12.1°C), and the mean school size was 1.20.

<u>Bryde's whale</u>

A total of 55 schools (75 individuals) were sighted, primarily in the west of 160°E. No mother and calf pairs were observed. The range of SST at sighting positions was 19.3°C–24.5°C (mean 21.8°C), and the mean school size was 1.36.

<u>Common minke whale</u>

Only 6 schools (6 individuals) were sighted, 3 each by *KY7* and *YS1*. The range of SST was 11.5°C–21.8°C (mean 17.6°C), and the mean school size was 1.00.

<u>Humpback whale</u>

A total of 4 schools (5 individuals) were sighted by *YS1* around 50°N. The range of SST was 10.3°C–11.8°C (mean 11.0°C). Photo-ID images were collected from 1 individual.

<u>Sperm whale</u>

This species was the most abundant with 114 schools (243 individuals) distributed throughout the research area. The mean school size was 2.13. The range of SST was 11.5°C–24.3°C (mean 18.2°C).

Table 6
Total number of humpback whale sightings during the Hachijojima Island survey 2024/25 season.

Survey type	Survey days	Sch.	Ind.	Photo-ID (individuals)
Dedicated survey	14	170	270	89
Opportunistic survey	15	109	158	56
Data provision	—	—	—	73
Total	29	279	428	218

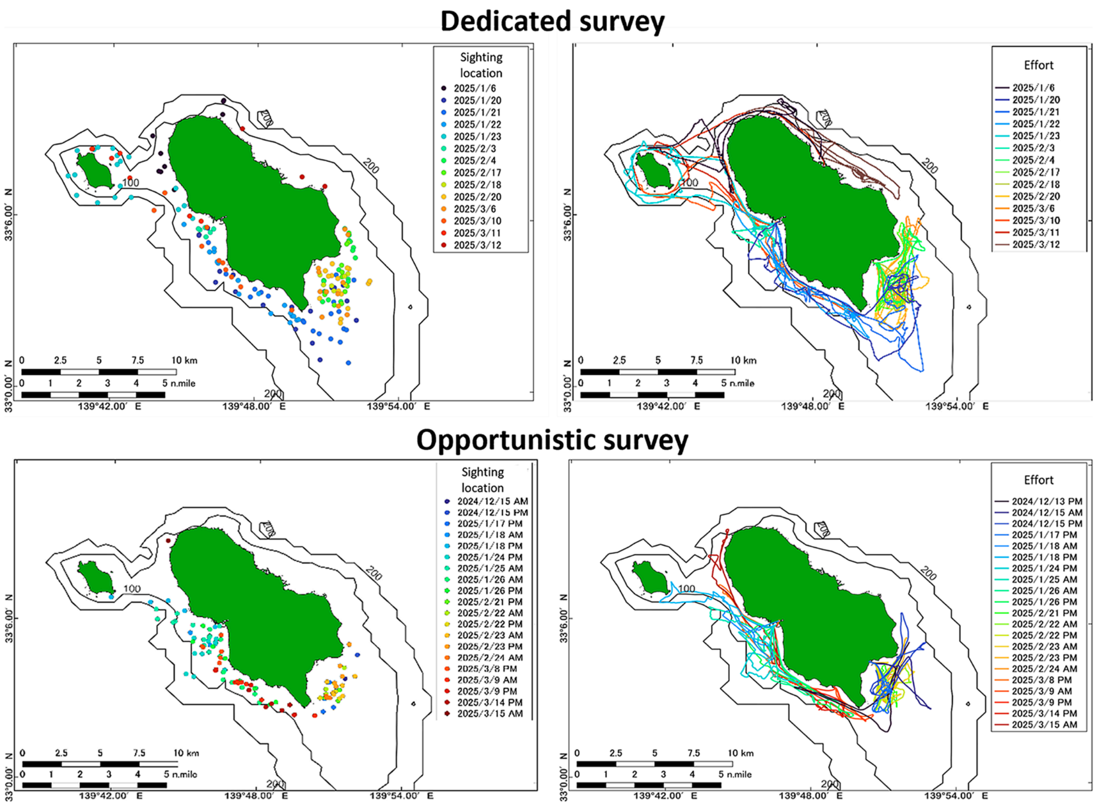

Figure 7. Sighting locations of humpback whales and survey tracks during the Hachijojima Island in 2024/25 season. Upper panels show dedicated survey results (left: sighting locations by date, right: survey effort tracks). Lower panels show opportunistic survey results aboard commercial whale watching vessels (left: sighting locations by date, right: survey tracks). Depth contours show 100 m and 200 m isobaths. Humpback whales were concentrated in waters shallower than 200 m around the southeastern and southwestern areas of the island.

Duplicate sightings

During the summer survey, duplicate sightings in IO mode were recorded for $g(0)$ estimations. A total of 174 whale schools were sighted by either TOP or IOP observers, with 51 confirmed duplicates. By species, blue whales had 25 total sightings with 7 duplicates, fin whales had 45 sightings with 14 duplicates, sei whales had 65 sightings with 23 duplicates, and Bryde′s whales had 36 sightings with 8 duplicates. Common minke whales had 4 sightings with no duplicates detected. These duplicate detection rates will be used for calculating detection probability $g(0)$ to adjust future abundance estimates.

Winter (Hachijojima Island)

A total of 279 humpback whale schools (428 individuals) were sighted, with whales concentrated in waters shallower than 200 m around the southeastern and southwestern areas of the island (Table 6, Figure 7).

Photo-identification images were collected from 218 individuals (including duplicates from dedicated surveys, opportunistic surveys, and images provided by Nature Kikaku Co.) (Table 6). Two mother-calf pairs were confirmed during the opportunistic surveys. No feeding behavior was observed throughout the survey period.

A notable observation was a sighting of a North Pacific right whale (*Eubalaena japonica*) at Hachijojima Island on 30 March 2025, the first record for the island. The individual was photographed during commercial whale watching operations, and the image was provided by Nature Kikaku Co. (Figure 8).

Figure 8. North Pacific right whale sighted at Hachijojima Island on 30 March 2025, the first record for this area. Photo: Nature Kikaku Co.

Experiments

Sighting distance and angle experiment

Distance and angle estimation experiments were conducted during both spring and summer surveys to calibrate observer measurements. In spring, experiments were conducted by *YS1* on 18 May and *YS2* on 29 April. In summer, *KY7* conducted the experiment on 27 August and *YS1* on 25 September. These experiments followed the IWC/SOWER and IWC-POWER protocols (IWC, 2012).

Photo-ID

A total of 159 individuals were photographed across all seasons (Table 7). In spring, 11 individuals were photographed, including five humpback whales and six killer whales. Summer surveys yielded only three photo-IDs (one blue whale, one humpback whale, and one killer whale) due to the focus on abundance estimation using IO mode. The Hachijojima Island survey was most productive with 145 humpback whale individuals photographed. All photographs were stored in the ICR catalog for future stock structure and movement analyses.

Biopsy sampling

Biopsy skin samples were collected using the Larsen system from 21 individuals (Table 8). Spring surveys collected 15 samples: *YS1* collected 5 samples (4 common minke whales, 1 fin whale) and *YS2* collected 10 samples (6 common minke whales, 4 fin whales). Summer surveys collected 6 samples, all fin whales from *YS1*. No biopsy

Table 7

Number of individuals photographed during the 2024 dedicated sighting surveys, by seasonal survey, research vessel and species.

Species	Spring	Summer	Hachijojima	Total
Blue whale	0	1	0	1
Humpback whale	5	1	145	151
Killer whale	6	1	0	7
Total	11	3	145	159

Table 8

Number of biopsy samples collected during the 2024 dedicated sighting surveys, by seasonal survey, research vessel and species.

Species	Spring	Summer	Hachijojima	Total
Common minke whale	10	0	0	10
Fin whale	5	6	0	11
Total	15	6	0	21

sampling was conducted during the Hachijojima Island survey. 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 summer surveys. A total of 13 satellite tags were deployed in the spring (common minke whales only), and 4 tags in the summer (fin whales only). Additionally, 2 acoustic tags were deployed on fin whales during the spring survey by *YS2*. A MINTAG, a newly developed smaller and lighter implantable satellite tag designed for long-distance deployment on fast swimming rorquals, was successfully deployed on one fin whale during the summer survey by *YS1*.Tracking data are available at https://mintag-project.com/follow-the-whales/#mintag-2024. This experimental tag aims to enable year-round tracking with improved retention time and reduced drag compared to conventional tags. Tracking and behavioral data obtained from these tags will contribute to the elucidation of the movement patterns of whales and the timing of migration between high latitude feeding areas and low latitude breeding areas.

HIGHLIGHTS OF THE SURVEY

The sighting surveys conducted in 2024 provided valuable data for studies on cetacean distribution and abundance across three seasons in both feeding and breeding areas. Key findings from each season are summarized below.

Spring Survey (April–May)

The spring survey successfully collected data on whale migration and stock structure in the western North Pacific. Common minke whales, the primary target species, were sighted in 35 schools (41 individuals), and 13 satellite tags were deployed, providing valuable data on their movement patterns. Notably, the continued presence of fin whales in the Okhotsk Sea was confirmed, with 33 schools (53 individuals) recorded. Humpback whales were abundantly observed in coastal waters of the Pacific side (43 schools/60 individuals), concentrated between 39°N–42°N, with many sightings west of Cape Erimo. These distribution patterns suggest seasonal northward migration toward feeding grounds. Bryde's whales were also sighted in small numbers, with 40°N representing the northern limit of their distribution. The successful deployment of two acoustic tags on fin whales by *YS2* represents a new experimental approach for studying whale vocalizations.

Summer Survey (August–September)

The summer survey provided crucial data for abundance estimation using IO mode, with sei whales being the most abundant baleen whale species (80 schools/96 individuals). The duplicate detection rates in IO mode are essential for calculating detection probability $g(0)$ for adjustment of future abundance estimates. Blue whales (22 schools/23 individuals) were concentrated primarily north of 45°N between 153°E–170°E. The successful deployment of a MINTAG on one fin whale represents a significant technological advancement, marking the first successful deployment from a large research vessel. Sperm whales were the most abundant species overall (114 schools/243 individuals), widely distributed throughout both survey areas between 35°N–51.5°N and 153°E–170°E. However, rough weather conditions limited the survey extent to 38°N instead of the planned 35°N, with the remaining southern area scheduled for coverage in 2025.

Winter Survey (Hachijojima Island, December–March)

A total of 279 humpback whale schools (428 individuals) were sighted over 29 survey days, concentrated in waters shallower than 200 m around the island. The combination of dedicated surveys (14 days) and opportunistic surveys aboard commercial whale watching vessels (15 days) proved effective for maintaining continuous monitoring despite weather constraints. Photo-identification images were collected from 218 individuals, providing valuable data for abundance estimates and individual tracking. The first recorded sighting of a North Pacific right whale at Hachijojima Island on 30 March 2025 represents a significant discovery for this critically endangered species. ICR has primarily conducted summer feeding area surveys, but with the addition of winter breeding area surveys around Hachijojima Island, a comprehensive year-round survey system linking feeding and breeding areas has been established. This year-round monitoring system is expected to elucidate the life history of this species in the western North Pacific, contribute to expanding fundamental knowledge of distribution patterns, migration routes, and reproductive dynamics of baleen whales under environmental changes such as the recent marked increase in sea surface temperatures, and provide a scientific foundation for appropriate resource management.

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Technical Report (not peer reviewed)

Results of the IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER) dedicated sighting survey in 2024—An overview—

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ABSTRACT

This paper outlines the main results of the 2024 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 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 2024 survey was conducted successfully between 2 August and 10 October 2024 in the southern Chukchi Sea and the eastern Bering Sea by the Japanese R/V *Yushin-Maru* No. 2. This was the first time the POWER cruise was conducted in the southern Chukchi Sea while the eastern Bering Sea was surveyed in 2017. The following whale species were sighted in the survey area: fin (80 schools/149 individual), common minke (5/6), humpback (20/36), gray (44/78), bowhead (1/2), sperm (3/3) and killer (18/85) whales. No sighting of North Pacific right whales was made. Photo-identification data were collected from 34 fin, 14 humpback, 5 gray, 1 bowhead and 10 killer whales. A total of 21 biopsy samples were collected from 7 fin, 2 sei, 8 humpback, 3 gray and 1 killer whales. A total of 163 sonobuoys were deployed, of which 150 were successful, for a total of over 545 monitoring hours. 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 2024 as part of the 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 2024 IWC-POWER focusing on the results within the survey area. The details are provided in Murase *et al.* (2024). General background of the IWC-POWER including objectives, research area, and general methodology is described in Matsuoka (2020).

OVERVIEW OF RESULTS OF THE 2024 IWC-POWER SURVEY

Itinerary

The survey was conducted between 2 August and 10 October 2024 by the Japanese R/V *Yushin-Maru* No. 2. The itinerary is shown in Table 1.

Research area

The research area for POWER 2024 was set in the US Exclusive Economic Zone (EEZ) from 51°N to 69°N and from approximately 175°W to 157°W (Figure 1). The southern Chukchi Sea stratum had not been previously surveyed by the IWC-POWER programme, while the northeastern and southeastern Bering Sea strata were surveyed in 2017.

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, photo-ID
Peter Duly (USA): Photo-ID data management, seabird sighting
Isamu Yoshimura (Japan): sighting data, marine debris and biopsy sample management

Table 1
The 2024 IWC-POWER survey itinerary.

Date (ship's time)	Event
1-Aug-2024	Pre-cruise meeting held at Shiogama
2-Aug	Vessel departed Shiogama
10-Aug	Vessel arrived at Dutch Harbor
12-Aug	Pre-cruise meeting held at Dutch Harbor
13-Aug	Vessel departed Dutch Harbor
17-Aug	Vessel started the survey in the research area Research Area (39 days)
24-Aug	Vessel completed the survey in the research area
26-Sep	Vessel arrived at Dutch Harbor
28-Sep	Post-cruise meeting held at Dutch Harbor
29-Sep	Vessel departed Dutch Harbor
10-Oct	Vessel arrived at Shiogama
11-Oct	Post-cruise meeting held at Shiogama

Searching effort

The survey was conducted using methods based on the guidelines of the IWC SC. Survey trackline coverage in the research area was 78.2% (1,253.3 n.miles of a planned distance of 1,603.4 n.miles), with a total of 585.4 n.miles in Passing with abeam closing mode (NSP) and 667.9 n.miles in Independent Observer passing mode (IO) (Table 3). Additionally, 88.2 n.miles were surveyed during transit between Japan to and from Dutch Harbor, and Dutch Harbor to and from the research area.

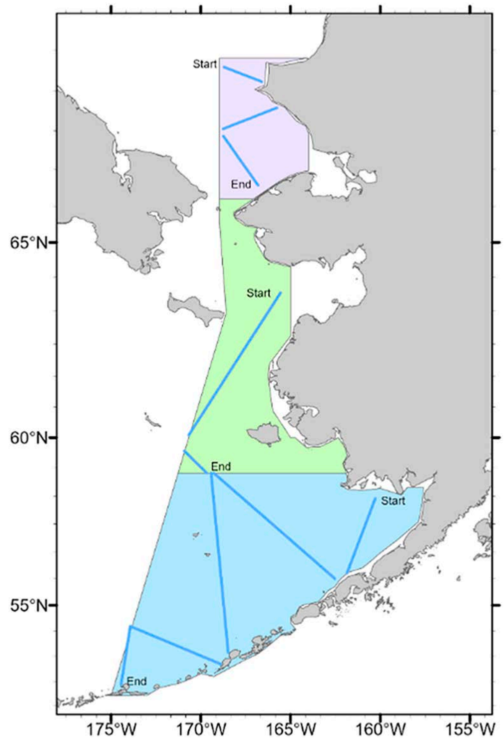

Figure 1. The entire research area (thin black line) and survey track lines (blue line) with start and end points for the 2024 IWC-POWER survey. Purple: southern Chukchi Sea stratum; green: northeastern Bering Sea stratum; blue: southeastern Bering Sea stratum.

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

Table 3
Summary of the searching effort (time and distance), experimental time (hours) in the survey area of the 2024 IWC-POWER survey.

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 Southern Chukchi Sea (Leg 301–308)	70	301	17-Aug.	22-Aug.	6:22:54	72.32	6:40:22	74.89	13:03:16	147.21	2:23:26	0:00:00
	US EEZ	308	6:00	18:30								
Research Area Northeastern Bering Sea (Leg 101–109)	71	101	24-Aug.	30-Aug.	10:18:43	117.48	11:45:11	133.95	22:03:54	251.43	0:48:21	3:59:19
	US EEZ	109	7:23	18:20								
Research Area Southeastern Bering Sea (Leg 151–177)	72	151	1-Sep.	24-Sep.	34:17:02	395.60	39:42:42	459.08	73:59:44	854.68	4:46:23	6:45:44
	US EEZ	177	6:00	19:09								

Table 4
Number of sightings for all species observed in the research area during the 2024 IWC-POWER survey (original track lines), by effort mode. NSP: Normal Passing with abeam closing mode; IO: Independent Observer mode, OE: Top down (TD) and drifting (DR). 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
Fin whale	39	76	0	41	73	0	0	0	0	80	149	0
Like fin	0	0	0	3	4	0	0	0	0	3	4	0
Common minke whale	3	4	0	0	0	0	2	2	0	5	6	0
Like minke	0	0	0	1	1	0	0	0	0	1	1	0
Humpback whale	9	9	0	10	26	0	1	1	0	20	36	0
Like humpback	0	0	0	1	1	0	0	0	0	1	1	0
Gray whale	14	23	0	23	47	0	7	8	0	44	78	0
Like gray	1	1	0	0	0	0	0	0	0	1	1	0
Bowhead whale	1	2	0	0	0	0	0	0	0	1	2	0
Sperm whale	3	3	0	0	0	0	0	0	0	3	3	0
Killer whale	5	43	6	12	39	0	1	3	0	18	85	6
Harbour porpoise	2	3	1	3	4	0	0	0	0	5	7	1
Dalli type Dall's porpoise	6	41	0	3	11	0	0	0	0	9	52	0
Unid. type Dall's porpoise	3	16	0	0	0	0	0	0	0	3	16	0
Unid. large baleen whale	5	5	0	8	8	0	1	1	0	14	14	0
Unid. small cetacean	1	2	0	0	0	0	0	0	0	1	2	0
Unid. cetacean	0	0	0	4	4	0	0	0	0	4	4	0

Summary of the sightings

The following whale species were sighted in the survey area: fin (80 schools/149 individual), common minke (5/6), humpback (20/36), gray (44/78), bowhead (1/2), sperm (3/3) and killer (18/85) whales (Table 4). No sighting of North Pacific right whales was made. These data will be mainly used to estimate abundance of several species.

Geographical distribution by species

Fin whale

Fin whales were observed, primarily in the western part of the southeastern Bering Sea stratum (Figure 2). Sea temperatures ranged from 3.9 to 9.2°C (25th to 75th quartiles: 7.8–8.7°C).

Humpback whale

Humpback whales were observed throughout the re-

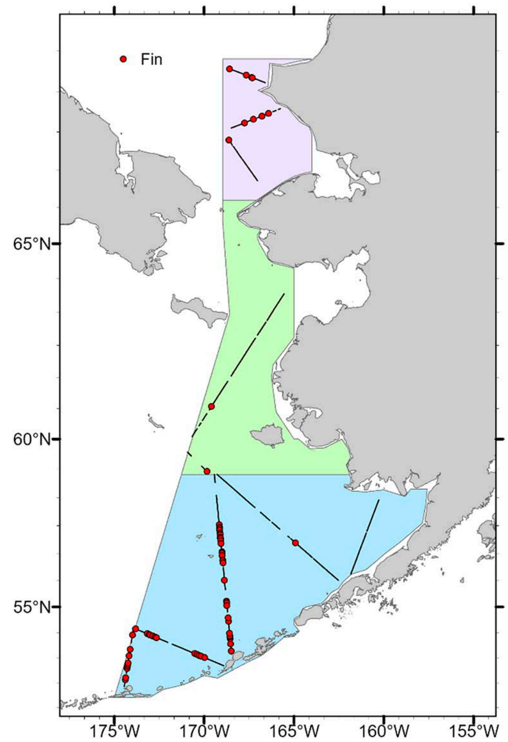

Figure 2. The searching effort (black lines) and sighting positions (red circles) of fin whales during the 2024 IWC-POWER survey.

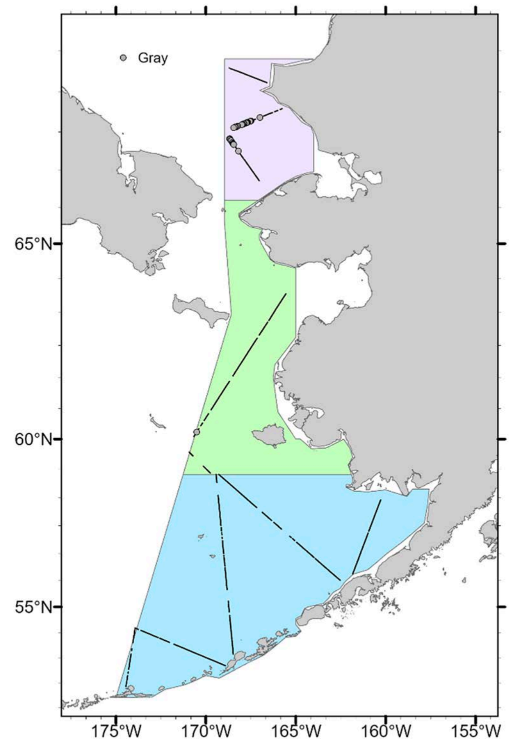

Figure 4. The searching effort (black lines) and sighting positions (gray circles) of gray whales during the 2024 IWC-POWER survey.

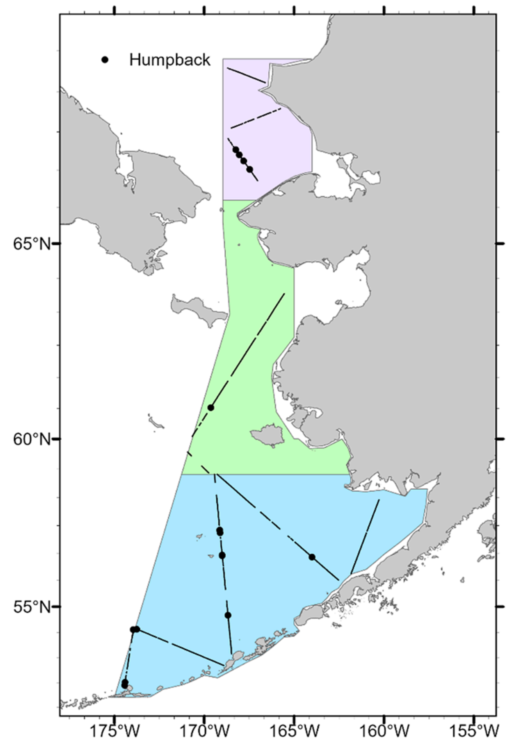

Figure 3. The searching effort (black lines) and sighting positions (black circles) of humpback whales during the 2024 IWC-POWER survey.

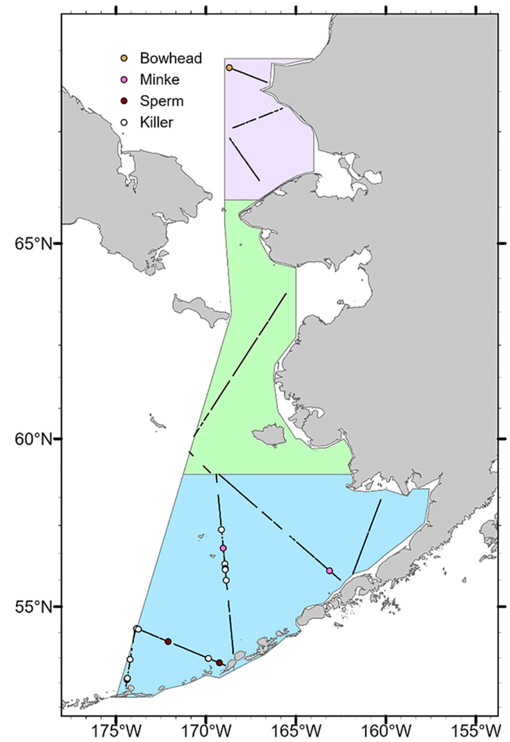

Figure 5. The searching effort (black line) and primary sighting positions of bowhead (yellowish brown circle), common minke (pink circles), sperm (brown circles) and killer (white circles) whale during the 2024 IWC-POWER survey.

search area (Figure 3). Sea temperatures ranged from 4.0 to 9.0°C (25th to 75th quartiles: 7.6–8.2°C).

Gray whale

Gray whales were observed, primarily in the southern Chukchi Sea stratum (Figure 4). Sea temperatures ranged from 3.7 to 7.1°C (25th to 75th quartiles: 3.9–5.4°C).

Other species

Sightings distributions of bowhead, common minke, sperm and killer whales are shown in Figure 5.

Identification of duplicated sightings

A total of 129 resighting was detected during IO Mode involving several baleen whale species. These data will be used to estimate $g(0)$, which in turn will be used to adjust abundance estimates.

Photo-ID experiments

Photo-ID data were obtained from a total of 64 individuals: fin (34 individuals), humpback (14), gray (5), bowhead (1) and killer (10) whales (Table 5). Images collected during the survey were uploaded to the IWC master photographic database in Adobe Lightroom (LR). 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 21 individual whales: 7 fin, 2 sei, 8 humpback, 3 gray and 1 killer 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 163 sonobuoys were deployed, of which 150 were successful, for a total of over 545 monitoring hours. Species detected include fin (106 buoys, 70.6%), killer (35, 23.3%), sperm (32 buoys, 21.3%), humpback (31, 20.6%), gray (7, 4.6%), and North Pacific right (3, 2.0%) whales. Other signals detected include bowhead whales (1, 0.6%), walrus (3, 2.0%), unidentified pinniped (1, 0.6%), earthquakes (1, 0.6%), and distant seismic airguns (1, 0.6%).

Estimated Angle and Distance Experiment

The Estimated Angle and Distance Experiment was conducted on 2 September for 6 hours 45 minutes whilst in the research area. A total of 72 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 14 marine macro debris objects were observed. Four items were recorded ʻon effortʼ (i.e., during the first 15 minutes of each hour) and 10 items were recorded during ʻoff effortʼ.

Satellite tagging studies

Deployment of SPLASH10-f-333 (Wildlife Computers, U.S.) during the high sea transit was planned but no attempt was made during this cruise due to inclement weather during the high sea transit.

HIGHLIGHTS OF THE SURVEY

It is concluded that the 2024 IWC-POWER survey was completed successfully by a group of international scientists and crews (Figure 6), 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.

Table 5

Summary of the Photo-IDʼd experiments, by each species conducted during the entire 2024 IWC-POWER survey.

Photo-ID	Fin	Humpback	Gray	Bowhead	Killer	Total
Entire 2024 IWC-POWER	34	14	5	1	10	64

Table 6

Summary of the number of species-specific biopsy samples collected in the entire 2024 IWC-POWER survey.

Biopsy samples	Fin	Sei	Humpback	Gray	Killer	Total
Entire 2024 IWC-POWER	7	2	8	3	1	21

Figure 6. Researchers and crew of the 2024 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.

This was the first time for POWER to enter the southern Chukchi Sea stratum mainly for gray whale studies. During the 2024 POWER cruise, only small concentrations of fin and humpback whales were observed around the Pribilof Islands in the southeastern Bering Sea stratum. Notably, they were virtually absent in Bristol Bay and the right whale critical habitat in 2024. These two species were widely distributed in this stratum in the 2017 POWER cruise, but sightings were rare on the shelf in 2024 compared to 2017. The differences between 2017 and 2024 need further investigations.

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Commentary

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

The establishment of a new research hub of the Institute of Cetacean Research in Taiji: meeting science with 400 years of whaling tradition

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In April 2024, the Institute of Cetacean Research (ICR) established a new research facility in Taiji Town, Wakayama Prefecture, the ICR Taiji Office. The ICR Taiji Office is situated within the newly completed International Cetacean Center (ICC), located at an elevation of over 80 meters above sea level making it less vulnerable to tsunamis, and has advanced research laboratories (Figure 1). The ICC spans approximately 1,880 square meters and has a reference library comprising over 30,000 volumes, multiple conference rooms, and a 90-seat lecture hall, all of which are accessible to the public. The ICR Taiji Office is equipped with laboratories for genetic, chemical, and biological analyses. It also features a wet laboratory, specimen and storage rooms. Yet, the significance of this establishment could extend far beyond the scientific infrastructure.

Why should one of Japan′s foremost research institutes have chosen to embed itself in Taiji Town—a small coastal town of fewer than 3,000 residents and of 5.81 square kilometers, one of the smallest in Japan? This article attempts to explain the reasons behind the establishment of the ICR Taiji Office. At the start, we would like to state that the ICR Taiji Office can be identified as a site where science and cultural traditions intersect, highlighting the role of diversity—biological, cultural, and epistemic—in shaping more inclusive approaches to sustainable resource management.

The rationale for establishing the ICR Taiji Office

Taiji is known as the birthplace of traditional Japanese whaling some 400 years ago. Whaling continues to be the main activity of the town in practice. The relationship between Taiji Town and the ICR can be traced back to the preparatory period for the establishment of the Taiji Whale Museum in the 1970s, when Professor Masaharu Nishiwaki and Dr. Seiji Ohsumi contributed to its foundation by organizing biological specimens and strengthening its scientific resources at the town′s request. Following this, ICR experts continued to provide academic advice on cetacean research in Taiji, building a foundation of scientific cooperation between the ICR and the town. A key moment in the evolution of this relationship came in 2011, however, when the marine station of the ICR located in Ayukawa, Miyagi Prefecture was extensively damaged by the Great East Japan Earthquake and subsequent tsunamis that affected mainly the north-eastern Japan. The earthquake and tsunamis swept away research instruments and equipment, as well as whale tissue samples stored at the marine station, making continued operation of the station impossible. At that time, Taiji Town generously offered provisional facilities to the ICR, which marked the beginning of further development to a long-term relationship, aligned with Taiji′s broader initiative to cultivate an academic identity—evolving from ′catch and consume′ to ′display and educate′ and, ultimately, to ′learn and research′.

While the establishment of the ICR Taiji Office originated in part from contingency, it may ultimately be seen as symbolic move to locate the research facility in a place that embodies the potential intersection between science and whaling tradition. This may not only represent a rational choice but also carry symbolic significance in linking the history of whaling with contemporary scientific knowledge, bridging accumulated experience with formal scientific understanding.

Enhancing conservation through sustainable use of whale resources based on science

One of the main aims of the ICR is to carry out scientific research on marine mammals to facilitate sound stock assessment. In this way, the sustainability in the use of some whale species is ensured. ICR and its researchers have carried out national whale research programs both in the western North Pacific (JARPN/JARPNII, NEWREP-NP) and the Antarctic (JARPA/JARPAII, NEWREP-A, JASS-A). ICR also collaborate in international whale research

Figure 1. External view of the International Cetacean Center (ICC) where the Institute of Cetacean Research Taiji Office is situated (top left); central hall of the ICC (top right); chemical laboratory (bottom left); lecture hall (bottom right).

initiatives such as the IWC POWER program in the North Pacific. These research programs are conducted to obtain the samples and data necessary for stock assessment, and for understanding the role of whales in the ecosystem. These long-term programs, though carried out beyond Taiji, constitute the core scientific foundation underpinning the resource-assessment research and initiatives currently being advanced in Taiji, grounded in decades of evidence-based practice.

The establishment of ICR Taiji Office has, therefore, the potential to further enhance the use of cetacean resources in the town under the sustainability principle. The sustainable use of biodiversity has been clearly articulated in international frameworks that Japan has endorsed. For example, Article 10 on sustainable use and Article 8(j) on traditional knowledge of the Convention on Biological Diversity (CBD) stated that '*Today our only option is to manage productivity and resources in a sustainable manner, reducing waste wherever possible, using the principles of adaptive management, and taking into account traditional knowledge which contributes to the maintenance of ecosystem services*'. Also, the United Nations Convention on the Law of the Sea (UNCLOS), emphasizes the integration of traditional knowledge and scientific management in resource governance.

By upholding scientific accountability based on evidence, it may become possible to move beyond emotional conflict and foster constructive international dialogue. The integration of Taiji's sustainability practices with the science of ICR can transcend the binary of 'use versus preservation', offering a practical framework for resource governance that aligns with major international organizations and agreements. Within this global legal and policy architecture, the ICR can be positioned as a scientific institution that supports sustainable resource management and international dialogue.

The enduring legacy of Taiji's sustainable use and resilience continues to shape the community's ethos today. These initiatives built an empirical foundation for sustainable use, but their significance in context of sustainability itself was often dismissed internationally. Despite this, both the ICR and this small town continued their missions quietly. The establishment of ICR Taiji Office may be seen as this intersection of these parallel efforts—tradition and science, local and global perspectives, past and future. It represents a commitment to transcend polarized debates and work toward a shared vision of coexistence. The whaling issues are highly complex and located at the huge intersection of history, politics, culture, ethics, human rights and environment. As Hamlet once questioned whether to endure or to act, humanity too faces a choice in how it responds to these complex challenges. Science can act as a guiding torch, illuminating common ground and fostering constructive dialogue.

Vision and outlook of the ICR

Leveraging both the Tokyo Office and the well-equipped Taiji Office, the ICR aims to achieve greater efficiency in cetacean research and stock assessments. In particular, the Taiji Office will further advance experimental research through its laboratory capacity, thereby strengthening scientific foundations of the ICR. Simultaneously, as a scientific center, the ICR recognizes its responsibility to engage actively in educational and outreach activities for residents including children and students. It is also committed to pursuing the mission of passing on to the next generation the significance of cetacean diversity, the marine ecosystem around Japan, cetacean science, and whale-based food culture. Furthermore, by fostering collaboration with international research institutions and advancing global research on the sustainable use and conservation of cetaceans, the ICR aspires to serve as a hub that shares scientific achievements and insights with the world for sustainability of both human and marine resources.

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Commentary

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Importance of Japan-Russia Cooperation in Cetacean Research in the Sea of Okhotsk

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It is known that many cetaceans migrate to feeding grounds in the Sea of Okhotsk during the boreal summer season, and surveys in this area can provide highly accurate abundance estimates as well as useful ecological information. Among the cetacean migrating into the Sea of Okhotsk, the common minke whale has been the subject of sighting surveys and related ecological research in this area since the late 1980s, in the context of a research cooperation between Japan and the Russian Federation. Results of this research collaboration contributed to the comprehensive assessment and in-depth assessment of this species by the International Whaling Commission Scientific Committee (IWC SC). These surveys have also contributed to the domestic management of Dall's porpoises, which was once one of the most important species in the Japanese dolphin fishery. After Japan's withdrawal from the IWC in 2019, further strengthening of the whale research collaboration between Japan and the Russian Federation in the Sea of Okhotsk is expected as updated abundance estimates of common minke whale in this area is important for the calculation of catch quotas of this species for Japan's sustainable commercial whaling in its Exclusive Economic Zone and Territorial Sea in line with the IWC's Revised Management Procedure.

History of cooperation

The first sighting survey conducted by Japan with permission to enter Russia's Exclusive Economic Zone (EEZ) in the Sea of Okhotsk was in 1989 during the former Soviet Union era. The main purpose of this first survey was to get information on the distribution of common minke whales. Although this year's survey was a preliminary feasibility study, it was very significant because it was the first time that a systematic sighting survey was conducted in the northernmost part of the Sea of Okhotsk. Following this, in 1990, two vessels conducted a full-scale sighting survey in the Sea of Okhotsk and off the eastern coast of the Kuril Islands on the Pacific side. Based on sighting data collected during this survey, the International Whaling Commission Scientific Committee (IWC SC) conducted a common minke whale abundance estimation (Buckland *et al.*, 1993). Later, in the late 1990s, sighting surveys in the Sea of Okhotsk were resumed in preparation for the IWC's common minke whale Revised Management Procedure (RMP) implementation trials, as the revision of the abundance of this species again became an important goal. However, it was noted that the sighting survey method was changed from the original approach to the Independent Observer (IO) method. The IO method is a less biased method for estimating abundance by considering the probability of missing whales on the track line. After a preliminary feasibility study, an IO mode sighting survey in the Sea of Okhotsk was conducted in 2003 using two research vessels, and based on the results of this survey, a revision of the abundance estimation was conducted (Okamura *et al.*, 2010).

In the process of RMP implementation of common minke whale, it was found that two stocks of this species, the Okhotsk Sea–West Pacific stock (O-stock) and the Sea of Japan–Yellow Sea–East China Sea stock (J-stock),

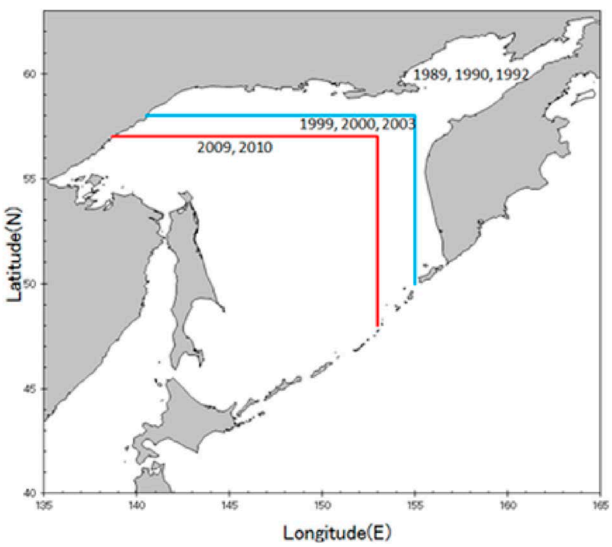

Figure 1. Expansion of Russian restricted area for sighting surveys.

mix from spring to fall in the Sea of Okhotsk, and the estimation of the mixing rate became an important issue. Therefore, at the end of the 2000′s, epidermal samples were collected by biopsy sampling and DNA analysis was conducted to estimate the stock mixing rate of this species in the Sea of Okhotsk. However, since the Russian export permit under Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) was not granted, the DNA analysis had to be conducted at the field using a simple approach. However, the initial objective was achieved (both stocks are mixed in the southwestern part of Okhotsk, while the O-stock occupies most of the northeastern part) (Yoshida *et al.*, 2011). However, due to the small number of samples, continued collection of DNA samples has been required.

On the other hand, the extent of the research area for sighting and biopsy sampling in the Sea of Okhotsk was gradually decreasing until the 2000′s for security reasons as shown in Figure 1. The restricted coastal areas, which are known to have a relatively high density of common minke whales, increased gradually. The importance of surveying this area was recognized. However, the existence of a restricted area by Russia prevented surveys by Japanese vessels in the coastal areas for a long time. Considering this situation, sighting surveys by Russian vessels was planned (instead of Japanese vessels) since the mid 2010′s and has been continued until recent days as a joint survey by Japan and Russia.

Past results

Japanese research vessels during the Japan-Russia joint sighting surveys in the Sea of Okhotsk that started in 1989 discovered six species of baleen whales: common minke, fin, sei, humpback, North Pacific right and gray

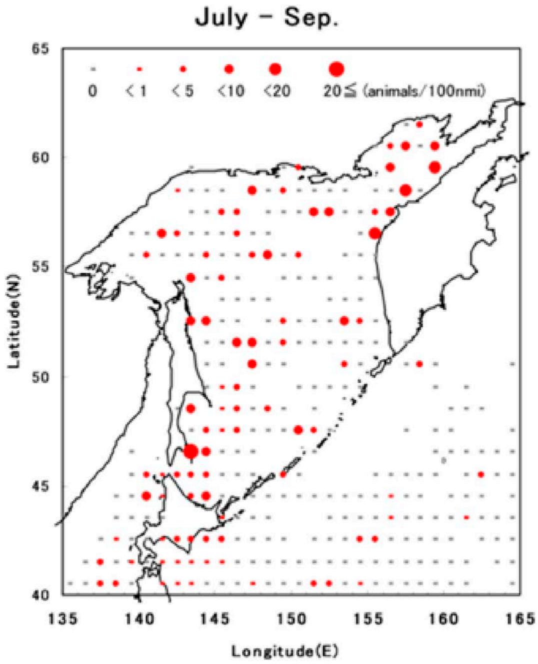

Figure 2. Density index of common minke whales (No. animals/100 n.miles) based on sighting surveys in the Okhotsk Sea and adjacent waters.

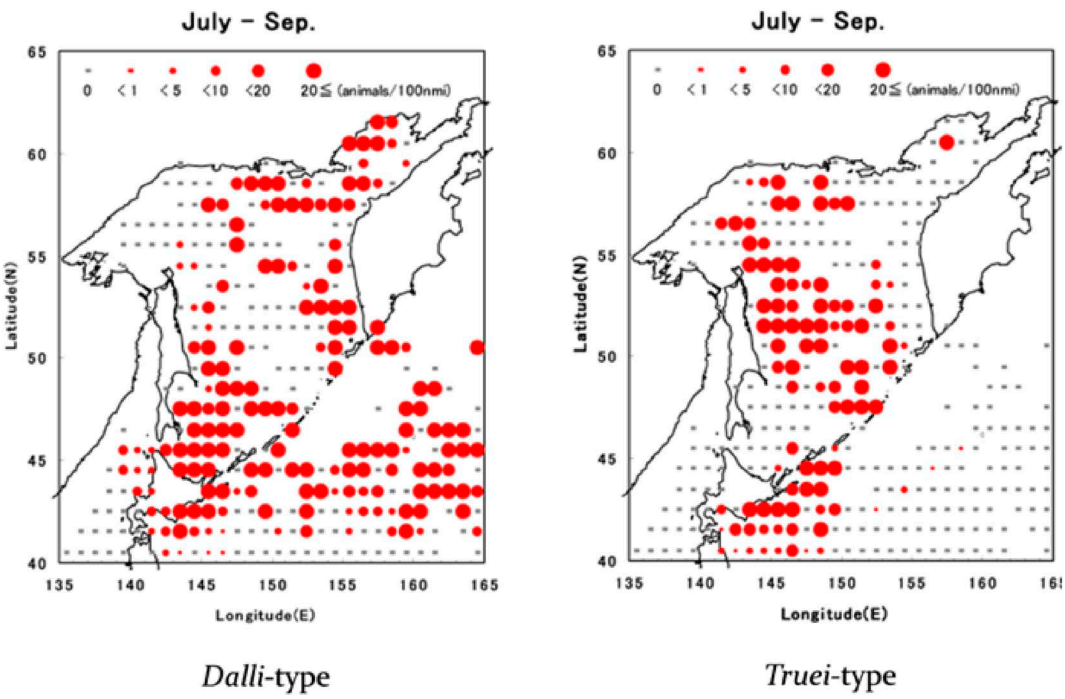

Figure 3. Density index of Dall′s porpoises (No. animals/100 n.miles) based on sighting surveys in the Okhotsk Sea and adjacent waters.

whales, and six species of toothed whales: sperm, Baird's beaked, killer, Pacific white-sided dolphin, Dall′ porpoise and harbor porpoise. Since bowhead and beluga whales are mainly distributed in the northern coastal waters (IWC, 1993; Rugh *et al.*, 2003), sightings of these species were made only when coastal areas were surveyed by a Russian research vessel, in the late 2010s.

Information on the distribution of common minke whales and Dall's porpoises, which have been the most important species since the beginning of the joint project, was presented in terms of the number of animals found per survey distance (per one degree of latitude and longitude) (Miyashita and Zharikov, 2013). The sighting data used were obtained from July to September from 1989 to 2003. Common minke whales were widely distributed throughout the Sea of Okhotsk but the species is clearly more abundant closer to the coast (Figure 2). This species is known to congregate in small bays and near shore areas, and current sighting surveys, which do not adequately survey very nearshore areas, may underestimate abundance estimates.

Two body color types, *Dalli*-type and *Truei*-type, are known, with the former distributed mainly in the southwestern and northeastern regions and the latter mainly in the central region (Figure 3). Based on the distribution of mother and calf pairs, which suggested the reproduction area, three stocks were distributed in the Sea of Okhotsk: two *Dalli*-type stocks in the southwestern and northeastern areas, and one *Truei*-type stock in the central area.

Need for future research cooperation

There are several considerations regarding future research cooperation in the Sea of Okhotsk. First, since important cetacean species migrate to the Sea of Okhotsk during the boreal summer season, continued cooperative sighting surveys for monitoring purposes is essential. Second, since sighting surveys of the entire Sea of Okhotsk are desirable, surveys by Russian vessels, which are capable of surveying coastal areas, are important. However, it is not easy to cover the entire Sea of Okhotsk in a limited period, so ideally surveys could be divided between Japanese vessels covering the central area and Russian vessels covering the coastal area. Third, the collection of biopsy samples of common minke whale is very important. This requires equipment and expertise (for the operations in Russian vessels) and CITES import permits (for the operations of Japanese vessels). These aspects should be addressed to expedite the process. Fourth, photo-id work for individual identification and matching should be promoted for some relevant species as such exercise will contribute to understanding movement and migration. This work is in progress for North Pacific right, humpback and killer whales.

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National meetings

Participation of scientists from the Institute of Cetacean Research in National Meetings in 2025

The 91st Annual Meeting and Symposium of the Tohoku Branch of the Japanese Biochemical Society

The Japanese Biochemical Society (JBS) was established in 1925. The JBS is a leading academic organization in Japan dedicated to advancing the field of biochemistry and molecular biology. The JBS is also an active member of international scientific communities, including the Federation of Asian and Oceanian Biochemists and Molecular Biologists and the International Union of Biochemistry and Molecular Biology. Through its activities, the JBS plays a vital role in fostering innovation, education, and scientific excellence in Japan and beyond.

The 2025 Annual Meeting of the Tohoku Branch of the JBS was held on 14 June at the Tohoku Medical and Pharmaceutical University, Miyagi. Yasunaga from the Institute of Cetacean Research (ICR) participated in the meeting as a co-author of the study titled 'The nasal administration of balenine improves the pathology of MPTP-induced Parkinson's disease in mouse models'.

The 2025 Spring 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 JSFS 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 2025 Spring Meeting of the JSFS was held from 26 to 29 March at Kitasato University, Sagamihara Campus, Kanagawa. Yamada, Katsumata, Isoda and Hakamada from the ICR presented the study titled 'Development of passive acoustic monitoring methods for baleen whales during autumn and winter'. Additionally, Isoda, Taguchi, Goto and Katsumata participated as co-authors in three research presentations: 'Abundance estimation of Antarctic krill in the NEWREP-A survey area (35°–165°E)', 'Population genetic analysis of humpback whales around Hachijojima using microsatellite DNA and SNPs', and 'Humpback whale return rates to waters around Hachijojima using whale watching data (2016–2023)'.

Venue of the 2025 Spring Meeting of the Japanese Society of Fisheries Science (Kitasato University, Sagamihara Campus, Kanagawa, Japan).

The 25th Tokyo Bay Symposium

The 25th Tokyo Bay Symposium was organized by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) to bring together private companies, NPOs, citizens, universities, research institutions, and government bodies to share the latest knowledge, and consider the better environment and future of Tokyo Bay.

The symposium was held on 17 October at the Osanbashi Hall in Yokohama, Kanagawa. This year's theme was 'Research on marine organism reproduction in coastal areas', emphasizing the need for environmental restoration in coastal areas including harbors with greater consideration for the prosperity and generational succession of marine organisms. The symposium featured lectures by experts from various fields to deepen understanding of coastal environmental restoration. Katsumata from the ICR gave a lecture titled 'Environmental conditions of humpback whale breeding areas inferred from the sudden appearance around Hachijojima'.

The 25th Tokyo Bay Symposium venue (Osanbashi Hall, Osanbashi International Passenger Terminal, Kanagawa, Japan) (left) and lecture on humpback whale breeding areas at the symposium (right).

The 42nd Kyushu–Yamaguchi Branch Meeting of the Pharmaceutical Society of Japan

The Pharmaceutical Society of Japan (PSJ), founded in 1880, is a leading academic organization that advances pharmaceutical sciences throughout the country. The Kyushu–Yamaguchi Branch plays an important role in promoting research collaboration and education among universities and institutes in the region.

The 42nd Annual Meeting of the PSJ was held at Kyushu University on 15 November. Yasunaga, Sakai and Inoue from the ICR participated as co-authors of the study entitled ʻAnalysis of *D*-aspartic acid, *D*-alanine, and *D*-serine enantiomers in plasma and urine of the common minke whale from the western North Pacificʹ. The results provided a basis for future investigations of *D*-amino acids in marine mammals and their physiological significance.

The 2025 Marine Ecosystem Modeling Symposium

The 2025 Marine Ecosystem Modeling Symposium was held from 11 to 12 December at the Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Chiba, jointly organized by the Japan Fisheries Research and Education Agency and the Japanese Society of Fisheries Oceanography (JSFO). The symposium theme was ʻCurrent status of input data and utilization of model outputs for understanding ecosystem structure and functionʹ. The program consisted of three sessions: Input, Modeling, and Output, aiming to promote integrated understanding of marine ecosystems through practical examples of population dynamics models, food web models, and species distribution models. Katsumata and Hakamada from the ICR presented the study titled ʻInvestigating abundance and habitat of large whales — from survey design to analytical methodsʹ in the Input Session of the symposium.

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International meetings

Participation of scientists from the Institute of Cetacean Research in International Meetings in 2025

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 2025 NAMMCO SC Meeting (SC31) was held from 21 to 24 January in Tromsø, Norway. Three scientists from the Institute of Cetacean Research (ICR) participated in the meeting (Pastene, Konishi and Murata) as observers from Japan. They presented the following documents: 1) the 2023–2024 Japan progress report on large cetacean research, 2) the 2022–2023 Japan progress report on small cetacean research, 3) the 2023–2024 report on satellite tagging experiments at the ICR, 4) the progress of the intersessional work on the NAMMCO-Japan research collaboration on Northeast Atlantic-Northwest Pacific Ecosystem and 5) outline of an international workshop on the use of genetic data for the identification of whale stocks, which was held in Taiji, Wakayama, Japan. Furthermore, they provided two published papers for information to the meeting, which dealt with epigenetic studies on Antarctic minke whale. The report of the meeting can be found on the website of NAMMCO (https://nammco.no/wp-content/uploads/2025/02/report_sc31.pdf).

Marine Mammal Welfare Workshop and the 2025 Annual Meeting of NAMMCO Council

The NAMMCO Workshop on Marine Mammal Welfare was held on 24 March at the Fram Centre, Tromsø, Norway. The workshop, co-organized by NAMMCO and Japan, brought together about 60 participants—including hunters, veterinarians, scientists, and managers—from 11 communities and countries. Chaired by Ichiro Nomura from the Fisheries Agency of Japan (FAJ), the discussions focused on assessing welfare outcomes in marine mammal hunts. Presentations from regions of several countries, including Japan, were focused on the improvement of methods, data collection, and the importance of sharing experience to strengthen welfare standards while respecting cultural traditions. Yasunaga from the ICR presented the study titled 'The killing methods and data of time to death of cetaceans in the Japanese commercial whaling'.

Subsequently, the 32nd Annual Meeting of NAMMCO Council was held from 25 to 27 March in the same facility. Japan joined the meeting as an observer country, represented by officials from the FAJ, the Ministry of Foreign Affairs, the Ministry of Justice, and ICR (Yasunaga). The meeting reaffirmed NAMMCO's principle of sustainable use and responsible hunting of marine mammals and addressed key topics such as the outcomes of the North

Participants of the 31st Meeting of the NAMMCO Scientific Committee held at the Fram Centre, Tromsø, Norway.

The Fram Centre, Tromsø, Norway.

Atlantic Sightings Survey (NASS), the MINTAG satellite tagging project conducted with Japan, and the role of NAMMCO in contributing to the United Nation's Sustainable Development Goals. The meeting provided a valuable opportunity to exchange views on animal welfare and management, confirmed Japan's cooperative role, and strengthened international networks for the sustainable use of marine mammal resources.

NAMMCO Abundance Estimate Working Group (AEWG)

NAMMCO Abundance Estimates Working Group (AEWG) Meeting was held at the Greenland Representation in Copenhagen, Denmark, from 23 to 26 September. Scientists from four NAMMCO country members, five Invited Participants (IPs), four observers and two members from the NAMMCO Secretariat participated in the meeting. One scientist from the ICR (Hakamada) and one scientist from Tokyo University of Marine Science and Technology (TUMSAT) (Kitakado) participated in the meeting as observer and IP, respectively. Scientists from Greenland, Faroe Islands, Iceland and Norway presented their abundance estimates of several cetacean species based on NASS 2024, which were reviewed at the workshop. Scientists representing the International Whaling Commission (IWC) Scientific Committee's Abundance Estimates, Stock Status and International Cruises (ASI) working group were also present at the meeting.

NAMMCO Genetic Working Group meeting

The NAMMCO Genetic Working Group meeting was held online on 28 October, with an ICR scientist (Taguchi) attending as observer. The WG reviewed new information on the genetic structure of North Atlantic pilot whales and compared it with that in the existing literature. Preliminary genomic results showed no population structure across the North Atlantic but confirmed clear differentiation from the Mediterranean pilot whale. The WG agreed that the analyses show no evidence of genetic structure within the North Atlantic and recommended several additional analyses to reveal adaptive variation. These conclusions will inform the stock assessment to be carried out by the NAMMCO's Pilot Whale Working Group (PWWG) later in 2025.

Greenland Representation in Copenhagen, Denmark, venue for the AEWG Meeting.

NAMMCO-Japan MINTAG project meetings

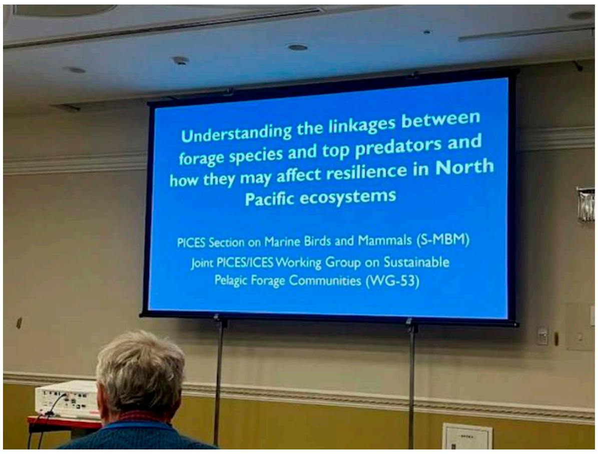
NAMMCO and Japan have agreed on a collaborative project to develop a new satellite tag suited for use on fast swimming rorquals (fin, sei, Bryde's, blue and minke whales) and pilot whales, which are of most interest to NAMMCO countries and Japan. The project is called MINTAG project. The project started in 2022 and will run for five years. The project is divided into four 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 FAJ. Yearly reports are available at https://mintag-project.com/about-us/#reports.

An in-person MINTAG Steering Group meeting was held from 19 to 20 January at the Fram Centre, Tromsø, Norway, with participation of Konishi (ICR). The main topic of this meeting were the evaluation of the tag performance for the 2024 deployments, and a web blog for the project in 2024 (https://mintag-project.com/follow-the-whales/#mintag-2024). During the year, Steering Group meetings were held online to discuss different technical aspects and progress of the MINTAG project; on 13 and 21 March (with participation of Konishi and Pastene from ICR) and on 30 April, 9 May, 8 September and 6 November (with participation of Katsumata and Pastene from ICR).

Korea–Japan Symposium on the Survey and Assessment of Cetaceans in the Northwest Pacific

The Korea–Japan Symposium on the Survey and Assessment of Cetaceans in the Northwest Pacific was held from 26 to 28 June at the Cetacean Research Institute (CRI) of the National Institute of Fisheries Science in Ulsan, Korea. The event was hosted by the CRI and brought together researchers from Japan and Korea to exchange knowledge and explore cooperation on line-transect data analysis, current sighting surveys, stock assessment strategies, and age estimation methods for baleen whales. Two scientists from the ICR (Matsuoka and Yasunaga), and one

The Cetacean Research Institute in Ulsan, Korea (left), and participants of the Korea–Japan Symposium (right)



Images of the 2025 Annual Meeting of the North Pacific Marine Science Organization held in Yokohama.

from TUMSAT (Kitakado) participated in the symposium. Matsuoka presented the study titled 'Sighting survey and assessment of whales in Japan', and Yasunaga presented the study titled 'Age estimation approaches of baleen whales: Especially AAR method based on aspartic acid isomerization in lens core' and other titled 'Topic: Strategies for Whale Health Research—Using Chemical Pollutants as an Example—'.

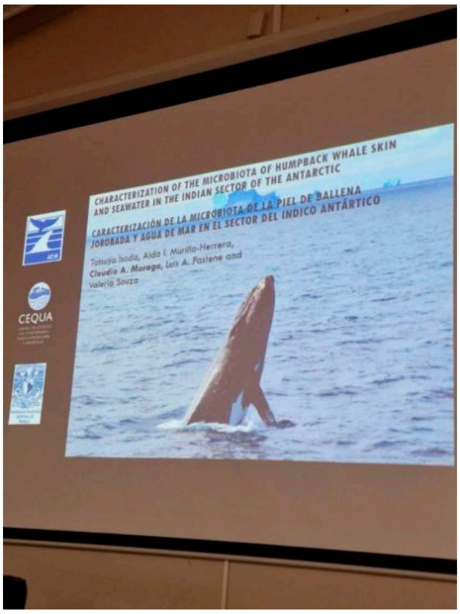
Annual Meeting of the North Pacific Marine Science Organization (PICES)

The North Pacific Marine Science Organization (PICES) is an intergovernmental science organization established in 1992. The aim of PICES is 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 of the member countries. The present members of PICES are Canada, Japan, People's Republic of China, Republic of Korea, the Russian Federation, and the United States of America.

The 2025 Meeting of the PICES was held in Yokohama, Kanagawa, Japan. The business meeting of the Marine Bird and Mammals (S-MBM) section was held on 8 November. Under the session 'Understanding the Linkages Between Forage Species and Top Predators and How They May Affect Resilience in North Pacific Ecosystems' held on 11 November, Tamura, Isoda and Fujise from the ICR presented the study titled 'The yearly changes of prey species and prey consumption by common minke, sei and Bryde's whale in the western North Pacific since 2000'. The report of the PICES Meeting can be found on the website of PICES (https://meetings.pices.int/).

X Latin American Congress on Antarctic Science/XII Chilean Congress of Antarctic Research

The 'X Congreso Latinoamericano de Ciencia Antártica/XII Congreso Chileno de Investigaciones Antárticas' (X Latin American Congress on Antarctic Science/XII Chilean Congress of Antarctic Research) was held at Universidad Austral de Chile (UACh) in Valdivia, Chile, from 28 July to 1 August. The meeting was organized by the Centro de Investigación Dinámica de Ecosistemas Marinos de Altas Latitudes (IDEAL) of the UACh and was supported by the Instituto Antártico Chileno (INACH) based in Punta Are-



Presentation of the study on humpback whale microbiota at the X Latin American Congress on Antarctic Science/XII Chilean Congress of Antarctic Research held in Valdivia, Chile.

A session of the 2025 Annual Meeting of the Convention on the Conservation of Antarctic Marine Living Resource's Working Group on Ecosystem Monitoring and Management held in Geilo, Norway.

nas, and the Scientific Committee on Antarctic Research (SCAR), represented in Chile by the Consejo Nacional de Investigación Antártica (CNIA). Isoda and Pastene from the ICR, through co-author Moraga (Centro de Estudios del Cuaternario de Fuego-Patagonia y Antártica, CEQUA), presented the study titled 'Characterization of the microbiota of humpback whale skin and seawater in the Indian sector of the Antarctic', which resulted from a research collaboration between ICR and CEQUA, a research institution in Punta Arenas, Chile, dedicated to the biological and ecological research in Chilean Patagonia.

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. CCAMLR has a Scientific Committee and several Working Groups. One of these is the Working Group on Ecosystem Monitoring and Management (EMM), which meets annually.

The 2025 Meeting of the EMM Working Group was held from 7 to 18 July in Geilo, Norway. The main items on the meeting agenda 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 and colleagues from ICR submitted a document titled 'Results of the Japanese Abundance and Stock structure Survey in the Antarctic (JASS-A) during the 2024/2025 austral summer season', which was presented by Murase (TUMSAT).

The 2025 Ecosystem Studies of the Subarctic and Arctic Seas (ESSAS) Open Science Meeting

The Ecosystem Studies of Subarctic and Arctic Seas (ESSAS) is a regional program of Integrated Marine Biosphere Research (IMBER) that addresses the need to understand how climate change will affect the marine ecosystems of the Subarctic and Arctic Seas and their sustainability. Originally established in 2005 as a GLOBEC regional program focusing on Subarctic seas, ESSAS expanded its geographic scope in 2015 to include Arctic regions. The ESSAS program conducts comparative studies to quantify and predict the impact of climate variability on the productivity and sustainability of these marine ecosystems through four working groups focusing on regional climate prediction, biophysical coupling, ecosystem modeling, and gadoid-crustacean interactions.

The 2025 ESSAS Open Science Meeting entitled 'Past, Present and Future of Marine Biodiversity and Ecosystems' was held from 24 to 26 June at the National Institute of Polar Research in Tachikawa, Tokyo, Japan.

Presentation of the POWER program at the 2025 ESSAS Open Science Meeting held in Tokyo, Japan.

Katsumata from the ICR presented the study ʹOverview of the North Pacific Ocean Whale and Ecosystem Research Programme (POWER) from 2010 to 2025ʹ.

The 2025 International Ocular Inflammation Society (IOIS) Congress

The International Ocular Inflammation Society (IOIS) is an academic organization dedicated to advancing research and clinical practice related to ocular inflammation. The congress of the Society provides a platform for presenting new findings and promoting international scientific exchange on this topic.

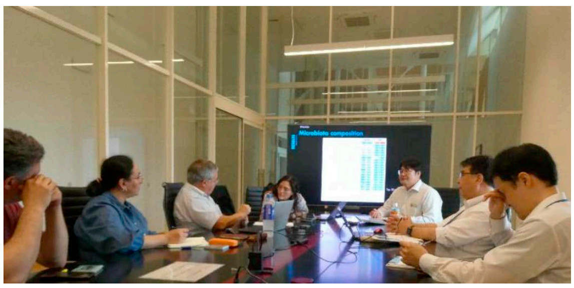
The 2025 IOIS Congress was held in Rio de Janeiro, Brazil from 25 to 28 June. The Congress featured a wide range of presentations in ocular immunology and retinal disease research. Yasunaga, Sakai and Fujise from ICR participated as co-authors in a collaborative study that examined the physiological effects of ω-3 long-chain polyunsaturated fatty acids (LCPUFAs) derived from whale oil on choroidal neovascularization. This presentation received an IOIS Congress Award, recognizing the studyʹs contribution to advancing understanding of nutritional modulation in ocular inflammation and pathophysiology of age-related macular degeneration.

International Ocular Inflammation Society 2025 ʹBest Free Paper—Category Poster Presentationsʹ Award Certificate.

International mini workshop on microbiota research at the Institute of Cetacean Research Taiji Office

The Executive Director (Paola Acuña) and Scientific Director (Jorge Acevedo) of CEQUA, a research institute located in Punta Arenas, Chile dedicated to the biological and ecological research in the Chilean Patagonia, visited the ICR Taiji Office from 3 to 6 October 2025. The visit was carried out in the context of a Memorandum of Understanding (MOU) signed by ICR and CEQUA in November 2022, which had as aim to facilitate long term research cooperation between ICR and CEQUA in the field of cetacean conservation and management. Acuña and Acevedo were accompanied by a doctoral research student (Aída Murillo) of the Universidad Nacional Autónoma de México (UNAM). Apart from offering lectures to the public of Taiji on the research activities of CEQUA, including specific research activities on whales, they and ICR scientists participated in a mini workshop on the feasibility of implementing microbiota research in ICR.

From the ICR, Fujise (Director General), Yasunaga (Head of Science), Isoda (Vice-Director of Research Department 1), Sugimoto (scientist from the Genetic Ecology Section), and Pastene (Scientific Advisor) participated in the mini workshop. The mini workshop, held on 5 October, had two main sections. The first section was dedicated to lectures including an introduction to microbiota research using DNA sequences of the 16S rRNA gene; and microbiota research in humpback whales from Stock D and G in the Southern Hemisphere. The second section was dedicated to panel discussions on the feasibility of implementing microbiota research on whales and environment at the ICR. The panel discussion was organized to discuss objectives, platforms and protocols for sampling, laboratory and analytical work and future microbiota research collaboration between ICR and CEQUA. Results of the mini workshop are being examined and evaluated by the ICR.



International mini workshop on microbiota research at the ICR Taiji Office, Wakayama, Japan.

Mid-term international review workshop of the Japanese Abundance and Stock structure Surveys (JASS-A)

The Japanese Abundance and Stock structure Surveys (JASS-A) is a research program designed and implemented by the ICR and authorized by the Government of Japan (GOJ) in the Antarctic. The main research objectives of JASS-A are: 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 and whale biology. JASS-A is based on systematic sighting surveys using Distance sampling (line transect), which are conducted alternatively in IWC Areas III, IV, V and VI by one or two specialized vessels. The tentative period of JASS-A is eight austral summer seasons (2019/20–2026/27).

The mid-term international review (MTR) workshop of JASS-A was carried out successfully in Tokyo between 20 and 22 October 2025 under two Terms of Reference: i) to evaluate the works conducted so far (2019/20–2024/25) in the context of the main and secondary objectives of JASS-A; and ii) to discuss recommendations for further field and analytical works with the aim of achieving the main and secondary objectives of JASS-A by the time of the final review of the program (after the final survey in 2026/27). A total of 28 scientific documents derived from the JASS-A program was discussed between Japanese scientists and invited participants from Norway, United Kingdom, Germany and South Africa. A total of 24 scientists, two government officials (FAJ) and two interpreters participated in the workshop. The scientific outputs from the JASS-A program were well evaluated and useful suggestions and recommendations were provided by the MTR workshop, which will improve the ICR's Antarctic research in the future.

Participants of the JASS-A mid-term international review workshop held in Tokyo, Japan.

Sixth Joint Meeting of the Acoustical Society of Japan and the Acoustical Society of America

The Acoustical Society of Japan (ASJ) was founded in 1936 by 15 physicists and has evolved into an interdisciplinary society along with the development of acoustics. Acoustics was originally a branch of physics. However, as a result of incorporating aspects of physiology, psychology, and computer science, it became an extensive field with various applications. The ASJ has eight technical committees.

A Joint Meeting of the Acoustical Society of Japan (ASJ) and the Acoustical Society of America (ASA) was held from 1 to 5 December at the Hilton Hawaiian Village Waikiki Beach Resort in Honolulu, Hawaii, USA. This international collaboration brings together acousticians from across the Pacific to exchange research findings and advance the field of acoustics. The meeting featured technical sessions across all branches of acoustics, including underwater acoustics, animal bioacoustics, acoustical oceanography, signal processing, and noise control. Special sessions and standing sessions were organized to address emerging topics and facilitate focused discussions on specific research areas. Yamada, Katsumata, Isoda and Matsuoka from the ICR presented the study titled 'Passive acoustic monitoring for baleen whale detections during winter off northeastern Japan' in the Baleen Whale Acoustics session of the meeting.

Technical Adviser Group (TAG) Meeting and 2026 cruise planning meeting for the IWC-POWER program

IWC-POWER (Pacific Ocean Whale and Ecosystem Research) is a large international research program aimed to study the abundance and abundance trend of large whales in the North Pacific through annual dedicated sighting surveys. The program is designated and implemented by the Scientific Committee of the IWC through a Steering Group, which in turn includes a Technical Adviser Group (TAG). The TAG usually meets once a year. The IWC-POWER program has carried out surveys with the participation of scientists from Japan, USA, Russian Federation, Republic of Korea and Mexico.

The 2025 TAG meeting and the 2026-2027 cruise planning meeting were held from 7 to 9 December at the International Cetacean Center, Taiji, Wakayama, Japan. The TAG Meeting was co-chaired by Kitakado of the TUMSAT and Matsuoka of ICR. Matsuoka also chaired the planning meeting. In addition, Miyashita, Katsumata and Murata from the ICR participated in the meetings.

II International Meeting for the Study of Aquatic Mammals by the Mexican Society on Aquatic Mammals and Latin American Society of Aquatic Mammal Specialists

Isoda and Pastene from the ICR were co-authors of the study titled 'Colaboración internacional para el estudio de cetáceos en sus áreas de alimentación: el ejemplo de CEQUA (Chile) y ICR (Japón)' (International collaboration for cetacean studies in feeding areas: the case of CEQUA (Chile) and ICR (Japan)), presented to the II Reunión Internacional para el Estudio de los Mamíferos Acuáticos SOMEMMA-SOLAMAC (II International Meeting for the Study of Aquatic Mammals - Mexican Society on Aquatic Mammals and Latin American Society of Aquatic Mammal Specialists), held at Mazatlán, Mexico, from 8 to 12 December.

Peer-reviewed publications

List of peer-reviewed publications based on the Institute of Cetacean Research (ICR)'s surveys up to 2025

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), and JASS-A 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.

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