SC/69A/REP/03/A

Sub-committees/working group name:

Report of Technical Advisory Workshop on Planning for the Medium-Long Term IWC-POWER Programme, Tokyo, 6-10 September 2022

IWC

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1. INTRODUCTORY ITEMS

The Workshop was held at the Japanese Fisheries Agency Crew House, Tokyo, from 6-10 September 2022. The list of participants is given as Annex A.

1.1 Opening remarks and welcoming address

Matsuoka welcomed the participants to the Workshop, expressing his pleasure that a face-to-face meeting was possible and noting that the Scientific Committee had agreed that the complexity of developing the medium-term IWC-POWER programme meant that a face-to-face meeting was essential. Unfortunately, circumstances prevented Staniland, Palka and An from attending but they sent their wishes for a successful meeting and noted their willingness to respond to requests and queries by email. All members of the Steering Group would be given the opportunity to review the draft report.

Fukui, Director for International Fisheries Coordination, Fisheries Agency of Japan welcomed the participants on behalf of the Japanese government in this meeting today. He stressed that the IWC-POWER programme, with its broad coverage of the North Pacific Ocean and with participation of experts from a number of countries, has made a substantial contribution to the development of scientific knowledge and evidence for proper conservation and management of large whales in the North Pacific. Given its outstanding scientific significance and development, Japan is proud to have co-sponsored the IWC-POWER programme over the last 13 years, including this year. He reiterated the thanks of his government to all who have worked for the IWC-POWER programme over many years. Although Japan is no longer a member of the IWC, it is pleased to continue the IWC-POWER programme under a co-operative relationship with the IWC Scientific Committee. Japan is looking forward to discussing the next phase of the IWC-POWER programme during this Workshop.

Although sorry that he was unable to attend in person, Staniland, Head of Science Conservation and Management at the IWC Secretariat sent a written message of support to the Workshop. He thanked all who attended for their continued support in providing expert advice to aid the planning and implementation of this important research programme. The international effort involved is one of the key strengths of the IWC-POWER programme that has provided priceless information on cetaceans for over 10 years. To date researchers from Japan, the Republic of Korea, the USA, Russia, Mexico and the UK have all participated on cruises. The sightings data, biopsy samples and photo-ID photographs feed directly into the work of the IWC Scientific Committee and underpin a great deal of the advice provided to the Commission. He stressed that the programme could not operate without the generous support of the Japanese Government who provide the vessel, crew and some of the scientists. Without this financial and logistical support the IWC-POWER programme would not be able to operate and our understanding of cetacean populations in the North Pacific would be severely limited. He drew attention to the recent comments by the Scientific Committee on the importance of the POWER programme:

> "The Committee reiterates to the Commission the great value of the data contributed by the IWC-POWER cruises which have covered many regions of the North Pacific Ocean not surveyed in recent years. The programme addresses important information gaps for several species and has already contributed greatly to the ongoing assessment work of the Committee."

1.2 Election of Chair and rapporteurs

Matsuoka and Kitakado shared the Chair. Donovan and Goetz acted as rapporteurs.

1.3 Adoption of Agenda

The adopted agenda is shown as Annex B.

1.4 Review of available documents

The list of documents is given as Annex C.

2. REVIEW OF DISCUSSIONS BY THE SCIENTIFIC COMMITTEE AT SC/68D

The IWC agreed (IWC, 2012a) that the long-term IWC-POWER programme

> 'will provide information to allow determination of the status of populations (and thus stock structure is inherently important) of large whales that are found in North Pacific waters and provide the necessary scientific background for appropriate conservation and management actions. The programme will primarily contribute information on abundance and trends in abundance of populations of large whales and try to identify the causes of any trends should these occur. The programme will learn from both the successes and weaknesses of past national and international programmes and cruises, including the IDCR/SOWER programme.'

2.1 Short term options (incl. information gaps)

The short-term (phase 1) objective of the IWC-POWER programme had been to focus on the 'least studied' areas of the central and Eastern North Pacific taking into account national programmes and much of these areas had now been covered with the notable exception of Russian waters. With respect to the short-term options, the Scientific Committee this year recognised the difficulties experienced in obtaining a permit to operate in the Russian waters of the Bering Sea and approved the 'back-up' plans developed to cover the waters south of the Aleutian Island Archipelago. It agreed that at least two more cruises are required to complete the initial programme but recognised that completion of unsurveyed areas of the Western Bering Sea area and East of Kamchatka was dependent on the international situation. The TAG noted these comments and they were taken into account in the discussions of the 2023 and 2024 cruises given in SC/69A/REP3B.

2.2 Medium and long-term (incl. information gaps)

The Committee also endorsed the updated medium-term objectives provided in SC/68C/Rep1. It agreed that the planning for the next phase of the IWC-POWER programme should begin as soon as possible with the aim to have it completed by 2024. In addition to the work undertaken in phase 1, the Committee had agreed that future cruises should have 'an emphasis on participation from all range states and also include consideration of more methodologically focussed cruises in some years (e.g. use of a towed acoustic array, telemetry work, use of SeaGlider etc.)'.

The TAG noted these comments and they were taken into account in its discussions, in particular under Item 7.

3. OBJECTIVES OF THE WORKSHOP

The primary focus of the Workshop was to continue the planning for the next phase of IWC-POWER (medium to long-term) by:

(1) reviewing the general (Item 4) and species-specific outcomes (Item 5) to date of the almost complete phase 1;

(2) reviewing progress on already identified analyses (and identifying any additional analyses) required to complete planning for the second phase by 2024 (see Table 1),

(3) updating the medium-term objectives (see Table 2) and in the light of these provide a broad outline of what phase 2 might look like to guide intersessional work (Item 7).

In addition, the Workshop developed plans for the 2023 cruise and discussed options for the 2024 cruise. Those discussions can be found in SC/69A/REP3B.

4. GENERAL SURVEY APPROACHES USED TO DATE (2010-2021)

The TAG welcomed the provision of Annex D that summarises the cruises undertaken to date and formed an important component of the discussions below.

4.1 Primary and secondary objectives of surveys related to field and analytical methods used given available resources

The aim of the first phase of IWC-POWER was to obtain baseline data on the distribution and abundance of cetaceans in the 'least studied' areas of the central and Eastern North Pacific with the focus on large whales but collecting data on other cetaceans and marine debris. During these surveys, data and samples were collected to assist in clarifying stock structure. This facilitates determination of appropriate management units (units-to-conserve) to allow the elucidation of status and the need if any for actions to reduce anthropogenic pressures that might negatively affect status. Given the lack of knowledge of the present situation in these areas, the initial aim was to cover them as quickly as possible given the resources available, such that the information obtained would guide the development of the medium-term strategy to allow the overall objective to eventually be met.

4.2 Distribution and abundance

4.2.1 Choice of survey areas and cruise track design

Fig. 1 shows the survey areas covered to date and those anticipated to be covered in the first phase of IWC-POWER. The choice of survey areas and strata was largely pragmatic based upon the number of days the vessel was available and transit times but included consideration of historical distribution and densities of the high priority species (see Table X) based upon examination of whaling data and past (1965-82) information from Japanese scouting vessels – see SC/63/Rep5. Some areas have been covered more than once, given the problems in obtaining permits to enter Russian waters. It should be noted that initially, Bryde's whales were not considered a high priority species for IWC-POWER (see SC/63/Rep5) but this was later revised on the advice of the Scientific Committee and hence the areas south of 40N were surveyed from 2013-2016. The fundamental approach to obtain information on distribution and abundance was line-transect survey; cruise design followed standard practice i.e. equal coverage probability using program DISTANCE and a random start point. Valuable information on the distribution/occurrence of cetacean species in these poorly studied areas has been obtained from sightings data and this is summarised by species for the large whales under Item 5.

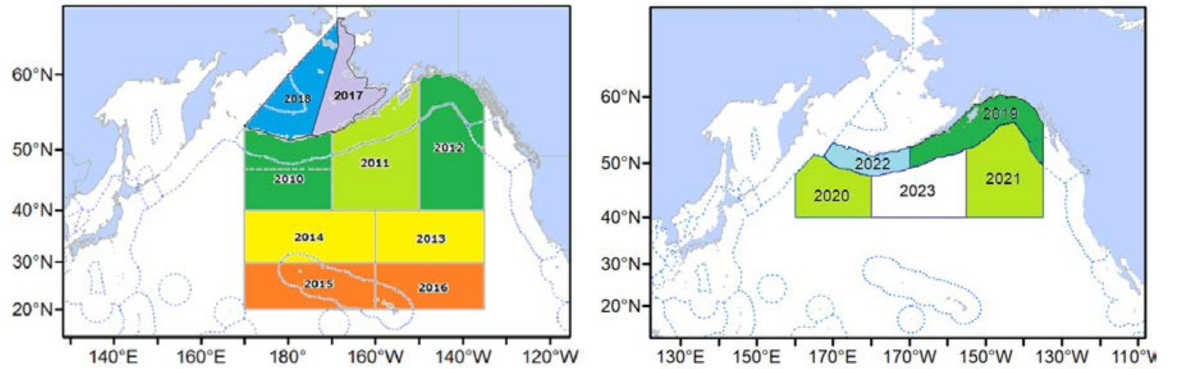

Fig. 1 Survey areas covered to date by year and those anticipated to be covered in the first phase of IWC-POWER. Plans for the 2023 cruise and discussed options for the 2024 cruise can be found in SC/69A/REP3B

4.2.2 Survey methods for Distance sampling (including survey modes, distance and angle experiments) and analytical approaches (design-based and spatial approaches)

4.2.2.3 SURVEY MODE

From 2010-2016, the surveys were carried out in 'NSP' mode (passing mode with abeam closing) that was believed to be the most appropriate given the priority species and the need to close to confirm species identity and group size (as well as to obtain biopsy samples and photographs). Later, it became apparent that the assumption that $g(0)$ is close to one for the larger whales might not be applicable and so from 2017, the survey mode changed to alternating between NSP and double platform (IO) mode (usually around every 50 n.miles on effort but at the discretion of the cruise leader depending *inter alia* on the density of sightings – IO is not practical in high density areas). The full analysis of these data is not complete for all species for which there is a sufficient sample size but this is underway. The results of these analyses will assist in determining the most appropriate survey mode strategy or strategies (it may vary by area/target species) for the next phase of IWC-POWER.

4.2.2.4 DISTANCE AND ANGLE EXPERIMENTS

DISTANCE based analyses require unbiassed and precise estimates of the position of sighted animals from the trackline (obtained by estimating the distance and angle to the sighting). It is therefore important that experiments are conducted to estimate the ability of the relevant crew and researchers to do this (ideally under a range of sightings conditions). All cruises to date have undertaken 'Distance and Angle Experiments' and analysis of these data is almost complete. Kitakado reported that the initial results show that bias, potentially a serious problem, is not present but that there is some variation in precision that will affect the CV of the estimates. The TAG looks forward to the final results of the analysis and **agrees** that:

(1) such experiments must be held for each future cruise where DISTANCE sampling is undertaken in accordance with IWC guidelines; and

(2) methods used to determine distance and angle at sea should continue to be reviewed in light of potential new methods and technology.

4.2.2.5 ESTIMATES

The line transect data provide an estimate of the number of animals present in the study area at the time of the survey. For the baleen whales, the areas covered by IWC-POWER usually represent feeding areas. It should be noted that there may be more than one population of any particular species within the survey area. It is also important to consider the timing of the surveys if comparing across years for the same geographical area when interpreting differences. For example, the cruises in the period up to 2016 took place in July and August whilst the surveys since 2017 have taken place in August and September. Note that this does not necessarily invalidate comparisons but this possibility should be considered.

To date, the primary analytical approach has been to produce standard design-based estimates of abundance (see WP10) as yet not corrected for $g(0)$ or taking into account additional variance although this work is underway. Estimates by species are considered where appropriate under Item 5.

The value of using spatial modelling approaches to estimate abundance and produce density maps is increasingly recognised. Where successful, this can reduce CVs and provide insights into those factors of importance in determining why animals are distributed within the study areas. This is especially important in the light of additional variance and potential changes in distribution (and thus abundance estimates in the same areas in different years) due to environmental changes and may directly affect our ability to estimate trends – a key component of the medium to long-term objectives of IWC-POWER. Completing the spatial modelling analyses for the existing IWC-POWER data is a high priority item and key to assisting in the design of the next phase of the programme (including choice of survey areas and stratification). Spatial modelling approaches also provide a better approach to recalculating abundance estimates for different geographical boundaries as new information on stock structure is obtained.

Similarly, completing the analysis to determine the power of various strategies to detect trends under different scenarios (e.g. with respect to different levels of increase or decrease in abundance, different time frames and/or survey frequency, different levels of survey effort and different levels of significance) is a high priority. Kitakado provided some valuable initial analyses to examine this and a number of informal suggestions were made to the author on improvements to be incorporated into the final analyses.

The TAG welcomed this work but **agrees** that, where possible, incorporation of a series of estimates into a population assessment model framework (e.g. see AWMP/RMP and in-depth assessment approaches) is the most appropriate way to examine status and management implications in light of uncertainty in both stock structure and abundance, rather than a traditional analysis of trends from two or more estimates that usually has low power if the estimates have CVs of more than 0.2 which is not uncommon, even without taking into account additional variance.

It is envisaged that the DISTANCE sampling approach will form the major component of the next phase of IWC-POWER.

4.2.3 Individual identification (photo and genetic)

Although DISTANCE sampling approaches are standard for many species, for others, mark-recapture methods to obtain abundance estimates from individual identification data are an alternative or preferable. It is important to note that whilst line transect abundance estimates represent a snapshot of animals in the survey area at a certain time, mark-recapture estimates represent an estimate of the number of animals using an area over time (depending on certain assumptions). Mark-recapture estimates are particularly suited to species where obtaining sufficient sample sizes is possible e.g. where large sampling effort is/has been possible e.g. humpback whales and eastern North Pacific blue whales (see Items 5.3 and 5.6) or small populations where densities are too low to obtain reliable abundance estimates with realistic levels of effort under the IWC-POWER programme (e.g. eastern North Pacific right whales – see Item 5.2). In most cases, the value of data collected by IWC-POWER has been and will be to contribute samples/photos from offshore areas to existing individual identification catalogues; such collaborations will also form an important part of the medium-term strategy. The possibility of focussed studies to collect such data in some small areas (e.g. targeted to North Pacific right or blue whales) in the medium-term plan is considered under Item 7.

It is envisaged that biopsy sampling and photo-ID using the current methods will continue to be an important component of IWC-POWER.

4.2.4 Acoustics

Acoustic techniques have not been used to estimate abundance in the IWC-POWER programme to date and even in principle, of the large whales it has only been successfully used to estimate the abundance of sperm whales using towed arrays of hydrophones (e.g. Lewis *et al.*, 2019, in the Mediterranean Sea). With current resources, this is unlikely to form part of the IWC-POWER programme although the possibility will be kept under review.

However, acoustics (directional sonobuoys) have been used successfully in the programme to improve detection of right whales to obtain biopsy samples and photo-ID data to assist in mark-recapture estimation (e.g. on the 2017 cruise – a similar approach was used for blue whales under IWC-SOWER). This is considered further for the medium-term programme e.g. see Table under Item 7.1.

4.2.5 Telemetry

In 2021, a feasibility experiment (total cruise time spent just under 6 hours) to investigate the use of telemetry to elucidate the diving behaviour of fin and sei whales was undertaken with the objective of using such data to investigate availability bias in order to try to correct abundance estimates (WP15). This was undertaken voluntarily by Japan with the equipment prepared by ICR. A type of Low-Impact Minimally Percutaneous External electronics Tag (LIMPET), SPLASH10-F-333 (Wildlife Computers) was used in the experiment. Tagging and biopsy experiments were conducted simultaneously. The tags were attached to 2 fin and 3 sei whales. Success rates were 33.3% (n=6) and 75.0% (n=4) for fin and sei whales, respectively. The field experiment was successful and dive sequence data were obtained from 2 fin and 2 sei whales via satellite. However, it was noted that improvements in the data transmission settings were needed as was the use of Mote (Wildlife Computers, US) - a stationary listening station that can continuously log telemetry data from satellite tags on animals within the reception range.

The TAG welcomed this initiative (and see Item 4.3.3). The value of telemetry in the next phase of the IWC-POWER programme is considered under the relevant agenda items below.

4.3 Stock structure and movements

4.3.1 Population structure related genetic analyses from biopsy samples

The genetic component of the IWC-POWER cruise (reviewed in WP8) has proved to be extremely successful and has already made important to contributions to the work of the Scientific Committee (e.g. the RMP *Implementation Review* for Bryde's whales and the ongoing Comprehensive Assessment of sei whales). Details are provided by species along with information on when analyses are expected to be completed under Item 5. In general, to date analyses have focussed on mtDNA and microsatellites (14-17 loci). For certain species (see Item 5) there is a move to include/move to SNPs (single nucleotide polymorphisms) that are more powerful and do not require cross-laboratory calibration.

It is envisaged that biopsy sampling and genetic analyses will continue to be an important component of IWC-POWER.

4.3.2 Movements from individual identification (photo and genetic)

'Recaptures' of individually identified animals can not only be used to estimate abundance but also provide information on movements. The likelihood of recaptures clearly increases where data are shared amongst all researchers across the Pacific, ideally in the form of single catalogues. As noted under Item 4.2.3, the major contribution of the IWC-POWER programme has been and will be to contribute samples/photos from offshore areas to existing individual identification catalogues; such collaborations will also form an important part of the medium-term strategy.

It is envisaged that biopsy sampling and photo-ID to identify individuals will continue to be an important component of IWC-POWER.

4.3.3 Telemetry

Telemetry can provide valuable information on long-term movements of whales that can in turn provide valuable information on potential mixing of populations and location of breeding grounds. To date the

IWC-POWER programme has only undertaken a feasibility study to use telemetry to investigate short-term diving behaviour (WP 10 and see Item 4.2.5). The use of telemetry for long-term movements (in the next phase of the IWC-POWER programme is considered under Item 7.

4.4 Marine debris

The IWC-POWER cruises have collected information on marine debris since 2010, using a strategy to minimise any disruption of the primary aim of collecting data on cetaceans (i.e. collecting such data only for the first 15 minutes of each hour). The data from 2010-2016 have been analysed in light of previous comments by the Scientific Committee and the TAG and the TAG looks forward to its publication in the near future. It is envisaged that such studies be continued in the next phase of the programme.

4.5 Other (e.g. related to environment)

During the first phase of IWC-POWER it had been agreed that it was not practical to undertake the collection of any more oceanographic information from the vessel than that which could easily be obtained without the need to stop the vessel (primarily sea surface temperature). However, the TAG **agrees** on the importance of oceanographic data to the IWC-POWER programme (e.g. with respect to spatial modelling). It **agrees** that a number of external data sources (e.g., satellite data and ocean models) can provide information and that these should be explored recognising that care is needed to determine that it can be obtained at a suitable scale. Although it is a low priority and the actual feasibility of the installation needs to be examined, the possibility of collecting data by an echosounder to qualitatively understand the distribution of prey species of cetaceans would be considered. This is considered further under Item 7.

5. REVIEW OF RESULTS AND AVAILABLE INFORMATION BY SPECIES

5.1 Fin whales (High priority)

5.1.1 Distribution and stock structure

Figs 2 and 3 show the distribution of sightings and biopsy samples for the cruises from 2010 to 2022. Fin whales are widely distributed throughout the surveyed areas north of 40N – this is broadly in accord with past summer catch data. The distribution of sightings suggest that fin whales are probably found to the west and east of the surveyed areas as they were in the past. The western waters are partly covered by Japanese national surveys (ref) but it is clear that for a full picture it will be necessary to obtain information from Russian waters. Unfortunately, proposed IWC-POWER cruises to Russian waters have not received permits by the Russian Federation (e.g. see discussion in SC69D). There is a suggestion that due to warmer waters as a result of climate change, fin whale distribution might extend further north into the northern Bering and Chukchi Seas. The 2024 cruise will likely extend to the north into part of the Chukchi Sea.

The spatial modelling referred to under Item 5.1.2 will greatly assist in developing density maps and planning for the next phase of IWC-POWER.

The biopsy samples (*n*=142) are well distributed throughout the surveyed area. The Workshop was informed that the Southwest Fisheries Science Center (SWFSC) in La Jolla California is developing methods to genotype SNP loci and that some IWC-POWER samples will be used in later genotyping (IWC, 2020). The ICR is planning laboratory work for mtDNA control region sequencing and microsatellite DNA (16 loci) genotyping for a stock structure studies that will incorporate IWC-POWER samples and samples from the western North Pacific from other sources (IWC, 2020). Genetic analyses on stock structure are ongoing and the completion of such analyses will greatly assist in the undertaking of any future Comprehensive Assessment of North Pacific fin whales.

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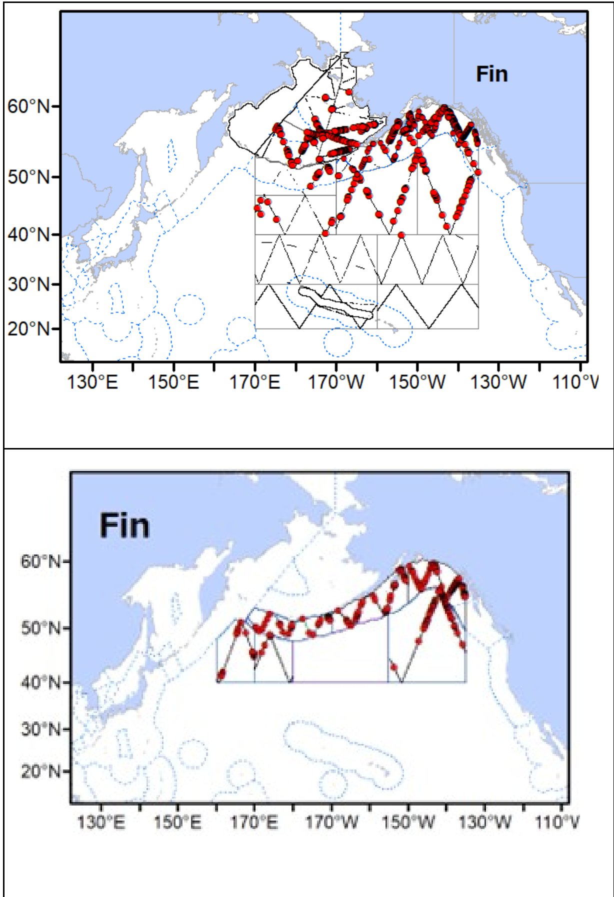


Fig. 2 Summary of sightings of fin whales for the cruises from 2010-2018 (top) and 2019-22 (bottom). Dotted blue lines: EEZs.

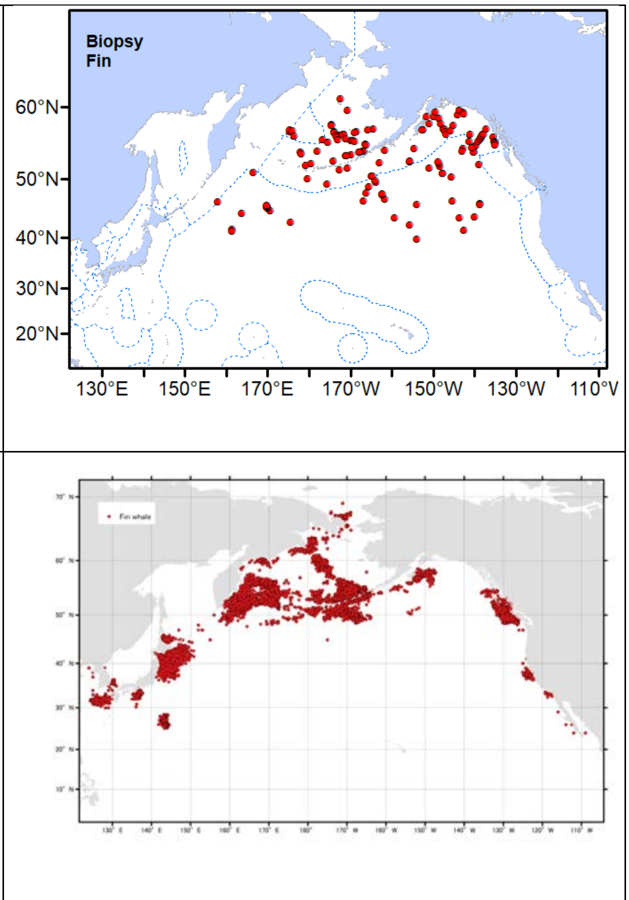


Fig. 3 (top) Summary of biopsy samples of fin whales for the cruises from 2010-2022, including samples collected during transit. Dotted blue lines: EEZs. For comparison with Figs 2 and 3 the bottom section shows the distribution of historic catches throughout the year – not just at the time of IWC-POWER surveys

5.1.2 Abundance

The TAG received a *preliminary* design-based estimates of fin whale abundance up to 2018 (WP10). These are uncorrected for *g*(0) or additional variance. To provide context *only* in terms of the development of the next phase of IWC-POWER, the uncorrected estimates for the Bering Sea (2017-2018) are around 14,000 (CV about 0.25) and for the rest of the surveyed areas south of the Aleutian Islands (2010-2012) around 29,000 (CV around 0.21). These preliminary estimates should **not** be cited and cannot be considered agreed estimates.

Analysis of the data to estimate g(0) is underway and additional variance will be investigated *inter alia* by comparing estimates from the early period (2010-12) with those for similar areas in the later period (i.e. 2019422), recognising that the survey periods for the later cruises were a little later (August-September compared to July-August). The TAG **recommends** that corrected fin whale design-based and spatial estimates for the whole period are developed as a high priority.

5.1.3 Outstanding issues relative to new surveys

The IWC-POWER data are invaluable for providing the first direct abundance estimates of fin whales for this part of the North Pacific. As noted under Item 5.1.1, the importance of obtaining estimates from Russian waters cannot be over-emphasised and whilst recognising the current political situation and difficulties, the TAG strongly **encourages** the IWC and relevant range states to continue to work together to try to obtain permission both to finish the first phase of IWC-POWER and to enable proper planning for phase 2 with respect to this species.

5.2 North Pacific Right whales (High priority)

5.2.1 Distribution and stock structure

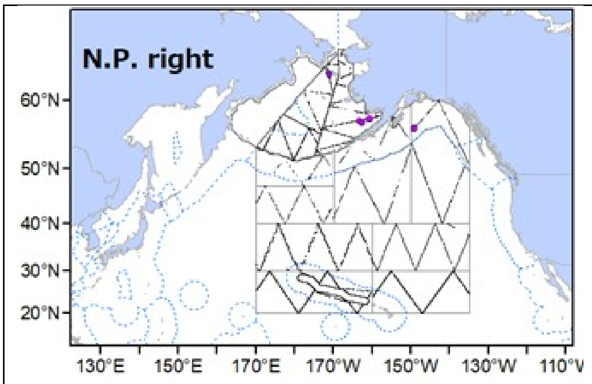


Fig. 4 Summary of sightings of North Pacific right whales for the cruises from 2010-2018. No sightings were made during the 2019-22 cruises.

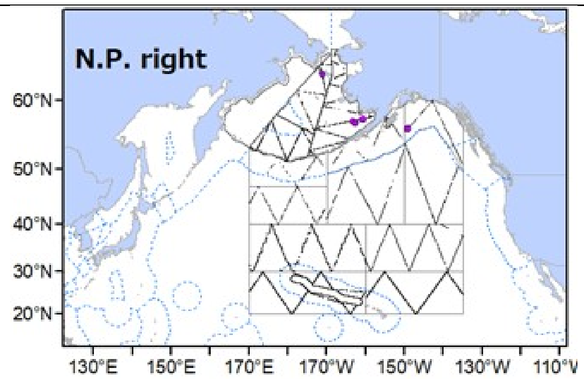


Fig. 5 Summary of biopsy samples of North Pacific right whales for the cruises from 2010-2021.

Few sightings (Fig. 4) of this species have been made even with the assistance of directional hydrophones to assist in detections. The sighting in the northern Bering Sea was unusual. Distribution is clearly limited in the eastern North Pacific within the IWC-POWER area.

High priority was given to obtaining biopsy samples (*n*=6) from any animals seen and these IWC-POWER samples have been incorporated into a larger scale study of North Pacific right whales. Pastene *et al.* (2022) summarized and analysed genetic data generated from these samples in combination with all other available genetic data of this species, in the context of a collaborative genetic study between the SWFSC and the ICR focused on stock structure. In summary, two markers were examined for samples from the eastern and western North Pacific (mtDNA, *n*=30 each for the west and east; microsatellites, *n*=19, west only).

The mtDNA results, suggesting population structuring, were consistent with the pattern of catch and sighting data showing higher densities on either side of the North Pacific, but little in between as suggested by Clapham et al. (2004). These findings support the hypothesis of different populations occurring in the eastern and western sides of the North Pacific. An alternative, although less likely interpretation of these results is that there is a single interbreeding population in the North Pacific that exhibits mtDNA structuring as a result of matrilineally driven seasonal site fidelity. Available and future genetic samples should be analysed for stock differentiation based on nuclear markers, microsatellite DNA and/or SNPs.

5.2.2 Abundance

There are insufficient sightings data to develop a reliable DISTANCE sampling based abundance estimate from the IWC-POWER cruises and the clearly low abundance makes it unlikely that such an approach will be successful in the future. The contribution of IWC-POWER to obtaining abundance estimates lies in providing individual identification data to existing catalogues to allow for mark-recapture abundance estimates to be derived. The use of acoustics to assist in the detection of North Pacific right whales to increase sample size for individual identification is recommended.

5.2.3 Outstanding issues relative to new survey

The major issue for the future is to determine strategies that will facilitate increased sample sizes to enable mark-recapture estimates to be developed in conjunction with other projects in the North Pacific.

***5.3** Blue whales (High priority)*

5.3.1 Distribution and stock structure

Blue whales have been observed throughout the IWC-POWER study area, primarily north of 40N as far as the Aleutian chain. The recent surveys including in transit data (and data from other sources including Japanese national surveys) show that that the western edge of the study area does not represent the western boundary for blue whales. The total number of IWC-POWER blue whale biopsy samples is 47 (including samples taken during transit). Even though the sample size is small, the samples are widely distributed throughout the IWC-POWER research area, north of 40°N (Fig. 7).

The Workshop was informed that SWFSC generated mitogenome sequences for the IWC-POWER samples up to 2017 (n=9) for use in a project evaluating the global subspecies taxonomy of blue whales (IWC, 2020). With respect to stock structure and contributing towards a future Comprehensive Assessment of North Pacific blue whales, the Workshop was informed that ICR is planning mtDNA and microsatellite laboratory work for a study that will also incorporate also samples from the western North Pacific (IWC, 2020).

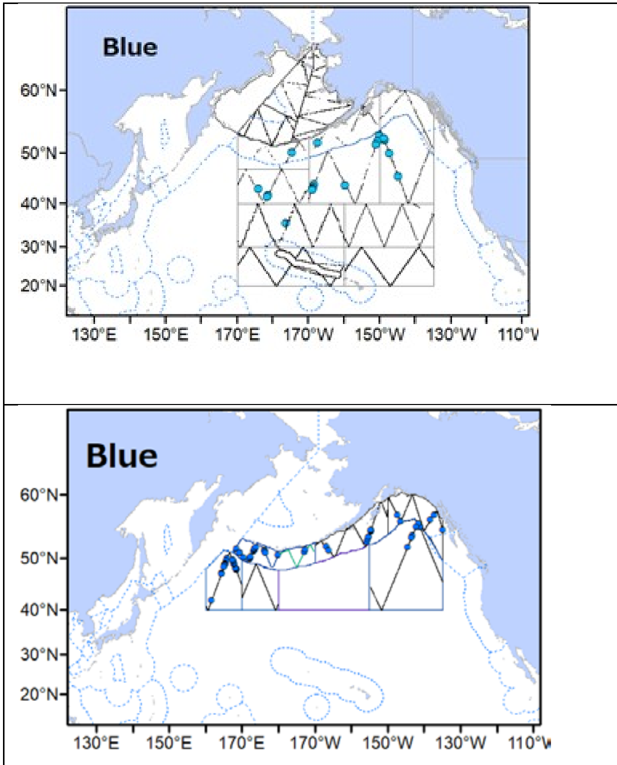


Fig. 6 Summary of sightings of blue whales for the cruises from 2010-2018 (top) and 2019-22 (bottom). Dotted blue lines: EEZs.

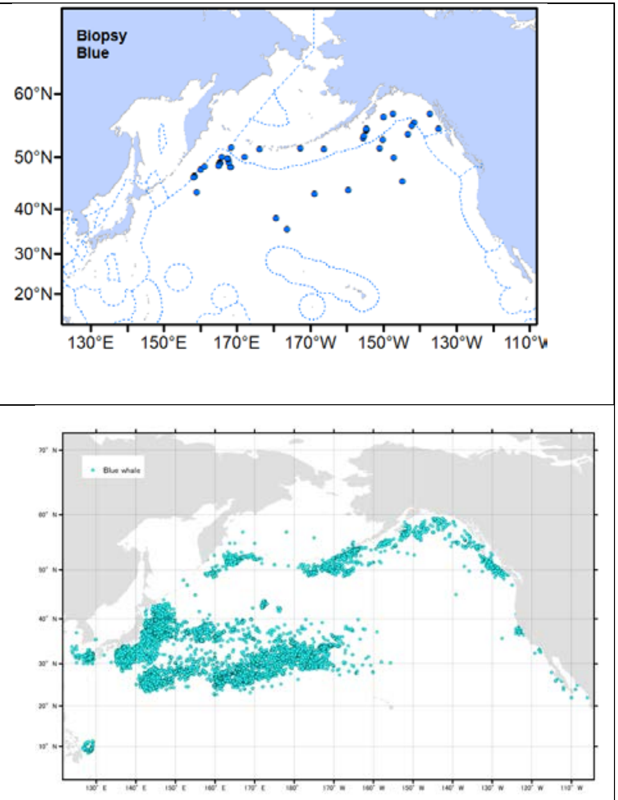


Fig. 7. Summary of sampling position of biopsy samples of blue whales collected for the cruises from surveys 2010-2022 including samples collected during in transit. Dotted blue line: EEZs. For comparison with Figs 6 and 7 top, the bottom section shows the distribution of historic catches throughout the year – not just at the time of IWC-POWER surveys

5.3.2 Abundance

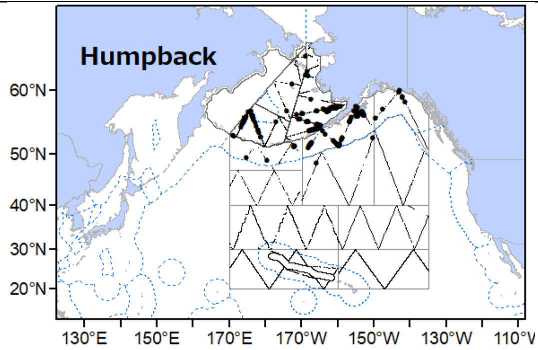
To date, only the data for the 2010-2012 surveys have been analysed. The sample size was small (15 primary sightings) and the *preliminary* design based estimate (uncorrected for $g(0)$ or additional variance) of around 1,100 with a CV of 0.38) is provided *only* to provide context in terms of the development of the next phase of IWC-POWER and should **not** be cited or considered an agreed estimate. The TAG **agrees** that an analysis of all of the blue whale data after completion of the 2023 survey should be undertaken promptly. Consideration should be given to obtaining mark-recapture abundance estimates from photo-ID efforts throughout the North Pacific.

5.3.3 Outstanding issues relative to new survey

The IWC-POWER sightings and biopsy data have provided the first systematic recent information on this species in these waters related to abundance and stock structure. Photo-ID efforts are promising. Full analyses of the available information (IWC-POWER and other sources) on these topics should be undertaken in the next 2-3 years to enable an appropriate strategy and priority for phase 2 (see Table 7).

5.4 Humpback whales (Medium priority)

5.4.1 Distribution and stock structure



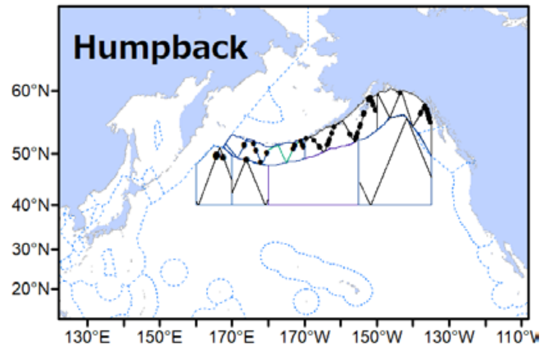
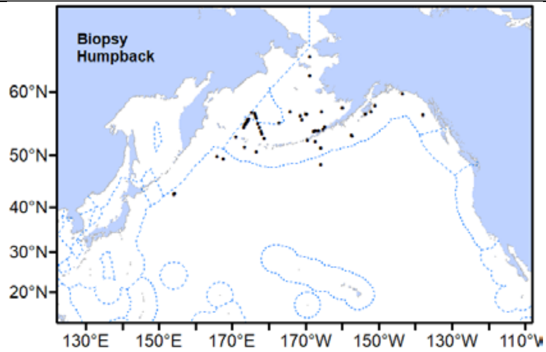


Fig. 8 Summary of sightings of humpback whales for the cruises from 2010-2018 (top) and 2019-22 (bottom). Dotted blue lines: EEZs.



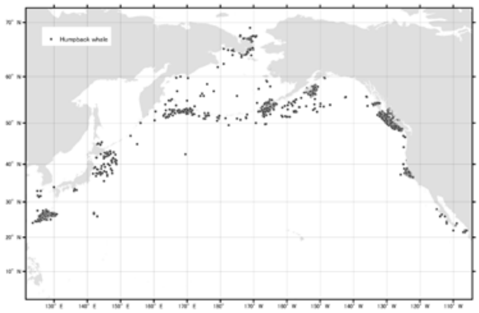


Fig. 9. Summary of sampling position of biopsy samples of humpback whales collected for the cruises from surveys 2010-2022 including samples collected during in transit. Dotted blue line: EEZs. For comparison with Figs 8 and 9 top, the bottom section shows the distribution of historic catches throughout the year – not just at the time of IWC-POWER surveys

Humpback whales were widely distributed throughout the surveyed areas north of around 50N (Fig. 8).

The total number of IWC-POWER humpback whale biopsy samples is 62 and they are widely distributed longitudinally in the IWC-POWER research area, north of 50°N (Fig. 9). These samples have not been analyzed yet.

5.4.2 Abundance

As for other species, preliminary abundance estimates were provided in WP10. Attention was drawn to differences in detection functions between the Gulf of Alaska and the Bering Sea and it was agreed that this should be investigated further before final estimates are presented to the Scientific Committee. It was noted that whilst IWC-POWER line-transect estimates can provide information to the ongoing Comprehensive Assessment of North Pacific humpback whales, mark-recapture estimates are the primary source of the abundance estimates used (IWC-POWER photographs make an important contribution to that effort).

5.5 Bryde's whales (eastern North Pacific, Medium priority)

5.5.1 Distribution and stock structure

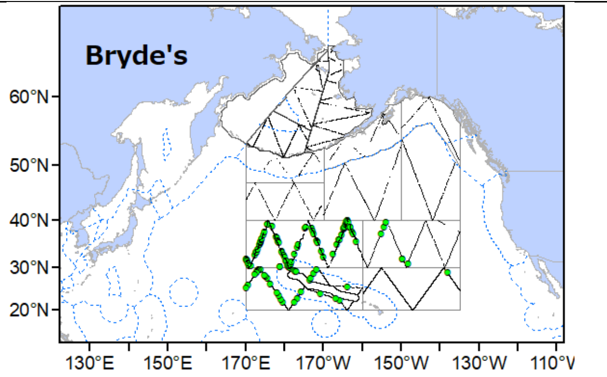
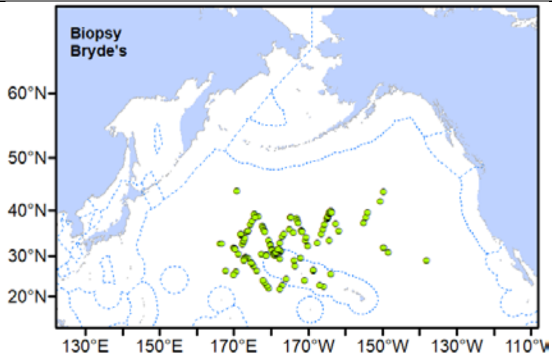
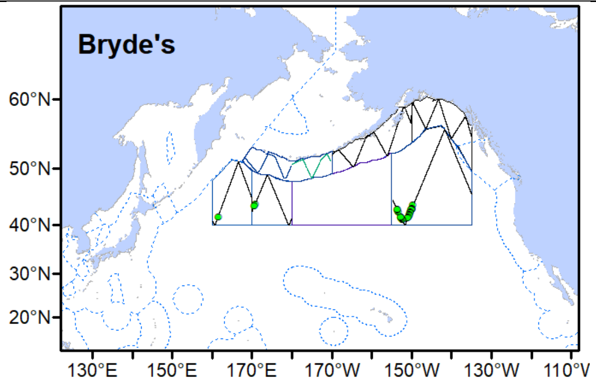
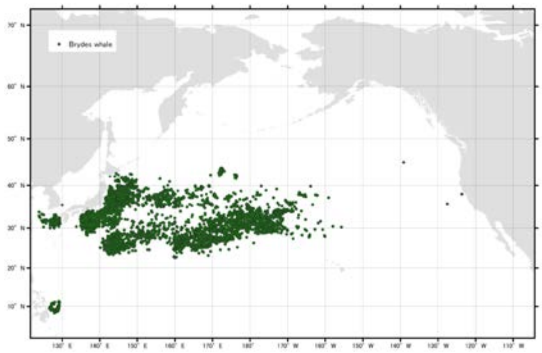
	
	

Fig. 10 Summary of sightings of Bryde's whales for the cruises from 2010-2018 (top) and 2019-22 (bottom). Dotted blue lines: EEZs.	Fig. 11. Summary of sampling position of biopsy samples of Bryde's whales collected for the cruises from surveys 2010-2022 including samples collected during in transit. Dotted blue line: EEZs. For comparison with Figs 10 and 11 top, the bottom section shows the distribution of historic catches throughout the year – not just at the time of IWC-POWER surveys

Bryde's whales were, as previously thought, primarily found south of around 40N. Within the surveyed areas they were most abundant between around170E and 160W but the former clearly did not represent a distribution boundary as witnessed by sightings by Japanese surveys.

The total number of IWC-POWER Bryde's whale biopsy samples is 139 and they are widely distributed in the IWC-POWER research area, south of 40°N (Fig. 11). The IWC-POWER samples have played a major role in the *Implementation Review* of this species in the western North Pacific related to stock structure, in conjunction with samples from Japanese whaling. In particular they were the predominant samples to the east of 180E. The results of that work have been extensively discussed within the Scientific Committee.

5.5.2 Abundance

The Scientific Committee has used abundance estimates from the IWC-POWER surveys as an important part of the *Implementation Review.*

5.5.3 Outstanding issues relative to new survey

For the future, primary biopsy sampling effort should be spent in areas east of 150°W in order to further examine the two stocks proposed for the western and central North Pacific. There is also a need to investigate the relationship between Bryde's whale stocks in the North Pacific with a genetically differentiated stock in the Gulf of California.

From the analytical point of view, additional analyses based on kinship could be valuable to assist the interpretation of the current results of the heterogeneity test and Bayesian analyses. Also, the development and use of additional genetic markers e.g. SNPs, are recommended to further examine the available genetic samples.

Given the other high priority species and the distribution of Bryde’s whales, the TAG suggests that a targeted survey or surveys should be considered later in the programme (e.g. after 2029) in light of further analysis of the existing data. Telemetry studies will be considered for long-term movements (relevant to distribution, movements within the surveyed area and identification of breeding areas) and diving behaviour (to investigate availability bias in line-transect estimates).

Previous recommendations for work to evaluate the use of photo-ID data for this species should be carried out to determine its value for Phase 2.

5.6 Sei whales (Medium priority)

5.6.1 Distribution and stock structure

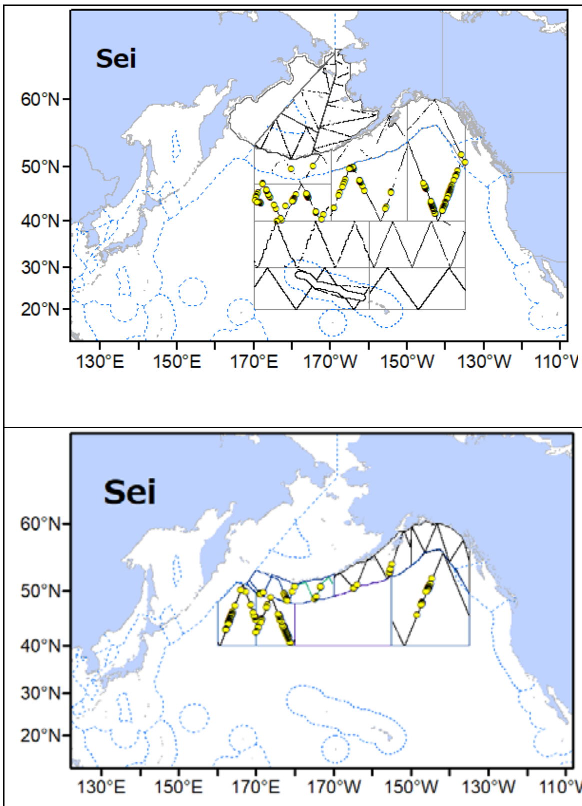


Fig. 12 Summary of sightings of sei whales for the cruises from 2010-2018 (top) and 2019-22 (bottom). Dotted blue lines: EEZs.

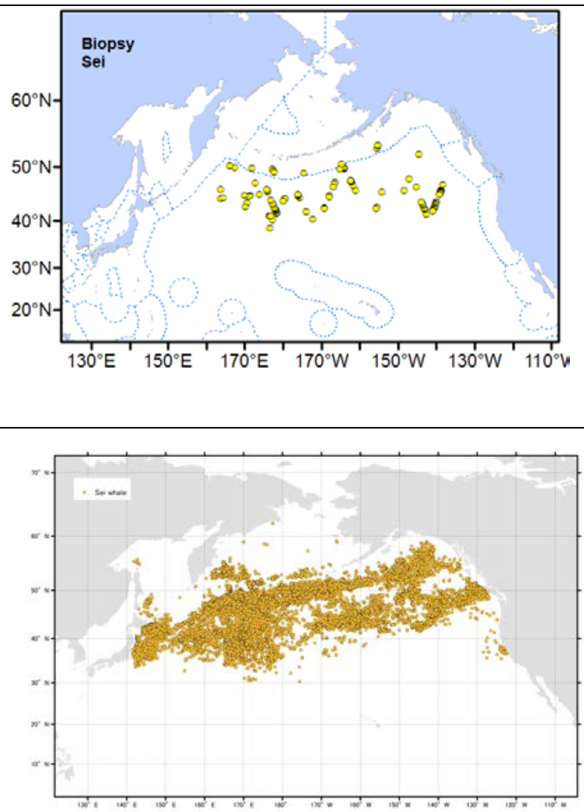


Fig. 13. Summary of sampling position of biopsy samples of sei whales collected for the cruises from surveys 2010-2022 including samples collected during in transit. Dotted blue line: EEZs. For comparison with Figs 12 and 13 top, the bottom section shows the distribution of historic catches throughout the year – not just at the time of IWC-POWER surveys

Sei whales were found throughout the surveyed areas between around 50N and 60N, as expected.

The total number of IWC-POWER sei whale biopsy samples is 126 and they are also widely distributed in the IWC-POWER research area, north of 40°N (Fig. 13). These samples are playing a major role in the ongoing Comprehensive Assessment of sei whales along with samples from Japanese cruises. The SC has decided to proceed with two hypotheses on stock structure, one that consider a single stock in the North Pacific and the other that consider five stocks. The first is based on the interpretation of genetic and non-genetic analyses while the second is based on the interpretation of mark-recapture data. Based on the results of the genetic analyses, the IWC-SC has agreed that the pelagic region of the North Pacific comprises a single stock of sei whales.

The IWC-POWER biopsy samples were important for the analyses described above because they covered the eastern North Pacific, an area where the number of historical samples was small and dated. The additional samples from IWC-POWER allowed an increase in the number of samples (increase in the power of the analysis) and allowed the testing for temporal genetic differences in the eastern North Pacific (e.g., Kanda et al., 2015). The use of techniques such as SNPs may assist where there are few samples such as the coastal areas (and see Item 5.6.3 below).

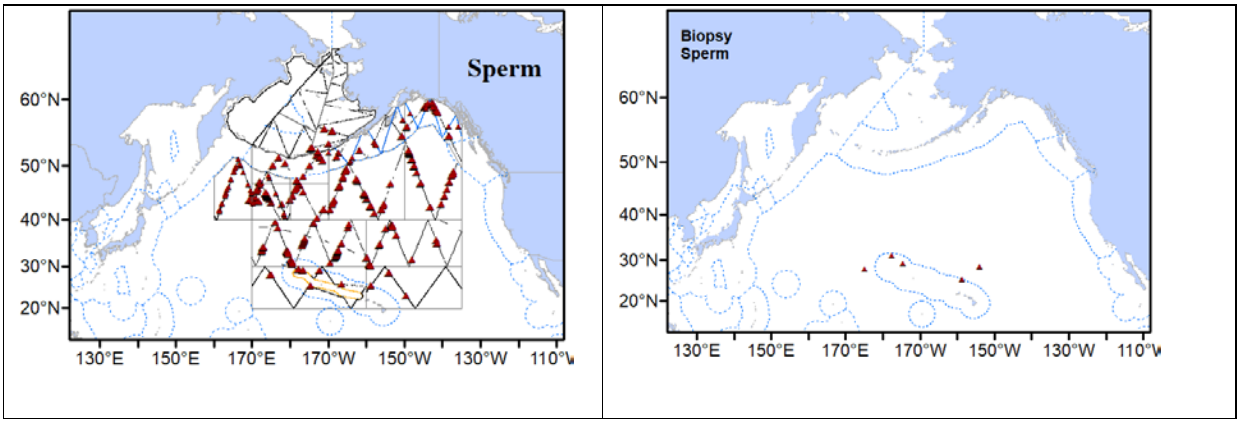
5.6.2 Abundance
The Scientific Committee is using abundance estimates from the IWC-POWER surveys as part of the Comprehensive Assessment of sei whales.

5.6.3 Outstanding issues relative to new survey
Results of the Comprehensive Assessment will help focus future IWC-POWER medium-term strategy and priorities for this species.

The TAG noted that the stock structure hypotheses with 5 stocks under discussion for the Comprehensive Assessment would benefit from samples from the coastal area (e.g. the Aleutians) and from where there were considerable catches in the past. However, the IWC-POWER surveys have seen few animals there and thus the possibility of obtaining biopsy samples appears low. The value of targeted telemetry seems more practical for Phase 2.

5.6.4 Other
Previous recommendations for work to evaluate the use of photo-ID data for this species should be carried out to determine its value for Phase 2.

5.7 Sperm whales (Medium priority)
5.7.1 Distribution and stock structure



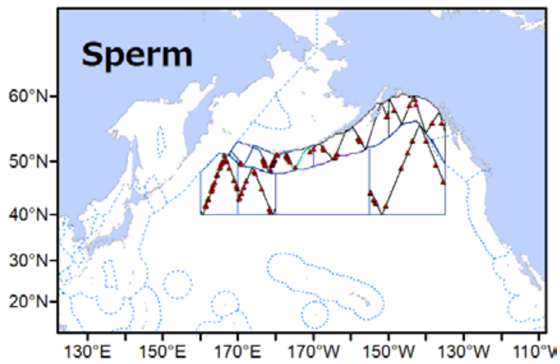


Fig. 14. Summary of sightings of sperm whales for the cruises from 2010-2018 (top) and 2019-22 (bottom). Dotted blue lines: EEZs.

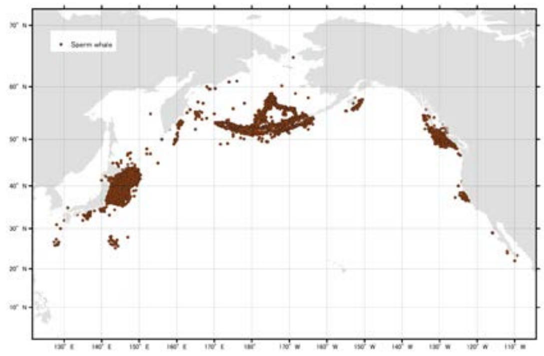


Fig. 15. Summary of sampling position of biopsy samples of sei whales collected for the cruises from surveys 2010-2022 including samples collected during in transit. Dotted blue line: EEZs. For comparison with Figs 14 and 15 top, the bottom section shows the distribution of historic catches throughout the year – not just at the time of IWC-POWER surveys

Sperm whales are seen commonly throughout the area apart from the Bering Sea.

Collection of biopsy samples is a low priority and the total number of IWC-POWER sperm whale biopsy samples is 6, and these were obtained south of 30°N (Figure 15). These samples have not been analysed yet and would only be of value in conjunction with other studies.

5.7.2 Abundance

Obtaining abundance estimates of sperm whales from visual surveys is problematic due to long dive times (and some other issues), as the Scientific Committee has previously noted but if certain assumptions are made they can provide a suitable index of abundance. Uncorrected abundance estimates provide minimum estimates and initial line transect abundance estimates from IWC-POWER (still being finalised) suggest tens of thousands of sperm whales in the North Pacific.

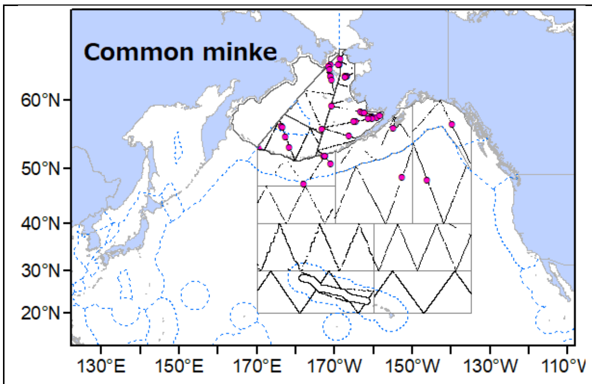
5.7.3 Outstanding issues relative to new survey

The TAG noted that the possibility of using towed acoustic arrays to try to obtain abundance estimates in some targeted years in the longer term could be considered under IWC-POWER, depending on availability of equipment, suitable vessels. and practicality in light of other priorities. Future surveys will contribute to indices of relative abundance.

5.8 Common minke whales (eastern North Pacific, Low priority)

5.8.1 Distribution and stock structure

The TAG noted that although common minke whales were reported, the sightings conditions for the surveys were not optimal for common minke whales that are a low priority for the IWC-POWER programme. Thus, the sightings data do not provide a reliable indication of overall distribution. They are not a target for biopsy sampling.



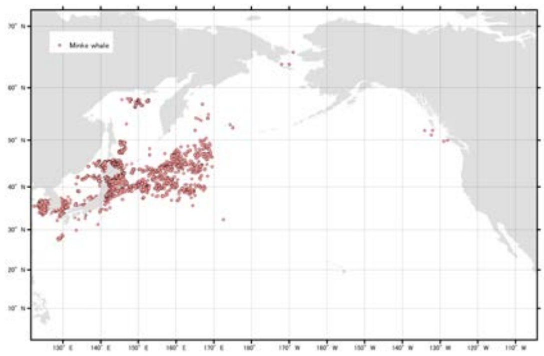


Fig. 17. For comparison with Fig. 16, shows the distribution of historic catches throughout the year – not just at the time of IWC-POWER surveys

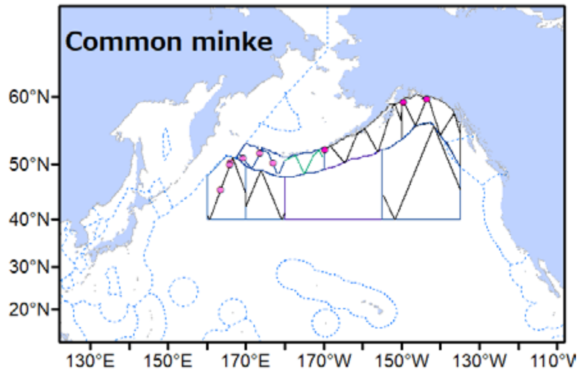


Fig. 16. Summary of sightings of common minke whales for the cruises from 2010-2018 (top) and 2019-22 (bottom). Dotted blue lines: EEZs.

5.8.2 Abundance

Although abundance estimates can be calculated from the IWC-POWER data, the TAG agreed that they are not reliable given the sub-optimal sightings conditions.

5.8.3 Outstanding issues relative to new survey

The TAG agreed that common minke whales remain a low priority for the IWC-POWER programme. However, if the Okhotsk Sea is able to be covered at some time in the future for high priority species (e.g. right whales) then it would be appropriate to consider modifying present ‘acceptable’ conditions to allow the estimation of abundance for this species. It would also be valuable to biopsy samples for this important area for any future in-depth assessment.

5.9 Other species

The TAG agreed that it was important to examine the distribution and abundance of the other species recorded during IWC-POWER in light of previous recommendations at a future meeting. Once available, these estimates will inform future IWC-POWER discussions.

6. REVIEW OF OTHER (I.E. NON IWC-POWER) PAST AND ONGOING SURVEY ACTIVITIES AND AVAILABILITY OF DATA

The TAG noted the enhanced value of collaborative analyses with surveys and other efforts occurring outside the IWC-POWER cruises. This is already the case for a number of Scientific Committee initiatives such as *Implementation Reviews* and Comprehensive Assessments as noted above. It was **agreed** that prior to the 2023 TAG meetings, the Steering Group should develop a list of relevant activities for discussion.

7. INITIAL PLAN FOR ACHIEVING MEDIUM TO LONG-TERM OBJECTIVES AND PRIORITIES BASED UPON LESSONS LEARNED UNDER ITEMS 4 AND 5

7.1 Update if necessary of objectives (e.g. stock structure, abundance, trends) and priority species

In light of the discussions above, the TAG spent considerable time updating the medium-long term objectives and **recommends** those to the Scientific Committee.

Table 1

Suggestions for updated medium-term priorities based upon results from Phase 1 for IWC-POWER (* refers to likelihood of obtaining an abundance estimate at least in some areas ** refers to likelihood of obtaining biopsy and/or photo-ID data from encountered schools).

NB Consideration of the effect of possible distribution changes due to climate change will be a general priority for most species (e.g. by extending the surveyed areas to the north). See Item 5 for more details and recommendations by species. The rationale/comments below represent only a brief summary

Initial priority/feasibility	Rationale/comments
Blue whale (High) High direct*, high opportunistic**	• Depletion level in the west is unknown but may be high given past catches. The population in the east is estimated to have recovered to 62-99% of its unexploited level Monahan *et al*., 2015) with abundance at about 2-3,000 based on mark-recapture estimates from long-term studies south and east of the IWC-POWER survey area. • Initial line transect abundance estimates from IWC-POWER (still being finalised) suggest around one thousand animals in the surveyed area. • Results of genetic analyses of existing samples (43 IWC-POWER samples in conjunction samples from other programmes e.g. samples collected by Japan in the west) will inform on population structure and management units. Consideration of other data sources (e.g. 'songs' – see Monnahan, 2014) to complement genetic studies should be undertaken including analysis of existing sonobuoy data collected under IWC-POWER. • Given the size of the line-transect abundance estimate, the probability of obtaining mark-recapture estimates using data from the northern waters and in co-operation with the existing data from the USA and Japan is high if focussed cruises (or parts of cruises) are undertaken in specific areas in the east and west to collect photo-ID and biopsy samples. Opportunistic studies on other cruises should continue. • Continued collaboration with existing photo-id work e.g. US and Japanese national programmes is important and the possibility of a single catalogue should be investigated as a priority. • Telemetry studies will be considered for long-term movements (relevant to distribution, movements within the surveyed area and identification of breeding areas) and diving behaviour (to investigate availability bias in line-transect estimates, although the primary method for obtaining abundance estimates is likely to be mark-recapture)
Fin whale (High) High direct*, high opportunistic**	• Depletion level was thought to be high based upon the catch history at the start of IWC-POWER. As a result of IWC-POWER (and other work), the North Pacific fin whales are now a potential Comprehensive Assessment candidate and this will enable the present depletion level to be established • Initial line transect abundance estimates from IWC-POWER (still being finalised) suggest tens of thousands of fin whales in the North Pacific. • Results of genetic analyses (there are 142 IWC-POWER samples) will make an important contribution to understanding stock structure and management units in the North Pacific. These are expected within two years. This will help to develop future survey strategy as well as a Comprehensive Assessment. Incorporation of existing data from the USA, Japan and Korea is important. • Co-ordination with national programmes in Japan, Korea and USA should continue and be strengthened. Work in Russian Federation waters provided appropriate permits can be obtained is very important • Telemetry studies will be considered for long-term movements (relevant to distribution, movements within the surveyed area and identification of breeding areas) and diving behaviour (to investigate availability bias in line-transect estimates)
Right whale (High) High direct*, high opportunistic**	• Depletion level: highly depleted based on catch history, especially in the east (data from US studies and IWC-POWER). • Absolute numbers in the east are well below 100 and the valuable data collected thus far from IWC-POWER should be incorporated and focussed studies in the east should continue. • Numbers in the west are ~~believed to be~~ considerably higher and whilst obtaining abundance from line-transect surveys is feasible this would require permits to operate in Russian waters including those close to the coast which is unlikely to be granted. Focussed studies to obtain photo-ID and biopsy samples in international waters in the west (e.g. international waters to the south and east of Kamchatka) should be undertaken. Collaboration with work by Japan and the USA is important and the possibility of a single catalogue should be investigated as a priority.

	• Telemetry studies will be considered for long-term movements (relevant to distribution, movements within the surveyed area and identification of breeding areas) provided that safeguards are in place (c.f. the telemetry programme for western gray whales off Sakhalin)
Sei whale (Medium) High direct*, high opportunistic**	• Depletion level: this is being investigated as part of the ongoing IWC Comprehensive Assessment to which IWC-POWER data (abundance, distribution, genetics) have proved invaluable • Initial abundance estimates from IWC-POWER (still being finalised) and Japan are in the tens of thousands • Analysis of genetic and other data have thus far led to two stock structure hypotheses – a single stock or a five stock-hypotheses with a single pelagic stock in the areas covered by IWC-POWER and Japan and five postulated coastal stocks. • Results of the Comprehensive Assessment will help focus future IWC-POWER medium-term strategy and priority for this species. • Whilst obtaining biopsy samples from the postulated coastal stocks will be very valuable, a targeted strategy to obtain these is infeasible given the very low densities in such areas covered by IWC-POWER thus far. • Telemetry studies will be considered for long-term movements (relevant to distribution, movements within the surveyed area and identification of breeding areas) and diving behaviour (to investigate availability bias in line-transect estimates)
Humpback whale (Medium) High direct*, high opportunistic**	• Good information already available from SPLASH and national programmes suggests overall high abundance (genetic and photo-ID mark-recapture) hence medium priority • IWC-POWER has contributed valuable data/samples to existing genetic and photo-ID databases and this should continue • Ongoing Comprehensive Assessment will assess status and potential depletion of populations in the North Pacific • Abundance estimates from IWC-POWER (still being finalised) can provide interesting 'snapshot' estimates to compare with the primary mark-recapture estimates by population/feeding aggregations • The results of the Comprehensive Assessment will assist in developing medium-term strategy and priority for this species by population within IWC-POWER • Telemetry studies will be considered for diving behaviour (to investigate availability bias in line-transect estimates)
Sperm whale (Medium) Medium direct* and low opportunistic**	• Depletion level: unknown but possibly high given catch history • Lack of good information on population structure and status although good distributional data from IWC-POWER • Obtaining abundance estimates from visual surveys can be problematic due to long dive times and other issues but if certain assumptions are made they can provide a suitable index of abundance. Uncorrected abundance estimates provide minimum estimates and initial line transect abundance estimates from IWC-POWER (still being finalised) suggest tens of thousands of sperm whales in the North Pacific • Obtaining biopsy samples and photo-ID has proved to be difficult under IWC-POWER and priority is low given this combined with the high population size • Possibility of using towed acoustic arrays in some years in the longer term could be considered depending on availability of equipment, suitable vessels. and practicality in light of other priorities

Bryde's whale (Medium)
High direct*, high opportunistic**
	• Suggest low priority for first six or so years of next phase of POWER because:
	  o Recently completed IR shows good population status and apparently low level of threats
	  o Removing from target species allows a great reduction in size of priority research area to north of 40ºN
	• A targeted survey or surveys is to be considered from 2029 in light of analysis of the existing data
	• Telemetry studies will be considered for long-term movements (relevant to distribution, movements within the surveyed area and identification of breeding areas) and diving behaviour (to investigate availability bias in line-transect estimates)

Common minke whale (Low) Suggest only opportunistic	• Depletion level (probably low east/central based upon catch history) and in west dealt with by national programmes. • From the outset of IWC-POWER it was agreed that common minke whales were a low priority for the programme thereby allowing acceptable sighting conditions to be set at higher sea states than optimal for minke whales to increase effort for the larger whales species. • However, if Okhotsk Sea is able to be covered for high priority species (e.g. right whales) then would provide valuable information incl. biopsy samples • If permission granted by Russian Federation then consider modifying present 'acceptable' conditions as at the present high range they are unsuitable for estimating abundance for this species

Gray whale (Low) Low direct*, high opportunistic**	• There are ASW hunts but the primary data sources to evaluate those are from other visual, genetic and photo-ID programmes (e.g. USA, Mexico, Sakhalin Island) – hence medium priority. These are evaluated under the AWMP and a series of rangewide workshops. • Main IWC-POWER contribution is in obtaining biopsy/photo-ID in areas outside those programmes for comparison to contribute to existing information on population structure. An important area for this would be in the feeding grounds especially the western Chukchi Sea which would require permission to operate in Russian waters. • Sharing of data with the other programmes primarily responsible for providing information on the assessment of gray whales should continue
Bowhead whale (Very low) Low direct*, high opportunistic**	• There are ASW hunts but the primary data sources to evaluate those are from the USA national programme. This is evaluated under the AWMP. • The IWC-POWER cruises in northern waters may encounter bowhead whales. If they do they should record the sightings data but no effort need to be expended on photo-ID or biopsy sampling as stock structure and abundance is well-known. An important area for this would be in the western Chukchi Sea but this would require permission to operate in Russian waters.

7.2 In light of objectives and previous experience, consideration of whether new survey areas should be considered and if so where (e.g. areas further north including Beaufort and Chukchi Seas, areas further south and east including breeding areas in winter) taking into account other likely research programmes (and see Item 6)

The TAG **agreed** that this item should be further considered at next year's meeting in light of the results of analyses recommended and discussions by the Scientific Committee of the updated medium- long-term priorities developed under Item 7.1. The discussion of appropriate regions will be an integration of scientific priorities, resources and the geopolitical situation. From a scientific perspective there is merit in covering the Okhotsk Sea (right and common minke whales), the Beaufort and Chukchi Seas (especially fin, humpback and gray whales) and investigating potential changes in density and distribution of various species in the light of changes in climate. However, the ability to detect changes should they occur (within and/or outside the present IWC-POWER area) is important to address at next year's meeting via power analyses (updated WP19), given the vessel resources likely to be available.

7.3 In light of objectives and previous experience, consideration of whether experimental cruises are needed to test new technology or methodological approaches

There was insufficient time to address this is any detail this year but suggestions above related to telemetry, acoustics, use of sea drones and glider should be considered further next year.

7.4 Field methods by objectives and taking into account feasibility and priority species in light of analytical approaches

The TAG referred to the discussions above related to the updated priorities. It noted that the primary research methods used to date (distance sampling, biopsy sampling and photoidentification were likely to remain the primary methods for the next phase) along with, depending on logistics and priorities, consideration of newer techniques such as telemetry or targeted surveys using acoustics will be considered.

8. PROPOSAL FOR NEXT THREE-FIVE SEASON'S WORK

The TAG **agreed** that this will be an important topic for next year's meeting in the light *inter alia* of the additional analyses of existing data and discussions of the updated priorities at SC69A.

9. OTHER GENERAL MATTERS

9.1 Participation of other range states in IWC-POWER and Co-ordination with other research activities

The Committee has long supported the IW-POWER programme. For little IWC funds, thanks to the generosity of the Government of Japan, systematic surveys and data collection has taken place in areas that have not been covered for decades, if ever. Many of those areas had been subject to intense whaling in the past. The TAG noted that Japan remains a co-owner of the IWC-POWER data and refers to the data access protocol for IWC-POWER and IWC-SOWER and IDCR data (SC Handbook).

The first phase of IWC-POWER has set a valuable baseline for meeting the long-term objective of understanding stock structure and estimating trends in several populations and determining where conservation priorities might lie. The ability to detect trends in a reasonable timeframe is largely dependent on the effort that is available. The TAG **reiterates** previous recommendations that the Scientific Committee:

(1) **encourages** all Member Governments and Range States to support IWC-POWER either financially or in-kind – in particular this might be achieved by co-ordinating existing research field work with that of IWC-POWER; and

(2) **encourages** the IWC to increase efforts to advertise its willingness to share IWC-POWER data for integrated analyses (e.g. biopsy and photo-ID data, data on marine debris), especially where analyses of such data alone will provide only limited information.

9.3. Permits and related matters

The TAG **reiterates** the importance of Governments and scientists to continue to work proactively to facilitate the obtaining of necessary research permits associated with the work of IWC-POWER including permission to operate in national waters and the CITES process for biopsy samples.

9.4 Workplan

Item	Activity	Responsible persons (lead in bold type)	Time
Data			
(1)	Complete validation of IWC-POWER sightings and effort data for the period up to the 2022 cruise and submit GPS and shape files	**Matsuoka** and Hughes	Ongoing
(3)	Complete importation and classification of 2022 IWC-POWER photographs into the IWC photographic database	Taylor, **Matsuoka** and Staniland	Ongoing
Analyses			
(1)	Complete review of angle/distance experiments, following the guidance provided in IWC (2019, item 6.2.1) and IWC (2020a), then publish	**Kitakado** and Team	Ongoing. Final draft expected at 2023 TAG
(2)	Develop updated abundance estimates (design-based) for humpback, blue, fin, sei and Bryde's whales following the advice provided in IWC (2020a) and later (incorporating estimates from (4) below if available).	**Matsuoka, Kitakado,** and scientists from TUMSAT/ICR	Ongoing. Some accepted by ASI. Updated drafts for others at 2023 TAG
(3)	Develop updated abundance estimates (model-based) for humpback, blue, fin, sei and Bryde's whales following the advice provided in IWC (2020a) and later (incorporating estimates from (4) below if available).	**Kitakado, Matsuoka** and scientists from TUMSAT/ICR	Ongoing. Updated draft expected at 2023 TAG
(4)	Provide updated estimates of *g*(0) for those species it is considered possible (including fin, sei and humpback) following the advice provided in IWC (2020a) and later.	**Hakamada** and scientists from TUMSAT/ICR	Ongoing. Final draft expected at 2023 TAG
(5)	Develop abundance estimates for small cetacean species (killer etc.)	**Matsuoka, Kitakado** and others	Ongoing. Updated draft expected at 2023 TAG
(6)	Continue simulation work investigating spatial modelling approaches following advice provided in IWC (2020a) and later.	**Kitakado** and Palka	Ongoing. Updated draft expected at 2023 TAG
(7)	Continue work on power analyses following advice provided in IWC (2020a) and later.	**Kitakado** and Palka	Ongoing. Updated draft expected at 2023 TAG
Future			
(1)	Develop a Factsheet covering IWC-POWER up to 2023 focussing on achievements and the next phase	**Staniland** and Steering Group	Present at SC68C

10. ADOPTION OF THE REPORT

The Chair thanked the participants for their hard work and the Government of Japan for its support for the meeting and for the cruise. The participants thanked the Chair for his hard work and leadership.

Annex A

TAG workshop for medium-long term and 2023 Planning Meetings for IWC-POWER

(Tokyo, 6-10 September 2022)

LIST OF PARTICIPANTS

Mitsuki Azeyanagi	Fisheries Agency of Japan
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Koji Matsuoka	Institute of Cetacean Research, Japan
Hiroto Murase	Tokyo University of Marine Science and Technology, Japan
Luis Pastene	Institute of Cetacean Research, Japan
Iain Staniland	Head of Science, IWC
Mioko Taguchi	Institute of Cetacean Research, Japan
Tatsuya Isoda	Secretariat, ICR
Midori Ota	Interpreter 1
Saemi Baba	Interpreter 2

Annex B

AGENDA

1. INTRODUCTORY ITEMS

1.1 Opening remarks and welcoming address

1.2 Election of Chair and rapporteurs

1.3 Adoption of Agenda

1.4 Review of available documents

2. REVIEW OF PLANNING DISCUSSION AT SC (SC/64/Rep1 and SC/65a/AnnexG)[1]

2.1 Short term options (incl. information gaps)

2.2 Medium and long-term (incl. information gaps)

3. OBJECTIVES OF THIS WORKSHOP

4. GENERAL SURVEY APPROACHES USED TO DATE (2010-2021)[2]

4.1 Primary and secondary objectives of surveys related to field and analytical methods used given available resources

4.2 Distribution and abundance

4.2.1 Choice of survey areas and cruise track design

4.2.2 Survey methods for Distance sampling (including survey modes, distance and angle experiments) and analytical approaches (design-based and spatial approaches)

4.2.3 Individual identification (photo and genetic)

4.2.4 Acoustics

4.3 Stock structure and movements

4.3.1 Population structure related genetic analyses from biopsy samples

4.3.2 Movements from individual identification (photo and genetic)

4.3.3 Telemetry

4.4 Marine debris

4.5 Other (e.g. related to environment)

5. REVIEW OF RESULTS AND AVAILABLE INFORMATION BY SPECIES

5.1 Fin whales

5.1.1 Distribution and stock structure

5.1.2 Abundance

5.1.3 Outstanding issues relative to new survey

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[1] including implications of the present political situation and work in waters of the Russian Federation

[2] Species specific considerations appear under Item 5

5.1.4 Other

5.2 North Pacific Right whales

5.2.1 Distribution and stock structure

5.2.2 Abundance

5.2.3 Outstanding issues relative to new survey

5.2.4 Other

5.3 Humpback whales

5.3.1 Distribution and stock structure

5.3.2 Abundance

5.3.3 Outstanding issues relative to new survey

5.3.4 Other

5.4 Common minke whales

5.4.1 Distribution and stock structure

5.4.2 Abundance

5.4.3 Outstanding issues relative to new survey

5.4.4 Other

5.5 Bryde’s whales

5.5.1 Distribution and stock structure

5.5.2 Abundance

5.5.3 Outstanding issues relative to new survey

5.5.4 Other

5.6 Blue whales

5.6.1 Distribution and stock structure

5.6.2 Abundance

5.6.3 Outstanding issues relative to new survey

5.6.4 Other

5.7 Sei whales

5.7.1 Distribution and stock structure

5.7.2 Abundance

5.7.3 Outstanding issues relative to new survey

5.7.4 Other

5.8 Sperm whales

5.8.1 Distribution and stock structure

5.8.2 Abundance

5.8.3 Outstanding issues relative to new survey

5.8.4 Other

5.9 Other

6. REVIEW OF OTHER (I.E. NON IWC-POWER) PAST AND ONGOING SURVEY ACTIVITIES AND AVAILABILITY OF DATA

7. INITIAL PLAN FOR ACHIEVING MEDIUM TO LONG-TERM OBJECTIVES AND PRIORITIES BASED UPON LESSONS LEARNED UNDER ITEMS 4 AND 5

7.1 Update if necessary of objectives (e.g. stock structure, abundance, trends) and priority species

7.2 In light of objectives and previous experience, consideration of whether new survey areas should be considered and if so where (e.g. areas further north including Beaufort and Chukchi Seas, areas further south and east including breeding areas in winter) taking into account other likely research programmes (and see Item 6)

7.3 In light of objectives and previous experience, consideration of whether experimental cruises are needed to test new technology or methodological approaches

7.4 Field methods by objectives and taking into account feasibility and priority species in light of analytical approaches

7.4.1 Changes in abundance and distribution

7.4.1.1 Research area choice and cruise design

7.4.1.2 Survey methods and analytical approaches including consideration of new technology (e.g. dive time correction via telemetry and or drones, portable echosounder, new environmental data to assist in spatial modelling)

7.4.2 Population structure and movements

7.4.2.10. Field protocols and priority species (biopsy, photo-id, acoustics, other)

7.4.3 Other

8. PROPOSAL FOR NEXT THREE-FIVE SEASON’S WORK

9. OTHER GENERAL MATTERS

9.1 Participation of other range states in IWC-POWER

9.2 Co-ordination with other research activities

9.3. Permits and related matters

9.4 Data Ownership and Data Archive

9.5 Publication

9.6 Other

10. OTHER

Annex C

DOCUMENTS

WP

1. Report of the meeting of the IWC-POWER Technical Advisory Group (TAG): January 2020 (SC/68B/Rep1)
2. Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG) and 2021 Planning Meeting: November 2020 (SC/68C/Rep1)
3. Report of the Steering Group of the IWC-POWER Programme to SC68C (SC/68C/ASI/17)
4. Report of the IWC-POWER Planning Meeting for 2022: Virtual meeting, 9 and 10 December 2021 (SC/68D/Rep03).
5. Report of SC/68D.
6. Overview of sighting surveys conducted on IWC-POWER cruises from 2010 to 2021.
7. An overview of the sighting studies on abundance based on IWC-POWER surveys.
8. An overview of the genetic studies on stock structure based on biopsy samples obtained by the IWC-POWER program and preliminary suggestions for sampling and analyses in the future.
9. Review of distance and angle experiment conducted in the IWC-POWER cruises.
10. Abundance estimates on design base analyses using 2010-2018 IWC-POWER sighting data.
11. Abundance estimation of floating marine debris in the North Pacific using 2010–2016 IWC-POWER data.
12. Results of the passive acoustic component of the IWC-POWER cruises, 2017-2019.
13. Summary of Photo-id
14. Cruise report of the 2021 IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER).
15. Results of the feasibility experiment of dive behavior tagging for fin and sei whales during 2021 POWER survey in the eastern North Pacific.
16. (to be updated) NP sighting survey data
17. Proposal for the middle-term survey after 2023 IWC-POWER (Draft).

Annex D

Overview of sightings surveys conducted on IWC POWER cruises from 2010 to 2021

(Compiled by Matsuoka and Yoshimura)

The IWC-POWER research cruises are an important component of the IWC's work, and the successor to the Southern Ocean programme (SOWER) which ran in the Antarctic for over thirty years and surveyed the complete circumpolar area south of 60°S three times. The IWC-POWER cruise was organized as a joint project between the IWC and Japan since 2010. The cruise plan was endorsed at the each of IWC/Scientific Committee (IWC/SC) meeting. As its name suggests, the cruises focus on the (North) Pacific Ocean, and particularly little studied areas, some of which have not been surveyed for 40 years. The programme is now entering its 13th year. Scientists from Japan, the Republic of Korea, the USA, Mexico and the UK have been participated in the fieldwork. In addition, scientists from Australia and Europe are members of a specialist IWC-POWER steering group. The survey was conducted using methods based on the guidelines of the IWC/SC. The acoustic survey was included from 2017 cruise to acoustically monitor for the presence of marine mammals, with particular importance for detecting and locating North Pacific right whales.

Table 1. Summary of the 2010-2021 IWC-POWER surveys.

No.	Year	Period	No. days	Research area	High Sea or Foreign EEZ	Vessel	Home port	Port of call	Inernational researchers	Survey mode	US Biopsy permit	Acoustic	Remarks
1	2010	July - August	60	South of Aleutian Is., North of 40N, 170E-170W	USA	KK1	Kushiro, Kushiro	-	Japan (2), USA(1), Korea(1),	NSP	-	-	
2	2011	July - August	60	South of Gulf of Alaska, North of 40N, 170W-150W	USA	YS3	Shimonoseki, Hakodate	-	Japan(1), USA(1)	NSP	-	-	Changed home port due to the Great East Japan Earthquake.
3	2012	July - August	60	South of Gulf of Alaska, North of 40N, 150W-135W	USA, Canada	YS3	Shiogama, Shiogama	-	Japan (2), USA(1), Korea(1),	NSP	-	-	
4	2013	July - August	60	Subtropics, 40N-30N, 160W-135W	High Sea	YS3	Shiogama, Shiogama	-	Japan(2),USA(1), Korea(1), Mexico(1)	NSP	-	-	
5	2014	July - August	60	Subtropics, 40N-30N, 170W-160W	High Sea, USA	YS3	Shiogama, Shiogama	-	Japan(2), USA(1), UK(1)	NSP	Yes	-	
6	2015	July - August	60	Subtropics, 30N-20N, 170E-160W	High Sea, USA	YS3	Shiogama, Shiogama	-	Japan(2), USA(1), UK(1)	NSP	Yes	-	
7	2016	July - August	60	Subtropics, 30N-20N, 160W-135W	High Sea, USA	YS3	Shiogama, Shiogama	-	Japan (2), USA(1), Korea(1),	NSP	Yes	-	
8	2017	Aug. - Sept.	76	Bering (Eeastern)	USA	YS2	Shiogama, Shiogama	Dutch Haobor (Twice)	Japan(2), USA(1), UK(1)	NSP, IO	Yes	Yes	
9	2018	Aug. - Sept.	76	Bering (Western)	USA	YS2	Shiogama, Shiogama	Dutch Haobor (Twice)	Japan(2), USA(2)	NSP, IO	Yes	Yes	
10	2019	Aug. - Sept.	85	South of Gulf of Alaska (US EEZ), 170W-135W	USA, Canada	YS2	Shiogama, Shiogama	Dutch Horbor, Kodiak	Japan(2), USA(2)	NSP, IO	Yes	Yes	Biopsy sampled in US EEZ. Original plan was Bering (western),
11	2020	Aug. - Sept.	60	Western NP, North of 40N, 160E-180	High Sea	YS2	Shiogama, Shiogama	-	Japan(3)	NSP, IO	-	-	Due to Covid-19, foreign port calls and international researchers couldnot board.
12	2021	Aug. - Sept.	60	Eastern NP, North of 40N, 155W-135W	High Sea	YS2	Shiogama, Shiogama	-	Japan(2), USA (1)	NSP, IO	-	-	Due to Covid-19, no foreign port calls. Original plan was Bering (western),
13	2022	Aug. - Sept.	60	South of Aleutian Is.(US EEZ), 167E-170W	USA	YS2	Shiogama, Shiogama	Dutch Haobor (Twice)	Japan(2), USA (2)	NSP, IO	Yes	Yes	Biopsy sampled in US EEZ. Original plan was eastern Kamchatka

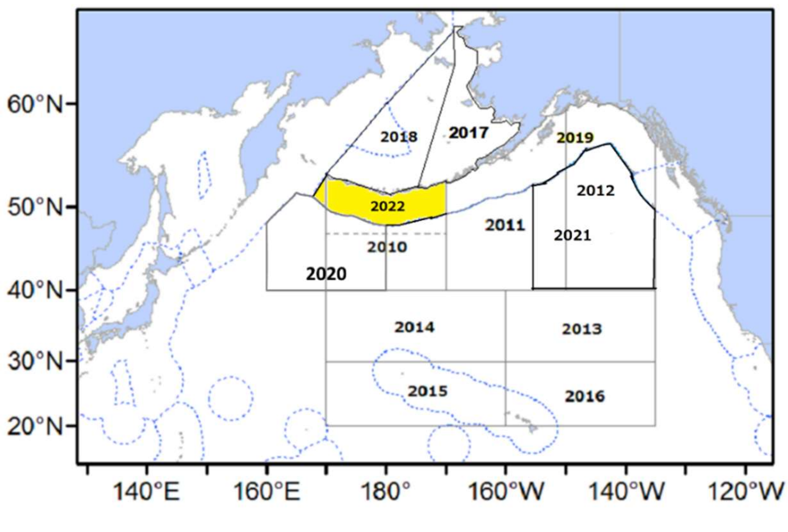


Figure 1. The High-Sea and foreign-EEZ in the North Pacific (dotted blue line) and research area of IWC-POWER 2010-2021. Yellow: 2021 research area.

Objectives

The programme had five main objectives: (a) obtain information for in-depth assessments of North Pacific sei, humpback and gray whales in terms of abundance, distribution and stock structure; (b) obtain information on the critically endangered North Pacific right whale population in the eastern Pacific; (c) completion of coverage of the northern range of fin whales following on the IWC-POWER cruises in 2010-12; (d) obtain baseline information on distribution, stock structure and abundance for a poorly known area for several large whale species/populations, including those that were known to have been depleted in the past but whose status is unclear; (e) obtain essential information for the development of the medium-long term international programme in the North Pacific in order to meet the Commission's long-term objectives.

Research vessel, crew, international researchers, searching distance

During the 13-year history of the program to 2021, a total search distance on primary effort of 34,932.1 n.miles (64,694 km) has been achieved during 837 ship-days in the North Pacific (Table1). Three research vessels were used (Tables 1 and 5). A total of 169 crewmembers have been engaged and a total of 48 international researchers from 4 North Pacific range nations selected by the IWC have been involved. The cruise leaders have usually participated for many years. There was an additional researcher (acoustic expert) onboard the 2017, 2018, 2019 and 2022 cruises. The acoustic researcher did not take part in sighting activity.

Sightings

A total of 76 blue whale (92 individuals), 929 fin whale (1,432 individuals), 400 sei whale (654 individuals), 272 Bryde's whale (318 individuals), 62 common minke whale (62 individuals), 534 humpback whale (917 individuals), 13 NP right whale (21 individuals), 614 sperm whale (972 individuals) school sightings were recorded (Table2).

Experiment

For the experiment, a total of 3,648 trials were conducted for distance and angle experiment (Table2). A total of 1,233 photo-ID photographs (individuals) were taken (Table 3), and a total of 560 biopsy samples (individuals) were collected (Table 4 and Figure 6). A total of 2,730 marine debris were recorded (Table 6).

Satellite-linked dive behavior tags were experimentally deployed during the 2021 IWC-POWER survey. The tags were attached to 2 fin and 3 sei whales. Success rates for each species were 33.3% (n=6) for fin and 75.0% (n=4) for sei whales (See WP15).

For the acoustic research, because these areas include habitat for the critically endangered eastern North Pacific right whale (Eubalaena japonica, hereafter 'right whale'), passive acoustics (via sonobuoys) was included to acoustically monitor for marine mammals, with particular emphasis on detecting and locating vocalizing right whales. Over the course of three years, a total of 722 buoys were deployed, of which 648 were successful, for a combined total of over 2,362 hours of acoustic monitoring. The most frequently detected species were fin whales, on 332 total buoys (51.2%), sperm whales (228, 35.1%), and killer whales (181, 27.9%), followed by humpback whales (94, 14.5%), right whales (75, 11.5%), blue whales (54, 8.3%), gray whales (14, 2.1%), and sei whales (4, 0.6%). (See WP12).

Table 2. Summary of the searching effort (n.miles) and major sightings including the transit survey between Japan and research area during 2010-2021 IWC-POWER surveys.

Year	2010		2011		2012		2013		2014		2015		2016		2017		2018		2019		2020		2021		Total	
Searching effort (n.miles)	1,986.3		3,097.7		2,676.6		4,342.2		3,761.1		4,305.6		3,443.8		1,989.9		2,470.7		2,556.1		2,424.3		1,877.8		34,932.1	
Species	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.
Blue whale	5	5	10	10	4	4	0	0	1	1	0	0	1	1	0	0	8	12	19	21	22	31	6	7	76	92
Fin whale	28	55	82	141	149	210	3	3	0	0	0	0	0	0	145	198	148	220	266	458	29	32	79	115	929	1,432
Like fin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	20	22	25	20	30	2	2	9	9	70	86
Sei whale	62	118	58	95	87	164	4	4	1	1	0	0	1	1	0	0	5	7	26	43	131	181	25	40	400	654
Like sei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	2	2	2	3	12	12	16	23	32	40
Bryde's whale	0	0	0	0	0	0	54	64	118	140	46	52	28	32	0	0	0	0	0	0	6	8	20	22	272	318
Like bryde's	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	1	1	0	0	24	26
Like sei/bryde's	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	1	1	0	0	24	26
Common minke whale	8	8	2	2	2	2	1	1	0	0	0	0	0	0	23	23	17	17	6	6	3	3	0	0	62	62
Like minke	1	1	2	2	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	0	0	0	1	1	8	8
Humpback whale	5	8	76	133	21	33	0	0	0	0	0	0	0	0	136	165	116	168	173	402	7	8	0	0	534	917
Like humpback	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	12	3	3	7	15	0	0	0	0	19	30
North Pacific right whale	0	0	0	0	1	1	0	0	0	0	0	0	0	0	7	15	5	5	0	0	0	0	0	0	13	21
Like right	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	0	0	0	0	0	0	0	0	2	2
Gray whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	22	28	90	6	15	0	0	0	0	49	127
Like gray	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	1	4	0	0	0	0	0	0	1	4
Sperm whale	75	92	95	119	50	57	67	99	78	155	32	93	32	115	25	33	35	36	50	61	56	90	19	22	614	972
Like sperm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	1	1	0	0	0	0	0	0	1	1
Baird's beaked whale	1	20	0	0	1	6	0	0	0	0	0	0	0	0	0	0	2	24	2	37	0	0	1	3	7	90
Cuvier’s beaked whale	0	0	0	0	1	4	2	6	6	13	5	9	2	5	0	0	0	0	3	5	1	5	0	0	20	47
Longman's beaked whale	0	0	0	0	0	0	0	0	0	0	1	110	0	0	0	0	0	0	0	0	0	0	0	0	1	110
Stejneger’s beaked whale	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
Mesoplodon spp.	3	6	7	26	3	9	9	22	8	19	3	4	2	3	0	0	0	0	0	0	4	9	0	0	39	98
Zhiphiidae	4	9	14	23	23	44	36	71	39	86	8	10	7	11	2	3	0	0	6	8	4	8	4	8	147	281
Killer whale	10	102	7	70	17	99	0	0	1	3	1	4	0	0	32	134	20	136	55	269	18	71	1	4	162	892
Unid. large cetacean	42	68	70	106	59	93	39	43	11	11	3	3	0	0	0	0	0	0	0	0	1	1	0	0	225	325
Unid. cetacean	6	16	3	3	1	1	11	66	10	11	2	2	7	7	6	6	4	4	0	0	4	10	5	5	59	131

Table 3. Summary of angle and distance experiment undertaken (number of trials).

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
Barrel distance	36	42	42	42	36	60	72	84	84	96	84	72	750
Barrel angle	36	42	42	42	36	60	72	84	84	96	84	72	750
IOP distance	-	-	-	-	-	60	72	84	84	96	72	84	552
IOP angle	-	-	-	-	-	60	72	84	84	96	72	84	552
Upper distance	36	24	37	37	24	40	60	60	48	60	48	48	522
Upper angle	36	24	37	37	24	40	60	60	48	60	48	48	522
Total	144	132	158	158	120	320	408	456	432	504	408	408	3,648

Table 4. Summary of whole photo-identification work undertaken including transit survey between Japan and the research area (number of individuals photographed). Number of killer whales in 2018 cruise maybe change after confirmed photos.

Photo-ID	2010	2011	2012	2013	2014	2015	2016	2017	2018**	2019	2020	2021	Total
Blue whale	3	9	4	0	1	0	1	0	8	16	26	7	75
Fin whale	0	25	59	3	0	0	0	79	69	51	1	31	318
Sei whale	0	27	51	2	0	0	1	0	0	0	0	15	96
Bryde's whale	0	0	0	6	73	49	12	0	0	0	0	13	153
Common minke whale	0	0	0	0	0	0	0	0	4	0	0	0	4
Humpback whale	5	48	26	0	0	0	0	48	39	30	3	0	199
North Pacific right whale	0	0	1	0	0	0	0	12	3	0	0	0	16
Gray whale	0	0	0	0	0	0	0	16	41	6	0	0	63
Sperm whale	0	0	1	0	4	22	2	0	4	0	0	0	33
Killer whale	45	18	50	0	3	4	0	84	33	19	17	3	276
Total	53	127	192	11	81	75	16	239	201	122	47	69	1,233

Table 5. Summary of whole biopsy work undertaken including transit survey between Japan and the research area (number of individuals sampled).

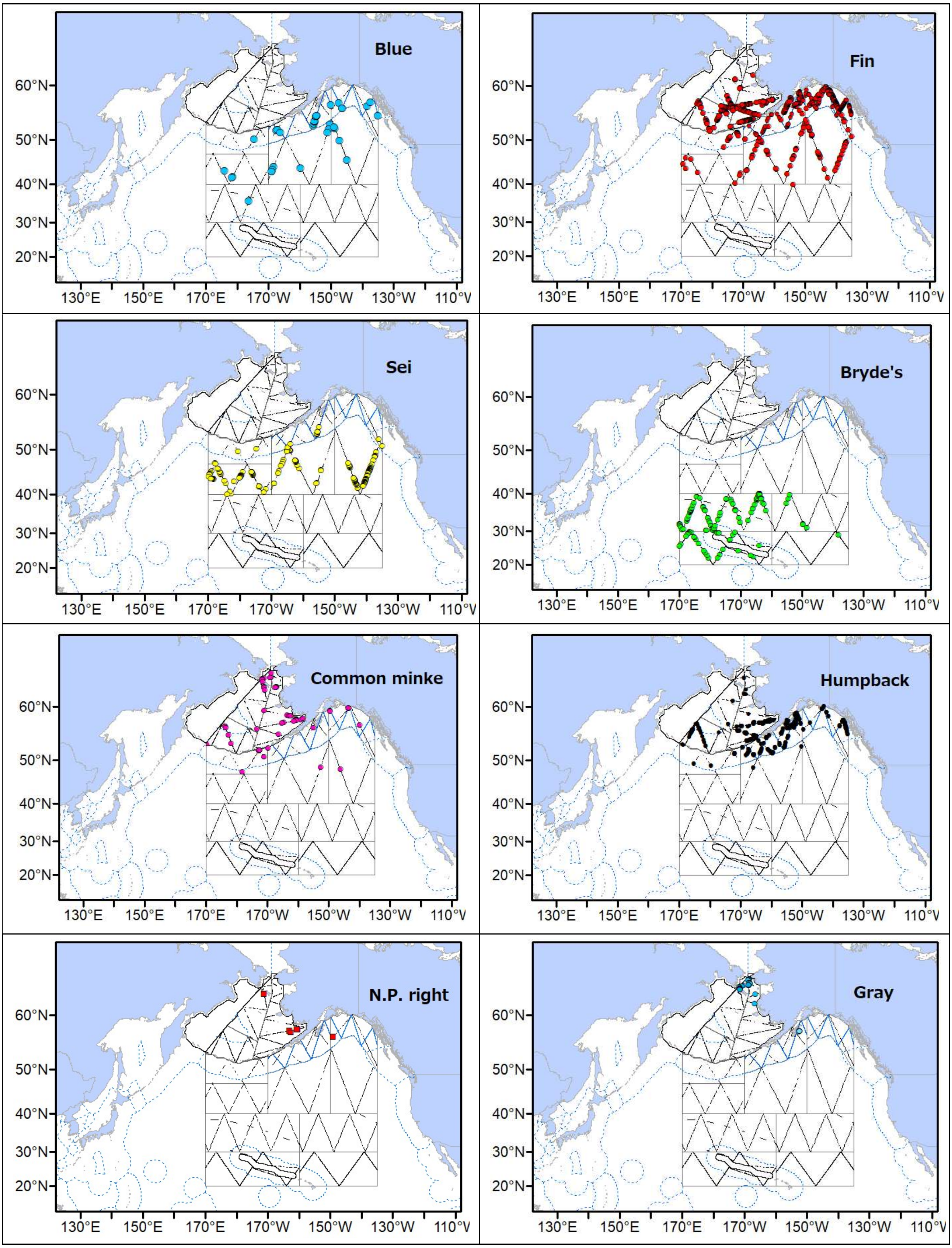
Biopsy sample (ind.)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
Blue whale	1	4	2	0	1	0	1	0	6	12	13	3	43
Fin whale	2	12	12	1	0	0	0	28	24	45	9	9	142
Sei whale	13	31	36	1	0	0	1	0	0	4	36	4	126
Bryde's whale	0	0	0	6	78	34	16	0	0	0	3	2	139
Common minke whale	0	0	0	0	0	0	0	0	0	0	0	0	0
Humpback whale	0	1	0	0	0	0	0	18	29	12	2	0	62
North Pacific right whale	0	0	0	0	0	0	0	3	3	0	0	0	6
Gray whale	0	0	0	0	0	0	0	9	7	2	0	0	18
Sperm whale	0	0	0	0	0	1	5	0	0	0	0	0	6
Killer whale	2	0	1	0	1	2	0	2	7	0	2	1	18
Total	18	48	51	8	80	37	23	60	76	75	65	19	560

Table 6. Some key characteristic of the three vessels used thus far.

Vessel	*Kaiko-Maru* (2010)	*Yushin-Maru No.3* (2011-2016)	*Yushin-Maru No.2* (2017-2021)
Call sign	JGDW	7JCH	JPPV
Length overall [m]	61.9	69.61	69.61
Molded breadth [m]	11.0	10.8	11.5
Gross tonnage (GT)	860.25	742	747
Barrel height [m]	19.5	19.5	19.5
IO barrel height [m]	14.5	13.5	13.5
Upper bridge height [m]	9.0	11.5	11.5
Bow height [m]	6.5	6.5	6.5
Engine power [PS / kW]	1471	5280 / 3900	5303 / 3900

Table 7. Number of marine debris items during whole cruises. Marine debris were recorded during whale observations, which were restricted to the first 15 minutes of every hour (on effort). In other time zones, it may be recorded as long as it does not interfere with the whale sighting survey (off effort).

Marine Debris	ON EFFORT	OFF EFFORT	ALL	PHOTO
2010	15	18	33	0
2011	34	98	132	12
2012	57	173	230	13
2013	1021	487	1508	29
2014	118	129	247	91
2015	173	26	199	32
2016	150	3	153	?
2017	12	0	12	0
2018	11	8	19	21
2019	41	1	42	7
2020	67	0	67	0
2021	88	0	88	3
TOTAL	1787	943	2730	208


Blue
Fin
Sei
Bryde's
Common minke
Humpback
N.P. right
Gray
60°N
50°N
40°N
30°N
20°N
130°E
150°E
170°E
170°W
150°W
130°W

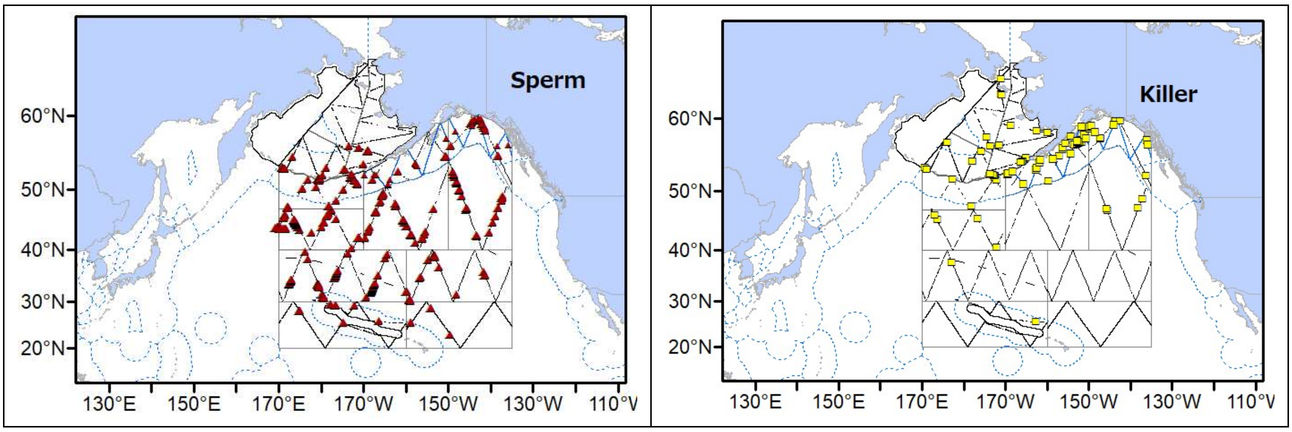


Figure 2. Sighting position in the research area by species, all years combined.

Figure 3. Bering Sea and depth of the water.

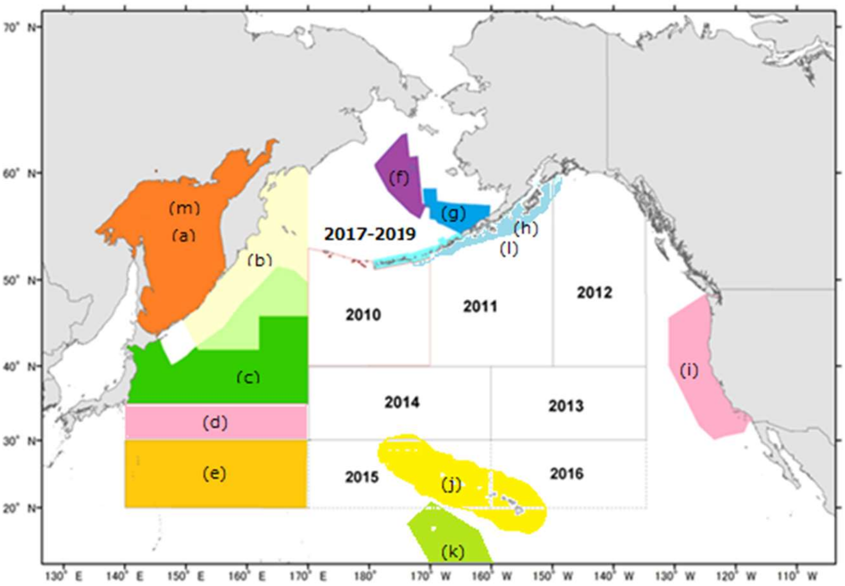


Figure 4. Schematic showing the proposed areas for coverage in the 2017-2019 period, prior to the start of the medium term period. Coloured areas represent surveys conducted in the North Pacific in recent years: (a): Miyashita and Berzin (1991), (b): Miyashita (2006), (c): Pastene *et al.* (2009), (d): Matsuoka *et al.* (2013), (e): Matsuoka *et al.* (2014), (f): Moore *et al.* (1999), (g): Moore *et al.* (2002), (h): Zerbini *et al.* (2007), (i) Barlow and Forney (2007), (j): Barlow (2006a), (k): Barlow (2006b), (l): Rone *et al.*, (2016), (m): Myasnikov *et al.*, (2016).

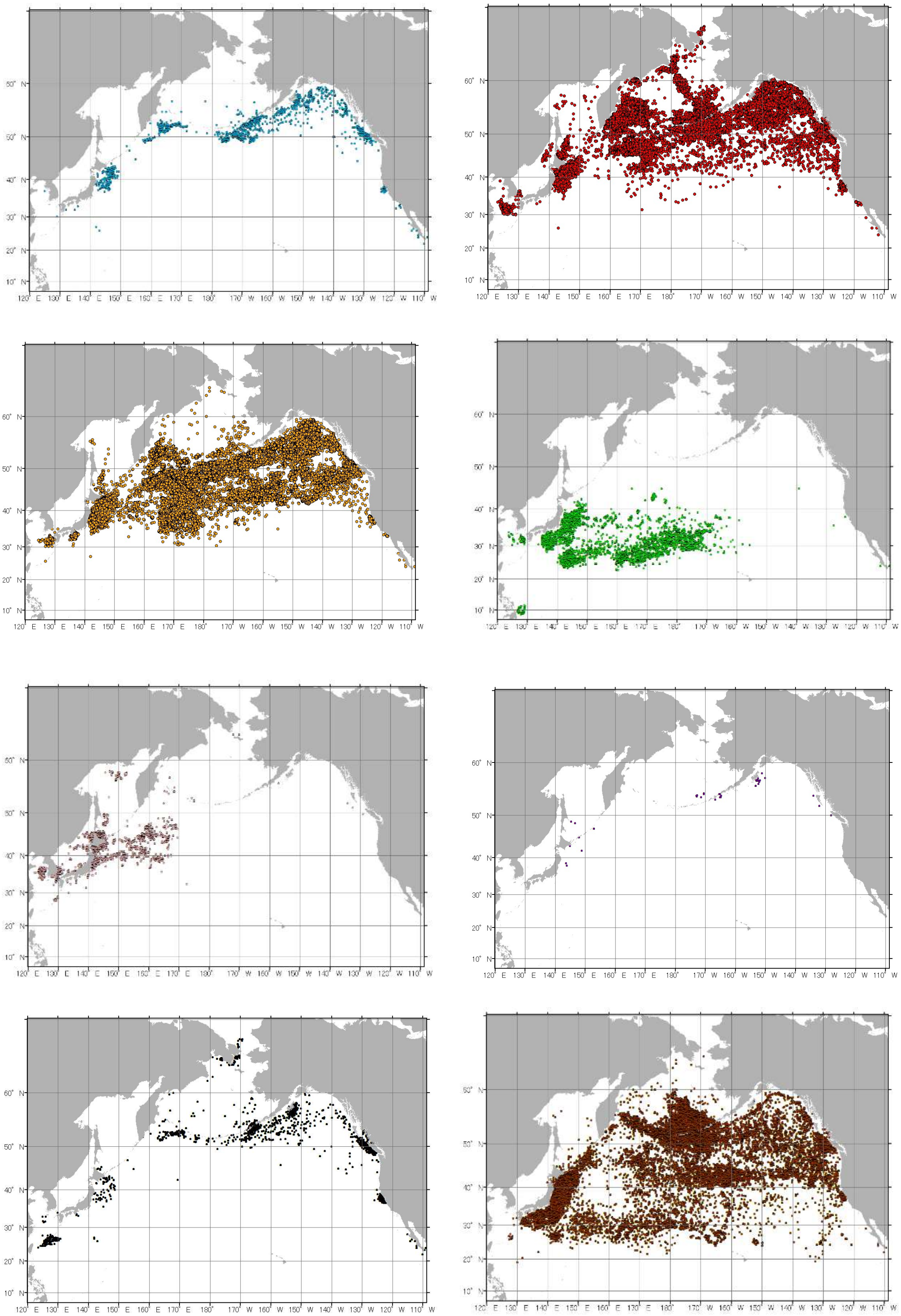
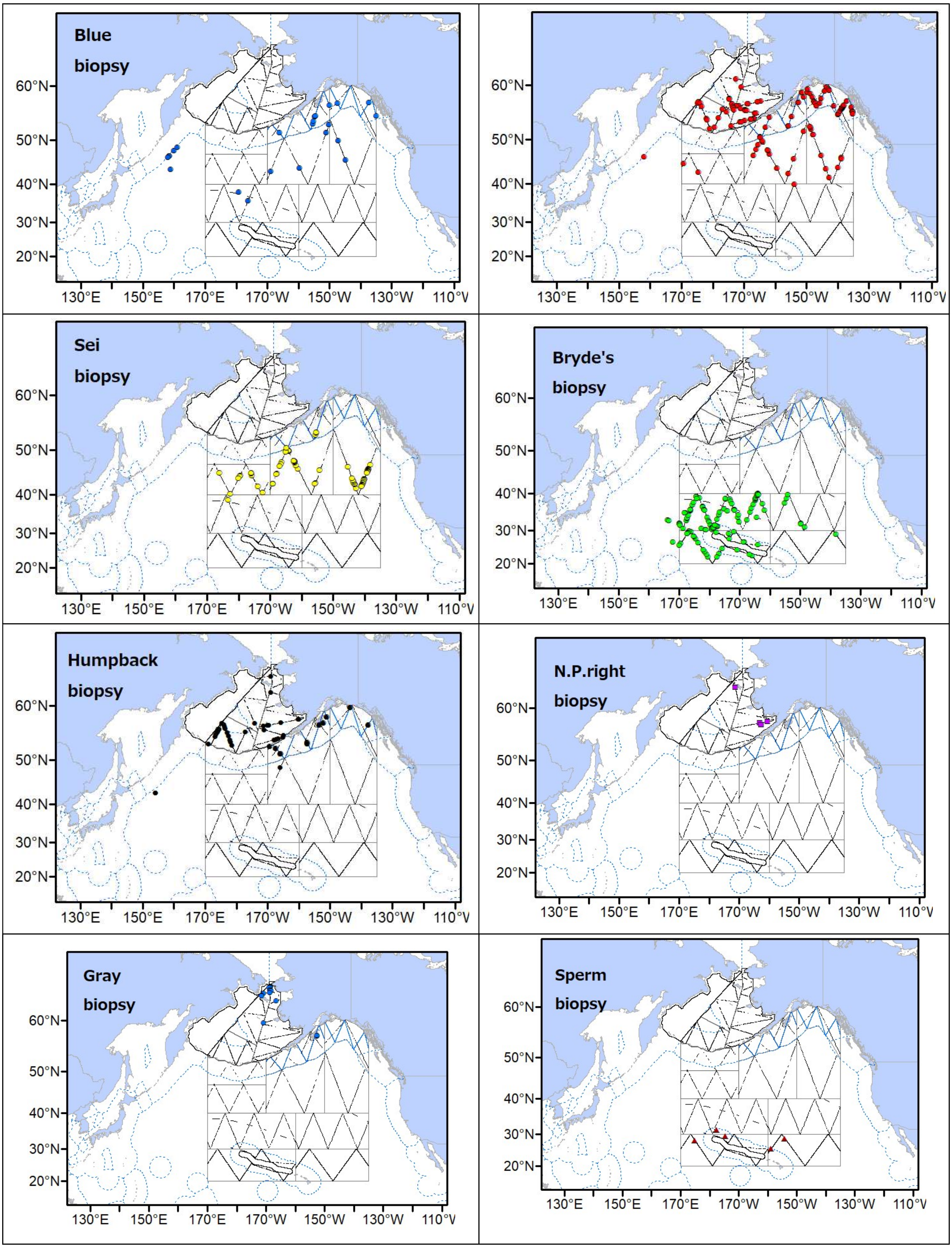


Figure 5. Plot of North Pacific blue (top left), fin (top right), sei (1st middle left), Bryde's (1st middle right), common minke (2nd middle, left), NP right (2nd middle, right), humpback (bottom left) and sperm (bottom right) whale catches from the IWC database (IWC catch databases, Version 6.1).


Blue
biopsy
Sei
biopsy
Humpback
biopsy
Gray
biopsy
Bryde's
biopsy
N.P.right
biopsy
Sperm
biopsy
60°N
50°N
40°N
30°N
20°N
130°E
150°E
170°E
170°W
150°W
130°W

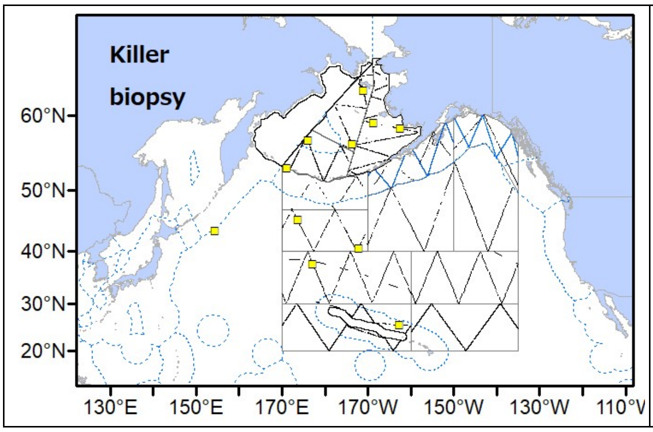


Figure 6. Biopsy sampling position by species, all years combined including transit survey between Japan and the research area (2010-2019).