Annex F

Report of the Sub-Committee on In Depth Assessment

Members: Palka (Convenor), An, Y-R, Aoki, Baba, Baker, Brownell, Butterworth, Cholewiak, Clapham, Cooke, Donovan, Goto, Hughes, Iñíguez, Inoue, Ivashchenko, Kato, Kitakado, Konishi, Maeda, Matsuoka, Miyashita, Mizroch, Moronuki, Morishita, Morita, Moronuki, Nakamura, Pastene, Punt, Taguchi, Tamura, Terai, Wade, Yasokawa, Yasunaga, Yoshida, Zerbini, Zharikov.

1. INTRODUCTORY ITEMS

1.1 Introductory remarks
Palka welcomed the participants.

1.2 Election of Chair
Palka was elected Chair for this meeting and encouraged participants to consider becoming a co-chair.

1.3 Appointment of Rapporteurs
Cooke, Clapham and Palka agreed to act as rapporteurs.

1.4 Adoption of Agenda
The adopted Agenda is shown in Appendix 1.

1.5 Documents available
The documents considered by the sub-committee were SC/67b/IA01-IA03, Murase *et al*. (2018) and SC/67b/SCSP03.

2. IN-DEPTH ASSESSMENT OF INDO-PACIFIC ANTARCTIC MINKE WHALES

An intersessional correspondence group was tasked to finalise a document synthesising the results of the in-depth assessment of an eastern Indian stock (I-stock) and a western South Pacific stock (P-stock) of Antarctic minke whales distributed between 35°E and 145°W. The assessment, carried out from 2001 to 2014, covered systematics, commercial and research catches, survey methods, stock structure, abundance estimates, spatial distribution patterns, biological information, population dynamics, species interactions, food habits, energetic requirements, pollutants and marine debris interactions. Last year a draft version of the paper was submitted to the Committee where comments were received. During the intersessional period the synthesis paper (Murase *et al.*, 2018) was finalised and submitted to the *Journal of Cetacean Research and Management*.

The sub-committee **commended** the authors for submitting the paper to a journal for publication and acknowledged the great effort that had gone into synthesising the results of this assessment. Because the paper has just started the review process, the sub-committee **agreed** to re-establish the intersessional correspondence group, under Murase (Tables 1 and 2). The terms of reference of the group is to ensure publication of the submitted paper that summarises the in-depth assessment of the Indo-Pacific Antarctic minke whale.

3. IN-DEPTH ASSESSMENT OF NORTH PACIFIC SEI WHALES

3.1 Progress on intersessional work
The intersessional correspondence group convened by Cooke worked during the year to compile input data for the population modelling exercise. The compiled datasets included: a historical catch series by sex and subarea; a table of absolute abundance estimates by sub-area for use in the assessment and model; an array of relative abundances by 10° square and 5-year period during 1965-2015 from Japanese scouting vessel and research cruises; and a data file of Japanese marks and recaptures. These inputs were used for some provisional runs of the assessment model developed by Punt, which were presented in SC/67b/IA01.

The sub-committee expressed its appreciation for the work of the intersessional group. The model structure and most of the model inputs were subject to further discussion and amendment at this meeting, as detailed in Item 3.2.

3.2 Preparation of data for assessment
3.2.1 Stock structure hypotheses

Last year the sub-committee agreed to proceed with two stock structure hypotheses for modelling purposes: (i) a single stock in the entire North Pacific; and (ii) five stocks with some overlap in feeding areas. The sub-committee had not attempted to reach agreement on the plausibility of the two hypotheses. The sub-committee had agreed that the evidence for multiple stocks was weak. However, because virtually all the genetic samples had been obtained in just one of the putative sub-areas (the Pelagic sub-area), the sub-committee was not able to reject the hypothesis of multiple stocks at this stage. The sub-committee emphasised that this decision to proceed does not imply endorsement of either hypothesis at this stage.

At the end of last year's meeting the sub-committee had revised its originally proposed sub-areas to bring them into line with the strata used in the IWC-POWER sightings surveys, to facilitate the extraction of abundance estimates by sub-area (IWC, 2018). However, at this meeting the sub-committee noted that this revision was problematic. Firstly, it did not respect the original oceanographic motivation for the sub-areas (Mizroch *et al.*, 2016); secondly, the revision resulted in a much greater inter-area movement of marked animals. The sub-committee therefore **agreed** to return to the original sub-areas, but with some modification in the western North Pacific. One modification was the line between the Pelagic and Western Coastal sub-areas was shifted westward to respect the original oceanographic motivation. This has the effect that Ogasawara and the pelagic catches are now included in the Pelagic sub-area, and the coastal catches remain within the Western Coastal sub-area. Also, as recommended by the intersessional correspondence group, the other modification was the line between the Eastern Coastal and Eastern North Pacific sub-areas was shifted south from 50°N to 48°N to facilitate the allocation of Canadian catches. A map of the revised sub-areas is given in Appendix 2.

The sub-committee considered that the re-extraction of data according to the sub-areas agreed this year would not be impractical. The catch series and relative abundance series were revised at this meeting, while the revision of the marking data and absolute abundance estimates could be entrusted to an intersessional group.

To ensure that the multi-stock hypothesis could be made consistent with available information, some overlap in feeding sub-areas was allowed between the five putative stocks. For each stock hypothesis, a schematic diagram of the feeding sub-areas and the allowed movements between them is shown in Appendix 3, along with a table of the 'mixing matrix' which links the putative stocks to feeding sub-areas.

The sub-committee once again stressed that these sub-areas have been agreed merely for the purpose of allowing the modelling work to proceed. No decision on the plausibility or otherwise of either hypothesis has been made.

3.2.2 Abundance and trends

A regression analysis of Japanese scouting vessel and dedicated survey data over the years 1965-2015 by 10° square and 5-year period had been prepared for the intersessional group and was reviewed by the sub-committee. The sub-committee noted that the data set is unbalanced; in the later years, there was effort only in the western north Pacific, not counting the areas to the south of 30° where only Bryde's whales were seen (see Appendix 4, Fig. 1). The unbalanced nature of the data is accounted for in principle by using the variance-covariance matrix in the fitting process, but the sub-committee nevertheless deemed it preferable not to use abundance indices that were based on less than 500nm survey effort. The resulting reduced set of abundance indices in given in Appendix 4 along with their correlation matrix.

Building on the work of the intersessional group, the sub-committee agreed in principle to a revised table of absolute abundance estimates (Appendix 5). However, the changes in the sub-areas necessitate some further reallocation of the estimates between sub-areas. The sub-committee **agreed** that this would be relatively straightforward, because nearly all the sightings were in the Pelagic sub-area, and that this task could be accomplished by the intersessional working group (see work plan in Item 5.1.2).

Some of the estimates in the table are annotated as minimum estimates, because they only covered part of the sub-area to which they apply. Some estimates are zero, and should be handled as recommended in the RMP specifications (IWC, 2012). Punt **agreed** to modify the likelihood function in the model to accommodate both minimum estimates and zero estimates.

3.2.3 Marking data

SC/67b/IA02 reported on 11 dedicated whale marking and sightings cruises conducted from 1962 to 1969 along the eastern North Pacific coast from northern California to the southern tip of Baja California and beyond. Most surveys were conducted in winter months and 991 groups of large whales were sighted. Sei whales were seen in all years and most months during which the surveys were conducted. A total of 31 groups of sei whales were seen. A total of 12 were potentially marked (hit or possible hit). Marks were recovered from 2 sei whales.

These mark recovery data were included in the analysis presented to the sub-committee in 2015 (Mizroch *et al.*, 2016) and have been incorporated into the marking data set to be used as input into the assessment.

In the intersessional period Allison and Yoshida prepared a data file on Japanese marks and recoveries of sei and Bryde's whales in the North Pacific during 1949-1981. These data had been used in the preliminary model runs reported in SC/67b/IA01.

The sub-committee discussed a number of issues associated with the marking data. These included marks placed where the species was uncertain, and tags recovered from species different than the one recorded on marking. The effective number of hits was also unclear, with some tags having been recovered from 'possible hits' and presumed misses. It was also not always clear when two tags had been placed in the same whale, when only one was recovered.

There were also some marks recovered at unknown locations: these had been found in the cooker, but it was unclear how long they had been there because the cookers were not cleaned out very often. There was a lot of grime and slime in there. The sub-committee considered that it was better to use these recoveries because they could be assigned to sub-area with little doubt.

Yoshida and Mizroch worked during the meeting to develop criteria for separating genuine marked sei whales from those which were likely Bryde's whales. However, it was not possible to resolve all remaining issues with the marking data set in the time available. These issues are listed in Appendix 6. The sub-committee **agreed** that the proposed intersessional correspondence group (see Item 5.1.2) should resolve these issues after the meeting and produce a final data set for use in the in-depth assessment. The sub-committee also **agreed** that the winter marks be used; Punt confirmed that this could be done through a simple modification to the model.

SC/67b/SCSP03 reported the results of the satellite monitored tagging experiments on North Pacific sei whales conducted during the 2017 NEWREP-NP survey. A total of 44 tagging experiments were conducted using SPOT6 type tags with LKArts system for attachments from Yushin-Maru-type sighting/sampling vessels. A total of 15 tags were deployed on sei whales, of these eight tags transmitted the locations and movement of the whales. Two sei whales were tracked for more than 35 days, and these two whales showed a longitudinal movement. In general, the tagging experiment of penetrate-type tags from sighting/sampling vessels seems to be practical. However, some technical improvements have been identified which could increase the tracking period.

Noting how tag data are valuable in documenting movement patterns which is an important aspect in this assessment, the sub-committee welcomed the results of the tagged North Pacific sei whales, and encouraged the placement of further, improved tags on future cruises throughout the North Pacific.

Attention SC, G:

The movement of the two tagged North Pacific sei whales presented at this meeting remained within the Pelagic sub-area. The sub-committee recommended that when feasible, any researcher working in the North Pacific tag sei whales in one or more of the other sub-areas to assist in quantifying the movement patterns of the animals.

3.2.4 Catch history

Based on the sub-areas agreed last year (IWC, 2018) during the intersessional period Cooke generated a catch series by sub-area and sex from 1907-2017. On the suggestion of Allison, the line between the Eastern Coastal and Eastern North Pacific sub-areas was moved from 50°N to 48°N so that the Canadian coastal catches that lacked position data could be assumed to have been taken within one sub-area, the Eastern North Pacific sub-area. The US coastal catches were assumed to have been taken in the Eastern Coastal sub-area. Of the Japanese coastal whaling catches for which position data were available, almost all sei whales were taken in the Western Coastal sub-area. Therefore, it was assumed that the Japanese coastal whaling catches without positions were also taken in the Western Coastal sub-area.

For those Japanese coastal catches that were not divided between sei and Bryde's whales, the sei/Bryde's split for the summary data followed Allison (2008). For those years and stations where the catches by sex were not divided into sei and Bryde's whales, the Bryde's whales catch by sex was estimated based on the average female proportion (44%) of Bryde's whales taken in the Western Coastal sub-area. This proportion showed little annual variation. The estimated Bryde's whale catches by sex were deducted from the combined catches by sex to yield estimates of sei whale catches by sex.

During this meeting the catch series was further revised to take account of the changes to sub-areas agreed at this meeting. The resulting catch series of sei whales by year, sub-area and sex, and the assumptions made to produce it, are given in Appendix 7.

The month is known for about 75% of the catch. Of the catch with known month, over 99% was taken in summer (May-October). Therefore, it was assumed for modelling purposes that all catches were taken in summer.

3.2.5 Life history parameters

The life history parameters of North Pacific sei whales were last reviewed by the Committee in 1974 (IWC, 1977). The age at sexual maturity (ASM) was estimated to be 10 year in the eastern North Pacific (Rice, 1977). Masaki (1976) estimated the mean age at sexual maturity of both sexes to have decreased with time from about 10 year prior to 1930 to 6 year (females) or 7.5 year (males) in the early 1960s. However, the latter estimates appear to have been based on transition layers without correction for the truncation effect in recent cohorts (IWC, 1984).

The 1974 assessment assumed a value of 0.06 for the natural mortality rate. However, this was based on estimates of total apparent mortality (Z) rates of 0.054 for males and 0.062 for females from catch curve analyses from the catches taken during 1967-1972, when the population could already have been impacted by exploitation, given catches of 35,000 sei whales prior to 1965.

There does not appear to be any more recent information on the age at maturity or mortality rate in North Pacific sei whales, despite the sampling of over 1,350 sei whales under JARPN II.

Taylor *et al.* (2007) estimated an age at first reproduction (AFR) of 9 year and an *M* value of 0.04 for sei whales based on inter-specific regressions. The sub-committee **agreed** to use an ASM of 8 year and an adult natural mortality rate of 0.04 for the in-depth assessment.

3.3 Assessment model

SC/67b/IA01 detailed the provisional model structure for North Pacific sei whales. This had been updated from last year to be able to accommodate the available data types (catches, estimates of absolute abundance, estimates of relative abundance, and mark-recapture data). Preliminary applications of the model based on 1-stock and 3-stock hypotheses indicated some conflicts between the catch and abundance data.

The main conflict arose in the Mixed sub-area, where the abundance was too small to enable all the catches to be taken. In discussion, it was noted that this problem was caused by treating the Mixed sub-area as a discrete feeding group. The sub-committee **agreed** that it should be treated as an area of overlap between multiple adjacent feeding groups, (potentially the Eastern North Pacific, Pelagic and Aleutian sub-areas) such that whaling in the Mixed sub-area could take whales from any of the overlapping feeding groups. This would make it less likely that the whalers would 'run out of whales'. Punt agreed to revise the model accordingly (see work plan in Item 5.1.2).

4. COMPREHENSIVE ASSESSMENT OF NORTH PACIFIC HUMPBACK WHALES

4.1 Progress on intersessional work

Work towards a Comprehensive Assessment of North Pacific humpback whales began in 2016, and included an intersessional workshop held in April 2017 (IWC, 2018). Following SC/67a, an intersessional steering group was formed to oversee additional work. Clapham presented the report of this group (SC/67b/IA03). The main tasks of the group were to prioritise stock structure hypotheses, facilitate further work on abundance estimates, and to prepare for a possible second workshop in 2018. Despite much discussion among members of the Steering Group, progress on these objectives was slow, in part because of uncertainty regarding stock structure hypotheses. Nonetheless, a way forward was agreed, details of which are given below. After consideration, the Steering Group concluded that insufficient progress had been made to justify holding a second workshop in 2018, and agreed that this meeting should be postponed.

4.2 Preparation of data for assessment

4.2.1 Stock structure hypotheses

The sub-committee **agreed** that simplified subdivisions of North Pacific humpback whale feeding habitats as proposed by the Steering Group were largely consistent with existing data, in particular with the results obtained by the SPLASH project. These subdivisions (areas for allocation of catches) are illustrated in Fig. 1 and include (from west to east): (1) the western Bering Sea and Aleutian Islands; (2) the eastern Bering Sea, Aleutian Islands and western Gulf of Alaska; (3) the Central Gulf of Alaska (including Prince William Sound); (4) southeast Alaska and northern British Columbia; (5) southern British Columbia and Washington State; and (6) California and Oregon. There remains an open question of whether area (1) above should include the Commander Islands.

With regard to breeding areas, the sub-committee **agreed** that sub-division of some of the breeding areas used in a former population assessment model (Ivashchenko *et al.*, 2016) was warranted, and the following approach was proposed:

(1) Mexico' should be divided into three distinct sub-areas: the Revillagigedo Archipelago, the Mexican mainland, and Baja California. The former two areas are considered breeding areas and Baja California a migratory route.
(2) The 'Asia' breeding area, which formerly encompassed the Philippines, Okinawa and Ogasawara should be sub-divided into two sub-areas: Okinawa with the Philippines (referred to as OK+PH), and Ogasawara. The latter is now considered a migratory corridor for whales wintering off Asia (but see below).

Four potential modeling scenarios were proposed, and these are illustrated in annex 1 of SC/67b/IA03. The potential usefulness of including an 'unknown' breeding area (which included the Marianas Islands) in at least a few modeling scenarios was also discussed. While there may be difficulties associated with the estimation of model parameters, this idea

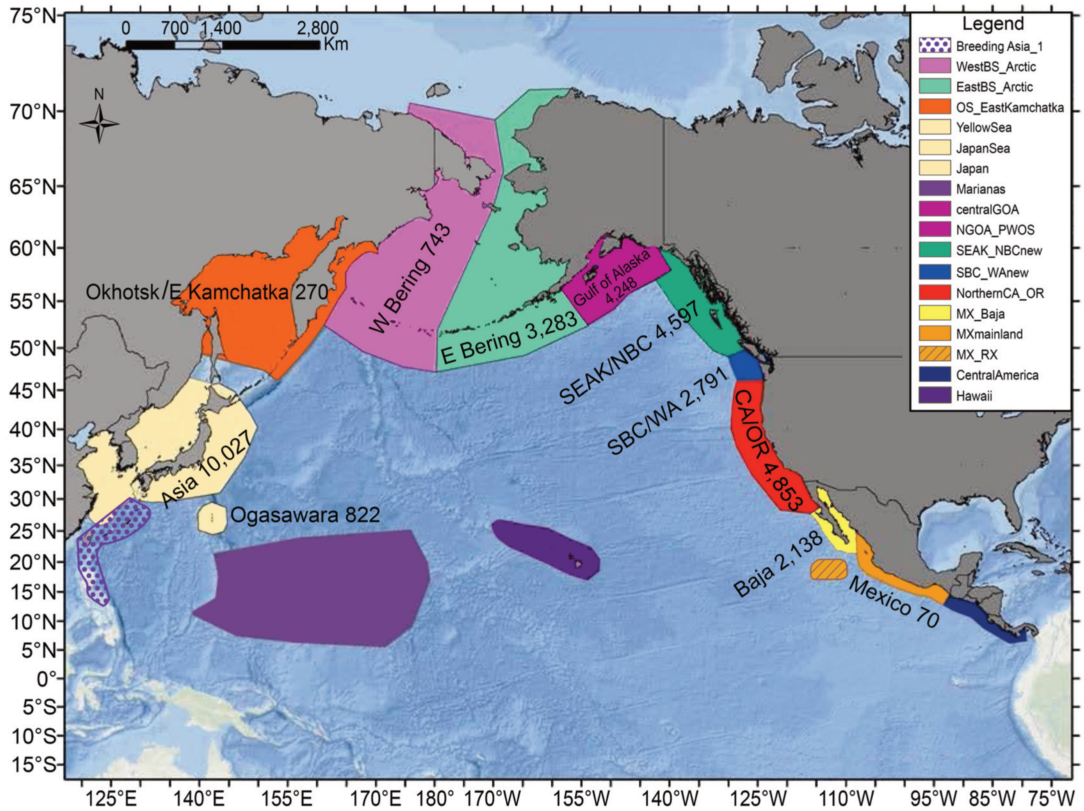

Fig. 1. Stock structure hypothesis scenario 1 that includes 7 feeding and 6 breeding areas (including the 'unknown' breeding area, which includes the Mariana Islands. Note that Japan, Ogasawara (in the west) and Baja California (in the east) are considered migratory routes. Catch numbers are shown.

should be explored further. If the Marianas are included (as part of the 'unknown breeding area') as a breeding ground in the model, consideration should be given to the allocation of catches from Ogasawara to both Asia and to the 'unknown' breeding area.

In addition to Baja California and Ogasawara, the proposed simplified stock structure considers Japan and the Kuril Islands as a migratory corridor that would be associated with the Asian breeding area.

The sub-committee **agreed** that it would be useful to analyse humpback photo-ids taken after the SPLASH project, particularly in some key areas, to help clarify the connections among them. The primary areas of interest include the Philippines, Japan, Russia, the Bering Sea, the Aleutian Islands, the Gulf of Alaska, and Mexico. This analysis involves a large-scale matching effort to collect and compare photo-id data from selected areas of the North Pacific, including those for which the SPLASH sample size was relatively low. If approved by the various catalogue holders involved (some of whom had already expressed tentative interest), the photo-id comparisons would be accomplished using the largely automated *Happywhale* system managed by Ted Cheeseman and discussed in the Working Group on Photo-Identification (see Cheeseman *et al.*, 2017; SC/67b/PH05).

Attention: SC; CG-R, G

The sub-committee ***recommended*** *that a large-scale matching effort of recent Pacific humpback whale photo-ids taken after SPLASH be conducted to help clarify the connections among the feeding/breeding areas within the North Pacific. In additions, analyses of these matches might also be used to derive new abundance estimates, subject to consideration of potential biases and differential survey effort. To obtain the most robust assessment and thus conservation advice, the sub-committee* ***encouraged*** *all catalogue holders to participate in this exercise, after the appropriate data sharing agreements are made.*

4.2.2 Abundance and trends

Previously planned intersessional work to re-compute abundance estimates was not completed and must now be undertaken in the period prior to SC/68a. It was noted that estimates for local areas in Japan might be available by next year. The sub-committee **encouraged** pursuit of these estimates, but the utility of these relative to areas proposed for the models would need to be assessed. Kato stated his belief that the humpback population was expanding and may be recolonising former migratory areas in Japan, notably Okinawa.

Preliminary estimates of humpback whale abundance developed from the IWC-POWER cruise were now available (SC/67b/NH04). The sub-committee **welcomed** these estimates, but noted that they would need to be recomputed relative to the areas proposed for the assessment model, if they are to be used.

4.2.3 Catch history

Catches have been assigned to the four scenarios described above, but may need to be adjusted if additional information requires changing the proposed feeding/breeding areas. Consideration should be given to the time period used in the assessment, and specifically whether historical catches before the modern era should be included.

The sub-committee **agreed** that it was probably unnecessary to consider a factor for struck and lost animals given the efficiency of modern whaling, and the uncertainties regarding incomplete catch series in earlier periods.

4.2.4 Life history parameters
There was no new information on life history parameters, and the model to be used in the assessment does not require age structure. If required for other analyses, the life history parameters summarised in Zerbini *et al.* (2010) may be utilised.

4.3 Assessment model
As previously, the sub-committee **agreed** that a simplified age-aggregated model should be used for the assessment. The model requires abundance estimates for both breeding and feeding areas as well as information on linkages between areas. Sensitivities to be explored include allocating the Commander Islands to either the western or eastern Bering Sea feeding areas (due to uncertainty about the migratory destinations of these whales); and modelling 'Asia' and 'Mexico' as previously defined in Ivashchenko *et al.* (2016).

5. WORK PLAN AND BUDGET REQUESTS FOR 2019-20

5.1 Work plan
5.1.1 In-depth assessment of Indo-Pacific Antarctic minke whales
To ensure the submitted paper that synthesises this in-depth assessment is published, the sub-committee **agreed** that the work plan (Table 1) is to re-establish the steering group convened by Murase (Table 2) to complete the journal's review process and further any needed work to ensure the paper is published. No funds related to this assessment are being requested.

5.1.2 In-depth assessment of North Pacific sei whales
In light of the intersessional work and further progress made during this meeting, the following work plan was **agreed**.

Table 1
Work plan for IA.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual meeting (SC/68b)
In-depth Assessment of Indo-Pacific Antarctic minke whales	Complete review of paper submitted for publication	-	-	-
In-depth Assessment of North Pacific sei whales	Re-establish the ISG (Table 2) to further data preparation and development of the assessment model	Review progress of intersessional work and continue the assessment	Finalise /continue preparation of assessment	Review progress of intersessional work and finalise the assessment
Comprehensive Assessment of North Pacific humpback whales	Re-establish the ISG (Table 2) to further data preparation, development of the assessment model and hold a Workshop	Review progress of intersessional work and continue the assessment	Finalise /continue preparation of assessment	Review progress of intersessional work and continue/finalise the assessment

Table 2
Intersessional e-mail groups for IA (see Annex Y for final list).

SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 5.1.1 IA	ICG-1	Antarctic minke whale publication	Continue editing the submitted paper that summarises the In-depth Assessment of the Indo-Pacific Antarctic minke whale to assist in publishing the paper.	Murase (Convenor), Donovan, Kato, Kitakado, Matsuoka, Palka, Pastene, Punt, Suydam. *antminkeass@dist.iwc.int*
Item 5.1.2 IA	SG-1	North Pacific sei whales	Continue progress on developing the in-depth assessment including: (i) Finalise and document the data inputs for the assessment. (ii) Modify the assessment model to incorporate the issues identified. (iii) Conduct runs of the assessment using the updated data and modified model. (iv) Review results of initial runs and specify alternative assumptions if required. (v) Report to next year's meeting on the input data, final model specifications and results.	Cooke (Convenor), Allison, Hakamada, Kitakato, Matsuoka, Mizroch, Palka, Punt, Yoshida. *npseiass@dist.iwc.int*
Item 5.1.3 IA	SG-2	North Pacific humpback whales	Further the preparations for the North Pacific humpback whale comprehensive assessment by: (i) Assess the feasibility of conducting mixed-stock analysis in the feeding grounds. (ii) Re-compute abundance and interchange rate estimates for North Pacific humpback whales for the various stock structure hypotheses agreed above. (iii) Revise the assessment model according to the stock structure hypotheses described above. (iv) Provide a 'dummy' file with input parameters for further model development and collate other information required for the assessment model. (v) Approach photo-id catalogue holders from key areas and conduct a large-scale matching effort to collect and compare photo-id data from selected areas of the North Pacific.	Clapham (Convenor) Baker, Calambokidis, Donovan, Kato, Kitakado, Ivashchenko, Matsuoka, Punt, Zerbini, Urban, Wade and Yoshida *npha@dist.iwc.int*

(i) Finalise and fully document the data inputs for the assessment, including revise the absolute abundance estimates by the revised sub-areas.
(ii) Modify the assessment model structure to incorporate the issues identified, including modify the likelihood to accommodate both minimum and zero estimates of abundance, use winter marks, and treat the Mixed sub-area as an area of overlap not a discrete feeding area.
(iii) Conduct runs of the assessment using the updated data and modified model.
(iv) Review results of initial runs and specify alternative assumptions if required. and
(v) Report to next year's meeting on the input data, final model specifications and results.

To oversee this work plan the sub-committee **agreed** to re-establish the intersessional steering group convened by Cooke (Table 2). It is expected that this work will be completed by the 2020 Committee meeting, if not by the 2019 meeting.

5.1.3 Comprehensive assessment of North Pacific humpback whales
In light of the conclusions regarding stock structure, the following work plan was **agreed** (Table 1):

(i) S. Baker will assess the feasibility of conducting mixed-stock analysis in the feeding grounds to better inform the allocation of catches for the assessment model.
(ii) Wade will re-compute abundance and interchange rate estimates for North Pacific humpback whales using the model described in Wade *et al.* (2016) for the various stock structure hypotheses agreed above.
(iii) Punt will revise the assessment model according to the stock structure hypotheses described above.
(iv) Ivashchenko and Zerbini will provide a 'dummy' file with input parameters to Punt for further model development. They will also collate other information required for the assessment model (in addition to the ones provided by Wade's model), which would be provided to Punt when all information needed for model runs becomes available.
(v) Photo-id catalogue holders from key areas will be approached with a view to conducting an update of SPLASH photo matching, in order to provide new information with which to refine existing stock structure hypotheses.

To oversee this work plan the sub-committee **agreed** to re-establish an intersessional steering group under Clapham (Table 2). To ensure progress of this Comprehensive Assessment, the sub-committee **agreed** that an intersessional workshop was necessary after the intersessional Steering Group decides sufficient progress has been made. Depending upon progress on this work, the intersessional steering group will determine the timing of the intersessional workshop which will be prior to SC/68b.

5.2 Budget request for 2019-20
To ensure progress of the in-depth assessment of North Pacific sei whales, the sub-committee **agreed** to request funds for Punt to modify the assessment model, run the modified model with the updated input data, and produce a report with a description of the model and results (Table 3).

To ensure progress of the Comprehensive Assessment of North Pacific humpback whales, the sub-committee **agreed** to request funds for an intersessional workshop and funds to modify the assessment model, run the modified model with the updated input data, and produce a report with a description of the model and results (Table 3). Details of work to be completed prior to this workshop are in Item 5.1.3.

6. ADOPTION OF REPORT
The report was adopted at 14:17 on 2 May 2018.

REFERENCES

Allison, C. 2008. Report of the second Intersessional Workshop on the western North Pacific Bryde's whale *Implementation*, Yokohama, 10-14 December 2006. Annex C. Catch series for western North Pacific Bryde's whales. *J. Cetacean Res. Manage. (Suppl.)* 10: 457-67.

Cheeseman, T., Johnson, T., Southerland, K. and Muldavin, N. 2017. Happywhale: Globalizing marine mammal photo identification via a citizen science web platform. Paper SC/67a/PH02 presented to the IWC Scientific Committee, May 2017, Bled, Slovenia (unpublished). 7pp. [Paper available from the Office of this Journal].

Ivashchenko, Y.V., Clapham, P.J., Punt, A.E., Wade, P.R. and Zerbini, A.N. 2016. Assessing the status and pre-exploitation abundance of North Pacific humpback whales: Round II. Paper SC/66b/IA19rev1 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 34pp. [Paper available from the Office of this Journal].

International Whaling Commission. 1977. Report of the Special Meeting of the Scientific Committee on sei and Bryde's whales, La Jolla, 3-13 December 1974. *Rep. Int. Whaling Commn. (Special Issue)* 1:1-9.

International Whaling Commission. 2012. The Revised Management Procedure (RMP) for Baleen Whales. *J. Cetacean Res. Manage. (Suppl.)* 13:483-94.

International Whaling Commission. 2018. Report of the Scientific Committee. Annex F. Report of the Sub-Committee on In-depth Assessments. *J. Cetacean Res. Manage. (Suppl.)* 19:174-82.

Masaki, Y. 1976. Biological studies on the North Pacific sei whale. *Bull. Far Seas Fish. Res. Lab.*14: 1-104.

Mizroch, S.A., Conn, P.B. and Rice, D.W. 2016. Revise of SC/66a/IA14: The mysterious sei whale: its distribution, movements and population decline in the North Pacific revealed by whaling data and recoveries of Discovery-type marks. Paper SC/66b/IA20 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 129pp. [Paper available from the Office of this Journal].

Murase, H., Palka, D., Punt, A.E., Pastene, L.A., Kitakado, T., Matsuoka, K., Hakamada, T., Okamura, M., Bando, T., Tamura, T., Konishi, K., Yasunaga, G., Isoda, T. and Kato, H. 2018. In-depth assessment of an eastern Indian Ocean stock and a western South Pacific stock of Antarctic minke whale from 2001 to 20014 conducted by the Scientific Committee of the International Whaling Commission: A sythesis and summary. *J. Cetacean Res. Manage*. [Submitted]

Rice, D.W. 1977. Synopsis of biological data on the sei whale and Bryde's whale in the eastern North Pacific. *Rep. Int. Whaling Commn. (Special Issue)* 1: 92-7.

Table 3

Summary of the 2-year budget request for IA.

RP no.	Title	2019 (£)	2020 (£)
Meetings/Workshop			
1	Intersessional workshop to progress Comprehensive Assessment of North Pacific Humpback Whales (probably in 2019 but might be in 2020)	8000	0
Modelling/Computing			
1	Modelling for the Comprehensive Assessment of the North Pacific humpback whale	3040	0
2	Modelling for the In-depth Assessment of the North Pacific sei whale	0	5000
Total request		**11040**	**5000**

Taylor, B.L., Chivers, S.J., Larese, J. and Perrin, W.F. 2007. Generation length and percent mature estimates for IUCN assessments of cetaceans. 24pp. US NMFS Administrative Report LJ-07-01, Southwest Fisheries Science Center, La Jolla, CA, USA.
Wade, P.R., Quinn, T.J., II, Barlow, J., Baker, C.S., Burdin, A.M., Calambokidis, J., Clapham, P.J., Falcone, E.A., Ford, J.K.B., Gabriele, C.M., Mattila, D.K., Rojas-Bracho, L., Straley, J.M., Taylor, B.L., Urbán R., J., Weller, D., Witteveen, B.H. and Yamaguchi, M. 2016. Estimates of abundance and migratory destination for North Pacific humpback whales in both summer feeding areas and winter mating and calving areas. Paper SC/66b/IA21 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 42pp. [Paper available from the Office of this Journal].
Zerbini, A.N., Clapham, P.J. and Wade, P.R. 2010. Assessing plausible rates of population growth in humpback whales from life-history data. *Mar. Biol.* 157(6): 1225-36.

Appendix 1

AGENDA

1. Introductory items
   1.1 Introductory remarks
   1.2 Election of Chair
   1.3 Appointment of rapporteurs
   1.4 Adoption of Agenda
   1.5 Documents available
2. In-depth assessment of Indo-Pacific Antarctic minke whales
3. In-depth assessment of North Pacific sei whales
   3.1 Progress on intersessional work
   3.2 Preparation of data for assessment
      3.2.1 Stock structure hypotheses
      3.2.2 Abundance and trends
      3.2.3 Marking data
      3.2.4 Catch history
      3.2.5 Life history parameters
   3.3 Assessment model
4. Comprehensive assessment of North Pacific humpback whales
   4.1 Progress on intersessional work
   4.2 Preparation of data for assessment
      4.2.1 Stock structure hypotheses
      4.2.2 Abundance and trends
      4.2.3 Catch history
      4.2.4 Life history parameters
   4.3 Assessment model
5. Work plan and budget requests for 2019-2020
   5.1 Work plan
      5.1.1 In-depth assessment of Indo-Pacific Antarctic minke whales
      5.1.2 In-depth assessment of North Pacific sei whales
      5.1.3 Comprehensive assessment of North Pacific humpback whales
   5.2 Budget request for 2019-2020
6. Adoption of report

Appendix 2

LINES FOR DIVIDING DATA INTO SUB-AREAS FOR IN-DEPTH ASSESSMENT OF NORTH PACIFIC SEI WHALES

S. Mizroch and J. Cooke

At the 2015 Committee meeting, it was agreed to proceed with the in-depth assessment of North Pacific sei whales with two alternative stock structure hypotheses (IWC, 2016). The available genetics, mark recovery, sightings, and seasonality evidence for both stock structure hypotheses was summarised in Appendix 4 of Annex G (IWC, 2016). At that time, the Committee was not in a position to specify precise sub-areas for the 5-stock hypothesis.

At the 2016 Committee meeting, with a view to facilitate the assignment of catches and abundance data to stocks, developed tentative simplified sub-areas for the five-stock hypothesis, as shown in Appendix 4 of Annex G (IWC, 2017) and reproduced here as Fig. 1.

At the 2017 Committee meeting, it was tentatively agreed to use the sub-areas in Appendix 2 of Annex F (IWC, 2018), also shown here in Fig. 2, for compiling catch and abundance data for use in the assessment model. It was also agreed that the intersessional correspondence group could modify them, if necessary to facilitate allocation of sightings and other data to the sub-areas. In addition, during 2017 the Committee agreed that sei whales do not occur to any significant extent in the following areas: Okhotsk Sea (apart from the Kuril Islands); Sea of Japan; waters north of the Bering Strait.

Meeting after adoption of the 2017 sub-committee report, the intersessional correspondence group modified the sub-areas to facilitate the assignment of the absolute abundance estimates from the POWER cruises, which used the EEZ as its definition of the survey blocks. The differences between the straight line definitions as defined in 2017 and the EEZ lines are shown in Fig. 3 (from SC/67b/IA01).

At the 2018 sub-committee meeting, it was noted that the revised lines did not respect the original oceanographic motivations for the sub-areas. To return to the original motivations and still facilitate the extraction of data by sub-area two decisions were made. One, the line between the Eastern Coastal and Eastern North Pacific sub-areas was shifted south from 50°N (as suggested in 2017) to 48°N to facilitate the allocation of Canadian catches (Fig. 3). And two, the line between the Pelagic and Western Coastal sub-areas was shifted westward to respect the original oceanographic motivation (Fig. 4).

The resulting sub-areas are shown in Fig. 5. And will be used to divide the data for this assessment. They do not represent agreed stock boundaries.

REFERENCES

International Whaling Commission 2016. Report of the Scientific Committee, Annex G: Report of the Sub-Committee on In-Depth Assessments. *J. Cetacean Res. Manage. (Suppl.)* 17:224-49.
International Whaling Commission 2017. Report of the Scientific Committee, Annex G: Report of the Sub-Committee on In-Depth Assessments. *J. Cetacean Res. Manage. (Suppl.)* 18:203-29.
International Whaling Commission 2018. Report of the Scientific Committee, Annex F: Report of the Sub-Committee on In-Depth Assessments. *J. Cetacean Res. Manage. (Suppl.)* 19:174-82.

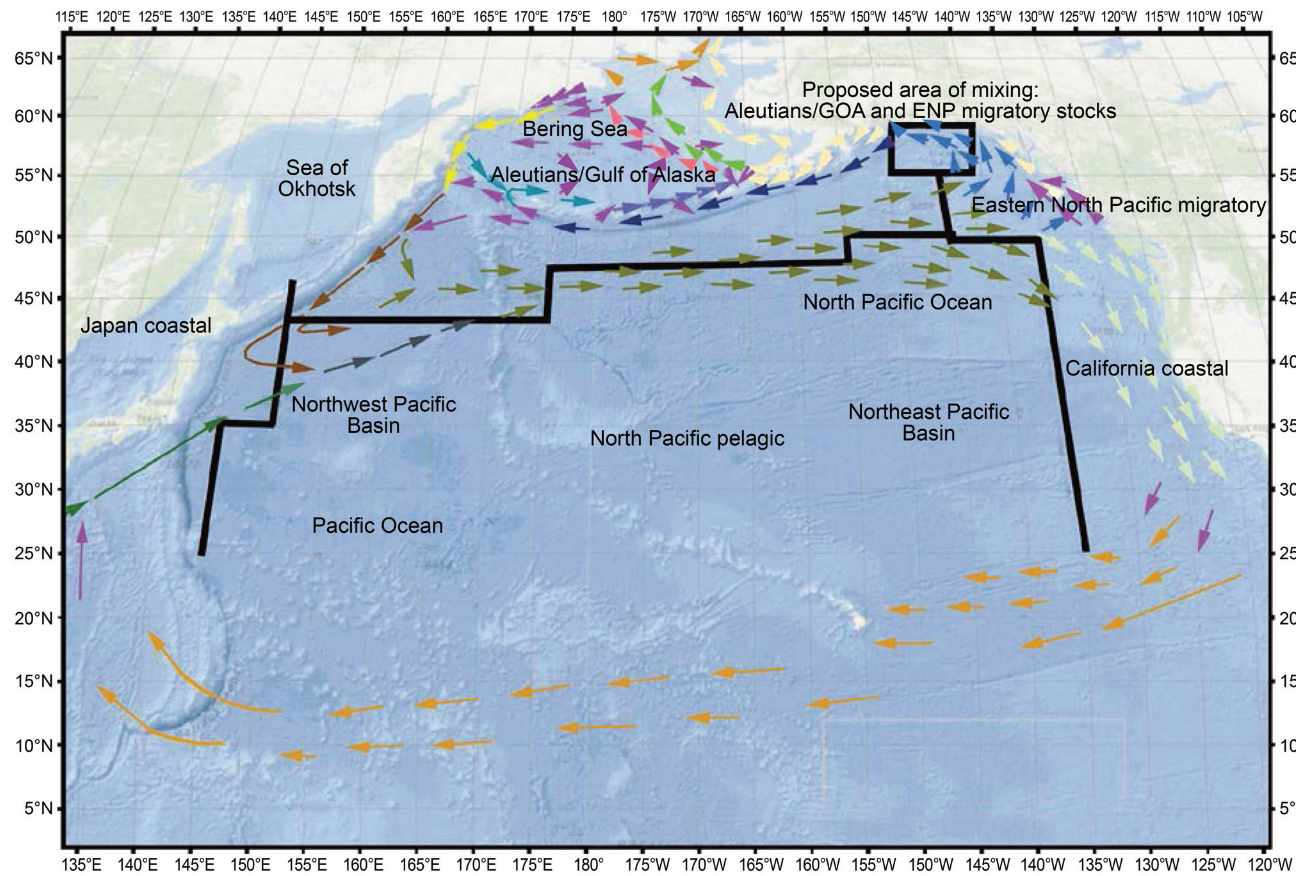

Fig. 1. From the 2016 Committee meeting, the tentative lines for dividing data into sub-areas.

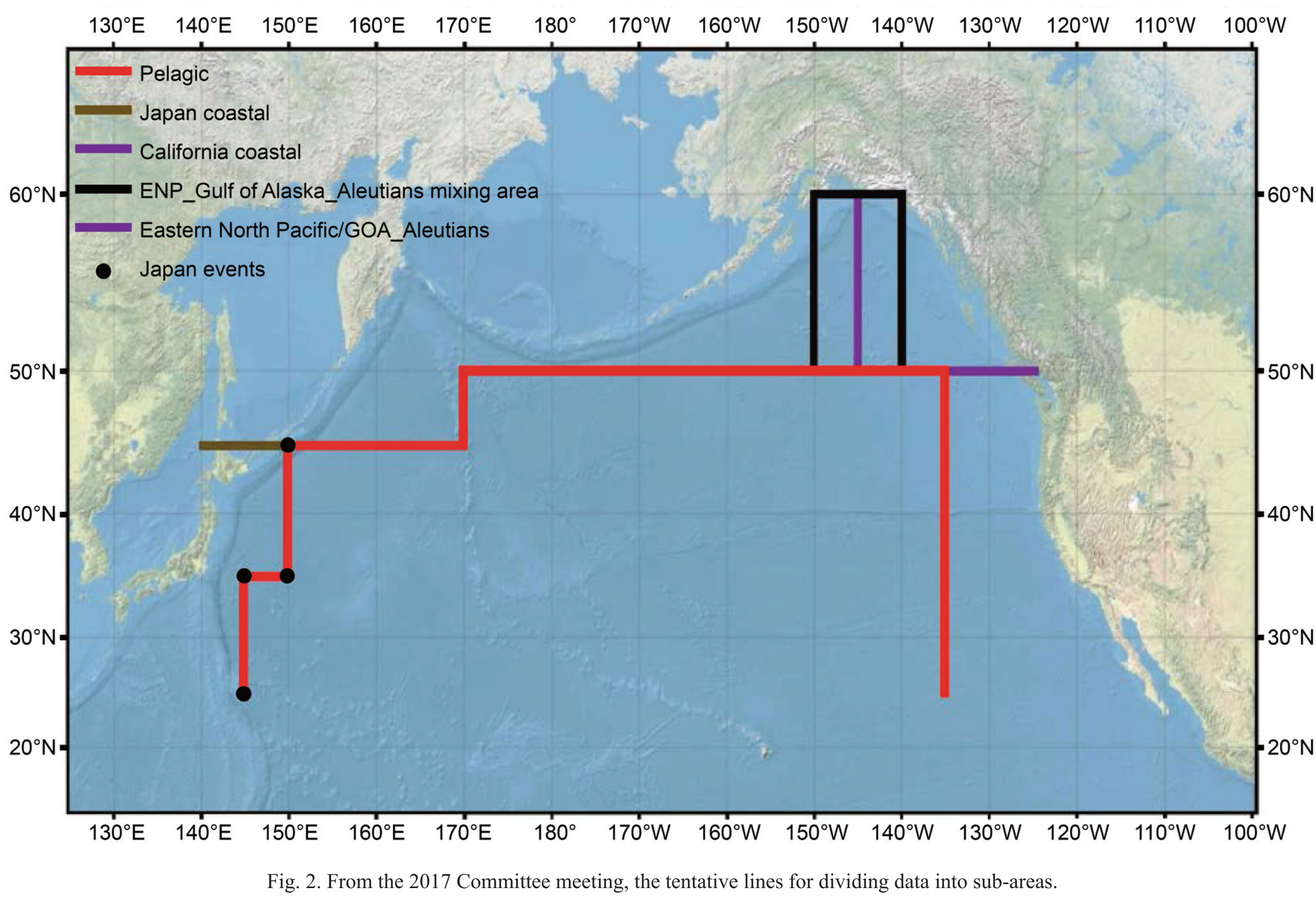

Fig. 2. From the 2017 Committee meeting, the tentative lines for dividing data into sub-areas.

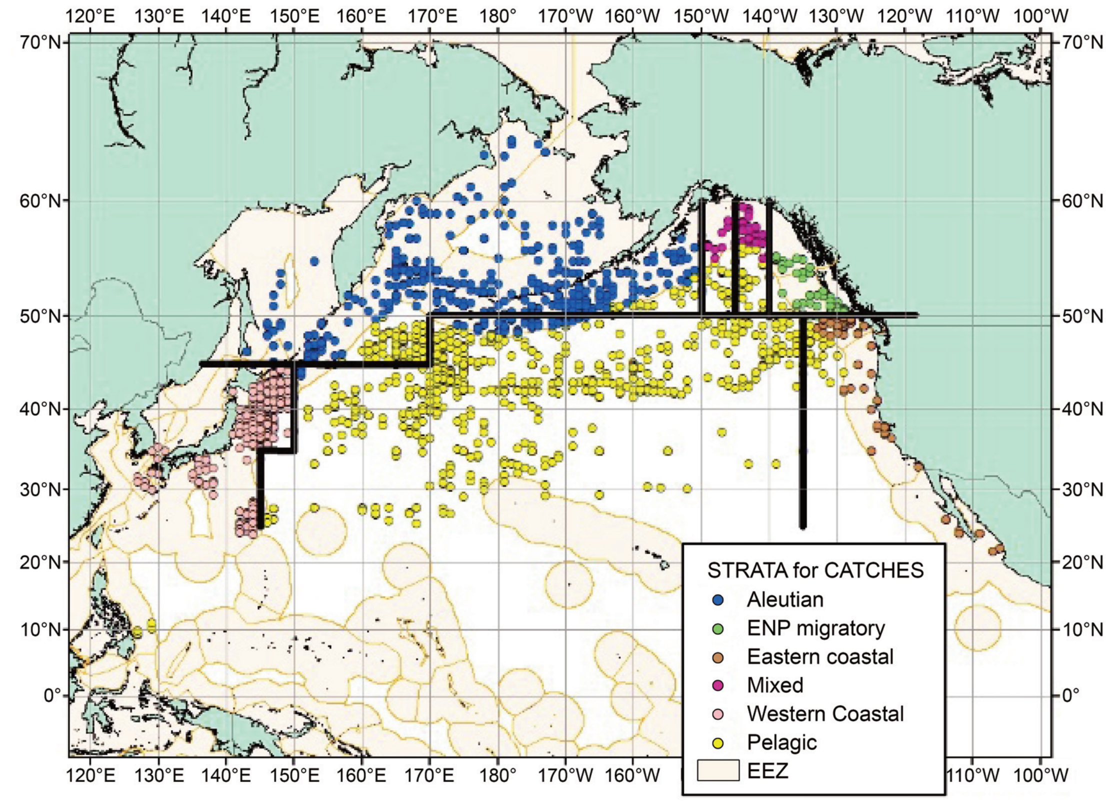

Fig. 3. From the 2017 Committee meeting, the tentative lines (solid bold black lines) and the EEZs (shaded and outlined in yellow) as suggested by the intersessional correspondence group used to divide catches (colored dots).

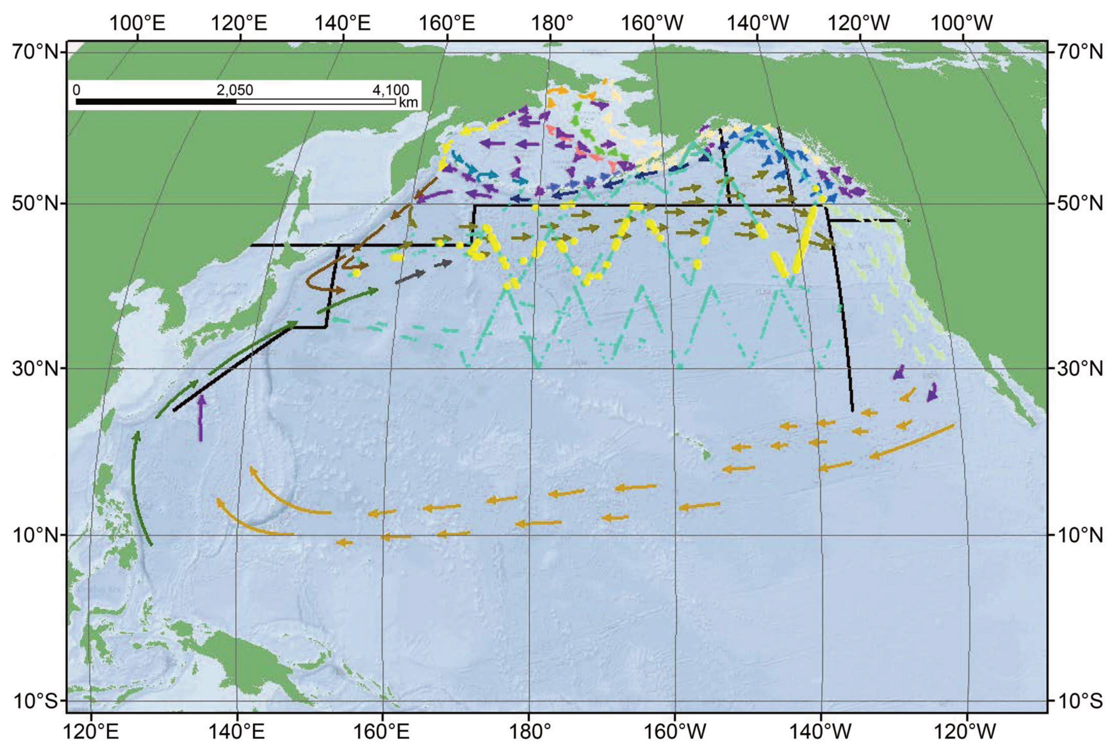

Fig. 4. Oceanographic features (colored arrows) and IWC-POWER cruise Bryde's sightings (yellow dots) and track lines (green lines) overlaying the 2018 lines (black lines) for dividing data into sub-areas.

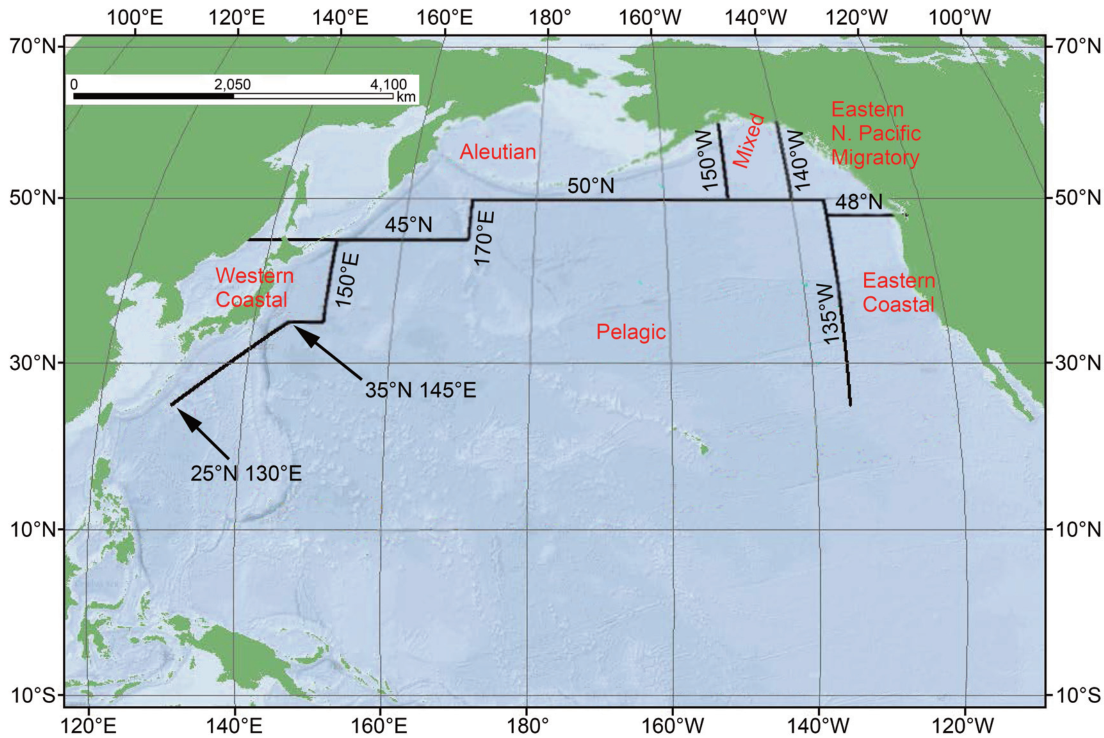

Fig. 5. Lines (black lines) for dividing data into sub-areas for the in-depth assessment of North Pacific sei whales. Red words indicate name of the sub-areas. Numbers indicate locations of the lines.

Appendix 3

MIXING MATRICES BETWEEN SUB-AREAS UNDER THE TWO STOCK STRUCTURE HYPOTHESES

One of pieces of data needed in the in-depth assessment of the North Pacific sei whale is, for each stock structure hypothesis, a 'mixing matrix'. A mixing matrix is a representation of how the animals move between the sub-areas (defined in Appendix 2). The assessment model will model the various types of input data (catches, marking/recoveries, and abundance estimates) to estimate the magnitude of movement that is supported by the data.

Under the 1-stock hypothesis, it is assumed sei whales can move between and within all of the sub-areas (Table 1; Fig. 1).

Under the 5-stock hypothesis, not all putative stocks move between all sub-areas (Table 2; Fig. 2). Thus, a '0' in Table 2 indicates which sub-areas it is assumed that particular stock does not utilise (Table 2). The coloured arrows in Fig. 2 indicate the sub-areas that the stocks in Table 2 move within and between.

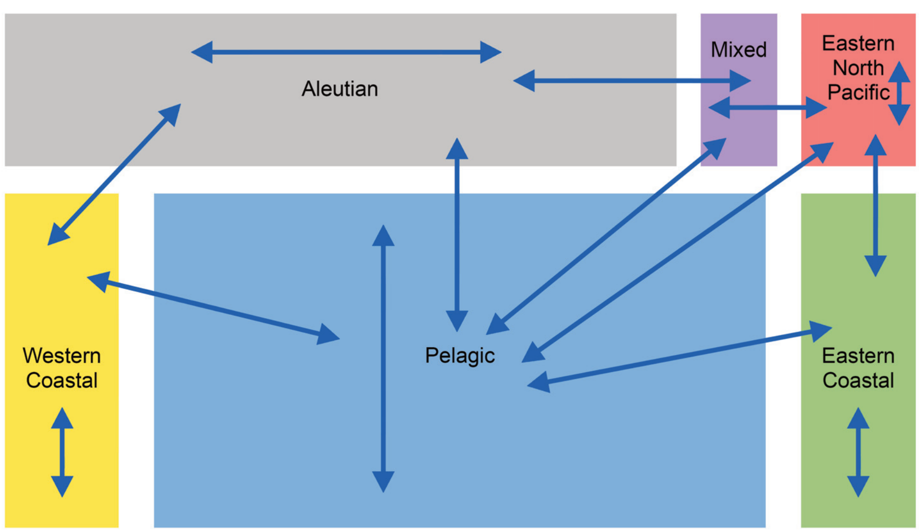

Fig. 1. Schematic representing the mixing matrix for the 1-stock structure hypothesis. Each box represents a sub-area and the arrows represent movements between two sub-areas or within a sub-area.

Table 1

Mixing matrix for the 1-stock hypothesis indicating which sub-areas the proposed stock utilises.

	Sub-areas					
Stocks	Western Coastal	Aleutians	Pelagic	Mixed	Eastern North Pacific	Eastern Coastal
Stock A	γ	γ	1	γ	γ	γ

γ = mixing

Table 2

Mixing matrix for the 5-stock hypothesis indicating which sub-areas the proposed stocks utilise.

	Sub-areas					
Stocks	Western Coastal	Aleutians	Pelagic	Mixed	Eastern North Pacific	Eastern Coastal
Stock A	1	0	0	0	0	0
Stock B	γ	1	0	γ	0	0
Stock C	γ	γ	1	γ	γ	γ
Stock D	0	0	0	γ	1	γ
Stock E	0	0	0	0	0	1

γ = mixing

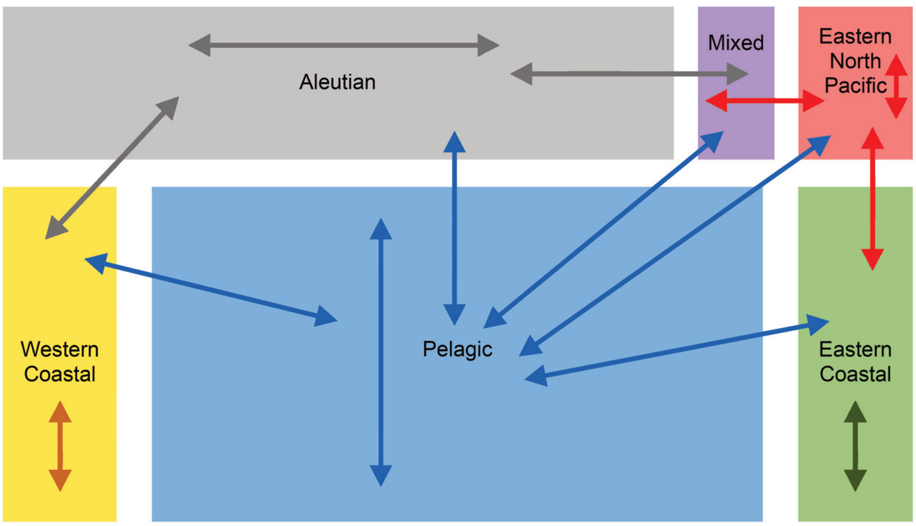

Fig. 2. Schematic representing the mixing matrix for the 5-stock structure hypothesis. Each box represents a sub-area and the arrows represent movements between two sub-areas or within a sub-area. Different coloured arrows represents different stocks as defined in Table 2.

Appendix 4

ANALYSIS OF NORTH PACIFIC SEI WHALE SUMMER DENSITY 1965-2015 FROM JAPANESE SCOUTING AND RESEARCH VESSEL SIGHTINGS

J.G. Cooke

Sightings and effort by Japanese scouting and research vessels in the North Pacific in summer, summarised by 10° square were taken from the following sources:

- seasons 1965-79: Published by Wada in *Rep. int. Whal. Commn* (1975-81).
- seasons 1980-96: Progress Reports Japan published in *Rep. int. Whal. Commn* (1982-98)
- seasons 1997-99: Progress Reports Japan, unpublished SC documents
- seasons 2000-05: Progress Reports Japan, published on-line (*http://iwc.int/scprogress*)
- seasons 2006-15: Supplied by T. Miyashita (by e-mail 24 July 2017).

The sightings of sei whales (animals) and effort (nm of track) are summarised in Table 1. All sightings of sei whales were in series M, N and P (30°-60°N) except for 42 whales in series L (20°-30°N) but the latter were in the early years (up to 1975) and may have been Bryde's whales. There were no sightings on the Okhotsk Sea (OS) or Sea of Japan (JS). This analysis used sei whale sightings and effort in series M, N and P in the North Pacific and Bering Sea, making a total of 7,301 sei whales for 1,167,517nm of track.

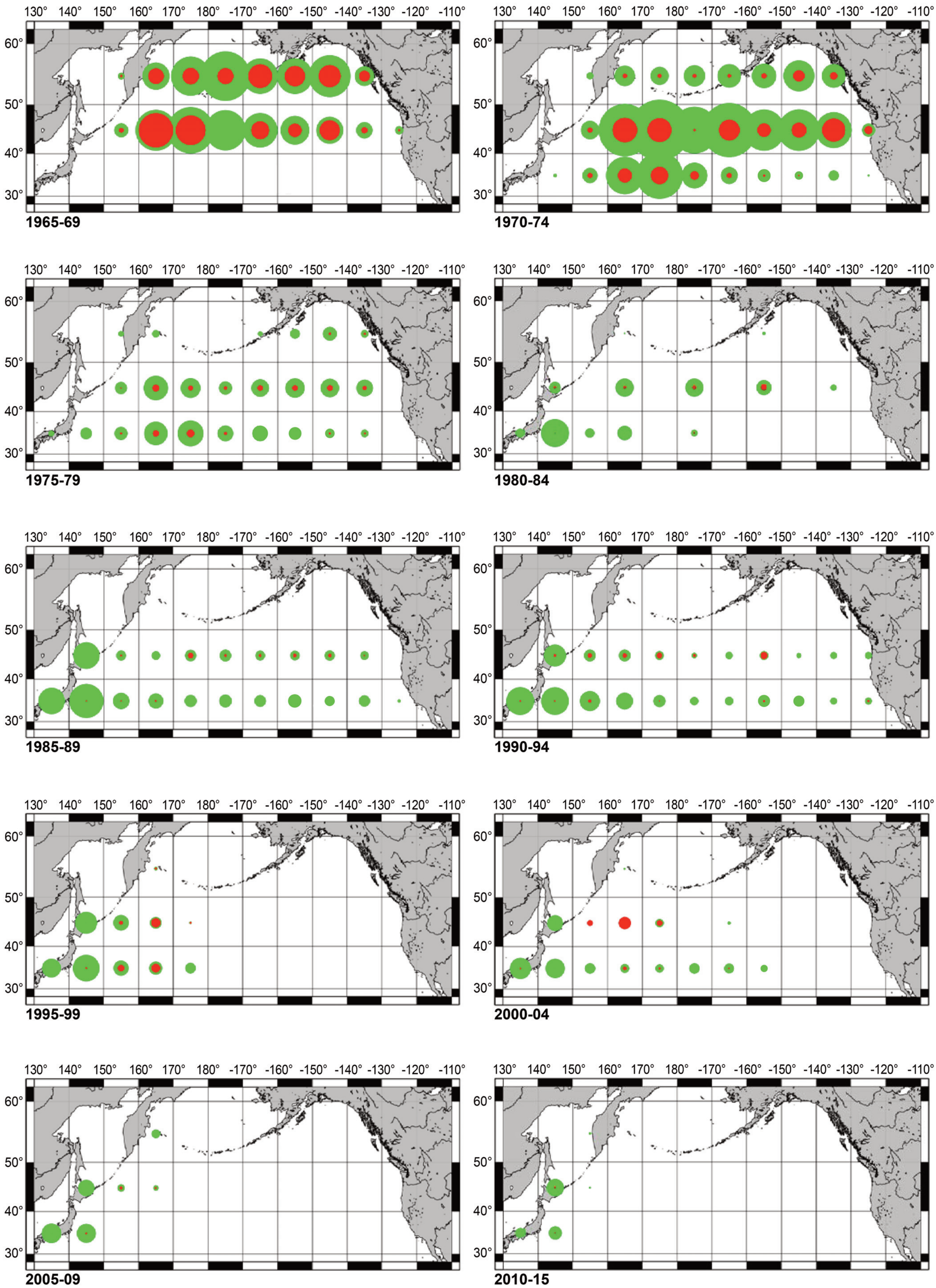

Fig. 1. Distribution of survey effort (nm of track) and sei whale sightings (animals counted) by 10° square by period. The areas of the green circles are proportional to survey effort. The areas of the red circles are proportional to sei whale counts.

Table 1

Summary of effort and sei whale sightings.

Series	Sea	Track (nm)	Sei
J	NP	7,630	0
K	NP	24,608	0
L	NP	92,043	42
L	ECS/NP	16,042	0
M	NP	323,355	665
M	ECS	10,252	0
N	NP	597,189	4,699
N	JS	14,909	0
N	OS	3,065	0
P	NP	183,107	1,838
P	OS	12,669	0
P	BS	63,866	99
Q	OS	240	0
Q	BS	832	0

Table 2

Assignment of 10° squares to nominal stock areas.

Series	Squares	Stock
M	20-21	W.Coastal
M	22-28	Pelagic
M	29-31	E. Coastal
N	21	W.Coastal
N	22-28	Pelagic
N	29-30	E. Coastal
P	22-27	Aleutian
P	28	Mixed
P	29-30	ENP

The nominal stock areas are defined in IWC (2018). Each 10° square was assigned to the nominal stock area with the largest area of overlap with that square (Table 2). The distribution of effort and sightings by period is summarised visually in Figs 1a-j.

The years of data were divided into 10 five-year periods, except that the last period (2010-15) was six years. The fitted model was log-linear with number of sei whale sightings as a negative binomial NB(p,k) dependent variable with constant k and with the offset log(Effort) where Effort is measured in nm of track. The models fitted with their AIC are listed in Table 3. All terms except the intercept were included as random effects. Further terms did not improve the fit. The best-fitting model was model D.

The Abundance Index for each square in a period is the fitted encounter rate for that square multiplied by the area of that square. The Abundance Index represents a relative index of sei whale abundance scaled to a nominal track half-width of 1nm. The calculated Abundance Indices are given in Table 4 by period, summed by nominal stock area and in total. The covariances (expressed as correlations) between Abundance Indices are given in Table 5. All period/sub-area combinations were used in the analysis, but only those period/sub-area combinations with more than 500nm of track were included in the results.

REFERENCE

International Whaling Commission 2018. Report of the Scientific Committee, Annex F: Report of the Sub-Committee on In-Depth Assessments. *J. Cetacean Res. Manage. (Suppl.)* 19:174-82.

Table 3

Results of fitting various models.

Case	LogLike	DF	AIC	Model
A	-1550.05	26.15	3152.40	Const + Series*Square
B	-1490.62	53.13	3087.51	Case A + Year
C	-1406.30	108.50	3029.60	Case B + Series*Square*Period
D	-1220.19	260.18	2960.73	Case C + Series*Square*Year

Table 4

Fitted Indices of Abundance (IA) by subarea and period.

Index	Period	SubArea	IA	CV
1	1965-69	Alt	20,295	0.104
2	1965-69	EC	7,204	0.315
3	1965-69	ENP	2,458	0.306
4	1965-69	Mixed	5,054	0.220
5	1965-69	Pel	63,054	0.127
6	1970-74	Alt	3,962	0.169
7	1970-74	EC	8,865	0.229
8	1970-74	ENP	873	0.342
9	1970-74	Mixed	1,340	0.289
10	1970-74	Pel	34,384	0.098
11	1975-79	Alt	3,269	0.336
12	1975-79	EC	4,192	0.315
13	1975-79	ENP	1,083	0.592
14	1975-79	Mixed	729	0.496
15	1975-79	Pel	20,589	0.113
16	1975-79	WC	129	0.593
17	1980-84	EC	3,107	0.439
18	1980-84	Pel	17,178	0.206
19	1980-84	WC	283	0.445
20	1985-89	EC	2,610	0.499
21	1985-89	Pel	16,687	0.211
22	1985-89	WC	71	0.546
23	1990-94	EC	3,119	0.452
24	1990-94	Pel	26,832	0.210
25	1990-94	WC	152	0.449
26	1995-99	Pel	44,470	0.201
27	1995-99	WC	138	0.536

Table 5 - Correlations between Abundance Indices.

	Period	SubArea	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	1965-69	Alt	1.000																
2	1965-69	EC	0.048	1.000															
3	1965-69	ENP	0.022	0.017	1.000														
4	1965-69	Mixed	0.016	0.005	0.008	1.000													
5	1965-69	Pel	0.048	0.103	0.010	0.008	1.000												
6	1970-74	Alt	0.042	0.025	0.003	0.002	-0.002	1.000											
7	1970-74	EC	0.024	0.315	0.004	0.005	0.013	0.057	1.000										
8	1970-74	ENP	-0.000	0.001	0.043	-0.001	-0.004	0.018	0.008	1.000									
9	1970-74	Mixed	0.009	-0.001	0.002	0.017	0.003	0.010	0.011	0.001	1.000								
10	1970-74	Pel	0.021	0.011	0.002	0.005	0.060	0.025	0.059	0.006	0.011	1.000							
11	1975-79	Alt	0.056	0.006	-0.000	-0.001	-0.024	0.189	0.012	0.002	-0.001	-0.027	1.000						
12	1975-79	EC	0.020	0.491	0.004	0.001	0.007	0.040	0.343	0.003	0.001	-0.001	0.176	1.000					
13	1975-79	ENP	0.006	-0.001	0.087	0.001	-0.004	0.007	0.002	0.065	0.001	-0.005	0.066	0.042	1.000				
14	1975-79	Mixed	0.001	-0.001		0.031	-0.006	0.005	0.000	0.001	0.042	-0.007	0.061	0.045	0.023	1.000			
15	1975-79	Pel	0.014	0.009	0.003	0.003	0.037	0.008	0.008	-0.000	0.002	0.038	0.107	0.078	0.040	0.040	1.000		
16	1975-79	WC	0.005	0.006	-0.001	-0.001	-0.003	0.013	0.006	-0.001	-0.001	-0.002	0.106	0.073	0.021	0.018	0.042	1.000	
17	1980-84	EC	0.023	0.528	0.007	0.002	0.014	0.048	0.355	0.006	0.003	0.003	0.058	0.579	0.011	0.010	0.012	-0.008	1.000
18	1980-84	Pel	0.018	0.029	0.004	0.003	0.077	0.027	0.014	0.003	0.002	0.059	0.029	0.025	0.006	0.005	0.067	-0.031	0.316
19	1980-84	WC	0.012	0.007	0.003	0.003	0.007	0.009	0.008	0.001	0.003	0.006	0.008	0.007	0.002	0.001	0.004	0.103	0.053
20	1985-89	EC	0.017	0.389	0.005	0.002	0.009	0.035	0.262	0.004	0.002	0.001	0.044	0.428	0.008	0.007	0.009	-0.004	0.470
21	1985-89	Pel	0.015	0.018	0.004	0.003	0.045	0.014	0.011	0.001	0.003	0.034	0.015	0.015	0.004	0.002	0.036	-0.017	0.032
22	1985-89	WC	0.002	0.004	0.001	0.000	-0.001	0.009	0.002	0.001	0.000	-0.001	0.007	0.004	0.001	0.000	-0.002	0.134	-0.002
23	1990-94	EC	0.016	0.334	0.005	0.002	0.009	0.032	0.228	0.004	0.002	0.003	0.036	0.355	0.007	0.006	0.008	-0.004	0.393
24	1990-94	Pel	0.023	0.017	0.005	0.006	0.041	0.014	0.015	0.000	0.005	0.028	0.013	0.015	0.004	0.002	0.033	-0.012	0.026
25	1990-94	WC	0.005	0.001	0.002	0.001	0.002	0.009	0.001	0.001	0.001	0.001	0.008	0.000	0.001	0.001	-0.000	0.138	-0.006
26	1995-99	Pel	0.025	0.019	0.006	0.007	0.057	0.015	0.015	0.001	0.005	0.041	0.014	0.015	0.005	0.002	0.043	-0.019	0.033
27	1995-99	WC	0.004	0.007	0.001	0.001	0.002	0.008	0.005	0.001	0.001	0.001	0.006	0.007	0.001	0.000	0.001	0.120	0.003
28	2000-04	Pel	0.023	0.015	0.005	0.006	0.049	0.016	0.014	0.001	0.005	0.030	0.015	0.014	0.004	0.002	0.036	-0.011	0.029
29	2000-04	WC	0.004	0.010	0.001	0.000	0.002	0.012	0.006	0.001	0.001	0.001	0.010	0.009	0.001	0.001	0.001	0.161	0.004
30	2005-09	Alt	0.081	0.022	0.006	0.002	-0.008	0.212	0.018	0.007	0.003	-0.016	0.529	0.063	0.021	0.017	0.022	-0.009	0.090
31	2005-09	Pel	0.018	0.035	0.005	0.002	0.093	0.028	0.016	0.003	0.002	0.068	0.029	0.027	0.006	0.005	0.071	-0.029	0.062
32	2005-09	WC	0.006	0.007	0.002	0.001	0.005	0.007	0.005	0.001	0.001	0.004	0.005	0.006	0.001	0.000	0.002	0.105	0.003
33	2010-15	WC	0.007	0.011	0.002	0.001	0.006	0.013	0.007	0.001	0.001	0.006	0.011	0.010	0.001	0.001	0.003	0.155	0.006

Table 5 (Cont.) - Correlations between Abundance Indices.

	Period	SubArea	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
18	1980-84	Pel	1.000															
19	1980-84	WC	0.078	1.000														
20	1985-89	EC	0.035	0.002	1.000													
21	1985-89	Pel	0.147	-0.001	0.158	1.000												
22	1985-89	WC	-0.014	0.051	0.037	0.024	1.000											
23	1990-94	EC	0.035	0.002	0.292	0.020	-0.000	1.000										
24	1990-94	Pel	0.110	0.002	0.018	0.064	-0.005	0.140	1.000									
25	1990-94	WC	-0.010	0.060	-0.004	-0.006	0.079	0.037	0.047	1.000								
26	1995-99	Pel	0.186	0.002	0.021	0.090	-0.010	0.023	0.088	-0.006	1.000							
27	1995-99	WC	-0.005	0.045	0.002	-0.003	0.076	0.003	0.000	0.072	0.044	1.000						
28	2000-04	Pel	0.139	0.004	0.019	0.078	-0.004	0.020	0.078	-0.002	0.101	-0.000	1.000					
29	2000-04	WC	-0.007	0.064	0.003	-0.004	0.098	0.004	-0.001	0.096	-0.005	0.091	0.065	1.000				
30	2005-09	Alt	0.088	0.004	0.068	0.046	0.001	0.058	0.041	0.002	0.052	0.002	0.045	0.005	1.000			
31	2005-09	Pel	0.312	-0.002	0.040	0.152	-0.013	0.041	0.136	-0.008	0.198	-0.004	0.161	-0.004	0.480	1.000		
32	2005-09	WC	-0.002	0.038	0.002	-0.001	0.069	0.003	0.002	0.064	0.000	0.066	0.002	0.082	0.070	0.074	1.000	
33	2010-15	WC	0.001	0.059	0.005	0.001	0.098	0.005	0.003	0.093	0.001	0.092	0.005	0.117	0.007	0.004	0.085	1.000

Appendix 5

ABUNDANCE ESTIMATES FOR USE IN THE NORTH PACIFIC SEI WHALE IN-DEPTH ASSESSMENT

The surveys and abundance estimates considered for possible use in the North Pacific sei whale in-depth assessment are listed in Appendix 3 table 1 of last year's IA report (IWC, 2018). The estimates selected at this meeting for use in the assessment, with adjustments for the modified sub-area definitions, are listed in Table 1. The sub-area definitions are given in fig.5 of Appendix 2.

Notes (see IWC, 2018 for supporting information)

(1) There were no sei whale sightings in the Aleutians (Alt) sub-area on the IWC-POWER cruises during 2010-11 and 2017. The western part of Alt (W. of 170°E) was surveyed in 2005 (Miyashita, 2006) without sei whale sightings and treated as making a zero contribution to the abundance in Alt.

(2) The 2012 IWC-POWER cruise covered all the Mixed (Mix) sub-area and part of the Eastern North Pacific (ENP) sub-area. Sei whales were sighted in the ENP but not in Mix sub-areas. Canadian surveys in Mix (IWC 2018) did not venture far enough offshore to encounter sei whales, hence the near absence of sei whale sightings was not informative.

(3) The eastern and western parts of the Pelagic (Pel) sub-area were surveyed by IWC-POWER and JARPN II over a similar range of years, hence the estimates are added together to yield a total estimate for Pel. The abundance in Pel south of 40°N in summer was negligible (IWC 2018).

(4) The two Western Coastal (WC) estimates are considered independent estimates pertaining to different years. The coastal part of JARPN II resulted in zero sei whale sightings.

(5) The zero estimates are to be handled according to annotation 29 to the Revised Management Procedure (IWC, 2012, p.493, annotation 29): the required calculations will be performed intersessionally.

(6) A suitable approach for handling minimum estimates will be developed intersessionally.

REFERENCES

Barlow, J. 2016. Cetacean abundance in the California Current estimated from ship-based line-transect surveys in 1991-2014. Southwest Fisheries Science Center Administrative Report LJ-16-01: 67pp.

International Whaling Commission. 2012. Annotations to the Revised Management Procedure for baleen whales. *J. Cetacean Res. Manage.* (*Suppl.*) 13 [p. 493, annotation 29].

International Whaling Commission. 2018. Report of the small group to determine abundance data that will be used in the north pacific sei whale in-depth assessment. *J. Cetacean Res. Manage.* (*Suppl.*) 19:181-2.

Miyashita, T. 2006. Cruise report of the sighting survey in the waters west of the Kuril Islands and the Kamchatka Peninsula in 2005. Paper SC/58/NPM5 presented to the IWC Scientific Committee, May 2006, St. Kitts and Nevis, West Indies. 9pp. [Paper available from the Office of this Journal].

Table 1

Abundance estimates for use in the assessment.

Subarea	Surveys	Reference	Year span	Nominal year	Estimate	CV	Type	Notes
Alt	POWER	SC/66a/IA12, SC67b/IA12	2010-11, 2017	2011	0		Zero	1, 5
Mix	POWER	SC/66a/IA12	2012	2012	0		Zero	2, 5
ENP	POWER	SC/66a/IA12	2012	2012	195	0.754	Minimum	2, 6
Pel (E. of 170°E)	POWER	SC/66a/IA12	2010-12	2011	27,002	0.236		
Pel (W. of 170°E)	JARPNII	SC/F16/JR12	2008-12	2011	3,917	0.208		
Pel	Combined			2011	30,919	0.208	Best	3
WC	JARPNII	SC/J09/JR15	2002-07	2004	162	0.434	Best	4
WC	JARPNII	SC/F16/JR12	2008-12	2010	444	0.561	Best	4
EC	SWFSC	Barlow *et al*. 2016	2008-14	2011	519	0.400	Minimum	6

Appendix 6

REMAINING ISSUES TO RESOLVE WITH RESPECT TO THE SEI WHALE MARKING DATA SET

J.G. Cooke

The marking data set consists of 2,286 marks potentially placed in sei whales in the North Pacific, including 2,265 by Japanese programmes, 18 by US programmes and 3 Canadian. 163 marks were recovered. Not all of these will have been effectively placed, and, especially for marks placed prior to 1962, there is some doubt about the species identification. Some marks placed in 'sei' whales were recovered in fin whales or Bryde's whales, and some were recovered as 'sei' whales in operations whose catch reports did not distinguish between sei and Bryde's whales.

A high fraction of the marks placed were recorded as multiple markings of the same whale, with an average of 1.9 marks per whale. The placement verdict (e.g. hit/miss/possible hit) is not always recorded separately for each mark, and multiple marks were not always recovered together or in the same whale.

The intersessional group will need to choose a consistent method for treating data from supposedly multiply marked whales, taking into account the pattern of recoveries from multiple markings (all or some recovered; recovered in same or different whales). It will also need to estimate the effective number of marks placed, taking into account the relative recovery rates for marks with different placement verdicts, and for multiple and singly-placed marks.

Appendix 7

NORTH PACIFIC SEI WHALE CATCH SERIES

J.G. Cooke

The sub-area adopted at this meeting for the purpose of data division are specified in Appendix 2. The historic catches of sei whales contained in the IWC Catch Database (Allison, 2017) were allocated to sub-areas and divided by sex. Some assumptions had to be made for catches that lacked exact positions or sex information.

Among the coastal whaling catches for which there are individual position data, very few sei whales were taken in the Pelagic sub-area. Hence it is assumed that the coastal whaling sei catches without positions were taken in the coastal sub-area where the whaling station was located. Specifically, this was the Western Coastal sub-area for Japanese and Korean catches, the North Eastern Pacific Migratory sub-area for Canadian catches, and the Eastern Coastal sub-area for US catches.

Catches taken by pelagic whalers in Mexican waters were assumed to be Bryde's whales (Rice, 1974).

The sei/Bryde's whale split for Japanese coastal whaling summary data on catches followed Allison (2008). To obtain catch data by sex, it was also necessary to split the individual data by species. The individual data are divided by sex, but not always by species. From the 1940's to the 1960's, some of the 'sei' individual data include some Bryde's whales, and some of the Bryde's whale individual data includes sei whales. Almost all the mixed-species individual data are in the Western Coastal sub-area. For those years with individual data by species, the Bryde's whales taken in the Western Coastal sub-area were 44% female (*n*=6,543) without much annual variation. This sex ratio was used to subtract presumed catches of Bryde's whales by sex from the combined species catches by sex for those years where the individual data were not divided by species. A net total of 1,632 presumed Bryde's whales were subtracted from the individual data (Table 1).

The resulting sei whale catch series by sub-area, sex and year is shown in Table 1.

REFERENCES

Allison, C. 2008. Catch series for western North Pacific Bryde's whales. *J. Cetacean Res. Manage*. (*Suppl.*) 10:457-467.

Allison, C. 2017. The IWC Catch Database version 6.1; Date: May 2017.

Rice, D.W. 1974. Whales and whale research in the eastern North Pacific. pp.170-195 *In*: W.E. Schevill (Ed.) *The Whale Problem: A Status Report*. Harvard University Press, Cambridge, MA.

Table 1

Abundance estimates for use in the assessment.

	Western coastal		Aleutian		Mixing area		Northeastern		Eastern coastal		Pelagic		Total	Brydes
Year	M	F	M	F	M	F	M	F	M	F	M	F	**M+F**	adjustment*
1906	8	8	0	0	0	0	0	0	0	0	0	0	**16**	
1907	21	22	0	0	0	0	0	0	0	0	0	0	**43**	
1908	49	52	0	0	0	0	0	0	0	0	0	0	**101**	
1909	28	30	0	0	0	0	0	0	0	0	0	0	**58**	
1910	51	54	0	0	0	0	0	0	0	0	0	0	**105**	
1911	106	111	0	0	0	0	0	0	0	0	0	0	**217**	
1912	76	79	0	0	0	0	0	0	0	0	0	0	**155**	
1913	115	121	0	0	0	0	2	1	0	0	0	0	**239**	
1914	89	94	0	0	0	0	11	8	0	0	0	0	**202**	
1915	272	285	0	0	0	0	0	0	0	0	0	0	**557**	
1916	144	151	0	0	0	0	14	11	0	0	0	0	**320**	
1917	195	203	0	0	0	0	85	62	0	0	0	0	**545**	
1918	289	302	0	0	0	0	77	57	0	0	0	0	**725**	
1919	441	461	0	0	0	0	44	32	2	3	0	0	**983**	
1920	147	154	0	0	0	0	97	71	6	7	0	0	**482**	
1921	188	197	0	0	0	0	0	0	0	0	0	0	**385**	
1922	91	96	0	0	0	0	1	1	0	0	0	0	**189**	
1923	204	213	0	0	0	0	31	23	0	0	0	0	**471**	
1924	259	270	0	0	0	0	70	30	1	1	2	1	**634**	
1925	181	190	1	4	0	0	36	32			2	1	**447**	
1926	206	216	3	1	0	0	14	12	9	16	4	3	**484**	
1927	207	216	2	1	0	0	5	2	0	0	2	1	**436**	
1928	112	117	0	1	0	0	8	5	5	7	0	0	**255**	
1929	152	148	0	0	0	0	39	28	4	5	0	1	**377**	-40
1930	166	174	1	1	0	0	51	37	0	0	4	3	**437**	
1931	138	144	1	1	0	0	0	0	0	0	1	1	**286**	
1932	128	133	0	0	0	0	0	0	0	0	2	1	**264**	
1933	122	127	2	1	0	0	1	0	0	0	7	6	**266**	
1934	106	110	1	2	0	0	0	0	0	0	2	1	**222**	
1935	139	146	0	0	0	0	0	0	0	0	6	6	**297**	
1936	119	124	0	0	0	0	0	0	0	0	11	10	**264**	
1937	132	137	1	1	0	0	0	0	0	0	26	25	**322**	
1938	181	190	0	0	0	0	0	0	0	0	11	11	**393**	
1939	223	234	0	0	0	0	0	0	0	0	14	14	**485**	
1940	147	154	2	1	0	0	0	0	0	0	10	9	**323**	
1941	220	230	11	8	0	0	0	0	0	0	14	13	**496**	
1942	105	110	2	2	0	0	0	0	0	1	8	7	**235**	
1943	121	126	11	7	0	0	0	0	1	1	30	28	**325**	
1944	261	273	15	11	0	0	0	0	1	1	62	59	**683**	
1945	30	32	0	0	0	0	0	0	0	0	0	0	**62**	

Table 1 (Cont.)
Abundance estimates for use in the assessment.

	Western coastal		**Aleutian**		**Mixing area**		**Northeastern**		**Eastern coastal**		**Pelagic**		**Total**	Brydes
Year	M	F	M	F	M	F	M	F	M	F	M	F	**M+F**	adjustment*
1946	186	261	0	0	0	0	0	0	0	0	0	0	**447**	-95
1947	180	248	0	0	0	0	0	0	0	3	0	0	**431**	46
1948	247	259	23	16	0	0	1	1	0	0	0	0	**547**	-29
1949	340	336	49	32	0	0	2	1	0	0	0	0	**760**	-56
1950	106	163	38	20	0	0	10	14	0	0	0	0	**351**	-30
1951	200	192	33	32	0	0	5	0	0	0	2	1	**465**	-27
1952	238	348	143	72	0	0	17	5	0	0	0	0	**823**	-79
1953	285	239	114	96	0	0	2	12	0	0	0	0	**748**	-61
1954	307	264	160	109	0	0	74	60	0	0	4	4	**982**	-73
1955	169	223	112	60	0	0	84	55	0	0	4	1	**708**	-66
1956	409	346	134	101	0	0	12	25	0	0	0	0	**1,027**	-24
1957	196	237	141	140	0	0	36	57	0	1	20	11	**839**	-39
1958	207	315	271	332	0	0	15	24	1	1	35	47	**1,248**	-180
1959	586	449	125	127	0	0	116	69	10	27	2	2	**1,513**	-36
1960	188	193	234	130	0	0	0	0	19	28	17	23	**832**	-173
1961	292	309	80	29	0	1	0	0	24	27	8	1	**771**	-41
1962	360	364	312	243	18	18	211	128	5	18	80	64	**1,821**	-269
1963	319	324	73	62	324	268	309	126	34	63	276	262	**2,440**	-199
1964	395	404	614	388	279	175	409	294	4	9	330	310	**3,611**	-65
1965	264	182	595	438	188	122	390	287	7	15	351	349	**3,188**	
1966	70	155	599	464	560	328	179	187	22	38	597	500	**3,699**	-55
1967	202	284	1,150	740	13	5	34	55	2	1	1,431	1,129	**5,046**	-41
1968	403	404	1,257	791	78	37	0	0	5	9	1,070	900	**4,954**	
1969	227	220	850	416	0	0	0	0	4	6	1,562	1,499	**4,784**	
1970	222	254	326	288	32	20	187	132	23	19	1,196	1,117	**3,816**	
1971	126	132	269	212	9	5	35	27	51	33	849	983	**2,731**	
1972	117	85	63	57	9	6	0	0	1	1	962	1,010	**2,311**	
1973	20	11	13	8	4	4	0	0	9	11	938	838	**1,856**	
1974	16	22	35	43	2	5	18	20	16	32	528	543	**1,280**	
1975	16	12	0	0	1	1	2	1	5	13	236	221	**508**	
2001	1	0	0	0	0	0	0	0	0	0	0	0	**1**	
2002	0	0	0	1	0	0	0	0	0	0	16	23	**40**	
2003	3	2	0	0	0	0	0	0	0	0	20	25	**50**	
2004	0	0	15	13	0	0	0	0	0	0	32	40	**100**	
2005	0	0	1	0	0	0	0	0	0	0	50	49	**100**	
2006	2	3	0	0	0	0	0	0	0	0	47	49	**101**	
2007	5	1	0	0	0	0	0	0	0	0	49	45	**100**	
2008	0	0	3	3	0	0	0	0	0	0	41	53	**100**	
2009	0	0	0	0	0	0	0	0	0	0	47	54	**101**	
2010	5	5	0	0	0	0	0	0	0	0	38	52	**100**	
2011	0	0	13	3	0	0	0	0	0	0	42	38	**96**	
2012	0	0	0	0	0	0	0	0	0	0	44	56	**100**	
2013	0	0	6	3	0	0	0	0	0	0	38	53	**100**	
2014	0	0	0	0	0	0	0	0	0	0	38	52	**90**	
2015	0	1	0	0	0	0	0	0	0	0	29	61	**91**	
2016	0	0	0	0	0	0	0	0	0	0	38	52	**90**	
2017	0	0	0	0	0	0	0	0	0	0	63	71	**134**	
Total	12,878	13,481	7,904	5,511	1,517	995	2,734	1,992	271	397	11,348	10,789	**69,817**	-1,632

*Adjustment that had been made for individual catches deemed to be Bryde's whales.