REPORT OF THE ABUNDANCE STEERING GROUP, 20-21 APRIL 2024, BLED, SLOVENIA

1. INTRODUCTORY ITEMS

The pre-meeting was held 20-21 April, 2024, in Bled, Slovenia. Participants were: Andriolo, Angliss, Biuw, Branch, Brannan, Butterworth, Cañadas, Chan, Citta, Cooke, Doniol-Valcroze, Donovan, Ferguson, Givens, Harris, Herr, Heinemann, Katara, Kelly, Kitakado, Marques, Miller, New, Palka, Porter, Punt, Širović, Skaug, Staniland, Sucunza, Trujillo, Viquerat, Wade, Walløe, Weller, Weinrich, Zerbini.

1.1 Opening remarks

The convenor, Givens, welcomed participants to the meeting, recalling that the Scientific Committee (SC) had agreed in 2016 to form the Standing Working Group for Abundance Estimates, Stock Status, and International Cruises (ASI) to ensure that abundance estimates used by the SC receive a consistent level of formal review. Since then, ASI has worked to develop a suitable review process and has undertaken many such reviews.

It had quickly become apparent that the workload for ASI was greater than could be accomplished during the annual SC meeting. Accordingly, in 2019 the SC agreed to form the Abundance Steering Group (ASG) to coordinate an intersessional review process. The ASG is comprised of the SC Chair and Vice Chair; the Secretariat's Head of Science, Conservation, and Management; the Secretariat's Lead for Statistics and Modeling; and the convenors of the following SC subcommittees and standing working groups: ASI, ASW, CMP, EM, IST, IA, NH, SM and SH. In addition to the members of ASG, numerous independent experts also participated in the ASG pre-meeting this year.

Givens thanked the participants for contributing their expertise to the pre-meeting, and he offered special thanks to the 19 independent reviewers (listed in item 4) whose thoughtful reviews, voluntarily contributed intersessionally, would be relied upon during ASG deliberations at the pre-meeting.

1.2 Election of Chair

Givens was elected Chair. New was elected Co-chair.

1.3 Appointment of rapporteurs

Doniol-Valcroze, Kelly, and Harris were appointed rapporteurs. Givens thanked them for their continuing commitment to helping ensure the success of ASG and ASI, and the outstanding work they contribute each year.

Givens noted that this ASG Report will focus on the conclusions on abundance estimates, given the limited time available for preparation and approval of the text. Other topics discussed by ASG will be summarized in the ASI Annex drafted during the Scientific Committee meeting next week.

1.4 Adoption of the agenda

The agenda, as adopted, is given as Appendix 1.

1.5 Documents available

The following documents were available: Andriolo et al. (in review), Biuw et al. (2024), Eguchi et al. (2023), Eguchi et al. (2024), Harris et al. (2024), Hedley et al (1999), Hedley et al. (2001), Herr et al. (2016), Herr et al. (2022), Liyanage et al. (2022), Mura et al. (in review), Stamation et al. (2020), Viquerat and Herr (2017), Viquerat et al. (2022), Williams et al. (2006), and SC/69b/SM/01. Reviews of documents presenting abundance estimates were also available to the ASG and have been archived by the Secretariat.

1.6 Online participation

Four experts were permitted to attend relevant ASG sessions via online participation, in accordance with the Scientific Committee's Rules of Procedure and recent guidance from the SC Chair. The relevant procedures were explained to all participants.

2. REVIEW OF ABUNDANCE ESTIMATES

Last year, ASG and ASI experimented with a new process to reduce redundancy in the review process. Feedback suggested this was successful. Therefore, the same approach was used this year. Each paper ASG reviewed was assigned a label of either "Needs further review" or "Does not need further review", in addition to the standard recommendations about endorsement and categorization. The "Needs further review" label was assigned to estimates where the ASG considered the quality of the review would be enhanced by discussion among the wider ASI, for example where the ASG had further questions or concerns, or where the ASG was uncertain about which category should apply. Estimates designated as "Does not need further review" will normally be endorsed en bloc, without discussion, unless an ASI participant requests that ASI revisit a specific paper.

ASG is also tasked with recommending whether each endorsed estimate should be published on the IWC webpage about abundance. Although all endorsed estimates are added to the IWC Table of Agreed Abundance Estimates, only some are presented online. In 2023, the SC agreed (IWC, 2023, item 3.2.1) that:

> …abundance estimates that represent very large areas or nearly complete populations, and are believed to have no severe biases, should be published on the webpage. Smaller sub-units or subregions of particular interest to the Commission or the public may also be included.

In what follows, if the ASG recommendation about an abundance estimate does not include mention of needing further review by ASI, and/or does not mention adding it to the webpage, this indicates that ASG did not support such action(s).

Thus, in summary, for each abundance estimate considered, ASG made four recommendations: endorsement, category, need for further review, and website inclusion.

2.1 Abundance Estimates

2.1.1 Eastern North Pacific gray whales

The US Southwest Fisheries Science Center of NOAA conducts shore-based surveys of eastern North Pacific (ENP) gray whales to estimate abundance. These estimates are obtained from visual survey data collected off central California between December and February during the gray whale southward migration and provide regular updates to a time series of abundance estimates that began in 1967. In 2015/2016, abundance was estimated at 26,960 (95% credible interval 24,420 – 29,830) whales, indicating that the population had roughly doubled since 1967 when it was estimated at 13,426 whales (95% CI 10,952 – 15,900). The population then declined to 20,580 whales (95% CI 18,700 – 22,870) in 2019/2020. Eguchi et al. (2023) and Eguchi et al. (2024) present new estimates of the abundance of ENP gray whales for 2022/2023 and 2023/2024, respectively.

The ASG noted that the new estimates use the same survey and analysis methods as those endorsed in 2010 and subsequent years. Therefore, the abbreviated ASG/ASI review process agreed upon last year (IWC, 2023, item 2.2.2) was applied for these two reports and no intersessional reviews were solicited.

The ASG noted that during SC69A, the Committee had recommended that the US update the estimates of detection probability, the proportion of night-time passage, and the availability bias correction factor for offshore whales. The ASG was informed that during the gray whale Unusual Mortality Event (UME) that was declared from 2019 to 2023, NOAA decided to prioritize annual surveys to better monitor the population trend. This had made it financially and logistically impossible to conduct the new experiments needed to address the recommended updates to correction factors. Now that the UME has ended, it should be possible to conduct those studies during non-survey years in the near future. Therefore, the ASG **recommended** that ASI reiterate its suggestion for updating these factors (with the additional inclusion of an availability correction for diving behaviour).

The ASG **recommended** that the 2023 estimate of 14,530 whales (95% CI 13,235 – 15,960) and the 2024 estimate of 19,260 whales (95% CI 17,400 – 21,301) be endorsed as Category 1A. The entire time series of abundance estimates provided by Eguchi et al. (2024) should be added to the webpage (revising any previous estimates that has changed as a result of this update, Table 1).

Table 1. Abundance estimates for eastern North Pacific gray whales (Eguchi et al. 2024). Shown are the year, abundance estimate (N), lower and upper 95% confidence interval limits, and analysis method.

Year	N	LCL	UCL	Method
1968	13,426	11,171	16,136	Laake
1969	14,548	12,440	17,013	Laake
1970	14,553	12,372	17,119	Laake

1971	12,771	10,899	14,965	Laake
1972	11,079	9,237	13,289	Laake
1973	17,365	14,849	20,308	Laake
1974	17,375	14,799	20,399	Laake
1975	15,290	12,973	18,021	Laake
1976	17,564	14,844	20,782	Laake
1977	18,377	15,714	21,491	Laake
1978	19,538	16,448	23,208	Laake
1979	15,384	13,155	17,991	Laake
1980	19,763	16,801	23,248	Laake
1985	23,499	19,744	27,968	Laake
1986	22,921	19,523	26,910	Laake
1988	26,916	24,026	30,154	Laake
1993	15,762	13,797	18,006	Laake
1994	20,103	18,050	22,389	Laake
1996	20,944	18,586	23,601	Laake
1998	21,135	18,501	24,145	Laake
2001	16,369	14,526	18,446	Laake

2002	16,033	14,007	18,352	Laake
2007	19,126	16,644	21,978	Laake
2007	20,640	18,569	23,986	Durban
2008	18,450	16,415	21,490	Durban
2010	20,960	19,200	23,060	Durban
2011	20,820	19,040	22,710	Durban
2015	23,440	21,265	26,056	Durban
2016	27,450	24,885	30,180	Durban
2020	20,630	18,840	22,711	Durban
2022	17,430	15,800	19,220	Durban
2023	14,530	13,235	15,960	Durban
2024	19,260	17,400	21,301	Durban

Harris et al. (2024) provide abundance estimates for gray whales from the Pacific Coast Feeding Group (PCFG), a small group of ENP gray whales that the Committee has recognized as a management group demonstrating strong seasonal fidelity to the Pacific Northwest and includes individuals observed in two or more years between 1 June and 30 November from 41°N to 52°N latitude. Boat-based photo-identification data of gray whale individuals from northern California (USA) to British Columbia (Canada) span 27 years (1996–2022) and are part of a research collaboration to understand gray whale population abundance, movements, and stock structure. Estimates of PCFG abundance were updated through 2022 using the population modelling framework described in Calambokidis et al. (2019) and suggest that the population has experienced a decline of 20.8 % from an observed peak in abundance in 2016. Although the authors experimented with an alternative stock boundary, they did not recommend this boundary nor the abundance estimates derived from using it (which were almost identical to those using historical boundaries).

The ASG noted that this constitutes a routine update since the survey and analysis methods in this study had not changed, and thus the abbreviated ASG/ASI review process was applied (IWC, 2023, item 2.2.2).

The ASG **recommended** that the 2021 estimate of 210 individuals (CV = 0.13) and the 2022 estimate of 202 individuals (CV = 0.09) based on the current boundary for the PCFG be endorsed as Category 1A. The entire time series should be added to the webpage (revising any previous estimates that have changed as a result of this update, Table 2). The ASG noted that issues related to boundaries were not its responsibility.

Table 2. Abundance estimates of PCFG gray whale abundance and CVs using 1998 - 2022 data from northern California to northern British Columbia (Harris et al. 2024)

Year	N	CV
1998	127	0.08
1999	147	0.11
2000	148	0.10
2001	179	0.08
2002	196	0.05
2003	209	0.09
2004	215	0.08
2005	220	0.12
2006	199	0.11
2007	198	0.13
2008	212	0.09
2009	214	0.10
2010	205	0.10
2011	210	0.08
2012	224	0.07
2013	243	0.06
2014	251	0.08
2015	253	0.07

2016	255	0.10
2017	228	0.10
2018	215	0.11
2019	212	0.08
2020	207	0.09
2021	210	0.13
2022	202	0.09

2.1.2 Southern hemisphere blue whales

Liyanage et al. (2022) report on the results of vessel-based opportunistic line transect surveys conducted in Sri Lankan waters (3,895 km^2) between 24 June and 12 July 2018 during an ecosystem survey. A total of 57 blue whale sightings were made with the largest aggregations being recorded at the intersection of the submarine canyon off the coastline of Mirissa and busy shipping lanes between Dondra Head and Galle, where previous ship strikes were recorded. Blue whale abundance within the survey area was estimated using conventional distance sampling methods.

There are at least six blue whale populations in the Southern Hemisphere, largely distinguished by unique song types. The estimate from Liyanage et al. (2022) pertains to the Central Indian Ocean (CIO) population, occurring from Sri Lanka to the southern Indian Ocean. The ASG noted that the survey area covers only a small portion of the range of the stock, but that in the absence of any other survey for this population, information from Sri Lankan waters is needed and important.

However, the ASG noted that because the survey effort was not dedicated to marine mammals, transects were not randomly placed in the survey area. In particular, numerous lines ran parallel to the coastline and thus likely followed contours of bathymetry and environmental gradients, which affects the validity of extrapolating to the entire survey area, especially since several aggregations of blue whales were observed at the entrance of underwater gullies. Sightings made on those lines parallel to the coast can be used to inform the detection function but should have been excluded from the estimation of encounter rates. Moreover, it was not clear if observations were being made during trawling bouts (for which low speed would bias the detection process).

Other concerns were expressed about the presence of only one observer working for long shifts, and distances to sightings being estimated by eye (though with regular distance training). It was also noted that the fit of the detection function was not ideal despite an acceptable Kolmogorov-Smirnov diagnostic, and it was suggested that a Cramér-von Mises test would have been more appropriate.

Given the above concerns, the ASG **recommended** that this estimate be considered as Not Suitable. However, the ASG noted that ecosystem surveys can, and have been, compatible with data collection for cetacean abundance estimation, especially if the above considerations are incorporated in the future.

2.1.3 Southern hemisphere fin whales

The ASG considered several estimates of fin whales in the southern hemisphere. The areas of these surveys were partially overlapping; see Figure 1.

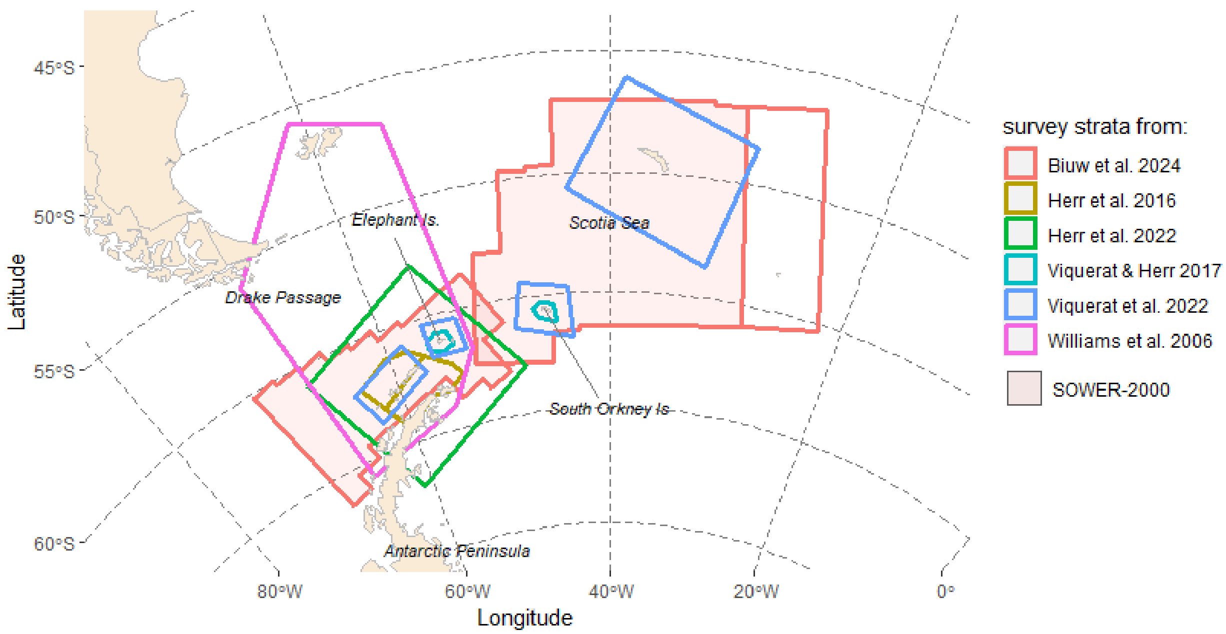

Figure 1. Study areas of recent surveys used to estimate Southern Hemisphere fin whale abundance.

The Scientific Committee had developed a programme called SOWER-2000[1] in collaboration with CCAMLR's Krill Synoptic Survey in the southwest Atlantic region in 2000 (see Fig. 1) that included placing cetacean observers on krill survey vessels as described by Hedley et al. (2001). Fin whale abundance estimates associated with a total of 9,740 km of vessel-based sighting effort was achieved by three krill research vessels, with 44 fin whale groups (117 individuals) and 12 'like-fin whale' groups (41 individuals) observed. A design-based abundance estimate of 3,180 (CV = 0.57) was derived for the Scotia Sea stratum and 1,492 (CV = 0.57) for the Antarctic Peninsula stratum. The study also reported a model-based fin whale abundance estimates of 4,510 for the Scotia Sea stratum and 1,410 for the Antarctic Peninsula stratum, with no associated uncertainty estimates.

The ASG agreed that the design-based estimation had been applied correctly, although bias is likely, due to several factors including small sample sizes due to poor weather affecting robust estimation of the detection function and g(0). However, the model-based estimates were not suitable due to a lack of a measure of uncertainty.

[1] SOWER = Southern Ocean Whale and Ecosystem Research. Note that the SOWER-2000 programme (IWC 2000) was in addition to the dedicated IWC IDCR/SOWER circumpolar cetacean cruises.

The ASG **recommended** that the 2000 Scotia Sea estimate of 3,180 (CV = 0.57) and 2000 Antarctic Peninsula estimate of 1,492 (CV = 0.57) be endorsed as Category 3.

Herr et al. (2016) present results from a dedicated aerial cetacean survey conducted from 25 January to 11 March 2013, around the West Antarctic Peninsula (WAP). Distance sampling data from 117 sightings (337 individuals) were used to produce density surface models for fin whales, and abundance was estimated over two strata (Bransfield Strait and Drake Passage).

The ASG noted that *g*(0) could likely be far less than 1 (e.g., perhaps as low as 0.25), given the survey helicopter's flight height and speed, and fin whale dive times. Other aspects of the survey design could also introduce non-ignorable bias. The ASG also noted that the confidence intervals currently do not include detection function uncertainty.

The ASG **recommended** that the 2013 Drake Passage estimate of 4,898 whales (95% CI 2,221 – 7,575) and the 2013 Bransfield Strait estimate of 94 whales (95% CI 0 – 210) be endorsed as Category 2 due to substantial negative bias induced by the assumption of *g*(0)=1 when *g*(0) is surely much lower. The estimates should be annotated in the IWC Table of Agreed Abundance Estimates to indicate that uncertainty about the detection function estimation is not reflected in the confidence intervals.

Viquerat and Herr (2017) describe a line-transect distance sampling survey for fin whales conducted around Elephant Island and the South Orkney Islands on board a CCAMLR fishing survey for fin fish in January and February, 2016. Collected data were used for model-based abundance estimates of fin whales in two strata. The average (± SE) density of fin whales was estimated at 0.0268 ± 0.0183 ind./km^2 in a 19,750 km^2 area around Elephant Island. In a 13,550 km^2 area around the South Orkney Islands, a density of 0.0588 ± 0.0381 ind./km^2 was estimated. Availability bias could not be accounted for, so it was acknowledged by Viquerat & Herr (2017) that results were negatively biased. The authors also noted that their results confirm a westerly extension of a recently described high-density area for fin whales in the West Antarctic Peninsula region.

The confidence intervals presented in the paper had a lower bound of zero, which was unrealistic given that whales were observed. Therefore, Katara implemented the approach from Buckland et al. (1993) to obtain improved confidence intervals to include on the IWC table of abundance estimates. These revised 95% confidence intervals are given in the recommendation below.

The survey described by Viquerat and Herr (2017) covers a very small area, and is focused around two island groups, with a linear connection following relatively constant bathymetry between the two. ASI usually considers estimates to pertain to areas, not stocks, unless authors claim otherwise, so the fact that the survey area does not correspond to any stock boundary is not, in itself, a problem. However, in the present case, the definition of 'the area' is quite unclear due to the nature of the survey tracks. Moreover, the estimated CVs are very large, and the uncertainty in the detection function was not incorporated.

The ASG therefore **recommended** that the 2016 Elephant Island estimate of 528 whales (95% CI 156 – 1,782) and the 2016 South Orkney Islands estimate of 796 whales (95% CI 249 – 2,541) be endorsed as Category 3.

Herr et al. (2022) describe vessel-supported helicopter surveys around the Antarctic Peninsula, the South Orkney Islands and Elephant Island in 2018 from which model-based abundance estimates for fin whales were derived. Data collection followed standard line transect distance sampling protocols with an adaptive ad-hoc survey design owing to the need to follow the vessel as it sampled other species. All sighting records of fin whales (not including any aggregations) collected during helicopter survey effort were analysed using multiple covariate distance sampling methods, with the assumption that the probability of detection on the trackline was 1. The aerial survey achieved 3,251 km of effort, during which 100 fin whale groups were detected. Generalised additive models were used to test the association of distance-corrected fin whale densities to various spatial and environmental covariates, and abundance estimates were derived. The survey region for which a fin whale abundance was estimated was derived by considering the region over which the prediction CV values were less than 1.0; the estimate was 7,909 (95% CI 1,047 – 15,743).

The methods applied by Herr et al. (2022) were broadly appropriate and corrected some of the issues with the approach identified in Herr et al (2016). However, there was still concern that no correction was made for availability bias, which remained potentially very high. The ASG noted that uncertainty from the detection function was not included in the variance estimate. Further, the estimated detection probabilities differed based on the fitted detection function in ways that were not fully expected given the properties of the model. The authors were asked to re-examine their results in response to the latter concern, and their response will be evaluated by ASI.

Viquerat et al. (2022) compiled records across 40 years from the Antarctic Peninsula and Scotia Sea from multiple sources (2,428 sightings, mainly from opportunistic presence-only data). Using an approach combining ensemble learning and maximum entropy, they estimated the abundance and distribution of fin whales in this region, with results showing a seasonal distribution pattern with pronounced centres of distribution from January-March along the West Antarctic Peninsula. Abundance estimates were provided for four local island groups and for three seasonal quarters.

The approach described by Viquerat et al. (2022) for estimating abundance is new and complex, making it difficult to fully assess. Common questions about maximum entropy models, such as how the background is selected, raise concerns about potential sources of unquantified bias that could affect the abundance estimate. It is also very unclear how to interpret an abundance estimate derived from data pooled across 40 years and extrapolated into areas where data were not available. The methodological framework being presented would benefit from simulation studies to assess performance, and this work is underway by the authors.

Although the group believed that the estimates might be informative in a broad sense, there were significant unresolved questions and concerns, and the group believed that the analysis method was insufficiently understood or tested to be endorsed in any existing category used by ASI. Therefore, ASG recommended that a new category, Undetermined, be established for such cases (item 2.2.3). The ASG **recommended** that the Viquerat et al. (2022) estimates be categorised as Undetermined for the reasons above.

Williams et al. (2006) describe an analysis of effort and sightings data collected along 9,650 km of transects aboard ships of opportunity (tourist vessels) in the Drake Passage and along the Antarctic Peninsula during the austral summers of 2000–2001 and 2001–2002. Generalized additive models with generalized cross-validation were used to express the heterogeneity of cetacean sightings as functions of spatial covariates. Models were used to map predicted densities and to estimate the abundance of a number of species, including fin whales. All species' distribution maps showed strong density gradients, which were robust to jackknife resampling when each of 14 trips was removed sequentially with replacement. Estimated abundance of fin whales was 4,487 (95% CI 1,326 – 15,179). These estimates agreed broadly with those reported from a designed survey conducted in the region during the previous austral summer (Hedley et al., 2001).

Insufficient details were provided in the paper to fully assess the methods (e.g., the approach to goodness-of-fit testing). Also, the assumption that $g(0)=1$, as well as potential issues with the observation process (e.g., platforms at different heights), would likely lead to substantial negative bias. However, the estimate does provide a general indication of fin whale abundance in the area, even though the data were collected from surveys in two different years.

The ASG **recommended** that the 2001–2002 Drake Passage-Antarctic Peninsula estimate of 4,487 whales (95% CI 1,326 – 15,179) be endorsed as Category 3.

Biuw et al. (2024) report findings from a recent multi-vessel single-platform sightings survey carried out in 2019 as part of a survey for Antarctic krill. Fin whales were encountered throughout the entire survey area, which covered the majority of CCAMLR Management Area 48, but were particularly abundant around the South Orkney Islands, south of South Georgia, and in the eastern Bransfield Strait. Distance sampling analyses suggest an average fin whale density throughout the Scotia Sea of 0.0256 (CV = 0.149) whales per km^2, which agrees well with recent density estimates reported from smaller sub-regions within the Scotia Sea. Design-based distance sampling analyses resulted in an estimated total fin whale abundance of 53,873 (95% CI 40,233 – 72,138). A density surface model fit to the same data resulted in a slightly lower estimate. These estimates are at least an order of magnitude greater than the previous estimate from the same region based on the SOWER-2000 data, suggesting that fin whale abundance has substantially increased in this region of the South Atlantic.

The ASG noted that this survey was not designed specifically for fin whale abundance estimation. However, the survey used standard distance sampling protocols for cetaceans and its study area was directly comparable to historic estimates such as SOWER-2000 and other recent surveys (Fig. 1), though differences in survey coverage due to weather conditions could affect the comparison of some areas (e.g., the West Antarctic Peninsula).

The ASG inquired about possible bias in the results due to the inclusion of “like-fin whales” sightings (which represented 21% of the data). Since few species in the area could be confused with fin whales (e.g., minke and sei whales), it was expected that the majority of these sightings were indeed fin whales, and therefore any resulting bias would be small. Moreover, most of these sightings were likely distant ones and should have little impact on the detection function. However, the ASG asked for a sensitivity analysis that excludes “like-fin whales” sightings from both the detection function and the encounter rate estimation.

The ASG discussed the heterogeneity in the detection process among observers and ships, especially with one ship having a much lower observation platform and two ships having too few observers to survey both the port and starboard quadrants. It was suggested that the observer term in the detection model may not be sufficient to account for these differences since it only affects the scale of the hazard-rate function. One vessel had too few sightings to be modelled on its own, but the ASG asked for a sensitivity analysis that fits a different detection function to each of the other two ships separately to examine how this would change the detection probabilities and their uncertainty. The results of the sensitivity analysis will be reviewed in ASI, and a category for the 2019 design-based estimate will be determined then.

2.1.4 Southern hemisphere right whales

Stamation et al. (2020) provide the first complete estimate of population size and rate of increase of southern right whales along the southeastern Australian coastline. In Australian waters, southern right whales form two genetically distinct populations that have shown contrasting patterns of recovery since whaling ceased: a western population in South Australia and Western Australia and an eastern population in southeastern Australia (Tasmania, Victoria and New South Wales). Stamation et al. (2020) provide an abundance estimate derived from a breeding female superpopulation mark-recapture model for the southeastern southern right whale population. They also derived an estimate of total population abundance, but this is potentially positively biased due to transiting whales from the southwestern population.

The ASG noted that the paper provided insufficient details about the statistical analysis and that one of the independent reviewers had raised significant concerns about the extent to which the analysis code did not seem to match the authors' description of their analysis nor standard POPAN model equations. Additional concerns were expressed about the possible failure to account for biases and uncertainty, and assumptions that would likely be violated.

The authors responded to ASG reviewers' comments by indicating that a revised analysis is being undertaken and would likely show the estimate in this paper to be an overestimate. While the authors are to be commended for providing an important first estimate for a small stock, for IWC purposes the ASG **recommended** that the current analysis be categorised as Not Suitable. The ASG welcomed the authors' plan to develop an improved analysis that it would be happy to review in the future if referred to it by the relevant convenor.

In consideration of this paper, the ASG noted that a simple *ad hoc* correction factor (3.94), developed in 2013 (IWC, 2013, p.450), used to convert breeding female numbers to total population, had been subsequently employed as in several studies of southern right whales around the world (including this paper). The Committee has previously noted (IWC 2022) that this factor does not include an uncertainty estimate, and that additional, more recent data should be incorporated. The ASG noted that updates to southern hemisphere right whale assessments currently in progress (SC/69B/SH/05 and SC/69B/SH/06, and Annex P (item 4)) estimate this factor and its associated uncertainty implicitly, providing stock-specific estimates; the ASG recommended that such an approach is to be preferred, and should supplant the previous approach and related recommendation relating to a general correction factor when possible.

2.1.5 Eastern Bering Sea beluga whales

SC/69b/SM/01 presents an investigation of spatially explicit models and ensemble modelling techniques for estimating animal abundance from line-transect survey data, with a case study on belugas from the Eastern Bering Sea (EBS) stock. The approach applied density surface models using both (1) stochastic partial differential equations and (2) basis-penalty smoothers. EBS beluga abundance estimates for 2017 and 2022 that were derived using post-stratified, design-based abundance estimators were compared with analogous estimates derived using these spatially explicit and ensemble modelling methods. Although the design-based estimators were slightly less precise than individual spatially explicit models (with one exception), precision was essentially equivalent between the design-based and ensemble model-averaged abundance estimators. The design-based estimates were 12,269 belugas in 2017 (CV = 0.12) and 20,635 belugas in 2022 (CV = 0.31; the study area was larger in 2022). The ensemble spatial models estimated that there were 11,597 belugas in 2017 (CV = 0.12) and 17,197 belugas in 2022 (CV = 0.33). Among the individual spatially explicit models, abundance estimates ranged from 11,242 to 11,962 (CV = 0.11 to 0.12) in 2017 and 12,593 to 21,508 (CV = 0.18 to 0.29) in 2022. Because spatial models identify spatial patterns in beluga density (the number of belugas per unit area) at finer resolutions than design-based models, the authors argue that their approach provides a reasonable path forward for estimating EBS beluga abundance and distribution in a way that is useful to management and conservation efforts.

The ASG recognised the large amount of work undertaken by the authors to fit a range of models, and to address many aspects of bias and variance propagation in spatial modelling. The group also noted the need to increase a collective understanding of relatively newer, evolving, or less familiar modelling approaches, such as those presented in SC/69B/SM/01.

The ASG noted that while the various beluga abundance estimates for 2017 were quite similar, the estimates for 2022 varied substantially. The authors considered that this variability among the 2022 estimates was likely due to two factors: 1) inclement weather caused poor sighting conditions, resulting gaps in spatial coverage; and 2) three large beluga groups were sighted near the southern edge of the survey region in an area never previously surveyed for this stock but included in the 2022 survey design based on Indigenous knowledge that the population occupied the area. The ASG was unable to understand fully to what extent the various features of the complex modelling approaches would differentially respond to inconsistent spatial coverage of survey effort, large variations in group size, and changing spatial extent of the survey region, to result in the large range of abundance estimates produced for the 2022 survey. Furthermore, there was a general wariness within the group regarding ensemble modelling, although it was recognized that ensemble approaches can sometimes be helpful for accounting for uncertainty in model selection. Several members considered that if ensemble methods were to be used in this analysis, the uniform weighting undertaken in SC/69B/SM/01 was not a suitable approach. Finally, the ASG noted that the perceived complexity of the spatial modelling approaches described in SC/69B/SM/01 was somewhat misleading, as such models all fit into a generalised additive model framework (Miller et al. 2020), with which the Committee is quite familiar. The main difference between the different model based approaches pertains to how one models and accounts for the spatial autocorrelation.

The ASG considered whether conventional design-based methods were generally preferable to model-based approaches, particularly given that the statistical properties of design-based methods were well understood. The authors pointed out, however, that while the survey design and realisation in 2017 met the fundamental assumptions necessary for a design-based analysis to generate unbiased abundance estimates, this was not the case for the 2022 survey. Specifically, in 2022 there were gaps in coverage, three large beluga groups were observed in the far south of the survey region, and (as in 2017) there was considerable variability in turbidity across the study area. These factors resulted in spatially heterogeneous detection probabilities. Given these issues, a model-based approach could provide more reliable estimates, provided that the model accurately represents how the data relate to the underlying biology.

In discussion, the authors were asked about the potential over-smoothing by the spline-based models along the onshore-to-offshore gradient around the plume region of the Yukon River Delta, resulting in higher beluga densities observed in the turbid waters inaccurately propagated into the surrounding regions. The authors noted that increasing the flexibility of the spatial model by adding further random effects to the spatial smooths might deal with the oversmoothing in some of the spline models. The issue of not propagating uncertainty from beluga availability estimates was also raised. The authors noted the sample size of the data used to derive the availability estimates was too small to support a reliable uncertainty estimate so that the decision not to propagate this uncertainty was a pragmatic one.

Noting the points raised by the ASG, the authors expressed their desire to continue to work on the models described in SC/69B/SM/01, particularly regarding the effects of differing degrees of flexibility in the spline-based approaches, compared to the approach using stochastic partial differential equations, to allow for comparisons of equivalent models.

The ASG recommended the 2017 design-based abundance estimate of Eastern Bering Sea belugas of 12,269 (CV = 0.12) be endorsed as Category 1A, and that the 2022 design-based abundance estimate of 20,635 (CV = 0.31) be endorsed as Category P (Preliminary). The ASG further recommended that a footnote be added to these abundance estimates to indicate that the associated CV will be an underestimate as uncertainty from the availability estimate was not propagated through to the final abundance estimates.

The ASG encouraged the authors to further investigate three issues: 1) whether specifying the same number of random effects for the spline-based models as allocated to the Matérn covariance models considerably changes the resulting density surfaces, area-integrated abundance estimates, and associated uncertainty; 2) whether the revised candidate models are all relevant and sufficiently different to justify the need to apply ensemble modelling techniques and, if so, apply a model complexity or uncertainty metric to allocate weights to the candidate models in the ensemble calculations; and 3) whether the large differences in the 2022 abundance estimates derived from the design-based and the spatial models can be straightforwardly explained. The ASG looks forward to reviewing updated beluga abundance estimates from the 2017 and 2022 surveys in the future, and insights from these investigations should help the ASG reconsider estimates from the spatial models for both surveys in that eventuality.

2.1.6 Other estimates

The ASG was informed by CMP that an abundance estimate of humpback whales in the Arabian Sea was ready for ASI review. The review will be conducted in 2024, with a recommendation finalised at a planned meeting of ASG in spring, 2025.

2.2 Review Process

2.2.1 Improvements to wording for Category 4

In 2023, ASI and the Committee developed a Category 4 for ASI endorsements of certain abundance estimation data. However, some concern was expressed about its clarity. The Committee agreed to “review this wording at SC69B and refine if necessary” (IWC, 2023, item 4.2). This year, the ASG **recommended** the following revision (that it agreed to use during the present ASG meeting if needed):

> ***Category 4****: Used when the Committee wishes to endorse small sample size data sets while not endorsing abundance estimates derived from those data. Application of many abundance estimation methods may be inadvisable when sample sizes are too small (e.g., too few sightings in a survey, or too few captures or recaptures in a photo-identification study). In such cases, endorsement of the data as Category 4 would be appropriate when the survey design and analysis were of sufficient quality to provide reliable general information about the low number of whales in the area. Then, these data could be used for fitting population models or In-depth Assessments despite not yielding (from themselves alone) a reliable abundance estimate. Because the RMP allows the use of abundance estimates with few or zero sightings, an abundance estimate derived from*

Category 4 data may be used with the RMP even though the estimate itself has not been endorsed for a higher category.

2.2.2 Expiration for Preliminary category (Category P)

Some abundance estimates categorized as Preliminary in recent years pertain to surveys conducted many years or even decades ago, for which the analyses are unlikely to be revisited. Other Preliminary endorsements pertain to recent estimates that have not yet been updated. Last year, some ASI members questioned whether a Preliminary rating should eventually expire, at which point the estimate might convert to Not Suitable (or some other category). ASI agreed to add this issue to its agenda for SC69B.

The ASG agreed that the current wording for the Preliminary category *('A preliminary estimate, not suitable for use at the time of review, but which may provide an acceptable estimate once finalized*.') means that the only reason the rating would need to be changed is if the estimate is updated or finalized, and therefore that this is no reason to assign a set expiry date. Therefore, the ASG **agreed** that no change is required to the present wording.

2.2.3 Suggestions and other matters

During the consideration of some new and complex methods for abundance estimation (Viquerat et al., 2022; item 2.1.3), the ASG had noted that it was unable to endorse an estimate immediately due to further methodological questions and potential concerns, but was also unwilling to categorise it as Not Suitable. The ASG therefore recommended that a new ASI Category be created to address such cases and agreed to use it at its present meeting, recognising that this will require agreement from ASI and the Committee:

> **Undetermined:** This category covers estimates for which the Scientific Committee is unable to assign another category at this time, for example, estimates derived from novel approaches that the Committee considers insufficiently understood or tested. When used, this categorisation should be accompanied by an annotation to explain the reason. Estimates categorised as Undetermined should not be added to the IWC Table of Agreed Abundance Estimates, and may be reconsidered as circumstances evolve.

3. METHODOLOGICAL REVIEWS

3.1 Estimation of franciscana abundance from passive acoustic monitoring

The Small Cetaceans Subcommittee requested a methodological review of certain strategies for estimating abundance of franciscana dolphins using a novel approach to passive acoustic monitoring. ASG conducted this review, with discussion and conclusions to be reported in the ASI Annex to the Scientific Committee report.

3.2 Spatially explicit models for line transect data

Recognizing that the Scientific Committee and ASI have a strong need to develop further expertise about relatively unfamiliar methods for spatial density modeling of line transect data, Givens and New asked the authors of SC/69b/SM/01 (see item 2.1.5) to present an overview of the methodology and advice for practitioners in addition to the abundance estimate itself. Two invited discussants (Skaug and Miller) offered further comments, followed by ASG discussion. A report will be provided in the ASI Annex to the Scientific Committee report.

The ASG welcomed news that the important documents regarding guidelines on spatial modelling developed in recent years (e.g., Miller and Bravington 2017, SC/69A/ASI/20)) will be incorporated as Appendices to the Scientific Committee Handbook and will be made easily available via the IWC website. Analogous plans for other estimation methods are also under development.

4. ADOPTION OF REPORT

Givens and New thanked the rapporteurs, Doniol-Valcroze, Kelly, and Harris for their enormous contributions to the success of the pre-meeting. They also thanked the members of the small group on acoustic methods for franciscana, the invited discussants for spatial density models, and the independent reviewers of abundance estimates, all of whom generously contributed their time and expertise:

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The report was adopted at 16:45 on April 22, 2024.

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Appendix 1: Agenda

1. INTRODUCTORY ITEMS
    - 1.1. Opening remarks
    - 1.2. Election of the Chair
    - 1.3. Appointment of rapporteurs
    - 1.4. Adoption of the agenda
    - 1.5. Documents available
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2. REVIEW OF ABUNDANCE ESTIMATES
    - 2.1. ABUNDANCE ESTIMATES
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        - 2.1.2. Southern hemisphere blue whales
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    - 2.2. REVIEW PROCESS
        - 2.2.1. Improvements to wording for Category 4
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3. METHODOLOGICAL REVIEWS
    - 3.1. Estimation of franciscana abundance from passive acoustic monitoring
    - 3.2. Spatially explicit models for line transect data
4. ADOPTION OF REPORT