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Progress report on pygmy blue whale assessments

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INTERNATIONAL WHALING COMMISSION

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Here I report on progress towards assessments from the 2018 IWC-funded project "Updated catch series and assessments of four pygmy blue whale populations". No previous population assessments have been conducted on any of the pygmy blue whale populations, and it was proposed to develop catch time series for each of the four populations, together with preliminary assessments based on minimum abundance estimates, to further the in-depth assessment of these populations. Due to a combination of extra work required to convert lectures to online format due to covid-19 impacts, the addition of new data about a fifth pygmy blue whale population, and anticipated new data from a collaboration with Microsoft's AI for Earth program, the assessments were not completed in time for the 2020 SC meeting.

In the original proposal four populations were recognised, but stable long-term song types now suggest there are five populations to consider: north-western Indian Ocean (NWIO) including Oman, north-western Madagascar and Diego Garcia; north-central Indian Ocean (NCIO) including Sri Lanka and Oman; south-western Indian Ocean (SWIO) including Madagascar; south-eastern Indian Ocean (SEIO) including western and southern Australia and Indonesia; and south-western Pacific Ocean (SWPO) from New Zealand to Tonga.

The fifth population is based on the addition of a new song type recorded off Oman and north-western Madagascar which suggests that there is a fifth previously unrecognized "Oman" blue whale population (Cerchio et al. 2018), with a submitted paper outlining the full evidence. As a result, this "Oman" population is now considered to be in the north-western Indian Ocean, while the "Sri Lanka" population is in the north-central Indian Ocean.

In previous work, acoustic records were compiled throughout the region of interest and beyond, and spatial models fitted to the detections of each song type, to produce spatial maps of population occurrence, and these were applied to historical catch locations to produce preliminary catch time series for the four original populations (Branch et al. 2018, Branch et al. 2019).

PROGRESS IN 2019-20

Assessing population boundaries between pygmy and Antarctic blue whales
Extensive work outlined in Branch et al. (2018, 2019) has been done to determine the most likely boundaries between pygmy and Antarctic blue whales (Fig. 1), and display current thinking about where each of the five populations of pygmy blue whales occur. One minor change is that a few blue whales south of the pygmy-Antarctic boundary in Fig 1 were identified as pygmy blue whales by the Soviet fleets, and these will be assigned to pygmy blue whales and not Antarctic blue whales, unlike in Branch et al. (2018, 2019).

Expansion of acoustic records
During the past year, collation of acoustic records has greatly expanded, such that the original group of 19 collaborators has expanded to 29 data contributors and 4351 data records (location by month), including all available data for the newly recognized NWIO population, supplied by Sal Cerchio.

Microsoft collaboration
A new collaboration was started with Ming Zhong of Microsoft's AI for Earth, and existing collaborators on this project, Kate Stafford and Maelle Torterotot, to apply neural networks to detect and identify blue whale calls from the French network of hydrophones in the central and western Indian Ocean. The large number of long-term recorders in this region coincides with the overlap in calls of the NCIO, SWIO, and SEIO populations, and will allow much more precise separation of catches. Preliminary results are highly promising, with very low false positive rates, among which were the detection of calls missed by humans in the training dataset. The addition of the finished project to the catch separation dataset is intended for next year's SC meeting.

Spatial model fitting
Spatial models have been developed and fitted to the acoustic data as outlined in Branch et al. (2018, 2019). In the latest iterations the models with binomial likelihood have been eliminated from consideration since these always provide model fits that are far worse than the spatial models with beta-binomial likelihoods.

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Bootstrapping and uncertainty
Work has started to generalize the process from fitting spatial models to obtaining final catch time series, so that bootstrapping can be used to assess how the uncertainty resulting from the input acoustic data propagates through to the catch time series. This has proven difficult to generalize since some of the expeditions catching pygmy blue whales did not report catch locations.

Moving from annual to seasonal estimates of catches
The collated acoustic data are now allocated to specific months, allowing for a more fine-scale incorporation of migration of each population to be estimated from the spatial models. Most catches were taken in November to May, but data are not available for all locations in all months, and therefore it will be necessary to group some months together to obtain meaningful spatial smoothers.

Compilation of abundance estimates and trend data for each population
NWIO (Oman): there are no known abundance estimates or trend data for this population, and it will therefore not be possible to conduct a population assessment.

NCIO (Sri Lanka): one abundance estimate is available, of 270 (CV = 0.09, 95% CI 226-322) in small area south of Sri Lanka (80°0′–81°25′E, 5°28′–5°53′N) based on a large number of repeated surveys in 2014 (Priyadarshana et al. 2016). No trend data are available.

SWIO (Madagascar): a small survey in the Madagascar Plateau region (25–35°S, 40–45°E) in December 1996, obtained an abundance estimate of 424 (CV = 0.42) based on confirmed blue whale sightings, or 472 (CV = 0.48) when 'like blue' sightings were also included (Best et al. 2003). No trend data are available.

SEIO (Australia/Indonesia): A line-transect survey south of Australia (35–45°S, 115-125°E) in 1993 estimated that there were 671 (CV = 0.45, 95% CI 279–1613), but this was in a small area (Kato et al. 2007). Mark-recapture analyses estimate that between 791 (95% CI 569–1147) individuals occur in the feeding area off west Australia (Jenner et al. 2008). An abundance estimate based on passive acoustics was obtained of 1,100 (95% CI 662-1559) during the southern migration October to December at the latitude of Exmouth (21°30'S) (McCauley and Jenner 2010). Long-term acoustic deployments off Perth Canyon (2000-2017) have shown increasing numbers of calls over time, that could be used to obtain rates of increase in the population (R. McCauley, pers. comm., 5 May 2020). In addition, off the Bonney coast, changes in acoustic calls over time were best explained by a population increase rate of 4.3% per year together with annual changes in upwelling intensity (McCauley et al. 2018).

SWPO (New Zealand): a mark-recapture estimate of 718 (95% 279–1926) is considered to be conservative (Barlow et al. 2018), since it is based largely on photo-id data from a small region. No trend data are available.

Assessment plan for each population
NWIO (Oman): it is not possible to conduct an assessment at this time.

NCIO (Sri Lanka): the available abundance estimate is from a very small area known to have a high concentration of blue whales. An assessment could be conducted assuming this 270 is the minimum abundance, but a complete assessment is best postponed until a more complete abundance estimate can be obtained from photo-id mark-recapture.

SWIO (Madagascar): the estimate of 424 could be treated as a minimum abundance, and an alternative estimate obtained by assuming that spatial model fits correctly capture the probability of occurrence of blue whales from this population, allowing for the extrapolation of this estimate into unsurveyed regions.

SEIO (Australia/Indonesia): individual abundance estimates may all be negatively biased, but an assessment could be conducted based on the mark-recapture estimate of 791, together with annual trends in acoustic call rates.

SWPO (New Zealand): as for the SEIO population, an assessment should be based on the mark-recapture estimate of 718.

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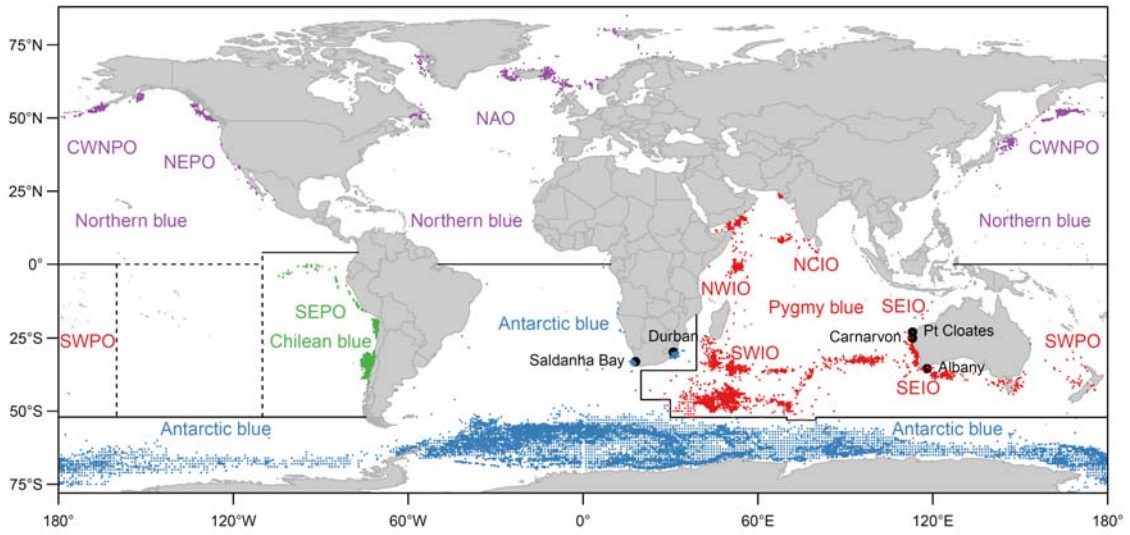

Fig. 1. Global blue whale catches of each of the four generally accepted subspecies (northern blue, Chilean blue, Antarctic blue, and pygmy blue), showing assumed boundaries in black used to enclose catches of each. Dashed boundaries enclose an area in the South Pacific with no known blue whale data. Individual populations are shown by acronyms for pygmy blue whales: north-west Indian Ocean (NWIO, Oman), north-central IO (NCIO, Sri Lanka), south-west IO (SWIO, Madagascar), south-east IO (SEIO, Australia/Indonesia), south-west Pacific Ocean (SWPO, New Zealand); Chilean blue whales (SEPO); and northern blue whales: north-east PO (NEPO, California/Mexico), central and western north PO (CWNPO, Japan to Gulf of Alaska), north Atlantic Ocean (NAO). Selected land stations are labelled