INTERNATIONAL WHALING COMMISSION

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PROJECT PROPOSAL REQUEST

1. . PROPOSAL TITLE

Assessment of Antarctic blue whales

2 . BRIEF OVERVIEW OF THE PROPOSAL AND ITS EXPECTED OUTCOME

We propose a full stock assessment of Antarctic blue whales, which would include the following components:

- Revising and updating a time series of historical catches
- Updated priors for rates of increase in Antarctic blue whales based biological parameters
- Compilation of abundance and trend estimates for Antarctic blue whales
- Fitting assessment model to available data in a Bayesian framework
- Preparing a report on the results for the Scientific Committee in 2024

3 . RELEVANT IWC SCIENTIFIC COMMITTEE GROUPS OR SUB-GROUPS

The SH Sub-Committee is currently finalizing abundance estimates and population structure for Antarctic blue whales, in preparation for IA, and this work should finish in 2023. All current indications are that Antarctic blue whales comprise a single population that mixes freely in the southern regions during their summer feeding period (Lang et al. 2020, Rand et al. 2022, Olson et al. 2022).

In 2024, IA will begin an in-depth assessment of Antarctic blue whales. The current proposed work directly fulfils this SC goal.

Previous assessments of this subspecies have been conducted by the PI (Branch et al. 2004, Branch 2008) and presented to the SC.

4 . TYPE OF PROJECT (PLEASE TICK)

Research project	X
Modelling	X
Workshop/meeting	
Database creation/maintenance	
Compilation work/editing *(e.g. on whalewatching regulations, SOCER, etc.)*	
Other *(please specify below)*	

5. BRIEF DESCRIPTION OF THE PROPOSAL AND ITS CONNECTION WITH SCIENTIFIC COMMITTEE RECOMMENDATIONS (DO NOT EXCEED 1500 WORDS)

(A) BACKGROUND, RATIONALE, AND RELEVANCE TO THE PRIORITIES IDENTIFIED BY THE IWC SCIENTIFIC COMMITTEE:

The Scientific Committee has overseen a long-running in-depth assessment of Southern Hemisphere blue whale populations, which is set to culminate in 2024 for Antarctic blue whales. We propose here to conduct the stock assessment itself, thus synthesizing the vast body of work conducted by the SC in the intervening years.

Antarctic blue whales (*B. m. intermedia*) are the largest of the blue whale subspecies, and, before whaling, by far the most numerous of all blue whale populations, accounting for around 90% of the abundance and historical catches of blue whales worldwide (Branch et al. 2008). They are a separate subspecies from pygmy blue whales (*B. m. brevicauda*) and northern blue whales (*B. m. musculus*), and from other populations (or subspecies) off Chile and in the northern Indian Ocean. Key features separating Antarctic blue whales from pygmy blue whales include a distinctive song (McDonald et al. 2006), geographic separation at 52-56°S in summer (Kato et al. 1995, Branch et al. 2007b), genetic differences (LeDuc et al. 2007), length differences (Ichihara 1966, Branch et al. 2021), differences in length at maturity (Branch & Mikhalev 2008), and a relatively longer tail region (Ichihara 1966).

The most recent assessments of this subspecies concluded that there were 239,000 Antarctic blue whales before whaling, before whaling reduced their abundance to just 360 individuals in 1973 before increasing at 7-8% per year to 2280 in 1998 (Branch et al. 2004, Branch 2008). Since that time, considerable new information has become available. Notably, new methods have been developed to separate catches of Antarctic and pygmy blue whales (Branch et al. 2007a, Branch et al. 2008, Branch et al. 2009), to characterize where different pygmy blue whale populations occur (Branch et al. 2007b, Branch et al. 2021), to assess sex ratios in Antarctic blue whales (Branch & Monnahan 2021), to estimate the frequency of twin births in Antarctic blue whales (Drinkwater & Branch 2022), to assess their genetic structure (Sremba et al. 2012, Attard et al. 2016) and movement rates (Rand et al. 2022, Olson et al. 2022), and to estimate length at maturity (Branch & Mikhalev 2008).

This year, ASI is assessing abundance estimates, which come from the entire population from the IDCR/SOWER line-transect surveys (Branch 2007), and for IWC Areas IIIE to VIW from the JARPA line-transect surveys (Matsuoka & Hakamada 2014). New mark-recapture estimates from photo-id are also available (Olson et al. 2018, Olson et al. 2021).

Additionally, this year SH and DNA jointly considered different hypotheses for stock structure, relying on existing reviews (Lang et al. 2020), information from satellite tags, and recaptures from photo-id and Discovery mark (Olson et al. 2022), and a movement model fitted to Discovery mark data (Rand et al. 2022). They concluded that Antarctic blue whales comprise a single well-mixed population for assessment purposes.

(B) SPECIFIC OBJECTIVES OR TOR AND DELIVERABLES/OUTCOMES:

Objectives

1) Revision of historical catches for Antarctic blue whales.
2) Develop and revise priors for rates of increase.
3) Compilation of abundance and trend estimates.
4) Development of an assessment model for Antarctic blue whales.

Deliverable

The main deliverable of this work will be a paper with the draft stock assessment presented to the SC in IA in May 2024.

Our intention is that after suitable revision, this will become a chapter in the PhD dissertation of the student (Zoe Rand), and that a peer reviewed paper will be submitted to a journal.

(c) Methodological approach/work plan/administrative details

Revision of historical catches

We will create an updated time series of catches for Antarctic blue whales. Previous time series (Branch et al. 2004, Branch et al. 2008) were based on an earlier version of the IWC catch database, which has since been updated, including newly recovered information on Soviet catches, and more refined separation of pygmy and Antarctic blue whales (Allison 2020). Additional analyses have also more rigorously separated Antarctic and pygmy blue whales by latitude and longitude using length distributions (Branch et al. 2007a, Branch et al. 2009, Branch et al. 2021), as depicted in Fig. 1. Finally, it is anticipated that data to be retrieved from an IWC-funded hydrophone project deployed off Durban, South Africa (F.W. Shabangu et al. in prep.), will resolve the greatest point of uncertainty: whether substantial catches off Durban were Antarctic or pygmy blue whales (Branch et al. 2008, Branch et al. 2021).

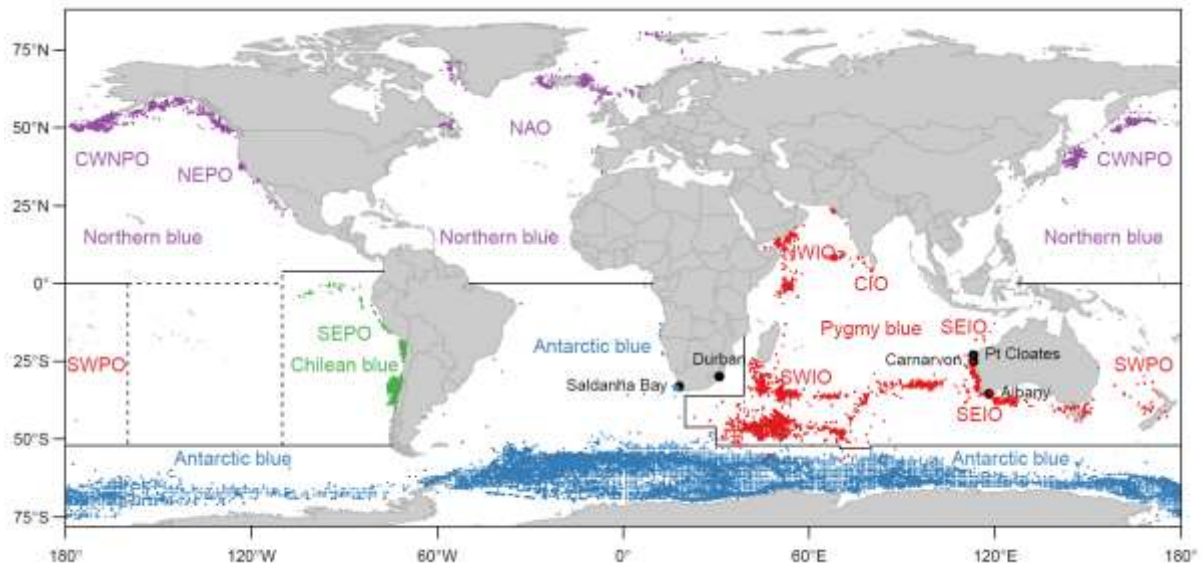

Figure 1: Estimated region containing catches of Antarctic blue whales. Note that allocation of catches taken from Durban remain uncertain at the time, but should be resolved through data currently being collected from a hydrophone off Durban.

Developing priors for rates of increase

Updated meta-analyses of rates of increase in other whale populations are now available (Punt & Allison 2010), and have been used for assessments of blue whales elsewhere (Monnahan et al. 2015). Additional work is planned to estimate biological parameters of Antarctic blue whales using earplug laminae data for Antarctic and pygmy blue whale data by the student and PI for this project (Z.R. Rand, T.A. Branch, H. Maeda in prep.). These will be used to develop an informative prior on the rate of increase from biological parameters, as used in previous assessments (Branch et al. 2004, Branch 2008).

Compilation of abundance and trend estimates

In the model, line-transect abundance estimates for the entire Antarctic (Branch 2007) will be treated as absolute estimates, and estimates for about half of the longitudinal region of the Antarctic (Matsuoka & Hakamada 2014) will be treated as relative abundance estimates. Mark-recapture estimates from photo-id (Olson et al. 2021) will be treated as absolute abundance estimates.

Should they prove useful, additional trend data may be included from Japanese Sighting Vessels (JSV) (Miyashita et al. 1995) as in Branch et al. (2004), trends in CPUE from temperate whaling stations (Best 2003), trends in Antarctic blue whale song production rates (e.g., McCauley et al. 2018), and reconstructed catch-per-unit-effort trends in modern whaling data from a newly formed project (L. Battle & T.A. Branch, in prep.).

Development of an assessment model

A Bayesian population dynamics model of abundance (N_t) will be fitted to the abundance estimates and indices of abundance, including historical catches (C_t). The standard "IWC baleen whale" model, a theta-logistic with z = 2.39, will be used, which ensures that maximum productivity occurs at 60% of carrying capacity (K), regardless of intrinsic growth rate r: $N_{t+1} = N_t + rN_t(1-[N/K]^z) - C_t$. Abundance estimates will be assumed to be lognormally distributed. The model will be implemented in either AD Model Builder (Fournier et al. 2012) or Stan (Gelman et al. 2015), since the posterior distribution is likely to be difficult to traverse, and both of these packages allow the use of the no-U-turn-sampler, which explore difficult posteriors efficiently (Monnahan & Kristensen 2018, Monnahan et al. 2017, Monnahan et al. 2019).

D) SUGGESTIONS FOR OUTREACH

The PI teaches a course called "Beautiful Graphics in R" and will produce graphics that can be used by the Secretariat to illustrate aspects of the project.

Social media: The PI runs two Twitter accounts for science outreach. One is dedicated to blue whales (@BlueWhaleNews), with 5,200 followers, where the PI has posted 3,500 tweets viewed 2.7 million times since 2015. The other is a more general account (@TrevorABranch) that can be used to amplify science stories, with 16,000 followers, where the PI has posted 52,000 tweets viewed 54 million times since 2015.

Links to broader scientific community: the PI has developed extensive collaborations in past projects on blue whales including large collaborations involving song records (Branch et al. 2021) and compilations of sightings and strandings (Branch et al. 2007b).

6 . TIMETABLE FOR ACTIVITIES AND OUTPUTS

Timeline feasibility

Previous work by the PI has developed now-outdated time series of catches (Branch et al. 2004, Branch et al. 2008), and similar models have been run by the PI and student for an Antarctic blue whale movement model that includes population dynamics (Rand et al. 2022), and for past Bayesian assessments of Antarctic blue whales (Branch et al. 2004, Branch 2008). We therefore consider this project to have a high probability of success in the time budgeted.

Activity to be undertaken	Key person(s)	Start(mm/yy)	Finish (mm/yy)
Revision of historical catches	Rand & Branch	10/2023	01/2024
Develop priors for rates of increase	Rand & Branch	10/2023	01/2024
Compilation of abundance and trend estimates	Rand & Branch	10/2023	01/2024
Development of assessment model	Rand & Branch	01/2024	04/2024

Expected outputs	Completion date (mm/yy)
SC document on stock assessment (deliverable)	04/2024
Scientific publication (intended)	12/2024

7. . RESEARCHERS' (OR STEERING GROUP) NAME(S) AND AFFILIATION

Please, also specify if the project team has any direct connection (e.g. same research group or institute, collaborator on common project) with people involved or likely to be involved in taking the funding decision (e.g. IWC SC heads of delegations, SC convenors, etc.). Add as many rows as you need to the table below.

Name	Affiliation	Connection with decision
Trevor Branch	University of Washington, Assoc. Professor	None
Zoe Rand	University of Washington, PhD student	None

8 TOTAL BUDGET

PROJECT BUDGET						Please indicate when funds will be needed			Co-funding funds only
	Description	**Cost per unit £GBP**	**Number of units**	**Total Cost £GBP**		**2022 £GBP**	**2023 + £GBP**		**Co-funding £GBP**
(1) Salaries (by person)	PI Trevor Branch 2023-24 PhD student Zoe Rand 2023-24 **(Indirect/overhead costs are not included)**	£16,631 £3,076	0.5 3	£8,316 £9,229		0	£17,545		0
(2) Travel/subsistence (by person or est. total for IPs)									
(5) Consumables									
(6) Shipping & Customs (by Item)									
(7) Insurance (by item)									
(8) Other	PhD tuition (2023-24) per quarter **(Indirect/overhead costs are not included)**	£4,772	1	£4,818		0	£4,818		0
			TOTAL	**£22,362**		0	£22,362		0

Co-funding Memo:

Source	**Purpose of Funding**	**Cost £GBP**		**Secured/Tentative?**
	TOTAL	**0**		0

Total value of project:	**Cost £22,362**
Funds requested from IWC	**£22,362**
Co-funding	**0**
TOTAL	**£22,362**

9. . DATA ARCHIVING/SHARING

The input data for the assessment (catches) are publicly available from the IWC Secretariat (Allison 2020), or available from scientific papers and SC documents (abundance estimates). The new data generated, such as historical time series of catches will be included in tables in the documents. Code for running the assessment (R/ADMB/TMB/Stan) will be deposited as supplementary materials in the final published paper and can be obtained by email request from the PI, as required.

10. . PERMITS (PLEASE TICK)

Do you have the necessary permits to carry out the field work and have animal welfare considerations been appropriately considered?	N/A
Do you have the appropriate permits (e.g. CITES) for the import/export of any samples?	N/A

If 'Yes' please provide further details and enclose copies where appropriate:

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