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PROJECT PROPOSAL REQUEST

1 . PROPOSAL TITLE

Passive acoustic monitoring of cetaceans from the former Durban whaling ground, western Indian Ocean

2 . BRIEF OVERVIEW OF THE PROPOSAL AND ITS EXPECTED OUTCOME

Seasonal occurrence of whales off the former Durban whaling ground, South Africa, are currently based on historic whale catches from over 6 decades ago. An acoustic recorder was deployed earlier this year with the goal of using acoustic signatures to separate historic catches of Antarctic and pygmy blue whales (*Balaenoptera musculus spp*) from that region and update our knowledge of species occurrence. Now, more acoustic research is planned to determine long-term seasonal acoustic occurrence and behaviour of other whales such as sperm and killer whales that are thought to occur in that region. Effects of noise and environmental conditions on whales will be evaluated. Results of this project will be important for updating management strategies of different whale species and in informing the current use of this ecoregion by different whale species.

3 . RELEVANT IWC SCIENTIFIC COMMITTEE GROUPS OR SUB-GROUPS

Outcomes of this work will be relevant to the following IWC Scientific Committee groups or sub-groups:

1. Sub-committee on other Southern Hemisphere Whale Stocks
2. Standing Working Group on Environmental Concerns
3. Working Group on Ecosystem Modelling Approaches
4. Sub-committee on Small Cetaceans
5. Sub-committee on Conservations Management Plans
6. IWC-SORP Acoustic Trend Working Group
7. IWC-SORP Southern Ocean Hydrophone Network

Information produced here on separating historic catches of Antarctic and pygmy blue whales, species occurrence in relation to environmental conditions will assist with designing and implementing strategies to manage, conserve, and reduce the impacts of noise and other factors on whales.

4 . TYPE OF PROJECT (PLEASE TICK)

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

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:

Through partial funding from the IWC, an acoustic recorder was deployed off Durban in early February 2022 to record whale sounds for a year with the main focus being on blue whales. However, more research is required to establish multi-year trends of whale acoustic occurrence in this poorly sampled region. To enhance passive acoustic monitoring (PAM) research of marine mammals in southern African region, it is important to conduct research over long temporal scales in addition to broad spatial scales. To date, only one long-term PAM research has been conducted off the former whaling ground in Durban; thus, there is a need to expand the data collection and knowledge generated. PAM can be successfully used to study the seasonal occurrence, and intra/interspecific behaviour in relation to environmental conditions. Furthermore, such scientific information established via PAM improves and updates our species knowledge established from whaling data.

We will use the distinct calls produced by different whale species to determine their occurrences over time and apportion the species composition of whale catches by applying appropriate methods (Leroy et al. 2021; Shabangu et al. 2017, 2019, 2020, 2021; Shabangu and Kowarski 2022). Species such as blue whales are rarely sighted in South African waters, and PAM has proved a useful method at detecting their acoustic presence (Shabangu et al. 2019; Letsheleha et al. 2022). The rationale for this project is to establish the proportion of seasonal occurrence of whales off Durban, South Africa. Establishing the ecological use of Durban will provide essential information about the migration and establish a link between the Southern Ocean and this low latitude region. Linkages of noise and environmental conditions to whale occurrence will be examined in the context of monitoring efforts to improve the recovery of whales. Of particular concern are recent plans for extensive seismic surveying in this region. Understanding a baseline of whale occurrence will be critical for future management and permitting.

This proposal is relevant to the needs of the IWC, IWC SORP and other committees listed above in item 3 as it uses a non-lethal method to study a poorly researched area to determine the presence and species composition of large whales. Study results will have a substantial impact on stock assessments for some populations, which are a high priority for current and planned in-depth assessments by the IWC. Relevant and specific to priorities of the IWC SC on other Southern Hemisphere Whale Stocks and other SC are the planned investigations of possible population structure of large whales (including blue whales), that will inform whether multiple or single stock assessments should be used. Links between the southern regions in Antarctica and northern regions (north of 55°S) in the mid- and low latitudes of the Southern Hemisphere through the use of PAM is essential in understanding the migratory patterns, and regional uses of habitats by different species. This study might possibly identify the location and time of the year when whale calls are most abundant off Durban, which could inform and direct photo-identification and satellite tagging studies to this location at a particular time of the year when whales can be easily accessible.

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

Detailed specific objectives of this project are:

1. Establish the occurrence and proportion of large whale species over different seasons of the year. Seasonal occurrence of baleen and large toothed whales will be determined using the presence of whale calls. Proportion of species occurrence will be determined based on the acoustic presence and absence of whale calls from the collected acoustic data. The above information will be used to determine if whales use this region year-round or seasonally for breeding, feeding, migration and/or overwintering.
2. Determine whether the behaviour of whales vary between different seasons and time of day. Call rates (i.e. number of calls per hour) will be used to determine the seasonal and diel-calling behaviour of whales, which might also give an indication of the number of whales in the region.
3. Determine which environmental variables influence the seasonal occurrence and behaviour of whales off Durban, South Africa. A suite of environmental variables (e.g. satellite-derived sea surface temperature, sea surface height, upwelling indices) will be considered to determine which variables predict the seasonal occurrence and behaviour of whales. Such information will be pivotal for the management and protection of the species, as it will highlight variables that are important for the occurrence of whale species and how whales respond to those environmental changes.
4. Determine the effects of noise on the occurrence and behaviour of blue whales and other whales. Daily, monthly and seasonal noise levels will be evaluated in relation to whale occurrence and behaviour, and

ocean sound spectra plots will be produced. This information will be specifically important for more coastal species such as southern right whales and inshore Bryde's whales (*B. edeni brydei*).

5. Describe the acoustic repertoire of marine mammals that occur in Durban, South Africa. This is very useful for this area given that there is limited acoustic research currently taking place.
6. Determine if the occurrence of whales have changed over time. The proportions of each species call type will be assumed to apply to historical catches, with adjustments for relative detectability and historical trends in abundance of each whale population, we will determine if seasonal occurrence has changed or not. The outcome will be to establish whale population structures off Durban, South Africa.
7. Comparison of seasonal acoustic occurrence and behaviour of whales off Durban to other regions such as the west coast of South Africa, Atlantic Ocean and Antarctica, Southern Ocean.

(C) METHODOLOGICAL APPROACH/WORK PLAN/ADMINISTRATIVE DETAILS

PAM data will be collected in Aliwal Shoal Marine Protected Area (30° 09' 50" S, 31° 0' 25" E), Durban, South Africa (Figure 1), on the shelf at a water depth of 300 m over the next two years (2023 and 2024). Acoustic data will be collected using autonomous acoustic recorder (Figure 2) of Autonomous Underwater Recorder for Acoustic Listening-Model 2 version 04.1.3 (Multi-Electronique Inc., Canada) that will sample at 18.5 minutes of every hour of the day for 365 days at a working bandwidth of 20 Hz to 16 kHz. The above sampling protocol (i.e. 18.5 min/hour) and sampling rate will be implemented to preserve the battery life of the acoustic system over the duration of the deployment. The hydrophone deployment will cover all seasons of the year and times of the day. The recorded data will be archived on board the acoustic recorder and will be retrieved once the recorder is recovered. Batteries and hard drive of the hydrophone will be replaced every 12 months, and the mooring will be redeployed for the next two years. Similarly, batteries of the acoustic releases will be replaced during the mooring haul out. Additionally, a Vemco VR2W acoustic receiver (Figure 2) will be deployed on the mooring to maintain a national registry of acoustic fish transmitter codes transmitted at 69 kHz which fosters greater collaboration and data sharing among local researchers and diversify the use of the mooring. There will be no habitat destruction by the mooring since its anchor will cover an area of 1 m² on the seafloor; however, this is the component of the mooring that will remain on the seafloor and will eventually corrode away over time. The above suggested method conforms to acceptable scientific standards that are currently used on the west coast of South Africa, Antarctica and elsewhere in the world to collect acoustic data in a non-invasive manner. RV Phakisa (from The South African Institute for Aquatic Biodiversity, and based in Durban), will be used for deploying and recovering the acoustic mooring, as the ship's crew is familiar with the area around the MPA, and the ship will not cause any habitat destruction during the mooring deployment.



Figure 1. Map showing the location of the mooring within the Aliwal Shoal MPA.

Retrieved acoustic data will be analysed using appropriate software such as Raven Pro (K. Lisa Yang Center for Conservation Bioacoustics, 2022) and XBAT in MATLAB; either manual or automated data analyses procedures will be implemented. We will use Antarctic blue whale Z-calls and pygmy blue whale calls to describe their occurrence, and D-calls will be used a proxy of foraging/mating for both blue whale subspecies. Furthermore, we will review the data for recorded calls of other whale species. Seasonal acoustic occurrence and behaviour from this site will be compared to data recorded simultaneously in other areas such as west coast of South

Africa, Bazaruto Archipelago, Mozambique, and Maud Rise, Antarctica, to establish trends of temporal presence and movement of whales. Statistical data analyses will be performed in R (R Core Team 2021) using relevant packages to fit ensemble models and machine learning techniques. Proportions of each whale species will be calculated. Sound propagation will be modelled for calls of each species to determine the detection range to estimate the approximate location of vocalizing whales and extract environmental conditions around the recorder mooring. Data on satellite-derived environmental conditions will be downloaded from open access online data depositories and processed in R using custom commands and available packages.

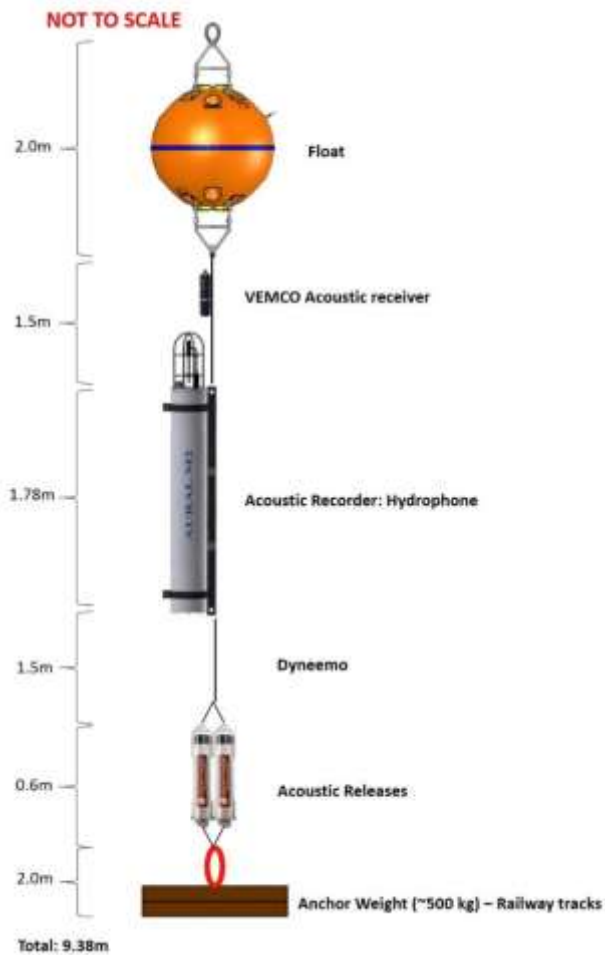


Figure 2. Schematic of the acoustic mooring.

(D) SUGGESTIONS FOR OUTREACH

- Research results will be published in peer-reviewed scientific journals
- Research results will be presented and reported to the IWC-SORP Acoustic Trends Working Group, IWC-SORP Southern Ocean Hydrophone Network, and Scientific Committee(s) of the IWC for dissemination and outreach
- A subsample of the acoustic data will be deposited to online open access data repositories
- Acoustic data will be shared with interested scientists and/or organisations upon request
- Results will be presented in local and international marine mammal conferences
- Social media platforms (such as Twitter) and magazines will be used to disseminate results to most of the marine mammal community and citizen scientists

Components of the project's results will be incorporated into graduate short courses and school visits.

6 . TIMETABLE FOR ACTIVITIES AND OUTPUTS

Activity to be undertaken	Key person(s)	Start(mm/yy)	Finish (mm/yy)
Ordering battery packs and hard drives	Fannie Shabangu and Els Vermeulen	09/22	10/22
Purchase mooring spare parts	Fannie Shabangu	01/23	02/23
Deploy acoustic recorder	Fannie Shabangu and colleagues	02/23	03/23
Retrieve and redeploy acoustic recorder	Fannie Shabangu and colleagues	02/24	03/24
Final retrieval, archival and analyses of collected acoustic data	Fannie Shabangu, Kate Stafford and Flore Samaran	02/25	12/25
Submit reports and present research results to relevant IWC SC Working Group(s)	Fannie Shabangu, Kate Stafford, Flore Samaran and Els Vermeulen	04/26	06/26
Writing and submission of research papers to journals	Fannie Shabangu, Kate Stafford, Flore Samaran and Els Vermeulen	07/26	01/27

Expected outputs	Completion date (mm/yy)
Acoustic data collection	02/25
Determination of proportion of seasonal acoustic occurrence of whales	12/25
Report back to the IWC SC Working Group(s)	05/26
Linking environmental conditions and noise levels to occurrence of whales, description of the acoustic repertoire of whales for population structure determination, and compare whale occurrence to other locations, historic whale catches, and sighting results	07/26
Submission of manuscripts to journals	07/27

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

Name	Affiliation	Connection with decision
Brian Miller	Australian Antarctic Division	Brian is a principal investigator on the IWC Antarctic Blue Whale Project and the long-term research project on IWC SORP Acoustic Trends in the Southern Ocean.
Ken Findlay	Cape Peninsula University of Technology	Ken is a member of various IWC Scientific Committees and has experience with whale species studied in this region.

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	2023 £GBP	2024 £GBP	Co-funding £GBP
(1) Salaries (by person)	None	None	None	0	0	0	12,000
(2) Travel/subsistence (by person or est. total for IPs)	Flights to and from research location, and accommodation at the research location	400	2	800	400	400	400
(3) Services (by item)	None	None	None	0	0	0	0
(4) Reusable equipment	- Shackles and dyneema to replace corroded mooring links	150	2	300	150	150	12000 for acoustic recorder
	- Hard drives for acoustic data back up and storage	120	4	480	240	240	
(5) Consumables	Battery packs to power for hydrophone and acoustic releases	800	2	1,600	800	800	0
(6) Shipping & Customs (by Item)	None	None	None	0	0	0	0
(7) Insurance (by item)	None	None	None	0	0	0	0
(8) Other	None	None	None	0	0	0	0
TOTAL				3,180	1,590	1,590	24,400

Co-funding Memo:

Source	Purpose of Funding	Cost £GBP	Secured/Tentative?
South African National Research Foundation	To cover costs for boat hire, boat fuel, skipper and skipper's crew	10,000	10,000 (secured)
TOTAL		10,000	10,000

Total value of project:	Cost £GBP
Funds requested from IWC	3,180
Co-funding	34,400
TOTAL	37,580

9 . DATA ARCHIVING/SHARING

The collected acoustic data will be partially shared (i.e. time series of automatic detections by species) in an open access data depository, and the complete dataset will be provided upon request. We will collaborate, communicate and share data together with results with researchers of the IWC-SORP Acoustic Trend Working Group, IWC-SORP Southern Ocean Hydrophone Network and any other individual or organization(s) who will be interested in the collected data. A copy of the recorded acoustic data will be archived on hard drives at the Mammal Research Institute Whale Unit, University of Pretoria, and data will be shared with interested parties upon request. Results of this work will be published in open access journals, and we are willing to abide by IWC data availability and sharing protocols.

10 . PERMITS (PLEASE TICK)

Do you have the necessary permits to carry out the field work and have animal welfare considerations been appropriately considered?	Not applicable
Do you have the appropriate permits (e.g. CITES) for the import/export of any samples?	Not applicable

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

References

- K. Lisa Yang Center for Conservation Bioacoustics (2022). Raven Pro: Interactive call analysis software (Version 1.6.3) [Computer Software]. Ithaca, NY: The Cornell Lab of Ornithology. Available from <http://www.birds.cornell.edu/raven>.
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- Letshelaha, I.S., Shabangu, F.W., Farrell, D., Andrew, R.K., la Grange, P.L., Findlay, K.P. (2022). Year-round acoustic monitoring of Antarctic blue and in whales in relation to environmental conditions off the west coast of South Africa. *Marine Biology*, 169, 41. <https://doi.org/10.1007/s00227-022-04026-x>.
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- Shabangu, F.W., Kowarski, K.A., 2022. The beat goes on: Humpback whale song seasonality in Antarctic and South African waters. *Frontiers in Marine Science*, 9, 827324. <https://doi.org/10.3389/fmars.2022.827324>
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- Shabangu, F.W., Yemane, D., Stafford, K.M., Ensor, P., Findlay, K.P., 2017. Modelling the effects of environmental conditions on the acoustic occurrence and behaviour of Antarctic blue whales. *PLoS One*, 12(2), e0172705. <https://doi.org/10.1371/journal.pone.0172705>.