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PROJECT PROPOSAL REQUEST

1 . PROPOSAL TITLE

Please provide the title of the project or the name of the workshop/meeting.

Assessment of spatiotemporal distribution of humpback whale and blue whale song along the Arabian Sea coast of Oman.

2 . BRIEF OVERVIEW OF THE PROPOSAL AND ITS EXPECTED OUTCOME

Give a very brief overview (max 150 words) on your proposal and its expected outcomes. Use bullet point to list outcomes. Be succinct and clear as this may be used to summarise your project for the report.

Use of passive acoustic monitoring techniques are considered essential for resolving population identity, connectivity and seasonal presence for blue whales and humpback whales in the Northern Indian Ocean (NIO). Illegal Soviet whaling in the 1960's depleted both stocks, potentially severely. Passive acoustic data collection along the Arabian Sea coast of Oman from May 2022 to April 2023 was previously funded by the IWC; this project focuses on analyses of those new datasets, with the following objectives:

- Continue a dedicated research program for Arabian Sea Humpback Whales (ASHWs) and NIO blue whales in the waters of Oman, in accordance with previous IWC recommendations
- Describe spatiotemporal distribution of ASHW and blue whale acoustic occurrence along the Arabian Sea coast of Oman, through an assessment of singing activity
- Develop an archive of acoustic data to assess occurrence of other cetaceans (including Bryde's and Sperm whales) in the study area

3 . RELEVANT IWC SCIENTIFIC COMMITTEE GROUPS OR SUB-GROUPS

List all the IWC Scientific Committee groups or sub-groups that the outcomes of this work would be relevant to and provide a brief (1-2 lines) explanation of how it would contribute more widely to their ongoing programmes of work. Where possible, do not simply list only the sub-committee within which or for which the project proposal was generated.

CMP – This work will provide data for the status assessment of: Arabian Sea Humpback whales, ASHW, currently the subject of a CMP initiative, specifically to provide data on the spatiotemporal distribution off the coast of Oman; and NIO blue whales, as a stock that can be considered for a CMP, and specifically address the question of which stock(s) were reduced by illegal Soviet whaling and may be threatened and in need of conservation action. .

SH –This work will fill data gaps identified in the context of the population assessments of non-Antarctic blue whales, and thereby inform catch allocations for the North Indian Ocean Populations, describing occurrence of an Oman acoustic population and assessing whether other acoustic populations may be present in the western Arabian Sea.

4 . TYPE OF PROJECT (PLEASE TICK)

Research project	X
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:

Provide a clear explanation of the background and rationale for the proposal and its relevance to Scientific Committee identified priorities. Clearly identify the most relevant and recent Scientific Committee recommendations.

Humpback whales

Existing genetic, demographic and behavioural evidence indicates that Arabian Sea humpback whales (ASHW) represent an isolated and unique population (Minton et al 2011, Pomilla, Amaral et al. 2014). The population exhibits a Northern Hemisphere breeding cycle, is believed to feed year-round, and lacks the typical latitudinal migrations and seasonal separation of breeding and feeding ecology exhibited by other populations of humpback whales globally. The population has been the subject of a standing agenda item and numerous recommendations for research and conservation actions in the IWC's Scientific Committee since 2010. These recommendations include the formation of a Conservation Management Plan for the population (e.g. IWC, 2016).

Previous acoustic monitoring of ASHW off Oman (SC/66b/SH32) in Hallaniyats Bay during 2011/2012, and the Gulf of Masirah during 2012/2013, indicated detection of song primarily from November through May, congruent with the Northern Hemisphere breeding cycle. Singing was heard in both sites, separated by approximately 400km, indicating that the population utilizes both of these regions; however, there was a stronger presence in Hallaniyats Bay, suggesting that the Hallaniyats Bay might serve as a more important habitat for breeding activity than the monitored region of the Gulf of Masirah. There also appeared to be a subtle northward shift in distribution of detections as the singing season progressed, both within Hallaniyats Bay, and from Hallaniyats Bay to the Gulf of Masirah, suggesting a seasonal shift in distribution for at least singing males and likely for the population as a whole.

Vessel based studies in March 2021 failed to encounter ASHW in the Hallaniyats Bay area, a finding anomalous to previous survey work (SC/68C/CMP/04). Elevated sea surface temperatures were considered related to this observation. In addition, preliminary assessment of acoustic data from Dhofar, Hallaniyats Bay, collected between 6th March to 1st October 2020 also revealed very few detections of ASHWs, with song found on only three days in March, none in April, and one day in May; this is highly incongruent with the findings from 2012, in which song was detected nearly daily during March (on 22 of 25 recording days), and intermittently in April (on 10 days) until early May (on 5 days) (SC/66b/SH32). These recent observations emphasise the importance of continued deployment of PAM instrumentation in the area to detect changes in habitat utilisation that could be linked to oceanographic processes affected by climate change.

Blue whales

Blue whales in the Indian Ocean (IO) comprise two or three subspecies (Antarctic, *Balaenoptera musculus intermedia*; pygmy, *B. m. brevicauda*; and North Indian Ocean, NIO, *B. m. indica*) (Rice 1998). The classification of a NIO population as a separate subspecies, *B. m. indica*, as opposed to a population of pygmy blue

whale, is debated and without scientific consensus (Rice 1998, Branch and Mikhalev 2008). Irrespective of taxonomic classification, a population reportedly resides year round in the northern Indian Ocean (Baldwin 2003, Branch et al. 2007b, Branch and Mikhalev 2008, Anderson et al. 2012, Ilangakoon and Sathasivam 2012, de Vos et al. 2014, Willson et al. 2019).

Populations of IO blue whales are thought to be defined by diagnostic song-types (McDonald et al. 2006). Pygmy blue whales are thought to be structured into at least 4 populations each with a diagnostic and spatially overlapping song-type, including a Northwest IO ("Oman" song), and Central IO ("Sri Lanka" song). The Sri Lanka acoustic population had been assumed to be synonymous with the northern Indian Ocean population, or subspecies (Branch et al. 2017b, Anderson et al. 2012). However, recent long-term PAM studies indicated a new putative blue whale song-type in the western Indian Ocean (NWIO song) predominately detected off Oman (Cerchio et al. 2020). The discovery of the NWIO song-type has particular relevance to the history of exploitation and conservation of NIO blue whales. A period of illegal whaling by the Soviet Union during 1963-1967 captured 1,294 blue whales in the northwest IO (Mikhalev 1996, 2000). The largest numbers of catches in the Arabian Sea was in the Gulf of Aden and the Arabian Peninsula, with additional smaller clusters in the central-eastern Arabian Sea off Lakshadweep/Maldives/western Sri Lanka and the Indus Canyon. These catches are generally allocated to the Sri Lanka acoustic population (Branch et al. 2007a, 2019, Anderson et al. 2012). However, timing of presence of the NWIO song-type off Oman suggests that the Soviet whaling targeted this population as well, and not only the more widely spread Sri Lanka acoustic population.

Furthermore, the potentially restricted range, intensive historic whaling, and the fact that the song-type has been previously undetected, suggests a small population that is in critical need of status assessment and conservation action.

The recordings from Oman that contributed to the identification of the new song type (Cerchio et al. 2020) were made from a shallow water recorder, and consequently were limited in detection range and provided song occurrences that were degraded due to propagation loss associated with the shelf. Through partial funding from IWC SC in 2020, and a loan of equipment, additional PAM effort was conducted in the deep water (~300m) on the shelf slope off Dhofar, Oman in 2020 and 2021. Recovered data yielded recordings from March to October 2020, and May to October 2021. Preliminary analysis of these recordings has revealed the detection and extensive presence of NWIO blue whale song, as well as intermittent periods of CIO (Sri Lanka) blue whale song, and at least one baleen whale stereotyped vocalization of unknown species attribution.

Current PAM Effort and Relevance to SC

The recent findings on ASHWs and NIO blue whales supported rationale for extended acoustic monitoring to better understand intra and inter annual presence of these populations across the Arabian Sea coast of Oman. In SC/68C, a year of PAM was funded through CMP and SH for three sites spread along an approximately 800 km stretch of coastline. The recorders will be deployed in May 2022, with a recovery/redeployment in October 2022, and final recovery in April 2023.

The current proposal is requesting funds to support analyses of these PAM data that are being collected.

The proposed work has particular relevance to the priorities of the CMP and SH subcommittees. In context of ASHW, the project directly addresses the draft recommendation made by the CMP subcommittee during SC68C to ensure that research includes:

continuous and simultaneous passive acoustic monitoring in identified ASHW habitat in both the western Arabian Sea (different parts of Oman's waters) and eastern Arabian Sea (Pakistan, India and Sri Lanka) to better understand the population's spatiotemporal distribution and potential connectivity across a larger area of suspected range, as well as to understand if range or distribution shifts begin to emerge as a result of climate change and other threats.

In the context of the ongoing population assessments of non-Antarctic blue whales in the SH subcommittee, the identification of a new population, and definition of a new IO song-type, the results of this study will provide critical new information for current efforts to assign catch allocations to IO populations (SC/68C/SH/17). The new data from the NIO has a profound effect on these allocation models and the resultant conclusions regarding status of IO populations. In addition, the work is of relevance to the CMP subcommittee, specifically addressing the question of which stock(s) were reduced by illegal Soviet whaling and may be threatened and in need of conservation action. Given the large number of blue whales taken in the Arabian Sea, it is likely that this NWIO blue whale population may be as threatened as the Arabian Sea humpback whale (which was taken by the Soviet whalers in far fewer numbers; Mikhalev 1997; Mikhalev 2000), and thus should also be considered for a CMP.

Specifically, this project addresses component (2) of recommendation SC2063, made by the SH subcommittee for northern and western Indian Ocean blue whales during IWC SC 68B:

Reiterating its advice that the distribution and population isolation of blue whales is poorly understood in the northern and western Indian Ocean (IWC 2019b:21), the sub-committee encourages researchers and range states to address the following research priorities:

- (1) continued photo-identification and genetic sampling of blue whales off Oman,*
- (2) passive acoustic monitoring to determine seasonal presence, population abundance and trends;***
- (3) comparison of blue whale photographic catalogues with other blue whale catalogues in Oman, India, Sri Lanka and any others available in the Indian Ocean (and possibly the Antarctic);*
- (4) collection and analysis of tissue samples, to better understand the taxonomy and stock structure of Arabian Sea blue whales.*

It is the intention of the research team that this acoustic work will be embedded in concerted efforts to ensure that research in Oman addresses humpback whale and blue whale conservation management needs, addressing all of the recommendations above.

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

Provide the specific objectives and the expected deliverables. In the case of workshops and meetings, include the Terms of Reference (ToR) and expected outcomes.

Objectives:

1. Validate data currently being collected from May 2022 to April 2023 at three sites off the Arabian Sea coast of Oman (Hallaniyats Bay, Masirah Island, Ras al Hadd) in preparation for assessment of blue whale and humpback whale presence.
2. Describe spatiotemporal distribution of ASHW song on multiple temporal scales (monthly, daily, hourly), at three sites spread across 750km on the Arabian Sea coast of Oman.
3. Describe spatiotemporal distribution of blue whale song on multiple temporal scales (monthly, daily, hourly), at three sites spread across 750km on the Arabian Sea coast of Oman, distinguishing between the newly described NWIO song, and CIO (Sri Lanka) song.
4. Assess acoustic data for vocalizations that may be attributed to Arabian Sea Bryde's whale or other cetaceans, if time covered by funding allows.

Deliverables

1. Progress Report to the IWC Scientific Committee in May 2023 (SC/69A) on preliminary results of May 2022 to October 2022 deployment.
2. Final Report to the IWC Scientific Committee in May 2024 (SC/69B) on complete results of May 2022 to October 2022, and October 2022 to May 2023 deployments.

(C) METHODOLOGICAL APPROACH/WORK PLAN/ADMINISTRATIVE DETAILS

Data Collection:

Acoustic recorders being used are Ocean Instruments SoundTraps (ST500-STD & ST600-STD), with a flat response from 20Hz-60kHz (+/- 3dB), a 34dB re 1V μ Pa-1 noise floor and a full scale response of 174.1 dB re 1V μ Pa-1 including system gain. The underwater mooring is comprised of a SoundTrap recorder tethered above an INNOVASEA/Vemco Ascent acoustic release unit, and suspended using an 11" deep water trawl float. Recording parameters will be set for 50% duty cycle (30min every 60min) and 24kHz sample rate; at this parameter setting the expected recording endurance is approximately 270 days. This provides some precaution with the target deployment duration scheduled for 180 days.

PAM data collection has been previously funded and is currently underway in May 2022. The three target sites include: 1) Dhofar, Hallaniyats Bay (17.38°N, 55.31°E); 2) Gulf of Masirah (~20.00°N, 58.60°E); 3) Ras Al Hadd (22.54 °N, 59.83°E). See Figure 1. The last site provides a crucial monitoring point between the Arabian Sea and Gulf of Oman. The units will be recovered in October 2022, redeployed for a second 6-month deployment, and recovered again in April 2023.



Figure 1. Passive acoustic monitoring sites in the Arabian Sea

Data Analysis:

This project is requesting funds to support analyses of the acoustic datasets from the three sites described above.

Upon recovery of each recording unit, acoustic data will be downloaded and verified. Long-term spectral averages will be generated using software packages such as Raven Pro or Triton (executed within Matlab) and will be reviewed by project PIs to verify consistency of recordings. The resulting 24kHz 16bit sound files will be down-sampled to 2kHz to increase manageability of the data set and resolution for low-frequency analysis.

Data analyses will consist of review of long-term spectral averages (LTSAs), spectrograms, and automated computer detected algorithms if possible. The frequency band between 0-1000Hz will be analyzed for baleen whale signals and other low-frequency signals. All datasets will be visually and aurally reviewed via long-term spectrograms using software packages such as Raven Pro or Triton. Daily occurrence will be logged for target baleen whale vocalizations (humpback song, NWIO and CIO blue whale song), as conducted for Cerchio et al. (2020). Where feasible, hourly presence will be quantified and the number of singing individuals will also be estimated based on overlapping sequences of song units. Other low frequency (in the 10-100Hz frequency range) baleen whale vocalizations, including any other blue whale song-types, potential Bryde's whale vocalizations, and LF downsweeps (potentially attributed to blue whales) will also be logged. Automated signal detectors, such as LFDCS (Baumgartner & Mussoline 2012) or Triton may also be explored to assess their utility in low-frequency signal detection as compared to manual analyses.

Results will be collated and reported as daily and hourly (where possible) occurrence for each species' song presence, and coded for estimated number of singers (as in Cerchio et al. 2020). Resultant temporal distributions of occurrence for the three sites will provide insights on the seasonality and movements of these

populations across the approximately 800km length of the Oman Arabian Sea coast.

(D) SUGGESTIONS FOR OUTREACH

Please, note that successful proponents will be requested to produce ad hoc material that will be used by the IWC Secretariat for dissemination and outreach.

Results of the proposed work will be highlighted and publicised by the Environment Society of Oman, Five Oceans Environmental Services, Future Seas and the African Aquatic Conservation Fund, each having outreach capacity that ranges from their local region to global in scope. Materials will be made available for to the IWC Secretariat to disseminate and use for outreach.

6 . TIMETABLE FOR ACTIVITIES AND OUTPUTS

Specify the timetable for project activities and expected outputs separately. For projects with multiple distinct elements please indicate interim goals and timeframes. Add as many rows as you need to the tables below. If publications are an expected output please note whether you will submit the manuscript to the IWC's Journal of Cetacean Research and Management.

Activity to be undertaken	Key person(s)	Start(mm/yy)	Finish (mm/yy)
Deploy and retrieve first 6-month deployment (under SC 2021 funding)	Willson	05/22	11/22
Analysis of first deployment data covering May to November 2022	Cerchio, Cholewiak and Analyst	1/23	07/23
Deploy and retrieve second 6-month deployment (under SC 2021 funding)	Willson	11/22	04/23
Analysis of second deployment data (November 2022 to May 2023)	Cerchio, Cholewiak and Analyst	01/24	7/24
Final analysis, report and manuscript preparation	Cerchio, Cholewiak and Willson	04/24	12/24

Expected outputs	Completion date (mm/yy)
Progress report to IWC Scientific Committee, SC 69A	05/23
Final report to IWC Scientific Committee, SC 69B	05/24
Submission to peer review journal	01/25

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
Salvatore Cerchio, P.I.	African Aquatic Conservation Fund	none
Andrew Willson, P.I.	Future Seas Global SPC (FSG)	none
Danielle Cholewiak	NOAA Northeast Fisheries Science Center (NEFSC)	Convenor of E

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)	S. Cerchio – PI, project supervision, final data analysis and report prep	44	350	15,400	3850	3850	7700
	Data analyst	20	540	10,800	5400	5400	
(2) Travel/subsistence (by person or est. total for IPs)							
(3) Services (by item)							
(4) Reusable equipment							
(5) Consumables	WD 5TB external hard drive for field archiving of data	80	4	320	160		160
	Seagate 10TB SATA hard drive for work station	240	2	480	240		240
(6) Shipping & Customs (by Item)							
(7) Insurance (by item)							
(8) Other							
TOTAL				27,000	9650	9650	8100

Co-funding Memo:

Source	Purpose of Funding	Cost £GBP	Secured/Tentative?
AACF	In kind support for PI's salary, existing hard drives	8100	Secured
TOTAL			

Total value of project:	Cost £GBP
Funds requested from IWC	18,900
Co-funding	8100
TOTAL	27,000

9 . DATA ARCHIVING/SHARING

Please state your plans for data archiving and sharing. Note that data collected primarily under IWC grants are considered publicly available after an agreed period of time for publication of papers, usually about two years. The work of the IWC depends on the voluntary contribution of data to the various databases and catalogues IWC supports. Please consult the Secretariat (secretariat@iwc.int).

Data will be archived by the African Aquatic Conservation Fund and Future Seas, with a backup copy maintained by NOAA Northeast Fisheries Science Center, and requests for further sharing agreements can be made to the project PI's.

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 (for analysis)
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:

References

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