SC/68B/RP/05

SH - Using bioacoustics to separate historic catches of Antarctic and pygmy blue whales from the former Durban whaling ground, western Indian Ocean

IWC

INTERNATIONAL
WHALING COMMISSION

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PROJECT PROPOSAL REQUEST

1. PROPOSAL TITLE

Using bioacoustics to separate historic catches of Antarctic and pygmy blue whales from the former Durban whaling ground, western Indian Ocean

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.

Blue whale catches from the former Durban whaling ground, South Africa, are difficult to apportion to subspecies because pygmy blue whales were only identified as a separate subspecies late in the history of exploitation. Available biological data are also insufficient to separate Durban catches. Here we propose the first study to collect passive acoustic monitoring (PAM) data off Durban to apportion historic blue whale catches among Antarctic and pygmy (likely SW Indian Ocean population) blue whales. Seasonal occurrence and behaviour of each subspecies will be determined acoustically, and the acoustic results used to split historical Durban catches between the two subspecies. Effects of noise and environmental conditions evaluated. Results will be important in informing current use of this ecoregion by blue whales, and assessing the current status of these two blue whale populations. Furthermore, other marine mammals that occur in that region will be studied using the acoustic data collected by this project.

Expected outcomes:

- Apportioning of historical blue whale catches off the Durban whaling ground to Antarctic and pygmy blue whales. The proportions of each call type at Durban will be assumed to apply to historical catches, with adjustments for relative detectability and historical trends in abundance of each population.
- Establish trends of the seasonal acoustic occurrence and behaviour of Antarctic and pygmy blue whales off Durban in relation to environmental conditions.
- Quantification of the effects of noise (anthropogenic and natural) and environmental conditions on the acoustic occurrences and behaviour of other marine mammals.
- Provide an indication of the possible ecological habitat use (residency, overwintering, breeding and/or migration corridor) of Durban by Antarctic and pygmy blue whales, and other acoustically detected marine mammals for stock assessment models and habitat use evaluation.
- Establish linkages between acoustic presence of other marine mammals (such as sperm whales, minke whales, humpback whales, Bryde's whales, and southern right whales) and whale catch statistics and sightings.
- Establish a population structure of humpback whales and sperm whales.

- Description of the acoustic repertoire of previously undescribed sounds of other marine mammals within this region.
- Demonstrate trends of the temporal presence and movement of whales between Durban, the west coast of South Africa, and the Southern Ocean through comparison of seasonal occurrence of whale calls between those sites.

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.

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 *(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:
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.

Little PAM research has been done on most of the marine mammals in southern African region. To date, no long-term PAM research has been conducted off the former whaling ground in Durban; thus, there is a knowledge gap that needs to be filled. PAM can be successfully used to study the seasonal occurrences, 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. For example, blue whales were caught extensively off Durban, South Africa but whalers did not differentiate between Antarctic blue whales (*Balaenoptera musculus intermedia*) and the smaller pygmy whales (*B. m. brevicauda*). In part, this was because pygmy blue whales were only identified as a separate subspecies long after most of the historical catches were taken and the catches at Durban had declined to low levels, although one catch there was identified as a pygmy blue whale.

We will use the distinct calls produced by these two blue whale subspecies to determine their occurrences over time and apportion the species composition of whale catches by applying appropriate assumptions. 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). The rationale of this project is to establish the proportion of occurrence of Antarctic and pygmy blue whales off Durban, South Africa. Establishing the ecological use of Durban will assist 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 the marine mammals.

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 less researched area to determine the presence and species composition of Antarctic and pygmy blue whales. The allocation of the 3,211 blue whale catches to some combination of Antarctic blue whales or SW Indian Ocean (Madagascar) pygmy blue whales, will have a substantial impact on stock assessments for both populations, both of 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 blue whales and other whales, which 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 through whale calls is essential in understanding the migratory patterns, and regional uses of habitats. This study might possibly identify the location and time of the year when whale calls are most abundant off Durban, which might inform and direct photo-identification and satellite tagging studies to a location at a particular time of the year when Antarctic and pygmy blue whales and other whales can be easily and reliably found.

(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.

The detailed specific objectives of this project are:

1. Apportion historical blue whale catches off the Durban whaling ground to Antarctic and pygmy blue whales based on recorded proportions of each call type, with adjustments for relative detectability and historical trends in abundance of each population.

2. Establish the occurrence and proportion of species occurrence over different seasons of the year. The seasonal occurrence of Antarctic and pygmy blue whales and other 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.

3. Determine whether the behaviour of Antarctic and pygmy blue whales and other whales vary between different seasons and time of the 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.

4. Determine which environmental variables influence the seasonal occurrence and behaviour of blue 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 Antarctic and pygmy blue whales and other 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 blue whales and other whale species and how the whales respond to those environmental changes.

5. 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.

6. Describe the acoustic repertoire of other marine mammals that occur in Durban, South Africa. The acoustic data will be evaluated for sounds from other marine mammals, and detected sounds will be documented and described for each species. This is very useful for this area given that there is limited acoustic research currently taking place.

7. Determine if the occurrence of Antarctic and pygmy blue whales and other 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.

8. Comparison of seasonal occurrence and behaviour of blue whales and other 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

Specify the methods to be applied (novel methods require more explanation than standard ones) and the broad workplan – the detailed timetable appears under Item 5 below.

In the case of workshops and meetings, include the broad work plan including any pre-requisites for the workshop/meeting to take place (apart from funding, e.g. completed analyses, papers etc.) and administrative details (e.g. location, dates, number of participants).

PAM data will be collected off Durban, South Africa (31.5 °E, 30.83 °S) on the shelf edge at a water depth of 1 000 m (Figure 1) over a period of 18 months. Acoustic data will be collected using autonomous acoustic recorder (SoundTrap ST500 series manufactured by OceanInstruments, New Zealand) that will sample at 20 minutes of every hour of the day for 441 days (when assuming water temperature of 15 °C at the instrument depth) at a working

bandwidth of 20 Hz to 12 kHz. The above sampling protocol (i.e. 20 min/hour) and sampling rate will be implemented to preserve the battery life of the acoustic system over the duration of the deployment. A total of 195 gigabytes of acoustic data is anticipated to be recorded from this data collection. The hydrophone deployment will cover all seasons of the year and times of the day. The acoustic recorder will be deployed at 300 m below the sea surface on the midwater buoy of an oceanographic mooring (Figure 1) of the TURBO-CYCLOPS project as part of the OceanX and BBC project. This unique opportunity to piggyback on planned oceanographic moorings leads to a much lower project costs compared to a dedicated hydrophone mooring. The recorded data will be archived on board the acoustic recorder and will be retrieved once the recorder is recovered.

Retrieved acoustic data will be analysed in appropriate software such as Raven Pro (Bioacoustics Research Program, 2017) 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 call(s) to describe their occurrence, and D-calls will be used a proxy of foraging for both blue whale subspecies. Seasonal occurrence and behaviour from this site will be compared to data recorded simultaneously in other areas such as Durban, South Africa, and the Southern Ocean, to establish trends of temporal presence and movement of whales. Statistical data analyses will be performed in R (R Core Team 2019) using relevant packages to fit ensemble models and machine learning techniques. Proportion of each whale species will be calculated, sound propagation will be modelled for calls of each species to determine the detection range to 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.

We will assume that the proportion of each call type detected at this location, by month, reflects the relative abundance of each calling population at this location. These proportions will then be applied to the historical catches (Branch et al. 2008, 2019) under the assumption that the relative densities of each population have not changed over time. Since all catches were caught from land stations in close proximity of Durban, a single recorder will provide precise data from the centre of the whaling grounds, and there will be no need to fit spatial smoothing models. However, account needs to be taken of the possibility that relative calling rates and loudness of calls differs between each population, since Antarctic blue whales call more frequently and possibly more loudly than Madagascar-population blue whales. A second factor needing to be taken into account is that Antarctic blue whales were severely depleted by whaling to just 0.15% of pre-whaling levels (Branch et al. 2004), while Madagascar-population pygmy blue whales were only targeted by whalers starting in the 1959/60 season (Ichihara 1961), and likely were little depleted before then. Therefore, a simple two-population model will be used to determine how to separate catches by year, under the assumption that Antarctic blue whales were depleted to 0.15% as reported in Branch et al. (2004), while Madagascar-population blue whales were depleted from 1959/60 onwards to lows of 10%, 30%, and 70% of pre-whaling levels by 1973 (when Soviet whaling on them ended).

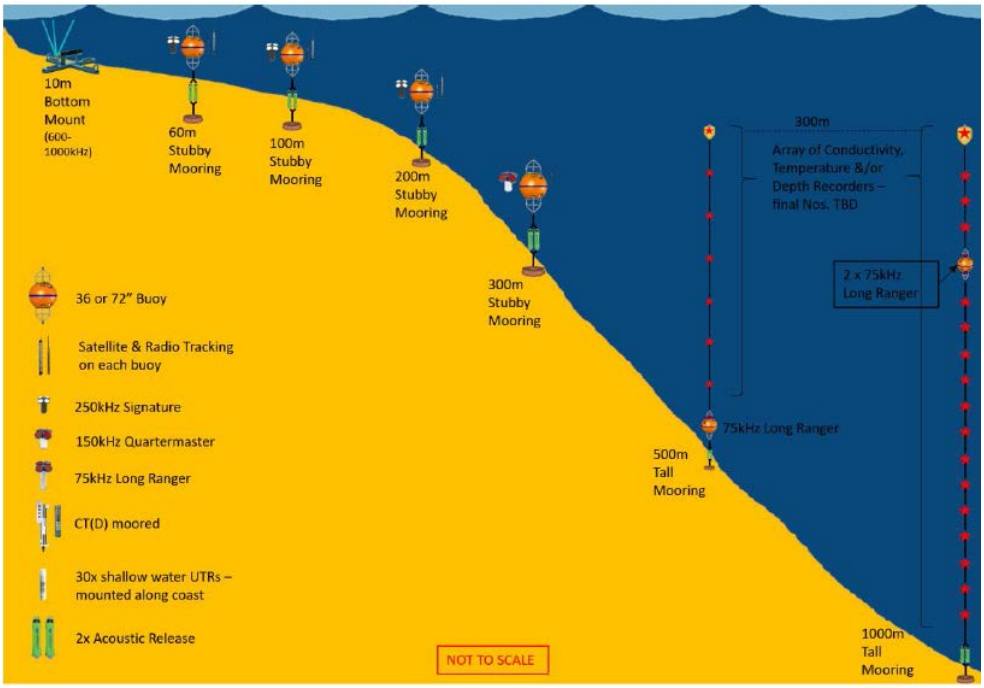

Figure 1. Schematic of an array of oceanographic moorings to be used to deploy the acoustic recorder. TURBO-CYCLOPS project oceanographers will set up the oceanographic mooring.

(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.

- 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 magazine 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

Specify the timetable for project activities and expected out puts 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)
Ordering of acoustic recorder and pressure valve	Fannie Shabangu and Els Vermeulen	09/20	10/20
Receive acoustic recorder and prepare for deployment	Fannie Shabangu	01/21	02/21

Deploy acoustic recorder	Fannie Shabangu and colleagues	07/21	07/21
Recover acoustic recorder	Fannie Shabangu and colleagues	10/22	10/22
Retrieval, archival and analyses of collected acoustic data	Fannie Shabangu and Kate Stafford	10/22	01/23
Incorporate results of acoustic occurrence trends into Antarctic blue whale population assessment models	Trevor Branch	01/23	04/23
Submit reports and present research results to relevant IWC SC Working Group(s)	Fannie Shabangu, Kate Stafford, Trevor Branch and Els Vermeulen	05/23	06/23
Writing and submission of research papers to journals	Fannie Shabangu, Kate Stafford, Trevor Branch and Els Vermeulen	07/23	01/24

Expected outputs	**Completion date (mm/yy)**
Acoustic data collection	10/22
Determination of proportion of seasonal acoustic occurrence of Antarctic and pygmy blue whales and other whales	01/23
Linking environmental conditions and noise levels to occurrence of whales, description of the acoustic repertoire of other whales for population structure determination, and compare whale occurrence to other locations, historic catches and sighting results.	04/23
Report back to the IWC SC Working Group(s)	05/23
Publication of journal articles	12/24

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**
Brian Miller	Australian Antarctic Division	Brian is principle 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 done research on most of the whale species studied here.

8. TOTAL BUDGET

Breakdown into: (1) salaries/wages (include name/position of each individual and breakdown of time and duties i; (2) travel/subsistence expenses (breakdown by person and justification) unless for IPs for workshops where a total estimate based on an average for the total number of IPs is acceptable; (3) services (e.g. aircraft/vessel time, consultancy fees, ARGOS fees, etc.; (4) reusable capital equipment (e.g. reusable equipment such as a hydrophone, cameras, etc. Note that this equipment will have to be registered at the IWC Secretariat and will remain property of the IWC at the end of the project), (5) expendable capital equipment (e.g. consumables, tags, stationery), (6) shipping costs, (7) insurance costs, (8) in kind co-funding (specify whether other funding is available for personnel/name, equipment, venues, etc.). Note that "Overheads" are not admissible. Add as many rows as you need to the table below.

Type	Detailed description	Cost in GB pounds
(1) Salaries (by person)	None	0
(2) Travel/subsistence (by person or est. total for IPs)	None	0
(3) Services (by item)	None	0
(4) Reusable equipment	SoundTrap ST500 STD – Long Term Recorder for collecting acoustic data	4 376
	6000 Meter Rated, Single Poppet, Titanium High Pressure Relief Valve, Cracking Pressure to extend the rated depth of the hydrophone from 200 m to 500 m below the sea surface in case of mooring drag	410
(5) Consumables	None	0
(6) Shipping (by Item)	Shipping of the SoundTrap from New Zealand to Cape Town, South Africa	114
	Shipping of 6000 Meter Rated, Single Poppet, Titanium High Pressure Relief Valve, Cracking Pressure 10psi from the UK to Cape Town, South Africa	110
(7) Insurance (by item)	None	0
(8) Co-funding	Value of applicants' time for project planning, running and management	6 000
	Data analyses resources	6 000
	Journal Publication fees	500
	Ship's time for the deployment and recovery of the acoustic recorder	10 000
	Equipment for setting the mooring	16 000
(9) Other	None	0
Total	**IWC funding sought**	**5 010**
	Applicant Organisation contributions	**39 500**

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).

The collected acoustic data will be partially shared in an open access data depositories, 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:

Appendix 2 – DRAFT SCORING SHEET

If a project presents multiple primary objectives which are achieved using sub-projects, a sheet should be used to evaluate each single sub-project. Note that not all criteria are equally applicable depending on the nature of the project (e.g. field work versus workshops).

IWC SCIENTIFIC COMMITTEE PROPOSALS FOR FUNDING - REVIEW CRITERIA - TEST				
TITLE OF THE PROJECT/sub-projects:		Using bioacoustics to separate historic catches of Antarctic and pygmy blue whales from the former Durban whaling ground, western Indian Ocean		
PRINCIPAL INVESTIGATOR:		Fannie W. Shabangu		
Key criteria		Explanation of scoring	Score	Supporting Remarks
Relevance to Scientific Committee priorities				
1	How well aligned are the scientific outcomes of the project/activity with the current SC priority areas?	1 - Not aligned/poorly aligned (e.g. too vague or generic reference to general SC priorities) 2 - Reasonably aligned (e.g. some aspects may be vague or links are not clear) 3 - Well aligned (e.g. outcomes clearly deliver in the most part on priority areas, may also address longer term or potential future issues). 4 – Closely aligned (e.g. of interest for multiple sub-groups or delivers on specific SC high priority topics/recommendations in the immediate or short term).		
2	To what extent will the outcomes of the project/activity contribute to improvements in the conservation and management of cetaceans?	1 - Not at all 2 - Poorly 3 - Reasonably or over the longer term 4 - Well or over the medium term 5 - Excellently or to almost immediate effect		
Note: if in each of the two above key criteria under this section the project does not score singularly at least 2 points, do not proceed in further evaluation. Of course, proposals within a sub-group would only be developed if in their estimation scores were of 4 or above.				
Approach and methodology				
3	What degree of scientific merit/value is there in carrying out the work?	1 - Not demonstrated or of low scientific value 2 - Useful/basic scientific value 3 - Very good scientific value 4 - Excellent/innovative scientific value		
4	Is the proposed methodology scientifically sound and feasible in terms of field and analytical methods?	1 - Feasibility unrealistic & poor methodology or not properly addressed 2 - Feasibility & methodology acceptable but would benefit from some substantial amendments		

		3 - Feasibility & methodology good, some small changes beneficial 4 - Feasibility & methodology excellent or a highly promising innovative approach to an important question facing the Committee		
5	What is the likelihood of success based on the proposed overall approach and methodology?	1 – No chance of success 2 - Low chance of success/better approaches available 3 - Medium chance of success/some changes to the approach necessary 4 - High chance of success/little or no changes to the approach necessary		
5a	Are objectives of the research likely to be achieved within the proposed time-frame?	1 – No or unlikely 2 – Partially or potentially ambitious 3 - Yes with some minor suggestions 4 – Yes		
5b	Are any proposed intermediary targets timely and achievable?	1 – No or unlikely 2 – Partially 3 - Probably 4 - Yes		
5c	Is the proposed time-frame/work necessary (e.g. can the project produce results in a shorter time period)?	1 – No or unlikely 2 – Partially 3 - Probably 4 - Yes		
5d	Is the sample size adequate to achieve the stated objectives?	1 – Not demonstrated/not properly addressed 2 – No or unlikely (too low/too high) 3 – Probably (additional analysis needed) 4 - Yes		
6	Is the project likely to affect adversely the population(s) involved?	1 - Not properly addressed/ unknown 2 - Yes severely 3 – Possibly at a low level 4 - No		
6a	IF YES, are analyses provided on simulations of the effects using different time-frames for the project if applicable?	1 – No 2 – Partially 3 - Yes		
Note: if in each of the above key criteria under this section the project does not score singularly at least 2 points, do not proceed in further evaluation. Of course, proposals within a sub-group would only be developed if in their estimation scores were of 3 or above.				
Project team and Project management				

7	To what extent does the team have the relevant expertise, experience, and balance?	1 – Poor or not demonstrated 2 – Sufficient 3 - Very good 4 - Excellent		
8	Contingency plan: To what extent have potential problems/risks been considered and appropriate mitigation proposed?	1 – Poor or not demonstrated 2 – Sufficient but could be improved 3 - Fully or requiring only minor suggestions or not applicable		
Value for Money				
10	Does the project represent good value for money?	1 – No or significant amendments would be needed 2 – Yes but with some minor amendments 3 – Yes		
11	Have sufficient links been made to the wider research community/other organisations/capacity building.	1 – No 2 – Some but significant amendments needed 3 – Yes but with some minor additions 4 – Yes or not applicable		