Report of the Southern Ocean Research Partnership (SORP) conference and workshops, 31 May – 2 June 2013

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ABSTRACT

A conference of the Southern Ocean Research Partnership (SORP) was held immediately preceding the annual meeting of the IWC Scientific Committee (65a), on Jeju Island, Republic of Korea, 31 May – 2 June 2013. Forty-seven delegates from 16 countries, including representatives of the IWC Secretariat, attended. The conference highlighted the progress and development of the SORP initiative to date, and the results of the five ongoing SORP research projects, including world first achievements. Workshops were convened by project Principal Investigators to update project plans for the next 3 to 12 years. These are presented in Annex 1 of this document. Given that 1) the SORP initiative has made significant contributions to cetacean research in the Southern Ocean since its inception in 2009; but 2) the voluntary contribution of the Australian Government to the IWC to initiate SORP and support its research projects is almost completely expended, the conference also made recommendations to ensure the further development of the Partnership. Meetings of the SORP Scientific Steering Committee, the Antarctic Blue Whale Project (ABWP) Scientific Steering Committee and a number of project technical committees were held throughout the conference. Full scientific progress reports for the period 2012/13 highlighting the results from each of the five SORP projects discussed during the conference can be found in the SORP annual report compiled by Bell (2013; SC/65a/O11Rev).

KEYWORDS: SOUTHERN OCEAN RESEARCH PARTNERSHIP, SORP, ANTARCTICA, ABUNDANCE ESTIMATE, ACOUSTICS, BIOPSY SAMPLING, PHOTO-ID, SATELLITE TAGGING, MOVEMENT

INTRODUCTION

A SORP conference and workshops was held immediately preceding the annual meeting of the IWC Scientific Committee (65a), on Jeju Island, Republic of Korea, 31 May – 2 June 2013. Forty-seven delegates from 16 countries, including representatives of the IWC Secretariat, attended. The conference agenda and list of participants can be found in Appendices 1 and 2, respectively.

Full scientific progress reports for the period 2012/13 detailing the results of the 5 ongoing SORP projects and key references can be found in the SORP annual report for the period 2012/13 compiled by Bell (2013; SC/65a/O11Rev). Previous project progress reports can be referred to in papers SC/63/O12 and SC/64/O13.

The annual meeting of the SORP Scientific Steering Committee, the meeting of the Antarctic Blue Whale Project (ABWP) Scientific Steering Committee and a number of project technical committees were also held throughout the conference.

OPENING COMMENTS

At the start of the proceedings, Dr. Nicholas Gales welcomed participants and invited each to introduce themselves and their affiliations.

Dr. Gales reminded participants of the history of the SORP: In 2008, Australia proposed to the International Whaling Commission (IWC) the development of regional non-lethal cetacean research partnerships. These research partnerships would use modern, non-lethal, scientific methods to provide the information necessary to best conserve and manage cetacean species. The proposal was received very positively by IWC member nations. The Australian Government is now supporting the Southern Ocean Research Partnership (SORP), established in March 2009. The aim of SORP is to develop a multi-lateral, non-lethal scientific whale research program that will improve the coordinated and cooperative delivery of science to the IWC, in line with IWC priorities. Current SORP Partners include Argentina, Australia, Brazil, Chile, France, Germany, New Zealand, Norway, South Africa and the United States of America.

The initial objectives, research plan, and procedural framework for the Partnership were developed at a workshop held in Sydney, Australia in March, 2009. Subsequently, a framework and set of objectives for SORP were endorsed by the IWC at its annual meeting in June 2009, and project plans were developed and endorsed by the Scientific Committee during meetings in June 2010, 2011 and 2012.

Dr. Gales iterated that the aims of the conference were to:

1) present the scientific results stemming from these IWC endorsed projects to date;
2) further develop and update the existing project plans during workshops convened by the Principal Investigators, for presentation to the Scientific Committee of IWC65a; and
3) formulate strategies to ensure the further development of the Partnership through collaboration, commitment and funding.

Moreover, it was announced that ideas for additional research that would demonstrably benefit from regional collaboration, and tie into IWC priorities, would be presented for possible future inclusion in existing SORP projects or development of new projects.

Dr. Gales concluded by stating that some of the broader data to be presented to the participants had come from the IDCR and SOWER surveys efforts, but now that these no longer take place, and are unlikely to be repeated in the current global financial climate, regional Partnerships such as SORP were essential for providing such data to the IWC.

Dr. Elanor Bell was conference organiser and both she and Victoria Wadley agreed to act as rapporteurs for the plenary sessions.

SORP PROJECT PRESENTATION SUMMARIES

A summary of each of the presentations delivered in plenary on Day 1 of the SORP conference is provided below. Copies of selected presentations will be made available at http://www.marinemammals.gov.au/sorp/2013-sorp-conference.

Antarctic Blue Whale Project

Presenters: Philip Hammond, University of St. Andrews, United Kingdom; Natalie Kelly, CSIRO, Australia; Victoria Wadley, Australian Antarctic Division, Australia

Intense whaling in the 20th century removed one-third of a million Antarctic blue whales from the Southern Ocean and reduced the population to a fraction of 1% of its pre-exploitation size. Analysis of data from the International Decade of Cetacean Research (IDCR) and Southern Ocean Whale and Ecosystem Research Programme (SOWER) surveys between 1978/79 and 2003/04 indicates a population of about 2,000 whales in the mid-1990s growing at around 7% per year. The inspiration for the Antarctic Blue Whale Project (ABWP) is the need for new information to assess the recovery of the Antarctic blue whale.

The Antarctic Blue Whale Project (ABWP) currently has six objectives:

1) to identify the most appropriate and efficient method to deliver a new circumpolar abundance estimate;
2) to develop and refine methods to improve survey efficiency;
3) to deliver a new circumpolar abundance estimate;
4) to improve understanding of population structure;
5) to improve understanding of linkages between breeding and feeding grounds; and
6) to characterise behaviour on the feeding grounds.

Methodology to address the first three objectives could include SOWER-like surveys but these would require very substantial resources that are unlikely to be available in the future. An alternative could be mark-recapture analyses of individual recognition data generated from identification photographs and biopsy samples. To be feasible, this would need a high encounter rate of individuals. Obtaining sufficient data from such a small population in such a large area would be challenging without a means of enhancing encounter rates; passive acoustic detection and tracking of whales could be a solution. Preliminary work in 2012 has demonstrated that the rate of encounters can be increased using passive acoustics in a study of pygmy blue whales off south eastern Australia. These results were essential input to designing a voyage to study Antarctic blue whales in 2013.

Objectives 4-6 are planned to be addressed using genetic analysis, satellite telemetry, and habitat modelling. Collaboration with tour boat operators is being developed with the aim of obtaining more information on blue whale encounters.

The Antarctic blue whale population may now number a few thousand but monitoring recovery remains expensive and logistically challenging, so identifying the most appropriate and efficient method is imperative, in line with Objective 1. In the example of Antarctic blue whales, it is not obvious which is the best approach, therefore we assessed both line transect and mark-recapture methods. We investigated several scenarios for current and future abundance. Using projected numbers of encounters (a function of abundance and survey method) we estimated expected precision for circumpolar abundance for a 6 or 12 year survey duration. The design of the line transect approach was somewhat optimised using results from previous sighting surveys.

For a mark-recapture approach, we investigated whether design could be improved using passive acoustics. Over a 6 year survey, no method returned a precise abundance estimate. However, over 12 years, both line transect and acoustic-assisted mark-recapture would have comparable precision under most scenarios; visual-only mark-recapture was still imprecise. Although acoustic-assisted mark-recapture theoretically yields more encounters, the effect of marking time (time to approach animals and collect identification data) decreases the realised number of encounters. In line transect, the numbers of encounters over an entire survey will dictate precision; for a mark-recapture, it is the number of recaptures. In order to judge performance of surveys modeled in the Antarctic blue whale survey research, over a 12 year survey, line transect approach could expect around 200 encounters; acoustic-assisted mark-recapture could expect around 20 recaptures.

Given the survey methods performed similarly in terms of predicted precision, other considerations influence the choice of method. Line transect requires dedicated vessels, set track lines, well trained observers and broad spatial coverage. Mark-recapture is relatively simple to implement, can focus on higher density regions for highly mobile species such as Antarctic blue whales, and data can be delivered by both dedicated vessels and platforms of opportunity. On balance, these factors suggest acoustic-assisted mark-recapture is more likely to deliver a precise estimate of circumpolar abundance for Antarctic blue whales.

The 2013 voyage of *Explorer* to the Ross Sea area aimed to:

1. Assess and refine passive acoustic methods for locating Antarctic blue whales
2. Collect photographic data and biopsies for individual identification of blue whales
3. Linking blue whale calls to their behaviour and environment
4. Collect distance sampling data for regional abundance estimate of cetacean species
5. Deploy satellite tags to describe the movement and behaviour of blue whales

Employing acoustic-assisted mark-recapture methodologies refined by SORP Partners, disposable directional hydrophones (DIFAR sonobuoys) were able to detect concentrated areas of blue whale abundance at distances of hundreds of kilometres. Following acoustic bearing angles, these concentrations of Antarctic blue whales were located and sampled.

To summarise the preliminary results:

- Passive acoustics was successful in guiding the research vessel toward visual encounters with individual Antarctic blue whales;
- 26,545 Antarctic blue whale calls were recorded;
- 84 Antarctic blue whales were sighted:
- 50 individual Antarctic blue whales were photographed for identification and matching;
- 23 Antarctic blue whales biopsies were collected; and
- 2 satellite tags deployed on Antarctic blue whales for the first time.

These results have been reported in seven papers to IWC SC 65a; further analyses are underway.

As a major outcome of the voyage, an integrated suite of methods is now available for future voyages in the ABWP, with the overall aim of obtaining a new circumpolar estimate of the abundance of Antarctic blue whales.

Blue and fin whale acoustic trends
Presenters: Flore Samaran, University of La Rochelle, France; Brian Miller, Australian Antarctic Division, Australia, on behalf of the SORP acoustic trends steering group.

The blue and fin whale acoustic trends project aims to implement a long term acoustic research program examining trends in Southern Ocean blue and fin whale population growth, distribution, and seasonal presence using passive acoustic monitoring techniques. Passive acoustic monitoring is a robust means of monitoring whales in remote and difficult to study areas, such as the Antarctic, over long time periods. Analysis of a wide range of available passive acoustic data has demonstrated spatial and temporal patterns in the occurrence of blue and fin whales in the Southern Ocean. However, the lack of overlap in years and locations monitored, and differences among instrumentation and analysis methods used, underlines the need for coordinated effort. To best exploit passive acoustic methods for monitoring purposes in the future, the SORP Acoustic Trends steering group proposes the placement and maintenance of a pan-Antarctic monitoring system with consistent spatial and temporal coverage in each of the six IWC management areas. Further, blueprints for instrument choice, hardware configurations and analysis methods are being prepared to suggest how data might be best collected and analyzed in a uniform manner to best address the specific research questions for each study species. Through a consistent multi-disciplinary approach with international collaborators, the *Blue and Fin Whale Acoustic Trends Project* aims to use passive acoustic recordings to measure long term distribution, seasonal occurrence, and population growth trends of fin and Antarctic blue whales in the Southern Ocean.

Distribution, abundance, migration patterns and foraging ecology of killer whales
Presenters: Robert Pitman, Southwest Fisheries Science Center, NOAA Fisheries Service, United States; Luciano Dalla Rosa, The Institute of Oceanography, Brazil; Nico de Bruyn, University of Pretoria, South Africa

The importance of studying Antarctic killer whales in an ecosystem context was stressed. The 4 different types that are currently recognized in the Antarctic were described, and the preferred prey types for each discussed. The tagging effort to date (33 tags deployed) and the tracking and dive depth data we have acquired from this effort were summarised. Currently, over 50,000 killer whale images from the Antarctic Peninsula area have been collected, enough to allow an estimate of abundance for the 3 different killer whale types that occur in the Antarctic Peninsula to be made. Tagging tracks have allowed the Principal Investigators to hypothesise what are believed to be 'physiological maintenance migrations' in killer whales to warmer waters to repair and replace their skin; and this may underlie migrations in all Antarctic whale migrations. Data from the first ever Antarctic minke whale satellite tagging (that took place during the last field season) were also summarised; tag life of up to 121 days allowed the Principal Investigators to collect extensive dive depth and movement data for 6 individuals.

A brief overview of the contribution that Dalla Rosa and his colleagues are able to provide to the SORP killer whale project through their cetacean project, under the Brazilian Antarctic Program, was also given. These cetacean surveys started back in 1997, and since then they covered about 7,000 nm of survey effort in the Antarctic Peninsula region and adjacent areas. During 14 Antarctic seasons, 93 on/off-effort killer sightings

were registered. Killer whale encounter rates have been calculated for different time periods and areas. Photo-identification was conducted whenever possible, primarily from small boats but also from the survey vessels. The efforts so far have resulted in 39 type A individuals identified, and just over 100 type Bs. The type A catalogue has already been shared with Pitman and Durban, and the type B catalogue is currently being updated. Acoustic recordings were obtained from type B killer whales and, more recently, biopsying efforts were initiated for genetic, stable isotope and contaminant analyses.

Regarding the challenges of conducting killer whale research in the Southern Ocean, it was noted that the cetacean studies conducted under the Brazilian Antarctic Program have also included other species and, particularly in recent years, have been part of multi-disciplinary research. Therefore, obtaining specific results on killer whales tends to take time, especially as the densities of animals are not very high. With regard to funding, it was noted that Dalla Rosa *et al.* have been able to get some ship time for dedicated cetacean research, but research money has been very limited, for example to purchase satellite tags that could contribute directly to the work of Pitman and Durban under the auspices of this SORP research project.

Sub-Antarctic component of project - Marion Island provides one of the few platforms for dedicated research on killer whales within the sub-Antarctic zone. Killer whales return predictably to the island during much of the year, with specific peak occurrences during September to December and April to May, associated with prey species presence. Land-based research on killer whales was consolidated within a dedicated killer whale programme in 2006. Field personnel are based permanently at the island and conduct consistent structured observations, photo-identification and photogrammetry of killer whales. These observations have delivered published insights into social structure (Tosh *et al.* 2008), abundance (Reisinger *et al.* 2011a), diet (Reisinger *et al.* 2011b) and preliminary assessments of ecological role (Reisinger *et al.* 2011c). An individual identification catalogue exists for comparison of individuals within and external to this population (Reisinger & de Bruyn 2012). In addition this work provided augmenting data that initiated a global review of killer whale ecology (de Bruyn *et al.* 2013). Since 2011, satellite device deployments have met with varied success. Initial attempts (12 devices) were marginally successful and only elucidated short term (< 3 day tracks) movements, primarily due to attachment issues. Subsequent deployments (12 devices), including those supported by SORP seed-funding, have enjoyed greater attachment success, with transmission durations of up to 58 days. Killer whale movements are localised during spring and autumn, but more wide ranging during late winter and summer, with some individuals heading >1300km north of the island towards the South African south-east coast. A total of 33 biopsy samples from 27 individuals have been collected for genetic, isotope and fatty acid analysis. Observational, movement and biopsy data collection are continuing. Marion Island provides a template for sub-Antarctic killer whale research and it is hoped that within the SORP umbrella, this research can be expanded to other locations within the sub-Antarctic region and linked to the Antarctic studies presented above.

Foraging ecology and predator-prey interactions between baleen whales (minke and humpback) and krill
Presenter: Ari Friedlaender, Duke University, United States

Quantifying the linkages between predators and their prey are fundamental to understanding ecosystem function. The goals of this research program are to use tag technology and concurrent oceanographic and prey mapping methods to study the relationships between humpback and minke whales and their prey around the Antarctic Peninsula. Short-term multi-sensor suction cup tags and long-term satellite-linked tags were used to study the foraging behaviours and movement patterns of baleen whales in relation to the distribution and abundance of krill and oceanographic variables. To date each type of tag has been deployed on both humpback and minke whales and comprehensive ecological analyses are being completed. From fine-scale tag and prey data, it has been shown that humpback whales feed in a manner consistent with optimal foraging theory: humpback whales feed when krill become available in the upper reaches of the water column in larger but less dense patches. However, within these patches, the deeper the whales feed the denser the krill density that they target. In addition, the feeding rates of minke whales are greater than those of any other baleen whale and that their foraging strategies, while similar to humpback whales in some respect, also include species-specific behaviours that indicate under sea-ice feeding. This information on the underwater behaviour of minke whales is the first of its kind for the species. Data from long-term satellite-linked tags, reveal that humpback whales range over broad spatial regions in the continental shelf waters of the Western Antarctic Peninsula. There is evidence that the size of their home ranges decreases throughout the feeding season in relation to the spatial distribution of krill. All of the humpback whales that have migrated while still carrying active tags, have travelled up the western side of South America. Antarctic minke whales were tagged for the first time in 2013. Their movement patterns are in the process of being analysed but include a variety of movement patterns. While some animals

remained in close proximity to near-shore bays for over 120 days, other whales moved from the Antarctic Peninsula into both the Weddell Sea to the north and east and the Bellingshausen Sea to the south and west. There is also evidence to support migration of some whales to tropical areas. While the main analytical focus of this work is to understand ecological linkages, the practical focus has been to develop methodologies that can be transported in a manner so as to replicate this research with international collaborators in a variety of regions around Antarctica. International collaboration and regional research studies are at the core of the Southern Ocean Research Partnership and efforts continue to develop both our research methods and collaborative relationships towards this goal.

Distribution and extent of mixing of humpback whale populations around Antarctica (Rochelle Constantine)
Presenter: Rochelle Constantine, University of Auckland, New Zealand, on behalf of the Committee: Rochelle Constantine, Mike Double, Phil Clapham, Alex Zerbini, C. Scott Baker, Claire Garrigue, Jooke Robbins

The 2010 Antarctic Whale Expedition, the first dedicated whale research voyage in the Antarctic waters south of New Zealand and east Australia, provided some very interesting results about the feeding grounds of Antarctic whales. Along with data from the French CETA voyage, it was determined that Area V, in particular around the Balleny Islands was an important feeding ground for east Australian humpback whales. What was surprising was that only one whale matched to New Caledonia, part of the endangered Oceania humpback whale population. 212 tissue samples from New Zealand humpback whales have recently been analysed, primarily on their northern migration. Matches were found to east Australia and New Caledonia. Analyses to determine whether we can assign these whales to a breeding ground has yet to be completed but to date it seems that they are travelling to breeding grounds in the western Oceania region.

This project is focused on determining where the Oceania whales' Antarctic feeding grounds are located. Historical data suggests that they may be in the far east of Area V spanning into Area VI and western Area I. It is currently logistically and financially unfeasible to conduct a dedicated voyage to these remote Antarctic waters, so the aim is to satellite tag whales as they migrate south past Raoul Island in the Kermadecs group, New Zealand and American Samoa. Identifying the breeding ground origins of whales migrating past Raoul Island will be done using photo-identification and genotyping. In addition, tissue samples will be archived for use in stable isotope analyses to ascertain prey type when on the feeding grounds.

This research will be the first large scale study to determine the feeding grounds of Oceania's whales and may hold insights into the slow recovery of whales from this region. Knowledge of their migration paths and prey types will help inform energetic models of these whales' interactions with their remote Antarctic feeding grounds.

Minke whales in sea ice
Presenter: Natalie Kelly, CSIRO, Australia

The aim of this presentation is to begin the consultation process required to determine the need for new SORP research concerned with the important research questions relating to the role of ice in Antarctic minke whale abundance, ecology and life history (refer to the plan presented in Annex 1).

Last year (IWC/SC/64), the Scientific Committee agreed upon circumpolar abundance estimates for Antarctic minke whales, valid for CPII and CPIII. With the inclusion of additional variance, there remained a lot of uncertainty around those estimates, making inference concerning any possible change in abundance difficult.

As previously noted, the SOWER survey effort has now ceased and it is highly unlikely that there will be another circumpolar survey programme. As such, it would seem that the scientific community is on the verge of a new era for Antarctic minke whales, an era in which uncertainty about changes in Antarctic minke whale population size remains, and there is also uncertainty about the potential for any circumpolar-level monitoring to provide necessary information to address the knowledge gaps. However, as with the Antarctic Blue Whale Project, there may be an opportunity within SORP to move towards a new circumpolar survey programme for Antarctic minke whales or at least, one that strives to build a non-lethal foundation upon which an efficient and unbiased survey programme can rest in the future.

The name 'minke whales in sea ice' is multifaceted. It alludes first to limitations in previous surveying methods in IDCR/SOWER, through to habitat preferences and an uncertain future, to climate change.

In the first instance a collaboration that seeks to understand the distribution and abundance of minke whales throughout the sea ice regions and into the open water, and throughout the circumpolar area, might be favourable. This means exploring various spatial and temporal scales, thus, aerial surveys could prove as useful as satellite tagging in this regard. A project such as this would also build neatly on past and current aerial survey and vessel-based research, and most certainly on some of the ground-breaking tagging and prey-field research presented today by Robert Pitman and Ari Friedlaender.

With the exception of some of the tagging work described within reports of various SORP projects, any broader-scale sampling for minke whales in sea ice regions is going to be logistically challenging and, as a corollary, expensive. As such, conducting Antarctic minke whale research under the auspices of SORP is logical.

Interest in developing a new SORP proposal will be gauged in a designated workshop session on Day 2. Here too, the 'big questions' for Antarctic minke whales, and how these might be answered most efficiently, will be discussed. It will also be determined whether research efforts to tackle these questions are better placed under the auspices of the current SORP, '*Foraging ecology and predator-prey interactions between baleen whales (minke and humpback) and krill'* project, or a new '*Whales and climate change*' project.

ADDITIONAL PLENARY PRESENTATIONS

Summaries of additional presentations delivered in plenary on Day 2 of the SORP conference are provided below. Copies of selected presentations will be made available at http://www.marinemammals.gov.au/sorp/2013-sorp-conference.

Parent-Offspring Mark-Recapture (PO-MR) for blue whales and beyond

Presenter: Mark Bravington, CSIRO, Australia

Modern genotyping technology can reliably find all Parent-Offspring Pairs (POPs) in a large collection of tissue samples (e.g. the recent CSIRO study of over 14,000 tuna samples), at very modest cost per sample (e.g. $20). This talk presented recent work showing how to estimate absolute abundance and demographic parameters from time-series of such POPs, by adapting Mark-Recapture principles. The results are highly relevant to the SORP Antarctic Blue Whale Project, but also to many other situations. The principles were explained, CVs presented for various sampling designs, and an explanation given of how PO-MR can be used to:

- estimate age-at-maturity without any age data;
- improve precision of abundance estimate (e.g. halving the CV from the same sample size);
- dramatically improve precision of trend estimate;
- remove bias due to heterogeneity-of-capture-probability;
- quickly reveal spatial population structure on an ecological, not evolutionary, time scale.

Follow-up on the performance and health effects of satellite tagging on humpback whales in the Gulf of Maine

Presenter: Jooke Robbins, Centre for Coastal Studies, United States

The preliminary results from an on-going project to assess the performance and health effects of satellite tagging on humpback whales (*Megaptera novaeangliae*) were presented. This is the collaborative effort of investigators from the Australian Antarctic Division, the Cascadia Research Collective, the Centre for Coastal Studies, the Marine Mammal Centre and the National Marine Mammal Laboratory. The Gulf of Maine (North Atlantic) was selected for this follow-up study because of the long seasonal residency of humpback whales, strong site fidelity, high observer effort and well-established longitudinal research program. Implantable satellite tags have been deployed on 35 well-studied individuals with strong prior residency characteristics and known demographic traits. Standard techniques were used to deploy satellite tags equipped with articulated (2011, n=19) or rigid (2012, n=16) anchoring systems. Tagged whales were then regularly re-encountered to assess the state of the tag, wounds at the tag site and the overall condition of the whale. Re-sightings of tagged whales to

date have revealed design flaws that could explain the relatively short and variable tag transmission durations on humpback whales. Some of the articulated anchors failed at the articulation point resulting in premature detachment of the electronics package and part of the anchor likely being left in the body of the whale. Another weakness was found at the interface between the anchoring system and the electronics resulting in bending and/or breakage of the tag in at least five cases. Because this latter interface is similar to those used in various tagging projects over the past 10 years it is possible that this type of failure occurs regularly but has not previously been documented. Tag modifications arising from this study have already doubled the average duration of tags and additional changes are still being evaluated. Health effects will continue to be examined as the project continues. The tagging component of the SORP project on humpback whale mixing in Antarctica has been postponed until October 2014 in order to take advantage of design improvements resulting from this study. Additional details on this research are available in SC/65a/SH05.

Measuring Foraging Effort of Satellite-Tracked Sperm Whales in the Gulf of Mexico
Presenter: Bruce Mate, Oregon State University, United States

To learn more about sperm whale foraging habits, PATF tags made by Wildlife Computers were deployed in OSU- designed attachment sleeves on 11 sperm whales in July 2011. These tags transmitted for an average of 26 d. Argos messages summarised 74% of all dive durations, maximum dive depths, dive shapes, and the surface duration of dives >10 min duration and >10 m depth, as well as histograms of the time spent in various depth ranges, maximum dive depths, and dive durations for ~ 60% of all dives. After programmed release, detailed dive data were available when the tags detached from the whale and floated to the surface for recovery. The longest lasting tag provided 42 days of continuous depth profiling with 1-s and 2-m resolution, 3-axis accelerometer data from changes in whale body movement, and GPS-quality locations. The acceleration data were used to identify foraging attempts (lunges), which occurred only during the bottom phase of dives and showed no periods of surface resting. The number of lunge events per dive dramatically increased during the last two weeks of the record, suggesting the whale encountered an area of higher prey density. Dives with many lunge events were interspersed with dives showing few lunge events, despite similar dive depths and durations. The high variability in lunges/dives suggests the whales' extensive movements are primarily due to searching for prey in a patchy environment.

Lunge data from this type of tag could help evaluate how whales make habitat selections and improve habitat modelling. It could also be the basis for conducting behavioural response studies on the disturbance effects of acoustic stimuli (such as seismic or sonar).

PROJECT PLANNING WORKSHOP PRESENTATIONS

Summaries of the presentations delivered for information during the project planning workshops held on Day 2 of the SORP conference are provided below. Presentations were not made in all workshops. Copies of selected presentations will be made available at http://www.marinemammals.gov.au/sorp/2013-sorp-conference.

Using Next Generation Sequencing to evaluate the subspecific taxonomy of blue whales
Presenter: Aimee Lang, NOAA, United States

An overview of plans to complete a comprehensive genetic assessment of the subspecific taxonomy of blue whales was presented. Next Generation Sequencing of whole mitogenomes (~16,000 bps) and 50 nuclear regions is being conducted using ~300 globally distributed blue whale samples. This data will be used to examine the phylogenetic relationships as well as the degree and timing of divergence between blue whales from different regions. This approach will provide greatly increased genome coverage when compared with previous genetic studies of blue whales and has been shown to substantially improve taxonomic resolution when utilized with other species. As part of this work, nuclear markers (Single Nucleotide Polymorphisms, SNPs) will be identified that can be utilized in future blue whale genetic studies. Given that SNP genotype data produced in different labs can be easily integrated, these markers may be useful in future genotyping of samples collected for the SORP Antarctic Blue Whale Project.

Habitat modelling efforts for blue whales in the Eastern North Pacific
Presenter: Daniel Palacios, NOAA, United States

An overview of habitat modelling efforts for blue whales in the Eastern North Pacific based on a long-term tracking data set and remote sensing was presented. The advantages and limitations of the approach due to the spatial and temporal resolution of the data sets was discussed but, overall, the results successfully captured the patterns of distribution and behaviour of this population. The fact that ecological concepts used to formulate habitat models could be transported and adapted to the ecology of blue whales in the Southern Hemisphere was highlighted.

Ongoing research projects on humpback, southern right and killer whales in SE Brazil
Presenter: Salvatore Siciliano, Escola Nacional de Saúde Pública/FIOCRUZ, Ministry of Health, Brazil

The presentation covered ongoing research projects on two species of baleen whales and killer whales along the south-eastern Brazilian coast. The projects are conducted on a regular basis by two research groups: (a) Escola Nacional de Saúde Pública/FIOCRUZ and the Instituto Megafauna Marinha, Rio de Janeiro and (b) Instituto Oceanográfico, Universidade de São Paulo (USP), São Paulo, Brazil.

The southern right whale project is evaluating the apparent decline of the number of sightings of this species in the last decade along the SE Brazilian coast. Probable cause of this decline could be related to increasing ship traffic and noise, as well as pollution, resulting in severe habitat degradation.

The humpback whale project includes a network for investigating cetacean strandings along the Rio de Janeiro and São Paulo state coasts. We investigated an unusual mortality of humpback whales in 2010 along the Brazilian coast and conclude from the necropsied whales that most were sick and suffering from malnutrition. The killer whale project is coordinated by ENSP/FIOCRUZ and uses the internet as a powerful source of information on sightings of orcas along the Rio de Janeiro state coast. The sites are: http://www.gemmlagos.com.br/ and https://www.facebook.com/pages/Rao-Rj-Rede-de-Avistamentos-de-Orcas-no-Litoral-do-Rio-de-Janeiro/146518685516591?ref=hl
So far we have made three matches of known killer whales along the Brazilian coast.

Studying the acoustic activity of blue whale subspecies to understand their seasonal distribution at the Indian Ocean basin scale.
Presenter: Flore Samaran, University of La Rochelle, France

Understanding the seasonal movements and distribution patterns of migratory species over ocean basin scales is vital for appropriate conservation and management measures. However, assessing populations over remote regions is challenging, particularly if they are rare. In the Southern and Indian oceans, two recognised subspecies of blue whales (*Balaenoptera musculus spp.*) with four 'acoustic populations' occur. Three of these are pygmy blue whale (*B.m. brevicauda*) populations (Sri Lanka, Australia, and Madagascar call types) while the fourth is the Antarctic blue whale (*B.m. intermedia*); each produces a different stereotype call. Past whaling catches have dramatically reduced their numbers but recent acoustic recordings show that these oceans are still important habitat for blue whales. Presently little is known about the seasonal movements and degree of overlap of these four populations, particularly in the central Indian Ocean. We examined the geographic, seasonal and diel occurrence of different blue whale acoustic populations using one year of passive acoustic recording from three sites located at different latitudes in the Indian Ocean. Calls of each blue whale population occur seasonally in different latitudes. For some call types and locations, there was spatial and temporal overlap, particularly between Antarctic and different pygmy blue whale acoustic populations. Except on the southernmost hydrophone, all three pygmy blue whale acoustic populations were found at different sites or during different seasons, which further suggests that these populations are generally geographically distinct. Only three of four populations exhibit diel variation in call production. At each latitude and season where calls were detected, Sri Lanka and Australia pygmy blue whales produce significantly more calls at night than during the day ($p<<0.001$) while Antarctic blue whales produce significantly more calls during the day than at night ($p<<0.001$) for all the year at southernmost latitudes, and only during autumn and winter months at the northernmost latitudes. This difference in diel patterns in call production may indicate that both subspecies feed

at different times of day and potentially on different prey. This unusual blue whale diversity in sub-Antarctic and sub-tropical waters indicates the importance of the area for blue whales in these former whaling grounds.

PRESENTATIONS ON THE USE OF AVAILABLE NATIONAL PLATFORMS

A summary of each of the presentations delivered in plenary on Day 3 of the SORP conference is provided below. Copies of selected presentations will be made available at http://www.marinemammals.gov.au/sorp/2013-sorp-conference.

Korean Antarctic Program and its research icebreaker, a new workhorse in the under-surveyed portion of Southern Ocean

Presenter: Hyoung Chul Shin, Korea Polar Research Institute, Republic of Korea

The Korea Polar Research Institute has been an operator in the Korean national polar program since 1987. The institute conducts research in both Antarctic and Arctic, runs one research breaker and a research station on King George Island, and its second station in Terra Nova Bay will be completed soon. The recently launched research icebreaker *Araon* is similar to most other current Antarctic research icebreakers in icebreaking capability, albeit slightly larger in size, and is equipped with modern scientific instrumentation. The *Araon* has begun to sail between the Antarctic and Arctic on a regular basis for scientific and logistic mission. The vessel will primarily operate in the Pacific sector of Southern Ocean, the waters between Antarctic Peninsula and Ross Sea including the Amundsen Sea, and often traverse between ports in Oceania and Chile. This encompasses a poorly surveyed portion of the Southern Ocean and offers a great deal of potential for data collection in locations currently unoccupied by international collaboration. The opportunities include a supply of platforms for instrument deployments and scientific personnel involved in SORP, and these could be further developed into data collaboration and even more highly coordinated collaborative efforts. Prior consultation and advance planning will greatly facilitate the process and partnership, and is welcomed by the Korean program.

Workshop of the South American members of SORP

Presenter: Miguel Iñiguez, Alternate Commissioner of Argentina to the IWC

Representatives of South American countries including Argentina, Brazil and Chile (founding members of SORP), as well as Ecuador, attended a workshop held in Buenos Aires, Argentina, 17-18 April 2013. Australian delegates also participated, representing the SORP Secretariat and Australian Government. The participants reinforced their commitment to the use of non-lethal methods for research on whales.

A summary of 2013 Latin American research projects within the SORP Antarctic Blue Whale Project (ABWP) was presented, including the recent Australian voyage using non-lethal techniques, the Argentinean voyage of 'Puerto Deseado', and Chilean work on the IWC blue whale photo identification catalogue. The potential resources from Latin American countries were discussed and the capacity for whale research investigated. Argentina announced the availability of the 50 m vessel 'Tango' for research in 2013-2014 in the Antarctic Peninsula area. The opportunities for capacity building for whale research amongst Latin American nations were also discussed. A proposal for a coordinator was considered and this issue was further discussed during the meeting of the ABWP Scientific Steering Committee.

Brazilian polar programme

Presenter: Luciano Dalla Rosa, The Institute of Oceanography, Brazil

Please refer to talk in plenary on day one for discussion of potential contribution of the Brazilian Antarctic Program to SORP that was reiterated in plenary on Day 3.

The South African Blue Whale Project (SABWP)
Presenter: Ken Findlay, University of Cape Town, South Africa

A brief overview of the South African Blue Whale Project was provided in which the rationale and methodology of the project's proposed work at both high latitudes (off the 0-20°E longitude sector of the Queen Maud Land coast of Antarctica (where the SOWER cruises suggest a hotspot for blue whales and where there are contemporary photo-identification and biopsy samples), and at low latitudes (off the coast of west South Africa and possibly Namibia where the proportion of Antarctic blue whales whales in the historical catches of some 12,000 individuals is believed to have been high). Localities and schedules for the proposed deployment of three Autonomous Acoustic Recorders (AURAL 2Ms) in both these regions were provided, the earliest of which will be deployed in July 2013. Also presented was a planned routing for a distance-based line-transect survey for blue whales in the 0-20°E longitude Antarctic Sector, the timing of which is very dependent on the availability of dedicated ship time on the SA Agulhas II). The results of fieldwork supported by SORP funding are presented in SC/65a/O10.

RECOMMENDATIONS FOR THE FURTHER DEVELOPMENT OF THE SORP INITIATIVE

Many recommendations for the development of individual projects are presented within the project plans developed during the workshops (Annex 1). However, during the SORP conference broader recommendations were agreed with a view to building on the successes of the Partnership to date, and ensuring both the continuation of this multi-national, regional collaboration and the delivery of high quality scientific information, in line with the priorities of the Scientific Committee of IWC, through the application non-lethal methods.

Recommendation 1: that SORP Partners seek funding from all available sources to support the 5 existing SORP research projects.

Recommendation 2: that SORP activities be actively communicated to the Commission of the IWC to ensure that they are aware of the scientific products of the initiative and **encourage** further financial support.

Recommendation 3: Greater emphasis on the dissemination of information related to the SORP projects and to simplify access to SORP related web information.

Recommendation 4: that the Partners in SORP employ all platforms of opportunity and, where applicable, citizen science, to collect data for inclusion in SORP research projects, thereby reducing the logistic constraints of circum-polar coverage and overall expenditure. Platforms of opportunity include, but are not limited to, tourist vessels and operations, polar programmes and their personnel, fishing vessels, other researchers, NGOs and volunteer groups, the general public and the internet.

Recommendation 5: that data collected from international, collaborative research efforts such as SORP are stored and archived in open-access, central repositories that have the capacity to handle both primary scientific data and information derived from citizen science, e.g. image catalogues. Similarly, genetic samples should be archived with the aim of applying new analytical technologies as and when they emerge, to maximise the information gained from each sample collected.

Recommendation 6: that the holders of large, long-term datasets that contain valuable information relevant to SORP, particularly acoustic data, should be **strongly encouraged** to analyse and publish these data as soon as possible, for consideration in the ongoing analyses/research effort.

CONCLUDING STATEMENT

The Southern Ocean Research Partnership (SORP) conference was successful in bringing together representatives of the scientific community from 16 nations to discuss the significant results arising from the use of non-lethal techniques for cetacean research, and collaboratively formulate plans for the future. The results underline the importance of such regional, multi-lateral partnerships in delivering robust scientific results that address IWC priorities.

ANNEX 1 – UPDATED SORP PROJECT PLANS - 2013

The original SORP project plans endorsed by the Scientific Committee of the IWC can be referred to in SC/63/O13. Progress reports for work undertaken following these SORP project plans has been reported in SC/63/O12, SC/64/O13 and SC/65a/O11Rev.

Given that the abovementioned documents demonstrate that 1) the SORP initiative has made significant contributions to cetacean research in the Southern Ocean since its inception in 2009; but 2) the voluntary contribution of the Australian Government to the IWC to initiate SORP and support its research projects is almost completely expended, the Principal Investigators of each of the 5 ongoing SORP research projects convened workshops outside plenary on Day 2 of the conference to discuss and update plans for the future of the projects, including a preliminary estimate of the financial and *in kind* support needed over timelines of 3 to 12 years to ensure the continuation of the SORP initiative. These revised project plans are summarised below. They will continue to be developed intersessionally.

ANTARCTIC BLUE WHALE PROJECT (ABWP), UPDATED PROJECT PLAN - 2013

1. Project title

Antarctic Blue Whale Project (ABWP)

2. Proponent(s) details

(a) Principal Investigators

	1	**2**
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Name	Philip Hammond	Mike Double
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(b) Co-investigators

	1	**2**
Title	Dr	Dr
Name:	Brian Miller	Natalie Kelly
Institutional Affiliation:	Australian Antarctic Division	Australian Antarctic Division
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Phone Number:		
Fax Number:		
Email:	brian.miller@aad.gov.au	natalie.kelly@aad.gov.au

3. Key stakeholders

Are there other key stakeholders involved in the project and how will they contribute to this work?

	1	**2**
Institution:	Many >30	
Contact:	International participation est. 100	

	researchers	
Contribution/ Involvement in project:	Participation in developing methods, providing sampling platforms, analysing data, publishing and communicating results.	

4. Project objectives (please list)

1. To identify the most appropriate and efficient method to deliver a new circumpolar abundance estimate
2. To develop and refine methods to improve survey efficiency
3. To deliver a new circumpolar abundance estimate
4. To improve understanding of population structure
5. To improve understanding of linkages between breeding and feeding grounds
6. To characterise behaviour on the feeding grounds

5. Priority areas for future research

(a) List your priority research questions

1. What is the current circumpolar abundance of Antarctic blue whales and are they recovering from exploitation?
2. What is their population structure?
3. What are their migration routes from feeding to breeding grounds?
4. How do they utilise resources on their feeding grounds?

(b) Briefly detail how the project will meet these priorities.

Through dedicated and opportunistic sampling of Antarctic blue whales using a range of techniques (biopsy sampling, photo-identification, passive acoustics, satellite telemetry) to generate data to be analysed using a range of methods including mark-recapture analysis, genetic analysis, and habitat modelling. Refer to detailed methods below.

6. Project methodology

Development of mark-recapture and survey methods. Scenario-testing to explore required sampling rate of individuals for biopsy and photo-identification. Establishing uniform sampling protocols to ensure data consistency. Acoustic tracking to increase encounter rates. Analysis of individual recognition data, using mark-recapture methods. Genetic analysis of tissue samples. Analysis of telemetry data.

The general approach and methods of the ABWP have been reviewed and endorsed by the Scientific Committee of the IWC.

Targeting 'hotspots'

Using historical sightings, catch and acoustic data (Kelly *et al*. 2012 (SC/64/SH10), Širović *et al*. 2007; Samaran *et al*. 2010) higher density 'hotspots' of Antarctic blue whales (ABWs) have been identified which will be targeted by these voyages.

Passive acoustics to increase capture rates

Passive acoustic tracking will primarily be used to increase encounter rates with ABWs. AN/SSQ DIFAR 53D sonobuoys will be deployed throughout the research area at four to six hour intervals. Upon detection of ABWs, sonobuoys will be deployed more frequently in an adaptive fashion to facilitate real-time tracking of vocalising whales. Audio from deployed sonobuoys will be recorded and monitored in real-time using dedicated VHF receivers connected to an acoustic tracking workstation. An acoustician will analyse incoming vocalisations to obtain bearings from the sonobuoy to the whale, and bearings from multiple sonobuoys will be used to triangulate the location of the whale. Ships will follow bearings and locations in order to obtain visual confirmation of whale species as well as identification photos and biopsy samples from ABWs. The locations of calling whales will be combined with visual observations to investigate the relationship between visually and acoustically observed behaviours and social interactions. Acoustic tracking equipment and protocols are described by Miller (SC/64/SH12 and SC/65a/SH18).

Observations
Whale observers will be rostered to look for whales and record information about behaviour, other cetaceans, seabirds, krill, and environmental data such as sea-state and visibility. The observers will work from designated observer platforms using high quality binoculars and ID guides provided by the IWC-ABWP. Sighting, effort and environmental data will be recorded in a database and linked to the vessel track. Upon sighting ABWs, the vessel will change course to approach whales facilitating photographs and biopsies. Rosters can be tailored to suit other scientific research programs being conducted onboard, e.g., 24 hours rosters or 12h on: 12h off or 8 hour shifts.

Individual whale identification photos
Digital photographs will be taken of every blue whale observed, as well as other cetacean species of opportunity. Digital photos will be examined for unique natural markings and identification of different individuals following methods outlined in Olson (2009; 2010) and Sears *et al.* (1990). Identification photos will be selected for each whale and identification numbers assigned in a photo-identification database. Refer also to Olson *et al.* 2013, SC/65a/SH11.

Individual whale biopsies
Fully trained and permitted personnel will collect whale tissue biopsies from the deck of vessels and/or small watercraft. Biopsies will be split and stored in a combination of ethanol, RNAlater®, and/or an ultra-low temperature freezer. These samples will be used for individual identification and analysis of population structure. Samples will be added to central repositories for use by other researchers.

Tagging and tracking ABWs
There is currently very little known about spatial movements of ABWs. Only 2 satellite tags have ever been deployed (Andrews-Goff *et al.* 2013, SC/65a/SH03; Double 2013, SC/65a/SH21). We therefore propose to satellite tag individual ABWs that we observe near the vessel that are behaving in a suitable manner (i.e. resting or feeding as opposed to travelling at speed), weather permitting. Satellite tags will be deployed from small water-craft. Once the tag is activated by immersion water it will transmit spatial locations via the Argos satellite system.

Long-term acoustic recordings
When possible, moored acoustic recorders will be deployed at the study sites. These recorders will be moored near the sea floor at depths up to 3 km and will operate continuously for up to 18 months. The precise location of the deployed recorder will be determined by querying an acoustic release. The recorders will be retrieved by personnel on subsequent voyages, or by vessels of opportunity.

Environmental data
In-built vessel systems will be used to derive sound-speed profiles, which will be employed to enhance the accuracy of the real-time acoustic tracking system. Sea-surface temperature and salinity, and ADCP data, will be collected as part of the environmental sampling regime via underway instruments. Current velocity from the ADCP will be used to model drift of sonobuoys in order to further improve real-time acoustic tracking accuracy. When possible, active acoustic data will be collected from multi-frequency echosounders while underway in order to monitor acoustic backscatter for potential prey of ABWs (i.e., krill and fish). Sea state, swell height, wind speed, and visibility and other data that may affect visual and acoustic observations will be recorded in a database at regular intervals by visual observation team. All environmental data will be time-stamped and be linked to vessel tracks.

7. Data collection

The ABWP will carry out dedicated surveys using acoustic tracking to collect biopsies and identification photographs, and to deploy satellite tags on ABWs. The focus of data collection will be to maximise the number of biopsy samples collected, whist maintaining the effort to obtain identification photographs.

The project will also employ all platforms of opportunity and, where applicable, citizen science, to collect data for inclusion in appropriate analyses. Platforms of opportunity include, but are not limited to, tourist vessels and operations, polar programmes and their personnel, fishing vessels, other researchers, NGOs and volunteer groups, the general public and the internet.

8. Data archiving and sharing

All data generated by the ABWP will be stored and archived in open-access, central repositories that have the capacity to handle both primary scientific data and information derived from citizen science, e.g. image catalogues. Genetic sub-samples will be archived with the aim of applying new analytical technologies as and when they emerge, to maximise the information gained from each sample collected

9. Data analysis

To deliver a precise estimate of ABW circumpolar abundance using a mark-recapture approach, genetic and photographic data for individual ABWs must be reviewed and reconciled with their respective catalogues.

Digital photographs of individual ABW will be entered into the Southern Hemisphere Blue Whale Catalogue (IWC-SORP). The mottling on the flank of blue whales is individually specific and has been used to build a mark-recapture catalogue for these whales (Olson 2009, 2010; Sears *et al*. 1990).

Biopsies will be used for individual identification and analysis of population structure via microsatellite loci or newly developed SNP loci. Total cellular DNA will be isolated from skin tissue using an automated Promega Maxwell ® 16 System. At least 10 microsatellite loci will be amplified for each sample using previously published primers (Steel *et al.* 2011). Sex will be determined using a fluorescent 5'exonuclease assay producing PCR product from the ZFX and ZFY orthologous gene sequences (Morin *et al.* 2005). Sequencing of the mitochondrial (mt) DNA control region (700bp) follows methods described in Olavarría *et al.* (2007). Samples will be archived with the aim of applying new analytical technologies as and when they emerge, to maximise the information gained from each sample collected

If tagging is possible on the voyages, we will retrieve satellite tracks of ABWs. These will be used to analyse the movement patterns and behaviour of ABWs.

Data from the sonobuoys will used to establish the relationships between call type and source level to better estimate the effective sampling area of long-term acoustic recorders. Relationships among acoustically and visually observed behaviour and genetics will provide information about temporal and spatial trends in whale behaviour (e.g., Oleson *et al*. 2007).

Signal processing methods to detect ABW calls will be applied to long-term recordings to provide a time series of ABW vocal activity (Širović *et al.* 2007). Long-term acoustic data will be compared with abundance estimates to investigate temporal and spatial trends of ABW vocalisations.

10. Other requirements necessary to achieve objectives listed (e.g., vessels, personnel, equipment)

Dedicated vessels and opportunistic sampling platforms to maximise circum-Antarctic coverage over a 12 year period; funding for equipment, e.g. sonobuoys, tags, laboratory consumables; capacity building for personnel; open-access, centralised data repositories.

11. Project work plan/timelines

Activity to be undertaken	Responsibility	Est. start date (mm/yy)	Est. finish date (mm/yy)
Inaugural meeting of Scientific Steering Committee (SSC)	Hammond/Wadley	06/13	06/13
Set up consortium in South America, new SORP proposal	Iniguez	09/13	09/13
Planning voyages to Antarctica	Walløe, Charassin	07/13	12/15
Training for photo-identification, Isla Chiloe	Galletti	11/13	02/14
Voyage of Argentinean *Tango* to Antarctic Peninsula	Iniguez	03/14	03/14

Genetic analysis of biopsy samples from *Amaltal Explorer* voyage	Double	07/13	12/13
Review of progress, meeting of Tech Committees and SSC	Hammond/ Wadley	12/13	12/13
Voyage of *Tango* from Argentina to Antarctic Peninsula	Iniguez	03/14	03/14
Voyage from Australia, location tba, possibly Prydz Bay	Double/Miller	02/15 tba	02/15 tba
Voyages in a 12-year series, annually or biannually	Double/Miller	Until 2025	Until 2025

12. Project outputs

Expected outputs	**Date of completion (mm/yy)**
Papers to IWC-SC from 2013 Antarctic blue whale voyage	06/13
Presentations to SMM Dunedin	12/13
Results from voyages, including abundance estimation, at annual or biannual intervals	Until 2025
Estimation of circumpolar abundance of Antarctic blue whales with CV 0.25, with population structure, movements and behaviour, links between feeding and breeding grounds	2025

13. Project Governance

How will you manage the project to ensure it will be successful in achieving the objectives and any outputs listed?

The Antarctic Blue Whale Project (ABWP) was proposed in 2009 as part of the establishment of the SORP initiative. Since then, provisional analyses have been completed to ensure this is a viable and defendable project, with repeated consultation with the Scientific Committee of the IWC (Kelly *et al.* 2011, 2012; Wadley *et al.* 2012). In 2013, an international Scientific Steering Committee (SSC) was appointed by the SORP and endorsed by the IWC to govern and guide the research.

Technical Committees will advise on sampling methods, passive acoustics and identification of individual whales. The Convenors of the Technical Committees report to the Scientific Steering Committee and attend its meetings as required. Membership of the Committees reflects the range of scientific disciplines, geographic location and career progression of the participants, with a focus on scientific excellence and standing in the international community. All the Committees are supported by the SORP and ABWP Secretariat, based at the Australian Antarctic Division in Hobart, Tasmania.

14. Project budget

(a) Provide an estimate of funds (GBP) required to achieve the project objectives listed.

Item (please specify each item)	**SORP funding sought (GBP)**	**Applicant Organisation contributions (GBP)**	**Other contributions** (provide name of contributor) **(GBP)**	**Total project budget (GBP) 2012/13**
Coordination in South America	8,800	Miguel Iniguez, Fundación Cethus *In kind* 1,000		9,800 est. excluding staff
Antarctic voyage			Prefectura coastguard *Tango* voyage, Argentina	2013/14 1,000,000

			1,000,000	
Continued mark-recapture effort over 12 years			Voyage every years for years 10,000,000	2016/17 to 2024/25 10,000,000
TOTAL GBP	8,800 est.	1,000	11,000,000 est.	11,009,800 est.

NB: The options for Norwegian contributions to SORP, including collaborative research aboard the R/V *G.O. Sars*, are being explored with reference to Norway's statements in the 2012 report of the Scientific Committee Section 19, p68. In addition, Australian scientists are seeking funding for another designated blue whale voyage in 2015. Estimates provided at 2013 value without allowing for inflation.

(b) Will the project share resources/equipment with any other projects?

The acoustic component of the ABWP closely links with the SORP blue and fin whale acoustic trends project.
The SORP killer whale project led by Robert Pitman has potential for tagging ABWs.
Collaborations with the South African Blue Whale Project are also under development.

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Annex A – Project planning workshop agenda

1. Project management
- Project structure and collaborators
    - Technical groups
- Consortium in South America
- Communications and media

2. Development of methods
- Recognition of individuals
- Genetics
    - Aims, analysis, preliminary results, sharing samples
- Mark-recapture methods
    - Data requirements
- Sampling design
- Potential for other sampling methods
    - Photogrammetry, focal follows

3. Links with SORP project on fin and blue whale acoustic trends
- Antarctic vs pygmy blue whales
- Using acoustics to find whales
    - On cruises - representative sample?
    - Information from moored acoustic recorders
- Relating trends in (acoustic) abundance to absolute abundance
- Killer whales
- Getting photos from tourists
- Mark-recapture estimation of abundance

4. Plans for future work
- Dedicated voyages – dates, locations
- Vessels of opportunity
- Approaches to funding agencies

Annex B – List of project planning workshop participants

Names		
Yong Rock An	Natalie Kelly	Salvatore Siciliano
John Bannister	Aimee Lang	Peter Thomas
Mark Bravington	Russell Leaper	Victoria Wadley
Bob Brownell	Víctor Enrique Marzari	
Nico de Bruyn	Bruce Mate	
Rochelle Constantine	Rob McCauley	
Greg Donovan	Brian Miller	
Mike Double	Hiroto Murase	
Ken Findlay	Carlos Olavarria	
Ari Friedlaender	Daniel Palacios	
Nick Gales	Robert Pitman	
Barbara Galletti	Vincent Ridoux	
Phil Hammond	Fabian Ritter	
Helena Herr	Jooke Robbins	
Miguel Iñiguez	Flore Samaran	

ANNEX C – Additional discussions/recommendations from project planning workshop

Future work plan

Project management and governance

Roll out strategic plan, implementation plan, communication plan
- Clarify structure diagram regarding ABWP relationship with IWC through SC
- Discuss at SSC the proposal for a coordinator for South America

Formalise Technical Committees convenors and activities
- Survey methods - data collection (vessel logistics, sampling protocols), data analysis
- Acoustics
- Individual recognition (photo-id, genetics)

Communications and media
- Provide a more accessible url for ABWP under SORP website, link all ABW sites
- Publicise results from *Explorer* voyage when data are analysed

Methods development

Data collection
- Revisit scenarios for number of samples per year using new information from Explorer cruise
- Prioritise biopsy collection at sea
- Refine data collection protocols to focus on maximising biopsy samples whilst still ensuring photo-identification

Analytical methods
- Continue development of methods to analyse multiple data sources (photos, genetic), close kin mark/recapture

Passive acoustics
- Continue *Explorer* data analysis and method development to increase detection range, estimate source levels, etc

Recognition of individuals
- Validate photo-identification matches with genetics, consider computer assisted matching
- Genetics
  - SNPs for genotyping (200-300 needed)
  - Protocols for archiving and access to samples

Capacity building
- Photo-identification training at Isla Chiloe Feb 2014

Vessels

Priorities for ship time in next 2-3 years (Argentina, Australia)
- Recommend covering new areas with as wide a longitudinal range, within logistical capabilities.

Potentially available vessels

- Continue to collate list of possible vessels
- Assessment of capability and suitability (e.g. ship noise)

Encourage photo-identification from tourist and fishing vessels to broaden spatial coverage

BLUE AND FIN WHALE ACOUSTIC TRENDS PROJECT, UPDATED PROJECT PLAN - 2013

1. Project title

Acoustic trends in abundance, distribution, and seasonal presence of Antarctic blue whales and fin whales in the Southern Ocean

2. Proponent(s) details

(a) Principal Investigators

	1	2
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(b) Co-investigators

	1	2
Title	Dr	Dr
Name:	Ken Findlay	Robert McCauley
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3. Key stakeholders

Are there other key stakeholders involved in the project and how will they contribute to this work?

	1	2
Institution:		
Contact:		
Contribution/ Involvement in project:		

4. Project objectives (please list)

1. Implement a long term acoustic research program that will examine trends in Southern Ocean blue and fin whale population growth, distribution, and seasonal presence through the use of passive acoustic monitoring techniques.

2. Our two main questions are: 1) where and when are blue and fin whales present? and 2) what are the relative acoustic densities of both species and do they show temporal patterns?

To answer to these two questions, we would like to deploy long term acoustic recorders through a pan-Antarctic acoustic monitoring system. Circumpolar coverage is important in order to provide an indicator of

changes in population numbers or relative abundance that might otherwise be confounded with changes in distribution. It is a realistic goal to attempt to have at least one instrument in each of the six IWC management areas. To be able to compare results between each region we would like to write a blue and fin blueprint manuscript is to provide an overview of available analysis methods and identify the most suitable method that can answer these questions using these acoustic data though an uniform manner.

5. Priority areas for future research

(a) List your priority research questions

1. Toward a pan-Antarctic Monitoring System: seek more collaborators for area not yet acoustically monitored, offer recommendations for instruments and mooring
2. The blueprints
3. Data archive

(b) Briefly detail how the project will meet these priorities.

The two main objectives of the Group have been aimed toward the best exploitation of passive acoustic data in the long term. The installation and maintenance for a period of 6 years of a pan-Antarctic PAM monitoring system and the blueprints for analysis methods for fin and blue whales will allow the objectives of our project to be achieved.

The Group is highly multi-disciplinary with a multi-national composition. However, additional collaborators (and financial support) are required, particularly in regard to circumpolar data collection. We trust that the project has much to offer to potential collaborators and, at present, the project has good support from the Australian, French, and German polar programs, with future support from the South African Antarctic program under consideration. Collaboration with UK, Argentina, Brazil, New Zealand or Korea could help to complete the circumpolar data collection.

The group continue to looking for others experts who would offer advice and feedback regarding the best practice of mooring, choice of instrument and analysis.

6. Project methodology

- Toward a pan-Antantarctic Monitoring System (collaborators)

Continuous circumpolar acoustic monitoring would be conducted over 6 years. Multi-year datasets could only be reliably collected along supply routes for Antarctic stations and oceanographic moorings that are serviced regularly. Further, instruments or instrument packages have to be simple to deploy and retrieve to minimize ship time spent on mooring operations.

- The blueprints

It will provide details on the precision and accuracy of the available methods, how the chosen method applies to the research questions, the type of data required (continuous/sub-sampled) and the feasibility of applying the chosen method for 'regular users' (i.e. non-acousticians/programmers). For the moment we focus on Antarctic blue whale calls and our approach is to work on available datasets from the PALAOA (AWI) and DEFLO-HYDRO (PELAGIS) projects.

7. Data collection

e.g. Sample sizes, seasonal spread of sampling effort
For future data collection refer below.

8. Data archiving and sharing

e.g. Image catalogues, data repositories

In a near future we would like to develop a PAM data archive. The requirement to have a central and standardised location for recording metadata with links to actual data is important in order to facilitate analysis of trends among different sites and over different time scales. Suggestions for metadata storage included the data catalogue for the International Whaling Commission, the PANGAEA information system (http://www.pangaea.de/about/), the Australian Antarctic Data Centre (http://data.aad.gov.au/) and the Australian Ocean Data Network (http://portal.aodn.org.au/webportal/).

9. Data analysis

Through the blueprints manuscripts, see below.

10. Other requirements necessary to achieve objectives listed (e.g., vessels, personnel, equipment)

Collaborators to deploy and retrieve instruments in area.

11. Project work plan/timelines

Activity to be undertaken	**Responsibility**	**Est. start date (mm/yy)**	**Est. finish date (mm/yy)**
Blueprints for analysis (Antarctic blue whales)	FS, IVO, KS	02/13	06/14
Blueprints for analysis (Fin whales)	IVO	2014	
Collaboration for pan Antarctic	ALL		
Deployment/retrieved of instruments (location)	ALL	2012	…
Deployment/retrieved of instruments (Technics)	ALL	2012	…
Analysis of the acoustic/behaviour data collected on the 2013 V	BM, FS	2014	

12. Project outputs

Expected outputs	**Date of completion (mm/yy)**
Blueprint meeting + report + MS	06/2014
Deployment/ Retrieval report (location and techniques)	

13. Project Governance

How will you manage the project to ensure it will be successful in achieving the objectives and any outputs listed?

e.g. Steering committees, Technical committees

14. Project budget

(a) Provide an estimate of funds (GBP) required to achieve the project objectives listed.

Item (please specify each item)	**SORP funding sought (GBP)**	**Applicant Organisation contributions (GBP)**	**Other contributions** (provide name of contributor) **(GBP)**	**Total project budget (GBP)**

TOTAL				

(b) Will the project share resources/equipment with any other projects?

Yes. There are clear link between this project and the SORP Antarctic Blue Whale Project. Furthermore, a number of the other SORP research projects have the potential to contribute opportunistically collected data to this project.

15. References

Not applicable.

Annex A – Project planning workshop agenda

- The pan-Antantarctic Monitoring System
  - Spatial coverage (collaborations)
  - Temporal coverage
  - Instrument
    - Mooring
    - Depth
    - Duty cycle

- The blueprint (briefly)
  - Data Archive

Annex B – List of project planning workshop participants

Name
Miguel Iñiguez
Victor Marzari
Russel Leaper
Aimee Lang
Daniel Palacios
Vincent Ridooux
Yong Rock Am
Iain Staniland

ANNEX C – Additional discussions/recommendations from project planning workshop

The Group discussed the following matters under the two Agenda Items specified:

Collaborations and the Pan Antarctic Monitoring Systems

The spatial coverage of the current and proposed circumpolar deployments of autonomous acoustic monitoring systems was described. Given that systems need to be deployed and recovered (with soak times of

approximately one year) the positions of the any of the deployments are associated across year voyages of national Antarctic Programmes and the re-supply of Antarctic bases, including those of the UK, Germany, South Africa, France and Australia. The lack of coverage in IWC Areas I and VI remains a concern. The role of the Steering Group was to facilitate information to new prospective project stakeholders, including the selection of the location and type of instrument deployment, guidance on analyses techniques and facilitation of research. It was noted that SORP was not in a position to supply instruments. Some discussion of the options of the type of instruments and mooring designs were presented and discussed including commercial off the shelf instruments, hired instruments and in-house manufacture options. Concern on both the calibration of instruments and various limitations with certain of the mooring approaches (such as in current strumming of cable mounted instruments) were noted.

Blueprint Guides to Best Practice in analysing information to address the key objectives of the Blue and Fin Whale Acoustic Trends Project including relative and seasonal abundance estimation and data archival systems.
A brief introduction to the open-access Australian Integrated Marine Observing System (IMOS) data archival system was provided and discussed. The group noted that open access where possible was a best practice model to follow in terms of data archival, but that there may be certain restrictions in data usage. This discussion extended into analyses of calls and background choruses and the masking of distant calls by choruses, duty cycles and caller localisation including the use of timing of signal arrival, multi-path modelling and DIFAR in the range detection and triangulation for localisation of callers. The role of the Steering group in the choice of many of these available options was noted.

DISTRIBUTION, ABUNDANCE, MIGRATION PATTERNS AND FORAGING ECOLOGY OF KILLER WHALES IN ANTARCTIC AND ADJACENT WATERS, UPDATED PROJECT PLAN - 2013

1. Project title

Distribution, abundance, migration patterns and foraging ecology of killer whales in Antarctic and adjacent waters

2. Proponent(s) details

(c) Principal Investigators

	1	2
Title		
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Phone Number	858 546-7092	
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Email	robert.pitman@noaa.gov	john.durban@noaa.gov

(b) Principal Investigators

	3	4
Title		
Name	Luciano Dalla Rosa	Christophe Guinet
Institutional Affiliation	Projeto Baleias/PROANTAR, Laboratório de Tartarugas e Mamíferos Marinhos, Instituto de Oceanografia, Universidade Federal do Rio Grande – FURG	Centre d'Etudes Biologiques de Chizé
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(c) Principal Investigators

	1	2
Title		
Name:	Paul Tixier	Nico de Bruyn
Institutional Affiliation:	Centre d'Etudes Biologiques de Chizé	Mammal Research Institute, Department of Zoology & Entomology, University of Pretoria, South Africa
Address:		
Phone Number:		
Fax Number:		
Email:	tixier@cebc.cnrs.fr	pjndebruyn@zoology.up.ac.za

3. Key stakeholders

Are there other key stakeholders involved in the project and how will they contribute to this work?

	1	2
Institution:	Aquatic Environment Fisheries Management | Resource Management and Programmes Ministry for Primary Industries	Institute for Terrestrial and Aquatic Wildlife Research University of Veterinary Medicine Hannover, Germany
Contact:	Rohan Currey	Helena Herr
Contribution/ Involvement in project:	Interested in management implications for toothfish fishery in Ross Sea	Will provide sightings and photographs of killer whales from helicopter surveys in the Weddell Sea

4. Project objectives (please list)

The broad aim of this study is to better understand the systematics and ecology of killer whales in Antarctic and surrounding waters. Achieving some of these objectives will require international collaboration with researchers from various land bases and research platforms around Antarctica and in subantarctic waters.

The main objectives of the proposed project are:

1. To compile a killer whale sightings database from land-based observations and research cruises and other cruises (tour ships, research vessels, etc.) to provide for the first time a detailed, up-to-date distribution map of the different killer whale types in Antarctic and adjacent waters, highlighting areas of concentration.

2. To organize photo-ID catalogues for selected areas (e.g., Ross Sea, Antarctic Peninsula, Crozet/Kerguelen Is., Marion Is.) to be used for estimating local populations of killer whales (Durban et al. 2010, Poncelet et al. 2010, Reisinger et al. 2011a) This will be based on photographs we have in hand (> 50,000 images collected to date) and will be collating, as well as those that have been (and will be) sent to us on request from other sources.

3. To collect projectile biopsy samples to support further phylogenetic studies of Antarctic and sub-Antarctic killer whales (e.g. Morin et al. 2010); the same samples will also be used for comparative food habit studies (stable isotopes/fatty acids) and contaminant loads (e.g., Krahn et al. 2008).

4. To deploy satellite tags to study local and seasonal movements of killer whales (Andrews et al. 2008) to determine if migration occurs among the different groups/populations and what the destinations might be, and also to investigate killer whale-habitat relationships..

5. To record, during focal follows, observations of foraging habits and prey preferences of the different killer whale types in Antarctica (e.g., Pitman and Durban 2011, 2012).

6. To record acoustic vocalizations of the different types of killer whales in Antarctica and the sub-Antarctic for comparative purposes.

7. To quantify size differences between groups of killer whales using laser-paired photogrammetry

5. Priority areas for future research

(a) List your priority research questions

We intend to use information gathered on prey specialisation, foraging habits, population sizes, and local and seasonal movements to assess cumulative ecological impact of the various types of killer whales in Antarctic and adjacent waters.

(b) Briefly detail how the project will meet these priorities.

All of these data will feed into modelling exercises (e.g. Reisinger *et al.* 2011b) to more fully explore the role of killer whales in the Antarctic ecosystem, and to assess their possible responses to climate change in Antarctica.

6. Project methodology

Our research in Antarctic waters will be conducted primarily as visiting scientists on board the tour vessel *National Geographic Explorer*. Using this model we have deployed over 25 satellite tags on killer whales in the Antarctic Peninsula area in the last 4 seasons, obtained several hours of acoustic recordings, and obtained over 35 biopsy samples. Additional data from the same area will be collected during the research activities of Projeto Baleias/PROANTAR (Brazilian Antarctic Program) around the Antarctic Peninsula. These activities will be conducted from the Polar Vessel Almirante Maximiano (91.6 m) and by launching small inflatable boats. Research around subantarctic islands will be conducted by fishery observers onboard longline fishing vessels and by workers from Alfred Faure Base on Possession Is., and occasionally from Port aux Francais on Kerguelen Is., and from shore-based operations at Marion Is. In addition, we will be collaborating with SORP and other researchers working on platforms operating around the continent, including on NSF-operated vessels, to provide a more comprehensive picture of the ecosystem impact of the world's largest apex predator in Antarctic waters. Pitman and Durban have access to NSF resources and logistical support (accommodations, helicopter time, lab space, etc.) at McMurdo Station through a current grant. Between McMurdo and tour ship support in the Peninsula area we have access to all 4 known killer whale ecotypes in Antarctica. De Bruyn has access to and logistic support for killer whale research at the South African National base station at Marion Island through a current National Research Foundation (RSA) grant.

7. Data collection

60 Wildlife Computer satellite tags per year will be deployed at Marion and Crozet Islands, and at various locations around the Antarctic continent, the latter with a strong emphasis on the Antarctic Peninsula (west Antarctica) and the Ross Sea (east Antarctica). Attempts will be made to biopsy each animal tagged or at the very least one or more of the animals from each tagged group. At least 2 hrs of acoustic recordings from each major location, and each identified ecotype will be collected using portable hydrophone and digital recorders. Attempts will be made to photograph every individual from every group encountered and photos will be archived in permanent, web-accessible databases.

8. Data archiving and sharing

Our Antarctic killer whale photo-ID catalogue will be posted online at the NMFS/SWFSC website; killer whale satellite tracks in near-real time will be posted on the SWFSC website with links to our educational outreach site. Tissue samples from Antarctica will be housed at the NMFS/SWFSC marine mammal tissue archive – the largest, most comprehensive marine mammal tissue archive in the world. These (and all) tissue samples are available to any legitimate researchers and can be accessed by submitting a proposal to the Loan Committee at SWFSC (contact Barbara.Taylor@noaa.gov). Photo-ID and samples collected from Marion Island will be housed at the Mammal Research Institute, University of Pretoria, RSA, and are available on request (contact: N. de Bruyn; pjndebruyn@zoology.up.ac.za). Killer whale photo-id data and samples collected under Projeto Baleias/PROANTAR will be housed at Federal University of Rio Grande - FURG (contact person: L. Dalla Rosa; e-mail: l.dalla@furg.br). Photo-id data for Crozet and Kerguelen islands will also be available on request (tixier@cebc.cnrs.fr).

9. Data analysis

Genetics and stable isotope analyses from Pitman and Durban samples will be conducted at their lab in La Jolla; they will also use extensive in-house expertise to maintain photo-id databases and process and analyse all satellite tracking data. All molecular analysis from de Bruyn will be done in collaboration with Durham University and at the Mammal Research Institute, while all other analysis will be done at the latter facility with in-house expertise. Genetics, contaminant and stable isotope analysis by Dalla Rosa and his colleagues will be done in-house or with partner Universities in Brazil.

10. Other requirements necessary to achieve objectives listed (e.g., vessels, personnel, equipment)

We will be looking to source additional ship time for directed killer whale research in Antarctic waters – for example, in 2012-13 Pitman and Durban participated in a month-long, NSF-sponsored whale tagging cruise in the Peninsula area aboard the R/V Pt. Sur and hope to duplicate this effort in 2013-14.

11. Project work plan/timelines

Activity to be undertaken	Responsibility	Est. start date (mm/yy)	Est. finish date (mm/yy)
Deploy 35 tags/per year (3 years) in the Antarctic Peninsula and Ross Sea area; collect photo-id, biopsy, acoustic data at the same time.	Pitman/Durban	Dec 2013	Mar 2018
Deploy 15 tags/year (3 years) at sub-Antarctic Marion Island, collect photo-ID, biopsy, photogrammetry data at the same time.	De Bruyn	April 2014	Mar 2018
Deploy 10 tags/year (3 years) around the Antarctic Peninsula, including the Weddell Sea, collect photo-ID, biopsy, photogrammetry data at the same time.	Dalla Rosa	Jan 2014	Mar 2018

12. Project outputs

Expected outputs	Date of completion (mm/yy)
A series of peer-reviewed, published papers on killer whale movements and ecology in Antarctic waters.	
A series of peer-reviewed published papers on killer whale demography, social associations, movement and diet from Marion Island and Crozet Island.	

13. Project Governance

How will you manage the project to ensure it will be successful in achieving the objectives and any outputs listed?

The 6 PIs identified above will conduct a workshop after the second season to insure that project objectives are being met and reassessed as necessary.

14. Project budget

(a) Provide an estimate of funds (GBP) required to achieve the project objectives listed.

Item (please specify each item)	**SORP funding sought (GBP)**	**Applicant Organisation contributions (GBP)**	**Other contributions** (provide name of contributor) **(GBP)**	**Total project budget (GBP)**
60 satellite tags/yr x 3 yrs = 180 tags	480k GBP	6.7k GBP SWFSC	31.3k GBP National Geographic	518k GBP
Travel to attend steering committee meeting –	20k GBP			20k GBP

TOTAL	500k GBP	6.7k GBP	31.3k GBP	538k GBP

(b) Will the project share resources/equipment with any other projects?

At any opportunity.

15. References

Durban, J., Ellifrit, D., Dahlheim, M., Waite, J., Matkin, C., Barrett-Lennard, L., Ellis, G., Pitman, R., LeDuc, R. and Wade, P. (2010) Photographic mark-recapture analysis of clustered mammal-eating killer whales around the Aleutian Islands and Gulf of Alaska Marine Biology 157:1591-1604.

Durban, J.W. and Pitman, R.L. (2011) Antarctic killer whales make rapid, round-trip movements to sub-tropical waters: evidence for physiological maintenance migrations? Biology Letters 8:274-277.

Krahn, M.M., Pitman, R.L., Burrows, D.G., Herman, D.P. and Pearce, R.W. (2008) Use of chemical tracers to assess diet and persistent organic pollutants in Antarctic Type C killer whales. Marine Mammal Science 24(3):643-663.

Pitman, R.L. and Durban, J.W. (2012) Cooperative hunting behavior, prey selectivity and prey handling by pack ice killer whales (*Orcinus orca*), type B, in Antarctic Peninsula waters. Marine Mammal Science 28:16-36.

Pitman, R.L. and Durban, J.W. (2010) Killer whale predation on penguins in Antarctica. Polar Biology 33:1589-1594.

Poncelet, E., Barbraud, C. and Guinet, C. (2010) Population dynamics of killer whales (*Orcinus orca*) in the Crozet Archipelago, southern Indian Ocean: a mark-recapture study from 1977 to 2002. Journal of Cetacean Management and Research 11:41–48.

Reisinger, R.R., de Bruyn, P.J.N. and Bester, M.N.(2011a) Abundance estimates of killer whales at subantarctic Marion Island. Aquatic Biology 12:177–185.

Reisinger, R.R., de Bruyn, P.J.N. and Bester, M.N. (2011b) Predatory impact of killer whales on pinniped and penguin populations at subantarctic Prince Edward Islands: fact and fiction. Journal of Zoology, London 285:1–10.

Annex A – Project planning workshop meeting agenda

Data collection:
1. Phylogenetic sampling –
    Biopsy - priority: around the continent; opportunistic and directed
    Photogrammetry – laser pointers
    Acoustics -
2. Movements – mainly satellite tagging but also photo-id; skin samples from lower latitudes to answer why?
3. Abundance estimates – photo-id catalogs; possibly surveys? Not SOWER?
4. Prey preferences – opportunistic (tour vessels) and focal follows on dedicated vessels.

Platforms:
1. Shipboard
    Dedicated – research vessels
    Opportunistic – tour ships, other
2. Land-based
    Observations, photo, biopsy?, tagging?

Annex B – List of project planning workshop participants

Name
Elanor Bell
Nico de Bruyn
Rochelle Constantine
Rohan Currey
Luciano Dalla Rosa
Helena Herr
Robert Pitman
Salvatore Siciliano

FORAGING ECOLOGY AND PREDATOR-PREY INTERACTIONS BETWEEN BALEEN WHALES (MINKE AND HUMPBACK) AND KRILL, UPDATED PROJECT PLAN - 2013

1. Project title

Foraging ecology and predator-prey interactions between baleen whales and krill

2. Proponent(s) details

(d) Principal Investigators

	1	2
Title	Dr.	Dr.
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Fax Number	252-504-7468	
Email	asf7@duke.edu	Nick.gales@aad.gov.au

(e) Co-investigators

	1	2
Title	Drs.	
Name:	Doug Nowacek, Andy Read, Dave Johnston	
Institutional Affiliation:	Duke University Marine Laboratory	
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Phone Number:		
Fax Number:		
Email:	Dpn3@duke.edu, aread@duke.edu, dwj2@duke.edu	

3. Key stakeholders: See Annex B for list of stakeholders indicated with * and their contributions noted.

Are there other key stakeholders involved in the project and how will they contribute to this work?

	1	2
Institution:		
Contact:		
Contribution/ Involvement in project:		

4. Project objectives (please list)

1. To conduct ecological research on humpback and minke whales around the Antarctic Peninsula; and

2. To develop methodological tools to understand the ecological relationships between whales, prey, and their environment; better understand the short and long-term movement patterns and behaviours of humpback and minke whales in relation to prey and environmental variability;

3) To use our portable research plan to conduct similar ecological research in collaboration with international partners in at least two other Antarctic regions (e.g. Ross Sea, East Antarctica, Weddell Sea).

5. Priority areas for future research

(a) List your priority research questions

1. How does the distribution and abundance of krill and environmental conditions affect the foraging behaviour of baleen whales (humpback and minke) around Antarctica and both fine and broad scales?
2. How similar or different are the behavioural patterns and foraging behaviour of humpback and minke whales?
3. How do sympatric baleen whales partition resources to avoid competition?
4. How may environmental change affect the foraging ecology and interactions between baleen whales and krill?
5. Are there regional differences in the ecological relationships between baleen whales and their prey across Antarctic regions?

(b) Briefly detail how the project will meet these priorities.

We will achieve our understanding of the ecological relationships between whales and their prey through a nested tagging and prey mapping approach. At fine spatio-temporal scales we deploy multi-sensor suction cup tags that measure underwater kinematic patterns. Concurrent prey mapping surveys allow us to determine how the distribution and abundance of krill affect whale feeding. At broad spatio-temporal scales, we deploy satellite-linked time-depth recording tags. Analysis of these data will allow inference about the habitat use and movement patterns of whales over long periods of time. We then use ecological modelling techniques to determine where and when whales forage. We have conducted this research on 5 separate research cruises to date and plan to replicate these efforts in at least two other Antarctic regions through international collaborations over the duration of the proposed research. We will continue to conduct our work in the Antarctic Peninsula during this time.

6. Project methodology

Our ecological sampling methods, including tagging and prey mapping, have been published in numerous peer-reviewed publications. See Nowacek *et al.* 2011, Ware *et al.* 2010, Friedlaender *et al.* accepted, Friedlaender *et al*. in review for details.

7. Data collection

To date, we have conducted fine-scale tagging and prey mapping research on 3 research cruises around the Antarctic Peninsula in May 2009, May 2010, and February 2013. We have deployed satellite-linked tags on 2 research cruises to date in the same region in January 2012 and February 2013. Satellite tags were deployed in the Ross Sea in January 2013, and we have opportunities to deploy satellite tags in the Ross Sea again in 2014 and around the Antarctic Peninsula on platforms of opportunity in 2014-2015. We will work with collaborators to conduct tagging efforts in two other Antarctic regions over the next 5 years via dedicated ship time.

8. Data archiving and sharing

All data are housed and archived with the PIs at Duke University and the Australian Antarctic Division and are available to collaborators upon request. Satellite tag data are also archived at the SWFSC in La Jolla, CA.

9. Data analysis

Data analyses are currently underway for a majority of the tag and prey data that have been collected to date. However, supplemental support is required for the PI to dedicate the time necessary to complete analysis on the abundance of data collected on the most recent voyage. Furthermore, we will attempt to disseminate data among the collaborators to take advantage of supported researchers to help with data analysis (e.g. Australian Antarctic Division).

10. Other requirements necessary to achieve objectives listed (e.g., vessels, personnel, equipment)

Vessel time and satellite tags remain the most limiting commodities for our research. For our continued work around the Antarctic Peninsula, we will submit research proposals for ship time and use platforms of opportunity to deploy satellite tags. However, for fine-scale work, dedicated ship time is required. We will seek support from the IWC-SC to purchase satellite-linked TDR tags for work in 2014. Scientific Echosounders and multi-sensor suction cup tags are maintained by the PIs and available for use with our collaborators. We have been successful in using students to help conduct analyses, however, salary support is required for the PI to manage the research proposal, conduct research, analyse data, and generate publications.

11. Project work plan/timelines

Activity to be undertaken	Responsibility	Est. start date (mm/yy)	Est. finish date (mm/yy)
Project Management	PI	current	12/2017
Analysis of existing data	PI and collab.	current	12/2017
Antarctic Peninsula Research Cruise: fine-scale and satellite tagging	PI and collab.	01/14	03/14
Ross Sea tag deployments	Pitman	01/14	02/14
Plan Research cruise to new Antarctic region with stakeholders	Stakeholders, PI	01/15	03/15
Research cruise to new Antarctic region- planned by stakeholders	Stakeholders, PI	01/16	04/16
Research cruise to new Antarctic region- planned by stakeholders	Stakeholders, PI	01/17	04/17

12. Project outputs

Expected outputs	Date of completion (mm/yy)
Fine-scale foraging behavior of minke whales	06/13
Satellite-linked movement of humpback and minke whales	06/14
Ecological niche modelling of minke and humpback whales	06/14
Annual reports to SORP and IWC	Annually
Comparative analysis of ecological relationships between Antarctic regions	12/17

13. Project Governance

How will you manage the project to ensure it will be successful in achieving the objectives and any outputs listed?

The Principal Investigators and collaborators will communicate as necessary (through email, skype, phone) with respect to developing proposals, sharing data and methodologies, and writing of scientific papers. This process has been successful to date and including more collaborators in the future should not affect this mechanism. The PIs will also convene a meeting at the Biennial conference on the biology of marine mammals in December 2013 in New Zealand.

14. Project budget

(a) Provide an estimate of funds (GBP) required to achieve the project objectives listed.

Item (please specify each item)	**SORP funding sought (GBP)**	**Applicant Organisation contributions (GBP)**	**Other contributions** (provide name of contributor) **(GBP)**	**Total project budget (GBP)**
Research Cruise in 2014 (proposed)	0		National Science Foundation	65,000
Project Management 2014	7,500			10,000
Satellite tags for minke whales	0		IWC Scientific Committee***	60,000
TOTAL	7,500			135,000

***We will submit a proposal to the IWC Scientific Committee to purchase satellite-linked tags to deploy on minke whales in 2014 with the intent to seek continued support during the span of the project. We have secured platforms of opportunity to deploy these tags in 2014 in the Ross Sea and Antarctic Peninsula.

(b) Will the project share resources/equipment with any other projects?

Yes, as is necessary, we will provide equipment from the PIs, or will help to prioritise purchasing of equipment for future voyages in other areas with collaborators and stakeholders.

15. References

Friedlaender, AS, Johnston, DW, Fraser, WR, Burns, J, Halpin, PN, and Costa, DP. (2011) Ecological niche modeling of sympatric krill predators around Marguerite Bay, Western Antarctic Peninsula. Deep-Sea Research II 58: 1729-1740. doi:10.1016/j.dsr2.2010.11.018

Friedlaender, AS, Tyson, R., Stimpert, and Nowacek, D. Accepted with revisions. Extreme diel variation in the feeding behavior of humpback whales along the Western Antarctic Peninsula in autumn. Marine Ecology Progress Series.

Nowacek, DP, Friedlaender, AS, Halpin, PN, Hazen, EL, Johnston, DW, Read, AJ, Espinasse, B, Zhou, M, and Y Zhu. (2011) Super-aggregations of krill and humpback whales in Wilhelmina Bay, Antarctic Peninsula. PLOS One 6(4) e19173

Ware, C., Friedlaender, AS, and Nowacek D.P. (2010) Shallow and deep lunge feeding of humpback whales off the West Antarctic Peninsula. Marine Mammal Science. doi:10.1111/j.1748-7962.2010.00427.x

Annex A – Project planning workshop agenda

- Introduction to the session and participants
- Discussion of existing research program, results, and planned activities.
- Introduction of other National research programs and potential avenues for future collaboration and proposal writing for ship time in other Antarctic regions.
- Discussion of methodologies and analytical tools

Annex B – List of project planning workshop participants

Stakeholders are indicated with * and their contributions to the project listed

Name	**Contributions**
Elanor Bell (rapporteur)	
Nico de Bruyn	
Rochelle Constantine	
Rohan Currey	
Luciano Dalla Rosa*	Logistic support and tagging around

	the Antarctic Peninsula
Bill de la Mare	
Ken Findlay*	Logistic support for ship time for tagging around the Weddell Sea
Ari Friedlaender (chair)	
Naoko Funahashi	
Nicholas Gales	
Helena Herr*	Logistic support for ship time and tagging in the Weddell Sea
Bruce Mate	
Robert McCauley	
Hiroto Murase	
Robert Pitman*	Logistic support and tagging in the Ross Sea and Peninsula
Vincent Ridoux*	Logistic support for ship time for tagging in East Antarctica
Hyoung Chul Shin	
Salvatore Siciliano	

DISTRIBUTION AND EXTENT OF MIXING OF HUMPBACK WHALE POPULATIONS AROUND ANTARCTICA, UPDATED PROJECT PLAN - 2013

1. Project title

Distribution and connectivity of southern hemisphere humpback whales

2. Proponent(s) details

(f) Principal Investigators

	1	2
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(g) Co-investigators

	1	2
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Fax Number:		
Email:	Alex.Zerbini@noaa.gov	Mike.Double@aad.gov.au
	3	4
Title	Dr	Prof.
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Email:	Phillip.Clapham@noaa.gov	Scott.Baker@oregonstate.edu
	5	
Title	Dr	
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Fax Number:		
Email:	op.cetaces@lagoon.nc	

3. Key stakeholders

Are there other key stakeholders involved in the project and how will they contribute to this work?

	1	2
Institution:	American Samoa Department of Wildlife Resources, Pago Pago	
Contact:	Alden Tagarino	
Contribution/ Involvement in project:	Logistics and field work support	

4. Project objectives (please list)

To determine the migratory destinations and extent of mixing of Southern Hemisphere humpback whales around Antarctica.

5. Priority areas for future research

(a) List your priority research questions

1. The initial focus of this project is to identify the feeding grounds of humpback whales from the Oceania breeding grounds (Eii – F), focusing particularly on a central breeding site (American Samoa) that has documented connectivity to other parts of Oceania.

2. To determine the breeding ground origins of humpback whales on their southern migration past Raoul Island, New Zealand.

(b) Briefly detail how the project will meet these priorities.

We will determine the migration pathways and feeding ground destinations as well as assigning whales to their breeding ground origins through the use of satellite tags, genotyping and photo-identification. This project has access to fully reconciled genetic and photo-ID datasets from Oceania, and partial datasets from east Australia and Antarctica which will allow efficient matching of new data from the October 2014 field season.

6. Project methodology

The primary aim of the project is to deploy satellite tags on humpback whales in American Samoa and Raoul Island on their southern migration to their Antarctic feeding grounds. We will deploy the tags from small research vessels in October 2014. In addition to tagging whales, we will collect small tissue biopsy samples and photo-identification images of whale flukes using standard protocols to determine the sex and identity of individuals. These data will be matched to existing datasets from Australia, Oceania and Antarctic waters to assign linkages to breeding grounds – this will be particularly important for Raoul Island as the origins of these whales are currently unknown. A portion of the tissue biopsy samples will be preserved for future analyses, including potentially stable isotope analysis for comparison to unique C/N signatures that identify prey types. The whale's migration path will be tracked via the Argos system and spatially mapped using ArcGIS or equivalent tools.

7. Data collection

We will deploy 30 tags on adult humpback whales at each location (Raoul Island and American Samoa) in October 2014. This month has been chosen as it has the highest number of whales in each location. The

whales are migrating past Raoul Island and starting their migration from their American Samoan breeding grounds. We will concentrate our efforts on deploying the satellite tags and aim to spend a month in the field in each location to achieve this goal. Due to the lower concentrations of whales at American Samoa, tag deployments may continue over a longer period at that location.

Attempts will be made to photo-identify and biopsy as many whales as possible with a particular focus on the tagged whales in order to determine the sex and origins of these individuals. Once tags are deployed they will be tracked via the ARGOS system and tracks mapped using spatial analysis tools.

8. Data archiving and sharing

Photo-identification images and tissue samples will be curated by the co-PIs and incorporated into the South Pacific Whale Research Consortium archives. The best fluke image for each individual from Raoul Island and American Samoa will be shared with the Antarctic Humpback Whale Catalogue and will also be posted on a website for others to match their fluke photographs increasing the chance of finding linkages to feeding and breeding grounds.

Once analyses are complete, the genetic sequences of individuals will be submitted to GenBank (http://www.ncbi.nlm.nih.gov/genbank/) which will allow public access to these data. Access to sub-samples of the remaining tissue samples will follow IWC protocols for assessment of the validity of the research to answer questions of interest to the IWC.

9. Data analysis

The satellite tracks of the whales will be downloaded at regular intervals with a balance between informative fixes balanced with preservation of battery life. The direction, speed and spatial characteristics of the environment through which the whales pass will all be mapped and analysed. All photo-ID images of whale flukes will be quality controlled and the best photograph matched to existing catalogues. We will match these images to the South Pacific Whale Research Consortium catalogues of whales from New Caledonia to French Polynesia, including the New Zealand migratory corridor. The fluke photographs will be made available to other catalogue holders e.g., the AHWC curated by the College of the Atlantic, east Australian and Antarctic Peninsula catalogues.

Tissue samples will be extracted, sexed and sequenced using standard protocols. Mitochondrial DNA and microsatellite or SNP analyses will be used to determine breeding ground origins and linkages between whales. These data will be matched to existing genotype datasets available to us courtesy of the South Pacific Whale Research Consortium, Southern Cross University and the Australian Antarctic Division. Once all analyses are complete we will write manuscripts from this work for publication in peer-reviewed journals.

10. Other requirements necessary to achieve objectives listed (e.g., vessels, personnel, equipment)

Vessels: We will charter a live-aboard vessel capable of carrying the RIB required for tagging and a team of eight researchers for the duration of the research at Raoul Island. In American Samoa the research team will be land-based and use a small vessel to access the whales in coastal waters.

Personnel: Research teams will be required in both field sites. A total of eight personnel will be needed at Raoul Island and four in American Samoa.

Equipment: We have access to a RIB that will require modification to attach a tagging platform to the bow of this vessel for work at Raoul Island. We also have access to cameras for photo-ID and biopsy rifle and crossbow systems for tag and biopsy dart deployments. We require a minimum of 60 satellite tags and ARGOS satellite time for this research.

11. Project work plan/timelines

Activity to be undertaken	Responsibility	Est. start date (mm/yy)	Est. finish date (mm/yy)
Planning, logistics, preparation	RC, JR	06/13	09/14
Field season	RC, JR	10/14	11/14

12. Project outputs

Expected outputs	Date of completion (mm/yy)
IWC SC reports	06/15
Peer reviewed publications	12/15
Popular science outreach	12/15

13. Project Governance

How will you manage the project to ensure it will be successful in achieving the objectives and any outputs listed?

This research will be led by the co-PIs with logistical, analysis and publication support from the other members of the Humpback Connectivity committee. Each of the co-PIs will be responsible for their respective field sites (Constantine for Raoul Island and Robbins for American Samoa).

14. Project budget

(a) Provide an estimate of funds (GBP) required to achieve the project objectives listed.

Item (please specify each item)	**SORP funding sought (GBP)**	**Applicant Organisation contributions (GBP)**	**Other contributions** (provide name of contributor) **(GBP)**	**Total project budget (GBP)**
Vessel time: Raoul - 34 days American Samoa – 30 days	Raoul GBP 83,400 Am Sam GBP 23,400			106,800
Tags – 60 @ GBP1563/tag	GBP 94,000		AAD in kind support for some tags	94,000
ARGOS satellite time – 60 @ GBP315/tag	GBP 18,900			18,900
Personnel - casual (GBP100/day x 34 days x 5 people)	GBP17,000			17,000
Personnel - salaried			GBP12,000 In-kind personnel time Rochelle Constantine (University of Auckland); AAD	12,000

			tagging specialist; Alex Zerbini (NOAA); Jooke Robbins (PCWS)	
Accommodation & costs – American Samoa	GBP 650			650
Travel (US & Australia to field sites)	GBP 5,210			5210
Genotyping	GBP5,210			5210
Photo-ID analysis			1,500	1500
Database management	GBP1,500			1500
TOTAL	249,270		13,500	GBP262,770

(b) Will the project share resources/equipment with any other projects?

Protocols and expertise.

15. References

Not applicable.

Annex A – Project planning workshop agenda

Planning for 2014 field research
Isotope and fatty acid analyses
Future research

Annex B – List of project planning workshop participants

Name	Affiliation	Email
Rochelle Constantine	University of Auckland	r.constantine@auckland.ac.nz
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Nick Gales	Australian Antarctic Division	nick.gales@aad.gov.au
Luciano Dalla Rosa	Universidade Federal do Rio Grande	l.dalla@furg.br
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Naoko Funahashi	IFAW Japan	naokof@jca.apc.org
Carole Carlson	Provincetown Center for Coastal Studies	carolecarlson123@gmail.com

Annex C – Additional discussions/recommendations from project planning workshop

Constantine reviewed the history and scope of this project, as well as the status of current work. The project is intended to look at the mixing of breeding stocks across the Antarctic, and whales that breed in Oceania were identified as the first focus of this research. The Antarctic Whale Expedition (AWE) and data obtained opportunistically during the French CETA program in 2010 have confirmed the strong connectivity between the Balleny Islands and east Australia. Unfortunately, that work did not provide new information on the Antarctic areas used by whales from Oceania. Given the formidable challenges of field work in other potential Antarctic feeding areas, it was previously agreed that the more feasible approach was to tag whales on their breeding grounds at the end of the breeding season. The Kermadec Islands and American Samoa had previously been identified based on logistical considerations, including latitude and the late season availability of whales. The tagging work is currently planned for October, 2014. It has been delayed in part because of the findings of an independent project underway to evaluate and improve tag duration. Maximal tag duration is of prime importance to the project in light of the costs and the long migration distance. In the meantime, photo-ID and genetic matching has been underway to strengthen our understanding of movements and exchange with available data from Oceania.

On the topic of tagging, de Bruyn noted that there are polyurethane plastics now that could potentially be used in tag design to allow a tag to be rigid during deployment, but brittle enough to yield in the case of shearing forces.

A question was asked about the likely migration distance (or range of distances) to have a better sense of the minimum tag duration that is likely needed for project success. A formal calculation had not yet been done, but Constantine estimated 6-8 weeks minimum from the Kermadec Islands, based on previous tagging efforts at New Caledonia.

Logistical planning and the status of funding were discussed. Constantine noted that an appropriate vessel has been identified for work at the Kermadec Islands (primarily Raoul Island) and was expecting in-kind tagging support from AAD (a tagger and tags). The vessel that has been identified for that work has the ability to carry a larger inflatable and an appropriate RIB is available from the University of Auckland. She noted that designs for the tagging platform mounted on the bow of the RIB would be appreciated. Tagging at American Samoa would rely on local vessels and tagging staff from NMML (Alex Zerbini). With the exception of tags, the majority of equipment (cameras, cross-bows, etc) at both locations are already in hand. Funding is still being sought for project costs.

A number of questions were asked regarding the population migrating past the Kermadecs. Constantine noted that it is a late September-November peak and there are currently no photo-ID or genetic data with which to determine the breeding grounds used by these individuals. She will engage the resident New Zealand Department of Conservation staff to collect visual information beyond counts this winter, such as behaviour and the presence of cow/calf pairs. This would have to involve streamlining the shore observations to reduce the burden on the field staff.

The group discussed the feasibility of improving the understanding of Antarctic habitat use and mixing indirectly, through stable isotope analysis of tissue samples. It is not clear that there are significant longitudinal or regional-specific isotopic signals in krill. Matt Pinkerton (NIWA New Zealand) has krill data sets from the Ross Sea that could potentially be explored and also there are potential synergies with the ICED program, although this would be outside of the scope of this project. Dalla Rosa noted that both biopsies and krill samples from the Antarctic Peninsula were being analysed and this could be a useful comparison to Oceania if such work were to go forward. Preserving the biopsy samples would allow for these kinds of analyses in the future, should they be deemed feasible. Biogeochemical signals (transferred from seawater through the food chain) may be another future avenue to explore.
The group discussed priority areas for future work and the rationales for prioritisation. Much of the current IWC Comprehensive Assessment work on other breeding stocks has already been completed, but data gaps have been noted and could inform future work. There has also been long-term work by Zerbini to identify the migratory destinations of whales from Brazil and such work could potentially contribute to the goals of this project. Dalla Rosa highlighted the Weddell Sea as a possible area for research. The group agreed that if Brazillian or Argentinean research programs have the capacity and interest to undertake research in the Weddell Sea then this could be another potential useful SORP collaboration. Passive acoustics might be a useful tool to provide advance information on habitat use in advance of logistically difficult field research. It was agreed that this

topic would remain open to allow the input from SORP members and other relevant researchers that could not be present.

Siciliano presented a summary of the work they have been conducting on killer whales, southern right whales and including health assessments of humpback whales especially in light of a recent increase in mortality events along the Brazilian coastline.

Follow-up post-meeting:
During follow-up with interested parties who were not able to attend the working group meeting there were suggestions for potential future areas of interest with regards to humpback connectivity. Alex Zerbini reiterated the tagging research that has been occurring along the Brazilian coast is informing migration routes to breeding grounds. These data would be well supported by tag deployment in Antarctic regions south of South America to understand the northern migration. Dalla Rosa suggested the Chilean coast (Fuegian Channels) where data to date suggest a discrete feeding area from the Antarctic Peninsula. Miguel Iñiguez reiterated the low levels of humpback whale research by Argentina but would work towards supporting humpback research through access to their Coastguard vessel in the region if that would be of assistance.

Ken Findlay suggested the Antarctic region south of Africa, bordering Areas II and III and near the ice edge, to be an area of potential interest. There is a lack of information about this area and he believed there would be interest from the South African government as it has relevance to the whale watching industry in coastal waters. Zerbini commented that there are tagging initiatives in Madagascar and Reunion Islands planned for this coming summer so this may inform potential future work on humpback connectivity in the next phase of this SORP research initiative. Constantine will follow up with suggested parties that may have an ongoing interest in Antarctic humpback whales so people are informed about possible future work as part of this SORP program. In conclusion, the Oceania tagging work will be the priority for the next two to three years but we envisage other Antarctic regions becoming the focus of humpback whale Antarctic connectivity research within three to five years time.

MINKE WHALES IN ICE, POTENTIAL NEW PROJECT OR RESEARCH TO INTEGRATE INTO EXISTING SORP PROJECTS

1. Research under development

Importance of sea ice to the lifecycles of Antarctic minke whales

2. Proponent(s) details

(h) Principal Investigators

	1	2
Title	Dr	Drs
Name	Natalie Kelly	Ari Friedlaender/Nick Gales/ Helena Herr
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Address		
Phone Number		
Fax Number		
Email	natalie.kelly@csiro.au	asf7@duke.edu/ nick.gales@aad.gov.au/ Helena.Herr@tiho-hannover.de

(i) Co-investigators

	1	2
Title	Dr	Dr
Name:	Robert Pitman	Bill de la Mare
Institutional Affiliation:		Australian Antarctic Division
Address:		
Phone Number:		
Fax Number:		
Email:	robert.pitman@noaa.gov	bill.delamare@aad.gov.au

3. Key stakeholders

Are there other key stakeholders involved in the project and how will they contribute to this work?

	1	2
Institution:		
Contact:		
Contribution/ Involvement in project:		

4. Project objectives (please list)

The importance of the sea ice field to Antarctic minke whales has been known for many decades. However, given the difficulty of accessing sea ice habitat to study this species, its interactions with ice remains largely undescribed. So we consider the question: *What is the role of sea ice in the lifecycles of Antarctic minke whales?* one that encapsulates many potential research questions, the application of which span many temporal and spatial scales. Application of this question will first consider more local spatial scales, with the hope then to extend study sites or predictions around the whole Antarctic coastline, both inside and outside of the sea ice regions (this is in recognition of the fact that there may be regional features that influence how minkes occupy sea ice habitats). It may be considered that some of these research questions

are related to abundance and some are related to ecological interactions. However, these are far from being mutually exclusive and both will augment understanding of the other.

Underneath the overarching question we consider other more specific ones, see below in section 5 (not necessarily an exhaustive list and not in any particular order). Naturally, many of these relate directly to existing SORP projects (in particular, '*Foraging ecology and predator-prey interactions between baleen whales (minke and humpback) and krill'* and '*Distribution, relative abundance, migration patterns and foraging ecology of three ecotypes of killer whales in the Southern Ocean*.'). Methods, as described below in section 6, and subsequent data and inferences currently in development in these existing SORP projects will aid enormously in further formulating hypotheses and approaches for a future SORP project that will focus on minkes in and around sea ice or, if not deemed appropriate in the near future, research approaches to be applied under existing SORP projects.

5. Priority areas for future research

(a) List your priority research questions

Specific questions:

1. What is the nature of the abundance and distribution of this species in various types of sea ice conditions?

2. Why are minke whales distributed in the ice? Merely seeking higher densities of food that may be more accessible to smaller-bodied animals; or seeking food sources that aren't being accessed by larger baleen whales; or are they seeking shelter from Type-A killer whales? Is it likely that morphological features of minkes whales allow them to make use of sea ice in a way that larger baleen whales cannot?

3. Why are they found in high densities in large embayments (e.g., Ross or Weddell Seas)?

4. How do minke whales interact with intra- and inter-annual dynamics of the sea ice field? In particular, this includes how this they interact with dynamics in the sea ice edge, a feature that has long been associated with higher densities of this species?

5. What is the nature and variability in diving behaviour and foraging in different environments throughout the sea ice region (circumpolar)?

6. In relation to trends in sea ice distribution and extent, how might these trends, in the face of climate change, influence minke whale behaviours, distribution and abundance in and around sea ice field?

7. Equally, how might increases in the krill fishery, or, concomitantly, recovery of other baleen species influence minke whale behaviours, distribution and abundance?

8. How do minke whales distribute themselves relative to gender, body size or population structure?

9. What are characteristics of seasonal migration (if migration occurs at all for some individuals)?

10. What is the nature of longitudinal distributions of minke whales? Are animals moving far during a single season in order to forage more widely? Are these longitudinal distributions related to population structure? Or is it more to do with a random shuffle of animals seeking prey?

11. How quickly does the local distribution of minke whales change? Do larger groups of animals vacate/move into areas over the space of a day or so or do they tend to loiter over longer periods?

12. What is the availability bias for minke whales within various sea ice/open water habitats? (Estimate to help with estimating absolute abundance for diving animals during aerial surveys.)

13. What is the nature of minke whale vocalisations and how might these inform development of longer term acoustics approaches to study this species?

14. How might activities of minke whales in and around sea ice regions have influenced recent open-water abundance estimates from IDCR/SOWER sighting data?

15. How do we get a better total abundance estimate of minke whales given that some proportion of the population is in the ice field some of the time?

(b) Briefly detail how the project will meet these priorities.

To be determined if project concept is endorsed.

6. Project methodology

Overall approaches to tackle the above questions, with some extensions of methods applied under existing SORP projects to ensure methods are well developed and tested, and that application is efficient in terms of existing sampling frameworks. The following points also contains recommendations and organisational contacts to help kick-start some of these research items.

I. *Collecting and correlating prey field maps, fine-scale tagging data and high scale sea ice data* (start with local scales, such as WAP, Ross Sea, Casey station, then extend to other locations circumpolar as is logistically possible).

II. *Fine-scale tag data would both location (GPS)-only and time-depth recording*. See sections of SORP report on detailing existing SORP projects '*Foraging ecology and predator-prey interactions between baleen whales (minke and humpback) and krill'* and '*Distribution, relative abundance, migration patterns and foraging ecology of three ecotypes of killer whales in the Southern Ocean*' for more details on tagging methodology. Further to the point of extending tagging effort to other sites in the Antarctic, there does need to be an effort in identifying regions were feeding animals aggregate with reliable frequency (feeding animals in large groups tend to be easier to approach and tag/biopsy sample/photograph); reports from tourist ships about 'friendly' minkes might be helpful in identifying such areas. However, it should be noted that weather/sea conditions that are best for tag/biopsy deployment are usually found in sheltered areas (embayments, heavy ice), which may produce a bias in the subsequent results.

III. *Behaviours of animals relative to ice habitat types* can also be studied at local scales using focal follows.

IV. *Mapping/remote sensing of krill relative to dynamics of outer pack.* This would include krill species delineation in deep embayments, such as the Ross Sea. There will be major logistical constraints of mapping krill with hydroacoustics in ice, but this item should still be pursued as a possible approach under this research aim. Current or proposed research activities to be aware of include a NSF sponsored project using autonomous vehicles under the ice in Ross Sea (lead by Stacey Kemp) and the recent SIPEX II voyages conducted on the *Aurora Australis*. There have also been previous efforts to study high-scale patterns in krill distribution and abundance by researchers such as Andy Brierley.

V. *Studying sea ice dynamics across seasonal and regional resolutions.* There is still some way to go in terms of understanding the application and limitation of various remotely sensed sea ice datasets. One idea would be to consider combining remote sensing covariates to help predict concentrations at higher spatial resolutions as that currently offered with sea ice data. Could also consider finer-scale sea ice data, such as those from photos taken during aerials surveys. (Friedlaender and Kelly will to talk to sea ice data specialists.) Given the nature of this component, there is an excellent possibly to bring a Masters or PhD student in to produce a discrete body of work.

VI. *Using aerial surveys (helicopters, fixed-wing or drones) to explore distribution and abundance of animals in broader regions of sea ice.* Given that dedicated aerial surveys are going to be expensive, it might be that opportunistic flying will provide data concerning whale distribution, perhaps particularly with the collection of aerial photographs and video. It should be noted that there are currently German three proposals for time to run helicopter surveys from the Polarstern (Feindt-Herr for details). Kelly is currently developing (with collaborators) a proposal to trial drones in the Antarctic to study cetaceans. Other opportunities include BAS flights to/from Rothera (Kelly has already spoken to Iain Staniland at

BAS about this); a New Zealand proposal to study killer whales in the Ross Sea using aerial survey which could be extended to include minke whales (Pitman for more details); and potential to use aircraft contracted by Australian Antarctic Division (Kelly to pursue information).

VII. *Deployments of satellite tags/biopsies from platforms of opportunity across broader regions.* See item 1.1 above. This would be an example piggy-backing tagging (or biopsy and photo-ID; see item below) onto other projects/other marine science voyages. National polar programmes should be approached to inquire as to feasibility of this from their resupply/research vessels. Aerial ops also provide an opportunity to increase field sampling opportunities for tagging or biopsying (e.g., killer whale tagging currently facilitated by helicopter flights from McMurdo to fast ice regions of the Ross Sea. An immediate option of this might with the German helicopter survey programme running from the *Polarstern*.

VIII. *Photo-ID and biopsy studies to study a) abundance (over a number of decades) and b) site fidelity.* Again, sampling for this would begin in the WAP and Ross Sea and possibly Casey. As a side note, biopsies are concurrently collected with satellite tagging on the WAP with a 50-60% sampling success rate.

IX. *Photogrammetry for estimating animal size.* Photographs taken for individual identification (see item 4 above) could yield estimates of animal lengths when laser sights are fitted to cameras. This could also potentially be achieved using small remote control helicopters/drones. It may be possible to supply all taggers with such laser sights.

7. Data collection

e.g., Sample sizes, seasonal spread of sampling effort

8. Data archiving and sharing

e.g., Image catalogues, data repositories

9. Data analysis

To be determined.

10. Other requirements necessary to achieve objectives listed (e.g., vessels, personnel, equipment)

To be determined.

11. Project work plan/timelines

Activity to be undertaken	Responsibility	Est. start date (mm/yy)	Est. finish date (mm/yy)
Produce background document into ideas for researching minkes in sea ice.	Kelly with assistance of others	07/13	05/14

12. Project outputs

Expected outputs	Date of completion (mm/yy)
Produce an application for a new SORP project concerned with minke whales in sea ice to be delivered at IWC/SC/65b in 2015	06/15

13. Project Governance

How will you manage the project to ensure it will be successful in achieving the objectives and any outputs listed?

e.g. Steering committees, technical committees

14. Project budget

A budget is not provided because this project is under consideration.

15. References

Not applicable.

Annex A – Project planning workshop agenda

No agenda.

Annex B – List of project planning workshop participants

Name
Elanor Bell (rapporteur)
Mark Bravington
Bob Brownell
Ari Friedlaender
Phil Hammond
Natalie Kelly (Chair)
Bill de la Mare
Helena Feindt-Herr
Hiroto Murase
Robert Pitman
Hyoung Chul Shin
Kyum Joon Park
Victoria Wadley

APPENDIX 1 – SOUTHERN OCEAN RESEARCH PARTNERSHIP (SORP) CONFERENCE AGENDA

Jeju Island, Republic of Korea, 31 May - 2 April 2013

SORP conference, Day 1 – 31 May 2013

Presentations highlighting SORP project results, the challenges, funding required and the way forward (45 minute talks plus 15 minutes for discussion)

09:00 Introduction, purpose and scope of event (Nick Gales)

09:30 Antarctic Blue Whale Project (Phil Hammond, Natalie Kelly and Victoria Wadley)

10:30 Break

11:00 Blue and fin whale acoustic trends (Flore Samaran and Brian Miller)

12:00 Distribution, abundance, migration patterns and foraging ecology of killer whales (Robert Pitman, Luciano Dalla Rosa and Nico de Bruyn)

13:00 Lunch

14:30 Foraging ecology and predator-prey interactions between baleen whales (minke and humpback) and krill (Ari Friedlaender)

15:30 Distribution and extent of mixing of humpback whale populations around Antarctica (Rochelle Constantine)

16:30 Break

17:00 Proposals for new SORP projects: Minke whales in ice (Natalie Kelly)

17:30 Summary of Day 1 and scope for breakout sessions on Day 2

18:00 Close

SORP conference, Day 2 – 1 June 2013

	Lotus 3	Lotus 2	Lily
08:30 – 10:00	Plenary • Close-kin mark recapture (Mark Bravington) • Tagging (Jooke Robbins) • Medium term tag development (Bruce Mate)		
Break 10:00-10:30			
10:30 – 12:30	Antarctic blue whale project (Phil Hammond) • Project management I • ID of individual whales (i) photos and (ii) biopsies		Foraging ecology and predator-prey interactions between baleen whales (minke and humpback) and krill (Ari Friedlaender) • National programmes • Analytical tools • Methods and locations • Feedback on Ari's SC minke paper
Lunch 12:30-14:00			
14:00 – 15:30	Antarctic blue whale project (Phil Hammond) • Survey methods • Acoustic tracking • Pygmy vs ABWs • Data for acoustic trends project • Project management II		Distribution, abundance, migration patterns and foraging ecology of killer whales (Robert Pitman) • Platforms and opportunities • Tags
Break 15:30 – 16:00			
16:00 – 17:30	Acoustic trends of Antarctic blue and fin whales (Flore Samaran) • Collaborations • Blueprints • Paris meeting (2013)	Minke whales in ice (Natalie Kelly) • Big research questions • Current research • Alignment with existing projects	Distribution and extent of mixing of humpback whale populations around Antarctica (Rochelle Constantine) • Planning and funding for Oct 2014 fieldwork • Isotopic analyses

SORP conference, Day 3 – 2 June 2013

08:30 Antarctic blue whale project (Lotus 3)
Data requirements and sampling design
Satellite telemetry and other methods (plus talk from Daniel Palacios on habitat modelling)
Plans for future work

10:30 Break

11:00 Use of available national platforms (Lotus 3)

- Korean Antarctic Program and its research icebreaker, a new workhorse in the under-surveyed portion of Southern Ocean? (Hyoung Chul Shin)
- Argentinean ship time (Miguel Iñiguez)
- Brazilian polar programme contribution to SORP (Luciano Dalla Rosa)
- South African Blue Whale Project (Ken Findlay)

12:00 Lunch

13:30 Project reports from Day 2 (Lotus 3)

15:00 Break

15:30 Antarctic Blue Whale scientific steering committee meeting (Lily)

17:00 SORP scientific steering committee meeting (Lily)

18:00 Close

APPENDIX 2 – LIST OF PARTICIPANTS

The SORP conference was attended by 47 delegates from 16 countries, including representatives of the IWC Secretariat.

Name	E-mail
Argentina	
Miguel Iñiguez	miguel.iniguez@cethus.org
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