Report on the Arabian Sea Humpback Whale Workshop:

Developing a collaborative research and conservation strategy

Dubai, 27-29 January 2015

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Executive Summary

Humpback whales in the Arabian Sea (ASHWs) form a discrete population that is designated as an endangered "subpopulation" on the IUCN Red List of Threatened Species. The primary objective of the workshop was to bring together regional scientists and conservationists who share concern for ASHWs (and other cetaceans in the region) and to begin developing a unified, collaborative research and conservation strategy that could be readily communicated to governments, intergovernmental organizations non-governmental organizations, donors and research colleagues.

Researchers and international experts presented summaries of what is known about the distribution, biology and threats to humpback whales in each of the represented Arabian Sea range states, as well as information about research techniques and tools for collaboration that could facilitate the implementation of a regional conservation-based research strategy.

Participants identified the main threats to whales in the region and knowledge gaps that must be filled in order to assess and protect ASHWs. Almost all current knowledge about this population is based on data collected in the Sultanate of Oman, which is the only country in which dedicated humpback whale research has taken place in recent years. The shortage of information on the population's full range and population size outside of Oman is one of the most significant impediments to the pursuit of a regional conservation strategy. Many of the workshop recommendations focus on harnessing the formal and informal networks and capacity of participants to fill these knowledge gaps.

The workshop made the following recommendations for follow-up action:

1. Form an Arabian Sea Humpback Whale Research Network: To include development of a mission statement and objectives and a clear set of conservation- and research-related roles for the members

2. Identify a focal point in each ASHW range state responsible for liaising with the network coordination team and for 1) verification and documentation of all ASHW stranding and sighting reports, 2) working with local communities, coastguards and others to collect data opportunistically and 3) assistance in drafting funding proposals and research plans for country-based or cross-border priority areas (in the most likely suspected current range of ASHW)

3. Develop a common (web-based) platform for sharing documents, data and research protocols among network members. To include, if possible, a regional Photo-ID matching platform.

4. Establish data-sharing agreements for any web-based/group-wide data repositories, and memoranda of understanding between partners who embark on shared analyses to ensure proper data ownership and publication rights.

5. Produce a "glossy" presentation of ASHW background and conservation concerns that network partners can use to raise awareness and attract funding.

6. Engage in dedicated fund-raising efforts to support network coordination and research activities at both national and regional scales.

7. Implement regional research activities that include passive acoustic monitoring at strategic locations, dedicated boat surveys for genetic sampling, photo-Identification and collecting data on distribution and numbers, and further analyses of acoustic and genetic data already obtained from Oman and other locations.

8. Create a common pool of equipment and other resources that can be used for research and analysis in different range states as required

9. Encourage Master's and PhD candidates from range states to conduct research and conservation work on ASHWs.

10. Execute a large-scale GIS exercise - mapping all known/confirmed ASHW sightings (with effort indices when available) and strandings for analysis of spatial/temporal trends, as well as overlap with known threats (e.g. shipping lanes, high-density fisheries that use gillnets or vertical lines, oil and gas exploration and development sites).

11. Maintain liaisons with international and inter-governmental organisations that can support the network's aims and objectives and ensure that network findings/results are applied toward regional and international management and conservation frameworks.

1 Background

1.1 Introduction from the Chair (Randall Reeves)

The chair, speaking on behalf of the organizers and sponsors, provided some background on the workshop's origins and rationale. As explained in more detail below, humpback whales (*Megaptera novaeangliae*) in the Arabian Sea form a discrete population that is designated as an Endangered "subpopulation" on the IUCN Red List of Threatened Species (http://www.iucnredlist.org/details/132835/0). As such, this population has become a global priority for both research and conservation. It is recognized as a conservation priority by the International Whaling Commission (IWC) and by various national and international bodies including the Convention on Migratory Species (CMS) and the IUCN. In 2014 the U.S. Marine Mammal Commission funded a proposal from WWF-Pakistan to hold a workshop intended to help stimulate interest and guide investment in research planning for Arabian Sea humpback whales (ASHWs). It was understood that this would be a technical workshop bringing together researchers who have worked or are working on cetaceans in the region and that it would lead to an immediate strategy for presentation to authorities and potential funders.

Organization of the workshop was led by WWF-Pakistan in close coordination with other WWF offices, Emirates Wildlife Society (EWS), Wildlife Conservation Society (WCS) and Environment Society of Oman (ESO). A brief pre-workshop organizational meeting took place immediately before the annual meeting of the IWC Scientific Committee in Bled, Slovenia, in June 2014. In addition to the major funding provided by the Marine Mammal Commission, significant financial and in-kind support was provided by these other partners.

The primary objective of the workshop was to bring together regional scientists and conservationists engaged in research and conservation of ASHWs (and other cetaceans in the region) and to initiate the development of a unified, collaborative research and conservation strategy that could be readily communicated to governments, intergovernmental organizations (IGOs), non-governmental organizations (NGOs), donors and research colleagues. Such a strategy would:

1. Identify Knowledge and Conservation gaps
2. Identify and prioritise research and conservation activities
3. Identify meaningful and achievable outcomes, and
4. Provide guidance on how to achieve such outcomes

While discussions and outcomes were to focus principally on ASHWs, it was assumed that strategies and planned activities would also benefit other baleen whales in the region, specifically Bryde's whales (*Balaenoptera edeni*) and blue whales (*B. musculus*). An effort was made to include representatives from Arabian Sea coastal range states from Yemen to Sri Lanka and the Maldives. Historical records, recent sightings, and strandings indicate that humpback whales are at least occasionally present in the waters of these states.

On the western side of the northern and central Indian Ocean, Southern Hemisphere humpback whales (IWC Stock C) migrate between the Antarctic and the east coast of Africa as far north as Somalia, Kenya and Tanzania where they are present primarily between June and November. There are no confirmed humpback whale sightings outside of this period in East Africa and East African waters appear to serve as a calving and breeding ground for a Southern Hemisphere population of humpback whales, with no indication of a regular link to the Arabian Sea. In the eastern extent of the Arabian Sea, a few sightings and strandings in the Maldives indicate that this archipelago may be an area of overlap or exchange between Southern Hemisphere and Arabian Sea populations.

The ASHW population is the only known non-migratory population of humpback whales in the world. However, apart from recent studies off the coast of Oman, very little is known about the Arabian Sea

population's current range, ecology and population status. The first session of the workshop focused on providing participants with an overview of what is known on the population's status and history.

1.2 Summary of Arabian Sea Humpback Whale population status and knowledge

1.2.1 The Unfolding Mystery: The Arabian Sea Humpback Whale – the only known non-migratory population of humpback whales in the world - Gianna Minton, WWF Gabon/Environment Society Oman (ESO) and Andrew Willson, ESO

Early records of humpback whales from the Arabian Sea region include whaling data and observations collected from merchant vessels (Brown 1957; Slijper *et al.* 1964; Wray & Martin 1980). No feasible migration routes could link this population to areas where humpback whales are known to congregate in high latitudes of the Northern Hemisphere, and it was formerly assumed that these animals belonged to a Southern Hemisphere Indian Ocean or Pacific stock. However, these early observers were unable to account for sightings made in the Arabian Sea during the austral summer. In a review of records in the northern Indian Ocean, Reeves *et al.* (1991) explored the hypothesis that some humpback whales are year-round residents in the Arabian Sea. Evidence revealed in the late 1990s that 242 humpback whales had been killed illegally off Oman, India and Pakistan in November 1965 and 1966 (Mikhalev 1997; Mikhalev 2000) supported the hypothesis that Arabian Sea humpback whales are a distinct stock that adheres to a Northern Hemisphere breeding schedule.

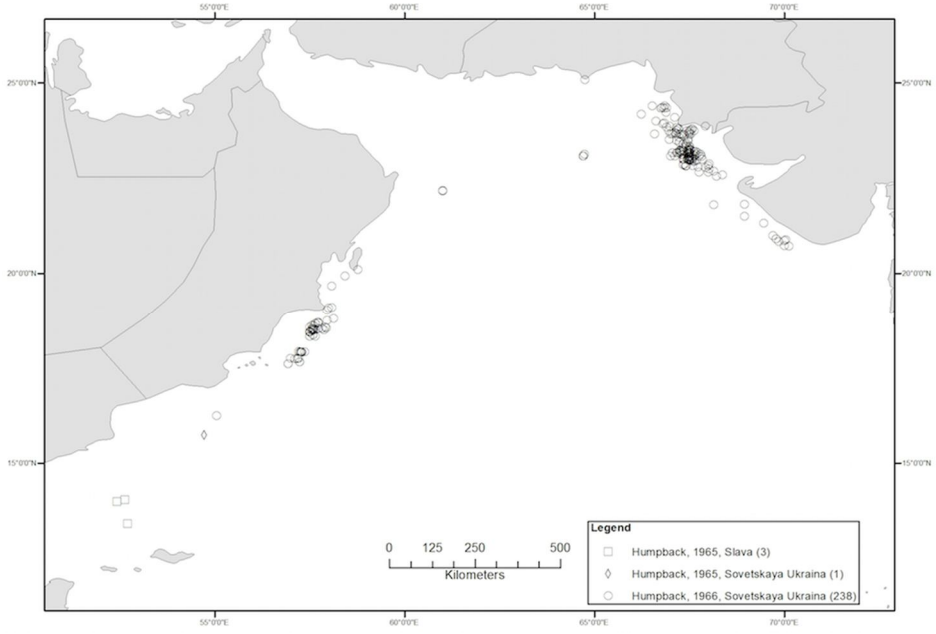


Figure 1. Soviet-era humpback whale catch locations in the Arabian Sea, 1965-66. Source: IWC.

High primary productivity associated with strong monsoon-driven upwelling in the Arabian Sea apparently creates conditions suitable for feeding at latitudes where humpback whale breeding activity typically occurs (Reeves et al. 1991; Mikhalev 1997; Papastavrou & Van Waerebeek 1997; Baldwin 2000). Over 50% of the humpback whales killed and processed in the Arabian Sea (n=190) had full stomachs (Mikhalev 2000), indicating that feeding occurred there during the austral summer, when Southern Hemisphere populations are primarily feeding in the Southern Ocean. In addition, biological data on reproductive females and calf lengths indicated a reproductive cycle in line with Northern Hemisphere populations (Mikhalev 2000).

Those historical data, together with sightings of humpback whales from a seismic survey vessel off Oman in 1997 (Baldwin 2000), prompted a group of volunteer scientists to initiate a series of small-boat surveys

between 2000 and 2004 (Minton et al. 2010b). Their primary aim was to investigate the current distribution and status of humpback whales in the waters of Oman. Humpback whales were observed during surveys in Dhofar and the Gulf of Masirah on Oman's Arabian Sea coast, but not during surveys in the Muscat region in the Gulf of Oman. A roughly even ratio of males and females was genetically sampled in the Gulf of Masirah, which was surveyed in October and November, while almost all whales sampled in Dhofar in February/March were male. Song was detected frequently in the bay surrounding the Halaniyat Islands (formerly known as Kuria Muria Bay) in February and March, but observations of mother-calf pairs were sparse, and competitive groups were absent. Feeding was observed in both October/November and February/March, but behavioural and environmental observations suggest that the Gulf of Masirah is primarily a feeding ground, while the song incidence in the Dhofar region, particularly Halaniyat Bay, suggested this may be a breeding area (Minton et al. 2011).

A later analysis of the same small-boat survey data using a method that accounted for spatial auto-correlation confirmed that the "hotspots" identified in the Gulf of Masirah and Dhofar were a true reflection of animal distribution and not an artefact of haphazard sampling (Corkeron et al. 2011). Such "hotspots" have been further supported by survey effort off Oman in 2006, 2010, 2011, and 2014, when three satellite tags were placed on three male whales off the Dhofar coast (Environment Society Oman, unpublished data).

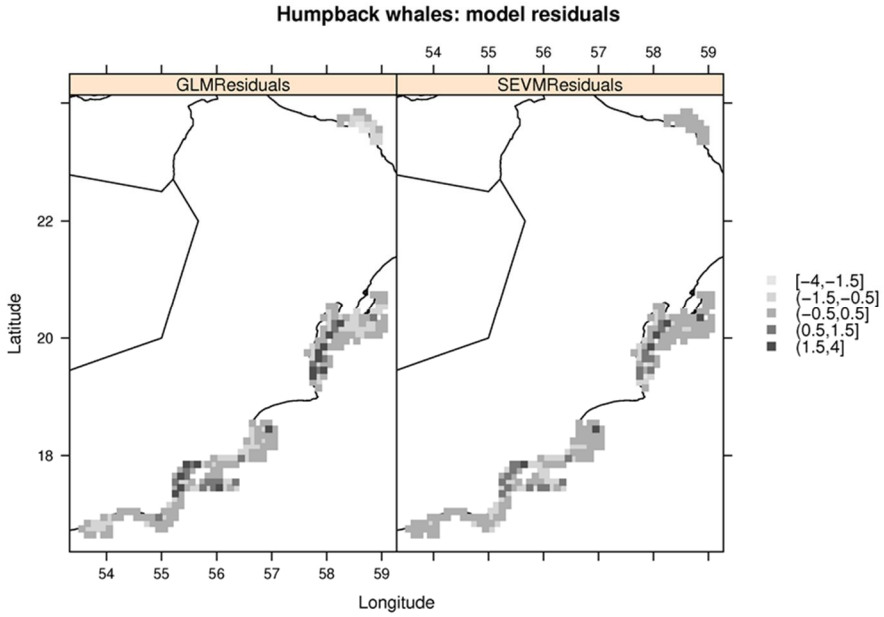


Figure 2. Plots of humpback whale relative density based on GLM and Eigenvector models using encounter rate data from small-boat surveys off Oman between 2000 and 2004. The highest densities were in the Dhofar to the south and the Gulf of Masirah to the north. Source: – Corkeron et al. (2011).

A Chapman's modified Petersen mark-recapture estimator was applied to various data pairings of tail fluke photos collected between 2000 and 2004 to calculate population abundance. All pairings yielded estimates of fewer than 100 individuals in the sampled population. A preferred estimate of 82 individuals (95% CI 60-111), all photographed in Oman, was used in a 2008 Red List assessment that led to designation of the ASHW subpopulation as Endangered (Minton et al. 2008).

Comparison of animals in the Oman photo-identification catalogue with those photographed in Zanzibar, Antongil Bay (Madagascar), Mayotte, Geyser Atoll (Comoros Archipelago), Mozambique and South Africa yielded no photographic matches (Minton et al. 2010a). This result is consistent with the hypothesis of a discrete population in the Arabian Sea, which is further supported by genetic analyses (e.g. Pomilla et al. 2014 See more detail below). Tattoo Skin Disease (TSD) is a recently identified and increasingly prevalent condition

in ASHWs (Van Bressem et al. 2014). Photographs indicate that the condition has spread rapidly across the population (or at least the portion of the population observed in Oman) during the past 15 years. TSD may signify that the individual's health is compromised and that it is at elevated risk of disease. TSD typically occurs in toothed cetaceans (odontocetes) and this is the first documentation of the disease in humpback whales globally. The prevalence of TSD amongst ASHWs may also be a reflection their isolation.

1.2.2 Taxonomic Status of Arabian Sea Humpback Whales - Robert L. Brownell Jr., NOAA Fisheries, Southwest Fisheries Science Center, California

The Society for Marine Mammalogy's Committee on Taxonomy recently issued the following statement regarding humpback whale taxonomy (*www.marinemammalscience.org*, consulted on 30 January 2015): "Jackson et al. (2014) have recognized three subspecies of the humpback whale based on mtDNA and DNA relationships and distribution: *Megaptera novaeangliae kuzira* (North Pacific), *M. n. novaeangliae* (North Atlantic) and *M. n. australis* (Southern Hemisphere)." The Committee has accepted this subspecies breakdown.

Recent genetic analyses (Pomilla, Amaral et al. 2014), provides justification for the review of the Arabian Sea humpback whale population as a fourth subspecies. The nominal species *Megaptera indica* (Gervais 1883) appears to provide an appropriate trinomial for such a subspecies (*M. n. indica*), but the type specimen needs to be examined and its genetic identity confirmed before such a name is formally applied.

2 Regional strengths, challenges and opportunities – range state reviews

Range state reviews were presented, following a template circulated in advance of the workshop that requested information on:

5. Strengths - e.g. ongoing monitoring and research, results related to humpback whales (and other balaenopterids), internal and external sources of data and funding,
6. Challenges or problems, and
7. Opportunities for future work.

These reviews are summarised below.

2.1 Yemen/Gulf of Aden, Red Sea and Somali Coast – Robert Baldwin, Five Oceans Environmental Services

There is currently no dedicated cetacean research or monitoring in Yemen, Somalia or the Gulf Aden and security/political concerns limit the potential for field study there. Existing sources of data include whaling records (especially Soviet whaling in the mid-1960s), aerial and small-boat surveys conducted along the Somaliland coast by IUCN in the late 1990s and incidental (opportunistic) records, most recently from a GEF/UNEP project at Socotra Island run by the Yemen Environment Protection Agency. These data suggest that humpback whales occur only rarely in the Gulf of Aden. Records in the extreme north of the Red Sea (off Egypt and Israel and in the Gulf of Aqaba) months include a sighting in 1998 and eight further sightings between 2006 and 2012 (including a mother-calf pair) (G. Notarbartolo di Sciara, pers. comm.). These records imply passage through not only the Gulf of Aden, but also the entire Red Sea or an isolated Red Sea population (these animals have not been photographically identified in the Oman photo-identification catalogue). A Southern Hemisphere male humpback whale instrumented with a satellite tag in northern Madagascar in 2012 was tracked to the East Africa mainland, and was heading northwards along the Somali coast at approximately 3° N when the signal was lost. The distribution of humpback whales off Oman is thought to extend at least to the Yemen border (Yukhov 1969), and very likely continues westwards from the border to some extent. The origin of the humpback whales observed in the Red Sea remains uncertain; they could be part of the Arabian Sea population or they could be part of the northern most extent of Southern Hemisphere migrants.

2.2 The Sultanate of Oman – Suaad al Harthi, Environment Society of Oman

Whale and dolphin research and conservation in Oman consist of two main types of ongoing monitoring:

- Stranding surveys and response: Collection of specimens by the Oman Natural History Museum has been ongoing since 1985. Stranding responses are coordinated through the National Stranding Response Committee, which is hosted by the Ministry of Environment and Climate Affairs. Responders collect samples, and all photographs are centrally archived.

- Boat-based field surveys: Dedicated field surveys have been ongoing since 2000, focusing on photo-identification, biopsies for genetic analyses, some localised acoustic recordings, leading to estimation of relative abundance. Passive acoustic monitoring began in 2011 in order to obtain year-round presence-absence information from the known hotspots of Halaniyat Bay and the Gulf of Masirah. Satellite tagging was initiated in 2014 specifically to understand broader-scale movements and residency periods within these same hotspots. Movements and residency times outside the hotspots and during the summer South West monsoon months are poorly known.

These efforts in Oman include advocacy and conservation Action in the following arenas:

1. Government liaison: The Environment Society of Oman (ESO) provides project updates and scientific findings to the Ministry of Environment and Climate Affairs and the Ministry of Agriculture and Fisheries.

2. Port Industry Advocacy: A forum was established by ESO to highlight issues related to shipping activities within sensitive whale habitats.

3. Whale and dolphin watching guidelines: A government- and industry-supported programme, jointly funded by the ESO and IWC, was initiated in 2013 to develop and disseminate whale and dolphin watching guidelines. Follow-up work and a strategy are expected in 2015.

4. Industry collaborations: Data from industry are used to inform mitigation measures for seismic surveys and shipping. Collaborative relationships have been established between ESO and Five Oceans Environmental Services (5OES) on the one hand and various industry representatives on the other. Some details are given under Item 3.2.6.

These activities have generated the following data that are used to aid conservation and management of cetaceans:

1. Survey data: From dedicated boat-based surveys since 1999 (15 survey periods) including effort, sightings, photographs, processed photograph metadata, biopsy samples for genetic analysis, GPS tracks, and boat-based acoustic recordings and metadata.

2. Oman Cetacean Database (OMCD): This Access database, hosted by ESO and curated by experts involved in the surveys, includes opportunistic and survey sightings records, from 1955 to present.

3. Oman humpback whale photo-ID catalogue: This Access catalogue, hosted by ESO and curated by experts associated with the surveys, includes all vetted photographs of humpback whales obtained since 1986 (total of 86 different individuals at the time of this workshop).

4. Oman passive acoustic monitoring data: These archived acoustic record files with associated metadata, hosted by ESO and curated by experts associated with the surveys, includes records from six deployment sites in two study areas over two years between 2011 and 2013.

5. Oman cetacean strandings database: This Access database (currently in excess of 1150 records), with no defined host and curated independently by experts in the 5OES office, contains information on cetacean strandings throughout Oman from 1955 to the present, including data obtained from both dedicated beach surveys and opportunistic reports. It is linked to an archive of photographs of stranded cetaceans.

6. Oman cetacean tissue sample archive: This archive, hosted by 5OES and curated independently by experts in the 5OES office, consists of tissue samples collected from stranded carcasses and live animals (via biopsy). Ownership of the material varies. There is routine exchange of samples with WCS and research partners at the Sackler Institute of Conservation Genomics at the American Museum of Natural History.

Capacity: Significant capacity for ASHW research and conservation work exists in Oman. Among the important themes from a researcher's perspective are the gathering of "third-party" data, interviews, strandings, vessel surveys, remote sensing, laboratory processing, and data archiving and processing. Many of these have been and are being addressed through partnerships. Programme weaknesses are in the areas of bycatch data gathering (particularly via onboard observers) and advanced stranding response (detailed necropsies, handling of live animals, etc.).

Sources of Funding: Two funding models are noteworthy. In 1999-2010, field research was enabled by in-kind donations of equipment and other resources and by volunteered time from specialists. From 2011 to the present, field surveys have been fully funded from private sector corporate and social responsibility budgets (particularly Renaissance SAOG). Grants have also been provided by the IWC. Specialist research continues to be supported in-kind by organisations including WCS (genetics and field work) and NOAA (satellite tagging).

Threats: Fishing is viewed as a chronic and severe threat and probably the most serious threat for ASHW in Oman. Around 30-40% of individuals in the Oman photo-identification catalogue bear signs of net entanglement. The ASHW hotspot in the Gulf of Masirah is a particularly problematic area. The issues of habitat modification and competition for prey with fisheries are poorly understood. Port development and shipping are increasing and will continue to do so with the expansion of Salalah and Sohar ports and construction of the new multi-purpose port within prime humpback whale habitat at Duqm. Recent seismic surveys in the Gulf of Masirah have raised concerns about noise and potential oil pollution.

Political Support: Responsibility for cetacean conservation is shared by the Ministry of Environment and Climate Affairs (MECA) and the Ministry of Agriculture and Fisheries Wealth (MAFW). MECA chairs the National Stranding Response Committee. MAFW is responsible for cetaceans as marine biological resources and the IWC Commissioner is appointed from this ministry. ESO has collaborated with MECA, MAFW and Sultan Qaboos University on a community-based bycatch assessment project on Masirah Island. This project has support for continuation into the future.

Opportunities: ESO provides a platform for establishing research partnerships, bringing expertise into Oman and applying for and managing funding. Links with government facilitate obtaining permits. Ongoing field research led by specialists provides opportunities for Omani and regional colleagues to gain valuable experience. The Masirah bycatch project has been identified as a priority for continuation and it will require further technical support and partnerships. Other opportunities exist to manage shipping and vessel routing with respect to sensitive whale areas.

2.3 Islamic Republic of Iran – Hamed al Moshiri and Elnaz Jafari, Plan for the Land Society

Plan 4 the Land in Iran has established a stranding network that conducts intertidal zone and coastal water surveys, carcass sampling from strandings and genetic analyses. We are trying to improve public knowledge about marine mammals, from indigenous people to stakeholders and decision makers, especially people whose livelihoods depend on the sea. Despite many stranding reports of various small cetacean species in recent years, we have only one confirmed record of a humpback whale, a juvenile caught in fishing net off of Qeshm Island near the Straits of Hormuz in July 2012. The animal was freed by local fishermen before scientists could sample it or take good photographs, but some poor-quality video confirms the species identification.

Among the challenges faced are the following:

- Sanctions that limit exchange with outside countries.
- Lack of research or laboratory facilities.
- Lack of national marine mammal protection legislation though improvement is expected in the near future.
- Unsustainable and illegal fishing, which threatens not only marine mammals but also the entire environment. A stronger legal basis and fisheries enforcement are needed.
- Rapid coastal development
- Military exercises and activities
- Scarcity of direct interaction with international experts and funding bodies

Opportunities:

- Further development of the national stranding network
- Plan for the Land has a good working relationship with the Department of Environment as well as some other stakeholders
- Enthusiastic volunteers and experts who are always ready to contribute to our activities
- Good relations with some international experts

2.4 Status of Humpback Whales and Marine Cetacean Research in Pakistan – Muhammad Shoaib Kiani, Institute of Marine Science, University of Karachi

Knowledge of humpback whales in Pakistan is derived mainly from strandings and net entanglement records, other beach-cast remains, illegal Soviet whaling records and incidental or opportunistic observations. Apart from these, no dedicated research or monitoring programs exist. All available records are archived at the Centre of Excellence in Marine Biology/Institute of Marine Science, University of Karachi. The methods used to verify and archive information from third-party sightings and strandings need to be aligned with regional protocols. A review of information on baleen whales is currently underway with the intention of developing a peer-reviewed publication. In the meantime, the available records are being used for advocacy and awareness-raising. Active research is hampered mainly by lack of funding, logistics and prevailing security conditions. The most prominent achievements in recent years were the adoption of a graduate-level marine mammal course at the University and the preparation of a Pakistan National Cetacean Action Plan. Efforts are underway to develop collaborations with industry.

Research is boosted by increasing interest in cetacean research among students, good coverage in print and electronic media, receptive coastal fishing communities, an informal strandings network and motivated NGOs like WWF-Pakistan, IUCN and small local research/conservation groups. Locally significant threats include unregulated fisheries, habitat degradation, pollution, shipping/marine traffic, and oil and gas exploration.

Political interest and support are generally forthcoming once a strong and convincing case has been presented, e.g. for inclusion of cetaceans in the Balochistan and Sindh Wildlife Acts and for completion of basic work to declare the first two marine protected areas in Pakistan. Many positive factors are present that should enable Pakistan to conduct credible humpback whale research and thereby contribute to regional and international efforts to understand and conserve the ASHW population. The current scenario indicates that this research will be treated as a high priority now and in the future, which gives hope for the continued survival of this population.

2.5 India – Dipani Sutaria, James Cook University, Australia (presentation delivered via Skype)

There have been confirmed sightings of three species of baleen whales in Indian waters – blue whales, humpback whales and Bryde's whales. Of these, Bryde's whales are the most common on both the east and west coasts. Blue whales and humpback whales are both rare and endangered in this region. Despite an active stranding network and regular beach patrols for turtle research on the east coast, humpback whales have been reported only from the west coast, mainly in the northern Arabian Sea. No dedicated research on baleen whales has been carried out in India, even though all marine mammals are listed in Schedule I of the Wildlife Protection Act (1972).

Historical data show that Soviet whalers killed 164 humpback whales off the Gulf of Kutch, Gujarat, and an additional 12 close to the Gulf of Khambhat over a 10-day period in 1966 (Mikhalev 1997). Records prior to 2006 need to be re-assessed to verify the species of baleen whale reported. Since 2006, there have been a few confirmed records of humpback whales off Gujarat:

- The carcass of a juvenile was found in Mundra, Gujarat, in 2013.
- The Coast Guard reported sightings in 2006 off the coast of Jakhau and in 2008 off the coast of Jakhau, but photographs are available only for 2006.
- Fishermen off the coast of Porbandar-Veraval rescued a humpback whale from fishing net in 2008 (documented by photos, videos, and media articles).
- In 2014 the National Institute of Ocean Technology, Chennai, reported that it had a recording of humpback whale song from near Cochin, Kerala (SW coast of India). Whether this represents a whale moving south from the Arabian Sea or north from around Sri Lanka is uncertain.

Waters off Gujarat seem to provide suitable habitat for humpback whales. They are highly productive and biologically diverse, supporting shrimp, squid, lobster and elasmobranch fisheries. The continental shelf is very wide, slopes gently and extends in some places to 300 km from shore. Fishermen from all over India come there to fish as the Indus River empties into the Arabian Sea just at the border between India and Pakistan, driving high productivity. The region is thus important not only for whales but also more generally for biological diversity and richness. Whale sightings are common all through the year, bur more so between November and April, for Gujarat fishers.

The research team, led by the author and made up of seven scientists based in different locations in India, has prioritised understanding the spatial and temporal aspects of whale distribution along the coast of Gujarat because this is considered a potential hotspot. An IWC-funded project currently underway is seeking to map distribution through interviews and opportunistic vessel surveys as a preliminary step towards designing and resourcing a series of dedicated transect surveys. The teams intend to work in four locations off the west coast of India (Gujarat, Maharashtra, Kerala and Lakshadweep). Work is planned in Gujarat and thereafter at the other sites, thus forming a baleen whale research network on the west coast. All of the research teams have basic drop/dip hydrophone systems to record underwater sound. Work will be carried out in collaboration with the Indian Coast Guard, captains and crew of fishing boats, and captains of local shipping and transport vessels (dhows). Workshops will cover basic information on marine mammals (specifically humpback whales),

data collection protocols for humpback whales, and disentanglement training when possible. All information collected via our project will be shared with the ASHW network.

2.6 Sri Lanka – Asha de Vos, The Sri Lankan Blue Whale Project

Given the low frequency of occurrence of humpback whales in Sri Lankan waters, a dedicated project for this species does not exist. In the recent past, data have been gathered through opportunistic encounters by whale-watch operators, underwater photographers, ship crews and research projects focussing on other species. Humpback whale records from Sri Lanka amount to approximately 20 sightings and strandings between 1846 and 2014. Current limited data indicate that sightings and strandings occur in all months apart from May, June, July and August. However these data need to be critically evaluated to verify that they are indeed all humpback whales. Challenges to collecting data include a lack of funds and logistics. As the southern coast of Sri Lanka is the site of one of the busiest shipping lanes in the world, ship-strike is potentially the biggest threat to all large whales in that area. Incidental catch, which includes entanglement and bycatch, is also important as it can result in death. Other potential stressors include oil and gas development and pollution.

Sri Lankan authorities, which include the Department of Wildlife Conservation, the Coast Guard and the National Aquatic Research and Development Agency, have shown growing interest in and support for all aspects of large whale research within Sri Lankan waters. There appears to be a number of opportunities, which include private sector engagement, engagement with the Sri Lanka Ports Authority and similar collaborations. There are also opportunities for data sharing. Photographs of a humpback whale recently sighted off southern Sri Lanka were compared with ESO's photo-ID catalogue from Oman, demonstrating one of the opportunities for collaboration amongst stakeholders within the region.

2.7 Maldives – Charles Anderson, Independent Researcher

Humpback whales are rare in the Maldives. There are no humpback whale strandings amongst 200 or so known records and there is only one sighting amongst around 5000 sightings from cetacean surveys. However, 19 reports (supported by photos or detailed descriptions) have been received from third parties (mostly divers). These sighting records fall into two seasonal groups: (1) During June-October (peak in August-September) humpbacks have been recorded in the central and southern Maldives; these are believed to be migrants from the Southern Ocean. (2) During December-January (plus one record in April) humpbacks have been recorded in the central and northern Maldives; these are believed to be Arabian Sea animals.

3 What needs to be known to improve the conservation status of ASHWs

The following sessions of the workshop focused on assessing knowledge gaps and threats that need to be addressed in order to design effective conservation measures on both national and regional levels. The first group of presentations concerned knowledge gaps related to the biology and distribution of ASHWs, while the second suite of presentations concerned potential and known threats to whales in the Arabian Sea.

3.1 Biology

3.1.1 Regional Stranding Records: usefulness for determining range in absence of other data – Robert L. Brownell Jr., NOAA Fisheries, Southwest Fisheries Science Center, California

There are several reports every year of stranded baleen whales in the Arabian Sea and these can be used to help determine the current range and distribution of the ASHW population. However, the reports often contain too few details to confirm the size of the animal, species, cause of death etc. Unfortunately, species identity and body size often prove to have been reported incorrectly once reliable data are obtained (if and when they are). Therefore, we need to find a better way to ensure that data on these stranded whales are

collected and reported correctly, especially when they are humpbacks. Most new reports on stranded whales initially come from newspaper, television and the so-called social media (Facebook, Twitter etc.). All of these sources need to be used more effectively to obtain detailed and reliable information on stranded baleen whales.

Better ways to confirm species identification and determine whether the cause of death was related to human activities such as fishing (entanglement) or ship traffic (ship-strike) are required as is a focal point in each range state to compile the documentation and data from strandings. The minimum data needed to identify the species include at least one of the following:

- a photograph showing the lateral or dorsal side of head, the dorsal fin, a flipper, and/or the flukes,
- a count of the ventral groves, and, when possible,
- a skin sample and/or a baleen plate for identification purposes via genetics (preferably stored in ethanol or DMSO, but if neither of those is available, then stored in vodka or packed in dry salt and kept at moderate temperatures),
- Ear bones and scapula are also very valuable for confirmation of baleen whale species identity.

Past records of humpback whales in the Arabian Sea region need to be re-examined and the species confirmed. Sometimes the cause of death can be determined. The best approach might be to begin by trying to re-examine strandings by country. Each record of a humpback whale stranding needs to be accompanied by a statement on how the species identification was confirmed.

3.1.2 IUCN Red List Status – Randall Reeves, Chairman, IUCN/SSC Cetacean Specialist Group

As mentioned above, the Arabian Sea population of humpback whales was red-listed as Endangered in 2008 (Minton et al. 2008), whilst the humpback whale globally (at the species level) is listed as Least Concern. This population's Endangered listing was justified because it met the population size criterion of fewer than 250 mature individuals. The assessment noted that even if the current estimate of 82 animals (95% CI 60-111) all told (mature and immature) was an underestimate, it was "plausible" that there were fewer than 250 mature individuals. In fact, a total population of just over 400 would be required for the mature component (probably around 62%) to be as high as 250 individuals. It was considered "highly unlikely" that there were that many even if the estimate of 82 was strongly biased downward.

Thus, while its size may be underestimated somewhat, the ASHW population is definitely small, possibly declining and in serious trouble. In the near future, it may be found to qualify for listing as Critically Endangered. The population size criterion (Criterion D; see http://jr.iucnredlist.org/documents/redlist_cats_crit_en.pdf) for Critically Endangered status is fewer than 50 mature individuals, and 62% of 82 would be 51. It is possible that the ASHW population would also qualify for Critically Endangered according to at least one other criterion (C), which requires fewer than 250 mature (same as Endangered) *and* a continuing decline in numbers.

Discussion: Following this presentation, participants briefly discussed whether the ASHW population should be reassessed and considered for Critically Endangered status. It was generally agreed that while ongoing threats and recent genetic analyses indicating that the population is declining do provide some potential cause for re-assessment (see Items 3.1.3 and 3.2.3), too little is known about the population's current range, and broader-scale sampling (photographic and biopsy) is needed in areas other than Oman. The workshop concluded that it would be useful to carry out a study similar to that of Reeves et al. (1991) in which all records from the northern Indian Ocean are plotted temporally to search for possible trends or patterns in humpback whale distribution.

3.1.3 Genetics and health – Howard Rosenbaum, Ocean Giants Program, Global Conservation Programs, Wildlife Conservation Society (presentation delivered via Skype)

A regional assessment of population structure was conducted using 1,527 samples collected from whales at 14 sampling sites within the Southwest and Southeast Atlantic, the Southwest Indian Ocean, and northern Indian Ocean (IWC Breeding Stocks A, B, C, and ASHW, respectively). The results showed statistically highly significant mtDNA differentiation and isolation of ASHWs compared to the other stocks (Rosenbaum et al. 2009). A subsequent analysis of 11 microsatellite markers and mtDNA sequences extracted from 67 ASHW tissue samples showed significant genetic differentiation of the ASHW population from Southern Hemisphere breeding stocks (Pomilla, Amaral et al. 2014). While ASHWs likely originated from a population in the southern Indian Ocean, they have been isolated for approximately 70,000 years. Genetic diversity values were significantly lower than those obtained for Southern Hemisphere populations and signatures of ancient (~15,000 years ago) and recent (20th century) genetic bottlenecks were identified. These findings suggest that ASHWs are the world's most isolated humpback whale population. Pomilla, Amaral et al. (2014) concluded that, given the small size of the population, the threats it faces and the implications of their genetic results, its Red List status should be changed from Endangered to Critically Endangered.

An informal working group (led by Rosenbaum) had engaged in an e-mail discussion prior to the workshop to outline the next phases of possible genetic work (Appendix 6.4). Some of the tasks outlined, including the sexing of samples obtained since 2006, are deliverables under funding recently awarded by the IWC (Annex H, SC 2014).

Questions that could be addressed through genetic analyses include: 1) clarification of the taxonomic status of the ASHW population; 2) confirmation of the stock of origin (i.e. founder population) and an improved estimate of the duration of isolation using additional, more informative nuclear markers; 3) better understanding of genetic variability (by inferring a family tree of pedigrees) and assessment of potential inbreeding depression; 4) assessment of population health status (by assessing genetic variability of immune genes, e.g. the major histocompatibility complex); 5) estimation of individual ages (using DNA methylation techniques to include in mark-recapture analyses); 6) mapping habitat use by sexes and kin-group to inform spatial conservation measures; 7) incorporation of satellite tracking and small vessel survey data into spatial analyses of habitat use; and 8) consideration of the genetic potential for adaptation to climate change. These questions were ranked according to conservation importance and feasibility given likely sample sizes and other constraints (Appendix 6.4). Acquiring and analyzing samples from more of this population's known or suspected range was considered to be extremely important.

3.2 Threats

3.2.1 Acoustic Ecology and Anthropogenic Noise – Salvatore Cerchio, Wildlife Conservation Society

Humpback whales are known for their great diversity of vocalizations and the regularity and predictability of their vocal behaviour. Their sounds can be broadly classified into: *song*, a male breeding display; *social sounds*, all classes, likely having a communicative function; and *feeding cries*, likely aiding prey herding and/or coordinated foraging. Thus sound is clearly important to critical life functions. Humpback whale song has been studied extensively, and several fundamental features are shared among populations globally. All males in a population sing the same patterns (themes and phrases), and these change over time, with all males learning changes. Thus cultural transmission is considered a key component of singing behaviour, and populations that have demographic exchange of individuals share songs and song similarity is an indication of interaction and connectivity between populations. Whales in the South Indo-Atlantic region (Brazil, Gabon, Madagascar) all share the same song types, indicating relatively extensive interaction (Darling et al. 2005, Razafindrakoto et al. 2009, and Murray et al. 2012). Whales from Western Australia, share some but few

similarities with these regions, indicating limited interaction, but some exchange. Conversely, in a preliminary assessment, songs from the Arabian Sea (Oman) showed no similarities with Southern Hemisphere populations, another indication of this population's isolation (S. Cerchio pers. Obs.). Together, these studies of regional variation illustrate the power of song analysis for making inferences on population connectivity.

Because humpback whales vocalize frequently, Passive Acoustic Monitoring (PAM) for song and social sounds using stationary archival recorders is a highly effective method for assessing distribution across broad spatial and temporal scales. As an example, long-term PAM was used off northern Angola to document the complete migratory cycle of the humpback whale population as well as identify previously unrecognized breeding habitat, and provide inferences on spatial occurrence relative to shore and depth (Cherchio et al. 2010). In addition, PAM can provide valuable data on other species, such as blue whales, Bryde's whales, sperm whales and delphinid species (if recording across a broad frequency range). The information provided by such long-term monitoring studies in the Arabian Sea would be immediately applicable to conservation planning and impact assessment (e.g. in relation to offshore hydrocarbon development), without the need of more costly vessel surveys in difficult offshore waters.

A wide range of human activities produce underwater noise with the potential for impacts on cetaceans, including offshore oil and gas development, bathymetric and geophysical exploration (i.e., bottom mapping and seismic surveys), vessel traffic (including commercial freight, fishing, tourism, transportation, etc.), navy activities, and offshore alternative energy development (i.e., wind and tidal). There is potential for disturbance of breeding and resting behaviour, masking of communication, and even physiological damage (i.e. to hearing) if in close proximity or with long exposures to loud noises. Numerous studies globally have documented behavioural responses, such as changes in travel routes and distribution, and most recently more subtle responses such as shifts in vocal behaviour, to seismic airguns, echo sounders, navy sonar and ship noise (e.g. Richardson et al. 1995) In the Angola study mentioned above, seismic surveys were shown to affect humpback whale singing activity: the number of singers decreased with increasing loudness of nearby airgun pulses, suggesting that breeding displays were disrupted by whales either ceasing to sing or moving out of the area (Cherchio et al. 2014). It was also shown that noise from hydrocarbon exploration and production activities and vessel traffic contributes significantly to ambient noise within the communication bandwidth of humpback whales, likely acting to mask communication and breeding displays. Given the prevalence of oil and gas activities and ship traffic in the Arabian Sea, these same threats are clearly present. Furthermore, considering the endangered status and extremely low numbers of ASHWs, they may be much more at risk from such threats than other more robust populations. As an example of how to address and mitigate these threats, a result chain analysis was provided, with the objective of at least ceasing seismic survey activity in sensitive areas during the humpback whale breeding season. This would require the following activities: definition of areas of industry activity and important breeding habitat, development of direct tests of impacts, and development and implementation of mitigation measures by working with relevant state agencies and industry.

3.2.2 Entanglement – David Mattila, International Whaling Commission

Through the work of its Scientific Committee, the IWC has a long history of investigating accidental whale deaths caused by human activities. In 2010 the Commission held the first international expert workshop on the issue of welfare concerns associated with whale entanglement (IWC/62/15, found at http://iwc.int/entanglement). The workshop reviewed information available at the time, including reports describing entanglements, strandings data and inferences from studies of diagnostic scarring. It was noted that all large whales can become entangled and that while certain types of passive fishing gear may represent greater risks (e.g. gillnets, pot and set-net gear), whales can become entangled in any rope or net whether anchored or drifting in the water column. Entanglement can occur wherever whales and passive gear overlap and whales often drag the gear over thousands of kilometers. For a variety of reasons, the frequency of entanglement is generally under-estimated, and probably greatly so. While entanglement is both a welfare and

conservation problem for whales, it is also a safety and economic concern for humans. While recognizing that prevention of entanglement is the best solution for both whales and fishermen, the workshop recommended building global capacity for gathering data and responding to entanglement events, until preventative solutions are found.

A second workshop was convened in 2011 (IWC/64/WKM&AWIrep1, found at: http://iwc.int/entanglement) to develop a strategy and curriculum for capacity building based on consensus "principles and guidelines" (http://iwc.int/best-practice-guidelines-for-entanglement-response). It identified an expert advisory group of individuals to carry out the capacity-building initiative (http://iwc.int/entanglement-response-network). Working with governments engaged through the IWC, we have trained over 300 individuals in more than 20 countries since the beginning of 2012. The training events have often been hosted in partnership with other IGOs such as the UNEP Regional Seas programmes in the Greater Caribbean and the South Pacific and with regional agreements such as the Cartagena Convention and the Permanent Commission of the South Pacific. This work has been funded by national governments, IGOs and NGOs. Given the endangered status of ASHWs and their known interactions with fishing gear, the Arabian Sea region is considered a high priority for capacity-building efforts.

3.2.3 Using Spatial Ecology to Address Threats: an Example from Oman – Andrew Willson, Environment Society of Oman

Data from small-boat surveys conducted off the coast of Oman between 2001 and 2012 have been analysed to map the relative density of humpback whales and effort-corrected distribution maps reveal that a few core locations are used by the whales within the Gulf of Masirah (GOM) and to a lesser extent Halaniyat Bay. Whales are consistently present in the GOM year-round whereas they are present in the Halaniyat Bay mainly from January to April, during which time activities associated with breeding (song and surface active behaviour among males) are observed. Density plots from best daily satellite-derived locations of tracks of three individual males tagged in 2014 also support the notion that the GOM and the Halaniyat Bay provide important habitat. In the GOM, higher-use areas were adjacent to Duqm Port and in the north of the GOM.

The threats to humpback (and other baleen) whales in Oman can be readily summarized and classified as follows:

- Ports and shipping – ship strikes associated with port operations and ship navigation routes.
- Fishing – entanglement in gillnets and discarded nets, competition for prey.
- Offshore oil and gas development – awarding of concession areas, exploration (seismic), risks of spills once production under way.
- Coastal development – ports, bridges, access roads.
- Underwater noise and the increasing risks of toxic spills are associated with all above activities.

"Threat layers" overlaid on the habitat utilization maps show that humpback whales are exposed to a multitude of threats in Omani waters. Overlay maps have been shared with industry and government representatives to alert them to the fact that new development activities are likely to compound the existing risks to the whales. Among the activities of greatest concern are the following:

- There is an increasing dependence on surface-drifting gillnets, with more than 200 vessels of over 24 m length and more than a thousand skiffs deployed in the Gulf of Masirah alone. These nets may be up to 3km in length.
- Oman's largest fishing port is currently being constructed south of Duqm.
- A multi-purpose port is being constructed and developed in Duqm, involving drydock, petrochemical, container, bulk, and military facilities.

- Three new harbours are being developed in Halaniyats Bay.
- Fast-ferry (40+ knots) routes are appearing along broad areas of coastline.
- Marine seismic surveys have been conducted and others are planned in the Gulf of Masirah and other areas, to be followed by hydrocarbon drilling and test production phases.
- An oil tank farm and offshore loading facility are planned
- Coastal construction is under and more is planned, e.g. the city of Duqm, a 20 km bridge between the mainland and Masirah Island.

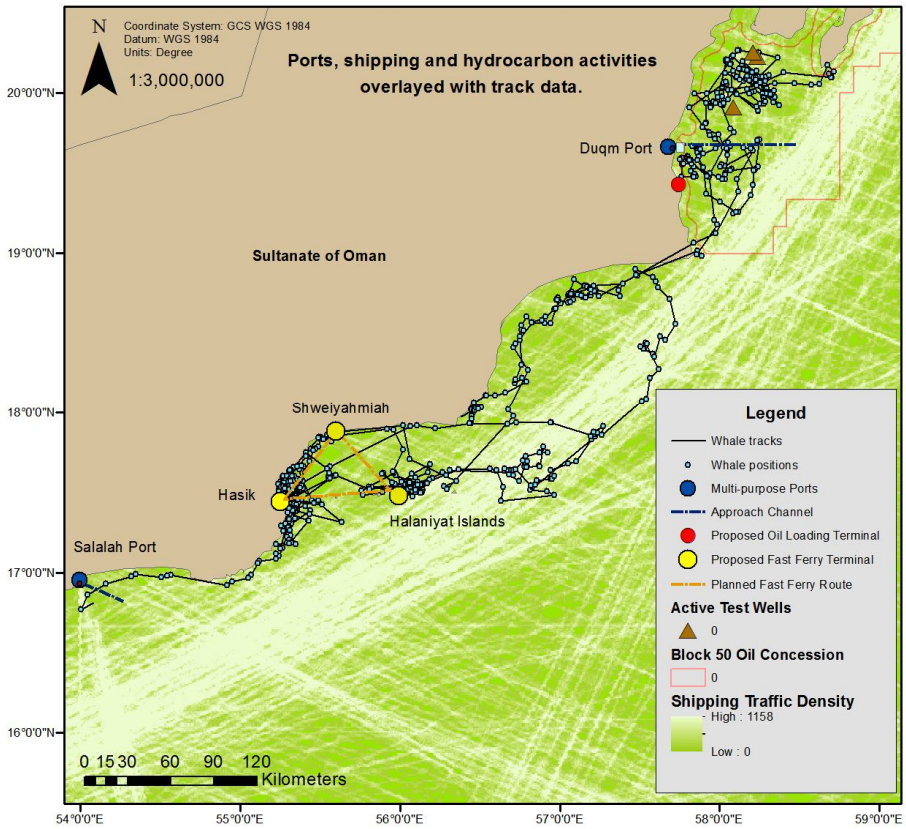


Figure 3. Example of a map developed to inform the Oman government on the overlap between humpback whale habitat (in this case based on positions derived from satellite tagged individuals), and existing and planned industrial and infrastructure development.

Previous mapping of baleen whale strandings revealed a high incidence within the Gulf of Masirah, particularly along its northern coastline. The incidence of strandings appears to correlate with threat exposure but this apparent correlation requires further study.

Among high priorities for mitigation planning in Oman are the provision of cetacean habitat sensitivity maps, feasibility assessment of fisheries entanglement mitigation options, review of port navigation routes, and critical evaluation of conditions placed on permits for seismic surveys. An improved understanding of spatial ecology is required to advance those priorities, and such understanding can be sought through acoustic data analysis, broad-scale vessel surveys and additional with satellite tracking. At the same time, it is necessary to strengthen communication links with industry officials and government authorities so that they are aware of options for mitigating the threat factors.

3.2.4 Indian Ocean Fisheries Bycatch – Charles Anderson, Independent Researcher

Within the Indian Ocean, the major oceanic fisheries are those for tuna. The average annual catch of tuna and related species in the Indian Ocean was just over 1.5 million tonnes during 2008-12. Of this, almost 1.1 million

tonnes (71%) came from the western and central Indian Ocean. The main fisheries for tuna and tuna-like species in the region are gillnet (40% of reported catch during 2008-12), purse seine (26%), longline (12%), handline and troll (11%) and pole and line (9%). A recent overview of interactions between cetaceans and these fisheries was given by Anderson (2014).

Major gillnet fishing nations include Iran, India, Sri Lanka, Pakistan, Oman and Yemen (all ASHW range states). Cetacean bycatch must be large, but is poorly documented. A rough but conservative estimation, based on the limited published information available, suggests that something in excess of 60,000 small cetaceans are taken as bycatch each year by western and central Indian Ocean tuna fisheries. The number of humpback whales entangled each year is unknown. There is an urgent need for monitoring and management of these fisheries including the development of mitigation methods to reduce cetacean bycatch. Large-scale gillnetting on the high seas (using nets in excess of 2.5 km length) is banned by both UN convention and IOTC resolution, but is being carried out illegally by Iran, Pakistan and possibly other countries; improved compliance is urgently needed. More generally, the large and still expanding gillnet capacity within the region needs to be capped and reduced.

Purse seining in the western and central Indian Ocean is dominated by French and Spanish fleets. An increasing proportion of sets is made on drifting fish aggregating devices (FADs) but there has been, and continues to be, a considerable number of sets made on free schools (i.e. non-FAD-associated tuna schools). Most cetaceans do not regularly associate with FADs and the major potential cetacean interactions are with free school sets. During 1981-1999, 9.6% of all sets were reported to have been made in association with baleen whales, probably mostly Bryde's whales (*Balaenoptera sp.*). When encircled, most whales are reported to escape by breaking through the net. The scale of mortality is unknown, but may have been of the order of 10s annually. The association of free schools of large yellowfin tuna with dolphins (mostly pantropical spotted dolphins *Stenella attenuata* and spinner dolphins *Stenella longrostris*) is more contentious. This association (which is common in the Eastern Tropical Pacific and is exploited by the purse seine fishery there) has always been reported to be rare in the western Indian Ocean. However, the tuna-dolphin association is common in many coastal areas of the region and widespread in the high seas of the western Indian Ocean north of 10°S. Setting on dolphin schools has also been reported to be rare, but its true scale is questionable. Setting on cetaceans has recently been banned by EU regulation (2007) and IOTC resolution (2013), so cetacean bycatch and mortality should be much reduced in the future. Complete (100%) coverage of the purse seine fleet by international observers would be ideal.

Longline fisheries were dominated for several decades by East Asian nations, but now increasing catches are made by coastal countries (notably India, Sri Lanka and Seychelles). A major issue for longliners is depredation – removal of bait and hooked fish by sharks and cetaceans. Several species of cetacean have been implicated, but the main one appears to be the false killer whale (*Pseudorca crassidens*). There is also some entanglement of cetaceans in longlines. Longline effort in the northern Arabian Sea has been high in the recent past, but the number of humpback whale entanglements is unknown. Development of mitigation measures (to deter both depredation and entanglement) is on-going and needs to be continued.

There has been a widespread failure to monitor and manage cetacean bycatch in Indian Ocean tuna fisheries, and to develop and implement mitigation measures. The enormous, and still growing, gillnet capacity in the region should be of particular concern. There is a need for increased observer coverage of all fisheries, supplemented by electronic monitoring.

3.2.5 Assessment of bycatch mortality in the tuna gillnets fisheries of Pakistan – Rab Nawaz, WWF Pakistan

Each year hundreds of gillnet boats sail from ports in Sindh and Baluchistan in search of high-value fish such as tuna, swordfish and mackerel. Due to the nature of the fishing gear, often gillnets kilometers long, many non-

target species such as sharks, dolphins, whales (including ASHWs) and turtles become entangled and die (bycatch). An initiative by WWF Pakistan is currently addressing the problem of poor information on bycatch along the coastline of Pakistan. A 24-month long assessment of bycatch mortality in tuna gillnets fishing was implemented between April 2012 and May 2014 and this represents a first step towards developing a mitigation strategy to protect threatened marine animals such as scalloped hammerheads (*Sphyrna lewini*), whale sharks (*Rhincodon typus*) and mammals such as Arabian Sea humpback whales. The initiative focuses on collecting data and raising awareness of skippers concerning the entanglement of non-target species in gillnets. The project collected data from more than 60 fishing trips from 2012 to 2104.

This is the first effort to better document Pakistan's gillnet fisheries. As part of the project, fishermen were trained on how to release animals safely. Those individuals are playing a crucial role by sharing their knowledge and experience with other fishermen and skippers who now follow the same practices to free endangered animals such as sea turtles, whale sharks and even manta rays. It is estimated that the tuna gillnet fleet has released around 6,000 green turtles and 28,000 olive Ridley turtles. Also, skippers have reported that at least five whale sharks and one manta ray were released safely back into the sea.

The project focused especially on cetacean mortality and it was estimated that approximately 11,000 cetaceans, including large baleen whales, were dying incidentally in tuna gillnets each year. These findings helped prompt the development of a cetacean action plan, which has been drafted and discussed with stakeholders. Information collected through this bycatch assessment will be incorporated into a strategy to protect the threatened marine mammals of Pakistan, to be prepared after consultation with the government and other stakeholders. This initiative will not only help protect animals from dying in gill-nets but also increase knowledge about marine life in the Indian Ocean and improve the potential for collaborative research in the region.

3.2.6 Port of Duqm, Oman, Whale Management and Mitigation Programme 2015 – Robert Baldwin, 5 Oceans Environmental Services, Oman

The Port of Duqm is located on the remote central Oman coast in an area where humpback whales are present in relatively high densities (see sections 1.1.1 and 3.2.3). It is a new, multipurpose industrial port and dry dock with a giant SEZ covering 1,777 km^2.

Five Oceans Environmental Services, an environmental consultancy company, has been commissioned by Port of Duqm Company (PDC) to develop a mitigation and management programme to help minimize the impacts of port construction and operations on whales. This mitigation programme, currently under development, aims to:

1. provide an understanding of whale habitats, movements, seasonality and sensitivity and of potential threats in and around the port area;
2. identify options for detecting and reporting whales and define a detailed response system (Detected-Report-Respond system) for mitigating impacts on whales, whilst also considering the safety of human life at sea and the security of assets;
3. integrate the system into PDC daily operations;
4. recognise the value of data collection, management and interpretation;
5. train key personnel; and
6. ensure that information is communicated to all relevant stakeholders.

Stakeholders include those at local, national and international levels. Among the latter is the International Maritime Organisation (IMO), which can, following a proposal from a member state, approve and adopt whale-related management and mitigation measures. Member states can then implement the actions arising from such measures.

To help develop the programme, several case studies were reviewed, including Boston Harbour, Glacier Bay (Alaska) and Santa Barbara Channel, California where whale-related management and mitigation programmes are already in place and operating. Literature and technology were reviewed to identify potential detection options, which include visual monitoring (shore- and vessel-based), satellite and radio tracking of whales, passive and active acoustic detection (such as through use of sonar and smart buoys), thermal imaging and other remote systems. Field identification (and training) materials support the detection aspect of the programme.

A system for reporting detected whales is under development. It includes a customised, low cost, low-tech decision support tool. The system is designed to be 'live', online, and accessible by multiple users, supported by basic software with Graphical User Interface and GIS format mapping tools. It enables automated report generation leading to a defined response as well as to automated database entry.

The response may require mitigation action, depending in part on the pre-defined zone in which the whale was detected. The response system includes a proximity alert, accompanied by a series of potential response actions classified according to the details of the detection and zonation. Special advice (and a trained Incident Response Team) is provided for incidents (ship strikes, entanglements, etc.) and activities/services under Environmental Permit (such as dredging, piling, and seismic surveys). Follow-up activities, after a response has been implemented, are also defined.

The main outputs of the programme will be:

- A handbook of guidelines and procedures for whale mitigation, monitoring and management at Port Duqm: D-R-R customised system and supporting software;
- Text for charts, pilot and notifications, including routing and speed limits;
- Sensitivity mapping and definition of spatial and temporal habitat use by whales;
- Whale identification guides, awareness program and materials;
- Distressed whale, stranding and entanglement response plans;
- Data collection, management and interpretation programme (including on-going research and monitoring requirements); and
- Trained personnel.

3.2.7 Ship-strikes of large whales in Sri Lanka: Conservation through science and engagement – Asha de Vos, The Sri Lankan Blue Whale Project

Ship-strike is the primary threat to large whales off Sri Lanka, particularly off the southern coast. As the main east-west route through the northern Indian Ocean, the southern coast of Sri Lanka supports one of the busiest shipping lanes in the world. Over 5,000 cargo ships larger than 10,000 GT transit this area every year (Kaluza et al. 2010). Based on satellite-derived commercial shipping density data, southern Sri Lanka is in the top 0.2% globally in terms of ship traffic (Eiden and Martinsen 2010).

The overlap between shipping lanes off southern Sri Lanka and habitat of large whales is high (de Vos, Pattiaratchi and Harcourt 2014). Total mortality due to ship-strike in this region is unknown, but during a 12-day period in 2012, two pygmy blue whales were struck and killed by vessels: one draped across the bow of a container ship which entered Colombo Harbour, the other found at sea off the south coast with large propeller gashes. In 2003 a Bryde's whale was found wrapped on the bow of a container ship which entered Colombo Harbour. De Vos and Brownell (de Vos, Wu and Brownell Jr. 2013) inferred from these and other incidents that various large whale species experience a relatively high incidence of ship-strike mortality off southern Sri Lanka. Clear evidence of deaths being caused by ship-strike is fairly rare. It is often difficult to ascertain the cause of death when the only basis is a decomposed beached carcass, and most ship-struck whales probably do not strand but rather sink offshore without being documented (Allison et al. 1991). Given this, it is likely

that the events reported by de Vos et al. (de Vos et al. 2013) are only a small fraction of the ship strikes that actually occur.

There has been a fourfold increase in global ship traffic since the early 1990s (Tournadre 2014), with the largest growth in the Indian Ocean and Western Pacific. Increases within this region reflect the redistribution of international trade and highlight the growing threat to all large whales, particularly off Sri Lanka where ship traffic is projected to increase due to expanded economic activity following the end of a thirty-year war (Ondaatjie 2011) and the construction of a new international port in Hambantota off the southeast coast, close to known foraging areas of pygmy blue whales. Given that large vessel traffic is projected to double in the next 10-20 years (Southall 2005), the recovery of populations of large whales, including both blue and humpback whales, could be limited by the ship-strike threat.

To address the issue in Sri Lanka we are using General Additive Models (2013) to relate the number of whales observed in each segment of ocean area to a number of habitat variables including temperature, salinity, and surface chlorophyll concentrations. The models will predict the number of whales present in 2 x 2 km grid squares and therefore whale density. The models will be ground-truthed through boat-based surveys using standard distance sampling methodology (Buckland et al. 2001).To determine ship movements within the study area (largely focused on the southern coast) we will use one year of ship Automatic Identification System (AIS) data to analyze traffic patterns of ships >100 m length. We will then consider a minimum of three alternative shipping routes based on transit analyses (alternatives will include existing routes comprising an inbound and outbound lane and a middle separation zone). We will overlay number of whales predicted by models in the 2 x 2 km grid cells on a map of each shipping route to assess risk. It is important to emphasize that we communicate regularly with relevant government stakeholders about the research and this outreach has helped to change the mindset and response of policy makers.

3.2.8 Large whale and ship collisions around the world: understanding and reducing impacts – David Mattila, International Whaling Commission

Through its Scientific Committee, the IWC attempts to improve understanding of where and in what circumstances whales are at the greatest risk from ship strikes. In order to assist this effort, the IWC has constructed a global ship-strike database, with a web-based entry capability. This database currently holds over 1,000 records (https://iwc.int/index.php?cID=872&cType=document). Given the endangered status of ASHWs, and the levels of ship traffic throughout the region, the IWC considers this cause of accidental mortality to be a potential impediment to the recovery of the population.

In order to understand the issue and develop recommendations for actions to reduce ship strikes globally, the IWC has held several workshops of technical experts, shipping representatives and International Maritime Organization representatives. At the most recent workshop (Panama, June 2014), technologies and actions used around the world to reduce ship strikes were reviewed. While some technologies may assist in the detection of whales in certain conditions, they all have shortcomings, and most cannot provide information in time for large vessels to undertake effective, strike-avoidance actions. Therefore the workshop agreed that currently the simplest and best way to prevent ship strikes is by planning voyage tracks so that they avoid areas with high concentrations of whales, and any Traffic Separation Scheme (TSS) proposed to the IMO should take whale distribution into consideration. If concentration areas cannot be avoided, then slowing vessel to 10 knots or less will significantly reduce the likelihood of fatal ship strikes. The IWC has partnered with the IMO to produce outreach materials for mariners on this issue, in Arabic, Chinese, English, French, Russian and Spanish (https://iwc.int/ship-strikes), and the IWC has obtained official observer status with the IMO. This enables the IWC to convey its recommendations directly to the IMO.

4 Tools and Resources Required for Collaboration

The next series of presentations focused on tools and resources that can be used to facilitate regional and international collaboration, ranging from informal networks of researchers to formal inter-governmental organisations. Practical examples were given of data sharing platforms and online databases, as well as software and tools for standardization of data collection protocols.

4.1 Developing Collaborative Frameworks – Ken Findlay, Mammal Research Institute Whale Unit, University of Pretoria

A brief overview of a number of Collaborative Frameworks was provided, each falling within four possible categories;

- Consortia and Partnerships;
- Research Projects;
- Research Programmes; and
- Data Sharing Agreements.

Advantages of Collaborative Frameworks were shown to outweigh disadvantages, although it was noted that dedicated administrative resources were often needed. Different examples of Collaborative Frameworks were provided including Consortia or Partnerships at a) multinational levels such as the Southern Ocean Research Partnership (SORP), or b) at regional levels such as the South Pacific Whale Research Consortium (SPWRC), or the Indo-South Atlantic Humpback Whale Consortium (ISACH- no longer operative), and project-based frameworks such as Structures of Populations, Levels of Abundance and Status of Humpbacks (SPLASH) and Years of the North Atlantic Humpback (YoNAH). A way forward for the development of a Collaborative Framework was suggested to include two components, namely:

- The definition of a series of regional research priorities that are achievable in the short term, and
- The parallel development of a Partnership to a) share resources, experience, data etc., b) facilitate opportunities for funding, exposure and advocacy through and c) align capacity and comparable methodologies.

Existing structures within the region or relevant to the region were not reviewed as these had been discussed earlier in the workshop.

Discussion: This session generated a great deal of discussion on how these models might be applied in the Arabian Sea region. Mattila pointed out that some of the most successful initiatives involving humpback whales arose from a simple desire to share data and compare photo-ID catalogues, and then built on additional projects and collaborations. He emphasized that data-sharing agreements and MoUs between partners that clearly state the conditions under which data can be shared and viewed and that stipulate authorship arrangements for any publications that arise from data comparisons/collaborations, are essential to making partnerships work. Lack of such written agreements can lead to misunderstanding and mistrust, which can ruin collaborations. Also, ensuring that MoUs are between organisations, rather than individuals, helps to ensure continuity, and regular (e.g. annual) face-to-face meetings are essential to maintain project momentum. This of course requires substantial funding. It was suggested that airlines and shipping companies, as well as international funding bodies, be considered as potential donors. “Branding” – e.g. through a catchy name or logo - may engender network cohesiveness as well as recognition by potential funders/contributors. Other factors that can increase the chances of successful collaborative projects are institutional support and endorsement by bodies like the IWC.

4.2 Inter-governmental Organisations (IGO's) and the opportunities they offer

4.2.1 IUCN and IWC – Randall Reeves, Chairman, IUCN/SSC Cetacean Specialist Group

IUCN and the IWC are among the international institutional structures that can facilitate collaborative networks of cetacean researchers and conservationists. In addition to the IUCN Species Survival Commission's (SSC's) Cetacean Specialist Group (a volunteer network of cetacean experts; http://www.iucn-csg.org/) and the Red List (see 3.1.2, above), a Marine Mammal Protected Area Task Force (MMPATF) was established in 2013 as a joint undertaking of the SSC and the IUCN World Commission on Protected Areas. This task force has been working closely with an International Committee on Marine Mammal Protected Areas to identify Important Marine Mammal Areas, which are meant to feed into some of the processes described by Glowka below under Item 4.2.2. It is expected that ASHWs (as well as blue whales and Bryde's whales) and areas known or suspected to be "important" to them will be highlighted by the MMPATF.

As mentioned a number of times elsewhere in this report (e.g. Items 1.2 and 3.2.8), the IWC has increasingly shown a strong interest in, and concern about, the ASHW population. The Standing Working Group on Conservation Management Plans (CMPs) (within the IWC's Conservation Committee) has recommended that "key range states" proceed to develop a CMP for this population (https://iwc.int/private/downloads/4932vjecqp0kk40ko8cskoco8/64-CC%2012%20Rev.pdf; also see https://iwc.int/conservation-management-plans). In addition, members and invited participants to the IWC's Scientific Committee are bound to continue presenting their results, proposals etc. concerning Arabian Sea baleen whales at annual meetings of the committee. It is also worth noting that the Scientific Committee at its meeting in June 2014 approved a proposal from Willson, Rosenbaum and Sutaria that included dedicated survey work across two field seasons in India and support for new genetic analyses of ASHW samples.

4.2.2 Convention on Migratory Species and EBSAs: Building the Basis for International Cooperation for Area-based Conservation Measures for Arabian Sea Humpback Whales and other Cetaceans – Lyle Glowka, Executive Coordinator, CMS Office – Abu Dhabi

The Convention on Migratory Species (CMS) is the only global biodiversity-related treaty aiming to conserve avian, terrestrial and marine migratory species. CMS has 120 Contracting Parties. Of countries thought to be ASHW range states, only the Maldives, Oman and the United Arab Emirates have yet to join CMS.

CMS is an appendix-driven convention. The listing of species and populations on Appendix I or II has legal implications for Contracting Party Range States. The blue whale and humpback whale are listed on Appendix I (species considered to be in danger of extinction) and Bryde's whale is listed on Appendix II (species requiring international cooperative measures to maintain or improve their conservation status). The humpback whale is also listed for "Concerted Action" and in a 2014 review, ASHWs were specifically mentioned by the CMS Scientific Council rapporteur for humpback whales (Howard Rosenbaum, WCS) who made some specific recommendations for future work (UN Doc. UNEP/CMS/ScC18/Inf.6.1.1/Rev.1).

CMS's promotes individual and cooperative State actions through a migratory range approach. There are several tools: (1) national level action (Convention obligations): reduce threats, eliminate obstacles to migration, conserve/restore habitat, strict protection (Appendix I species); (2) flag vessel jurisdiction (on the high seas); (3) CMS Conference of Parties (COP) resolutions: bycatch, gill nets, marine debris, underwater noise, cetaceans global programme; integrating migratory species considerations into national biodiversity strategies and action plans and environmental impact assessments; (4) cooperation with other IGOs (e.g. CITES, IWC (CMS-IWC memorandum of understanding), CBD (e.g. the EBSA process – see below); and (5) development and implementation of CMS Instruments to coordinate activities and promote cooperation among range states (legally binding treaties, memoranda of understanding and/or action plans). CMS has developed international agreements for seabirds, sharks, marine turtles, cetaceans and dugongs. Stand-alone

action plans include the recently adopted Pacific loggerhead turtle action plan. The CMS Dugong MoU work in the Arabian Gulf focuses on fisheries interactions such as entanglement and the CMS Office – Abu Dhabi is exploring entanglement as a common threat to marine turtles and cetaceans as well, hence interest in ASHWs.

The CMS has been promoting ecological networks as an area-based conservation tool to promote connectivity. This has developed in parallel to the CBD's process to identify and describe ecologically or biologically sensitive areas (EBSAs). The EBSA process synthesizes best available scientific and technical information to support expert scientific judgment on whether areas meet one or more of seven criteria: (1) uniqueness or rarity; (2) special importance for life history stages of species; (3) importance for threatened, endangered or declining species and/or habitats; (4) vulnerability, fragility, sensitivity, or slow recovery; (5) biological productivity; (6) biological diversity; and (7) naturalness. EBSA workshops collect, compile, analyse, synthesize and map spatially referenced data including those related to physical oceanography, seafloor geology, corals and other habitats, fisheries and species diversity including migratory seabirds, turtles and marine mammals. Between 2011 and 2014 eleven regional workshops took place resulting in 204 EBSAs being described for marine areas within and beyond the limits of national jurisdiction.

In 2015 the CBD will organize EBSA workshops for the Northwest Indian Ocean and Adjacent Sea Areas (April 2015, UAE) and the Northeast Indian Ocean (March 2015, Sri Lanka). Both workshops offer opportunities for the cetacean research and conservation community to make inputs that will put marine areas important to endangered populations and sub-populations such as ASHWs on the map and could later lead to the adoption of area-based and other conservation and management measures across their range.

4.3 Capacity building and "Animal Counting" toolkit – Tim Collins, Wildlife Conservation Society

Knowledge gaps for ASHWs are considerable and will be best addressed through a coordinated and collaborative effort, including collaborative research. Addressing many of the research questions will require targeted training. Improving capacity across the region will make the ASHW network more efficient and effective.

Chosen research methods should be rigorous and incorporate comparable analyses of comparable data. Some training will be required to achieve this, and given that some questions (for instance those related to abundance and distribution) are more important than others, training should be targeted at these priorities, at least initially. Any capacity building program also needs to be adaptive; cetacean science is constantly evolving and the most pertinent questions for ASHWs may well change through time. There is a clear need for routine assessment of the directions being taken.

A primary concern with ASHWs is their rarity, which presents an implicit research challenge irrespective of the question being asked. Careful survey design, gap analysis and power analysis can help to define when, where and how much effort should be applied. The choice of where to begin should be guided by the list of identified research needs (see sections 5. 2 and annex 3.1) and where conservation and threat mitigation can be most effectively applied.

Aligning protocols

Some questions can be immediately addressed by aligning capacities and ensuring that comparable methods are used. There are two good regional examples of where research is ongoing but protocols and/or levels of rigour differ:

Strandings data are being collected in many range states but are of uneven quality. Developing standard protocols for data storage, species identification, sample collection and quality control will greatly improve the utility of these data. Analyses of strandings are likely to be important for better understanding population

status, as well as for identifying where certain threats (ship strike, entanglement) are of most concern. These data can be collated into larger databases, for instance the IWC ship strikes database (see section 3. 2.8)

Community and fisherman interviews are being used in Pakistan and India to learn more about where cetaceans (including ASHWs) occur. Some small but useful details have emerged, including reports of feeding (Pakistan) and breeding (singing reported by fishermen in India). However interview protocols are not standardised. Those aspects that relate to cetaceans should share common formats, and seek to address research needs identified in this report.

Regional exchanges

Regional exchanges can provide great platforms for training and networking. The 2014 pre-monsoon field season in Oman, with participation of investigators from Iran, Pakistan and India, was an excellent example of this. However, raising capacity to address specific questions will require some targeted training sessions, either as part of participation in field work, training workshops or visits by technical experts to projects in range states.

Strategic and targeted training

As the regional initiative develops, opportunities should be identified for the strategic involvement of trainers in local research. This is particularly pertinent for field surveys, strandings work and focused biopsy and acoustic work. Research needs are prioritised below (section 5.2 and appendix 6.4.1) but addressing them will require a concerted planning and fundraising effort. Opportunities for training need to be identified at the earliest possible stages of planning.

An example of a targeted training program is the Ocean Initiatives (OI) 'small boat survey toolkit.' The vision of OI is to put the fundamental tools (the 'toolkit') for surveying cetaceans within reach of scientists working in countries with limited resources for marine research. Reliable abundance estimates can be generated using well-designed and well-executed small-boat surveys but awareness of the need for rigour is often lacking and some of the methods are challenging. OI hopes to conduct small-boat surveys with capacity building integrated seamlessly through all stages of study design, data collection, analysis and reporting. OI intends to do this by identifying local teams, carrying out modest training, conducting short systematic surveys to estimate abundance, and leaving local partners with new skills and equipment. The toolkit consists of materials considered essential to the successful completion of low-cost cetacean surveys (contact rmcw@st-andrews.ac.uk for details). It will be supported by a series of videos, including interviews with statisticians, field biologists and end-users of science to convey basic principles, as well as a non-technical handbook illustrated with practical case studies that present different study design and analysis challenges.

Leveraging partnerships for analyses

Many other skills and tools are expensive and difficult to transfer in the short term but have been identified as critical for improving conservation outcomes. Developing the skills and acquiring the resources necessary to address the deficiencies is likely to take years. There is a clear need in the short term to side-step this by leveraging partnerships. There are several existing programs that can immediately add capacity to the ASHW network. These include:

1. WWF-Pakistan fisheries engagement
2. WCS Ocean Giants Program (genetics, acoustics, field techniques, analyses)
3. IWC strandings, ship strike and entanglement workshops, and
4. Graduate student fellowships within national and international institutions

More targeted partnerships can be useful for the completion of more challenging analyses. There are several prior examples from the Arabian Sea region and include assessments of strandings, spatial analyses,

abundance estimation, genetics and bycatch (e.g. Corkeron et al. 2011, Pomilla, Amaral et al. 2014, Kershaw et al. 2013, Minton et al. 2011, Van Waerebeek et al. 1999, and Anderson 2014).

Development of a targeted academic programme

There is considerable scope and precedent for building a cadre of students who focus on cetacean issues in the northern Indian Ocean. An excellent example was presented by Sahar Izadi, an Iranian student whose MSc thesis at the Sea Mammal Research Unit (SMRU) at St. Andrew's University focused on the development and evaluation of robust line-transect survey designs for cetaceans in the Gulf of Oman. The designs are practical and could be put into practice should funding be obtained.

Combining conservation and research objectives with capacity building through the creation of MSc and PhD opportunities for researchers in range states is an ideal approach, and in fact, several recently awarded PhD's have concerned cetaceans in the region, including ASHWs. Range state universities have expressed interest in extending studentships to marine subjects (Sultan Qaboos University in Oman, Karachi, UAE-based campuses) and external opportunities should also be pursued (e.g. universities in the USA, SA and UK). International studentships are particularly important for developing stronger capacity in technical disciplines such as genetics, acoustics and spatial analysis.

4.4 Research/database platforms: common data protocols, storage and exchange – Andrew Willson, Environment Society of Oman

The design of a given database reflects both the structure of the framework that hosts it and the nature of the project it is meant to serve. Among the factors influencing the design are geographical scope (e.g. national, regional or global), whether the database is intended to support multi-disciplinary programme or a single project focused, and who needs access to the database, i.e. is it public or limited to a specific group. The following summarizes the databases and structures available:

- Oman Whale and Dolphin Stranding Database: National database. Single project, multi-partnership approach. Off-line with information communicated by phone, e-mail, Whats App. Data collation within Access system. Advantage of having data screened prior to entry.
- Mammal Research Institute Whale Unit, University of Pretoria: National cetacean database, multi-partnership, housing multiple projects. Off-line, with central data entry facility. Ability to query multiple data-sets and generate outputs.
- ESO Sighting Forms: At front end of website, simple form which is completed, then e-mailed to manager of database to assess value for inclusion. Input facility to database. http://www.eso.org.om/index/sighting.php
- Marine Mammal Conservation Network India: On-line database platform. Strandings information and photos can be uploaded online. All data records can be accessed by public. Screening and quality of information unknown. http://www.marinemammals.in/database/submit-a-record
- UAE Dolphin Project: Designed for public to report sightings, rather than complete database. Sightings information visualized with maps and public access. http://www.uaedolphinproject.org/sighting-map/
- Whale Strandings Indonesia: On-line database for comprehensive stranding assessments. No public entry or access; closed to network. Good opportunities for compiling data from wide spatial extent. http://www.whalestrandingindonesia.com
- North Atlantic Humpback Whale Catalogue: To handle photo-ID pictures and data. Multi-agency, single-purpose of allowing photo comparison. The data housed on an existing platform (Flikr). http://www.coa.edu/nahwc.htm
- Mobi: Smart phone application designed for reporting of sightings from public and tourist vessels - facilitates access to sightings information. http://www.sprep.org/biodiversity-ecosystems-management/mobi-marine-mammal-survey-app-for-smartphones-now-available

- Match My Whale: Uses public participation in matching flukes in large catalogues, and allows public to upload photos. http://match.mywhale.org
- Whale FM: Uses public participation to identify whale song. Apparently faster than automatic detection systems? http://whale.fm
- Cetamada Fluke Matching: On-line system with access to registered researchers only. Allows uploading of photos and complete automatic matching through a sophisticated detection algorithm. In Beta testing. Potentially powerful and useful for rapid assessment.
- Southern Ocean Research Partnership: Regional, multi-agency, multi-purpose programme with open and closed database segments. Comprehensive although requires extensive IT support and administration. User agreements and MoUs among agencies are essential. https://data.marinemammals.gov.au
- OBIS: Ocean Biogeographic Information System. Global compilation of wide range of oceanographic and biological data. Can host meta-data, useful for impact assessment work, provides transparency for existing information. http://www.iobis.org
- International Whaling Commission Ship Strike Database: Global coverage, central database held off-line. Allows for annual review of threats to whales from ship traffic. Contribution to this database by countries and researchers in Arabian Sea region is recommended. https://iwc.int/ship-strikes

In conclusion, a wide variety of approaches and formats is available. Not all have been successful. Some have run out of expertise and time or proven inappropriate for the framework. When considering how to set up a database, it is important to keep in mind the central objectives behind it, e.g. facilitation, data-sharing, format standardization, wish to give a public face to a collaborative exercise.

5 Way forward

The last portion of the workshop was dedicated to developing a collaborative strategy for advancing research and conservation of the ASHW population. Participants were divided into three break-out groups, each tasked with identifying priority actions from a different angle. This prioritization exercise helped the full group come together again on the last morning of the workshop to discuss an implementation strategy, drawing from the previous days' presentations on tools for collaboration in order to develop a structure and research action plan, taking into account the particular constraints and opportunities present in the Arabian Sea region.

5.1 Break-out groups

Participants were divided into the following break-out groups:

Group 1 : Defining population research and monitoring priorities (including cross-taxa synergies)
Chair: Ken Findlay Rapporteur: Gianna Minton
Group 2: Defining threat assessment and mitigation research
Chair: Randall Reeves Rapporteur: Andy Willson
Group 3: Stakeholder engagement including resources/funding
Chair: Charles Anderson Rapporteur: Marina Antonopoulou

Prior to the break-out session, some discussion of research requirements was held within the plenary environment. It was noted that conservation of ASHWs will require a radical improvement in our understanding of population numbers, distribution, movements, ecology and threats. In order to achieve this there is a need to both align and raise (where necessary) research capacity in the Arabian Sea region. Given the urgency of the conservation concerns, capacity-raising efforts should be directed towards the outcomes of most concern. These were broadly identified as follows:

1. Population identity (who are they and how isolated are they?)

    a. Extend the geographic range of sampling
        i. genetics
        ii. song
        iii. strandings
    b. Extend the scope of analyses to incorporate samples from neighbouring regions
2. Updated estimates of ASHW population size and other demographic parameters
    a. Obtain data from other areas in addition to Oman
    b. Explore other statistical models
        i. Abundance estimation using close-kin/epigenetics
        ii. Investigate survivorship and recruitment
        iii. Population viability models
3. Improved understanding of spatial ecology and behaviour
    a. Local scales
        i. Gulf of Masirah
        ii. Greater Rann of Kutch
    b. Regional scale
        i. Migratory routes
        ii. Overlaps (co-occurrence) with major threats
4. Population trend (is the population going up or down?)
    a. Short-term within Oman
    b. Region-wide through dedicated monitoring over longer term
5. Documentation and reporting of specific threat factors:
    a. Improved effort towards detecting, reporting, investigating and documenting strandings
    b. Determination of where the risks of entanglement are greatest
        i. Fieldwork
        ii. Spatial analysis
    c. Improved understanding of other overlaps
        i. Shipping lanes, ferry routes
        ii. Sites of offshore oil and gas development (particularly seismic surveys in breeding season)
    d. Opportunities for mitigation

Full reports from the break-out groups are presented in the Appendix. However, in brief, the groups concluded the following:

Break-out Group 1 defined the following six research priorities (roughly in order of priority):

- Review and analyse existing data, including genetic samples that have already been collected in Oman and other range states, data from passive acoustic devices that were deployed in Oman in 2012, and thoroughly review stranding information from all range states.
- Identify focal individuals who can pursue opportunistic and dedicated data collection on humpback whale distribution in each range country or location.
- Deploy passive acoustic devices in key locations throughout the suspected current range of ASHWs – with an initial phase in areas of known occurrence and/or concentrations of Soviet catches, and a second phase of deployment to be informed by the opportunistic and dedicated data collection in point 2 above.
- Conduct dedicated vessel surveys in range states other than Oman to include photo-ID and if possible genetic sampling in order to obtain more information on current distribution, range and population identity. Surveys should be designed to allow analyses of relative density and habitat use by whales (if they are observed).

- Obtain a new abundance estimate for Oman waters to allow trend analysis; this will require dedicated boat-based photo-ID surveys of at least the Gulf of Masirah.
- Repeat dedicated vessel surveys in range states other than Oman to allow analyses of trends in the longer term and over a wider geographic range.

Break-out Group 2 determined that most of the action items for the three highest-priority threats are meant to enable risk assessments to identify times and places where preventative or mitigation measures are needed. The actions considered to be of highest priority were:

- Fisheries – Collate data on fishing effort within the range of the whale population, including seasons, locations, gear types, etc. It was understood that nearly comprehensive data of the kind needed are available for Pakistan but that existing data from the other range states and for fleets operating outside EEZs are fragmentary at best.
- Vessel traffic – Collate vessel AIS data, some of which are available to WWF.
- Noise – Establish listening stations in strategic locations in order to obtain baseline (current) information on the underwater acoustic environment throughout the likely range of the population.

Break-out Group 3 identified stakeholders with whom the network as a whole and its members in each range state could engage for advocacy, awareness raising and collaboration on data collection, as follows:

- Government sector (regulatory bodies for fisheries, ports and coastal development, conservation legislation etc.)
- Private sector (port development, oil and gas industry, tourism etc.)
- National and regional NGOs
- International NGOs (WWF, WCS, etc.) and IGOs (IUCN, IWC, IOTCC etc.).

The group also identified stakeholders that could be approached for funding of research and conservation activities, as follows:

- Small grants (e.g. MBZ, SOS etc.)
- Bilateral country agreements
- Larger international/cross-border project funding bodies (e.g. GEF)
- Private sector (e.g. banks, oil industry, shipping companies)
- National funds (e.g. science and technology, industry, higher education ministries).

As an immediate goal, the group suggested that a "glossy" brochure be drafted presenting the status and conservation threats to ASHWs. Network members could use this to lobby governments for management support and to help with fund-raising. The brochure and the budget outlined in it should be based on the scientific and threat-mitigation priorities agreed at this workshop, but written in a way that can be understood by non-scientists who might provide funding and other kinds of support.

It was also suggested that a communications coordinator and a fund-raising coordinator be identified. They would ensure that the network is presented in a cohesive and consistent manner and that fund-raising is coordinated to avoid multiple applications to the same funding sources.

5.2 Strategy for a Way Forward

After some deliberation on what type of collaborative structure would be most appropriate, workshop participants decided to form a research and conservation *network*. Such a network was preferred over a

consortium, which carries implications of institutional commitments and formal collaboration, while a network has many positive connotations consistent with the group's aims – including multi-directional communication and regular exchange among members. The group provisionally decided to call the initiative the *Arabian Sea Humpback Whale Research Network.*

The network's aims and functions will initially include:

1. Identify a focal point in each country, and create a brief list of targets for this person to strive toward in terms of data collection/verification and liaising with the network.
2. Identify a handful of network coordination roles – e.g. fund-raising, scientific advisor, meetings and administration/secretariat, -- and agree on which individuals/institutions will take on those roles.
3. Activities to be promoted and coordinated within the network will include:
4. Population research and monitoring priorities (as identified by Break-out Group 1)
5. Threat assessment/quantification/mitigation priorities (as identified by Break-out Group 2)
6. Development of a stakeholder engagement strategy (as considered by Break-out Group 3)

5.3 Implementation Scheme and Work Plan

The agreed plans and structure are reflected in the diagram below, which includes formalisation of the roles of individuals and organisations within the network who volunteered their time and resources.

In summary, the following individuals and organisations agreed to take on the following roles, subject to funding being available to support time and resources that will be needed to support the network:

Co-coordinators: Gianna Minton (WWF Gabon/ESO) and Marina Antonopoulou (EWS)
Funding Coordinator: Rab Nawaz, WWF – Pakistan
Scientific Coordinator: Tim Collins, WCS
Outreach and communications coordination: EWS and WWF – Pakistan
Technical support and advice: Andy Willson, Rob Baldwin, Ken Findlay
Liaison with IGOs: Randall Reeves, Lyle Glowka, David Mattila.

The diagram below shows how the various "branches" of the network are expected to interact and build on one another's work. Basically the network programme structure is separated into three tiers:

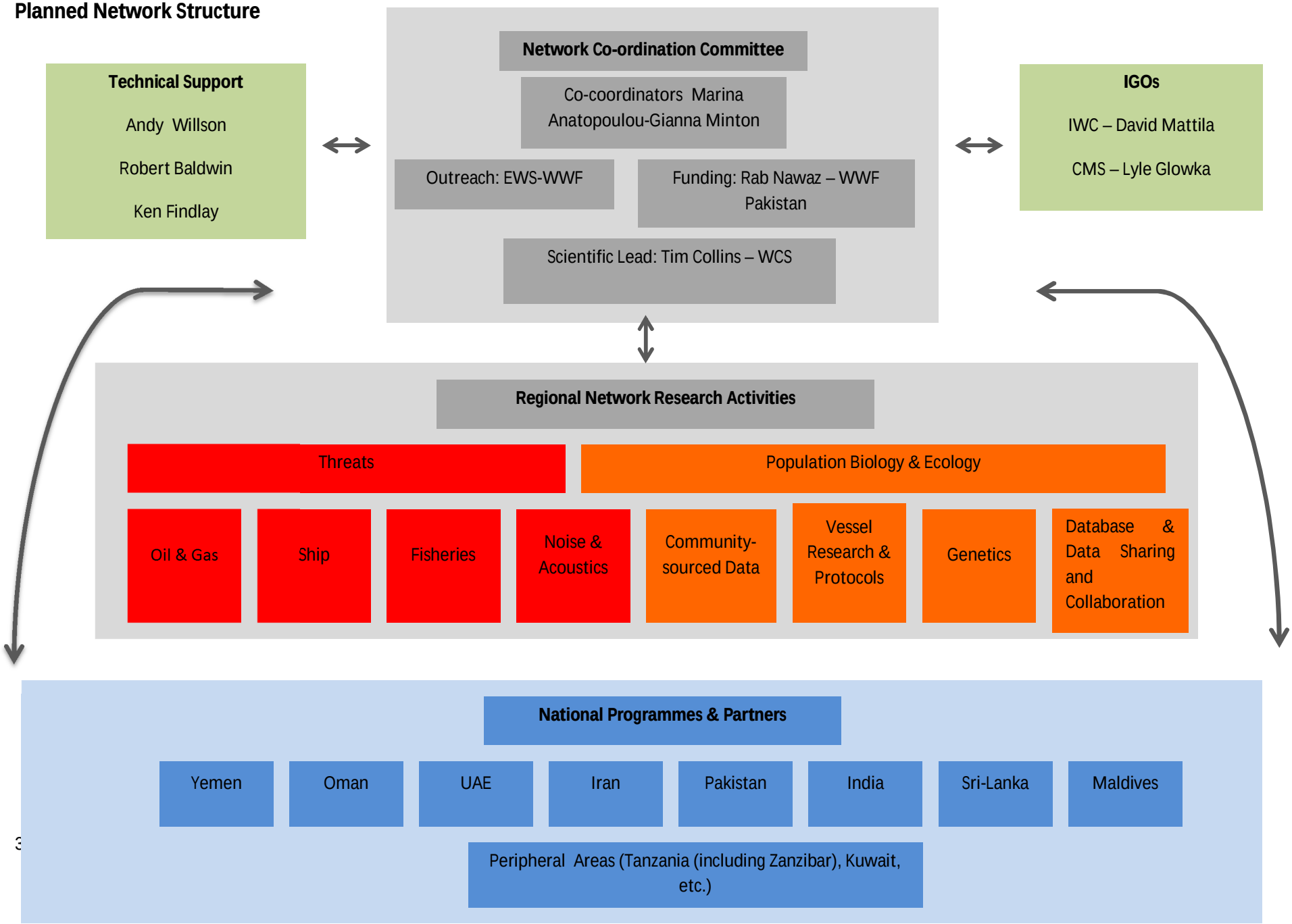
- Network Administrative Duties
- Regional Projects
- National Country-based Programmes

A number of short-term actions or goals were agreed to help advance the network's aims, as follows:

1. The finalization and translation of the workshop report to be shared with a number of international organisations (WWF, WCS, IWC, CMS), national/government organisations and stakeholders in range states and beyond (US Marine Mammal Commission, relevant government agencies). WWF Pakistan agreed to ensure translation of the report into Farsi/Persian, Urdu, Arabic and Hindi. A few copies will be printed in English – but the majority of distribution will take place electronically in PDF format.
2. The development of a "glossy" brochure to present the network's aims, activities and budget requirements. This should be drafted in a professional, but not overly scientific format to appeal to a wide range of potential funders.
3. The development of an online database/repository where different types of resources and data can be shared among network members including :

a. Literature/references and reports from different range states;
b. Photographs, stranding reports, newspaper articles and other sources of verification of humpback whale occurrence in different range states;
c. Standardized data collection forms and protocols and resources that can be used by network members;
d. Eventually (when proper data-sharing agreements are in place) a regional database of photographs to be used for photo-identification and matching across range states/study sites.

Planned Network Structure



6 Appendices

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6.2 Agenda

ARABIAN SEA HUMPBACK WHALE (ASHW) WORKSHOP: DEVELOPING A COLLABORATIVE RESEARCH AND CONSERVATION STRATEGY – DUBAI, JANUARY 2015

The meeting was broadly structured as follows:

Day 1: Background on ASHWs and the threats that affect them. This includes concise overviews of a) what we currently know, b) what we need to know to improve their conservation status, c) brief reviews of regional knowledge and d) focused presentations on particular threats. The sessions will provide attendees with the context, tools and language for discussions on Days 2 and 3.

Day 2: Strategies for collaboration will be presented in the morning. A plenary session prior to lunch will focus on ranking threats to ASHWs, an essential step before the afternoon session. In the afternoon attendees will join break-out groups with discussion focussing on specified topics.

Day 3: Outlining the strategy. To include identification of conservation outcomes and the research and management activities required to accomplish them.

The meeting format included **Plenary** sessions, where the whole group met together (main meeting room), **Presentations** that focussed on particular topics (main meeting room) and **Break-out Groups**, during which smaller groups were tasked with discussion of specified topics.

DAY 1: TUESDAY 27TH JANUARY

8:30 – 10:30	Setting the scene	
8:30 – 8:45	Welcome, and meeting logistics	*(Nawaz, Antonopoulou)*
8:45 – 9:00	Personal introductions	
9:05 – 9:25	Background to the ASHW workshop	(*Reeves*)
9:25 – 10:00	ASHW Background Part I **- A concise review of what we know about ASHWs**	
	Overview:	(*Minton*)
	Isolation: Genetics and population identity	(*Brownell*)
10:00 – 10:30	Coffee Break	
10:30 – 12:30	Highlighting Regional Strengths, Challenges and Opportunities	
Range state reviews (to follow specific format provided before meeting)		
10:30 – 10:40	Yemen/Gulf of Aden and the Somali Coast	(*Baldwin*)
10:40 – 11:00	Oman and east coast UAE	(*Al Harthi*)
11:00 – 11:15	Gulf and Iran	(*Moshiri, Jafari*)
11:15 – 11:30	Pakistan	(*Kiani*)
11:30 – 11:45	India/Gulf of Kutch	(*Sutaria*)
11:45 – 12:00	Maldives	(*Anderson*)
12:00 – 12:15	Sri Lanka	(*De Vos*)
12:30 – 13:30	Lunch	
13:30 – 15:30	ASHW Background Part II	
Biology		
	Status	(*Reeves*)
	Genetics and health	(*Rosenbaum* Skype)
	Strandings	(*Brownell*)
Threats and biological responses to them (an overview)		
	Acoustic ecology and threat of noise	(*Cerchio*)
	Spatial ecology	(*Willson*)

15:30 – 16:00 Coffee Break
16:00 – 18: 00 Presentations on threats (case studies)

Indian Ocean bycatch	(*Anderson*)
Pakistan/Iran bycatch	(*Nawaz*)
Entanglement	(*Mattila)*
Ship traffic	
Ports & options for threat mitigation	(*Baldwin*)
Ship strikes and shipping routes	(*Mattila and de Vos*)

DAY 2: WEDNESDAY 28TH JANUARY - DISCUSSING IDEAS AND ELEMENTS OF A REGIONAL STRATEGY

08:30 – 10:00 Tools and Resources Required for Collaboration - Part I

Developing collaborative frameworks	(*Findlay, Mattila*)
International/Inter-governmental organisations -	
IWC and IUCN	(*Reeves*)
CMS	(*Glowka)*

10:00 – 10:30 Coffee break
10:30 – 11:30 Tools and Resources for Collaboration - Part II – fundamental elements of a strategy

Collecting data and conducting analyses	
Building capacity and providing technical support	(*Collins*)
Web-based platforms	(*Willson*)
Promote regional network activities	

11:30-12:15 Organizing and charging break-out groups for afternoon session
12:30 – 14:00 Lunch
14:00 – 15:30 Dedicated break-out group sessions

Group 1 - Defining population research and monitoring priorities	(*Findlay*)
Group 2 - Defining threat assessment and mitigation research	(*Reeves*)
Group 3 - Stakeholder engagement including resources/funding	(*Anderson*)

15:30 – 16:00 Coffee Break
16:00 – 17:30 Break out groups report back (with discussion)

DAY 3: THURSDAY 29TH JANUARY - DRAFTING OF A REGIONAL STRATEGY

8:30 – 10:30

- Developing a draft strategy
- Research Objectives and Benchmarks
- Priority Activities and Timeline
- Resource requirements and funding

10:30 – 11:00 Coffee break
11:00 – 12:00

- Immediate tasks and Follow-up
- Information needed from attendees
- EBSA Workshop Dubai
- Reporting to: MMC, IWC, and Feedback to CMS and IUCN
- Reporting of findings to range state governments and NGOs
- Establishing a suitable communication mechanism

12:00 -12:30 Close of meeting. Parting comments from Chair and hosts. Photos etc.

6.3 Break out Group reports

6.3.1 Discussions of the Group 1 dedicated break-out group session - Defining population research and monitoring priorities (including cross-taxa synergies)

Findlay (Chair) Minton (Rapporteur)

The group was tasked with identifying and prioritising research activities to address population and biological questions relating to Arabian Sea Humpback Whales (ASHW) across their range. Whilst humpback whales were identified as the focal species, synergies in cross-taxa research were considered. The discussions commenced with a brief overview of what is known concerning four topics: Distribution, Movements and Spatial Ecology; Basic Biology; Population Identity and Structure; and Abundance and Trends of the population. This exercise helped identify basic knowledge gaps and research needs. In particular it was noted that there is little information from the region outside of Oman (apart from the Soviet catch data of the mid 1960s) and that more information was required from elsewhere in the range for all of four topics.

The group then identified a series of needed research activities as follows:

1. Acoustic assessment across range (possibly as two-tiered approach): Deployment of a system of autonomous acoustic recording instruments across the population range is a cost-effective technique to monitor occurrence and distribution of humpback whales in the coastal waters of the range nations. Furthermore analyses of humpback song structure across the range may provide some information on population structure. An ancillary benefit of such a system is that it would provide acoustic information on other Balaenopterid species and anthropogenic noise. This would best be carried out in a two-tiered approach with instruments initially broadly spaced over the range, followed later by a second series of deployments based on results of the initial focal-point sampling.
2. Review of strandings across range: The incidence of stranding records of humpback whales across the region is relatively low, and a review of the identification and provenance of all known Balaenopterid stranding records was proposed.
3. New tissue sampling effort across range: Noting that all of the humpback whale genetic material used in by Pomilla et al (2014) originated in Oman, the group identified the need for tissue samples from across the population range.
4. Identifying focal points in each range state/location to coordinate community outreach and opportunistic data collection, obtain new stranding information and make use of platforms of opportunity (fishing boats, seismic vessels, coastguard and navy vessels etc.)
5. Repeat of Oman abundance estimates (photo-ID and genetic mark-recapture) including targeting of recent reports of large aggregations of whales. Noting the lack of any trend information for the ASHW population, and that such information would be impossible to obtain across the entire region in the short term, the group proposed that the genetic and photo-identification sampling carried out between 2000 and 2004 in Oman be repeated. Such sampling should also attempt to target large aggregations of humpback whales that have been reported recently to the north of the Gulf of Masirah.
6. Abundance estimates (photo-ID and genetic mark-recapture) in other areas of range:
7. Noting the shortage of data and samples from areas outside of Oman, the group proposed that small-boat surveys (visual and acoustic) be carried out where possible across the population range, with particular emphasis on areas of historical catches or where the habitat appears especially suitable. Whilst a major aim of these surveys would be to collect material to inform abundance estimation, any new information generated from such surveys on distribution, habitat use and population identity and structure would be valuable.

8. Processing and analysis of existing genetic and acoustic data/samples: Noting that there are both acoustic data and genetic samples that have been collected but not analysed, the group proposed that these be processed and analysed in the immediate future.

The four research topics identified initially will all be addressed by three or more of the above numbered research activities as follows:

- Distribution, Movements and Spatial Ecology – activities 1, 2, 4 and 8
- Basic Biology – activities 1, 2, 3 and 4
- Population Identity & Structure – activities 1, 2, 3 and 8
- Abundance & Trends – activities 3, 5, 6 and 7.

After assessing the feasibility of these research activities by country (see Table below), the group then merged and ranked the research activities into the following priorities, roughly in descending order:

1. Review and analyze existing data including a review of stranding information.
2. Identify focal points on humpback whale distribution in each range country/location.
3. Acoustic deployments (two-tiered)
4. Dedicated small-vessel surveys in range states other than Oman (as per the Table below)
5. Repeat of Oman abundance estimate with return to Gulf of Masirah (photo-ID through dedicated boat surveys to allow trend analysis)
6. Repeat of dedicated small-vessel surveys in range states other than Oman for trends in the longer term

In conclusion the group briefly discussed the advantages of satellite tagging to elucidate spatial ecology across the population range. It was noted that this would be best achieved if satellite tagging were carried out over the summer South West monsoon period.

Table 1. Feasibility of identified research activities by country. Yes = definitely feasible; Probably = probably feasible; Blank = uncertain or not feasible.

Country	**Platforms Of Opportunity**	**Acoustic Deployment**	**Strandings**	**Dedicated Small Boat Surveys**
Somalia	Yes		Probably	
Socotra	Probably	Probably		
Yemen			Probably	
Egypt		Yes		
Saudi Arabia	Probably		Yes	
Oman	Yes	Yes	Yes	Yes
Iran	Probably	Explore Feasibility	Yes	Yes
Pakistan	Yes	Probably	Yes	Yes
India	Yes	Yes	Yes	Yes
Sri Lanka	Yes	Yes	Yes	Yes
Maldives		Yes		

6.3.2 Discussions of the Group 2 dedicated break-out group session - Defining threat assessment and mitigation research

Reeves (Chair) Willson (Rapporteur)

This group's remit was to focus on threat factors and the kinds of research needed to assess and mitigate threats.

Threats can be characterized or classified in a number of ways, e.g. according to whether they are lethal or non-lethal, acute or chronic, local or range-wide, certain or uncertain. The group quickly concluded that there are two major lethal threats to this population: entanglements in fishing gear and ship strikes (although the workshop was not aware of any direct evidence of humpback whales being struck within the Arabian Sea). These two threats are likely present to differing degrees throughout the population's range, but severity is variable such that there are local hotspots of risk – where the animals occur in high density on fishing grounds or in busy shipping lanes. A third major threat is underwater noise, which is likely rarely lethal and which has some aspects that are acute/occasional (e.g. noise from seismic surveys, pile-driving, and military sonar exercises) and other aspects that are chronic (e.g. noise from shipping, offshore windfarms). This threat, like the other two, varies in severity across the population's range, depending on the distribution of noise-generating human activities and also on the distribution and activity state of the whales (e.g. feeding, socializing, mother-calf interaction, travelling, resting). There is considerable uncertainty around the impacts of noise on humpback whales, and particularly in regard to its population-level consequences.

Highest priority was assigned to the three main threats described above, and therefore it was agreed that the human activities responsible for them – fishing, shipping, offshore oil and gas development, etc. – are the ones needing immediate research attention. It was recognized that other potential threats exist, including chemical pollution, habitat loss due to port and other coastal development, changes in the quality or availability of prey, and the demographic or stochastic effects of small population size.

Most of the action items identified for the three highest priority threats are meant to enable risk assessments to determine times and places where mitigation measures are needed to protect the whales from given threats. The actions considered highest priority by the group are listed below. For a somewhat more detailed breakdown see the table below.

Fisheries

Collate data on fishing effort within the range of the whale population, including seasons, locations, gear types, etc. It was understood that nearly comprehensive data of the kind needed are available for Pakistan but existing data from other range states and for fleets operating outside EEZs are at best fragmentary.

Vessel traffic

Collate vessel traffic AIS data, some of which are available to WWF.

Noise

Establish listening stations in strategic locations in order to obtain baseline (current) information on the underwater acoustic environment throughout the likely range of the population.

	Threat/Activity	Priority	Required Bio & Ecology	Threats Information Required	Investigation Approach	Mitigation Considerations
Fishing	Gill/drift net entanglement	1	Hotspots range-wide Transient pathways range-wide Activity state by habitat Photo-ID – fisheries entanglement – scarring (revise/update 2008 study) Foraging ecology	Fishing effort: Seasonality & distribution Gear types Bycatch (entanglement) rates	Co-occurrence risk assessment Fisheries observer programmes Community bycatch interviews Examinations of stranded whales Analyses of scarring shown on photographs	Time and area closures Entanglement response training Alternative livelihoods Alternative gear technology Alternative fisheries Gear swap-out Incentive schemes Accreditation schemes
	Other passive fishing gear (e.g. pots, traps)	1			As above	As above
	Discarded gear	2				Education Disposal facilities and incentives
Ports & Shipping	Ship strike: Port approaches and operational areas	1	Hotspots range-wide Transient pathways range-wide Activity state by habitat	Master plans on future developments Place AIS recording devices in sensitive areas (Rab to ask Global Fishing Initiative) Fast ferry routes and schedules	Co-occurrence risk assessment – traffic density and habitat utilisation as for Bay of Fundy/Boston Harbour/Santa Barbara Channel	Discussion with Industry: Speed Watch keeping Route planning Lane and approach channel placement Exclusion zones Detection & reporting schemes Port and route planning (fast ferry)
	Ship strike: Offshore shipping routes	1		Source AIS data – new sources; Density maps Speed data Place AIS recording devices in sensitive areas	Co-occurrence risk assessment – traffic density and habitat utlisation as for Alaska/Boston/ Santa Barbara	Gov & IGO Initiatives: Speed Watch keeping Route planning Lane and approach channel placement Detection & reporting schemes
Noise	All sources: shipping, fishing and background		Hotspots range-wide Transient pathways range-wide Activity state by habitat Disturbance,	Establish Acoustic baseline: Noise monitoring programme (PAM). Noise modeling from AIS tracks	Co-occurrence assessment; Modelling sound fields and monitoring sources; overlay mapping with ASHW distribution and habitat usage	Speed Route planning Lane and approach channel placement Detection & report schemes Noise and vibration reduction
Oil & Gas	Oil spill accident	2	Hotspots range-wide Transient pathways range-wide Activity state by habitat	Spill risk assessment	Oil spill sensitivity mapping	Oil spill contingency planning and training
	Seismic surveys	1		Concession areas Schedule of activities Seismic with info on airgun sources	Modelling sound fields and monitoring sources; overlay mapping with ASHW distribution and habitat usage	Time-area consideration of scheduling activities On-board mitigation personnel Mitigation procedures
Coastal Development	Urban development	TBD	Hotspots range-wide Transient pathways range-wide Activity state by habitat	TBD	TBD	TBD
	Whale watching	TBD		TBD	TBD	TBD

6.3.3 Discussions of the Group 3 dedicated break-out group session – Stakeholder Engagement and fundraising

Anderson (Chair) Antonopoulou (Rapporteur):

This break-out group identified the stakeholders that could be engaged in research and conservation efforts for the ASHW and explored potential communication and fund-raising strategies, as outlined in the table below.

STAKEHOLDER CATEGORIES **Government**	
▪ Executive, Legislative, Judicial ▪ Federal Bodies / State Authorities ▪ Environmental / Wildlife Protection Authorities ▪ Monitoring and Controlling Organisations (Coast Guard, Military)	▪ Fisheries Regulatory Authorities ▪ International Conventions Focal Points (RECOFI, CMS, CBD, IOTC, IMO) ▪ Port and Shipping Regulatory Authorities ▪ Research Organizations
Private / Semi-private / Business	
▪ Oil and Gas ▪ Environmental Consultants ▪ Ports and Shipping	▪ Tourism (tour operators, cruise operators) ▪ Fishermen and Fisheries Cooperatives
Non- Government & other	
▪ Universities ▪ Individual researchers ▪ Coastal Communities & leaders	▪ General public ▪ Media ▪ Environmental NGOs and CBOs
International – Intergovernmental	
Key ▪ International Whaling Commission (IWC) ▪ Convention of Migratory Species (CMS) ▪ Indian Ocean Tuna Commission (IOTC) ▪ IUCN – Cetacean Specialist Group ▪ International NGOs (WCS, WWF, WDC)	**Secondary** ▪ CITES ▪ International Maritime Organization (IMO) ▪ Intergovernmental Oceanographic Commission (IOC) ▪ UN Food and Agriculture Organisation (FAO)

POTENTIAL FUNDING SUPPORT	
Small Grants ▪ IUCN – SSC: Save Our Species ▪ Mohamed bin Zayed Species Conservation Fund ▪ IWC ▪ International NGOs: WWF, ZSL, RFS ▪ GIZ ▪ UNDP small grants ▪ Google and Disney grants ▪ Ocean Park Conservation Foundation	**Bilateral relations** ▪ NOAA ▪ MMC ▪ Australian Government interest ▪ EU? ▪ Bilateral relations within the region
Larger funding mechanisms GEF	**Private Sector International / Local** ▪ HP Foundation, HSBC, Toyota Foundation ▪ O&G international funds (Total Foundation)
National funding streams & in-kind support ▪ Universities ▪ Funds for scientific research (by gov) ▪ Private sector (key stakeholders) ▪ Wealthy individuals	

Challenges

- Barriers for countries to receiving international funds
- Barriers for national funds to be diverted in the region

	ENGAGEMENT OPPORTUNITIES
Stakeholder category	**Stakeholder interest & Engagement Opportunities**
Government	**Interest** International obligations and pressure **Engagement Opportunities** ***Short term – Priority opportunities*** ▪ Workshop report to be distributed to government stakeholders ▪ Workshop with government stakeholders ▪ Strategy to identify long term/ongoing regional mechanism ***General*** ▪ Awareness of regional and international commitments (CMS, IWC etc.) ▪ General capacity building on priority issues (identified by other working groups) ▪ Awareness e.g. incidental capture as a wider problem (cross-taxa)
Oil and Gas	**Interest** ▪ Social Corporate Responsibility and reputational risk: oil spills, seismic survey impacts ▪ Environmental compliance **Engagement Opportunities** ▪ EIAs, mitigation plans, platforms of opportunity
Environmental Consultants (EIA, Observers for seismic surveys)	**Interest** ▪ EIAs & information source ▪ Access to developers ▪ Business development opportunities **Engagement Opportunities** ▪ Awareness, information sharing ▪ CMS with CBD to integrate migratory species with EIA guidelines
Port Authorities - Shipping	**Interest** Security and safety **Engagement Opportunities** Case study from Duqm Port
Tourism	**Interest** Socio-economic aspects & employment International exposure Links with potential alternative livelihoods **Engagement Opportunities** Case study?; sightings reports
Fishermen	**Interest** Loss of gear Links with healthy marine environment – livelihoods Safety implications of entanglement **Engagement Opportunities** See break-out group (2)
Public & overall	**Engagement Opportunities** ***Short term – Priority*** ▪ Outreach strategy linked with fundraising & stakeholder engagement ▪ Communications coordinator with national focal points ▪ Common messaging ▪ Glossy story to engage public & stakeholders ***General*** ▪ Tools (ID apps, social media, platforms…?) ▪ Researchers as communicators (stories from the field) ▪ Collaborative research on cetacean encounters

6.4 Arabian Sea Humpback Whales - Working Document: Genetic Research Topics and Priorities

Contributors as of 27 January, 2014: Ana Rita Amaral, Robert Baldwin, Tim Collins, Francine Kershaw, Gianna Minton, Andrew Willson, Robert L. Brownell, Jr. and Howard C. Rosenbaum

1. Background

Following on recent publications on Arabian Sea humpback whales (ASHWs) and other cetaceans, this group initiated a discussion to outline some key questions to be addressed with molecular markers for ASHWs. This Working Document sets the stage for the next phase of genetic work that can be undertaken. It is intended to help prioritize and recognize feasibility for particular research questions, especially as research priorities are set for the region overall. There are some initially planned tasks for which the IWC has provided a small grant, which are outlined in section 2 below. Section 3 explores the possible research questions that could be addressed through genetic analyses, and section 4 ranks those different research questions in terms of priority and feasibility given likely sample sizes and other constraints.

2. Outlined Plan, IWC Funding (2015-2016)

Year 1:

The last genetic analysis was conducted on samples collected up to 2005. Since this time additional samples have been collected (n≈20-30). Molecular sexing of these samples will provide the ability to assign sexes to individuals in the Oman Photo-ID database prior to the next season of satellite tagging (for which it is critical to understand the sex of each individual as part of the protocol in discerning which individuals to target). Evaluation of habitat use by males and females will also be enabled, further supporting the satellite telemetry research. A key next step is to arrange CITES transfer of samples from Oman.

Year 1 and Year 2:

New techniques and molecular markers have been identified that will enable reworking of archived samples to evaluate genetic diversity and differentiation for this population, as well as to have a more precise estimate of how long this population has been isolated. This will build on the recent work of Pomilla, Amaral et al. (2014). We intend to collect data to match the mtDNA and microsatellite dataset in that paper, as well as acquire sequence data (e.g. SNPs) from other gene regions. Likely results include a better understanding of the historical demography of this population and the mechanisms that led to its low genetic diversity and distinctiveness from original SH humpback whale stocks. By having the multi-locus genotype profiles for all sampled animals, any new animals that are collected from mortalities or biopsy sampled without a good photo-id can be matched to the genetic database.

3. Pertinent Research Questions:

1. Taxonomic status: Aim: to clarify the taxonomic status of the ASHW population. The dataset we already have can support the classification as subspecies, as levels of genetic differentiation (based on FST) for the mtDNA control region and nuclear microsatellites between the ASHW population and other breeding stocks in the Southern Hemisphere falls within the range of differentiation reported for ocean-basin comparisons of the mtDNA control region and nuclear introns between the North Atlantic, North Pacific and Southern Ocean (Jackson et al. 2014). These levels of differentiation were deemed adequate to support sub-species designation of humpback whales in each of the three ocean basins (Jackson et al. 2014). Notwithstanding the mitochondrial and microsatellite support, additional nuclear markers would be desirable to confirm these results.

2. Stock origin / isolation : Aim: to clarify the origin of the ASHW. Which stock in the Southern Ocean migrated to and resultantly, was the 'founder' to this population? How long has the ASHW population been isolated for? We currently have an estimate from mitochondrial DNA of around 70 000 years, but it would be important to confirm this estimate with additional, more informative nuclear DNA markers. For this we would need to generate additional data from ASHW and from other stocks (SH Mn Breeding Stocks C and D).

3. Inbreeding effects & depression / Relatedness and family trees: Aim: study the genetic variability of the population in detail by inferring a family tree or pedigree and assess the degree of potential inbreeding, including considerations related to inbreeding depression, i.e. breeding of related individuals. In order to do this we would need a considerable number of highly variable genetic markers in order to obtain the genetic profile of each individual in the population (i.e. 20 or more microsatellites or SNPs).

4. Health status/resiliency, genetics-based: Aim: assess the health status of the population by assessing genetic variability of the MHC (major histocompatibility complex). For this some genes of this gene family would have to be sequenced. Working with these genes can be extremely challenging because they are not single-copy and sometimes it is not easy to sequence the same copy for all the samples.

5. Age determination, POP's and Mark Recapture models: Aim: Estimate the age of the individuals in the population using DNA methylation techniques to better inform mark-recapture models. In addition to adding important resolution to the existing identification catalogue, information on age-structure could also be incorporated into models to produce more robust estimates of population viability and recovery. Genotypic data could also be used to identify parent-offspring pairs (POP's) that could inform extended close-kin mark-recapture models (sensu Bravington et al. 2014). This has the potential to dramatically improve the precision of existing abundance estimates (close-kin MR models can be made robust against bias arising from unmodelled heterogeneity), a prime concern given likely limitations for work in important areas of their range (e.g. Gulf of Aden). Precision could be improved further using epigenetic age data to tell which animal is the parent and which the offspring.

6. Spatial analysis of genetic identity and association: Aim: to map habitat use to inform spatial conservation measures. This analysis will incorporate the information from the sexing analysis, the Photo-ID catalogue, group sightings data, and genetic pedigree information with existing habitat modeling efforts to explore kin- and social-group associations, and whether different sexes and different family groups use different habitats. This would require the availability of highly variable genetic markers (i.e. 20 or more microsatellites or genomic SNPs).

7. Habitat Utilization and Sex Association: Aim: To incorporate genetic data from sexing of individuals within the habitat utilization spatial analysis from animals sampled during a) satellite tracking studies, and b) small vessel line transect surveys conducted in Oman. There is also the opportunity for additional analysis to look at site fidelity and M/F ratios of encountered groups with reference to observed behavior. Spatial and genetic data sources will be integrated as part of an on-going postgraduate study: 'Spatial ecology of the Arabian Sea Humpback Whale'.

8. Genetic potential for adaptation to climate change: Aim: To understand which genes are involved in climate adaptation and assess their variability relative to other, less isolated populations. However, the feasibility of carrying out this task in a wild system is very low given a range of constraints, including the requirements of samples from different tissues of the animal and a controlled environment in order to isolate the drivers of gene expression. Therefore this task is not included in the current table, but could be revisited at a later date.

4. Prioritization of Research Questions

Following an email brainstorming exchange between the partners listed on this document, we attempted to capture and prioritize potential research questions using genetic markers. The questions and tasks were

ranked based on two sets of criteria: priority and feasibility. For discussion and illustrative purposes, aims/questions were prioritized based on the suggestions from the research team and therefore were generally all considered to be high or medium priority. Categories of high and medium were allocated based on consideration of immediate conservation impact and factors related to feasibility. Feasibility includes consideration of the following factors: number of samples, genetic markers that need to be generated, the resources available and those that would need to be secured, and staff time. As some of these factors have yet to be properly assessed, the table represents a preliminary assessment of feasibility for each task to advance the discussion and establish needs and resources now and going forward.

Question/ Tasks	**Priority**	**Most suitable genetic markers**	**Feasibility**	
			Archived samples	**With new samples****
Sexing of new samples	High	Specific sex markers	Feasible	Feasible (Those collected in Feb-March 2015 could be added since backlog of samples have yet to be transferred)
Taxonomic status	High	Intronic or Genomic SNPs* However, potential no new data collection needed. Might be able to justify with previous sub-species id, latest genetic results.	Feasible.	Feasible (Analysis would be enhanced with samples from other parts of range)
Stock origin / isolation	Medium/ High	Intronic or Genomic SNPs*	Feasible	Feasible
Inbreeding effects and depression / Relatedness and family trees	Medium	Genomic SNPs*, Microsatellites	Feasible	Feasible (Additional samples necessary for comparison of inbreeding across populations spatial analysis. Not necessary for spatial analysis within Oman)
Health status / Resiliency, genetics based	Medium	MHC, Specific genes	Maybe (MHC is a complex region of the genome to work with)	Maybe (MHC is a complex region of the genome to work with. Additional samples would be necessary for inter-population comparisons of genetic diversity)
Age determination / POPs to inform Mark-recapture	High	Epigenetics / DNA methylation, Genomic SNPs	Maybe (May not be able to carry out this type of analysis	Maybe (New samples will have to be properly stored;

models			based on gene expression on archived samples; requires individuals of known age for calibration)	requires individuals of known age for calibration)

*A note on Introns vs. SNPs

SNPs can be obtained by sequencing targeted introns (intronic SNPs). We were aiming to sequence 7-9 introns, which would result in approximately a total of 4000-5000 base pairs in total. However the variability of these markers is very low or even inexistent among ASHW individuals (see Ruegg et al 2013, Jackson et al 2014). Therefore this dataset would be useful in comparisons with other humpback whale populations, namely in assessing sub-species status and inferring stock origin and demographic history. Consideration here is how much variability might we detect in these markers to address the relevant questions.

SNPs can also be obtained by following a population genomics approach using a technique like RAD tagging or the less costly Genotype by Sequencing (GBS) – genomic SNPs. This could result in potentially thousands of markers, allowing more detailed analysis of the ASHW individuals, including assessing inbreeding, family trees and looking at specific genomic regions that could be responsible for the isolation / health status of the population. The costs associated with generating, managing and analyzing data (staff time) may be higher but may allow for broader analyses. How 'good' the data from GBS would/could be has yet to be determined.

5. Sampling Priorities

Acquiring and analysing, new samples not only from the Oman population, but also throughout the possible range of humpback whales in the Arabian Sea is extremely important to help clarify some of the questions proposed in this document. For current and future sampling efforts, we recommend the following:

Regionally:

- Conduct a census of genetic samples that might be available within the regional network of collaborators/workshop participants.
- Support / encouragement for tissue collection from strandings, including the standardization of a stranding protocol for collection of samples. NB, the only other sample that has been analyzed comes from a 2002 stranding in Pakistan.
- Prioritization of biopsy sampling of ASHWs in other parts of the range

Oman

- Continuation of the long-term efforts by ESO and colleagues in Oman to collect biopsies during small vessel surveys. The Gulf of Masirah and Masirah Island represent priorities for dedicated work given the higher encounter rate of new individuals. Sex ratios in the Gulf of Masirah are also closer to parity than those observed in Hasik.

References

Allison, P. A., C. R. Smith, H. Kukert, J. W. Deming & B. A. Bennet (1991) Deep-water taphonomy of vertebrate carcasses: A whale skeleton in the bathyal Santa Catalina Basin. *Paleobiology,* 17**,** 78-89.

Baldwin, R. M. (2000) Oman's humpback whales (Megaptera novaeangliae) *The Journal of Oman Studies,* 11 11-18.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers & L. Thomas. 2001. *Introduction to distance sampling: Estimating abundance of biological populations*. Oxford: Oxford University Press.

Cerchio S, Strindberg S, Collins T, Bennett C, and Rosenbaum H. 2014. Seismic surveys negatively affect humpback whale singing activity off northern Angola. PLoS-ONE 9(3): e86464.

Cerchio S, Collins T, Strindberg S, Bennett C, and Rosenbaum H. 2010. Humpback whale singing activity off northern Angola: an indication of the migratory cycle, breeding habitat and impact of seismic surveys on singer number. Paper SC/62/SH12 presented to the IWC.

Corkeron, P. J., G. M. T. Collins, K. Findlay, A. Willson & R. Baldwin (2011) Spatial models of sparse data to inform cetacean conservation planning: an example from Oman. *Endangered Species Research,* 15**,** 39-52.

Darling, J.D., and R.S. Sousa-Lima. 2005. Songs indicate interaction between humpback whale (*Megaptera novaeangliae*) populations in the Western and Eastern South Atlantic Ocean. Marine Mammal Science 21:557-566.

de Vos, A., C. Pattiaratchi & R. Harcourt (2014) Inter-Annual Variability in Blue Whale Distribution off Southern Sri Lanka between 2011 and 2012. *Journal of Marine Science and Engineering,* 2**,** 534-550.

de Vos, A., T. Wu & R. L. Brownell Jr. (2013) Recent blue whale deaths due to ship strike around Sri Lanka. *Paper presented to the scientific committee of the IWC,* SC/65a/HIM03.

Eiden, G. & T. Martinsen (2010) Maritime traffic density - results of PASTA MARE project. *Preparatory Action for Assessment of the Capacity of Spaceborne Automatic Identification System Receivers to Support EU Maritime Policy,* Technical Note 4.1 Vessel Density Mapping.

Kaluza, P., A. Kolzsch, M. T. Gastner & B. Blasius (2010) The complex network of global cargo ship movements. *Journal of the Royal Society Interface,* 7**,** 1093-1103.

Minton, G., S. Cherchio, T. J. Q. Collins, P. J. Ersts, K. P. Findlay, C. Pomilla, D. Bennett, M. Meyer, Y. Razafindrakoto, D. Kotze, H. Oosthuizen, M. Leslie, N. Andrianarivelo, R. M. Baldwin, L. Ponnampalam & H. C. Rosenbaum (2010a) A note on the comparison of humpback whale tail fluke catalogues from the Sultanate of Oman with Madagascar and the East African Mainland. *Journal of Cetacean Research and Management,* 11**,** 65-68.

Minton, G., T. J. Q. Collins, K. P. Findlay & R. Baldwin (2010b) Cetacean distribution in the coastal waters of the Sultanate of Oman. *Journal of Cetacean Research and Management,* 11**,** 301-313.

Minton, G., T. J. Q. Collins, K. P. Findlay, P. J. Ersts, H. C. Rosenbaum, P. Berggren & R. M. Baldwin (2011) Seasonal distribution, abundance, habitat use and population identity of humpback whales in Oman. *Journal of Cetacean Research and Management,* Special Issue on Southern Hemisphere Humpback Whales**,** 185–198.

Minton, G., T. J. Q. Collins, C. Pomilla, K. P. Findlay, H. C. Rosenbaum, R. Baldwin & R. L. Brownell Jr (2008) Megaptera novaeangliae, Araiban Sea subpopulation. *IUCN Red List of Threatened Species,* http://www.iucnredlist.org/details/132835.

Author. 2011. Sri Lanka post-war growth stays above 8%. *Bloomberg*.

Murray A, Cerchio S, McCauley R, et al. 2012. Minimal similarity in songs suggests limited exchange between humpback whales (*Megaptera novaeangliae*) in the southern Indian Ocean. Marine Mammal Science 28 (1):E41-E57.

Pomilla, C., A. R. Amaral, T. Collins, G. Minton, K. Findlay, M. S. Leslie, L. Ponnampalam, R. Baldwin & H. Rosenbaum (2014) The World's Most Isolated and Distinct Whale Population? Humpback Whales of the Arabian Sea. *PLoS ONE,* 9**,** e114162.

Razafindrakoto Y, Cerchio S, Collins T, et al. 2009. Similarity of humpback whale song from Madagascar and Gabon. Paper SC/61/SH8 presented to the IWC.

Redfern, J. V., M. F. Mckenna, T. J. Moore, J. Calambokidis, M. L. Deangelis, E. A. Becker, J. Barlow, K. A. Forney, P. C. Fiedler & S. J. Chivers (2013) Assessing the risk of ships striking large whales in Marine Spatial Planning. *Conservation Biology,* 27**,** 292-302.

Reeves, R. R., S. Leatherwood & V. Papastavrou. 1991. Possible stock affinities of humpback whales in the northern Indian Ocean. In *Cetaceans and Cetacean Research in the Indian Ocean Sanctuary: Marine Mammal Technical Report Number 3,* eds. S. Leatherwood & G. P. Donovan, 259-269. Nairobi, Kenya: UNEP.

Richardson WJ, Greene CR, Malme CI, Thomson DH (1995) Marine Mammals and Noise. San Diego: Academic Press.

Southall, B. L. 2005. Shipping noise and marine mammals: A forum for science, management and technology. Arlington, Virginia: National Oceanic and Atmospheric Administration.

Tournadre, J. (2014) Anthropogenic pressure on the open ocean: The growth of ship traffic revealed by altimeter data analysis. *Geophysical Research Letters***,** n/a-n/a.

Van Bressem, M.-F., G. Minton, T. Collins, A. Willson, R. Baldwin & K. Van Waerebeek (2014) Tattoo-like skin disease in the endangered subpopulation of the Humpback Whale, Megaptera novaeangliae, in Oman (Cetacea: Balaenopteridae). *Zoology in the Middle East***,** 1-8. DOI: 10.1080/09397140.2014.994316

Yukhov, V. L. 1969. Observations of cetaceans in the Gulf of Aden and the northwestern part of the Arabian Sea. Translated by S. Pearson, National Marine Laboratory Seattle USA. 1-6. Moscow, Izd-vo "Nauka". Morskie Mlekopitayashchie.