OTN Red Sea - Project Plan

The Sudan

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1. Background

<u>Array Name</u>: ***Red Sea State of Sudan Acoustic Array***

<u>Concept</u>:

Background:

The status of global shark and ray (elasmobranch) stocks is of increasing concern (Baum *et al.* 2003) and there have been repeated calls for management and conservation action (Dulvy *et al.* 2008). The Red Sea is famous for its rich diversity and abundance of elasmobranch species that provide a substantial draw for the diving industry in Egypt and the developing tourism sectors in Sudan and Saudi Arabia. To ensure the sustainable exploitation of elasmobranchs for the commercial sector (fisheries and tourism) and for maintaining ecosystem biodiversity there is a requirement for species-specific elasmobranch management plans. Management of large highly mobile marine species requires data on residency, movement and seasonal migration patterns. To date, there is limited data available regarding elasmobranch stock structure (population demographics and residency/movement) and associated fisheries impacts in the Red Sea region, although there has ben a notable increase in fishing pressure.

2011 Research Plans

To address this knowledge gap, this project will establish an acoustic array on offshore reefs along the Red Sea State coast of Sudan and in the marine protected area of Dungonab Bay. This will facilitate a four-year monitoring program, which will collaborate with current Red Sea initiatives, relevant Sudanese authorities and will undertake regional capacity building. The project will install VEMCO acoustic monitors (VR2W-69) and apply acoustic tags (V16) to key 'endangered' and 'vulnerable' elasmobranch species: scalloped hammerhead (*Sphryna lewini*), grey reef (*C. amblyrhynchos*) sharks and manta rays (*Manta alfredi*).

Overall Research OBJECTIVES:

1. To monitor localised and regional residency and movement patterns of target elasmobranch species;
2. To identify core habitats (aggregation sites) and quantify species-specific home-range size;
3. To determine large-scale movements and identify potential migration corridors for conservation and protection;
4. To provide training to regional counterparts (academics) on required fieldwork, equipment maintenance and analysis;
5. To improve regional capacity for the monitoring of the residency/movement of marine species and to develop collaborative initiatives between Red Sea Academic institutions.

1) Residency and movements of *endangered* and *threatened* shark species on offshore reefs of the Red Sea, Sudan.

The target shark species for this component of the project are the scalloped hammerhead and the grey reef shark. These species have been selected based on (i) life-history traits which render them highly susceptible to fisheries exploitation, both by commercial and artisanal fishing practices, (ii) their suitability as key indicator species of predator biomass on reefs and (iii) their regional economic importance in the diving tourism sector. Both species have undergone large population declines in certain geographic localities (Baum *et al.* 2003, Baum & Myers 2006, Robbins *et al.* 2006) and are listed as 'endangered' and 'vulnerable' by the International Union for the Conservation of Nature (IUCN Red List 2009). The scalloped hammerhead shark is a large coastal-pelagic species which demonstrates site fidelity, commonly forms large aggregations at offshore reefs and young move between coastal nurseries and offshore reefs, exacerbating the vulnerability of all life-stages to localised fishing pressure (Klimley 1985, 1987). All life-stages of the grey reef shark are associated with low lying tropical offshore reef complexes and they are therefore vulnerable to localised fishing pressure, typical of artisanal practices on the offshore Red Sea reefs (Mckibben and Nelson 1986, McVean *et al*. 2006). Preliminary analysis of Divers Aware of Sharks data in Sudan (DAS – a program established by the project leaders in 2007) revealed considerable overlap in the habitat of the two target species. A regional acoustic array will therefore be effective for monitoring both species simultaneously.

To examine residency (site attachment) and movement patterns between offshore reefs, specifically stepping stone movements between reefs, acoustic monitors will be positioned at six offshore reef sites in a north-south orientation along the coast of Sudan. The six reefs will include, Angarosh, Qita 'el Banna, Sha'ab Rumi, Sanganeb, Jumna and Sha'ab Anbar (Fig. 1) where both species are observed. Accepting that sharks may remain on a single offshore reef but undertake movements around the outer edge of the reef driven by environmental conditions, four acoustic monitors will be deployed per reef site on the north, south, east and west plateau depending on size. Acoustic monitors will be secured using rock and sand anchors (see details below).

A total of 20 grey reef and 20 scalloped hammerhead sharks will be tagged during the first field phase (2012). Five grey and five scalloped hammerhead sharks will be tagged with VEMCO V16 tags on 4 of the 6 selected reef sites (the sites with the highest numbers of observed sharks from the DAS program) – Angarosh, Sha'ab Rumi, Sanganeb and Jumna. Sharks of a similar size will be tagged at each site. For three of these sites V16TP tags will be used to examine seasonal depth/temperature profiles. All tags will be purchased with other secured funding.

Sharks will be caught using 'polyball fishing', a form of free drifting multiple floats with single drop lines. This method is preferred over standard longlines to reduce mortality risks through enabling the animals to continue to manoeuvre once caught. Sharks will be worked up at the side of a boat, and basic data recorded including; basic morphometric measurements [total length (TL), precaudal length (PCL), fork length (FL) and clasper length (CL)], sex (presence/absence of claspers) and fin clip/muscle biopsy/blood samples taken for additional genetics and biogeochemical studies. V16 tags will be internally inserted in the peritoneal cavity through minor invasive surgery and closed with a single suture (work up time of approximately 5 mins.). External marker tags will be applied.

Through the use of V16 tags, this project will track individual sharks over a 4-year period, monitoring multi-species residency at specific reef sites and movements among localized and regional reefs. Trans-boundary movements of these species between the Red Sea countries, seasonal migrations and large-scale movements into other regions such as the Gulf of Aden/Indian Ocean will be documented through the attachment of satellite tags (Wildlife Computer – MK10). Satellite tags will be purchased with pending funding.

2) Residency and movement of a unique aggregation of manta rays relative to designated marine protected area boundaries in the Red Sea, Sudan.

Manta rays are known to live in excess of 20 years and to have low fecundity, giving birth to a live single pup, possibly two pups on occasion. The main threats to manta ray species are directed and undirected (bycatch) fishing activities. This species is targeted for their meat, skin, cartilage and branchial plates (White et al. 2006). This has resulted in a well-developed global fishery, which mostly operates illegally.

Dungonab Bay represents a unique site on a global scale, where a large aggregation, consisting of several hundred manta rays, occurs in a region with minimal human development/disturbance. This aggregation of manta rays is commonly observed at the surface in the Bay during September, October and November. Throughout the rest of the year, there are anecdotal sightings of small numbers of manta rays, but the large aggregation is not observed. Initial placard tagging of manta rays (undertaken by the Project leaders) revealed that manta rays moved out of Dungonab Bay to the offshore reefs (for example Angarosh).

Dungonab Bay was pronounced a marine protected area in 2007, but to date no research has been undertaken to assess the efficiency of this site for protecting potentially mobile species such as manta rays.

The second component of this project will focus on determining the residency, fine-scale localized movements and potential larger scale movements of manta rays within and outside of Dungonab Bay (Figure 2). This project will determine how effective the current Dungonab Bay marine protected area boundaries are for protecting this species in Red Sea waters. An array of 20 acoustic monitors will be positioned within the Bay (Figure 3), including ‘hotspot’ sites identified from the DAS program and a gate where animals have been observed on the outer edge of the park (Figure 4). All acoustic monitors will be secured using sand anchors. Acoustic monitors installed on offshore reefs (see (1) above) will enable tracking of larger scale movements (manta rays have been observed on most of the selected offshore reefs as part of the DAS program). In addition to acoustic tracking work, seasonal sampling of zooplankton will be undertaken and remote sensing techniques will be employed to better understand behavioural decisions driving residency and movement patterns.

A total of 20 manta rays will be equipped with standard V16 tags. All manta rays will be tagged within the core distribution area within Dungonab Bay during the known aggregation period (Sept-Nov 2012). Manta rays will either be tagged externally while free swimming, but the team plans to attempt to capture manta rays using seine nets and insert tags internally (discussions are currently underway with other researchers who suggest this approach is more suitable due to external tag retention issues). All tags will be purchased with other secured funding.

Significance for Red Sea region

The establishment of the Red Sea State of Sudan acoustic array will form a framework to facilitate the study of multiple marine species (i.e. important commercial fish species such as grouper) and will be critical for stimulating and enhancing regional marine conservation and management initiatives. An important component of this overall project is to ensure regional capacity building.

This data is anticipated to contribute directly to regional management plans for elasmobranchs and to promote the development of a series of marine protected areas along the coast of Sudan. Note, the current marine protected areas of Sanganeb and Dungonab Bay are currently listed as nominations for World Heritage Site status.

2. Initial Array Design

a. **Equipment and Services**:
    i. Dalhousie will provide:
        - 40 acoustic receivers: Vemco VR2W-69KHz, with lithium batteries,
  II. ***partner*** will provide:
    i. Boat time/logistics for deployments and tagging work,
    ii. Qualified personnel for deployment and tagging work,
    iii. Boat time for maintenance and uploading of data,
    iv. Range testing boat time with qualified personnel,
    v. Satellite tags for sharks: MK10 x 9,
    vi. Acoustic tags for sharks and rays: V16 x 60.

b. **Proposed Array Locations:**

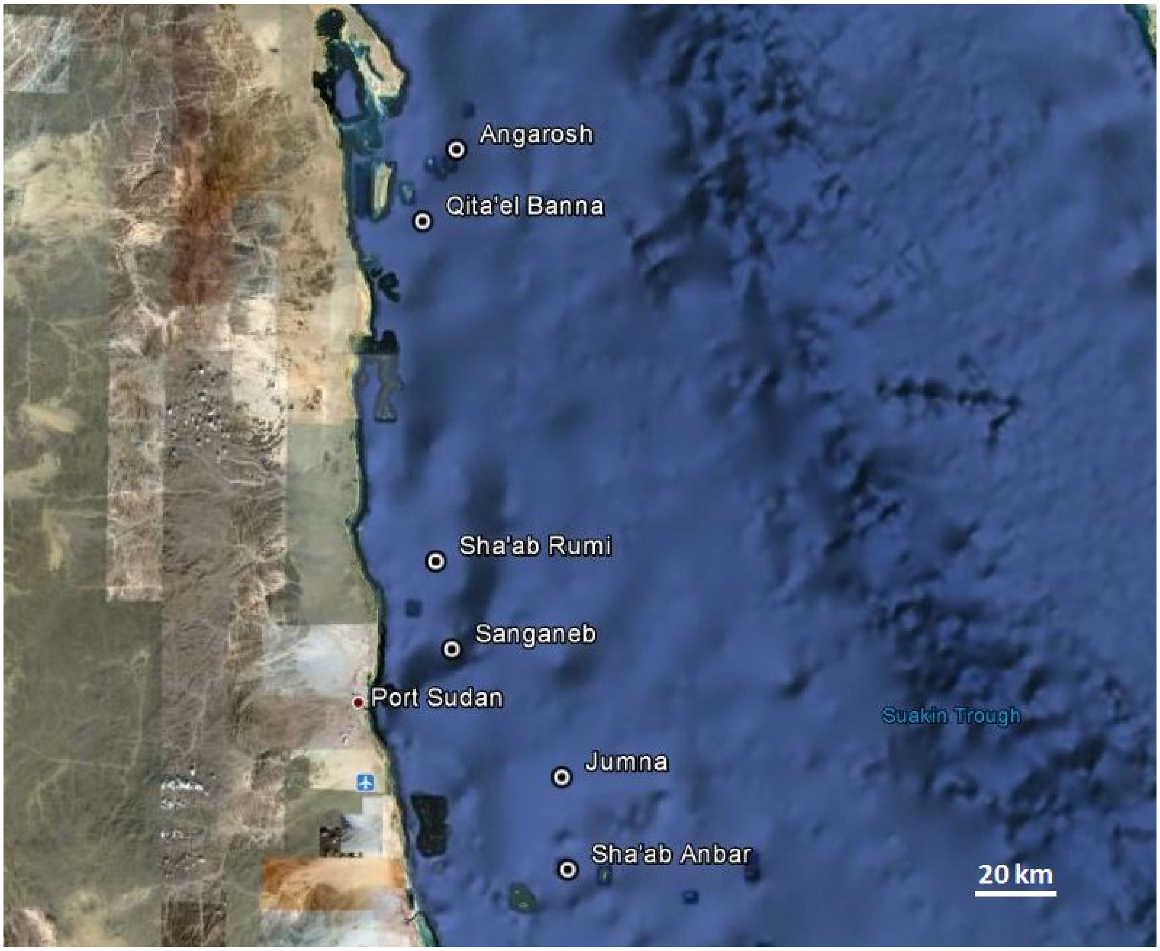

Figure 1: Locations of VR2-69KHz receivers for monitoring residency/ movements of scalloped hammerhead, and grey reef sharks and large scale movements of manta rays.

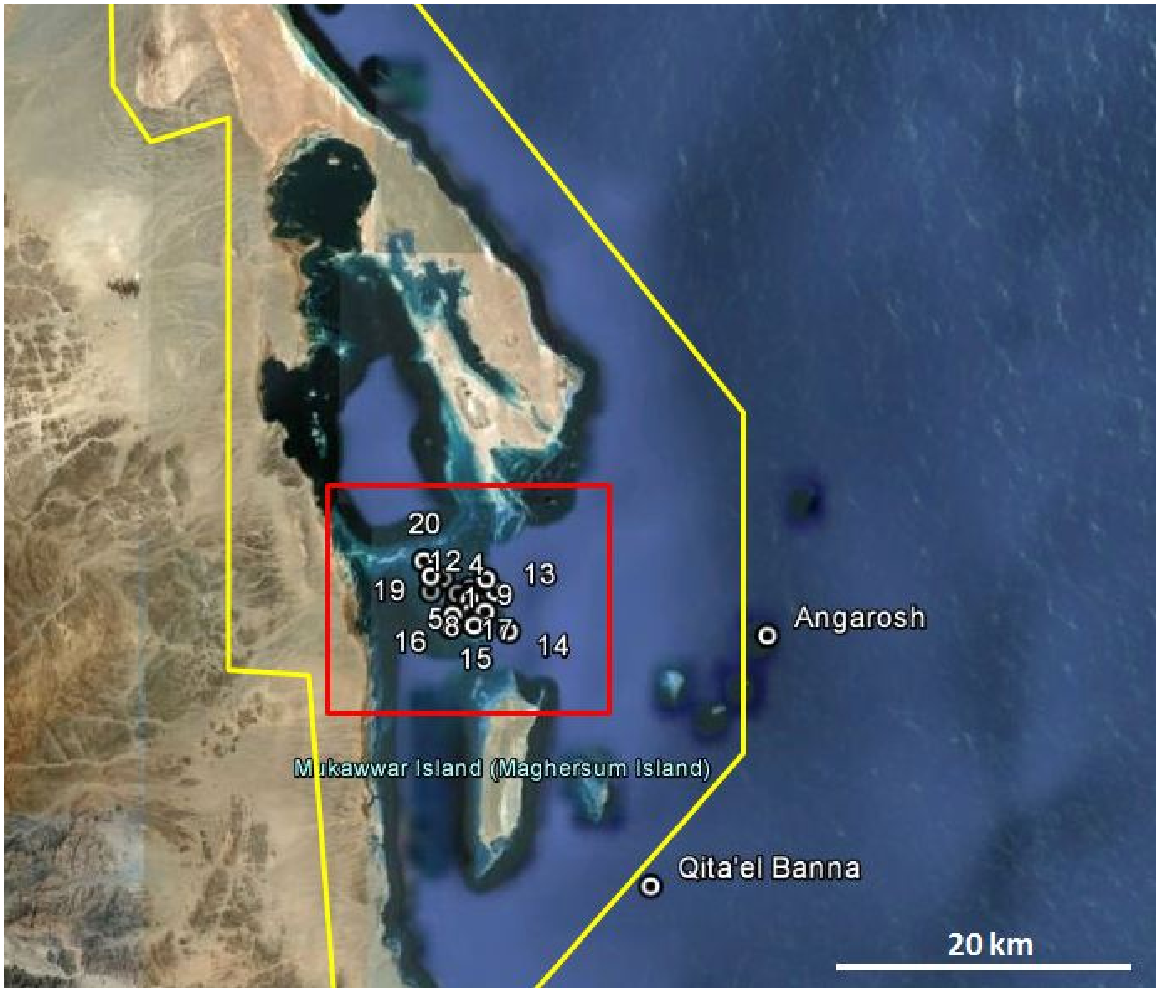

Figure 2: Location of manta ray core VR2-69KHz receiver array within Dungonab Marine Reserve. The yellow line represents the boundary of the marine reserve and red square shows the location of the array within the reserve. The two points outside of the reserve boundary are monitor site from the reef array (each with four monitors);

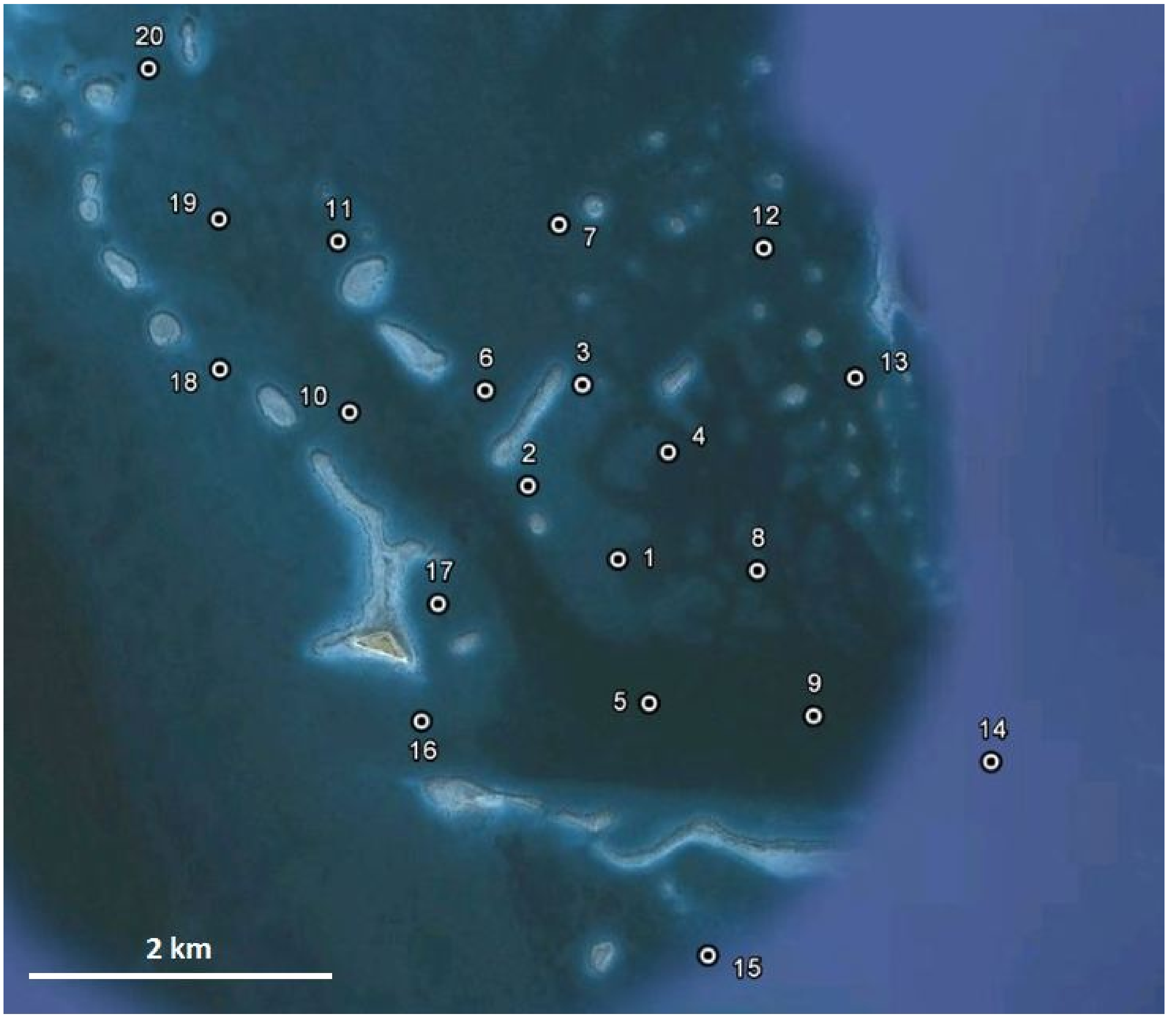

Figure 3: Specific locations of manta ray core array VR2-69KHz receivers, locations based on ‘hotspot’ sites (Figure. 4) identified from the DAS program and a gate where animals have been observed on the outer edge of the park;

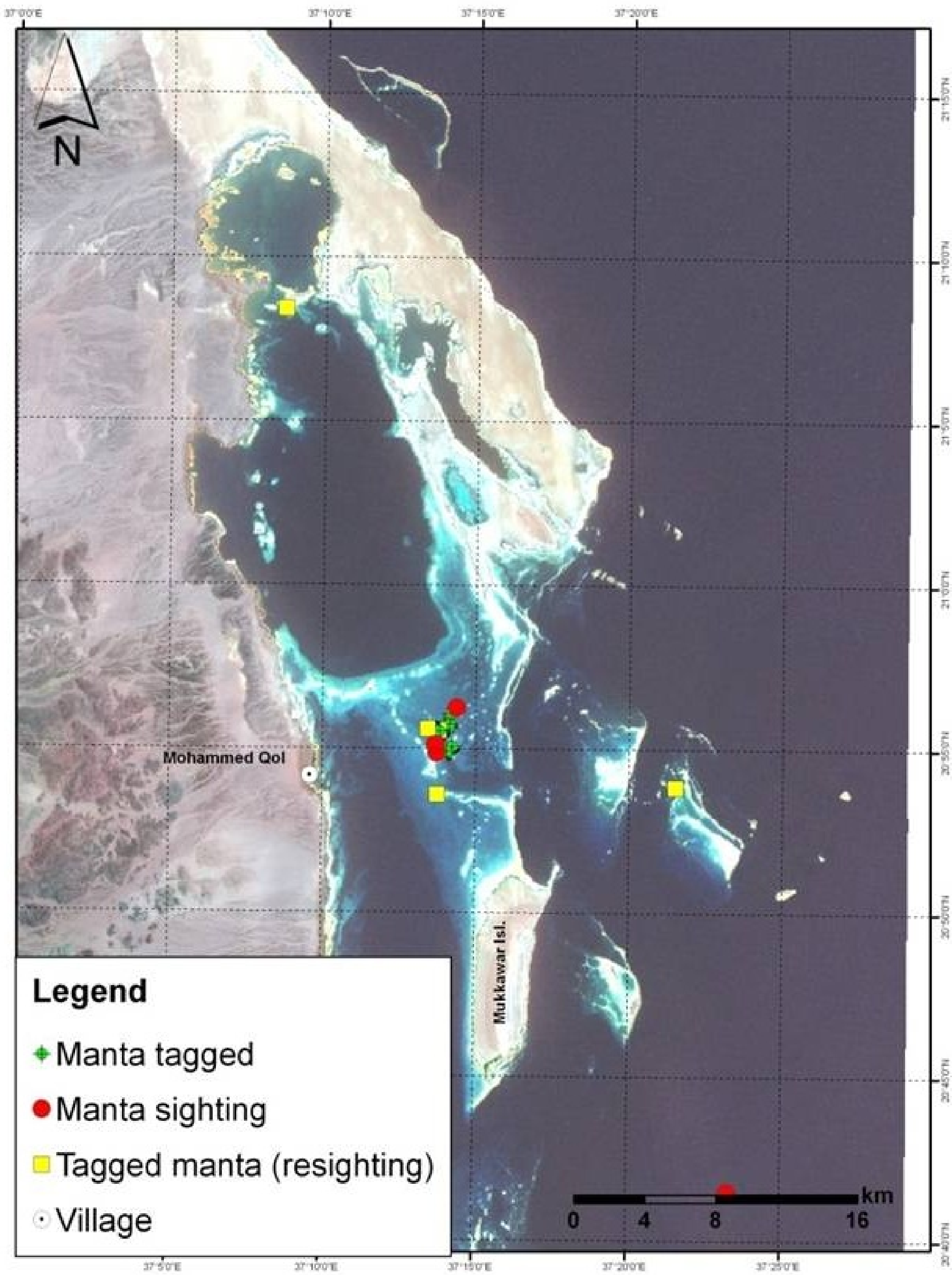

Figure 4: Hotspot sites identified from the DAS (Divers Aware of Sharks) program including the gate where animals have been observed on the outer edge of the park;

Table 1: Proposed locations of individual monitors along (a) offshore reefs, and (b) in Dungonab Bay

(a)

Monitor Location Name	Station Latitiude (DD)	Station Longitude (DD)
Angarosh N	20.89794	37.45146
Angarosh E	20.89507	37.45403
Angarosh S	20.89260	37.45107
Angarosh W	20.89595	37.44838
Qita'el Banna N	20.73002	37.37039
Qita'el Banna E	20.72862	37.37148
Qita'el Banna S	20.72738	37.37052
Qita'el Banna W	20.72864	37.36884
Sha'ab Rumi N	19.94440	37.40830
Sha'ab Rumi E	19.94226	37.40985
Sha'ab Rumi S	19.93925	37.41004
Sha'ab Rumi W	19.94239	37.40729
Sanganeb N	19.74280	37.44780
Sanganeb E	19.74090	37.45092
Sanganeb S	19.73833	37.44998
Sanganeb W	19.74008	37.44689
Jumna N	19.45000	37.71670
Jumna E	19.44360	37.72278
Jumna S	19.44043	37.71619
Jumna W	19.44531	37.71191
Sha'ab Anbar N	19.24726	37.72426
Sha'ab Anbar E	19.23786	37.73107
Sha'ab Anbar S	19.23120	37.72129
Sha'ab Anbar W	19.25220	37.70357

(b)

MonitorSite Number	Station Latitude (DD)	Station Longitude (DD)
1	20.91109	37.24339
2	20.91605	37.23689
3	20.92287	37.24083
4	20.91833	37.24701
5	20.90139	37.24565
6	20.92248	37.23380
7	20.93367	37.23913
8	20.91034	37.25344
9	20.90054	37.25751
10	20.92100	37.22403
11	20.93253	37.22318
12	20.93209	37.25390
13	20.92335	37.26050
14	20.89745	37.27031
15	20.88438	37.24990
16	20.90016	37.22923
17	20.90809	37.23041
18	20.92390	37.21467
19	20.93403	37.21459
20	20.94418	37.20950

3. Deployment Schedule

The deployment of all acoustic receivers and tagging of sharks and rays is planned in two field phases (scalloped hammerhead and grey reef shark – April/May 2012 / manta rays September 2012).

4. Maintenance Schedule

It is expected that service trips to the Red Sea State of Sudan acoustic aray will take place (at a minimum) once a year, at which time batteries will be changed if needed in the receivers, and biofouling will be removed from the receivers. Maintenance checks and upgrades (at a minimum batteries and corroded parts will be replaced, where applicable, full replacement units will be provided) will be performed during those trips. It is expected that during maintenance trips, equipment at each station will be recovered, maintained and redeployed in a timely manner as to avoid any prolonged absence of acoustic receivers on the acoustic array.

5. Data Retrieval Schedule

Data will be uploaded from the receivers once a year, and submitted to OTN in the manner outlined in the OTN Data Management Policy.

6. Mooring Design

Illustrations of the type of moorings that will be used to position VR2W-69 monitors in the Red Sea can be seen in Figure 5. For the offshore reefs, where there are high current conditions, monitors will be anchored through drilling (using air drill) and securing monitors stand with a rock anchor. Monitors will be bolted to a metal rod that is then bolted to the rock anchor, no float or rope will be required. In Dungonab Bay, where conditions are favourable, monitor stands will be secured to the seabed using sand anchors. We will either use a similar design to offshore reefs or Secure monitor on cable (using zip ties and security twine) and a small sub-surface float. All monitors will be secure approx 0.75m above the seabed.

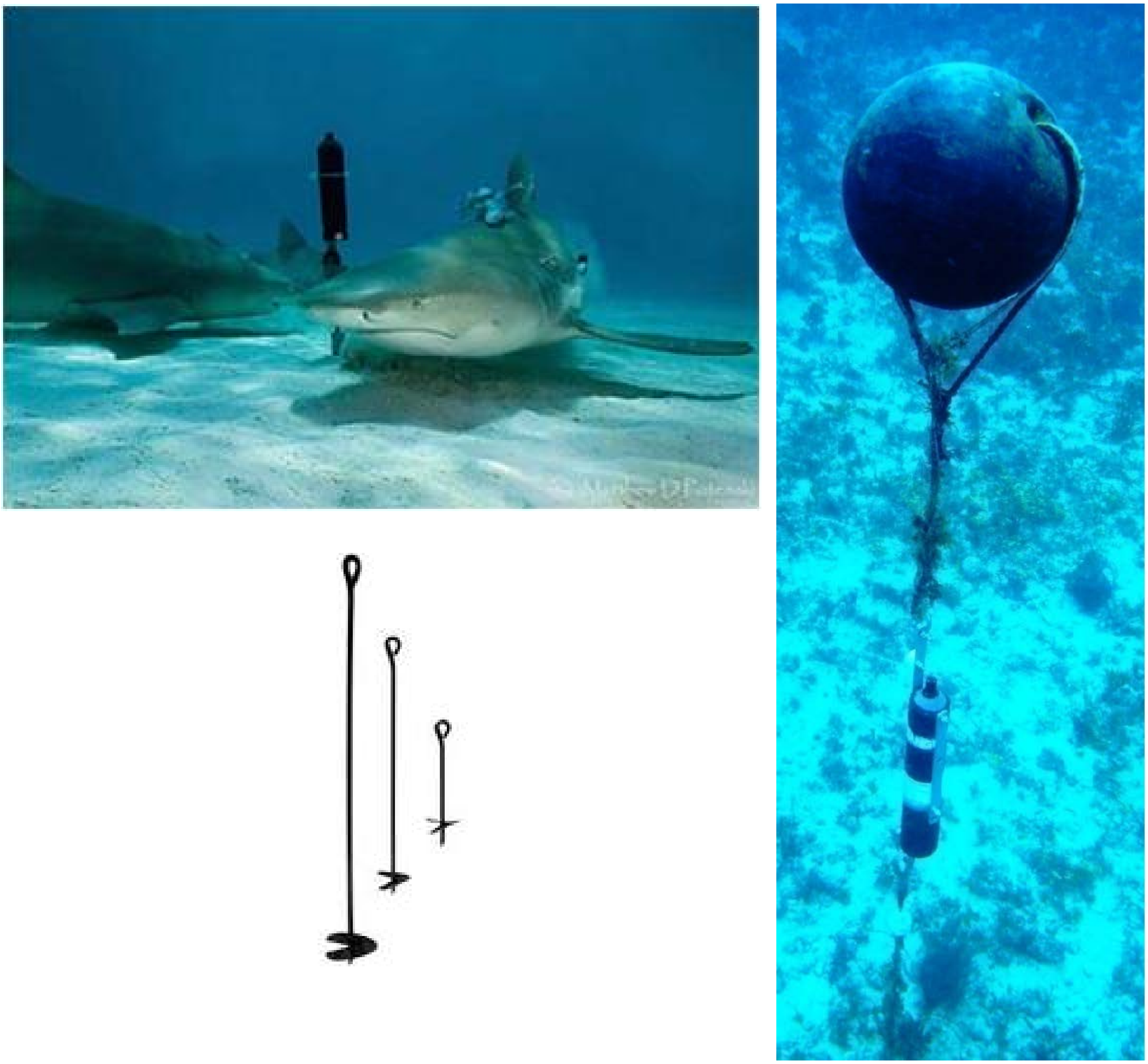

Figure 5: Illustrations of mooring type for VR2W-69; (i) VR2W attached to metal rod with no float (for offshore deployments) and using rock anchor, (ii) VR2W-69 attached to metal rod with cables from anchor to rod and rod to float (potential for Dungonab), and (iii) Auger or sand anchor for Dungonab Bay attachment to substratum.

7. Shipping Details

Dalhousie University will cover costs of shipping the equipment to <location to be decided>. Dalhousie will ensure that the acoustic receivers are in good working order and condition before they are shipped.

8. Roles and Responsibilities

Roles and responsibilities for the deployment of this array are divided as follows:

Red Sea State of Sudan – Deployment Team:

- Design array; Nigel Hussey, Steven Kessel and Aaron Fisk
- Set deployment schedule(s); Nigel Hussey, Steven Kessel and Aaron Fisk
- Design moorings; Nigel Hussey and Steven Kessel
- Reserve and provide shiptime; Nigel Hussey and Steven Kessel
- Test receivers prior to deployment (Dalhousie will not be testing receivers prior to shipping); Nigel Hussey and Steven Kessel
- Perform range testing during initial deployment; Nigel Hussey and Steven Kessel
- Lead deployment activities; Nigel Hussey and Steven Kessel
- Upload and provide data to OTN as specified in section 5; Nigel Hussey and Steven Kessel

The team is required to coordinate and order parts/equipment with enough lead-time, such that the team will have all required items at time of deployment.

9. Receiver Replacement

Lost or damaged receivers may be replaced at Dalhousie's discretion.

10. Risk Management

The table below identifies the risks associated with the deployment and also identifies how/if the OTN team plans to address these items.

RISK FACTORS	IMPACT	RISK LEVEL	MITIGATION STRATEGIES
Faulty Receiver discovered after partner takes possession of the equipment	1. A hole in the planned array 2. Array would need to be modified at certain sites 3. Lost equipment 4. Dalhousie	Medium	1. In instances where the equipment cannot be tested before they are shipped to the partner, the agreement will be modified to indicate the partner is responsible for testing.

	could be in non-compliance with the collaboration agreement		
Faulty deployment vessel and/or positioning equipment	1. Inability to deploy equipment at desired locations	Low	1. Maintain communication lines with partners so alternate cruise plan can be developed, if required. 2. Team must carry appropriate GPS positioning equipment and navigational software.
Inclement weather forces deployment crew to stay on shore	1. Deployment activities delayed	Low	1. Plan deployment window for most favorable weather conditions 2. Ensure safety time window to account for unfavorable weather conditions
Poor mooring design	1. Lost equipment and/or hole(s) in array design 2. Environmental hazards	Low	1. Ensure mooring design well in advance of deployment and have it reviewed by a panel of like-minded and experienced individuals. 2. Collaborators should think about range testing their line with various types of tags in various weather conditions
Line can't be deployed in the planned position	1. The line cannot be deployed	Medium	1. Engage regional authorities to review the environmental impact of the line

because of unknown obstacles and/or regional embargoes/environmental concerns			placement 2. Ensure line placement is approved by an appropriate regional body. 3. Maintain open communication so alternate deployment locations can be developed, if required.
Collaborator does not provide data and/or metadata or data/metadata of poor quality	1. Data from the line is meaningless or non-existent 2. Data quality compromised	Low	1. Partner required to sign and comply with OTN data policy 2. Examine collaborator's existing systems 3. Employ OTN data quality control procedures

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