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Tourism Development Authority
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Red Sea Sustainable Development

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Report on Mooring Buoy Implementation Plan (2.3.2)
A Supplement to the Red Sea Mooring Buoy Strategy

International Resources Group and partners:
Winrock International
PA Government Services, Inc.
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GOVERNMENT OF EGYPT

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EGYPTIAN ENVIRONMENTAL AFFAIRS AGENCY

Nature Conservation Sector

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Tranche 2 Policy Measures
2.3 Red Sea Southern Zone Conservation Management Plan

Report on Mooring Buoy Implementation Plan (2.3.2)
A Supplement to the Red Sea Mooring Buoy Strategy

Prepared for U.S. Agency for International Development
Egypt Mission

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EXECUTIVE SUMMARY

This *Mooring Buoy Implementation Plan (MBI Plan)* is an outgrowth of the previously drafted *Red Sea Mooring Buoy Strategy.* Both of these documents have been prepared within the overall framework of the EEAA-USAID's *Red Sea Sustainable Development Program*. The purpose of the plan is to identify the practical steps to be taken by EEAA, in fulfilling the key initiatives discussed in the strategy. The timeframe for plan implementation is 2003-2004, although some activities will necessarily require an additional year to complete.

The *MBI Plan* also discusses the geographic sectors in the Red Sea where maintenance of the mooring system is most critical and where future expansion should be focussed. Two of the sectors hold the highest priority for mooring work: *Safaga Sector* (N. Red Sea) for maintenance and some new installations, and *Zabargad Sector* (S. Red Sea) for new installations in a hitherto un-serviced area. Mooring implementation plans have been prepared for both areas.

EEAA's proposed implementation activities may be summarized as follows:

- **To establish a full-service NCS/EEAA mooring team.** Additional commercial divers and support personnel will be hired, equipped and trained, and provided with appropriate support services within the Red Sea Protectorates.

- **To create a *Sea Ranger Auxiliary (SRA)* group.** The *SRA*, a voluntary organization, will draw membership from selected dive operators to extend the 'eyes and ears' of the rangers at sea, to promote conservation practices, and to alert the rangers to problems such as physical damage to the mooring system, destructive practices of dive boats, dumping garbage at sea, illegal fishing or unsafe handling of dive boats in the vicinity of divers.

- **To procure, stockpile and evaluate critical mooring equipment.** Procurement will be made of essential equipment and spare parts. Without this procurement component, the mooring system will ultimately founder. Having a stock of underwater hydraulic tools and associated hardware is the most critical equipment requirement. Other mooring equipment can be acquired in Egypt and will not need to be stockpiled. Pre-installed environmental moorings are the first line of defence in protecting coral reefs from dive boats and their anchors, but maintaining the system's integrity ultimately rests on immediate access to workable tools. Evaluating the serviceability of mooring components will also identify any weak links.

- **To determine the state of the mooring system *in situ*.** Field data is needed on the reliability and durability of specific components comprising the system. During survey missions, positional data will be acquired for mapping the associated reefs, particularly in the south, between N Lat. 24º 35' (Ras Honkorab) and N Lat. 24º 10º (Fury Shoals/Sataya). Mapping of

the area south of Ras Banas, from N Lat. 23º 50' (Mikauwa & Horseshoe reef) extending to N Lat. 23º 20' (St. John's Reef), will be carried out in conjunction with a survey of reefs used by safari boats, as a preliminary step to installing new moorings.

- To maintain and expand the mooring system in the Northern Red Sea. (Mooring maintenance and new installations by EEAA/HEPCA will be performed in concert with local dive centres in the *Safaga Sector* during 2004. The most urgent sites are the 9 reefs from Ras Soma to Gamul Kebir[1] and 7 oceanic reefs[2]. The Gouna and Hurghada dive operators will be consulted to determine the mooring needs in the *Northern Islands Sector*. Maintenance will be undertaken in the Gouna area. New installations will be made at several sites frequented by safari vessels further to the north.

- **To maintain and expand the mooring system in the Southern Red Sea**. In the *Wadi Gimal–Hematah Sector* from Marsa Alam to Ras Banas (N25º–N24º), the moorings installed last year will be checked, repaired as required, and mapped using differential GPS by EEAA/HEPCA, with local dive centre support. Marsa Alam safari boat operators will be consulted to determine the mooring needs in the *Zabargad Sector* stretching from Ras Banas to Mirear Is (N24º–N23º). EEAA will arrange for at least two installation missions during 2004, with additional work being scheduled for 2005.

- **To adopt a revenue generation mechanism for funding the mooring system**. There are an estimated 800 installed moorings in the Red Sea, representing a substantial investment. At current prices, the replacement value of the system (hardware and installations) is estimated to be $756,000 or LE 4,690,000[3]. To maintain these assets, annual support funds for mooring activities should be part of the overall revenue generation scheme adopted by EEAA and the RSG for the Red Sea. Funds earmarked for moorings should be in an operating account separate from the general support funds for the Red Sea Protectorates. This will ensure the continuity of: fund allocations; system integrity; annual budget preparations; and regularly scheduled activities. This approach will preclude chronic equipment failures that occur when the system is neglected and allowed to run down.

- **To forge agreements for cost-sharing moorings with the dive industry.** EEAA in concert with its partners will endeavour to arrange for cost-

[1] Ras Abu Soma, Abu Soma Garden, Tobia Arbaa, Tobia Hamra, Tobia Kebir, Tobia Soraya, Tobia "Beda", Gamul Soraya, and Gamul Kebir.
[2] Panorama, Middle Reef, Hal Hal, Shaab Sheer, Shaab Claude, Shaab Humdallah, and Abu Kafan.
[3] Replacing the system would entail re-installing 300 imported double mantas (duty paid) and 500 locally supplied double pins. Total cost of double pin installations will be 50% less than double mantas, *if duty is levied on the mantas.* With no duty, double pin installations are approximately 33% cheaper than double mantas.

sharing agreements with stakeholders operating within mooring areas. These agreements will be made prior to specific operational missions. A more sustainable partnership will require long term commitments wherein local dive centers assume responsibility for topside mooring maintenance in their respective areas. The recent agreement between Orascom and the EEAA Red Sea Protectorates is an example of such collaboration specifying maintenance requirements as a contractual responsibility of the local dive centers and hotels[4].

- **To promote private sector involvement.** Dive operators are on the water everyday, so are in a position to monitor the moorings and conduct light maintenance. Accordingly, the *Plan* proposes several initiatives: adoption of a maintenance schedule that outlines periodic tasks on a monthly, quarterly, bi-annual and annual basis; delegation of specified monitoring and maintenance tasks to selected dive operators through their participation in the Sea Rangers Auxiliary, with EEAA providing appropriate training guidance and mooring materials. Another area for private sector involvement is adoption of best practice guidelines for using the system without damaging it. Boat captains and crew will be trained by dive centers or other organizations in order to preclude ramming the buoys, cutting pick-up lines with drive props, overstressing anchors by manoeuvring against them, or by simultaneously tying more than 3 boats to a single mooring.

[4] Agreement specifies that the 5 El Gouna diving centers should be responsible for basic maintenance of the mooring systems of certain reefs around El Gouna. Most importantly, maintenance *should be a requirement/responsibility of the diving centers and will [be] added to the contracts of the diving centers and the hotels.*

1 INTRODUCTION

Support for the mooring system falls within the framework of EEAA-USAID's *Red Sea Sustainable Development Program*. The strategic objective of the mooring system is to allow benign use of coral reefs by the tourist industry while preserving their ecological integrity. To ensure this harmonious balance, a number of practical implementation steps have already been taken based on past experience. The steps to follow are discussed in this *Mooring Buoy Implementation Plan (MBI Plan)*, which is an outgrowth of the previously drafted *Red Sea Mooring Buoy Strategy*

1.1 History of Environmental Moorings

With the growth of dive-based tourism during the past 10 years, many of the suitable island and associated submerged reefs have become frequented by divers and snorkelers using day-boats operating from Hurghada, Safaga and other ports and, in the case of remote reefs and islands, by safari boats. Daily dive trips along coastal fringing reefs are mobilized directly from the beach, with or without Zodiac support, at those few sites where Sharms facilitate access across the reef to the open sea. Visitor statistics indicate that some 800,000 divers and snorkelers visit the Red Sea annually during a normal year, and that the number continues to grow.

Use of environmental moorings has a 10-year history in the Red Sea, beginning with HEPCA and the dive industry, and continuing with EEAA in collaboration with USAID throughout the 1990s to (a) research mooring systems; (b) procure specialized equipment; (c) train commercial divers; and (d) install moorings. By January 2000, the installed base of moorings reached an estimated 450, primarily in the N. half of the Red Sea. Since then, the system has expanded to more than 800 moorings with new installation being made in 2003 and early 2004.

1.2 Description of Mooring System

Two kinds of mooring hardware are in-service in the Red Sea. The Manta-ray system is used for sandy bottoms where penetration is relatively easy (see *Figure 11)*. The HALAS Pin System is used for sites with a hard substrate, such as the rock surface of dead coral reefs. Collectively, this hardware has dramatically reduced reef damage by boat anchors at commonly frequented sites. However, given the increasing tourist demand for a relatively limited number of dive sites, there has been an increase in the size of dive boats; the number of boats in operation; and the number of customers aboard each boat. This has resulted in overloading the mooring system at popular sites, to say nothing of the environmental impact of too many divers on too few sites. Solutions to these emerging issues are highlighted in this *Mooring Implementation Plan*.

1.3 Use of Moorings as a Management Tool

As discussed in the *Mooring Buoy Strategy*, removing a fixed mooring can solve overuse of a reef. A manta's down-line can be decoupled from the anchor eye shackle on the seafloor and replaced with a short buoyed marker line. It is invisible from the surface, but can still be located by mooring specialists when returned to service.

Periodic monitoring of dive sites by the EEAA Rangers, combined with dive guide suggestions, can yield recommendations for temporary site closures. Sites should be closed for extended periods if overuse has induced environmental degradation—see *Figures 7 and 8*—or sites are seasonal nursery grounds for marine species. Recent reef monitoring indicates that some reefs have exceeded their carrying capacity and should be closed (Hanafy 2002).

2 ESTABLISH A FULL-SERVICE NCS/EEAA MOORING TEAM

2.1 Build Capacity within EEAA for Making Installations

The Red Sea now has upwards of 800 environmental moorings, distributed N-to-S along a 500-km stretch from Qeisum to Fury Shoals. This represents the largest installed mooring system in the world. The area is sufficiently extensive that three operational maintenance units should be dedicated. At present, there is only one dedicated unit (HEPCA) in Hurghada[5]. Accordingly, the *Implementation Plan* recommends the creation of a second full-service Mooring Installation Unit within EEAA. This unit will have responsibility for making new installations in the marine areas of: Wadi Gimal--Hematah Protected Area; those south of Ras Banas; and the Far Islands of Abu El Kizan and Zabargad--Rocky Is. In addition to their prime role in making new installations, they will also provide assistance to a new NGO - private sector partnership currently being formed in the south (see 2.2).

Estimated cost to establish a Red Sea Environmental Mooring Team. The cost to establish a fully functional mooring team from scratch is $220,000[6]. This is a realistic figure based on EEAA/PSU/HEPCA cost history. Note that this estimate *excludes* costs of subsidiary services (such as GIS) or costs of mooring materials to be installed. In fact, it is only after the team is created—and the $220,000 spent—that the work can commence (see *Table 1– Cost to establish a Red Sea Environmental Mooring Team[7]).*

Planned actions. During 2004, EEAA will initiate the contracting process for hiring 6 new commercial divers. These divers will be properly equipped and trained to do the job in a safe and effective manner. Note that training commercial divers to safely use underwater tools is an order of magnitude greater than standard SCUBA training (see *Figure 13).* The present partnership, comprising the EEAA, Red Sea Governorate and HEPCA, will continue to install and maintain the mooring system in the N Red Sea.

[5]Another private-sector unit is owned by Marine Solutions in El Gouna, but it is used primarily for jetty-construction on a contract basis and is not dedicated to moorings.
[6]Estimates are based on a minimum of a 1-year period.

[7] Basic requirements to create a core team, properly trained and equipped to service the mooring system. Minimum of 1 year, applied to the salary costs of the personnel.

2.2 Promoting Establishment of a Third Private Sector Mooring Team

Notwithstanding the planned presence of two mooring teams (HEPCA and EEAA), encouragement should also be given to the creation of a third full-service mooring team. This should be a commercial enterprise or a group of enterprises, and might be based permanently in the south where mooring demands are expected to increase dramatically during the next few years. Such a development is in keeping with the objective of promoting private sector involvement in the mooring system, as well as providing systems redundancy in the event that one of the mooring units' disbands.

Planned actions. EEAA should encourage establishment of a private sector group by providing advice on hydraulic equipment needs, mooring materials, and with HEPCA training on how to make installations. EEAA may selectively help by loaning tools, supplying some materials, choosing dive sites in collaboration with the dive industry, as well as setting the standards.

3 CREATE A SEA RANGERS AUXILIARY (SRA)

3.1 Mismatch between Extensive Geographic Area and Capacity to Manage It

A daunting challenge for the Red Sea Rangers is how to adequately patrol, monitor and manage the extensive coastal fringing reefs, and the near shore and offshore submerged reefs. With up to 1500 dive boats operating in the Red Sea daily, it is clearly impossible to cover the 525 km distance from North Qeisum Is. (east of Ras Gemsa) to St. John's Reef (south of Ras Banas), yet the dive and fishing industries regularly utilize these areas.

One solution to the situation of being "too thin on the ground", is to create a *Sea Ranger Auxiliary (SRA)* group of individuals drawn from selected dive centers. The role of this voluntary organization will be to extend the 'eyes and ears' of the rangers at sea, to promote proper conservation practices, and to alert the rangers to problems requiring attention such as damage to the mooring system, destructive practices of dive boats, dumping of garbage at sea, illegal fishing and breaches of safety.

3.2 Training and empowerment

SRA members will receive training for the role in which they are participating. EEAA/NCS will take the lead in preparing resource and training materials, after consultation with HEPCA, RSADWS and the dive industry. This training will be co-ordinated by EEAA and may be administered by other conservation or training organizations. SRA members shall successfully undertake training in the following areas:

- Communicating with EEAA Rangers (radio, cell phones, satellite phone)
- Alerting Rangers about real-time conservation issues on the sea & coast
- Faxing reports to EEAA
- Knowledge of key laws pertaining to Red Sea marine conservation
- Knowledge about the mooring system and best practices for its use

- Reporting to EEAA on problems with specific moorings
- Using GPS to mark field locations
- Coordinating and conducting simple mooring maintenance
- Public relations--how to deal with competitors (other dive operators)
- Public relations--How to deal with the public

SRA members should, as far as practicable, participate in both a *theoretical* training course and practical training exercises on the aforementioned subjects. Theoretical training will provide the knowledge required to carry out the responsibilities identified above. Practical training exercises should be provided in a modular format.

Once persons are accepted into the Auxiliary, it is the intention of EEAA to provide annual identification cards to SRA members as well as a distinctive cap, arm band, and other identifying livery.

Planned Actions. EEAA will define the roles and responsibility of a *Sea Rangers Auxiliary (SRA)* and design a pilot program at two locations, one in the south at Wadi Gimal, and the other in the north at Safaga. Reference to *Annex 1 – Creation of a Sea Rangers Auxiliary*, discusses (a) how EEAA will select participants, (b) what implementation steps will be taken, and (c) the type of training that will be offered to the participants.

4 PROCURE, STOCKPILE & EVALUTE MOORING EQUIPMENT

4.1 Trends in Types and Use of Mooring Hardware

Based on experience, stronger mooring components are now being used in the system, as well as multiple anchors in lieu of singles. Future procurement must reflect these evolutionary changes so that sufficient equipment and spare parts are stockpiled, without which the mooring system will founder. Having a stock of underwater hydraulic tools with associated hardware is the most critical requirement. Reference to Table 2, lists the tools (with prices) that are used by the EEAA/HEPCA commercial divers to install moorings[8]. Environmental moorings remain the first line of defence in protecting coral reefs from dive boats and their anchors, but maintaining the system integrity ultimately rests on having serviceable hydraulic tools (see Figures 9 and 12). Other mooring equipment can be acquired in Egypt without the need for stockpiling.

Strengthening mooring hardware. In consultation with the dive industry and direct feedback from the mooring units of HEPCA and EEAA, it was recognized that existing anchors, pins, and mooring arrays were not always strong enough for Red

[8] Specifications for installation tools used in the Red Sea have changed little over time. The items listed are either still in use, or are included in the March ’04 Red Sea procurement list. Several items are now sourced in Egypt and are being used in lieu of imported equipment. Most of the 2003 prices were provided by Environmental Moorings International Inc. Key Largo, Florida. USA. Email: EMIHALAS@AOL.COM.

Sea conditions. During the past 2 years, the EEAA/PSU has increased the diameter specification for the imported heavy duty Poly Pro down-line rope (which links the surface buoy to the anchor) from 3/4 inch to 1 inch and last year to 1-1/4 inches. Similarly, the specification for manta-ray anchors has been modified to use the more robust MR-SR model over the MR-1 model. Reference to Table X lists the anchoring materials (with prices) for US-sourced materials that have been used by EEAA/HEPCA[9] (see Table 3–Anchoring materials used in the Red Sea & prices. Additionally, the Egyptian-made stainless steel pins w/anchor-eyes, used for hard substrate, have been braced by welding two identical pins together side-by-side to create one oversized pin.

Twinning the anchors. Some anchors fail or pull-out when undergoing excessive stress loads. Too many vessels tying up to the same mooring during windy conditions cause this. Safari boats are a principal concern because of their large size, sometimes up to 36m. To address this, EEAA/HEPCA/PSU has re-defined a *standard* installation to be one using a *pair* of installed anchors, situated 1m to 2m apart. Hence, twin Manta-ray anchors are installed where one used to suffice and anchor eye-pins are similarly doubled. The stress-load is then shared between the anchor points to minimize failure. A large-diameter link chain is then attached to both anchor eyes, and a link in the centre of the chain is used with a 2cm-diameter shackle as the take-off point to the buoy downline. These last components are available locally and have not been proof-tested by the manufacturer. Reference to *Figure 10* shows two stainless steel pin-anchors embedded into the reef top at Samadai, before the common chain has been attached.

4.2 Determining Specifications of Egyptian Mooring Materials

All mooring arrays are only as strong as the weakest link. Based upon recent installations made during the past 3-years, there is need to acquire performance specifications for those items of the mooring equipment that are purchased in Egypt, because the products are sold without proof testing. The specific focus of this action will be on locally-made items such as: (a) the 2” diameter polypropylene down-line rope which is not UV-treated; (b) the 7/8” shackles which may corrode easily in the threads; (c) the large link chain, and (d) the locally made soft-bottom anchor flukes which are made from steel having a lower tensile strength than the imported manta rays. With the substitution of locally-made or acquired components for imported equipment of known specification, it is imperative to ensure that the new components are as strong, or stronger, than those currently in use. However, specifications are not available from the manufacturer—and perhaps are not even known.

Planned actions. EEAA will engage an independent Egyptian engineering company that specializes in materials testing. The company will be charged with physically

[9] Specifications for mooring materials used in the Red Sea have evolved over time, in order to make the system stronger and more durable. The items listed were used in the past, or are still in use, or will be included in the March ’04 Red Sea procurement list. Several items are now sourced in Egypt and are being used in lieu of imported equipment. Most of the 2003 prices were provided by Environmental Moorings International Inc. Key Largo, Florida. USA. Email: EMIHALAS@AOL.COM.

testing various mooring components used in the system to determine normal working load limits, and point of failure. Further, steps can be taken to encourage key manufacturers or vendors to upgrade the specifications of their components where the strength is determined to be inadequate.

4.3 EEAA to Catalogue Component Failures in the Mooring System.

The purpose of this action is to document failures in the field in a systematic way in order to identify the "weakest links". Currently, mooring failures are discovered by the dive industry and are reported verbally or by letter to the EEAA & HEPCA. However, these reports are of a general nature, such as the "buoy is missing", or the "mooring is lost" and neglect to describe the specific component failure or why it may have occurred.

Planned actions. The EEAA will design an appropriate data form, and working with HEPCA and key dive centers will undertake to record more precise data on component failures. This data will be acquired as a by-product of mapping surveys and mooring maintenance and installation work.

5 SURVEY THE STATE OF THE MOORING SYSTEM

5.1 Track Geographic Extent of the System

For historical reasons, most of the mooring installations have been in the north around Hurghada and Safaga. With increased dive tourism in the south, officially sanctioned moorings there were over-subscribed. This has been partially redressed by the *Mooring Buoy Pilot Program*, which installed a total of 191 moorings from January to June 2003 at Samadai, Wadi El Gimal and Sataya/Fury Shoals. *Figure 4* is a map of the installed moorings in this area. The system must be expanded further in response to present safari boat activities in unserviced areas (*i.e.* St. John's Reef and the far north) and to meet anticipated diving demand.

A mission to the Far Islands is overdue—with the highest priority being *The Brothers* due to its special ecological worth, and increased rates of visitation by safari boats. New mooring methods for large safari boats exposed to rough conditions should be investigated as present equipment has proved ineffective. A Turtle & Bird nesting mission to Zabargad Is. will include a mooring-survey specialist to determine locations for future heavy-duty anchor installations or multiple-pin systems.

In the traditional dive areas of Safaga and El Gouna, maintenance was delayed, so priority will be given to Safaga (Section 6.1) and subsequently to El Gouna (Section 6.2).

5.2 Map Individual Mooring Locations

To date, mooring locations are generally known, but not with sufficient precision that would allow a diver to return to the location of a lost mooring and find the embedded hardware on the seabed. Positional errors are the norm because the reef itself will not

have been accurately mapped[10], and the location of the mooring on that reef will not have been measured[11]. A program to map mooring locations and their associated reefs has become a priority for several reasons: (a) there are more than 800 installations that must be maintained; (b) moorings are increasingly being installed in remote locations, so knowing their exact location is essential; (c) the cost of an installed mooring is high, so divers must be able to return to the exact location to do the maintenance.

6 MAINTAIN AND EXPAND MOORINGS IN NORTHERN RED SEA

Planned actions. EEAA will collaborate with concerned stakeholders to plan and begin installations of moorings in the Safaga Sector as a priority. Subsequent mooring activity in the N. Red Sea will focus on the environs of El Gouna and the Northern Islands**.**

6.1 Priority Implementation Plan for Safaga Sector: Sites from Ras Soma to Gamul Kebir; and Oceanic Reefs

The operational areas include (a) Safaga Bay or "lagoon" where the work will be focussed on Ras Abu Soma and Tobia Hamra, although moorings are needed at other nearby sites. For a map of the area, see *Figure 1*. The second operational area is the offshore reefs located 15km E. of Safaga which includes Panorama. These are mapped on *Figure 2*. Reference to *Table 4* summarizes the mission requirements and the roles of participating organizations.

Satellite maps of the two Safaga operational areas are shown in *Figures 1 and 2.*

[10] 1:50,000 Egyptian topo maps cover only islands and emergent reefs adjacent to the coast. Offshore reefs appear on 1:150,000 US and British Admiralty Charts but they are often inaccurate and too small a scale to be useful.

[11] Recently, the locations of new mooring installations have been recorded using handheld GPS, limited to an accuracy of 15m to 20m.

TABLE 4–MOORING INSTALLATION PLAN FOR SAFAGA (2004) [12]

MISSION REQUIREMENTS	INSTITUTIONAL ROLE(S) & COMMENTS
Overview	
Operational area(s)	(a) Safaga Bay or inner "lagoon" (see *Figure 1);* and (b) offshore reefs including Panorama, located 15km E. of Safaga (see *Figure 2)*. High priority sites at Ras Abu Soma and Tobia Hamra.
Situation	Insufficient moorings; some old moorings in wrong location; many broken & missing lines; worn lines need replacement; safari boats overload moorings; new mooring sites needed for use during southerly winds.
Initial phase	
Contact local users, partners and stakeholders	Emperor Divers (Soma), Robinson Club Dive Center, Barakuda Dive Center Lotus Bay, Orca Diving Center, Menadive, Duck's Dive Center, Shams Safaga, Safaga Paradise, Tom's Diver House, Dune Safaga
Acquire reports on the state of moorings	Acquired: Mooring Situation Report, Jan '04.
In-field needs assessment (no. of moorings, type and proposed location)	Rapid reconnaissance made on 17 Feb '03 by EEAA (T Kamel, M Shahat), PSU (J McEachern, M Habib, Dive Centers (P Meijer, L Wollinjack, L Geihsler); needs for lagoon only 9 double mantas, 17 double pins.
Acquire EEAA approval for mooring locations	Provided by Ayman Afifi, Manager of Red Sea Protectorates
Determine administrative responsibilities (planning, supervision, installations, monitoring, maintenance)	Planning EEAA & HEPCA in consultation with local dive centers; HEPCA to supervise installation; EEAA to monitor; local dive centers agree to topside maintenance (17 Feb '03).
Planning phase	
Preparation of mission plan	HEPCA w/EEAA Mooring Unit
Proposed schedule & start date	(a) Maintenance and new installs in Safaga Lagoon during early March; (b) offshore reefs in April. Start-date for (a) is March 7th.
Accommodation for mooring team	To be determined. Preference for hotel accommodation in Safaga; option of Hurghada if transport available.
Shipping of mooring materials	To be trucked from Hurghada/Gouna storage
Designated storage facilities in operating area	Temporary storage at Emperor Divers, Soma Bay. Offer made 3/ by P Meijer, Manager; large items at Soma Bay marina.
Funding and other support (cash, labour, equipment, transport, volunteers, other)	HEPCA (labour & mooring arrays); EEAA (hydraulic installation tools, mantas and pins); Dive Centers (dive boat & voluntary labour); transport to be determined.
Installation & equipment	
Boat type and captain	Daily dive boat with local Safaga captain
Hydraulic installation tools	EEAA to provide

[12] Currently being implemented within the Safaga inner bay or 'lagoon' area. The next phase will address the mooring needs of offshore reefs (Panorama, Middle Reef, Shaab Sheer, Shaab Claude, Shaab Humdallah, Abu Kafan, and others).

Mooring anchors (mantas, pins)	EEAA to provide; HEPCA has some "fluke w/chain" anchors.
Mooring arrays (buoys, polypropylene line, shackles, chafing hose, epoxy/cement)	HEPCA to provide; also available from EEAA
Personnel	
Coordination	Amr Ali for HEPCA; M El Shehat for EEAA
Mooring team members	HEPCA 4 commercial divers, chief is Omar; EEAA 1 diver M El Shahat.
On-deck data logging	EEAA ranger
Post-Installation	
Office data entry to EEAA GIS	EEAA Hurghada GIS unit
Monitoring of moorings	Local dive centers reporting to EEAA Mooring Unit & HEPCA
Maintenance of moorings	Local dive centers (topside arrays) & HEPCA (anchors)

6.2 Northern Islands Sector: Gouna to Shaab Ali

Situation. Reference to *Figure 3* is a map of the northern sector, showing the distribution of existing moorings and planned future sites from Ashrafi Islands to Shaab El Erg.

The southern half of this sector is serviced largely from El Gouna by local dive centers, operating daily dive boats. The centers are: Blue Brothers, Colona, TGI, The Dive Tribe and Easy Divers Academy. The more accessible dive sites visited are: Gota El Deir (NE of Gouna), Shaab El Erg (4 sites E of Gouna), and 5 sites to the SE at Umm Gamar, Abu Nugar, Gota Abu Galaua, Sahua Abu Galaua, and Shabaha. Shaab El Fanadir receives the heaviest visitation because of its proximity to both Hurghada and Gouna (see *Figure 14).*

Other sites are used to the NE but ferry times are longer and good sea conditions are pre-requisite. A number of these sites are used by live-aboards: Small Siyul, Big Siyul, Blind Reef, Yellowfish Reef, Abu Nuhas and Umm Usk. Further north lies Gobal Island whose eastern coast offers several sites (Bluff Point and Maalag Gobal).

The Northern Islands Sector is also home to a "Seaway of Shipwrecks". Using Hurghada as their home port, some 6-day safari trips offer diving on most of the major wrecks: *Ghiannis D., Carnatic, Chrisoula K., Seastar* (*Kimmon*)[13], *Rosalie Moller, The Barge, Ulysse*[14], *Sarah H.*[15], *Dunraven*[16], and *Thistlegorm*[17]. Future mooring installations must meet the needs of these specialized users.

[13] The wrecks of *Ghiannis D., Carnatic, Chrisoula K.*, and *Seastar* are all located at Abu Nuhas.
[14] The wrecks of *Rosalie Moller, The Barge, Ulysse*[14], are located at Goubal Island.
[15] Located at Shaq Rock.
[16] Located at Beacon Rock.
[17] Located east of S. Shaab Ali.

Most of the safari trips offer a mixture of reef diving and wrecks, and reach a northern terminus at either Shaab Ali or on the Sinai coast at Shaab Mahmud. Two versions of a common itinerary are shown in the following table:

TABLE 5 – ITINERARY(S) FOR 6-DAY SAFARIS THRU THE NORTHERN ISLANDS COMBINING REEF AND WRECK DIVING (FROM HURGHADA)

ROUTE			***ALTERNATE ROUTE***		
Day	***Location***	***Activity***	***Day***	***Location***	***Activity***
Day 1	HURGHADA	Depart a.m.	**Day 1**	HURGHADA	Depart a.m.
	Shaab El Erg	Check dive		Shaab El Erg	Check dive
	Umm Usk	Reef diving		Umm Usk	Reef diving
	Umm Usk	Overnight		Umm Usk	Overnight
Day 2	Abu Nuhas	Wreck diving (4 wrecks in area)	**Day 2**	Abu Nuhas	Wreck dives
	–	–		Strait of Gubal	Enroute
	Small Gubal/Big Gubal	Overnight		Beacon Rock	Overnight
Day 3	W. of Gubal	Wreck diving *Rosalie Moller*	**Day 3**	Ras Mohammad (if permitted) OR…	Reef diving
	Bluff Pt.	Reef diving		Shab Mahmud	Reef diving
	Shaab Ali	Overnight		Shaab Ali	Overnight
Day 4	E. of Shaab Ali	Wreck diving *Thistlegorm*	**Day 4**	E. of Shaab Ali	Wreck diving *Thistlegorm*
	Shag Rock	Reef diving		Strait of Gubal	Enroute
	Strait of Gubal	Enroute		Small Gubal Is.	Overnight
	Shaab Mahmud	Overnight		–	–
Day 5	Shaab Mahmud	Reef diving	**Day 5**	Gubal or *Rosalie Moller*	Reef diving or wreck diving
ß	Strait of Gubal	Enroute		–	–
	Umm Usk or Shaab El Erg	Overnight		Umm Usk or Shaab El Erg	Overnight
Day 6	Gotta Shaab El Erg or Abu Nugar	Reef diving	**Day 6**	Gotta Shaab El Erg or Abu Nugar	Reef diving
	HURGHADA	Arrive at port 4pm		HURGHADA	Arrive at port 4pm

Preparation of a mooring installation plan is scheduled for July ’04.

6.3 Far Islands: Al Akhawein Islands (The Brothers)

Two small elliptical islands 1 km apart lie 67 km east of Quseir. The smaller island is 0.1 km^2. The larger is 0.3 km^2 on which rests a 31-m high lighthouse. The depth between the islands ranges from 25 m to 70 m, and the islands are surrounded by a

vertical wall of coral with high biodiversity of both invertebrates and vertebrates, ranging from dense schools of *anthias* to several species of sharks in deeper water.

The shipwreck *Aida* lies on the islands' NW side. It sank in 1957 in 40m of water, and is now encrusted with abundant fish and soft corals. Other ancient wrecks lie within 100m of the *Aida* at depths between 9m-40m. In 1998, there were 6 day moorings at each island plus and several others for overnight mooring. The present status of moorings is unknown but safari operators report an acute lack of moorings. Further work must be undertaken at this site.

7 MAINTAIN AND EXPAND MOORINGS IN SOUTHERN RED SEA

Planned actions. EEAA will collaborate with concerned stakeholders to maintain existing moorings within the WG-Hematah Sector from Marsa Alam to Ras Banas. However, *the priority will be to survey and expand the mooring system in the far south within the Zabargad Sector*. These include sites from Ras Banas to Mirear Is, located between latitudes N24º–N23º. See Section 7.2 for a summary table of the implementation plans for this area.

7.1 WG-Hematah Sector: Sites from Marsa Alam to Ras Banas (N25º–N24º)

This sector received more than 160 of the 183 new installations made during the Pilot Implementation Phase, January to June 2003. Accordingly, only light maintenance is planned, with a few additional moorings. *Figure 5* maps the distribution of these installations. For a list of dive sites and their locations within this sector, see *Table 6 – Southern Red Sea sites from Marsa Alam to Ras Banas N25º–N24º.*

7.2 Priority Implementation Plan for Zabargad Sector: Sites from Ras Banas to Mirear Island (N24º–N23º)

This area is subject to growing visitation by safari boats that bring their dive customers to some outstanding wilderness reefs, such as St. John's Reef. *Figure 6* is a satellite image of St. John's Reef and nearby reefs to the north, and new installations will be made here on a priority basis.

Safari boats operate primarily from Marsa Alam, with their owners based in Hurghada. There are currently no official EEAA moorings in the area, and vessels are casting anchors wherever they choose to overnight. For reef diving during the day, wire-rope is used to tie onto a coral block near the reef top. The constant motion of the wire-rope damages live coral by leaving 'saw cuts' on the coral block, and in high wind may dislodge the block entirely.

Planned actions. Key stakeholders include the safari boat operators that utilize the area, the Red Sea Diving & Watersports Association—particularly the southern Chapter at Marsa Shagara, and HEPCA. EEAA will schedule detailed survey

activities in late April, with plans for installation during for the period May–June 2004. Secondary stakeholders to be consulted are fishermen operating out of Shelatine, and local Coast Guard officials. *Table 7* is a preliminary installation plan.

TABLE 7–MOORING INSTALLATION PLAN, ZABARGAD SECTOR, 2004

MISSION REQUIREMENTS	INSTITUTIONAL ROLE(S) & COMMENTS
Overview	
Operational area(s)	(a) Various reefs S. of Ras Banas at Foul Bay, Horseshoe Reef, Abu Wasel, Shaab Umm Itli, Bolbin, St. John's Reef, and Mirear Is. (b) Several overnight anchorages at Mikauwa Is. (Sorenaka), Zabargad Is., Sichel Reef, and St. John's Reef.
Situation	Used for wilderness diving by safari boats. No official EEAA moorings or presence in the area. For reef diving, wire-rope is used to tie onto coral blocks, which damages or dislodges live coral. Vessels mooring for the night drop anchors wherever they choose.
Initial phase	
Contact local users, partners and stakeholders	HEPCA; RSADWS; safari boat owners in Hurghada (and possibly Sharm); Boat captains and dive guides in Marsa Alam.
Acquire reports on the state of moorings	Verbal report provided by Amr Ali, owner-operator of safari boats utilizing the area. More reports will be sought.
In-field needs assessment (no. of moorings, type and proposed location)	Rapid reconnaissance scheduled for 1 week in late April '04.
Acquire EEAA approval for mooring locations	To be provided by Ayman Afifi, Manager of Red Sea Protectorates
Determine administrative responsibilities (planning, supervision, installations, monitoring, maintenance)	To be determined, but EEAA and HEPCA will lead initial planning.
Planning phase	
Preparation of mission plan	HEPCA w/EEAA Mooring Unit
Proposed schedule & start date	(a) New installs scheduled for late May and June '04. Start-date, to be determined.
Accommodation for mooring team	On-board safari vessel.
Shipping of mooring materials	To be trucked from Hurghada/Gouna storage by EEAA.
Designated storage facilities in operating area	Temporary storage at Marsa Alam port (to be negotiated)
Funding and other support (cash, labour, equipment, transport, volunteers, other)	HEPCA (labour & mooring arrays); EEAA (hydraulic installation tools, mantas and pins); safari owners to cost share provision of safari boat (to be arranged).
Installation & equipment	

Boat type and captain	Safari boat with local Marsa Alam-based captain
Hydraulic installation tools	EEAA to provide
Mooring anchors (mantas, pins)	EEAA to provide; HEPCA has some "fluke w/chain" anchors.
Mooring arrays (buoys, polypropylene line, shackles, chafing hose, epoxy/cement)	HEPCA to provide; also available from EEAA
Personnel	
Coordination	Amr Ali for HEPCA; M El Shehat for EEAA and T Kamal for EEAA Mooring unit
Mooring team members	HEPCA 4 commercial divers, chief is Omar; EEAA 1 diver M El Shahat.
On-deck data logging	EEAA ranger
Post-Installation	
Office data entry to EEAA GIS	EEAA Hurghada GIS unit
Monitoring of moorings	Senior dive guides aboard safari boats
Maintenance of moorings	To be determined. Discussions to be held with several reliable safari boat operators to arrange for stockpiling of topside mooring materials.

Reference to *Table 8* below, lists some 20 southern Red Sea reefs or islands lying between Ras Banas and Mirear Is. (N Lat. N24º–N23º). Beyond Mirear Island, there are 6 additional sites extending south to Marsa Halaib; see *Table 9* – S. Red Sea, Sites From Mirear Is. to Halaib (N Lat. 23º–N22º).

TABLE 8 – S. RED SEA SITES, RAS BANAS TO MIREAR IS. N24º–N23º
(See also UK Admiralty chart no. 63, "El Akhawein to Rabigh")

No.	Site name	Latitude	Longitude	Feature
45	Port Berenice	N23/56	E035/29	Harbour
46	Philadelphus Point	N23/56	E035/36	Reef
47	Foul Bay	N23/55/000	E035/47/000	Reef
48	Ras Banas	N23/55/000	E035/47/000	Ras
49	Mikauwa Is. (Sorenaka)	N23/49/833	E035/48/670	Overnight
50	Horseshoe Reef	N23/47/600	E035/48/190	Reef
51	White Rock	N23/42/000	E035/43/000	Rock
52	Abu Wasel	N23/37/460	E035/49/340	Reef
53	Shaab Umm Itli	N23/37/400	E035/49/270	Reef
54	Zabargad Jetty	N23/37/118	E036/12/226	Overnight
55	Zabargad S.	N23/35/882	E036/12/472	Overnight
56	Rocky Is.	N23/33/841	E036/14/922	Island
57	Reef (report)	N23/34/000	E036/19/000	Reef
58	Port Berenice	N23/55/000	E035/29/000	Sub-reef
59	Bolbin Reef	N23/27/000	E035/35/000	Reef
60	Sichel Reef	N23/23/062	E035/45/733	Overnight

61	St. John's Reef	N23/23/150	E035/48/490	Overnight
61b	Abou Daleb	N23/20/98	E034/46/38	-
62	St. John's Reef-1	N23/20/435	E035/51/268	Reef
63	St. John's Reef-2	N23/20/390	E035/51/310	Reef
64	Mirear Is.	N23/11/000	E035/45/000	Reef

TABLE 9 – S. RED SEA, SITES FROM MIREAR IS. TO HALAIB N23º–N22º
(See also UK Admiralty chart no. 63, "El Akhawein to Rabigh")

No.	Site name	Latitude	Longitude	Feature
65	Sharm El Madfa	N22/58/000	E035/40/000	Reef
66	Shaab Abu Fendera	N22/55/000	E036/15/000	Reef
67	Marsa Sha'ab	N22/51/000	E035/45/000	Reef
68	Gimeida	N22/47/000	E035/33/000	Reef
69	Wreck	N22/38/000	E036/36/000	Wreck
70	Marsa Halaib	N22/18/234	E036/38/540	
NB number "3" in red may be erroneous				

7.3 Far Islands: Zabargad and Rocky Islands

Zabargad Island. This triangular island is 5km^2, and is located 46 km southeast of Ras Banas. It offers good protection for boats, outstanding shallow reefs, distinctive coral peaks on the south side, and a rich diversity of fish, turtles, octopus, and many other species. In 1998, there were 12 moorings and several others dedicated to overnight mooring.

Rocky Island. 5.5km southeast of Zabargad lies 0.3 km^2 Rocky Is. Because of strong winds and currents--especially on the northern side--it is not recommended for inexperienced divers as it is difficult to retrieve them with the boat. The safest diving is on the eastern side, which is co-extensive with the best quality coral. The attraction of Rocky island is the likelihood of encountering large pelagics such as Napoleons and sharks. By 1998, there were six moorings, however an updated status report is urgently needed for both Zabargad and Rocky islands, and is scheduled for May '04.

8 GENERATE REVENUE TO FUND THE MOORING SYSTEM

There are an estimated 800 installed moorings in the Red Sea, representing a substantial investment. At current prices, the replacement value of the system (hardware and installations) is estimated to be $756,000 or LE 4,690,000[18]

[18] Replacing the system would entail re-installing 300 imported double mantas (duty paid) and 500 locally supplied double pins. Total cost of double pin installations will be 50% less than double mantas,

8.1 Cost of Installing Moorings (See Annex for Detailed Table)

Most users of moorings are unaware of the financial costs of the system. The cost to install one twinned manta in the Red Sea is $1,054, without duty. By comparison installation of a twin pin anchor is 33% less, or approximately $700/installation. Table 9 provides a breakdown of incurred costs for twinned mantas imported into Egypt from the USA.

TABLE 9 – ESTIMATED COST[19] OF ONE MOORING INSTALLATION IN THE RED SEA USING TWINNED MANTAS FOR A SOFT-BOTTOM SITE

Equipment Item	*$ Unit price without shipping*	*Cost for 1 mooring (includes 10% shipping)*
MOORING ARRAY & ANCHORS		
MOORING BUOY 18-inch Sur-Moor T3C White	$90/each	90.00
3/4-inch POLYPROPYLENE LINE for pick-up	$185 /roll	7.50[20]
2-inch POLYPROPYLENE LINE for downline, 600 ft. roll, UV treated, heavy duty	$765.00/roll	92.40[21]
SHACKLE 1/2-inch SS w/cable ties	$12.50/each	13.75
SHACKLE 7/8-inch Galvanized	$12/each	39.00[22]
CHAFING HOSE 1-inch ID Nylon reinforced	$1.50/foot	4.95[23]
CHAFING HOSE (FIRE HOSE) 2-1/2 inch, single jacket, 250 psi	$3.25/foot	10.80[24]
CABLE TIES	$0.75/ea.	3.30
MANTA RAY MARINE MOORING ANCHOR TYPE MR-SRM[25]	$170/each	374.00
HEAVY DUTY CHAIN (local) 7/8th"	$25	50.00
Subtotal equipment =		**$685.70**
INSTALLATION COSTS		
LIVE-ABOARD BOAT RENT w/crew	$500/day	167.00[26]
LAND TRANSPORT FOR PERSONNEL AND MOORING MATERIALS[27]	$180/mission	10.00
5 COMMERCIAL DIVERS[28]	$65.00/day	22.00[29]

if duty is levied on the mantas. With no duty, double pin installations are approximately 33% cheaper than double mantas.

[19] 2003 prices for materials apply to US-sourced materials—without duty. Chain is locally procured. Costs for installation and offsite support are all local costs.

[20] 25 ft of pick-up line, plus 10% shipping.

[21] Downline for a manta installed at 20m depth, plus 10% shipping.

[22] 3 Shackles used on twin mantas interconnected with chain, plus 10% shipping

[23] Assumes 3 ft used, plus shipping.

[24] Assumes 3 ft used, plus shipping.

[25] Heavy duty, includes custom one piece 7-ft x 1-in anchor rod with forged eye-nut

[26] Assumes that in 1 day, 3 double mantas can be installed and load-locked.

[27] One round trip for materials. Two round trips for personnel on a 7-day mission.

[28] Daily cost of one commercial diver is LE 1800/22 workdays = LE 82/day or US$ 13/day.

3 SUPPORT PERSONNEL[30]	$19.80/day	6.60
PERDIEMS (commercial divers & support personnel)		30.00
GIS SUPPORT		10.00
Subtotal installation costs =		**$245.60**
OTHER FIXED COSTS		
INSTALLATION TOOLKIT SET (for combined soft & hard bottoms)	16,000[31]	117.30
GPS DIFFERENTIAL w/software	10,000	5.00
Subtotal other costs =		**$122.30**
TOTAL 1 MOORING (without duty) =		**$1,053.60**
TOTAL 1 MOORING (with duty)[32] =		**$1,355.00**

Source: J. McEachern

8.2 Revenue Generation, Annual Allocations and Reducing Costs

To determine financially sustainable mechanisms for funding the mooring system. Two parallel approaches are being pursued by EEAA relating to (a) revenue generation; and (b) cost-sharing the installations (see next paragraph). Revenue generation: the allocation of annual support funds for mooring activities should be part of the overall revenue generation scheme adopted by EEAA and the RSG for work in the Red Sea. Funds earmarked for moorings should be in a separate operating account from general support funds going to the Red Sea Protectorates, in order to ensure the continuity of fund allocations and the mooring system use for which these funds are allocated. By such means, annual budgets can be prepared and maintenance performed on a regularly scheduled basis. This approach will forestall equipment failures that occur when the system is neglected and allowed to run down.

Reducing costs. Operating a mooring "system" is not limited to the purchase of mooring installation tools, arrays, and anchoring equipment. Other essential inputs include a seaworthy service boat with crew and an auxiliary inflatable; a minimum of five highly trained commercial divers; an on-deck supervisor to support daily operations; and a part-time administrator to log records. Further items include: a 4WD pick-up truck w/crew cab: communications equipment; some office equipment and furnishings, and access to a GIS database for mapping services.

Experience during the *Pilot Program* indicates that reducing the costs of the mooring system will undermine its durability. However, cost-sharing measures among stakeholders should be introduced such as discounted rates for contracted support services or direct cash infusions.

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[29] Assumes that in 1 day, 3 double mantas can be installed and load-locked.
[30] Daily cost of EEAA support persons is LE 900/22 workdays = LE 41/day or US$ 6.60/day.
[31] Price with shipping = $17,600 without duty. Service life assumed to be 150 double mantas, or 300 singles, and then all tools are replaced.
[32] Duty rate @ 40% charged against the subtotal for equipment (less cost of locally purchased chain), plus the value for the installation toolkit set.

9 FORGE AGREEMENTS WITH TOURISM INDUSTRY FOR COST-SHARING MOORINGS

9.1 Share Costs and Cost-Recovery

Subsidized services for mooring maintenance constitute the most viable approach to system sustainability at this time. Services include monitoring the moorings and providing labour, boat rental, land transport, accommodation and meals for dive crews in the field. The *Pilot Program* was successful in sharing costs among RSG, HEPCA, EEAA, PSU/USAID and local dive operators doing maintenance and installation work in Safaga and the south. By comparison, all mooring activities from 1996 to 1999 were underwritten by USAID through EST project administration.

The *Strategy* report of 5/03 discusses *total cost recovery* as a way of ensuring mooring system sustainability. Although a reasonable objective in itself, it is presently more realistic to view the mooring system as one part of EEAA's overall package of conservation management services in the Red Sea. From this perspective, paying for the mooring system should be linked to the introduction of an umbrella revenue generation scheme for the Red Sea.

However, if government funding proves unreliable, privatising the system in selected locations is a practical option. This approach has worked effectively in the Great Barrier Reef Marine Park, although some of their moorings have been retained under public ownership. Candidate reefs for privatisation in the Red Sea are *house reefs* situated near local dive centres. They are usually too small to accommodate guests from more than one or two dive centres and could be conveniently managed on a daily basis by those centres.

9.2 Sourcing Mooring Equipment from Egypt

Procurement from the USA using government channels is both cumbersome and time-consuming. It will be a significant advantage if equal or better products can be obtained in Egypt at lower cost such as the stainless steel pin anchors that are manufactured locally.

Installing Manta and HALAS systems requires: (a) *mooring arrays* such as mooring buoys, heavy duty polypropylene buoy line, SS shackle, chafing hose, cable tie; (b) *anchoring equipment* such as anchor eye pins, manta-ray anchors, sea-cement and underwater epoxy; and (c) *hydraulic installation equipment* such as power unit, hoses, couplers, hydraulic drill, hydraulic hammer, and installation tool kit.
The service life of installation equipment is 3 to 4 years and has previously been sourced from Environmental Moorings International, Key Largo, Florida. A description of mooring hardware and durability is found in *Annex 3*.

In the interests of long-term self-sufficiency, it is recommended that for each hardware component of the mooring system an Egyptian-made substitute be found and assessed in accordance with existing performance standards. Exceptions would be

the specialized underwater anchor installation tools such as the Stanley hydraulic jack-hammers, core drills and power packs.

Planned Actions. To share the cost of maintaining and installing moorings with the industry. EEAA in concert with its partners will endeavour to arrange for cost-sharing agreements with stakeholders operating within areas having moorings. At the least, such agreements will be made prior to specific operational missions. A more sustainable partnership will involve longer term commitments, especially with respect to local dive centers assuming responsibility for topside maintenance of moorings in their area. The recent agreement between Orascom and the EEAA Red Sea Protectorates is one such example of collaboration *(Annex 2 – Agreement with diving centers of El Gouna & mooring maintenance of dive sites).*

10 PROMOTING PRIVATE SECTOR INVOLVEMENT

10.1 Defining a Private Sector Role and Responsibility

Devise new ways to maintain the system. Wear and tear on the mooring system became particularly acute during 2000 and early 2001 when expansion of the system was curtailed due to cost-cuts. Maintenance was reduced so parts of the system in Hurghada and Safaga were out of commission and some of the earliest installations south of Quseir disappeared altogether. The mooring system requires a monitoring and maintenance schedule; if it is deferred, higher rates of wear and tear will soon destroy the mooring.

The operational lessons of the *Pilot Implementation* show that the private sector can play a role, as long as: (a) a maintenance schedule is adopted that outlines periodic tasks on a monthly, quarterly, bi-annual and annual basis; and (b) that specific monitoring and maintenance tasks are discussed and delegated to selected dive operators, preferably through an association. Dive operators are on the water everyday so are in a position to monitor the moorings and conduct light maintenance (see *Annex 4–Operational lessons from pilot implementation).*

EEAA would provide appropriate training guidance and mooring materials. The efficacy of this approach was corroborated by the success of our Pilot Program in the south.

Public support. Public influence and pressure can be effective by influencing government to support the system. Efforts will be made to raise public and stakeholder awareness about the moorings and their importance to both conservation and a sustainable tourist industry. The subject of mooring access as a conservation management tool should be on the agenda, especially in Hurghada. For example, when a stressed reef needs to be *rested,* the mooring can be decommissioned by temporarily detaching the bottom-line from the anchor-eye.

Develop operational partnerships. Many partnerships are consultative only. EEAA favors the creation of an operational partnership in the S to assume maintenance of the mooring system by the S dive community. The details of such an alliance have yet to be arranged but initial efforts would begin modestly in order to validate the

approaches. EEAA would work with selected dive operators to monitor and maintain the system through the nascent S. Branch of the Red Sea Association for Diving and Watersports. EEAA would provide training and materials while the dive industry would furnish labour, boat support and record-keeping.

11 POLICY REFORM

11.1 Current Mooring Practices in the Red Sea

Installation of mooring buoys requires the permission of the EEAA's Red Sea Protectorates. After an application is received, the Rangers mooring unit and HEPCA commercial divers discuss the rationale. Security and convenience to dive vessels, and improved reef protection result from eliminating individual anchoring.

Historically, the EEAA has discouraged dive operators and resorts from establishing their own mooring systems because moorings are a public asset and should be uniformly accessible. Also, a publicly-owned mooring system facilitates setting equipment standards, ensuring that conservation laws are upheld, and evaluating hardware performance to enhance the system's longevity. However, private moorings will likely be sanctioned in future, particularly with respect to resort house reefs proximate to local dive centres. Since house reefs are seldom used by other dive operates, denying access to the public is not an issue.

The spatial distribution of EEAA moorings in the Red Sea has favoured the Hurghada and Safaga environs; limited installations exist along the fringing reef and coastal islands south of Quseir. Under the pilot project a substantial number of moorings were installed in the south around Wadi Gimal, Hematah, Wadi Lahmi, and Fury Shoals. The few moorings in the far north are used by live-aboards. No EEAA moorings lie south of Ras Banas, although safari boats regularly anchor on the reefs there.

The EEAA mooring system has been 18-months to two years behind tourism's growth curve in areas south of Marsa Alam, so the dive industry has installed private moorings. These temporary moorings pass a wire coil around a coral head and tie the vessel's painter to the end of the loop. Some wire ropes are left in place. Others are tied on for the day only, particularly if a dive operator wants to discourage others from accessing a dive site. This practice is common in the Qulaan islands, the submerged reefs at Hematah and Wadi Lahmi, and at reefs visited by safari boats south of Ras Banas, including St. John's reef, and the reefs around the far northern islands.

11.2 Suggested Policies Derived from Operational Experience

1. The RSP (Red Sea Protectorates) Office supports a mooring system throughout the Red Sea to control coral reef access by the dive industry in order to ensure ecologically sustainable use.

2. The RSP Office utilizes environmental anchors to prevent reef damage from individual anchors of dive vessels.

3. The Red Sea Mooring System is owned by the EEAA. The system uses Manta-ray anchors for soft substrates and stainless steel pins for hard substrates.

4. The RSP Office discourages private mooring installations on coral reefs. Permission is granted in exceptional cases but only after a thorough review by the EEAA mooring unit.

5. The Red Sea Protectorates will execute a new policy for mooring maintenance in the southern Red Sea to create a partnership amongst dive centres, who will take a leading role in mooring maintenance and monitoring in their home waters, and the EEAA, who will provide appropriate mooring equipment and train selected dive operators to implement the program.

6. The Red Sea Protectorates will undertake a cost-benefit analysis of sub-contracting mooring installations to the private sector, particularly in areas remote from EEAA's operation-bases at Hurghada and Marsa Alam.

12 REFERENCES

McEachern, John. *Red Sea Mooring Buoy Strategy and Implementation Plan* (Draft). May 2003, PSU/EEPP/EEAA. MOBIS Task Order No. 263-M-00-03-00002-00, USAID, Egypt. 47pp.

ANNEXES

TABLE 1–COST TO ESTABLISH A RED SEA ENVIRONMENTAL MOORING TEAM[33]

(Estimates are based on a minimum of a 1-year period)

EXPENSE ITEM	LE	USD	NOTES
Personnel[34]			
5 Commercial divers	96,000	15,485	The 5th diver relieves the 4-man dive team; and substitutes during sickness or other absences.
1 On-deck supervisor	19,200	3,095	Supervises the work; records the data; this person is also a diver trained in the mooring system and can fill-in where necessary.
1 Office support person	9,600	1,550	Arranges stakeholder meetings; organizes missions; prepares mooring reports; and keeps the accounts.
1 Guard	6,000	970	Guards storage shed and fenced yard.
Training in mooring system	5,000	805	5-day training on using the hydraulic tools for installing the Halas system.
Dive equipment (personal issue)	111,600	18,000	For 6 divers. Includes regulator, octopus, UW computer, depth/pressure gauge, BC vest, full wetsuit, boots, dive knife, mask, fins, snorkel, weight belt.
Flotation work jacket (personal issue)	4,950	800	6 divers. For on-deck weather protection and safety (USCG-approved)
Dan insurance	5,580	900	For 6 divers
Land-based facilities	0	0	
Office rent with utilities[35]	16,800	2,710	Annual rent. Minimum 3 rooms (1 office, 1 storage, 1 meeting), plus 1 workshop
Furniture & supplies	18,600	3,000	One time furniture cost.

[33] Basic requirements to create a core team, properly trained and equipped to service the mooring system. Minimum of 1 year, applied to the salary costs of the personnel.

[34] Personnel:

- Five commercial divers comprising the core installation team
- One on-deck supervisor manages the work; operates the hydraulic power unit and provides topside services (monitoring for safety, buoy and rope preparation, splicing, handling of tools, and other duties).

[35] Rents estimated from the Hurghada local market for 2003.

EXPENSE ITEM	LE	USD	NOTES
Communication equipment purchase, and monthly fixed cost	27,280	4,400	2 Office phones, 2 mobiles, fax, and one satellite phone.
Computer systems	34,100	5,500	1 laptop for field/office use; 1 desktop with Laser printer + A3-size inkjet printer.
Workshop	8,400	1,355	Annual rent. Small workshop to maintain tools needed for mooring installations
Primary storage shed w/fenced yard	6,000	970	Locked shed. Used for mooring materials, spools of rope, manta rays, pins. 18" mooring buoys stored in fenced yard.
Remote storage shed(s)	3,600	580	Needed in one or more remote locations (such as the S. Red Sea) to support work in remote coastal sectors.
Transport[36]	0	0	**Imported**
1 Full size heavy duty 4WD pickup truck w/8' bed	210,800	34,000	Used for transport of mooring materials and support equipment to-and-from the jobsite. An common example is the F-250 SD XLT SuperCab 4X4 with 8' bed
1 Van (extended wheelbase model)	186,000	30,000	Needed to move 6 to 8 persons with personal gear & dive gear to the jobsite
Specialized tools for installing moorings[37]	0	0	**Imported**
1 Combined set of marinized underwater hydraulic tools for Mooring system	111,600	18,000	Tools in the combined set allows installations in soft-bottom and hard-bottom sites. Hydraulic equipment includes: power unit; hoses; hammer; Stinger drive gad set; load locker ram; drill; coring barrel; hammer drill; and adapters.
1 Set of tools for workshop	6,000	970	
1 Differential GPS w/real time software	62,000	10,000	Used for recording location of installed moorings (< meter accuracy)

[36] Equipment: US prices w/shipping included. Assumes no imposition of GOE duty.

[37] Equipment: US prices w/shipping included. Assumes no imposition of GOE duty. Mooring tools have an operating life of 3 years.

EXPENSE ITEM	LE	USD	NOTES
Vessels	0	0	**Egyptian**
1 Mooring vessel 10m (new, made in Egypt)	400,000	64,520	Used for all Red Sea inshore coastal mooring installations and maintenance
1 Mooring vessel 14m (to be rented for 36 days/year)	90,000	14,515	Rented live-aboard vessel used to make moorings in remote locations. Bunk capacity for 8 persons. Daily rental = LE 2500.
Total cost estimate =	**1,439,110**	**232,125**	NB this is the price of entry into the mooring business. No actual installations are accomplished within this estimate.

Source: John McEachern (Feb ’04)

TABLE 2–TOOLS USED FOR MOORING INSTALLATIONS & PRICES (2003 prices for US-sourced tools, used in the Red Sea by EEAA/HEPCA)[38]

Equipment Item	*US$ Price*	*Comments*
MANTA RAY INSTALLATION EQUIPMENT		
SGC-18 "Stinger" drive gad set, 1-1/8" shank, 3 couplers	$999/each	2 extensions, 1 radiused drive tip, gad extractor bar.
SG-3 RADIUSED DRIVE TIP	$165/each	0.76 m/30"
LL-1M Load locker ram assembly	$2,250/each	Used to "toggle or "load" test MANTA RAY Anchors.
HYDRAULIC INSTALLATION EQUIPMENT, PRICED INDIVIDUALLY PER UNIT		
HYDRAULIC POWER UNIT, Marinized with aluminum frame	$4,699/unit	16 hp Briggs & Stratton engine, gasoline, portable, runs installation equipment.
HP1 STANLEY HYDRAULIC POWER UNIT	$5,324/unit	With Honda engine #HP18264
HYDRAULIC HOSES	$990/set	Dual 125 ft. power and return with stainless steel couplers.
HYDRAULIC COUPLERS	$90/set	Stainless steel, 1/2-inch male/female.
DL-09 STANLEY HYDRAULIC DRILL	$1,795/each	w/hose whips, fittings
DL-09-652 SEAL KIT	$32.10/each	
IW-12 IMPACT WRENCH - UW /340C	$2,423.00/each	This unit needs to be adapted for underwater drill use. The DL-09 drill is the standard drilling tool.
SEAL KITS FOR IW-12 -uw #13695	$25.90/each	
IW-16 IMPACT WRENCH - UW/ 350	$3,851/each	
SEAL KITS FOR IW-16 - #09602	$42.80/each	
BR-67 STANLEY HYDRAULIC HAMMER	$2,200/each	For Manta Ray installations
SEAL KITS FOR BR67 - 04596	$41.60/each	
2-CB CORING BARREL	$295/each	2-Inch Carbide-tipped coring barrel- 24" length
3/4 DB DRILL BIT	$115/each	3/4 Inch Carbide drill bit (5/8-11) - 27" length

[38] Specifications for installation tools used in the Red Sea have changed little over time. The items listed are either still in use, or are included in the March ’04 Red Sea procurement list. Several items are now sourced in Egypt and are being used in lieu of imported equipment. Most of the 2003 prices were provided by Environmental Moorings International Inc. Key Largo, Florida. USA. Email: EMIHALAS@AOL.COM.

Equipment Item	***US$ Price***	***Comments***
SPECIAL: 3/4 DB WITH ADAPTOR	$135/set	Drill bit
ADAPTOR	$65/each	Fits 5/8"x16 male thread on drill to drill bit or core barrel.
INSTALLATION TOOL KIT	$399 /kit[39]	Two 100 lb. Lift bags, uw tool bag, pipe wrenches, hammer, rod, lines w/snaps, mixing bowls w/lids, marking tape, etc.
HARD BOTTOM EQUIPMENT (BY SET, OR COMPONENT PIECES)		
HARD BOTTOM INSTALLATION SET	$7,605	Package price. Lists @ $7,844
HYDRAULIC POWER UNIT, marinized with aluminum frame	$4,699/unit	16 hp Briggs & Stratton engine, gasoline, portable, runs installation equipment.
HYDRAULIC HOSES	$990/set	Dual 125 ft. power and return, stainless steel fittings
DL-09 STANLEY HYDRAULIC DRILL	$1,795/each	Underwater specification w/hose whips, fittings
2-CB CORING BARREL	$295/each	2-Inch Carbide-tipped coring barrel- 24" length
ADAPTOR	$65/each	To fit 5/8"x16 male thread on drill to drill bit or core barrel
VERY HARD BOTTOM EQUIPMENT (VOLCANIC ROCK)		
V. HARD BOTTOM INSTALLATION SET	$8,585	Package price. Lists @ $8,724
STANLEY HD-45 UW HAMMER DRILL	$2,980/each	Underwater hammer drill. Used instead of DL-09 drill.
HD-45 drill steel and adaptor	$55/set	Used instead of 2CB/adaptor
SOFT BOTTOM EQUIPMENT		
MANTA RAY SYSTEM INSTALLATION SET	$10,948	Package price. Lists @ $11,087
HYDRAULIC POWER UNIT, marinized with aluminum frame	$4,699/unit	16 hp Briggs & Stratton engine,gasoline, portable, runs installation equipment
HYDRAULIC HOSES	$990/set	Dual 125 ft. power and return with stainless steel fittings.
BR-67 STANLEY UW HYDRAULIC HAMMER	$2,200/each	Underwater specification for Manta Ray installations.
SGC-18 "Stinger" drive gad set, 1-1/8" shank, 3 couplers	$999/each	2 extensions, 1 radiused drive tip, gad extractor bar.
LL-1M Load locker ram assembly	$2,199/each	Used to "toggle or "load" test MANTA RAY Anchors.
EQUIPMENT FOR BOTH HARD (HB) & SOFT BOTTOM (MR)		
COMBINED STANDARD (HB/MR) INSTALLATION SET	$13,003	Package price. Lists @ $13,242

[39] Price depends on content/needs of project.

Equipment Item	***US$ Price***	***Comments***
COMBINED (TOTAL) INSTALLATION SET	16,038	Package price. Lists @ $16,277
HYDRAULIC POWER UNIT, marinized with aluminum frame	$4,699/unit	16 hp Briggs & Stratton engine, gasoline, portable
HYDRAULIC HOSES	$990/set	Dual 125 ft. power and return, stainless steel fittings
BR-67 STANLEY UW HYDRAULIC HAMMER	$2,200/each	Underwater specification, for Manta Ray installations
SGC-18 "Stinger" drive gad set, 1-1/8" shank, 3 couplers	$999/each	2 extensions, 1 radiused drive tip, gad extractor bar.
LL-1M Load locker ram assembly	$2,199/each	Used to "toggle or "load" test MANTA RAY Anchors.
DL-09 STANLEY UW HYDRAULIC DRILL	$1,795/each	Underwater specification, w/hose whips, fittings
2-CB CORING BARREL	$295/each	2-Inch Carbide tipped coring barrel- 24" length
ADAPTOR	$65/each	To fit 5/8"x16 male thread on drill to drill bit or core barrel.
STANLEY HD-45 UW Hammer drill	$2,980/each	Underwater specification
HD-45 drill steel and adaptor	$55/set	

TABLE 3 – ANCHORING MATERIALS USED IN RED SEA & PRICES (2003 prices for US-sourced materials that have been used by EEAA/HEPCA)[40]

Equipment Item	*US$ Price*	*Comments*
MOORING ARRAYS		
MOORING BUOY (Standard) 18-inch polyethelene	$75/each	Foam-filled, true white, one-inch pipe, blue reflective stripe, bushings attached. (Colors available, add $ 2.00. BALLASTED BUOYS add $2.00/lb).
MOORING BUOY 18-inch Sur-Moor T3C White	$90/each	Mfg. TAYLOR with 2-inch tube diameter
30-inch polyethelene MOORING BUOY	$255/each	Foam-filled, true white, 1-1/2 inch pipe (adjustable), blue reflective stripe, bushings attached. (Colors available, add $ 3.00, BALLAST add $2.00/lb).
24-inch polyethelene MOORING BUOY	$145/each	Foam-filled, true white, 1-1/2 inch pipe (adjustable), blue reflective stripe, bushings attached. (Colors available, add $ 2.00, BALLAST add $2.00/lb).
DEMARCATION BUOY, 9-in. diam., 62-in. high	$195 /each	Lettering, stainless eye.
7/8-inch POLY PLUS BUOY LINE	$375 /roll	600 ft. roll, UV treated, medium duty.
7/8-inch POLYPROPYLENE BUOY LINE	$245 /roll	600 ft. roll, UV treated, medium duty.
3/4-inch POLYPROPYLENE LINE	$185 /roll	600 ft. roll, UV treated, light duty, for demarcation buoys.
2-inch POLYPROPYLENE LINE	$765.00/roll	600 ft. roll, UV treated, heavy duty
SHACKLE 1/2-inch	$12.50/each	Stainless steel, with cable tie locks.
SHACKLE 5/8-inch	$9/each	Galvanized.
SHACKLE 7/8-inch	$12/each	Galvanized.
CHAFING HOSE 1-inch ID	$1.50/foot	Nylon reinforced (100 ft. minimum)
CHAFING HOSE (FIRE HOSE)	$2.25/foot $2.75/foot $3.25/foot	1-1/2 inch, single jacket, 250 psi 2-inch, ssingle jacket, 250 psi 2-1/2 inch, single jacket, 250 psi
Soft LEAD SHEET	$1.50/each	4"x 3" x 1/8", 1/4 lb.
CABLE TIE	$0.75/ea.	Heavy duty
MOORING ANCHORING SYSTEMS FOR SOLID SUBSTRATE		
MOORING ANCHOR EYE, Standard, 5/8-inch 316 stainless steel	$45/each	18-inch depth, Reinforced eye with "T". Use with cement.
MOORING ANCHOR EYE, 5/8-inch 316 stainless steel,	$50/each	18-inch depth, threaded for use with epoxy in hard rock.

[40] Specifications for mooring materials used in the Red Sea have evolved over time, in order to make the system stronger and more durable. The items listed were used in the past, or are still in use, or will be included in the March ’04 Red Sea procurement list. Several items are now sourced in Egypt and are being used in lieu of imported equipment. Most of the 2003 prices were provided by Environmental Moorings International Inc. Key Largo, Florida. USA. Email: EMIHALAS@AOL.COM.

Equipment Item	***US$ Price***	***Comments***
"U" ANCHOR HEAVY DUTY MOORING, 3/4-inch	$95/each	Stainless steel, 24-inch depth, 12-inch interior width.
Portland Type II CEMENT	$20 /bag	90-lb. Bag.
UNDERWATER ADHESIVE, 2-part epoxy	$28 /applic.	Dual tube, 11 oz., with/nozzle. Extra nozzles @ $3.00/each
REEF EPOXY for site restoration	$40 /application	Large dual tube-22 oz.
UNDERWATER ADHESIVE	$80/each to $90/each	Dual tube applicator, 11 oz. /22 oz.
MOORING ANCHORING SYSTEMS (FOR SOFT SUBSTRATE, SAND/RUBBLE		
MANTA RAY MARINE MOORING ANCHORS		Heavy duty, includes custom one piece 7-ft x 1-in anchor rod with forged eye-nut
MR-SRM	$170/each	(Wt. 42.5 lbs.)
MR-1M	$140/each	(Wt. 33.5 lbs.)
MR-2M	$130/each	(Wt. 31.5 lbs.)

TABLE 6 – S. RED SEA SITES, MARSA ALAM TO RAS BANAS N25º–N24º
(See also UK Admiralty chart no. 63, "El Akhawein to Rabigh")

No.	Site name	Latitude	Longitude	Feature
01	Marsa Alam	N25/04/733	E034/53/557	Harbour
02	Shaab Marsa Alam	N25/04/264	E034/56/334	Reef
03	Daedalus	N24/55/920	E035/52/325	Overnight
04	Dolphin	N24/59/182	E035/00/325	Overnight
05	Shaab Samadai	N24/	E035/	Small reef
06	Shaab Nakari	N24/56/621	E034/59/007	Reef
07	Ghadir 1	N24/50/260	E035/01/576	Reef
08	Ghadir 2	N24/50/237	E035/01/950	Reef overnight
09	Ghadir 3	N24/51/774	E035/03/824	Reef
10	Ghadir 4	N24/50/212	E035/04/549	Reef overnight
11	Ghadir 5	N24/50/150	E035/05/418	Reef
12	Ghadir 6	N24/	E035/	Reef
13	Shaab Sharm N.	N24/47/297	E035/10/514	Reef
14	Shaab Sharm S.	N24/47/235	E035/10/862	Reef
15	Shaab Ghadeira	N24/41/478	E035/08/753	Reef overnight
16	Erg Wadi El Gimal	N24/41/400	E035/15/150	Reef
17	Ras Baghdadi	N24/40/000	E035/06/000	Reef
18	Gezirat Wadi El Gimal	N24/40/000	E035/10/000	Island
19	Wadi El Gimal S.	N24/38/618	E035/10/956	Overnight
20	Sharm El Luli	N24/37/000	E035/07/000	Overnight
21	Ras Hankorab	N24/33/572	E035/10/121	Overnight
22	Small reef	N24/27/021	E035/20/044	Reef
23	Ras Qulaan	N24/27/182	E035/12/336	Reef
24	Shab Range	N24/24/728	E035/15/480	Reef
25	Gezirat Siyul	N24/	E035/	Island
26	Habili Siyul	N24/22/733	E035/22/743	-
27	Gezirat Showarit	N24/	E035/	Island
28	Marsa Wadi Lahmi	N24/14/000	E035/25/000	Harbour
29	Shaab Wadi Lahmi	N24/12/754	E035/33/360	Reef
30	Abu Galawa S.	N24/	E035/	-
31				
32	Hamatah	N24/17/255	E035/22/855	Harbour
33	Hamatah	N24/17/255	E035/22/855	Island
34	Shaab Broor Hamatah	N24/24/380	E035/15/950	Overnight
35	Gagamil	N24/14/238	E035/39/213	Reef
36	Abou Galawa Kebir	N24/13/677	E035/24/745	Reef
37	Sataya Lagoon	N24/10/153	E035/40/485	Overnight
38	Sataya Wreck	N24/10	E035/34/430	Reef
39	Sataya Amphora	N24/09/122	E035/40/947	Reef

No.	Site name	Latitude	Longitude	Feature
40	Shaab Sataya S.	N24/09/726	E035/42/292	Reef
41	Shaab Sabila	N24/11/375	E035/39/060	Reef
42	Fury Shoal S.	N24/09/540	E035/40/802	Reef
43	Reef Point 1	N24/02/708	E035/41/562	Reef
44	Reef Point 2 (Shaab Stechali)	N23/59/656	E035/45/902	Reef

ANNEX 1 – CREATION OF A SEA RANGERS AUXILIARY (SRA)

The *SRA* is a voluntary organization that will draw membership from selected dive operators. The role of this voluntary organization will be to extend the 'eyes and ears' of the rangers at sea, to promote proper conservation practices, and to alert the rangers to problems requiring attention such as damage to the mooring system, destructive practices of dive boats, dumping of garbage at sea, illegal fishing, and other matters.

1 Selection of participants

EEAA/NCS will review the credentials of candidates to serve in the Sea Rangers Auxiliary (SRA) to ensure that they have the potential abilities to undertake the responsibilities of SRA members. Specifically, members must meet, and continue to meet, one or more of the following criteria that satisfy EEAA/NCS's requirements:

- Be an experienced dive vessel or dive center operator or owner with the requisite knowledge and motivation to conserve Red Sea marine life, protect coral reefs, and ensure that good practices are followed in using the mooring system.

- Be an experienced dive quide willing to act as a crewmember member and obtain the skills and knowledge required to perform duties on board a vessel in support of EEAA/NCS Red Sea Rangers.

- Be able to contribute in some other way which would be of benefit to the Red Sea marine conservation.

2 General steps for EEAA/NCS

EEAA/NCS, under the direction of the Ranger Manager for Red Sea, will establish a unit in the Red Sea Protectorates to develop and oversee the creation of the SRA. The SRA unit will be supervised by a Senior Ranger and involve responsibilities of other field-based rangers.

EEAA/NCS will initially implement the SRA in one or two pilot areas, in order to prove the effectiveness of the approach before its widespread adoption.

EEAA/NCS working with their partners and dive industry stakeholders will define a list of duties and responsibilities for SRA members. This list must take into account the circumstance that SRA members already have full-time jobs, thus limiting the time available for voluntary activities.

It is the intention of EEAA to provide annual Identification cards to SRA members as well as a SRA cap, arm band, and other identifying livery.

3 Training

SRA members will receive training for the role in which they are participating. EEAA/NCS will take the lead in preparing resource and training materials, after consultation with HEPCA, RSADWS and the dive industry. This training will be co-ordinated by EEAA and may be administered by other conservation or training organizations.

SRA members shall successfully undertake training in the following areas:

- Communicating with EEAA Rangers (radio, cell phones, satellite phone)
- Alerting Rangers about real-time conservation issues on the sea & coast
- Faxing reports to EEAA
- Knowledge of key laws pertaining to Red Sea marine conservation
- Knowledge about the mooring system and best practices for its use
- Reporting to EEAA on problems with specific moorings
- Using GPS to mark field locations
- Coordinating and conducting simple mooring maintenance
- Public relations--how to deal with competitors (other dive operators)
- Public relations--How to deal with the public

SRA members should, as far as practicable, participate in both a *theoretical* training course and *practical* training exercises on the aforementioned subjects. Theoretical training will provide the knowledge required to carry out the responsibilities identified above. Practical training exercises should be provided in a modular format.

ANNEX 2 – AGREEMENT WITH DIVING CENTERS OF EL GOUNA ON MOORING MAINTENANCE OF DIVE SITES

(Excerpt from ORASCOM's letter of 13 March 2004 to EEAA Red Sea Protectorates, from Philip A. Jones, Abu Tig Marina, addressed to Dr. M. Hanafy, J. McEachern, M. Habib)

13 March 2004

…. Following our recent meeting and discussion at your offices with regards to the El Gouna diving centers being responsible for maintenance of the mooring systems on certain reefs around El Gouna. I am pleased to inform you that Mr. Samih Saweris has agreed with your proposal.

The following was agreed upon:

1. That after an initial intensive mooring installation/maintenance program (10 days with a live-aboard boat) to be carried out by HEPCA/EEAA, the 5 El Gouna diving centers should be responsible for basic maintenance of the mooring systems of certain reefs around El Gouna.
2. This should be a requirement/responsibility of the diving centers and will [be] added to the contracts of the diving centers and the hotels.
3. The equipment used for maintenance (e.g. ropes) should be provided initially by the EEAA.
4. The cost of the live-aboard boat (10 days to do the mooring installation/maintenance program) should be split equally between the following parties:
    a. Egyptian Environmental Policy Program (EEPP)
    b. Red Sea Governorates' Environmental Fund
    c. Diving Centers of El Gouna
    d. Orascom Projects & Touristic Development (OPTD)

In addition to this, the dive centers are distributing between themselves a standardized map of all the dive sites and will start to make observations of the current condition of the mooring systems. This should help with the mooring installation/maintenance program.

Regards,

(Signed by)

Philip A. Jones
Marina Manager
Abu Tig Marina
OPTD
El Gouna

ANNEX 3 - DESCRIPTION OF MOORING HARDWARE & DURABILITY

The USAID *EST Project*, working with EEAA and HEPCA, played the leading role in promoting the use of embedment anchors and mooring systems in the Red Sea that could be used in a variety of environmentally sensitive substrates. The *EST project* contracted with J. Halas in the 1990s to train the HEPCA commercial diving crew in use of the new mooring system. Some of these original commercial divers are still working today.

1 Use of Pin-anchors in hard rock

When solid limestone substrate is available, coring a hole and cementing a stainless steel eye-pin into the bottom continues to be a strong, long-term, cost-effective method of securing a mooring system in a coral reef environment (*Figure 4*). Pins are primarily used on the reef top, but may also be effective for deep water applications where bottom time is limited. Unlike manta-ray anchor installations, however, the holding power of installed pins cannot actually be field-tested as there is no equivalent “load locking” procedure for an installed pin as there is for a manta.

2 Strengthening the pins

In Florida, the single cemented eye pin has been complemented by a heavy-duty inverted U-shaped anchor for larger vessels and heavier sea conditions. These U-shaped anchors were seen by the Rangers participating in the observational study tour to Florida two years ago. The EEAA/PSU procured 30 of these and the mooring team has been testing them during the pilot phase. If the foundation rock is strong, then embedding two anchor-legs affords twice the holding power. However, it is not always possible to find solid rock beneath both legs. Furthermore, the distance between the legs is only <30 cm, which may lead to failure of the rock itself if extreme forces act on the embedded U-shaped anchor.

3 The Egyptian welded pin anchor (EWP)

Notwithstanding the stronger U-shaped pin-anchor, the Red Sea mooring team has devised an Egyptian welded pin anchor (EWP) that also affords additional strength. The EWP anchor consists of two 52cm long single pins w/eye and cross-rods , made from 316 stainless steel, positioned side-by-side, and welded at 4 points. This step is necessary to overcome the 16mm diameter limitation of stainless steel rod stocked in Egypt. *Figure 5* illustrates the EWP anchor that has been purchased for use by the project and installed at many southern locations during the pilot phase.

4 Twinning anchors to ensure holding power of the substrate

For hard substrates subject to heavy use, twinning the Egyptian welded pin anchor provides maximum holding-power. *Figure 6* shows two newly-installed pins,

cemented in place, on the reef top at Samadai. A 1m chain will subsequently be shackled to each eye and the mooring down-line affixed midway along the chain.

In unconsolidated substrates such as sand, grass, and loose rubble environments, a Manta-ray TM anchor, driven in with jack-hammer and load-locked, is a strong, cost-effective method of securing mooring systems. *Figure 7* illustrates this type of anchor after installation. For heavier duty applications, multiple Manta-ray TM anchors can provide additional holding power. Most embedment anchoring systems can be installed with portable diver-operated hydraulic tools from a daily dive boat.

Embedment anchor systems complement one another, providing security in both hard and soft substrates. They offer a point of attachment for buoy systems that utilize minimal hardware and eliminate the need for heavy chain or cable. These systems can be used with floating line and minimal scope, in close proximity to delicate bottom features without sacrificing holding power or causing damage to the surrounding habitat. The use of embedment anchoring systems has also become the preferred mooring technique for demarcation buoys, channel markers, and the securing of underwater scientific instruments.

ANNEX 4 - OPERATIONAL LESSONS FROM PILOT IMPLEMENTATION

(Excerpt from *Pilot Implementation Plan*, June 2003)

A key consideration in the mooring buoy strategy is its sustainability; the EEAA and its local partners must be able to continue installing new moorings and maintain existing ones after USAID assistance ceases. Therefore, cooperation between local diving centres, HEPCA, and the EEAA was recognized as essential and relevant parties were consulted and mobilized early in the planning process.

The *Pilot Implementation Plan* utilized the services of HEPCA to capitalize on their expertise, gained in part by previous USAID funding and training support. HEPCA is now receiving upwards of LE200,000 per year from the Red Sea Governorate to defray the costs of overhead, staff salaries, and locally-purchased equipment and supplies.

Local diving centres are considered crucial partners in the mooring program, as they can monitor the condition of existing moorings and report on maintenance needs, misuse, and additional installation locations. Diving centres and safari organizers are also in a position to provide logistical assistance to mooring installation and maintenance teams by transporting them to the sites. Many have demonstrated their willingness to offer support, such as in Safaga where mooring-reinstallation teams were given transportation and logistical support by local dive operators. A discussion of some of the key lessons that were learned appear below:

1 Manpower and work schedule

- The captain of the selected live-aboard must have extensive experience and a good reputation among the community.
- EEAA should recruit six additional commercial divers, in order to supply two installation and maintenance teams to cover the whole area.
- The mooring-installation dive team in the south should comprise a minimum of 5 divers to maximize efficiency.
- Installation of mooring buoys in the southern zone should consist of one-week trips. After returning, the team should rest for a minimum of one week.
- Maintenance should at least be done every 6 months in all areas. However, a more ambitious schedule is ideal, as outlined in *Section 3.4.*

2 Choosing anchor sites

- Surveying to determine mooring installation sites should initially include dive centers, day-boat captains, safari boat captains, and boat owners.
- Experienced boat captains are a good source of knowledge, and often have a different perspective from dive center operators.

- EEAA Red Sea Rangers assigned to the monitoring unit also have a key role in site selection. They can examine proposed sites in terms of the reef's carrying capacity to absorb projected levels of visitation.

3 Transportation & equipment

- Southern zone installation should be made from a live-aboard (safari) boat, 24m-30m long and 5m-6m wide.
- EEAA should purchase a live-aboard boat for mooring installation and maintenance purposes as the monies spent on boat rental, $500 or LE3,000 per day, soon surpass the amount needed for a one-time purchase. The Florida Keys NMS dedicates a Boston Whaler boat for this purpose.
- EEAA should own at least two installation sets[41], especially the hydraulic power unit (see *Figure 8*). One would be based in the northern Red Sea and the other in the south. Ideally, a third spare-unit should be *taken aboard* safari mooring vessels when making installations in the south and Far Islands in case of breakdown.
- Mobilizing men, mooring installation equipment, and materials requires a large pickup truck to support activities of the 5-person commercial dive team. The pickup must be 4WD and have a crew cab w/4 doors for convenience. This vehicle should be based in the south where it can also serve the needs of the Wadi Gimal - Hematah Protected Area.

4 Maintaining the mooring system

Based on the implementation Pilot and discussions with stakeholders, a suggested maintenance schedule follows that includes details in order to: (a) demonstrate that monitoring and maintaining the mooring system is an essential task to ensure integrity of the system; (b) illustrate the magnitude of the task; and (c) identify the shared roles of Red Sea users who can contribute to one or more of the activities.

(a) Monthly

- Inspect all buoys and pick-up lines for their condition.
- Clean the pickup line of growth and replace as required.
- Clean and check for cracks; replace as required.
- Inspect and clean exposed portions of the buoy through-line and replace as required..

If buoys and lines are not cleaned on a regular basis users may question the integrity of the system and choose to anchor or tie-off on a reef instead. It was noted during the

[41] Installation tools include: manta drive steel kits, hydraulic power unit, hydraulic hoses w/stainless steel couplers, UW hydraulic jack hammer, UW core drill, and marine load locker.

EEAA Rangers' observational study tour of the U.S. Virgin Islands National Park in 2001, that mooring staff inspected buoys and lines on a monthly basis.

(b) Every 3 months

- Inspect the down-line and protective hosing for wear or damage. Replace as required.
- Inspect shackle for wear or damage. Replace as required..
- Inspect anchor. Examine contact area between anchor and shackle for signs of wear.
- With respect to pin-anchors, inspect the anchor mount-site and surrounding area to detect movement between anchor and cement core or between the cement court and the surrounding substrate. Sometimes failure occurs in the surrounding coral rock, and not in the hardware.

(c) Every 6 months: consider replacing buoy through-line and pick-up line every 6 months if the system is used daily.

(d) Every 12 months: replace pin in down-line shackle if necessary.

(e) Every 24 months: replace the down-line if needed.

5 Modifications that can be instituted

1. Remove the entire system for cleaning and repair on a rotating schedule rather than during on-site maintenance. Rough weather conditions often preclude sufficient time for cleaning on-site. However, this practice requires building an inventory of spare mooring systems in the Red Sea and may therefore become cost-prohibitive.

2. Consider using polyplus line rather than polypropylene. Red Sea team has found that polyplus is more durable and resistant than polypropylene. However, polyplus does not float, so a larger diameter mooring buoy may be needed to compensate.

3. Replace the shackle pins every 6 months to preclude breakage.

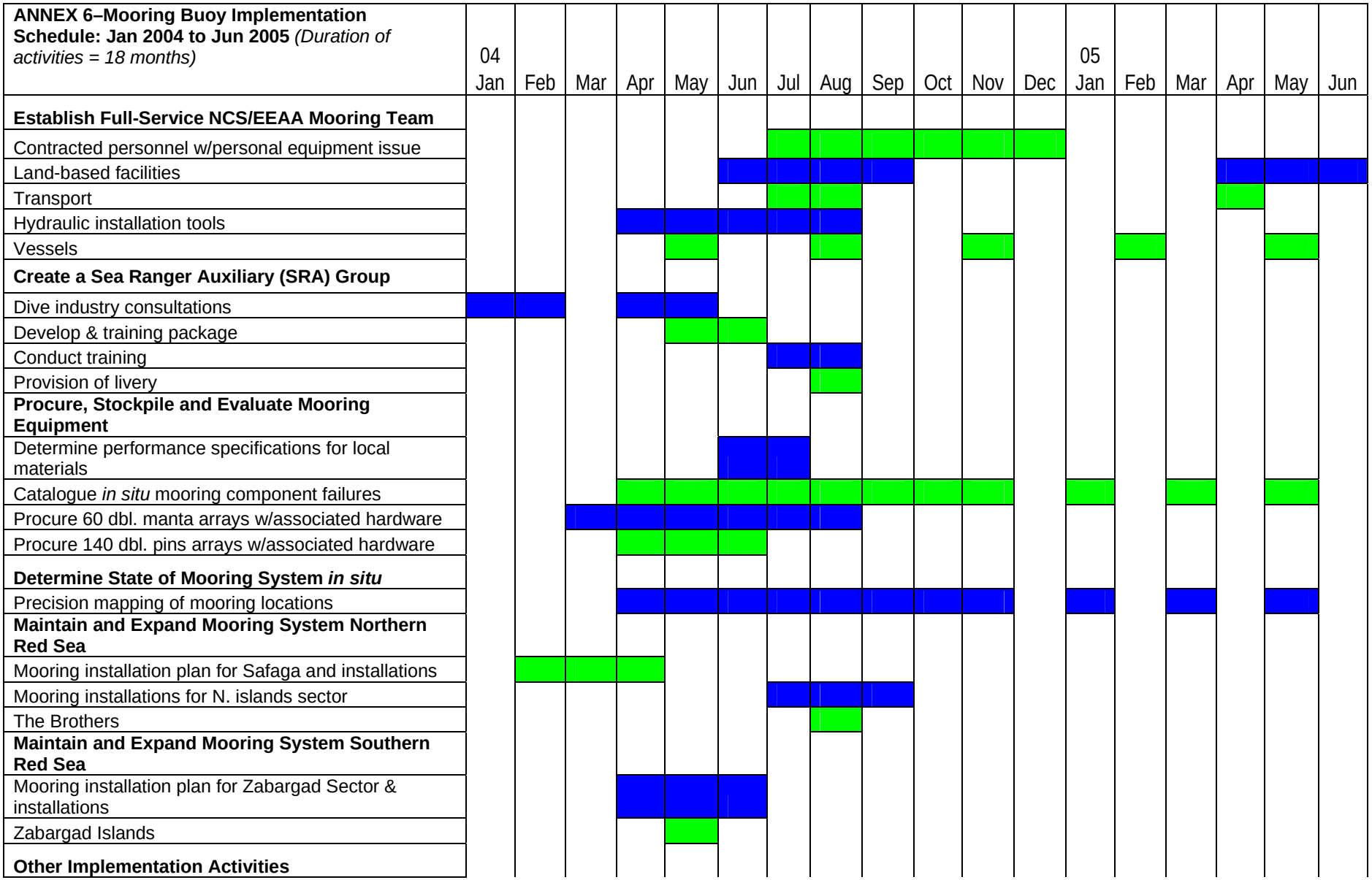
6 Ensuring proper use

Management of the moorings must include training the vessel captains in the use and maintenance of mooring buoys and lines. One of the leading causes of mooring damage is improper use, such as ramming mooring buoys and lines. The captain training program that was instituted by HEPCA and USAID several years ago was re-activated in 2002-03 by AED, while EEAA/PSU also arranged for seamanship training by the Naval Institute in Alexandria..Taken together, these courses addressed general boat handling, seamanship, environmental sensitivity, and mooring use.

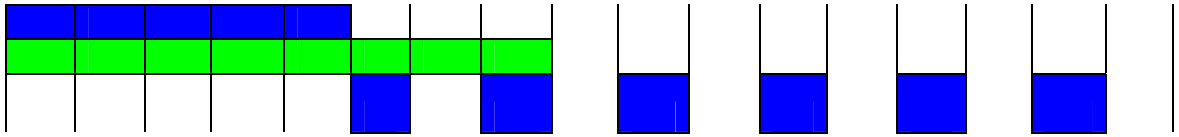
Annex 5: Estimated Cost to Implement Mooring Buoy Plan *(Estimates Based on Activities Listed in the Plan for 2004-05)*	**US$**	**Egypt LE***	**Status of Specs & Comments**
Establish Full-Service NCS/EEAA Mooring Team			
Personnel w/personal equipment issue	41,605	257,951	Details in Table 1 of Plan
Land-based facilities	18,515	114,793	
Transport: 1 pickup truck (in Customs); 1 van (to procure)	64,000	396,800	PSU procured pickup truck in 2003
Hydraulic installation tools (PSU procured 5/04)	0	0	Cost = $28,970
Vessels	79,035	490,017	Manufactured in Egypt
Subtotal =	169,155	1,048,761	
Create a Sea Ranger Auxiliary (SRA) Group			
Dive industry consultations	3,000	18,600	Wadi Gemal, Lahmi, Safaga
Develop & training package	6,500	40,300	
Conduct training	8,000	49,600	Includes transport & accommodation
Provision of livery	900	5,580	For 18 persons
Subtotal =	18,400	114,080	
Procure, Stockpile and Evaluate Mooring Equipment			
Determine performance specifications local materials	12,000	74,400	Engineering consulting firm
Catalogue *in situ* mooring component failures	3,000	18,600	EEAA rangers & auxiliary
Procure 40 dbl. manta arrays w/associated hardware (EEPP procured)	0	0	Cost = $27,440 (Unit cost $686)
Procure 90 dbl. pins arrays w/associated hardware (50% EEPP procured)	20,700	128,340	Cost = $41,400 (unit cost $460)
Subtotal =	35,700	221,340	
Determine state of mooring system *in situ*			
Precision mapping of mooring locations	18,500	114,700	As an adjunct to maintenance
Subtotal =	18,500	114,700	
Maintain & Expand Mooring System Northern Red Sea			
Mooring installation plan for Safaga	19,200	119,040	Table 4 in Plan
Mooring installations for Northern islands sector	28,000	173,600	
The Brothers	12,000	74,400	
Subtotal =	59,200	367,040	
Maintain & Expand Mooring System Southern Red Sea			
Mooring installation plan for Zabargad Sector	36,000	223,200	Table 7 in Plan
Zabargad Islands	2,000	12,400	
Subtotal =	38,000	235,600	
Other implementation activities			
Adopt revenue mechanism to fund moorings	12,000	74,400	Local consultant

Forge agreements for cost-sharing with dive industry	3,000	18,600	
Promote private sector involvement	6,800	42,160	Travel & consultation
Subtotal =	21,800	135,160	
Estimated Total for Mooring Plan Implementation	**360,755**	**2,236,681**	

*Note: * Exchange rate of LE 6.20 = $US 1.00 has been used*

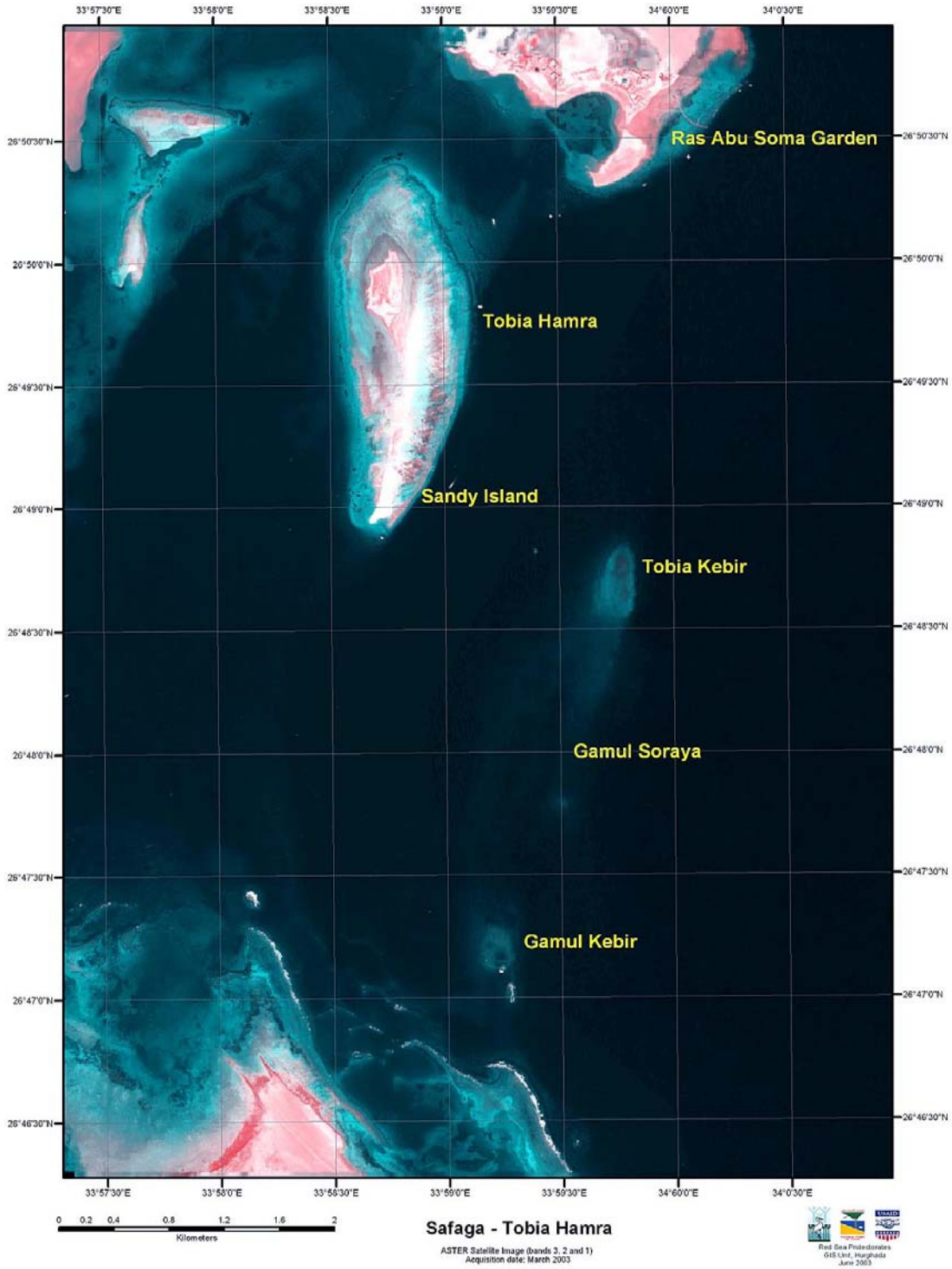

ANNEX 6–Mooring Buoy Implementation Schedule: Jan 2004 to Jun 2005 (Duration of activities = 18 months)
04 Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
05 Jan
Feb
Mar
Apr
May
Jun
Establish Full-Service NCS/EEAA Mooring Team
Contracted personnel w/personal equipment issue
Land-based facilities
Transport
Hydraulic installation tools
Vessels
Create a Sea Ranger Auxiliary (SRA) Group
Dive industry consultations
Develop & training package
Conduct training
Provision of livery
Procure, Stockpile and Evaluate Mooring Equipment
Determine performance specifications for local materials
Catalogue in situ mooring component failures
Procure 60 dbl. manta arrays w/associated hardware
Procure 140 dbl. pins arrays w/associated hardware
Determine State of Mooring System in situ
Precision mapping of mooring locations
Maintain and Expand Mooring System Northern Red Sea
Mooring installation plan for Safaga and installations
Mooring installations for N. islands sector
The Brothers
Maintain and Expand Mooring System Southern Red Sea
Mooring installation plan for Zabargad Sector & installations
Zabargad Islands
Other Implementation Activities

Adopt revenue mechanism to fund moorings
Forge agreements for cost-sharing w/dive industry
Promote private sector to maintain moorings (topside arrays)



FIGURES

Figure 1 – Safaga – Tobia Hamra and adjacent reefs



With the development of Soma Bay (top-right), increased diving activity occurs at *Ras Abu Soma Garden* and along the eastern side of *Tobia Hamra*. These areas are a priority for new installations and refurbishment of old moorings using stronger components. The EEAA has just approved construction of a day facility on *Sandy Is*.

Figure 2 – Safaga – Offshore reefs including Panorama (15 km E. of Safaga)

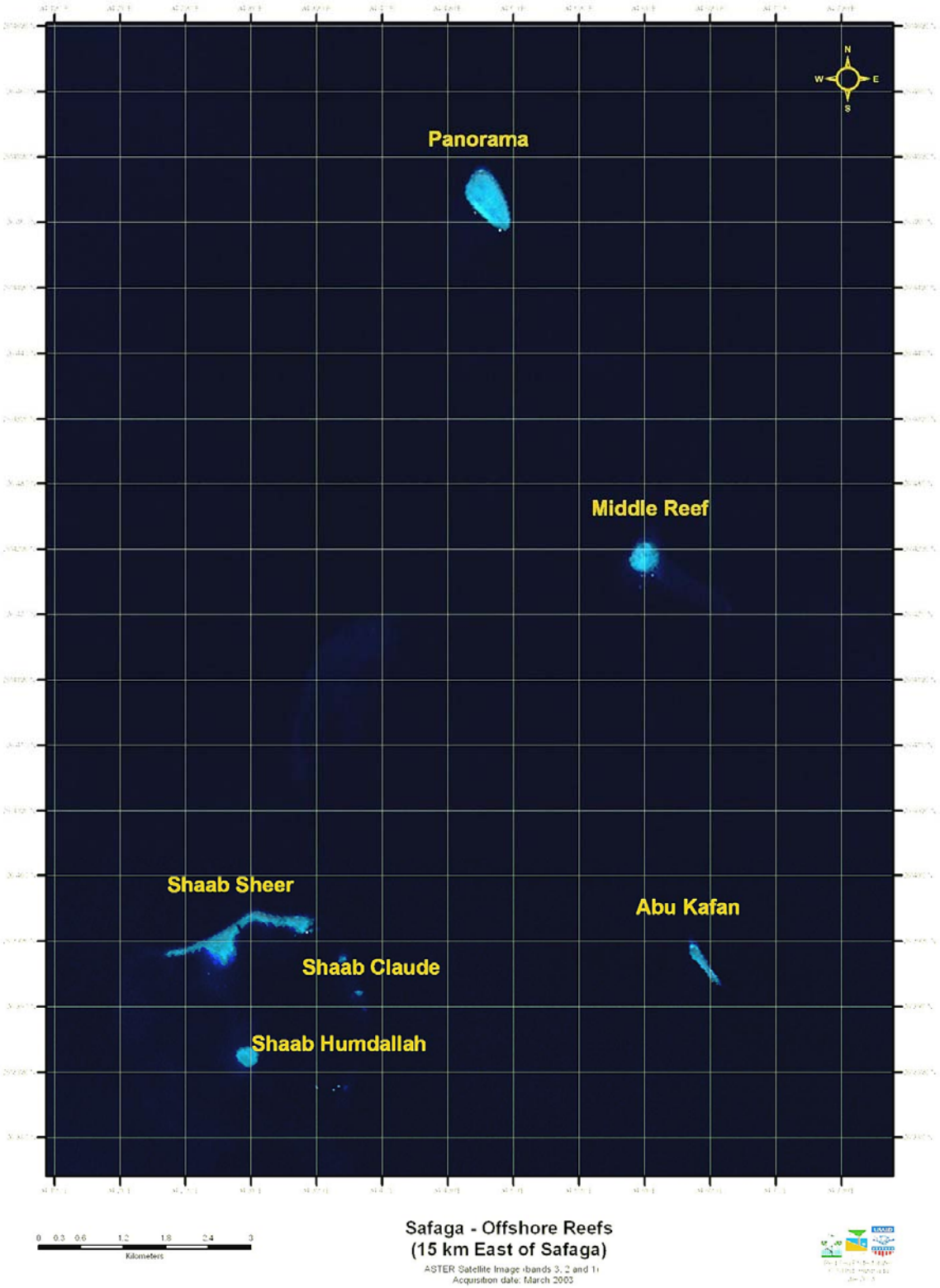


Figure 3 – Moorings Northern Red Sea, Ashrafi Islands to Shaab El Erg
(Magenta dots are existing moorings. Yellow dots indicate future mooring sites)

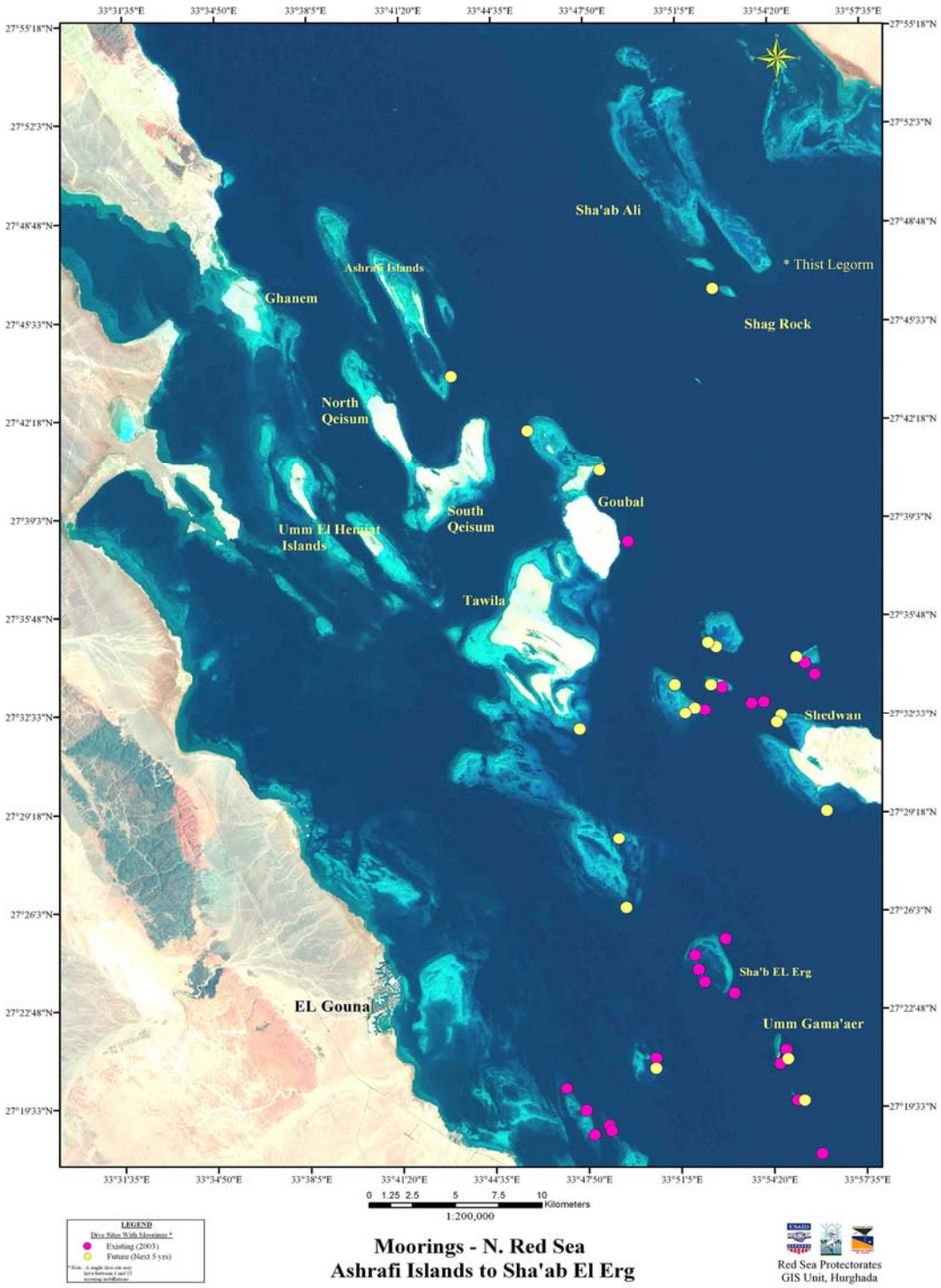


Figure 4 – Moorings Southern Red Sea, Marsa Alam—Wadi Gimal—Ras Banas

There are few dive sites south of *Wadi Gimal* before reaching *Wadi Lahmi* where offshore reefs extend E. to *Sataya*. Yellow dots are reefs with installed moorings.

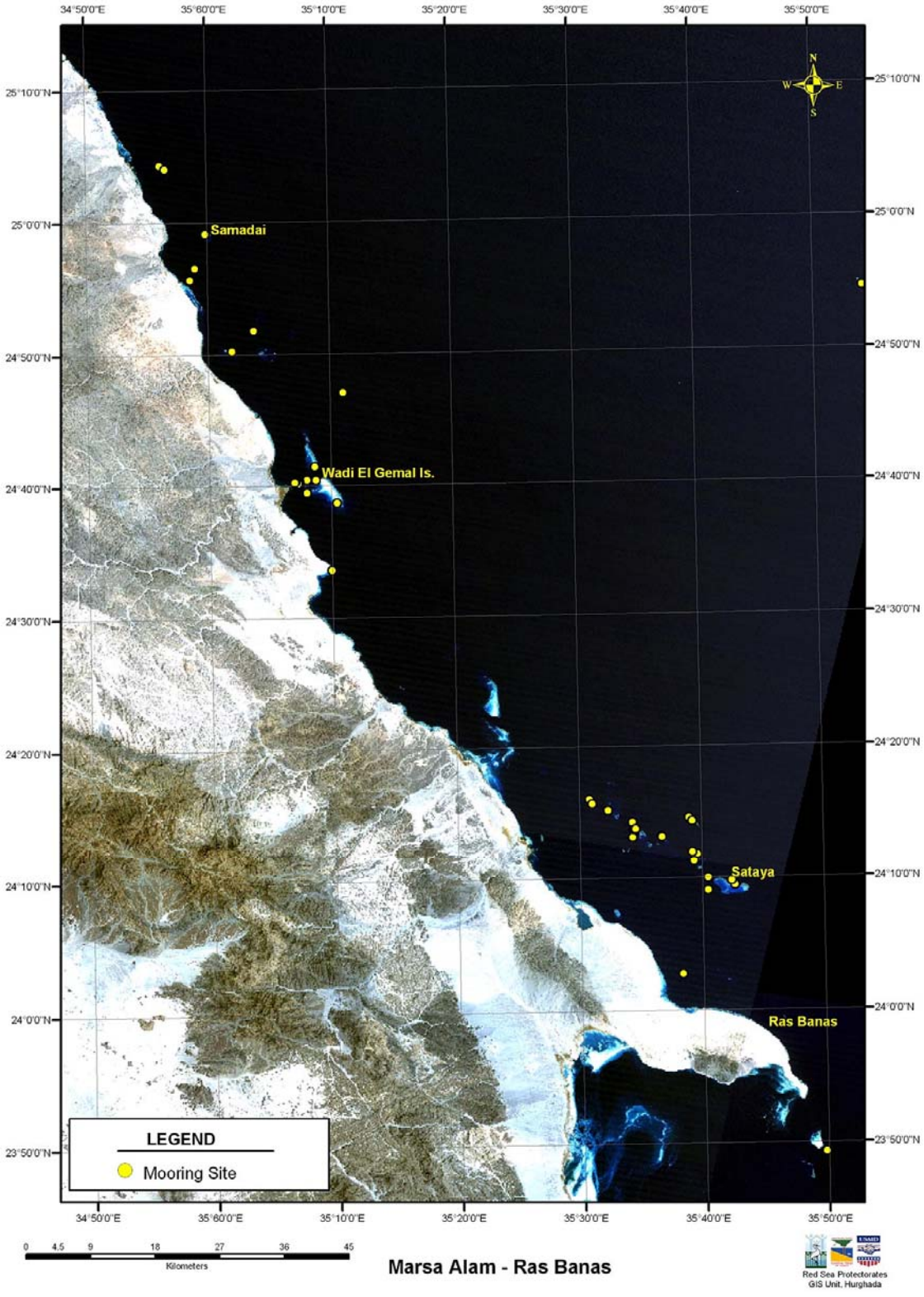


Figure 5 – S. Red Sea Reefs Lying 15-20 km Offshore from Wadi Lahmi

Yellow dots = indicate moorings installed in 2003 by EEAA/HEPCA/RSG. Note: mooring locations have not been geo-referenced to this image and exhibit error.

The 5 kilometre-long reef known as *Sataya*, or *Fury Shoals*, is a refuge for juvenile Dolphins. A site management plan will be prepared for this site, similar in concept to the plan developed for *Samadai*. Moorings will be used to restrict vessel access and to demarcate the management zones.

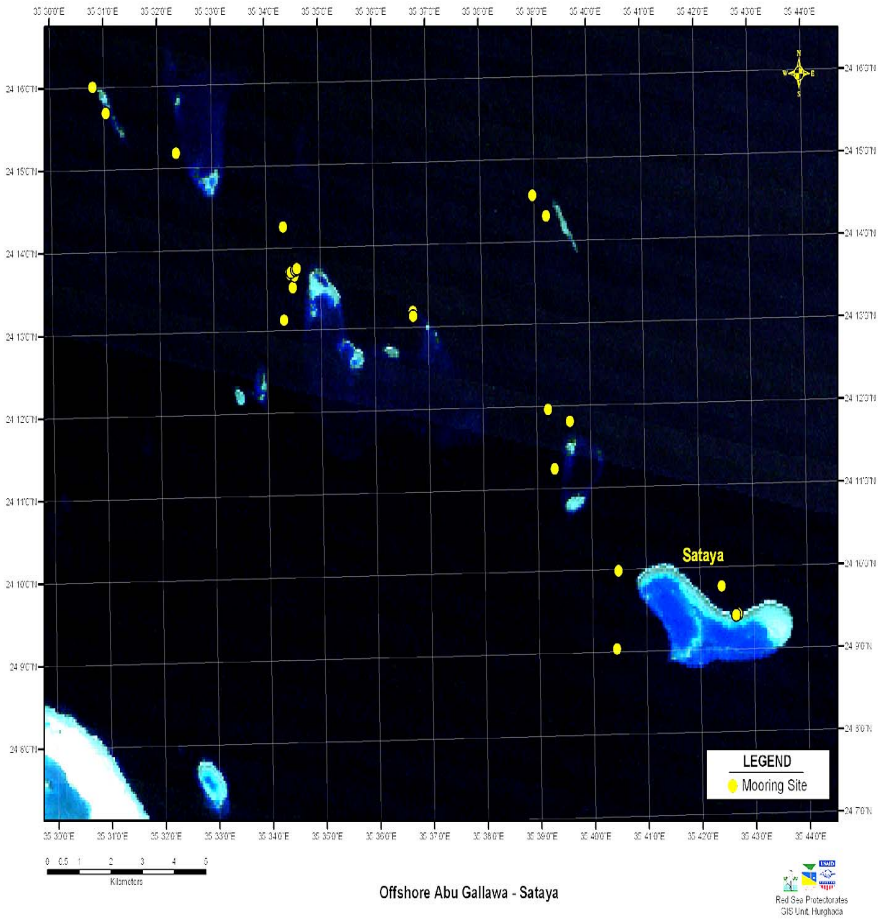
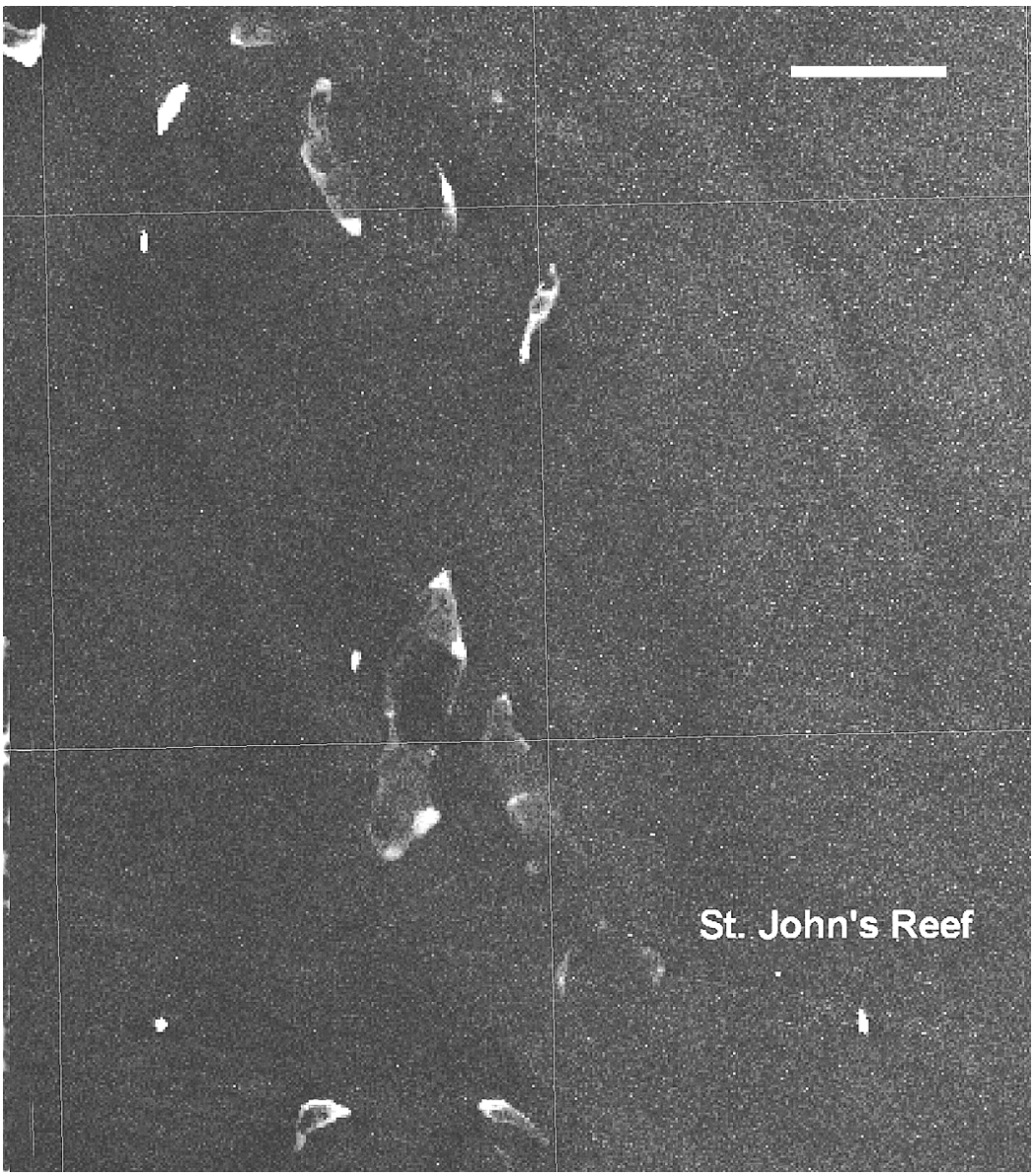


Figure 6 – Submerged reefs south of Ras Banas, from N Lat. 23º44' to 23º22'
(Scale: length of the white scale bar at top-right = 5 kilometres)



Mapping these reefs, and those of the Fury Shoals, is a EEAA priority. Large-scale satellite imagery will be employed, complemented by field measurements from differential GPS. Existing marine charts are grossly inaccurate and do not reflect the perimeter boundaries.

Safari boats operating from Marsa Alam visit this area. TDA has ambitious plans for resort development south of Ras Banas in addition to the planned development for coastal sites within Wadi Gimel—Hematah PA. The combined long-term effect of these developments will be to dramatically increase use of these reefs over the next decade.

Figure 7 – Dive boats sharing a mooring…far in excess of the 3-vessel limit

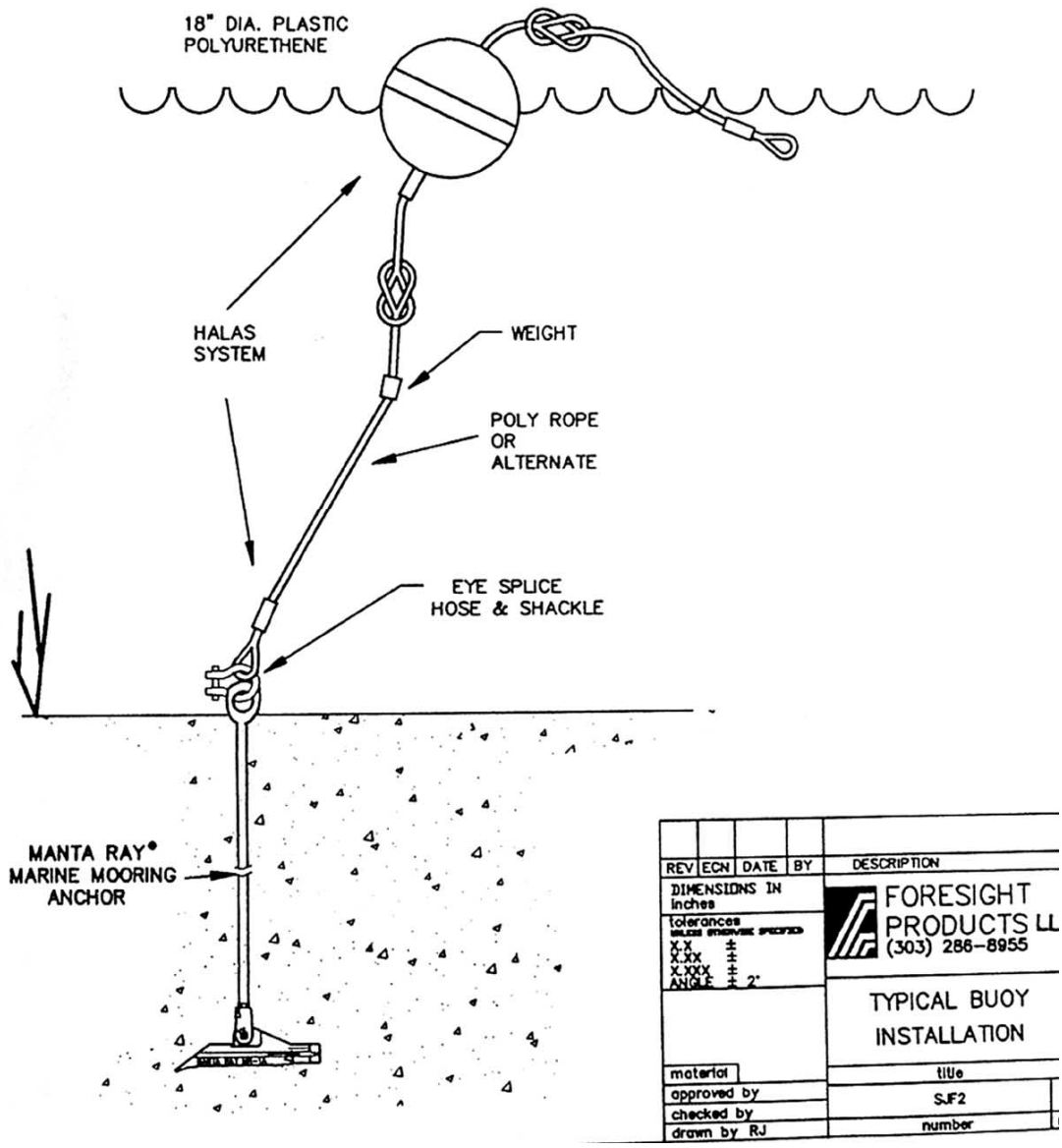
Figure 8 – Dive boats anchored to a top-side reef pin at Gamul Soraya (Safaga)

Figure 9 - UW hydraulic core drill employed by a 2-man crew on the reef top

A Stanley UW hydraulic core drill employed by a 2-man HEPCA crew on the reef top at Samadai (June '03). The second diver is standing on the drill handles to add weight, and only his feet show. A carbide-tipped drill bit may take 1.5 hours to penetrate 18".

Figure 10 - Two stainless steel pin-anchors drilled and cemented into the reef top

Figure 11 - Single manta ray anchor installation (drawing)



The drawing illustrates a single manta ray anchor installation. In the Red Sea, the 18" Buoy is tethered several meters below the surface to keep the down-line taut and discourage theft. For areas of high anchor loading, EEAA/PSU/HEPCA currently installs double mantas, side-by-side, for each mooring. Double mantas are employed for safari boats and at popular dive locations in Safaga and Hurghada where daily dive boats are rafted together. In the Red Sea, most of the mantas are installed in 12m to 25m of water. Beyond 25m, the hydraulic pressure of the power unit is obstructed by the ambient pressure.

Figure 12 - Hydraulic power unit with 2 mantas

One of two EEAA hydraulic power units with 2 manta anchors, types MR-SRM & MR-1M. The power unit stays on the deck of the mooring vessel and drives the underwater jack-hammer and core drills through high pressure hydraulic hoses. Properly functioning UW installation tools constitutes the bedrock of the mooring system. *No tools*, means *no mooring system*.

Figure 13 – HEPCA & EEAA divers installing manta rays at Samadai Reef

Figure 14 – Dive boats moored alongside Sha'ab El Fanadir, near Hurghada
(Source: *QuickBird* satellite image taken from an orbital altitude of 450 km, February '04)