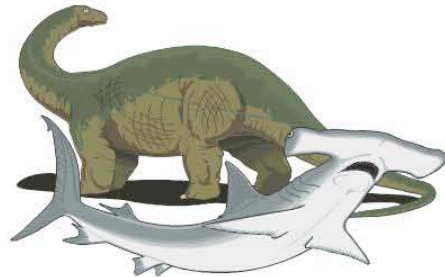


EXERCISE JURASSIC SHARK

COCOS ISLAND, COSTA RICA

2 - 15 JULY 2006



POST EXERCISE REPORT

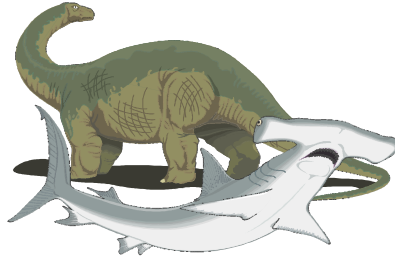


www.jurassic-shark.org.uk



*Joint Services
Shark Tagging Team
Cocos Island
02-15 July 2006*

EXERCISE JURASSIC SHARK COCOS ISLAND 2 – 15 JULY 2006



“It seems to me that the issue of conservation of the natural world is something that can unite humanity, if the people know enough about it, and can be persuaded to change the way in which we behave – that gross materialism and the search for material wealth are not the only things in life”

David Attenborough, 2006¹

“Studying sharks in the wild can be difficult, not so much because they have sharp teeth, but also because they live in rather inaccessible places and often travel vast distances”

Mark Carwardine, 2002²



Project endorsed by
Royal Geographical Society
with IBG
Advancing geography and geographical learning



¹ From: Porritt, J, 2006 'Planet Earth the Future What the Experts Say.'

² From: Carwardine, M & Watterson, K., 2002 'The Shark Watcher's Handbook.'



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Spear Guns on the deck of the Undersea Hunter

EXECUTIVE SUMMARY

EXERCISE JURASSIC SHARK was a remarkably successful expedition, which integrated the aims of science and adventurous training into one very high profile project. Key points are:

- **Aim.** The aim was to tag 13 Scalloped Hammerhead Sharks. The expedition ultimately tagged 15 with 5 satellite tags and 10 radio tags. In addition, two new radio receivers were deployed and the data collected from 2 existing receivers.
- **Team.** The 14-man team was composed of 5 Army, 4 RN and 4 RAF and 1 civilian scientist.
- **Scientific Work.** The scientific work was carried out under the direction of the Director of Field Operations from the Shark Research Institute (SRI). The whole team were involved with the scientific work; tagging itself was only one of the tasks.³ The full value of the scientific equipment used was in the region of £20K (costs were shared with the SRI).
- **Obstacles.** The loss of one of the two spears was a significant problem that was addressed by the design, manufacture, testing and re-design of a new spear by the team working together with the ship's engineer. This was a considerable amount of work, which ultimately resulted in the tagging of one shark. The uploading of the daily diary to the internet via satellite was another problem due to the slow connection speed of the GPS phone and frequent loss of connection. This late night activity would often take up to an hour.
- **Local Liaison.** The team were accompanied by the President of PRETOMA (Programa Restauración de Tortugas Marinas) – a Costa Rican NGO. His presence proved inspirational to the team as a whole and ensured that the team were fully aware of the significance of the work.
- **Diving.** The diving was highly adventurous. This was mainly because the scientific requirement meant diving in marginal conditions in order to achieve the aim. The use of re-breathers added a new dimension to the diving, which significantly enhanced the skills of those using them.
- **Publicity.** The expedition website (www.jurassic-shark.org.uk) has received over 6300 unique hits. The daily uploading of the expedition diary by satellite proved exceptionally popular. The expedition has also been the subject of double page articles in *Soldier* and *Dive* magazines in addition to numerous other publications. It has also featured on the radio and TV (BFBS) and has been invited to present at the Diving Officers' Conference in Dec 06.
- **Scientific Reports.** It is expected that the SRI will ultimately publish two scientific papers (one for satellite tags and one for radio tags).
- **What Next?** Another Costa Rican NGO (MarViva)⁴ has offered (subject to successful contract negotiation) SRI, PRETOMA and the Joint Services Shark Tagging Team (JSSTT) the use of their research vessel at minimal cost. EXERCISE JURASSIC SHARK 2 is therefore being planned for July/August 2008. It will be a 3 to 4 week, Tri-Service expedition to tag sharks around Malpelo (Colombia), Cocos Island (Costa Rica) and Darwin/Wolfe (Galápagos islands, Ecuador), plus a number of little known seamounts. The aim is to make a significant contribution to the scientific basis for the Eastern Tropical Pacific Seascape Initiative (a marine reserve).

³ The full range of scientific tasks included: Equipment assembly (tags, receivers and spearguns), electronic registration of radio tags with the receivers, deployment and retrieval of radio receivers, downloading data from the radio receivers, tag management and deployment, Detection and tracking of tagged sharks (using a hydrophone), equipment improvisation and improvement, report writing.

⁴ [MarViva](#) is a non-profit, non governmental organisation that works together with the authorities and communities to protect marine resources along the Eastern Tropical Pacific and the Caribbean.

INTRODUCTION

1. EXERCISE JURASSIC SHARK was a British military diving expedition to electronically tag Scalloped Hammerhead Sharks (*Sphryna lewini*) around Cocos Island, 550 km off the Pacific coast of Costa Rica. As a military expedition the aim was to develop the kind of leadership, teamwork, courage and co-operation that is vital to operational capability. Beyond that, EXERCISE JURASSIC SHARK exposed military personnel to a unique conservation project and offered the opportunity to publicise the plight of shark populations in general. The tagging was carried out under the direction of the Shark Research Institute (SRI) and the Programa Restauracion Tortugas Marinas (PRETOMA - a Costa Rican conservation group) and was approved and supported by both the Joint Services Expedition Trust and the Royal Geographical Society. The project itself was endorsed by the Marine Conservation Society and the Shark Trust.

2. This project informed the scientific basis for the Eastern Pacific Tropical Seascape (EPTS) Initiative, which brings together the islands of the Galápagos, Gorgona, Malpelo, Cocos and Coiba in a single conservation plan. Whilst remote, these islands are not biologically isolated. Five major ocean currents, including cold water from Antarctica and three tectonic plates converge in the area, creating a migratory path for a large number of species. The expedition worked with the SRI and PRETOMA to use radio and satellite tags to track the hammerhead sharks that live in the open waters of the eastern Pacific. This work will help to identify migratory corridors and those areas in need of special protection.

AIM

3. The original aim of the expedition was to electronically tag 13 Scalloped Hammerhead Sharks in order to provide evidence about both their movements and habits. The Expedition ultimately tagged 15 with 5 satellite tags and 10 radio tags. In addition, two new radio receivers were deployed and the data collected from 2 existing receivers.

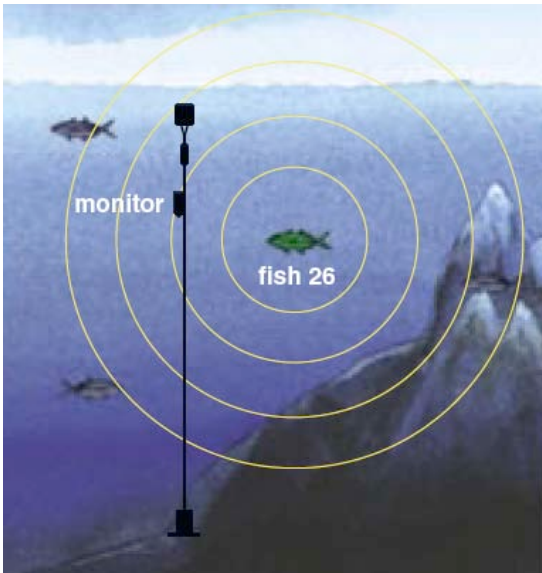
WHY IS SHARK RESEARCH IMPORTANT?

4. Sharks are a vital component of marine ecosystems; as apex predators they control their prey populations: stabilising population fluctuations and removing diseased or genetically flawed individuals. Their disappearance can be extremely damaging. Nevertheless, sharks are being subjected to intense fishing pressure as a result of the high demand for shark fins and cartilage. Since many sharks travel long distances, crossing oceans and national boundaries, they are susceptible to the unregulated fishing efforts of multiple nations. Consequently, shark populations have plummeted worldwide to less than 30 percent of their numbers two decades ago. This decline, coupled with the slow reproductive rate of most sharks has meant that there is now considerable concern about the health of shark populations and an urgent need for effective conservation and management.

METHODOLOGY

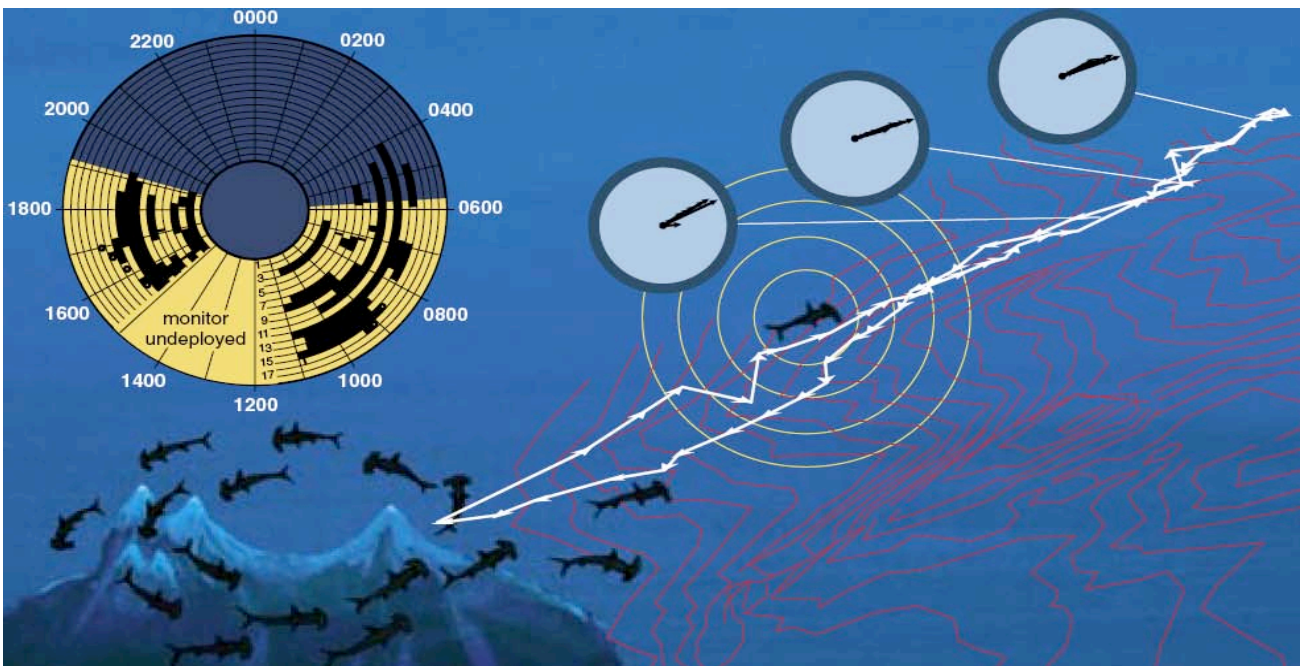
5. The hammerheads were tagged while they are free swimming. Cleaning stations occupied by small yellow Barber Fish (a type of Butterfly Fish) were the key to the team's success. These stations appear to be the main reason for the high levels of hammerhead activity around the island. The sharks spend the night feeding in deep water and then come up to the cleaning stations during the day in order to have their parasites removed by these tenacious little fish. Divers wait for the hammerheads to swim into a cleaning station and

then move in slowly to tag them using a spear gun. The sharks swim much more slowly and often roll over to one side while waiting to be cleaned. The sharks seemed to enter a trance-like state when they are at the cleaning station and generally reacted by simply swimming away (catching sharks to tag them, while being the traditional method, is very traumatic on the animal, and in some cases causes the shark to die). Closed and semi-closed circuit re-breathers were used by a proportion of the team in order to get as close to the sharks as possible.



Above: The radio tag transmits a unique electronic signature that is picked up and logged by the receiver as the shark swims past. Below: Hammerhead sharks at other sites have been found to depart at dusk and return before dawn. They return using the same precise route (as illustrated by the linked arrows). It is thought that they follow geomagnetic signatures (red lines). From: Klimley, A.P., Richert, J.E. and Jorgensen, S. J., 2005 'The Home of Blue Water Fish' American Scientist 93: 42-49.

6. Besides the tags, the team also deployed two new radio receivers at different sites (Amigos and Isla Manuelita)¹, and retrieved data from two previously deployed radio receivers (at Dirty Rock and Bajo Alcyone). These record the presence of a radio tag when the shark swims past; logging the comings and goings of a tagged shark as it moves around the island (see diagram below). Of the 15 tagged sharks, 10 were tagged with radio tags and 5 with satellite tags. The satellite tags are designed to read the temperature, depth and approximate location experienced by the shark every 1 to 6 minutes for periods up to 120 days. They then release themselves from the shark and download this information to a satellite. The radio receivers give us information about the sharks in relation to specific sites, whereas the satellite tags will ultimately give us an indication of where they go to feed and breed. This is vital to know because the sharks almost certainly leave the twelve mile protection zone. The radio tagged sharks were also followed using a hydrophone, bought with sponsorship from ATKINS. This expensive piece of equipment was given to PRETOMA by the expedition and brings the total value of scientific equipment left behind to approximately £20,000.





Illegal fishing boat.



Diving conditions were sometimes challenging.

7. The team were also able to make a much more immediate and practical difference to the conservation of sharks when an illegal fishing boat (see left) was found close to a seamount first discovered by Jacques Cousteau (Alcyone). The fishing boat was well within the twelve mile exclusion zone and had clearly set long lines within a few hundred metres of Cocos Island's best dive site. We photographed the boat together with the GPS position and subsequently reported it to the National Park headquarters on the island. PRETOMA also filed an official complaint. Long lining is an indiscriminate killer of sharks and other animals, which has yet to be completely stopped around the island and is a massive problem for the long-term future of Costa Rica's shark fishery as a whole.

8. Diving conditions varied from benign to extremely challenging as the requirements of the project meant that the team had to dive some of the more seaward sites in bad weather. This resulted in strong currents and difficult surface conditions; waves were sometimes in excess of 2 metres high (see left). The worst aspect of the weather, however, was undoubtedly the rain. Cocos Island experiences an amazing 350 inches of rain per year and most of it seemed to fall during the expedition!

BACKGROUND

9. Costa Rica can also play an important role to promote the conservation and sustainable use of sharks in the Eastern Tropical Pacific, especially considering the nation's international reputation as a conservationist country. This reputation is tarnished however, by Costa Rica's decision to support shark finning international flag fleets. These boats land their shark fins illegally at private docks against Customs regulations.

10. The Costa Rican longline fishery was initiated in Costa Rica in 1982 as a consequence of an official mission from the Government of Taiwan. By 1987, Costa Rica already possessed the largest longline fleet in Latin America. Currently, over 550 vessels operate under Costa Rican flag. However, over 2,500 large scale longliners, from Asian nations, notably Taiwan, reap the Eastern Pacific to catch shark for the Asian shark fin soup market. The effect of this monumental fishing effort has been devastating to local shark populations. Globally, sharks are estimated to have declined 90% during the last 50 years. In the Exclusive Economic Zone of Costa Rica, studies show a reduction of sharks of 60% from 1991 to 2001.

11. As shark populations dwindle in the region, fishermen increase their fishing effort in Marine Protected Areas (MPA) such as Cocos Island, where sharks are still relatively plentiful. Even though the Costa Rican government has expressed its commitment to strictly protect the island from illegal fisheries, resources are scarce and poaching is a constant problem, adding pressure to the shark populations that the 12 mile no-take area is designed to protect.



Monofilament line used in long line fishing collected from the Cocos Island MPA.

12. Efforts are currently underway to improve shark conservation in Costa Rica and the region. It is not only necessary to better understand shark movements within the MPA of Cocos Island, but the connectivity with other oceanic islands of the region as well, in order to design management plans accordingly. The SRI (USA) and PRETOMA (Costa Rica) have teamed up to carry out this necessary work. Including those tagged on this expedition a total of 21 Scalloped Hammerhead Sharks have now been tagged with acoustic telemetry tags and 5 with satellite archival tags. These sharks will allow the study of both the short range movements of these sharks within the MPA of Cocos Island and long range movements of sharks in the Eastern Pacific. The two organisations will use the information generated to lobby for and promote improved shark conservation policy in the region.

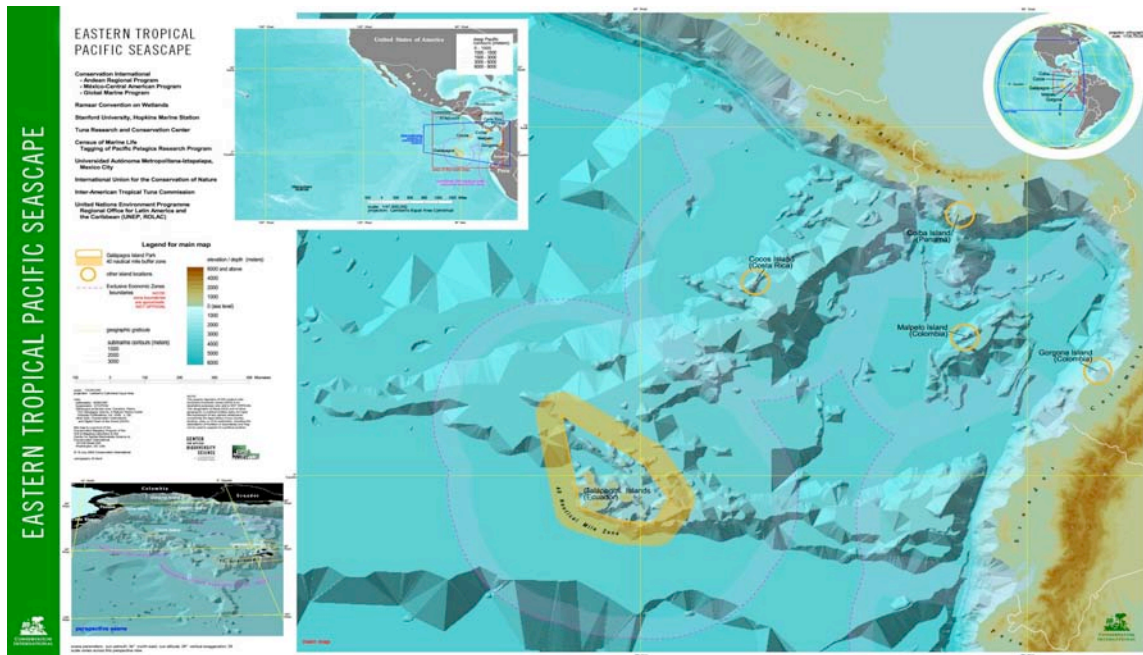


Finned hammerhead shark (photo supplied by Randall Arauz).

EASTERN PACIFIC TROPICAL SEASCAPE INITIATIVE

13. Four governments – those of Costa Rica, Panama, Colombia and Ecuador – have joined with over 50 partners, including leading conservation and research groups, to launch the first ever attempt to pursue integrated ecosystem management across multiple international political jurisdictions. The ETPS initiative, which is partially funded by the United Nations Foundation, is part of a broader \$15 million agreement between the Foundation, the Global Conservation Fund at Conservation International (CI) (with funds from the Gordon and Betty Moore Foundation) and the UNESCO World Heritage Centre to conserve current

and proposed Natural World Heritage Sites. ETPS aims to establish a functional marine conservation corridor by creating a network of marine protected areas across the 211 million hectare expanse of sea that falls inside the four countries' exclusive economic zones.



Eastern Pacific Tropical Seascape Initiative (From: Conservation International, 2002).

COCOS ISLAND

14. Cocos Island is located in the Eastern Tropical Pacific, 300 miles off the coast of Costa Rica. Formed during a volcanic upheaval around two-and-a-half million years ago, Cocos Island is composed from lava flows of basaltic rock, labacorite and andecite. The island's landmass is made up of four mountain peaks - the highest is Cerro Yglesias, at 2,080 ft (634 M). The island has two large bays with safe anchorages and sandy beaches: Chatham is on the northeast side, and Wafer lies on the northwest. The island is completely undeveloped and has no airstrip. It is the only island in the tropical eastern Pacific with a humid tropical forest. Its position as the first point of contact with the northern equatorial counter current and the myriad of interactions between the island and the surrounding marine ecosystem make the area an ideal laboratory for the study of biological processes. The underwater world of the national park is considered one of the best places in the world to view large pelagic species. A map of the dive sites is at Annex E.



Two views of Cocos Island.

JOINT SERVICES EXPEDITIONS TRUST

15. This expedition enjoyed 'sponsored' status from the Joint Services Expeditions Trust (JSET) and would not have been possible without this key source of both funding and high level approval. Details can be found in 2005DIN06-103.

*Below: The team office on board the Undersea Hunter.
Right: Concentration was sometimes required.*



EXPEDITION PLANNING

16. Key expedition planning events were as follows:

Ser (a)	Date (b)	Event (c)
1	May 05	Publication of Defence Information Notice (DIN).
2	04 Jul 05	JSATFA Submitted.
3	05 Oct 05	JSET Presentation (1).
4	23 Jan 06	RGS Grant Application Submitted.
5	09 Mar 06	Exercise Authorised by LONDIST.
6	24 Mar 06	RGS Approval/Support Received.
7	05 Apr 06	Remote/High Risk Presentation.
8	25 Apr 06	JSET Presentation (2).
9	19 May 06	Admin Instruction Issued.
10	01 Jun 06	Dispensation to dive to 40m granted (See Annex F)
11	10/11 Jun 06	Training Weekend – Fort Bovisand, Plymouth.
12	02 – 15 Jul 06	Expedition in the Field.

ADMINISTRATION

17. **Research Permits.** The research was carried out under permit from the Costa Rican government (Resolucion No 003-005). This was organised by PRETOMA as part of the ongoing research.

18. **Personnel.** The nominal roll is at Annex A.

19. **Flights.** Flights were with Continental Airlines from Gatwick South Terminal:

a. **Out.**

02 Jul 06 Gatwick South Terminal to Houston CO 35 0930 -1340hrs

02 Jul 06 Houston to San José CO 1499 1756 – 2040hrs

b. **Return.**

14 Jul 06 San José to Newark CO 1797 0800 – 1517hrs

14 Jul 06 Newark to Gatwick South Terminal CO 18 1840 – 0640hrs
(+1 day)

N.B. Dr Antoniou joined the team in Houston (Flight CO 1499) and departed on CO 1485 at 0700 hrs on 14 Jul 06.

20. **Baggage Allowance.** Possession of a NATO travel order increased the total weight that can be carried per person from 46 kg to 64 kg. However, there was an issue with the number of bags carried for each person, which resulted in an excess baggage charge of \$200 on the return journey. Continental Airlines policy on applicable baggage allowances is summarised below:

a. **Standard Allowance.** The standard allowance was 2 bags per person with a maximum weight of 23 kg.

b. **Military Customers (on Military Orders).** Up to two bags up to a maximum of 32 kg could be carried.

c. **Diving Equipment.** Continental accepts one dive bag as part of the free baggage allowance. An empty dive cylinder or up to 3 re-breather cylinders is not be included in determining the Free Baggage Allowance and is subject to an excess baggage charge.

21. **Carriage of Cylinders.** All (re-breather/BC emergency) cylinders were removed from the luggage by the American authorities on the return journey. No explanation was offered and the expedition was unable to recoup the costs incurred.



22. **MV Undersea Hunter.** The research vessel *MV Undersea Hunter* (shown left) was built in Florida in 1968 for Perry Oceanographic and was used for twenty years as a submarine support vessel. Working primarily in the Bahamas and the Caribbean, she completed hundreds of research and photographic missions. She was refurbished in June 1990. Already a capable and well-proven research vessel, the *Undersea Hunter* was modified to accommodate 14 passengers. She has a fuel capacity of 40 tons and water capacity of 26 tons and proved to be an ideal research platform.

23. **Land Accommodation.** The expedition spent the first (02 Jul 06) and last night (13 Jul 06) of the expedition in the *Best Western Irazu*, Km 3 Autopista General Canas, San José 1000, Costa Rica. All accommodation was in twin share rooms/cabins as appropriate.

24. **Documentation.** All expedition members were required to be in possession of the following documentation on arrival at Gatwick:

- a. Passport (valid for a minimum of 6 months from 15 Jul 06).
- b. NATO Travel Order (see Para. 12).
- c. DAN Membership Card.
- d. Military ID Card (MOD 90).
- e. Current BSAC medical.
- f. Qualification book (or card).
- g. Diving Logbook.
- h. Proof of BSAC membership.

25. **Insurance.** Service personnel taking part in Adventurous Training (AT) are considered to be engaged in the course of their normal duties. Nevertheless, the CASEVAC requirements meant that it was mandatory for all expedition members to be in possession of DAN (Europe) insurance on this expedition. The cost was £48 and was arranged on an individual basis by visiting www.daneurope.org/eng/english.htm.

26. **Money.** The currency in Costa Rica is the Colone; however, the US \$ was found to be universally accepted. There was a departure tax of US\$ 26 per person.

27. **CILOR.** CILOR was permissible for this expedition. The rate for Costa Rica was £8.87 per person per day. A representative from each Service was given the responsibility for claiming this money.

28. **Clothing.** Nights on Cocos Island could be chilly and/or drizzly but a fleece and/or light jacket proved more than adequate. Shoes were not required on board the boat but adequate footwear was necessary for going ashore on Cocos Island. Two expedition shirts and a baseball hat were given to each expedition member on departure from the UK. Shirts and hats were also given to personnel from SRI, PRETOMA, the *Undersea Hunter* and Cocos Island National Park.

29. **Group Equipment:** The following equipment was taken on behalf of the group:

- a. **NERA Satellite Worldphone.** L/Cpl Prevett was responsible for ensuring that the satellite phone was collected/returned from/to Adventurous Training Group (Army) and that it was capable of communicating with the website. Details are at Annex L.
- b. **Laptop Computers.** A total of 6 laptop computers were carried on the expedition. These proved vital for setting up the scientific equipment, downloading data from the radio receivers and writing up the results.



c. **Satellite EPIRB Personal Locator Beacons.** The carriage of satellite EPIRBs in addition to the standard radio type was a requirement arising from the remote/high risk presentation. Four EPIRBs + aluminium dive canisters (shown left) were purchased by the Army Sub-Aqua Diving Association (ASADA) on behalf of the expedition. These were carried at all times during the diving.

d. **Shark Tags/Spear Guns.** Dr Antoniou was responsible for all scientific equipment (including the spear guns, satellite tags, radio tags, radio receivers and the hydrophone).

*Top left: Setting up the receivers.
Top Right: Spear Guns (Less tips).
Left: Satellite EPIRB.*

DIVING OFFICER'S REPORT

30. **Introduction.** EXERCISE JURASSIC SHARK diving was conducted in accordance with JSSADR and BSAC Safe Diving Practices. Due to the nature of the diving that would take place it was decided that the minimum qualification level of diver should be BSAC Dive Leader or equivalent PADI level of qualification, and that all divers be nitrox qualified. The expedition consisted of two First Class Divers (both SADS), seven Advanced Divers, three Dive Leaders, one PADI Dive Master and one PADI OWSI.

31. **Pre-Expedition Training Weekend.** A training weekend took place at Fort Bovisand, Plymouth on 10/11 Jun 06. The aim of the training weekend was to introduce team members to each other, check the serviceability of personal equipment and conduct spear gun training. The only absentees were Able Rating Dan Evans, who was on duty, and Dr Alex Antoniou, the expedition scientist from the Shark Research Institute. The team

members had the use of the facilities from JSSADC, including a RIB. A second RIB was provided by Bovington Garrison Sub-Aqua Club. The team members had the use of a RIB and access to compressed air from JSSADC. The first day consisted of a shakedown dive in the morning on the Glenstrathallan with a maximum depth to 18 metres, where members had the opportunity to carry out mid-water deployment of DSMBs, a skill that would be required on the expedition. The afternoon was taken up with spear gun lectures followed by practical use of spear guns in Bovisand Harbour. It soon became apparent that reloading of the spear guns underwater would be more demanding than initially anticipated. The second day of the training week-end saw the team dive HMS Scylla in Whitsand Bay to the west of Plymouth Sound. This allowed the team to conduct a deeper dive to 25metres which would hold us in good stead for Cocos.



Training weekend at Fort Bovisand, Plymouth. Left: Team Photo, Right: spear gun lesson.

32. **Diving Regulations.** All diving was carried out in accordance with JSSADR. The 30m rule was waived for this expedition (See Annex F).

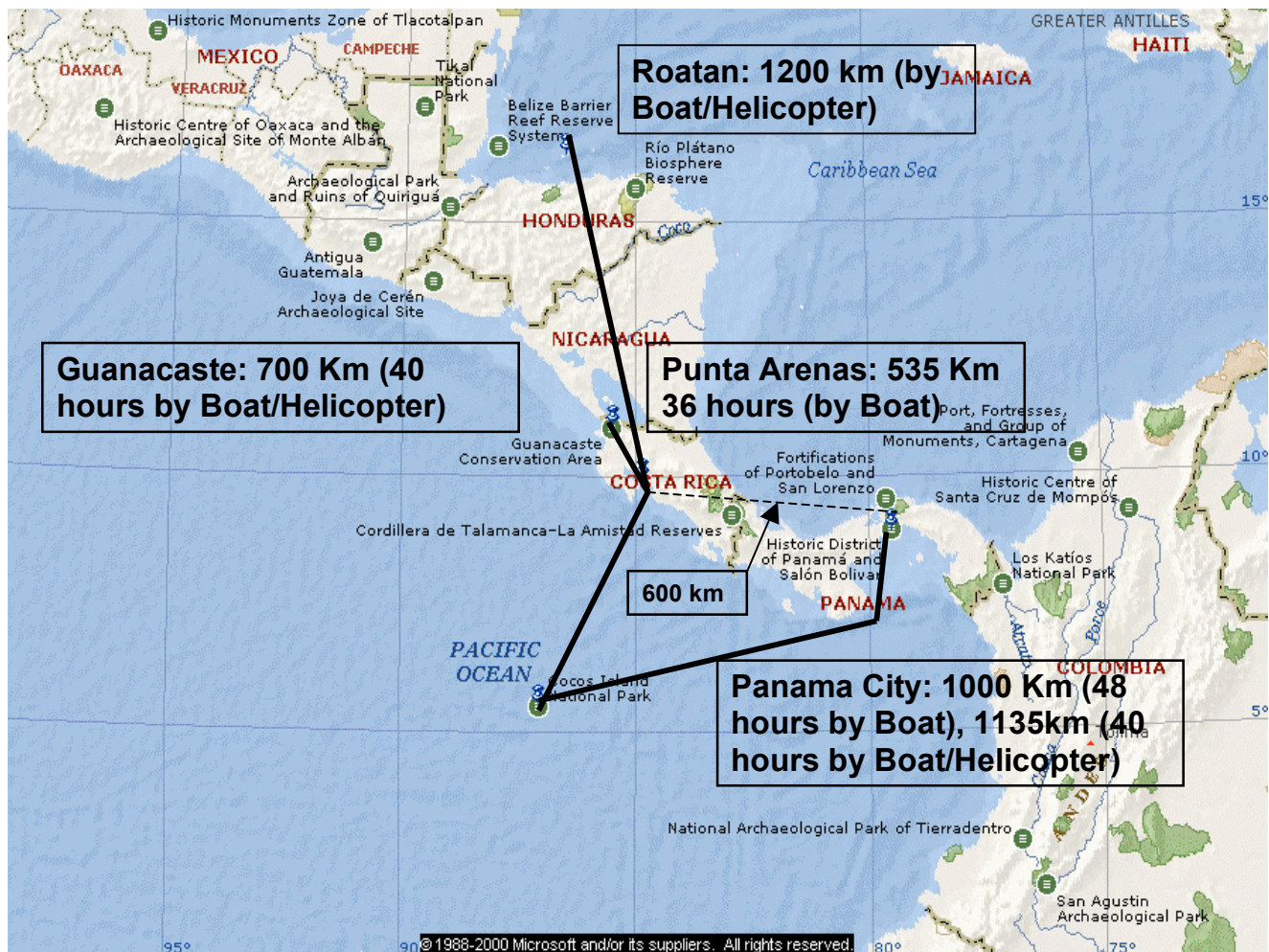
33. **Expedition Dives.** The diving in Cocos was as demanding and challenging as anticipated. Although permission had been granted to dive to 40 metres the maximum depth attained during the expedition, to achieve the aim, was 36 metres. Four of the fourteen divers used Semi-Closed Circuit Re- Breathers (SCCRBs), with the remaining ten divers using open circuit systems. To help reduce nitrogen overloading all diving was conducted using Nitrox. Each diver analysed their own mixtures which ranged from 30% to 33% for the open circuit divers, and up to 48% for SCCRb divers.

34. **Dive Sites.** A diving summary is at Annex D.

35. **Re-Breathers.** Two Draeger Dolphin SCCRbS were loaned to the expedition by JSSADC, Fort Bovisand. These were insured through the PRI at the Armoured Centre, Bovington. The cost of £5000 worth of insurance was £42 (compared with £150 if arranged directly with the same insurer: Towergate Wilson). Dr Antoniou used his personal SCCRb and Sgt Thomas used his personal Closed Circuit Re-Breather (Buddy Inspiration). The SCCRb cylinders and Sofnalime were supplied by the *Undersea Hunter*.

36. **Casualty Evacuation and Recompression.** The key dangers were decompression illness, physical injury (primarily from the use of spear guns, not sharks) and lost divers. The expedition managed the risk of a decompression incident through the use of Nitrox, capping depths/times and imposing mandatory safety stops. Oxygen was freely available on board the boat. Physical injury could be treated on site using our own doctor, medical supplies and satellite telephone. All divers carried either a personal radio beacons (that can be detected

at a distance of up to 8 km), satellite EPIRB (see Para 25 c) or both. In the event that casualty evacuation was required the expedition would have been dependant on the US Coastguard for helicopter evacuation. However, availability could not be guaranteed and the distance out to sea meant that helicopter evacuation from the mainland was impossible - leaving the 36 hour sea crossing as the only reliable route back to help. Recompression chambers were located at Roatan, Guanacaste and Panama City. A casualty would have taken a minimum of 40 hours to reach a recompression chamber. The locations of the nearest recompression facilities together with estimated travel times are shown below:



COMMUNICATIONS (SEE ANNEX L)

37. **Website.** The EXERCISE JURASSIC SHARK website (www.jurassic-shark.org.uk) was created for promotional and sponsorship purposes; in addition to this it was utilised as an information portal for expedition members and other external bodies. Between 17 Jan 06 and 10 Nov 06 the website received 6332 unique hits.

38. **Uploading to the Web.** Because the modern world relies so heavily on up-to-date information it was decided that the website should be updated whilst the expedition was deployed. To do this in such a remote location such as Cocos Island, satellite technology had to be used as no other means of communicating with the outside world is available. Adventurous Training Group (Army) kindly provided a Nera Worldphone (satellite phone). For voice calls this phone is more than adequate; however for data calls it turned out to be problematic due to the extremely slow connection speed; at 2.4kbps it is approximately 23 times slower than a normal dial up modem. Because of this it was decided not to use the

satellite phone to update the web site directly. It was felt that it would be far too time consuming and costly and also had the potential to corrupt the website.

39. **Video.** Two digital video camcorders were used to document the expedition:



a. Sony PD150 DVcam recorder used for all underwater video footage. The underwater housing used was an Amphibico housing specially designed for the PD150.

b. Sony VX2100 miniDV recorder used to record top-side video footage. A wide angle adapter was also used with this camera.

Left: Major Mark Foster with video camera.

MEDICAL OFFICER'S REPORT

40. **Overview.** The remote location meant that a comprehensive medical kit was put together. Envenomations, ear infections and the usual coughs and colds were covered for. Minor surgical instruments, sutures and antiseptics were carried as well as the emergency airway, anaphylactic injections and stronger painkillers. The *Undersea Hunter* also had a fairly comprehensive medical kit including 100% O₂ and a defibrillator, although most of the medicine names were in Spanish.

41. **Sea Sickness.** The journey to/from Cocos Island was approximately 36 hrs each way in the open sea. Sea sickness was a considerable problem when heading into the sea whilst putting together and testing the science equipment on the way out to the island. There was no problem on the way back.

42. **Vaccinations.** No specific vaccinations or Malaria prophylaxis were required for this expedition.

43. **Sun Protection.** It rained for the majority of the time on Cocos Island. Had this not been the case then exposure to the sun might have been a significant problem.

SUMMARY

44. **Financial Summary.** A financial summary is at Annex B.

45. **Expedition Timetable.** An outline timetable for the expedition is at Annex C.

46. **Scientific Results.** Actual data from the 15 tags deployed by the expedition cannot be published in this report because the results of the expedition will ultimately be reported in appropriate scientific publications. However, we do know that one radio tag almost certainly dropped off its host shark as the hydrophone consistently picked up the same signal at the same site. One of the satellite tags also failed to download its data successfully. Nevertheless, the remaining four satellite tags successfully downloaded data, which included

water temperature, diving depth, and light data. Getting data from four out of five tags is considered to be an excellent result as there is often a 50% fail rate for this type of archival pop-up tags.



47. **What Next?** A Costa Rican NGO (MarViva)⁵ has offered (subject to successful contract negotiation) SRI, PRETOMA and the Joint Services Shark Tagging Team (JSSTT) the use of their research vessel at minimal cost. EXERCISE JURASSIC SHARK 2 is therefore being planned for July/August 2008. It will be a 3 to 4 week, tri-Service expedition to tag sharks around Malpelo (Colombia), Cocos Island (Costa Rica) and Darwin/Wolfe (Galápagos Islands, Ecuador), plus a number of little known seamounts. The aim is to make a significant contribution to the scientific basis for the Eastern Tropical Pacific Seascape Initiative.

Proteus anchored off Cocos Island: This boat is owned by MarViva and might be the base for the next expedition in 2008.

48. **Overall Summary.** This was an extremely ambitious expedition, which ultimately proved to be a remarkable success: A total of 15 Scalloped Hammerhead Sharks were tagged (with 10 radio tags and 5 satellite tags). In addition two radio receivers were deployed and data from two existing radio receivers downloaded. Above all, this was an expedition that was defined by the scientific project: The whole team were fully engaged in the work and the degree of problem solving and level of adventurous activity was significantly enhanced by the need to deploy a considerable amount of scientific equipment within an incredibly short space of time. Cocos Island provided the adventure, we provided the team, SRI and PRETOMA provided the scientific component, conservation context and an infectious passion for the work. The result was an expedition that surpassed all expectations.

49. **Acknowledgements.** We would like to express our gratitude to Dr Alex Antoniou, Mr Randall Arauz and the crew of the *Undersea Hunter*. Together they made the expedition.

Signed on Original

Andy Reid
Major
Expedition Leader

⁵ [MarViva](#) is a non-profit, non governmental organisation that works together with the authorities and communities to protect marine resources along the Eastern Tropical Pacific and the Caribbean.

Annexes:

- A. Nominal Roll.
- B. Financial Summary
- C. Expedition Timetable
- D. Diving Summary
- E. Diving Locations
- F. Dispensation to Dive to 40m.
- G. Re-Breather Report
- H. Scientific Report
- I. List of Tagged Sharks
- J. Hydrophone Officer's Report
- K. Shark Species Identified Around Cocos Island
- L. Website And Communications Report
- M. Media Handling Plan
- N. Press Release
- O. Media Coverage
- P. Expedition Diary
- Q. Bibliography
- R. Contacts

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Project endorsed by
.....

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Geographical
Society**
with IBG

Advancing geography
and geographical learning



**ANNEX A TO
JURASSIC SHARK PXR
DATED 01 DEC 06**

EXERCISE JURASSIC SHARK – NOMINAL ROLL

Ser (a)	Service No (b)	Rank (c)	1st Name (d)	Surname (e)	Service (f)	Unit (g)	Dive Quals (h)	Expedition Role (i)
1	541682	Major	Andy	Reid	Army	DGT&E/ARTD	SADS/AI/1 st Class	Expedition Leader/Army Team Leader Semi-Closed Circuit Re-Breather User
2	547525	Major	Mark	Foster	Army	AMD (HS)	SADS/AI	Medical Officer Video Camera Operator
3	CO36230L	Lt Cdr	Simon	Fleisher	RN	Phoenix	Advanced Diver OWI	RN Team Leader
4	2638682J	Sqn Ldr	Stuart	Edmondson	RAF	RAF Coningsby	Dive Leader	Hydrophone Officer Sponsorship Officer
5	2644199E	Flt Lt	Mark	Tillyard	RAF	RAF Coningsby	Advanced Diver AI	EPIRB Officer RAF Team Leader
6	8304423K	Flt Lt	Matt	Palmer	RAF	RAF Lossie- mouth	Dive Leader	Assistant Hydrophone Officer
7	24763971	WO1	Colin	Bartholomew	Army	ATDU, Bovington	Dive Leader	Army Sponsorship Officer
8	24530978	WO1	Kenny	McDonald	Army	DPA, Abbey Wood	SADS/OWI/1 st Class	Diving Officer
9	PO43770G	Sgt	Gareth	Thomas	RM	HMS Raleigh	SADS/AI	Closed Circuit Re-Breather User
10	D8427416	Cpl	Nick	Badham	RAF	RAF Cottesmore	Advanced Diver OWI	Expedition Clothing Officer
11	25081486	LCpl	Kelvin	Prevett	Army (TA)	211 Port & Reclam Coy (V)	Advanced Diver	Communications Officer/Webmaster Video Camera Operator
12	D218232H	POA(SE)	Steve	Paris-Hunter	RN	HMS Endurance	Advanced Diver	Semi-Closed Circuit Re-Breather Officer
13	D249085N	Able Rating	Daniel	Evans	RN	COMDEVFLOT	PADI Divemaster	Tagging Officer
14	N/A	Dr	Alex	Antoniou	Civilian	SRI	PADI OWSI	Science Officer/SCCRB User Video Camera Operator
15	N/A	Mr	Randall	Arauz	Civilian	PRETOMA		Director of PRETOMA

**ANNEX B TO
JURASSIC SHARK PXR
DATED 01 DEC 06**

FINANCIAL SUMMARY

Income	Received	Expenditure	£
Joint Services Expedition Trust.	15000	Boat/Diving	27160
Personal Contributions ¹	12874	Flights	10257
Flights	3945	10 x Radio Tags/2 x Radio Receivers	2568
Atkins	2500	National Park Fees	1769
RAF Special Projects	2000	Contribution to Hydrophone Purchase	1563
RN Sports Lottery	2000	Tagging Equipment	841
RAF Cottesmore	1600	Land Accommodation	740
LONDIST G3 PAT	1400	Transport to/from Punta Arenas	410
Royal Geographical Society ²	1250	Food	1719
Trenchard Memorial Trust Fund	1235	Expedition Shirts/Hats	823
RN funds	1200	DAN Insurance	624
Adventurous Training Group (Land)	1000	Replacement of Confiscated Cylinders	510
Army CILOR	576	Rainforest Visit	368
RAF CILOR	470	Final Dinner	336
RN CILOR	461	Nitrox	317
RAF Sports Lottery	688	Satellite Phone Bill	253
Selex	600	Soda Lime for Re-breathers	215
BIBMTF ³	500	DVD	200
Building Society Interest	421	Departure Tax	187
RAF Coningsby	300	Website Costs (Until 2008)	89
RAF Lossiemouth	300	Excess Luggage Fee	109
Adjutant General's Corps	250	Promotional Material	112
Ulysses Trust	300	Spear Gun Training	50
Light Dragoons	300	6' x 2' Expedition Banner	50
Army Sub-Aqua Diving Association	125	Bovington SAC RIB Hire	45
Lignacite	50	SCCRB Insurance	42
211 Port & Reclam Coy	30	RGS Application Fee	10
		Expedition Stamp	8
TOTAL INCOME	51375	TOTAL EXPENDITURE	51375

NOTES

- 1 - Personal Contributions = 25% of the Total Cost.
- 2 - Trinity and Patrick Award.
- 3 - Berlin Infantry Brigade Memorial Trust Fund.

**ANNEX C TO
JURASSIC SHARK PXR
DATED 01 DEC 06**

EXPEDITION TIMETABLE

Ser (a)	Date (b)	Time (c)	Activity (d)
1	10 Jun 06	AM PM	Training Weekend – Fort Bovisand Dive 1: Glenstrathallen – Shakedown Dive Dive 2: Fort Bovisand - Spear Gun Training
2	11 Jun 06	AM	Dive 3: HMS Scylla
3	02 Jul 06	0630hrs 0930-1340hrs 1756-2040hrs 2130-2200hrs	Continental Check-In London Gatwick – South Terminal Gatwick to Houston (CO 35) Houston to San José (CO 1499) Arrive San José
4	03 Jul 06	1100hrs 1400hrs 1430hrs	Depart San José Board <i>Undersea Hunter</i> Depart for Cocos Island
5	04 Jul 06	2359hrs	Puntarenas – Cocos Island Arrive Cocos Island
6	05 Jul 06		Dive 1: Manuelita (Inside) – Shakedown Dive Dive 2: Manuelita (Outside)/Dirty Rock Dive 3: Dirty Rock/Manuelita (Outside) Dive 4: Manuelita (Inside) – Night Dive
7	06 Jul 06		Dive 1: Big Dos Amigos/Small Dos Amigos Dive 2: Small Dos Amigos/Big Dos Amigos Dive 3: Dirty Rock/Manuelita (Outside)
8	07 Jul 06		Dive 1: Submerged Rock/Alcyone Dive 2: Alcyone/Submerged Rock Dive 3: Silverado/Manuelita (Outside)
9	08 Jul 06		Dive 1: Alcyone/Dirty Rock Dive 2: Dirty Rock/Manuelita (Outside) Dive 3: Viking Rock/Dirty Rock
10	09 Jul 06		Dive 1: Big Dos Amigos/Little Dos Amigos Dive 2: Dirty Rock/ Manuelita (Outside) Dive 3: Manuelita (Outside)/Viking Rock
11	10 Jul 06		Dive 1: Dirty Rock/Alcyone Dive 2: Alcyone/Dirty Rock Dive 3: Manuelita (Outside)/Lobster Rock
12	11 Jul 06	1600hrs	Dive 1: Alcyone/Punta Maria Dive 2: Punta Maria/Alcyone Dive 3: Dirty Rock/Silverado Depart Cocos Island
13	12 Jul 06		Cocos Island - Puntarenas
14	13 Jul 06	0800hrs 0900 hrs 1500 hrs	Disembark <i>Undersea Hunter</i> Visit to Rain Forest Arrive San José
15	14 Jul 06	0530 hrs 0800 - 1517 hrs 1840 -	Check-In San José to Newark (CO 1797) Newark to Gatwick (CO 18)
16	15 Jul 06	0640hrs	Arrive London Gatwick South Terminal

**ANNEX D TO
JURASSIC SHARK PXR
DATED 01 DEC 06**

DIVING SUMMARY

Ser (a)	Name (b)	Dive Number/Total Dive Times (mins) (c)																						Total (d)	Time (e)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
1	Maj Andy Reid	55	56	48	43	54	62	53	59	38	63	46	49	60	42	60	57	60	40	60	45	44	54	22	1148
2	Dr Alex Antoniou	60	50	40	0	45	50	60	57	60	63	60	62	62	64	62	60	42	57	57	51	43	68	21	1173
3	Maj Mark Foster	43	34	37	41	45	41	52	57	43	63	47	45	56	42	46	54	60	44	60	46	46	54	22	1056
4	Lt Cdr Simon Fleisher	55	56	40	42	45	41	44	49	40	60	47	45	45	58	60	58	38	45	46	45	44	54	22	1057
5	Sqn Ldr Stuart Edmondson	43	34	37	41	38	62	41	45	32	63	36	47	48	40	55	53	52	43	59	42	46	59	22	1016
6	Flt Lt Mark Tillyard	51	36	36	42	40	50	56	50	57	55	50	59	58	58	60	58	52	43	57	52	43	66	22	1129
7	Flt Lt Matt Palmer	54	55	40	42	38	62	41	57	43	63	36	49	48	41	47	51	47	52	57	45	37	65	22	1070
8	WO1 Kenny McDonald	47	38	38	39	40	50	55	52	57	54	49	60	60	46	54	50	47	52	58	41	43	66	22	1096
9	WO1 Colin Bartholomew	40	32	32	38	37	42	51	52	55	51	50	59	57	46	54	50	38	45	46	49	37	64	22	1025
10	Sgt Gareth Thomas	40	32	39	38	45	50	60	56	60	63	61	62	62	63	62	60	43	57	46	51	43	68	22	1161
11	Cpl Nick Badham	60	50	40	42	42	45	45	49	40	60	47	45	56	40	55	54	51	50	56	40	42	54	22	1063
12	L/Cpl Kelvin Prevett	51	36	36	42	37	42	51	53	55	51	49	59	60	43	46	54	60	44	60	42	46	59	22	1076
13	POA(SE) Stephen Paris-Hunter	54	55	48	43	54	62	50	59	38	63	45	49	60	41	60	56	59	40	60	46	45	54	22	1141
14	Able Rating Daniel Evans	47	38	38	39	42	41	43	45	32	63	47	44	45	41	47	50	51	50	56	51	43	54	22	1007
15	Max Depth for Dive	21	34	33	20	30	31	33	33	33	30	32	35	35	34	32	31	34	36	31	30	31	34	307	15218

DIVE LOCATIONS



MANUELITA (INSIDE)

Depth: 6 - 21m

Marine life: White Tip sharks, Marble and Spotted Eagle Rays

Description: Expedition's first warm-up dive and night dive, which faces the calm waters of Chatham Bay. Watching the large schools of White Tip sharks feeding on the night dive was one of the main experiences of the expedition.

MANUELITA (OUTSIDE)

Depth: 18 - 39m

Marine life: Hammerhead sharks, White Tip sharks, Eagle rays, Manta Rays, Yellow Fin tuna, turtles, Jacks

Description: Several cleaning stations for the Hammerheads were the main attraction of the ocean side of Manuelita. A gradually descending slope, it contains huge boulders where we could easily hide to watch and tag the Hammerheads. Some members of the team were fortunate enough to get a glimpse of a large Manta Ray.

LOBSTER ROCK

Depth: 12 - 33m

Marine life: White Tip sharks, Moray eels

Description: On this finger-like rock, divers could easily approach large white tips lying on the bottom in great numbers.

SILVERADO

Depth: 10 - 12m

Marine life: Silvertip sharks and Red-Lipped Batfish.

Description: Silverado is the only known cleaning station for Silvertip sharks at Cocos Island. It was an unforgettable experience watching the Silvertips at such close quarters. Half the team were fortunate enough to see a huge 3m (500 Kg) Silvertip on one of the dives. The strange Red-Lipped Batfish was also seen on this dive.

ALCYONE

Depth: 27 - 36m

Marine life: Hammerheads, White Tip sharks, Silky Sharks, Marble rays, Eagle Rays, Yellow fin tuna, Wahoos, Dolphins.

Description: This legendary seamount was one of our most popular dives. An unbelievable number of Hammerheads were seen here and it was an extremely successful place to tag them. We also replaced one of the submerged receivers here.

SUBMERGED ROCK

Depth: 6 - 33m

Marine life: White tips, Hammerheads, marble rays.

Description: Swimming through this splendid arched hole we saw colourful scenery and plenty of marine life. We were also fortunate enough to see Galapagos sharks.

SMALL DOS AMIGOS

Depth: 18 - 36m

Marine life: Hammerhead sharks, Galapagos sharks, White Tip sharks, Eagle rays, dolphins.

Description: The southernmost part of the island where the open sea current first reaches the island, bringing with it some exciting surprises. We were also fortunate enough to see Galapagos sharks and dolphins.

BIG DOS AMIGOS

Depth: 18 - 36m

Marine life: White tips, marble rays, hammerheads, turtles.

Description: The view through this underwater majestic arch was a wonderful spectacle.

PUNTA MARIA

Depth: 24 - 36m

Marine life: Hammerheads, white tips

Description: This seamount that rises from a deep sandy area provided an abundance of marine wildlife and a spectacular cleaning station for hammerheads.

DIRTY ROCK

Depth: 6 - 39m

Marine life: Hammerheads, Whale Sharks, white tips, marble rays, eagle rays, mobula rays, jacks, turtles, dolphins.

Description: Dirty Rock was one of the expedition's most popular dive sites, with spectacular rock formations where vast amounts of wildlife congregated. Some of us were fortunate enough to get a glimpse of a Whale Shark.



VIKING ROCK

Depth: 12 - 40m

Marine life: Hammerheads, White Tips, Marble Rays, Eagle Rays.

Description: A pleasant dive with plenty of wildlife. Not many opportunities to see sharks.

DISPENSATION TO DIVE TO 40M



Superintendent of Diving
Fleet Diving Headquarters
RECLAIM Building, Horsea Island,
PORTSMOUTH, Hants. PO6 4TT



Telephone: 023 9222 4148 (Admin)
Military Network: 93832 4148
Fax: 023 9222 4150
e.mail: fdhqregistry@a.dii.mod.uk

Reference: 258/10/1

See Distribution

Date: 01 Jun 06

DISPENSATION 31/06

EXERCISE JURASSIC SHARK (02 – 15 JUL 06) – DISPENSATION TO DIVE TO 40M

References:

- A. JSSADR dated 01 Apr 05.
- B. DGTE/ITC3a dated 05 May 06.

1. Dispensation to dive to 40m on the above exercise is approved subject to the following conditions:

- a. No planned decompression diving may be conducted.
- b. A safety stop of at least 3 minutes @ 6m must be carried out prior to the completion of each dive.
- c. Nitrox diving is only to be conducted with a maximum PP^{O_2} of 1.4 bars and the MOD restricted accordingly.
- d. Diving to depths exceeding 30m should only be made when necessary at the expedition leader's discretion and should be the exception rather than the rule.
- e. All diving must be conducted in accordance with Reference A and BSAC safe diving practices.

f. Any occurrences of DCI are to be reported to SofD by quickest possible means and further diving is to cease until authority to continue is granted by SofD or his nominated deputy.

g. On completion of the exercise a record of all diving practices conducted is to be forwarded to SofD.

2. This dispensation is extant for the period of the above exercise only.

Signed on Original

C R AMEYE
Cdr RN
SofD

External:

Action:

Maj AJ Reid (Expedition Leader)

RE-BREATHING REPORT (DRAEGER DOLPHIN SEMI CLOSED CIRCUIT RE-BREATHING)

POA Paris-Hunter

Two Draeger Dolphin Semi-Closed Circuit Re-Breathers (SCCRBs) were provided by JSSADC Fort Bovisand for use on EXERCISE JURASSIC SHARK by the two team members who were suitably qualified.

Major Andrew Reid and Petty Officer Stephen Paris-Hunter picked up the Draeger Dolphin re-breathers the week of the 11 June so we had time to familiarize ourselves with the equipment and to check them prior to taking them to Cocos Island. Spares were provided and used during our time away.

Once on board the SCCRBs were assembled using cylinders supplied by the *Undersea Hunter*. It became apparent that a standard length hose for AP200 was too short by approximately 150mm. Fortunately two other members in the team had longer hoses and were able to swap. A good size inflation hose is 950mm in length. It recommended that anybody considering using these SCCRBs should either purchase a longer inflation hose or ask to sign out a suitable hose from Fort Bovisand at the same time as signing out the Draeger Dolphin itself. It is also recommended that a diffuser is fitted to the relief valve in order to reduce the size of bubbles.

The expedition scientific officer was also an instructor for the use of the Draeger Dolphin and therefore used the same setup as ourselves. The only difference was that he had an O₂ analyzer fitted which gave him his PPO₂ level at all time which is extremely important. With over two hundred hours use on the Dolphin SCCRb his experience proved tremendously valuable.

With the advice from our instructor we chose to work out our MOD from the O₂ content in the bag assuming a VO₂ work rate of 1.25 LPM. We were very careful during our dives not to exert ourselves because we knew that an increased work rate of 1.75 LPM would give us only 22% O₂ in the bag. This would clearly change our MOD and more importantly our no stop times. It was suggested to us that we should use a flow rate 5.7 LPM and not the 10.4 LPM jet to avoid the amount of bubbles being expelled from the relief valve. The 5.7 LPM jet proved to be suitable for our diving knowing that if there was a shortage of O₂ in the bag the flow rate the dosage unit incorporating lung demand valve would inject more O₂ if necessary.

We looked at two examples which are shown below and decided with much deliberation to use the second example which made more sense to us both and our instructor. We found it difficult to comprehend that we are expected to estimate our work rate in the water prior to the dive. A far safer method is to consider purchasing an O₂ analyzing gauge which attaches to the breathing bag and accurately monitors the O₂ in the bag and therefore giving you your PPO₂ level. This way it would eliminate any doubt as to the limits of the re-breather.

Both Draeger Dolphin users found the first two dives challenging. Getting the weight right and its distribution proved a little troublesome. On the first two dives we chose to buddy an experienced diver on open circuit as a precaution. On the third dive we were comfortable enough to dive together, which paid dividends when it came to tagging sharks and taking photographs of the marine life. Of the 15 tags deployed 11 were attached by those with either a closed circuit or semi closed circuit re-breathers.

Before each dive we calculated our decompression penalties for planning our dives and also our CNS and UPTD to ensure we were within our limits.

Major Andrew Reid did have a problem with the mouth piece which made diving a little uncomfortable but this was soon remedied by moving the counter weights on the inhalation and exhalation hose to the rear.

On the final day of diving it was necessary to revert back to open circuit because the *Undersea Hunter* ran out of Soda lime. The transition was straight forward but it became very apparent to both Draeger users the benefit of a semi closed circuit re-breather in terms of quiet operation and reduced bubble production.

Overall we were very pleased with the Draeger Dolphin SCCRB and would use them more often given the chance. It would have been beneficial if an O₂ analyser had been incorporated into the re-breather.

EXAMPLE 1

Select dive site depth. = **35m**

Select optimum nitrox for planned max depth. MOD taken from the mix in the cylinder.

PPO₂ = 1.40

Mix in the cylinder = **46 % EAN**

Calculate optimum flow rate. Add 25% safety margin

$$= \frac{160 \text{ (constant)} + 25\%}{(\text{FO}_2 - 20)}$$

$$= \frac{160}{46 - 20} + 25\%$$

$$= \frac{160}{26} + 25\%$$

$$= 6.15 + 25\%$$

$$= 7.7 \text{ LPM}$$

$$= \textbf{Required black jet at 10.4}$$

LPM

Estimate expected work rate during the dive = 1.25LPM

Calculate the FO₂ expected in the breathing bag. Ensure that VO₂ is above 21%.

$$\begin{aligned} \text{Cylinder FO}_2 &= \text{FO}_2 \text{ as a decimal} \\ \text{Flow rate} &= \text{LPM} \\ \text{VO}_2 &= \text{estimated work rate} \\ \frac{(\text{Cylinder FO}_2 \times \text{Flow rate}) - \text{VO}_2}{(\text{Flow rate} - \text{VO}_2)} &= \frac{(0.46 \times 10.4) - 1.25}{10.4 - 1.25} \\ &= \frac{3.534}{9.15} \\ &= 0.386 \\ &= 38.6 \% \\ &= \mathbf{39 \% \text{ in the bag.}} \end{aligned}$$

MOD = 26 metres.

Recalculate the FO₂ using worst case work rate. Ensure that VO₂ is still above 21%.

$$\begin{aligned} \frac{(\text{Cylinder FO}_2 \times \text{Flow rate}) - \text{VO}_2}{(\text{Flow rate} - \text{VO}_2)} &= \frac{(0.46 \times 10.4) - 2.5}{10.4 - 2.5} \\ &= \frac{2.284}{7.9} \\ &= 0.289 \\ &= 28.9 \% \\ &= \mathbf{29 \% \text{ in the bag.}} \end{aligned}$$

Calculate max expected duration of main cylinder.

Litres available: 200 Bar x 3 litres = 600 litres

Minus reserve: 50 Bar = 150 litres

Minus intermediate pressure of 17 bar x 3 litres = 51 litres

Usable air = 399 litres

Flow rate: = 10.4 LPM

Duration: = **38 minutes**

Calculate EAD for planned depth.

$$\begin{aligned} \frac{(1 - \text{FO}_2) \times (\text{Depth} + 10) - 10}{0.79} &= \frac{(1 - 0.39 \times 35 + 10) - 10}{0.79} \\ &= \frac{(0.61 \times 45) - 10}{0.79} \end{aligned}$$

$$\begin{aligned}
&= (0.772 \times 45) - 10 \\
&= 24.7 \\
&= \underline{\underline{25 \text{ metres EAD}}}
\end{aligned}$$

EXAMPLE 2

- Select dive site depth. = 35m
- Select optimum nitrox for planned max depth. MOD taken from the mix in the cylinder.
- PPO₂ = 1.40
- Mix in the cylinder = 46% EAN
- Flow rate used = 5.7 LPM black jet at used
- Estimate expected work rate during the dive. = **1.25LPM**
- Calculate the FO₂ expected in the breathing bag. Ensure that VO₂ is above 21%.

$$\begin{aligned}
&\text{Cylinder FO}_2 &= & \text{FO}_2 \text{ as a decimal} \\
&\text{Flow rate} &= & \text{litres/minute} \\
&\text{VO}_2 &= & \text{estimated work rate} \\
&\frac{(\text{Cylinder FO}_2 \times \text{Flow rate}) - \text{VO}_2}{(\text{Flow rate} - \text{VO}_2)} &= & \frac{(0.46 \times 5.7) - 1.25}{5.7 - 1.25} \\
&&= & \frac{1.372}{4.45} \\
&&= & 0.308 \\
&&= & 30.8 \% \\
&&= & \underline{\underline{31 \% \text{ in the bag.}}}
\end{aligned}$$

Recalculate the FO₂ using worst case work rate. Ensure that VO₂ is still above 21%.

$$\begin{aligned}
&\frac{(\text{Cylinder FO}_2 \times \text{Flow rate}) - \text{VO}_2}{(\text{Flow rate} - \text{VO}_2)} &= & \frac{(0.46 \times 5.7) - 1.75}{5.7 - 1.75} \\
&&= & \frac{0.872}{3.95} \\
&&= & 0.2207 \\
&&= & 22.1 \% \\
&&= & \underline{\underline{22 \% \text{ in the bag.}}}
\end{aligned}$$

Calculate max expected duration of main cylinder.

Litres available: 200 Bar x 3 litres = 600 litres
 Minus reserve: 50 Bar = 150 litres
 Minus intermediate pressure of 17 bar x 3 litres = 51 litres
 Usable air = 399 litres
 Flow rate: = 5.7 LPM
 Duration: = **70 minutes**

Calculate EAD for planned depth.

$$\begin{aligned}
 & \frac{(1 - FO_2) \times (\text{Depth} + 10) - 10}{0.79} = \frac{(1 - 0.31 \times 35 + 10) - 10}{0.79} \\
 & = \frac{(0.69 \times 45) - 10}{0.79} \\
 & = (0.873 \times 45) - 10 \\
 & = 29.3 \\
 & = \mathbf{\underline{30 \text{ metres EAD}}}
 \end{aligned}$$



Semi-Closed Circuit Re-Breathers.



Sgt Gareth Thomas checking his Closed Circuit Re-Breather.

SCIENTIFIC REPORT

1. **Tagging Equipment.** The equipment discussed below was used to tag hammerhead sharks during the expedition. If an opportunity had been presented to tag a whale shark, the same general equipment would have been used; specific differences have been indicated in the paragraphs below.
2. **General Arrangement.** Sharks were tagged using a 3-band spear gun, firing a modified spear incorporating a 'tag applicator' tip. The applicator held a stainless steel barb which was attached to the tag; EX JURASSIC SHARK deployed both satellite and radio tags. The radio tags could be detected by either a fixed receiver or a portable hydrophone.
3. **Spear Guns.** The Expedition used two 4D46T 'Magnum' spear guns, manufactured by JBL Enterprises Inc, Orange, California, USA. This model can be disassembled for transport in purpose-made case. The component parts were as follows: a barrel split into 2 pieces, one including the trigger mechanism and the other 3 rubber firing bands; a rubber butt plate; a spear tether, approximately 5m long incorporating a rubber shock absorber and a stainless steel slide to fit over the spear; a spear in 2 parts that screwed together, using PTFE tape for added security. To prevent salt-water corrosion, both guns were rinsed in fresh water after every dive.
4. **Improvised Spear.** During the early phase of the Expedition, one of the spears was lost. It was believed that the tether had become caught around a sharp piece of rock or barnacle; when the tether was pulled to recover the spear, the tether was cut. The spear was lost at around 30m towards the end of a dive when most of the divers had already started their ascent. A search was not possible immediately, and prevailing weather conditions prevented the Expedition members from returning to the site for several days. Consequently, the spear was never recovered. However, the Undersea Hunter's mechanic modified an old spear held on board (without its spear gun). This work included welding in a section of stainless steel rod to make the spear the correct length and providing a tethering slide to fit over the spear; despite his best endeavours, the spear proved unreliable, losing power quickly and not travelling straight. It was used to tag a few sharks, but a great deal of luck was needed in addition to the operator's skill. It is recommended that at least one spare spear is provided with each spear gun on future expeditions. In addition, for the remainder of the expedition, spears were recovered after firing by swimming to them and carefully disentangling the tether from the sea bed, rather than simply pulling on the tether.
5. **Applicator Tips.** Two sizes of applicator tips were manufactured by a machine shop to specifications provided by the SRI. The smaller tips were approximately 120mm long, designed to penetrate through the skin and into the muscle just below a hammerhead's dorsal fin; they carried a barb approximately 35mm long. The whale shark's skin was considerably thicker than that of a hammerhead, requiring an applicator tip approximately 200mm long and carrying a barb 45mm long. Consequently, only one firing band was needed to tag hammerhead sharks, whereas all 3 would have been used for a whale shark. It was essential that the barb lodged in the animal's muscle tissue. Had it penetrated just the skin, the shark's natural defence

mechanisms would have slowly rejected the barb, just as the human body will slowly force out a splinter in the skin.

In addition to the applicator tips, a barbed, hollow needle had also been manufactured for the SRI, in order to gather tissue samples from whale sharks. As the Expedition did not encounter a whale shark closely enough to tag, the sampling needle was never used. However, the loss of the spear and subsequent local manufacture of a replacement described above led to an incompatibility between spears and applicator tips. Whilst not insurmountable, this reaffirms the requirement for future expeditions to provide spare spears with every spear gun.

6. **Damage to Tips.** During tagging, experience showed that the applicator tip was bent on almost every use. The degree of bending depended on the angle from which the tagger fired the spear gun and the shark's subsequent reaction. However, straightening the tips induced fatigue and the tip snapped on several occasions. Whilst the Undersea Hunter's mechanic was able to weld the 2 parts together, the repaired tips were not as robust as the originals and repeatedly failed. It is recommended that future expeditions provision applicator tips at the ratio of one tip to every 3 tags, and ensure their support vessel has the capability to weld stainless steel.

7. **Tags.** The Expedition deployed 2 different types of tag: radio tags and satellite tags. Each was crimped to a barb by a piece of 3/32" plastic-coated stainless steel wire; the length of wire was commensurate with the species of shark and the depth of skin penetration required.

8. **Satellite Tags.** Five scalloped hammerhead sharks (all females) were tagged around Cocos Island, Costa Rica, with PTT-100 archival pop-up satellite tags (Microwave Telemetry, Columbia, MD). These tags are designed to archive temperature and pressure readings and record time of sunrise and sunset for subsequent geo-location calculation. Tags are rated to withstand 3000psi (2000 m) and have an optional pressure initiated pop-off feature to allow the tag to pop off and start transmitting if it descends below a predetermined depth or remains at a constant depth over a predetermined length of time. The tags that were used in this study had preset attachment intervals of 10 days (one tag), 30 days (three tags), and 120 days (one tag). Sex of the animals was determined from the absence of claspers (the male sexual organs), and total length of the animals was estimated to be 1.8–3.0m. After pop-up, data will be transmitted through the Argos satellite system. ARGOS DCLS earth orbiting satellite system provides autonomous, daily, global locations for monitoring wildlife (Argos 1996). The system consists of two operational TIROS-N satellites in low-Earth (830-870 km), near polar orbits with on-board radio receiver and transmitter units, a series of Earth-based receiver stations, several Earth-based Global Processing Centres (GPCs) and a radio-frequency transmitter (commonly known as Platform Transmitter Terminal or PTT) attached to the host animal.



Physical Specifications for Pop-Up Tag

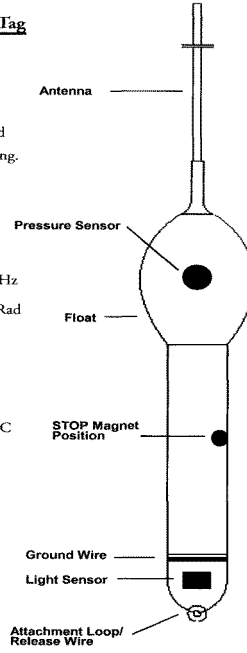
Dimensions: L 13.3" x 1.6" dia.
Weight: 65 to 68 grams
Pressure rating: 3000 psi
Antenna: Hard nylon coated flexible stranded marine grade stainless steel, 8.5" (216mm) long.

General Electrical Specifications

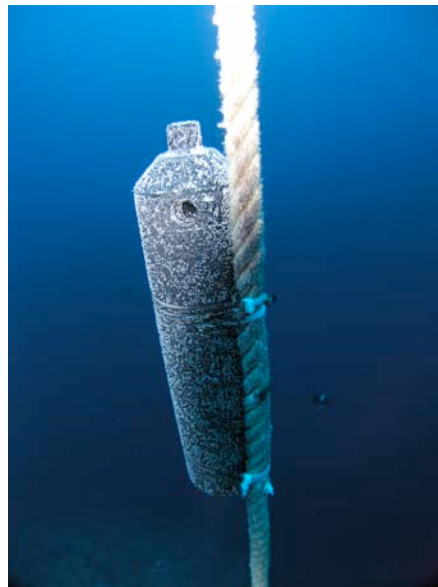
Operating frequency: 401.650 MHz ± 36 kHz
Modulation Tri Phase PSK: ± 1.1Rad ± 0.1Rad
Quiescent current: 3µA
Spurious emissions: -45 dB
Transmission interval: 45-90 sec.
Operating temperature range: -15 +45 Deg C
Temperature sensor range: 0 to +35 Deg C

Sensors

The Archival Pop-Up tag comes complete with sensors to measure temperature, light level, pressure and its own battery voltage.

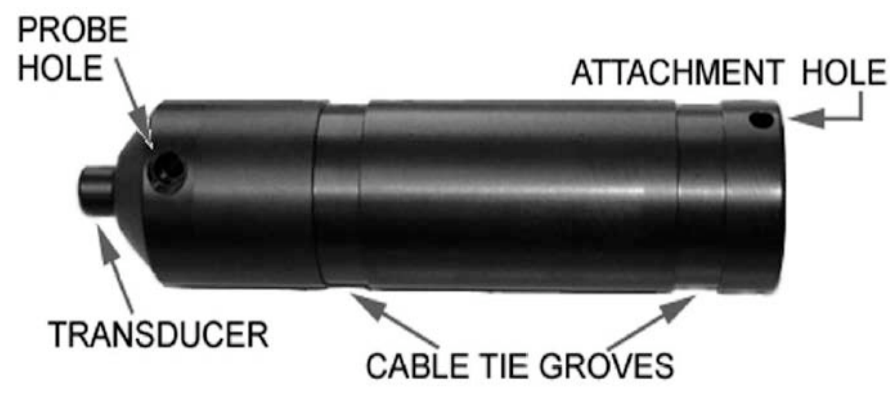


9. **V16 Coded Transmitter.** “Coded mode” V16 tags send acoustic ping trains that are infrequent and random between a pre-specified range. This ping train includes an ID number which permits identification of the specific tag. For applications such as site residency studies and automated monitoring of migrations, coded transmissions are desirable because of significantly increased battery life and the large number of tags that can be used on the same frequency. In this study, the V16 tags were being used to determine the residency of *Sphryna lewini*, the Scalloped Hammerhead Shark.



Left: A selection tags and receivers used on the expedition. Right: Receiver underwater.

10. **VR2 Submersible Receivers.** The VR2 is a submersible, multi-channel acoustic receiver capable of identifying VEMCO coded transmitters, which in the case for this study are the V16 coded transmitters. The receiver can decode up to 256 different coded telemetry transmitters and up to 65536 coded pingers. The receiver is housed in a corrosion resistant cylindrical plastic high pressure case, and incorporates an integral transducer at one end of the case. The VR2 features include a Smart LED, one megabyte of data storage, a resume study feature, and a replaceable battery (a single Lithium cell). The VR2 records the pinger code number and date/time for each valid detection. This information is stored in memory until downloaded from the receiver using a VR PC interface and an IBM/PC/AT computer running the VR2PC software.



The VR2 Submersible Receiver.

11. **Visual Tags.** As part of the SRI's 'Operation Whale Shark' initiative, the Expedition also prepared visual tags bearing a unique registration number. These were to be attached to whale sharks once they had been fitted with a satellite tag and a tissue sample had been taken. As the Expedition did not encounter a whale shark close enough to tag, the visual tags were not employed.


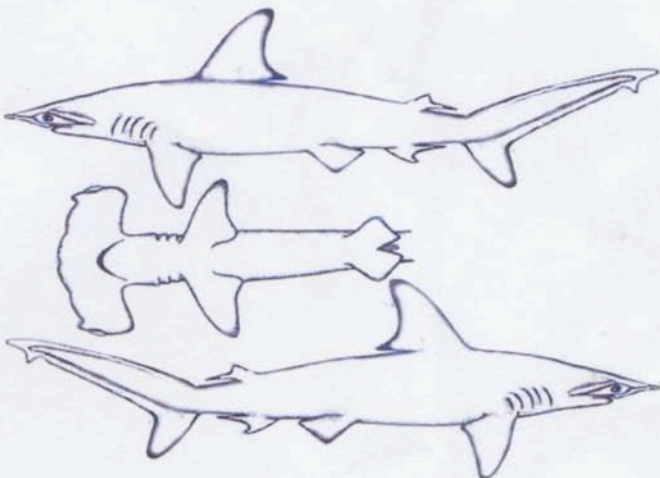
12. **Tag Attachment Methodology.** To minimise stress, we deployed tags without catching the animals. Sharks were encountered on specific dive sites where they are known to come to because of "cleaning stations." Here the animals come in close to the site for cleaner fish (barber fish and king angel fish) to make contact who proceed to pick off any parasites on the sharks skin. The tag was driven into the dorsal musculature below the first dorsal fin using a spear gun. The tag used was a JBL Travel Magnum Spear gun. For the satellite tags, the full tag setup consisted of the pop-up satellite tag unit, a monofilament line, and a double barbed stainless steel anchor. The radio tag setup was similar, but instead of using monofilament line, coated stainless steel tethers were used. Custom made tag applicator spear tips were made in order to accommodate the stainless steel anchors. The JBL gun has three rubber bands. This study only required the use of one of the rubber bands, which provided enough power to insert the tag 10 cm into the shark. The tag was attached just below the dorsal fin into the musculature of the shark.

13. **Tagging Officer's Report.** Tags were distributed on a dive by dive basis, this was important because each tag, both radio and satellite, has an on/off switch activated by a small magnet. To activate the tag the magnet must be removed prior to tagging. If the tag was not deployed, it was very important to put the magnet back on the tag to deactivate it hence not wasting any of the battery life giving us maximum data return when the tag was eventually deployed. A table was drawn up by Wtr Evans who issued the tags throughout the expedition. The table required the person using the spear gun to

sign out the tag, note their team and the date on which they were signing on. It was then their responsibility to sign back in the tags to Wtr Evans on completion of the dive. If the tag was deployed then the tag was simply crossed out and the word 'TAGGED' would be noted underneath. An example of the table used is below:

Radio Tag	Signed Out	Signed In	Signed Out	Signed In
30XX	Sgt Thomas Blue Team 9/7/06	Sgt Thomas Blue Team 9/7/06		
30XX TAGGED	Maj Reid Yellow Team 9/7/06	TAGGED	TAGGED	TAGGED
Sat Tag	Signed Out	Signed In	Signed Out	Signed In
69XX	Sqn Ldr Edmondson Yellow Team 9/7/06			

14. **SRI Data Collection Form.** All tagged sharks were recorded on the following form:

 SCALLOPED HAMMERHEAD SHARK STUDY DATA COLLECTION FORM	
Support Vessel: _____ Captain: _____	Country/Island: _____ Date: _____ Time: _____ GPS: _____ Location (Describe surroundings - on surface, on bottom, etc.) _____ Size of shark: _____ Sex of shark: _____ Notes: (Describe scars & markings. Mark any unusual scars on the sketch below) Attach photo if available.)
<p style="text-align: center;">SURFACE DATA</p> Air temperature: _____ Cloud conditions: _____ Wind direction & strength: _____ Barometric Pressure: _____	
<p style="text-align: center;">SUB-SURFACE DATA</p> Visibility: _____ ft. (measured or estimated) Water Temperature Bottom: _____ Surface: _____ Chemistry: _____ Current Direction: _____ to _____ Strength: _____ Waves Height: _____ Strength: _____ Water depth: _____ Depth shark encountered: _____ Swimming direction: _____ Environmental conditions: (reef, plankton, schooling fish)	
<p style="text-align: center;">PHOTO/VIDEO</p> U/W Photos by: _____ _____ U/W Video by: _____ _____	
<p style="text-align: center;">REPORT COMPLETED BY:</p> Name: _____ Contact Info: _____ _____	<p style="text-align: center;">TAGGING INFORMATION</p> Visual ID Tag # _____ Tagger: _____ Date: _____ Satellite Tag # _____ Tagger: _____ Date: _____ CHAT Tag # _____ Tagger: _____ Date: _____ Tissue Sample# _____ Vials # _____ Date: _____ Name of shark: _____
	<p>BEHAVIOR OF THE SHARK</p>
	43

**ANNEX I TO
JURASSIC SHARK PXR
DATED 01 DEC 06**

TAGGED SHARKS

Ser (a)	Date (b)	Location (c)	Depth (d)	Type of Tag (e)	Sex (f)	Size (g)	Tagged by (h)	Remarks (i)
1	06 Jul 06	Small Dos Amigos Rock	30m	Radio	Female	3m	Sgt Thomas	Spear Lost Re-breather
2	06 Jul 06	Manuelita Island (West side)	21m	Satellite	Female	3m	Sgt Thomas	Re-breather
3	06 Jul 06	Small Dos Amigos Rock	18m	Radio	Female	2.5m	PO Paris-Hunter	Re-breather
4	07 Jul 06	Alcyone	26m	Satellite	Female	3m	Sgt Thomas	Re-breather
5	07 Jul 06	Alcyone	26m	Radio	Female	3m	Sgt Thomas	Re-breather
6	07 Jul 06	Alcyone	26m	Radio	Female	1.8m	Maj Reid	Spear Tip Snapped. Tag all the way through the shark. Re-breather
7	08 Jul 06	Dirty Rock	28m	Radio	Female	2.8m	Cpl Badham	Open Circuit
8	08 Jul 06	Dirty Rock	22m	Satellite	Female	1.5m	Sgt Thomas	Spear Tip Snapped Re-breather
9	09 Jul 06	Small Dos Amigos Rock	25m	Radio	Female	3m	Sgt Thomas	Re-breather
10	09 Jul 06	Small Dos Amigos Rock	25m	Radio	Female	3m	Sgt Thomas	Re-breather
11	10 Jul 06	Alcyone	26m	Radio	Female	2.5m	WO1 Bartholomew	Open Circuit
12	10 Jul 06	Dirty Rock	33m	Radio	Female	2m	Cpl Badham	Open Circuit
13	10 Jul 06	Alcyone	28m	Radio	Female	2.5m	WO1 Bartholomew	Open Circuit
14	11 Jul 06	Punta Maria	25m	Satellite	Female	2.5m	Randall Arauz	Open Circuit
15	11 Jul 06	Alcyone	30m	Satellite	Female	3m	Dr Antoniou	Re-breather. Tagged through the dorsal fin.

HYDROPHONE OFFICER'S REPORT

Introduction

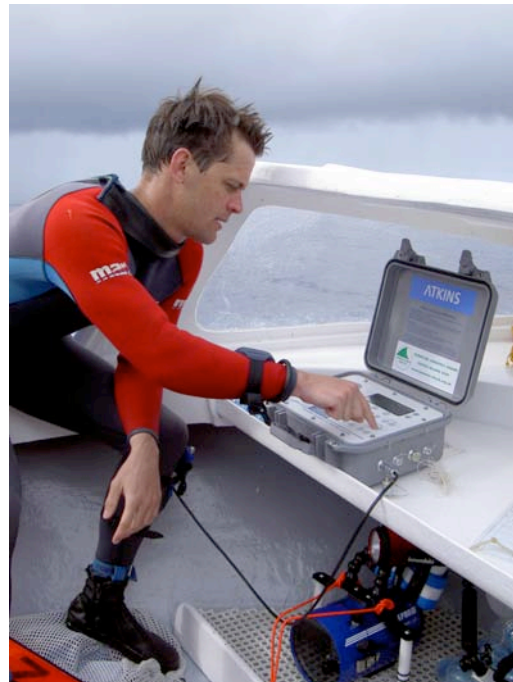
1. Having tagged the Hammerhead sharks, an equally important task is the gathering of data produced by the radio tags. This report summarises the equipment used and how it was implemented.

Equipment

2. Three pieces of equipment were used on EX JURASSIC SHARK: radio transmitter tags, submerged receiver with VR PC (Computer Interface) and portable hydrophone receiver. These were all procured from VEMCO, a leader in the design and manufacture of oceanographic research tools.



The hydrophone.



The hydrophone in use by Sqn Ldr Stuart Edmondson.

Methodology

3. Each of the 10 radio transmitters were activated in turn and a VR2 receiver used to confirm that each transmitter emitted the correct 'ping'. The VR2 receivers were attached to a mooring line, approximately 4m in length, with a 20 Kg lead weight at one end and a buoy at the other. The above two VR2 receivers were then deployed at dive sites where Hammer Head sharks are known to congregate, at a depth of 30m. The team members of EX JURASSIC SHARK also recovered two VR2 receivers that had been deployed in Jul 05, to download the data using the VR PC (Computer Interface), and then they were re-deployed. At the conclusion of EX JURASSIC SHARK there

were now 4 submerged receivers monitoring the coast of Cocos Island. The VR2 receiver logs the date and time whenever it detects the transmission from a radio transmitter tag in the close vicinity; this includes any tags that have been attached to sharks elsewhere in the world that appear at the receiver site. This data is then useful in assessing the migratory patterns of Hammerhead Sharks to and around Cocos Island, including daily times for when the sharks arrive and depart from the coastal waters around the island.

Portable Hydrophone Receiver (VR100)

4. Features.

- General-purpose ultrasonic receiver.
- Contained in hardened, splash-resistant case (400mm x 300mm x 200mm).
- Software based digital processing and controller functionality.
- Detects coded tags on 8 separate frequencies simultaneously.
- In-built GPS facility.
- 9 hr re-chargeable battery life.
- Detectors: Omni-directional hydrophone and directional hydrophone.

5. Configuration. Before the hydrophone could be used it had to be configured to detect the radio transmitters being used. Therefore, one of the 8 channels was set to 69 kHz. Furthermore, a number of radio transmitters were then activated to confirm that the hydrophone detects each of them correctly in turn.

6. Deployment. Having tested its functionality and tagged some of the hammerhead sharks, the hydrophone was deployed, using the omni-directional hydrophone, on one of the Undersea Hunter's skiffs every dive throughout the expedition. Prior to entering the water it would be switched on and the omni-directional hydrophone lowered into the water for a few minutes. Any radio transmitters that were in the vicinity could be heard over the receiver's speakers. The receiver would then decipher the 'pings' and display the transmitter serial number. The date, time and GPS location is automatically logged every time a tag is detected. This would then be repeated after the dive. Over the 7 days of diving the hydrophone recorded a significant amount of data, providing information covering the movement of Hammerhead Sharks around Cocos Island, which will be downloaded onto computer and analysed by SRI at a later date.

7. Use. In the evening, having completed diving for the day, a small team would board one of the skiffs with the hydrophone receiver and head out to one of the locations where Hammerhead Sharks had been detected during the day. Firstly, with the omni-directional hydrophone connected, the team would confirm that a tagged shark was in the vicinity of the boat. Then the directional hydrophone (attached to a wooden pole and held over the side) would be connected to confirm the direction of the shark relative to the boat. By moving the boat and rotating the directional hydrophone the team were able to continually work out the location of the shark, thereby 'tracking' it into the night and proving that they move out into open water at night.

8. Improvements. A suggested improvement is to permanently attach the hydrophone to one of the MarViva vessels that patrol the marine protected zone around Cocos Island. This would rapidly generate a large amount of useful data that would be invaluable in establishing the movement of Hammerhead Sharks around the island,

rather than only collecting a limited amount of data on the infrequent short SRI visits made to the island.



The hydrophone team operating at night.

Conclusion

9. The deployment of the 10 radio transmitters on Hammerhead Sharks on EX JURASSIC SHARK has been a huge success and will hopefully provide SRI with some extremely useful data in the future. The addition of 2 more submerged receivers will further assist in the gathering of data on the movement of Hammer Head sharks around Cocos Island. Furthermore, EX JURASSIC SHARK has provided SRI with its first portable hydrophone receiver. This has also collected some invaluable data on the movement of the sharks around the Island. However, its full potential could be realised if the portable hydrophone receiver was fitted (loaned) to one of the MarViva patrol vessels.

**ANNEX K TO
JURASSIC SHARK PXR
DATED 01 DEC 06**

SHARK SPECIES IDENTIFIED AROUND COCOS ISLAND

Ser	Common Name	Scientific Name	Description	Size	Habitat, Behaviour and Biology	Abundance	Team Sighting
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1	Whale Shark	<i>Rhincodon typus</i>	Dark blue-gray to brown with a pattern of large white spots and lines above, fading into white below; three ridges along sides of body. Broad, flat head with small eyes just behind wide, terminal mouth. Unmistakable. Largest of all fishes.	Average 4 – 12 m (13-40 ft) Max 13.7 m (44.5 ft)	Occurs inshore and over deep water, from the surface to at least 240 m (800 ft). Swims with its mouth open feeding on zooplankton, squid and small fish.	Most often seen at Dirty Rock and Manuelita.	One sighted at Dirty Rock, a short video recording captured by LCpl Kelvin Prevett. Size 3.5 – 4 m max.
2	Silvertip Shark	<i>Carcharhinus albimarginatus</i>	Conspicuous white tips and trailing edges of all fins. Stocky body, dark gray above, white below.	Average 0.7 m (2–7 ft) Max 3 m (10 ft)	Most often observed along outer reefs and blue water near rocks and pinnacles. Usually solitary or in small groups. Feeds on fishes, including small sharks, eagle rays and octopus. Usually shy; reported attacks on divers when injured fish were present.	Most often observed at Silverado, periodically at other sites	2 sighted at Silverado. Video footage recorded by Maj Mark Foster. Largest of the two 3 m
3	Silky Shark	<i>Carcharhinus falciformis</i>	Sloping first dorsal fin begins behind rear tips of pectoral fins; tips of fins dusky. Body dark gray to	0.6 to 3.5m (2 -11ft)	Most often observed along outer reef slopes and in blue water near rocks and	Occasionally; most often observed in open water or	2 sighted one at Alcyone, the other at Manuelita. Video footage recorded by

Ser	Common Name	Scientific Name	Description	Size	Habitat, Behaviour and Biology	Abundance	Team Sighting
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
			gray brown above, white below.		pinnacles; also in blue water from the surface to 50 m. Solitary and in small groups. Feeds on fishes, squid, and pelagic crabs, yellow fin tuna, rainbow runners, bottlenose dolphins and brown boobies. Curious, will make a close pass at divers.	off sea mounts.	Maj Mark Foster. Largest 3 m
4	Galapagos Shark	<i>Carcharhinus galapagensis</i>	Moderately large first dorsal fin begins above inner margin of pectoral fin; tip pointed to somewhat rounded. Body brownish grey above, white below.	0.6 to 3.7 m (2 – 12 ft)	Occurs both close to islands and off shore; from the surface to 50 m. Solitary and in small groups and aggregations. Feeds on fishes, squid and octopi. Curious and bold; may closely approach divers repeatedly. Known to attack divers.	Uncommon ; observed at Dirty Rock and Manta Corner	A number sighted at Dirty Rock and Punta Maria. Video footage recorded by Maj Mark Foster. Largest 3m
5	Black Tip Shark	<i>Carcharhinus limbatus</i>	Prominent black tips usually on all fins except upper lobe of tail. Posterior edge of first dorsal fin and tail often black ; anal fin white. Large first dorsal fin, with pointed or sharply rounded tip. Snout as long as width of mouth.	0.6 m 2.5 m (2 - 8ft)	Often seen inshore, near mouths of rivers, and along reef drop offs; adults also occur offshore. Feeds primarily on a variety of fishes, rays and squid. Feeds with	Uncommon, Dirty Rock Dos Amigos and Manuelita	Sighted by Dr Alex Antoniou at Dos Amigos. Video footage captured by Alex Antoniou. Size 1.5 – 2m

Ser	Common Name	Scientific Name	Description	Size	Habitat, Behaviour and Biology	Abundance	Team Sighting
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
			Body grey or grey-brown above, white below and shaded white band on side of body		silky sharks, yellow fin tuna rainbow runners bottlenose dolphins and brown boobies. Bold will circle divers at very close range.		
6	White Tip Reef Shark	<i>Triaenodon obesus</i>	Conspicuous white tips on first dorsal fin and upper lobe of tail; second dorsal fin and lower lobe of tail sometimes with white tips. A slender shark with a blunt head, grey-brown above shading to whitish below. Extremely short broad snout.	0.6m at birth to over 2m (2 ft – 7ft)	Often observed resting on the bottom on rocky reefs, boulder areas and in caves. Often in groups. Most active at night. Large groups have been observed swimming in place in strong currents. Feeds on small fishes, octopi and crustaceans. Large groups have learned to follow divers at night, opportunistically feeding on prey illuminated by divers' lights. Will approach at close range. Considered harmless, but has bitten divers when harassed.	Abundant - the most common shark at Cocos Island	Continuously sighted at all dive sites. Captured video footage by Maj Mark Foster and LCpl Kelvin Prevett.
7	Scalloped Hammerhead Sharks	<i>Sphyrna lewini</i>	Head broad and hammer-shaped with anterior notches. First dorsal fin begins above or slightly	Max 4.2 m (14 ft)	Congregates in schools near seamounts and costal islands. Schooling	Common; large schools most often observed	Sightings at most dive sites. Large schools spotted at Dos Amigos, Dirty

Ser	Common Name	Scientific Name	Description	Size	Habitat, Behaviour and Biology	Abundance	Team Sighting
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
			behind base of pectoral fin. Tips of pectoral fins dusky to black. Body grey-brown above, white below.		believed to be associated with mating. Feeds primarily on a variety of fishes (sharks, reef fishes, rays, batfish), as well as squid, octopi, shrimp, crabs, and lobsters. Shy and difficult to approach.	below thermocline in cooler water and strong current . Alcyone, Dirty rock, Dos Amigos, Manuelita and Sharkfin Rock.	rock, Manuelita and Alcyone. Video footage recorded by Maj Mark Foster and LCpl Kelvin Prevett.

WEBSITE AND COMMUNICATIONS REPORT

References:

- A. TELENOR Data Application - Configuring dial up internet access (Document Number: 2003INMC072103-4 Issue: 1.01), dated 30 July 03.
- B. NERA Worldphone User Manual (Document Number: QLZB 911084 Rev.B1 11/00).

Introduction

1. The EXERCISE JURASSIC SHARK website was created for promotional and sponsorship purposes. In addition to this it was utilised as an information portal for expedition members and other external bodies. Because the modern world relies so heavily on up to date information it was decided that the website should be updated whilst the expedition was deployed. To do this in such a remote location such as Cocos Island, satellite technology had to be used as no other means of communicating with the outside world is available.

Aim

2. The aim of this document is to show how the basics of the site were set up along with useful satellite phone/data communication setup tips.

Domain Name

3. A domain name is a unique web site address which can be purchased from various companies on the World Wide Web (WWW); the exercise name was used as the basis of the website domain name hence, www.jurassic-shark.org.uk was created.

4. The domain name was purchased via www.just-the-name.co.uk; however there are many domain name providers on the market. The reasoning behind using this company was past experience of their customer services and their excellent domain name masking service.

Masking

5. Domain name masking is a means of disguising a web address; the reason EX JURASSIC SHARK utilised this service was on a cost basis, paying for web space can be costly and most Internet Service Providers (ISP) provide a free web space for their subscribers; however, using this free service normally means you have to use their domain name. As this free service was used but a unique name was required the Expedition needed to use masking.

Webspace

6. Web space is a space provided on a server/computer system where data can be stored and viewed on the WWW. There are many companies that provided this service which is more commonly known as hosting, however this too can be costly. As described above many ISP provide a free hosting service; Exercise Jurassic Shark used the free service provided by NTL Ltd from one of the expedition member's personal NTL account.

Website

7. The website was created six months prior to deployment; as with all websites it is a living document and will be continually updated post expedition. It was created for free by one of the expedition members using Macromedia Dreamweaver 8, Macromedia Flash 8 and Adobe Photoshop CS(2) on an Apple MAC G5, however most modern PC over the last few years will be more than adequate for most applications. The content was created by the expedition webmaster in consultation with the expedition leader. Other relevant websites were also used for some of the site content. Whilst deployed on the expedition the web site was updated utilising satellite email services back to the UK where a non expedition member kindly updated the website on the expedition's behalf. The website was updated this way due to the very slow connection speed when using the Nera Worldphone which is described in more detail within the satellite phone section.

8. Note: Flash content was kept to a minimum due to Flash not working correctly on the Defence Information Infrastructure (Current) (DII(C)) and it is more memory intensive for WWW users, thus slowing down their viewing experience. When Defence Information Infrastructure (Future) (DII (F)) rolls out, this problem should be rectified.

Satellite Services

9. The TELENOR Satellite Services communications (<http://www.satellite-email.com/>) was used for email back to the UK via a laptop and satellite phone, this service was used as it has been optimised for low-bandwidth Inmarsat terminals unlike most other ISP. To use the e-mail service, the user must first create an e-mail account on the registration page available at <http://www.satellite-email.com>. When registering, the user will choose a user ID and password for the new e-mail account.

Note: It would be advisable to set this up before deploying into the field.

10. Unlike other services, Telenor Satellite Services' Internet Access is tailored to work with the rather narrow bandwidth that the Inmarsat terminal offers. Other advantages include:

- No registration or subscription fee for Internet access through Telenor's Land Earth Stations (LES).
- Direct access to the Internet backbone via a Telenor LES, offering the highest level of quality and accessibility.
- Free e-mail account and no subscription fee, plus an easy-to-use mail account interface.
- All e-mail registration pages have been optimized with regard to design and with a minimum of graphics to reduce download time.

11. No extra charge for airtime when you use **Short Code 28** for Internet and e-mail access. Standard prices are used.

Note: Short code setup is described in full at Ref: A.

12. A land earth station is simply a point on land where the satellite transmits to before onward transmission.

Satellite Phone



13. The Army adventure training group (ATG) kindly provided a Nera Worldphone (satellite phone). For voice calls this phone is more than adequate; however for data calls it turned out to be problematic, due to the extremely slow connection speed; at 2.4kbps it is approximately 23 times slower than a normal dial up modem. Because of this it was decided not to use the satellite phone to update the web site directly, it was felt that it would be far too time consuming and costly; it also had the potential to corrupt the website.

Left: LCpl Prevett uploading the daily diary to the website by satellite phone.

Satellite Phone Connection Whilst Deployed

14. As mentioned earlier, the satellite phone was more than adequate for voice calls, however it was extremely slow when connecting to the WWW; once connected it was usable as long as the connection was not dropped (cut off). On occasions it took approximately 15minutes to connect to the WWW and then some times dropped out and the user would have to start all over again. It was also necessary to reboot (restart) the laptop on numerous occasions as it would not recognise the satellite phone.

Laptop

15. The laptop used in conjunction with satellite phone was a standard Pentium 3 laptop running Windows 2000 (Windows XP would be just as suitable). To enable the laptop to talk to the satellite phone it was essential to load the correct driver. The driver was not supplied with the phone, but sourced from the WWW. The driver needed was downloaded from the Telenor website (www.telenor.com). The driver used was mdmnera.inf, however Neraw2k.inf will work as well. Ref: A explains in full how to set up a laptop for connection to the internet via a Nera Worldphone (satellite phone).

Additional Equipment

16. Additional equipment used was a USB to Serial (9pin) converter with a Serial (9 pin) female to male cable as the laptop did not have a Serial (9 pin) port which is needed to connect to the satellite phone and a surge protector/multi extension lead was also used.

Note: Modern satellite phones may not need this cable as they may well have a more modern connection.

Website

17. This report was not intended to describe how to build a web site, should additional information be required please contact the author of this report.

Satellite phone/laptop connection

18. Some basic configuration is necessary. Configuration instructions can be obtained from Ref: A and Ref: B. these manuals explain how to set up a modem and a Dial-Up Connection on your PC, and how to configure Internet Explorer and Outlook or Outlook Express. After configuration has been completed, just dial Short Code 28 and you will gain access to the Internet. No password or user ID is required for this service as long as the Telenor service is used.

Note: It was necessary to change the land earth station of the phone to Telenor 01 or 04, as in the supplied state BT 02 the connection was far too noisy for data communication.

Finance

19. The total cost of the website and communications equipment was £47.96 to date; however, this does not include the satellite phone bill as this was not known when this report was compiled. The total cost consisted of:

- a. Domain name purchase - £9.99 (two year subscription).
- b. Domain Masking purchase - £11.99 (yearly subscription).
- c. USB to Serial (9 pin) converter - £17.99 (one off purchase).
- d. Serial (9 pin) male to female cable lead - £7.99 (one off purchase).

Additional Communications

20. The boat was equipped with VHF radio, satellite telephone and email service; it was hoped that the Undersea Hunter communications on board would be the cheapest and easiest way of updating the website via email back to the UK, however, this was not the case as it was not serviceable; it was possible to make voice calls, however the cost were comparable to the satellite phone supplied by ATG so this method was little used by the expedition members.

Summary

21. The EXERCISE JURASSIC SHARK website has proven to be a very successful tool for advertising the expedition and also goes some way to helping with sponsorship, should an expedition wish to update a website in the field again it would be advisable to use a NERA World Communicator satellite phone (this recommendation is only current in 2006; 2007 will see the release of a newer improved models) as this will provide a far superior connection speed.

K D PREVETT
Lance Corporal
Expedition Webmaster and Communications Officer

MEDIA HANDLING PLAN

Issue

1. EXERCISE JURASSIC SHARK is a Joint Service diving expedition taking place between the 2nd and 15th July off the Pacific Coast of Costa Rica. The expedition is being organised by Directorate General Training and Education in conjunction with the Shark Research Institute. Fourteen military and civilian staff will electronically tag 13 Hammerhead Sharks and provide scientists with evidence on their habits and distribution, in order to protect species of Hammerhead Shark.

Key Aims of the Strategy

2. To maximise coverage of EXERCISE JURASSIC SHARK, in all sections of the media, before and during the exercise, in order to achieve the MOD's objectives. Media handling of the expedition will raise awareness of MOD environmental activities and acting as a force for good in the world, and demonstrate the skill and value of the Armed Forces and MOD civilians.

Background

3. The expedition to the Cocos Island, 535km off the Pacific Coast of Costa Rica enjoys sponsored status from the Joint Services Expedition Trust (JSET) and has been approved by the Royal Geographical Society. The team will consist of 4 RAF Officers, 4 Army, 1 TA Reservist, 1 Royal Marine, 3 Naval Officers and Other Ranks, and one Civilian.

4. Pre-expedition training will take place at Fort Bovisand, Plymouth on the 10-11 June. The team will then leave the UK on the 2 July to live aboard the *Undersea Hunter* off the Cocos Islands for 10 days (including travel to the island), where they will undertake their work. The successfully tagged hammerheads can then be monitored and their distribution tracked.

Objectives

5. To encourage maximum support and involvement for the expedition locally, and to raise awareness of the contribution the Armed Forces can make to the marine environment. Little is known about the migratory habits of hammerheads and this exercise will demonstrate the skill and contribution of the Armed Forces among marine conservation groups and the diving community. The exercise will also illustrate adventurous training opportunities available to both Regular and Reserve forces to aid recruitment.

Handling

6. The DPT will gather material for all media. This will involve material from Fort Bovisand this weekend and the regular series of telephone interviews during the

expedition. Underwater photography will be provided by the expedition team to supplement copy.

Internal Communication

7. The team consists of members from all Services, including Reserves and Civilians, and is an excellent opportunity to demonstrate interoperability amongst the Defence community.

8. Editorial and stills photography will be supplied to the MOD Internet and Intranet, Focus and all Single Service publications.

9. Audio will also be provided to MOD Internet documenting the progress of the exercise.

10. Stills and copy will also be provided to SaBRE highlighting adventurous training opportunities for Reserve Forces.

External Communication

11. The South West Regional Press Office will arrange a local media opportunity at Fort Bovisand for the regional broadcast and print media. Also available will be an internal MOD news team from the defence press office in the South West so that expedition members can be interviewed about their forthcoming mission.

12. Regular telephone interviews with the expedition team will be conducted by DPT Audio (Heidi Mines) and marketed to regional radio stations, special interest radio programmes and the Guardian Unlimited Podcast. Should appropriate underwater video be sought, there may be an opportunity to provide a small video file to supplement a Podcast feature for the Defence Internet.

13. Marine conservation and diving magazines will also be targeted specifically with specialist copy and stills photography.

PRESS RELEASE



MINISTRY OF DEFENCE

defence NEWS

Issued by: **Directorate General Media & Communication**
Defence Press Office South West, Room 2/14,
Naval Base Headquarters, Building MO49, HM Naval Base,
Plymouth, Devon PL2 2BG

133/06

8 June 2006

DIVERS TRAIN IN THE SOUTH WEST TO TAG SHARKS

A tri-Service and civilian team of divers is heading a daring scientific expedition to electronically tag the Hammerhead Shark off the volcanic Cocos Island, off the Pacific coast of Costa Rica.

The sailors, soldiers and airmen are preparing for their environmental challenge by training at the MoD sub-aqua diving centre, Fort Bovisand near Plymouth.

The expedition is led by Major Andy Reid (Army), who said: "An expedition such as this is all about experiencing controlled exposure to risk with the aim of developing the kind of leadership, teamwork, courage and co-operation that is vital to military operational capability. Beyond that Exercise Jurassic Shark forms part of an important conservation project, which exploits the skills of a Joint Services team to best effect. Sharks are in dramatic decline around the world and this is our chance to make a difference by establishing those parts of the shark's habitat that most need protection."

The sharks will be tagged with radio transmitters while the shark is swimming freely by divers using spear guns. The sharks are known to enter a trance-like state whilst being cleaned by smaller fish at 'cleaning stations' along the reef, enabling the divers to get close enough to place a tag through their dorsal fin. The tags will send signals to receivers and therefore, track the movements of the sharks. This research will help determine migratory routes. The information is needed to better protect the Cocos Island National Park and inform the scientific basis for the Eastern Pacific Tropical Seascape Initiative, which seeks to extend the protection given to this part of the Pacific.

The Cocos Island National Park is a UNESCO World Heritage site and the work is of international environmental importance value, underlining the value placed on the

quality of military training and of the experience of personnel. The Armed Forces are dedicated to both adventurous training as a developmental activity and to stewardship of the environment.

The fieldwork expedition is carried out under the direction of the Shark Research Institute (which works to correct misconceptions about sharks and to stop the slaughter of 100 million annually) and is approved and supported by the Royal Geographical Society.

end

EXAMPLES OF MEDIA COVERAGE/REPORTS

- *Dive Magazine* Oct 06
- *Soldier Magazine* Sept 06
- Shark Focus (Shark Trust's Magazine).
- Plankton Forum: 'Successful Shark Research Expedition to Cocos Island, Costa Rica' and '15 more sharks tagged.'
- SRI: 'The Return of Jurassic Shark.'
- Sea Turtle Biology and Conservation (CTURTLE): 'Successful Shark Research Expedition.'
- Undersea Hunter: 'Exercise Jurassic Shark Project and Trip Report.'
- Focus Magazine Aug 06: 'Up Close and Personal With Sharks.'
- Defence News and Defence Net – 'The Return Of Jurassic Shark – 15 Of Them!'
- TV Coverage BFBS – 'A Daring Tri-Service Diving Expedition.'
- PRETOMA – 'Successful Shark Research Expedition to Cocos Island, Costa Rica.'
- BBC News: 'RAF Pilot In Shark Diving Mission.'
- BBC News: 'Marine's Underwater Shark Mission'
- DLO News: 'Andover Man Goes To Jurassic Shark' (Page 56).
- McCabe Wordpress - Divers Train In The South West To Tag Sharks
- The Shark Research Institute Website: Expeditions Section
- Scubaboard: 'Divers Go To Depths Of Pacific To Tag Sharks.'
- Wrecks and Reefs: 'Marine And RAF Pilot's Shark Mission.'
- Defence News (Mod Web): 'Divers Go To Depths Of Pacific To Tag Sharks' (Audio)
- This Is Bristol: 'Diver Aims For Shark Tagging First!'
- Western Daily Press: 'Diver Kenny To Play Game Of Shark Tag!'
- BFBS Radio- 1420hrs on 29th June 2006
- BBC Radio Dorset 'Drive Time' @ 1745 Hrs on Friday 09 June 2006
- Royal Navy: 'Divers Train In the South West To Tag Sharks.'
- This Is Cornwall: 'Divers Train In the South West To Tag Sharks.'
- This Is Plymouth: 'Diving With The Sharks.'
- The Extra Series: Thursday 15 June 2006.

EXPEDITION DIARY

02 Jul 06 (by Lt Cdr Fleisher)

The first day of EXERCISE JURASSIC SHARK started at around 0300hrs for most members of the team, as travelled to Gatwick Airport for the 0630hrs check-in. Despite the sadness caused by England's unfortunate exit from the World Cup finals, the team members, representing each of the Armed Forces, successfully managed to negotiate the first hurdle - jointly checking in a myriad of diving equipment (including re-breathers), underwater video cameras and personal effects. By 0930hrs Continental Airways flight 35 was in the air for the first leg of the expedition's 24-hour journey to San José in Costa Rica, via Houston.

The first flight was a 10-hour transatlantic crossing to George Bush International Airport in Houston, where everybody was greeted with Texan drawls of "have a nice day" accompanied by a breathtaking display of American immigration efficiency (2-hour wait complete with fingerprint and iris scans just in case there were any undetected terrorists or criminals in the party). Luckily, Maj Reid had factored this into the timings and team members were able to meet and greet their 14th member, Dr Antonio of the Shark Research Institute.

By 0630hrs (but feeling like 0030hrs on 3 Jul 06 to our tired bodies), the expedition members were off on the second leg, flight CO 1499 to San José, Costa Rica. The relative opulence and leg room of the previous Boeing 777 had been replaced by cattle truck-like conditions of an aged Boeing 757 for the 3-hour hop to the Central American mainland.

Upon arrival in San José, and after fighting their way through a barrage of airport baggage handlers, the expedition members finally managed to arrive at their accommodation for the first night, 15 minutes away from the airport.

03 Jul 06 (By Lt Cdr Fleisher)

After a refreshing night's sleep trying to combat the inevitable jet lag combined with the row coming from a pre-war air conditioning system, the expedition met at 1100hrs for a 3-hour bus journey to Puntarenas on the Pacific Coast of Costa Rica to board *Undersea Hunter*, the Expedition's base for the next 10 days. Costa Rica is nestled between Nicaragua to the North and Panama to the South but according to our enthusiastic bus driver boasts very high levels of literacy, low levels of unemployment and is politically very stable. The drive involved breathtaking views of volcanic mountains on the Caribbean side topped with lush, verdant vegetation. On the Pacific side, the view took in coffee and tropical fruit plantations together with a never-ending stream of articulated lorries carrying goods by road from one end of the Panama canal to the other using the Pan American Highway.

At the end of the journey, the group was dropped at a jetty in the port of Puntarenas to board a skiff for the 15-minute boat ride to *Undersea Hunter*. After a brief introductory

talk by the boat's senior Dive Master, David, members of the Expedition quickly set about getting their personal effects and dive equipment stowed for the 36-hour passage to Cocos Island. The accommodation consisted of 2-berth cabins with Maj Reid bravely volunteering to share a double bed with the expedition doctor and lead cameraman, Maj Foster (although the boat's crew subsequently re-jigged the accommodation plot to provide Maj Reid with his own cabin). At the same time, personnel started jostling for position in the race to be awarded the accolade of wearing the 'hat' for instances of absolute buffoonery in the service of improving the Expedition members' collective morale.

04 Jul 06 (By Flt Lt Palmer)

A full night's sleep was enjoyed by most of the Expedition members as *Undersea Hunter* made her way Westwards on the 36-hour crossing to Cocos Island. It was a very long way! With jet lag still affecting most people a majority were awake by 0500hrs; however, it was obvious that some people enjoyed their rest more than others, especially Flt Lt Mark Tillyard, who finally crawled up to breakfast 90 minutes late, claiming that it was all his cabin-mate's fault.



After breakfast, the team gathered to receive instruction on tagging equipment from Dr Antoniou. WO1 McDonald was late for the brief, as he had misplaced \$300 since departing the hotel in San José and his Scottish nature was busy tearing luggage apart in a desperate attempt to locate the cash. After the introduction to the equipment, the team divided into smaller groups to assemble and test the tagging gear.

The 10 radio transmitters destined to track the hammerheads were connected to barbs by steel wire by Lt Cdr Fleisher, Flt Lt Palmer and Sgt Thomas. Additionally, 2 Archival Pop-Up Tags were attached to barbs for hammerhead sharks, whilst 3 more were joined to larger barbs for attachment to whale sharks. The Quality Assurance team was introduced a little late during this process, resulting in much muttering from Sgt Thomas and unwrapping of 'Gorilla' tape from the barbs.



Concurrently, the radio receivers were loaded with fresh batteries by Flt Lt Tillyard, Cpl Badham and WTR Evans, and functionality between the transmitters and the receivers was tested by Sqn Ldr Edmondson and WO1 McDonald. Meanwhile, the 2 spear guns were assembled by POA(SE) Paris-Hunter and LCpl Prevett. These weapons appeared to have arrived from the set of Dr Who and would have petrified Cybermen, let alone 13 Servicemen.

Left: Learning about and preparing the tags (despite seasickness).

Whilst this flurry of activity ensued, Maj Foster stuck his camera lens rampantly into various faces and activities, recording all for posterity. Maj Reid diligently directed the day's events and certainly did not state that he had done 'nothing' throughout the day.

A superb lunch punctuated the tagging activities, and by mid afternoon, with all tasks completed and heavy rain outside, the film *Jurassic Park* was shown. Finally, WO1 McDonald received the news that the money he had lost in Puntarenas had been found. Words could not describe his joy! Day 3 of the Expedition, and the team still hadn't reached Cocos Island. As the sun set, the steady beat of the *Undersea Hunter's* engines continued to push the team gradually towards the 'Island of the Sharks'.

05 Jul 06 (By WO1 Bartholomew)

The ship's company started work extremely early at 0430hrs; their operation of the boat's crane to launch the 2 diving skiffs disrupted the sleep of many. The expedition personnel rose early, with most on deck by 0530hrs and extremely keen to go diving. Nerves were evident as individuals constantly checked their equipment. The loud, jovial banter soon tailed off (for about 10 seconds) and small congregations gathered in huddles to swap previous shark experiences. Tips on shark behavioural patterns and species to avoid were discussed in great detail.

At 0700hrs we had breakfast. It was astonishing how LCpl Prevett managed to be first in line for all the meals and snacks throughout the week! LCpl Prevett was heard to say "my figure is extremely difficult to maintain, and it took a lot of effort to get this large". Apparently it was as a result of an allergic reaction to fish when he was a young boy, causing his body to swell up!

Prior to the first dive, Wilson (one of the dive guides) gave a full dive brief. This included tips such as ideal points to view the sharks from, divers' behaviour in order not to scare the sharks away and other pertinent safety points. This was followed by Maj Reid thoroughly briefing all personnel on the forthcoming dive plan and aim.



Flt Lt Matt Palmer cleaning an encrusted radio receiver.

The first dive of the expedition consisted of 2 teams sailing a short distance by skiff to the Bajo Manuelita dive site. This was the only time that both skiffs (Yellow carrying 8 divers and Blue carrying 7) went to the same site together; future dives were to be at separate locations to minimise environmental impact and increase the chance of tagging sharks. The aim was to allow all divers to test and adjust their equipment, and conduct a shake down dive to check buoyancy. A maximum depth of 20m was allowed with a total dive time of 60 minutes (mins). All of the divers saw an abundance of white tip reef sharks and an array of other marine life that a diver would be lucky to experience on a 2 week expedition to the Red Sea. All the divers tested their equipment and made minor adjustments to it upon return to *Undersea Hunter*. The boat was absolutely buzzing with the excitement of the first dive and the prospect of things to come.

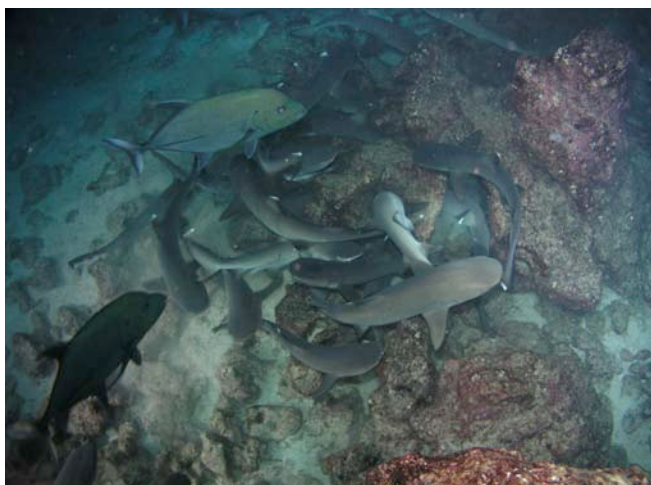


For the second and third dives, the Blue team sailed approximately 10 mins from *Undersea Hunter's* initial anchorage at Bahia Chatham to Dirty Rock, whilst the Yellow team had a short sail to the western side of Manuelita. The aim of both dives was to retrieve the VR2 radio receivers that had been placed some 6 months earlier by a previous SRI expedition. This would allow the Dr Antoniou to download and analyse stored data on shark movements. The Yellow team was successful in doing so but, unfortunately, the Blue team didn't have the strength to fight the current. Nonetheless, during their attempt they sighted a school of 40-50 hammerheads. The Yellow team also sighted a small school of 15 hammerheads.

Left: Sqn Ldr Stuart Edmondson deploying a receiver.

During the afternoon, the teams swapped dive sites. The Yellow team hoped to recover the VR2 radio receiver that the Blue team had failed to retrieve. They were successful in doing so, much to the jovial disgust of the Blue team. This was the first time the divers deployed with the spear guns, and although both teams encountered hammerheads, they were unable to tag them. The hammerheads did not enter the cleaning station, but continued to remain on the periphery. During the third dive, divers adopted a stealthier position behind the rocks, hoping the hammerheads would move into the cleaning station, allowing the spear gun diver to ambush the shark and tag it. Unfortunately this wasn't to happen straight away.

That evening, a night dive was conducted at the previously visited Bajo Manuelita with the aim of the dive being to witness the white tip reef sharks feed. During their dive, the divers shone their torches in the same direction to blind the fish, presenting the fish as easy prey for the hundreds of circling sharks. The divers were swimming approx 1-2



White Tip Reef Sharks at night.

meters away from the feeding frenzy which was extremely fast, furious, and exciting. On return to *Undersea Hunter* everybody was buzzing with excitement and went into a frenzy of discussion about how many sharks they had seen.

Shortly after dinner, Dr Antoniou delivered a lecture about varying shark species in the Eastern Pacific and the risks posed to them by industrial fishing techniques. This brief underlined the importance of the expedition's task.

06 Jul 06 (By POA(SE) Paris-Hunter and Sgt Thomas)

The day started early for the team and the *Undersea Hunter's* crew as the ship changed anchorage from Chatham Bay to Wafer Bay 3 nautical miles away. Sprits were high and the first dive brief of the day was thorough, as usual. Both boats were manned in a timely fashion and set off to the dive sites at Large and Small Dos Amigos.

The Yellow (the dive team were split into Blue and Yellow teams) skiff headed to Large Dos Amigos whilst the Blue boat steered for the smaller of the 2 islands. Whilst both teams hoped to see large numbers of sharks, both were to be disappointed. The oceanic current caused a great deal of surge and both teams encountered conditions of washing machine-like proportions. However, and to the Yellow team's delight, they had a brief encounter with a Galapagos shark.

During the day's second dive, POA(SE) Paris-Hunter, supported by the Yellow team, was successful in tagging a female hammerhead, despite the prevailing surge and conditions that were far from ideal. Maj Foster was on-hand to record the event on video. The Blue team was also successful in tagging a hammerhead, but unfortunately lost their spear in the process; this loss was to have a significant impact on the Expedition's capability to tag sharks for the remainder of the week. To try to mitigate the loss, Mora (*Undersea Hunter's* engineer) fabricated a replacement from an old spear found on board.

After lunch, the Yellow team deployed a receiver on the site at Dirty Rock, and then encountered a huge shoal of Bigeye Jacks as they conducted their safety stop at 6m. Sgt Thomas with the Blue team was successful in tagging a hammerhead with a satellite tag; Dr Antoniou later confirmed that this was the only hammerhead fitted with such a tag in the Eastern Pacific, which should yield extremely valuable results.

07 Jul 06 (By Sqn Ldr Edmondson)

For most of the expedition's personnel, the morning started with the sound of *Undersea Hunter's* engines starting at 0630hrs, as Captain Alcocer returned the ship to its former anchorage at Chatham Bay. Whilst the ship motored round, one of the skiffs headed for Alcyone, the most famous dive site at Cocos Island (discovered by Jacques Cousteau), to assess the conditions. Fortunately, all was well and subsequently half the team headed off for their first dive at Alcyone, with the remainder diving Submerged Rock off the south-eastern coast of Cocos Island.

Alcyone surpassed all the team's expectations, with a large number of hammerhead sharks. Furthermore, Sgt Thomas tagged 2 sharks; one with a radio tag and the other with a satellite tag. The dive ended with an extended safety stop as the team sighted a pod of dolphins and a number of large Wahoo (a sleek fish very similar in appearance to a Barracuda). Whilst Submerged Rock had plenty of shark activity, none of them were successfully tagged. This was possibly due to that team using the replacement spear and post-dive analysis revealed that its tether point required modification; Mora successfully completed this in time for the second dive.

The 2 teams swapped location for the second dive. Alcyone, once again, provided a fantastic dive and another shark was added to our growing list, tagged by Maj Reid. Unfortunately, Submerged Rock did not provide a suitable opportunity to test the modified spear.

Having set up the hydrophone the previous evening, it was put to good use and taken to Alcyone on the second dive. Whilst it detected the radio transmitter being carried by the divers, it did not detect the shark tagged on the first dive. Furthermore, just before the team left the dive site, it did pick up a transmitter that was dropped during the previous year.



The final dive of the day saw the Yellow and Blue teams going to Silverado and the western side of Manuelita respectively. Silverado is famous for its sighting of silver tip sharks and did not disappoint. Within minutes, a 2m-long silver tip swam within in a few metres of the divers. Having only just got over their excitement, the team got the experience of a life-time, as a 3m silver tip appeared out of the gloom and then spent 20 mins circling the team, sometimes as close as 2m. Just before the end of the dive, the team spotted a rare Red-Lipped Bat fish and an inquisitive silver tip joined the audience, bumping into Flt Lt

Palmer. Meanwhile, the team at Manuelita saw 2 Green Turtles and a Manta Ray.

At the end of an excellent day's diving, Sqn Ldr Edmondson and Flt Lt Palmer headed to shore on a kayak. Having trawled the beach's rocks, looking at the numerous inscriptions left by sailors over the last 2 centuries, they discovered an engraving on one of the rocks made by the crew of Jacques Cousteau's vessel *Alcyone*.

8 Jul 2006 (By WO1 McDonald)

Saturday 8 July 2006, our fourth day of diving and it is still raining! So far we have not seen a bright sunny start to a diving day and conditions are not looking as if they would improve, I suppose that is why it is called adventurous training.

The first dives of the day would see the blue team head to Dirty Rock and the yellow team making the trek around the east side of the island to Alcyone. The day did not start well when we returned to the seamount to find that the hammerheads were not coming in close enough to tag and that the receiver still could not be found. Sea conditions were not ideal and currents had picked up making it difficult to stay near the cleaning stations in both locations but especially at Alcyone. Always looking on the bright side the Blue team commented that they at least had a most exhilarating drift dive at their location.

Time for the second dive saw little change in the conditions at Dirty Rock however surface conditions subsequently deteriorated at Alcyone to the point where the Blue dive team were unable to dive this site and had to re-route to Isla Manuelita. It was beginning to look as if neither team would tag a shark today; however, this changed when a shark was tagged with a radio tag in the first minute of the second dive by the yellow team. This was the first shark to be tagged by a diver using open circuit SCUBA equipment and also the first to be tagged by a member of the RAF, no competition there then! All three Services have now tagged sharks, and with conditions on the water starting to improve the whole atmosphere changed and there was cheerful banter between not only the different services but also between boats.

The third dive of the day saw the Blue team return to Dirty Rock with the Yellow Team diving at Viking Rock a small outcrop on the west side of the island guarding Wafer Bay. The return trip to Dirty Rock was a huge success with a third satellite tag deployed late

in the dive by the Blue team, bringing the total number of tagged sharks to eight. In addition, a few members of the team were lucky enough to see a Manta Ray and a Whale Shark. Seeing these animals is an once-in-a-lifetime experience but WO1 McDonald managed to leave the lens cap on his camera and therefore missed the opportunity to photograph the Whale Shark. At least he has the memories of this amazing animal as do the rest of the expedition following a blow by blow account of the encounter. A final anecdote to the day was summed up when Dr Antoniou asked WO1 McDonald if the Whale Shark was a male or female to which he replied "That's the last place I was looking, I just saw the size of its head and mouth....that kept my attention".

The improvised replacement spear was still found to be veering off course despite the new collar and has yet to be used to successfully tag a shark. The day finished with a presentation by Randall Arauz (President of PRETOMA – the local conservation group with whom we are carrying out this research project) on shark finning and the impact of fishing on endangered marine species. This presentation had a profound impact on the team and underlined the importance of tracking the movements of Hammerhead Sharks. Tomorrow we hope to organise a search for the spear lost earlier on the expedition in order to bring the second spear gun into full working order. It is also vital that we locate and download the data from the receiver on the seamount before the end of the expedition, as this has been in location for a year and is where most of the sharks have been tagged. Maybe just maybe it will stop raining tomorrow?

09 Jul 06 (By Wtr Evans)

After a good night's sleep the Expedition woke up to another of Chico's hearty breakfasts prior to mustering and preparing their kit ready for the diving ahead. Following briefs by the dive masters, David (Blue team) and Wilson (Yellow team) the skiffs headed out for Small and Large Dos Amigos, both of which had proved to be prolific for hammerhead sightings. Conditions at Large Big Dos Amigos proved challenging and there were relatively few sharks in comparison to previous dives. The current was extremely strong and when a turtle couldn't keep up with it, the dive was aborted. The Blue team, diving Small Dos Amigos managed to tag 2 hammerhead sharks with radio tags.

In comparison to conditions at Dos Amigos, the second dive at Dirty Rock for Yellow team was considered to be the best of the week. There were hundreds of hammerhead sharks with most were arriving at a cleaning station although some were drifting through catching a ride with the steady current. Once on the surface, the hydrophone was deployed and used to track a shark previously tagged during the Expedition.

Once both skiffs had returned from diving for the day, a small team of Expedition members, including Maj Reid, Sqn Ldr Edmondson, Flt Lt Palmer, WO1 McDonald and Dr Antoniou, went out in one of the skiffs with the hydrophone to see if they could track any of the sharks tagged on this trip. This proved to be most successful as 2 sharks tagged at Dos Amigos were successfully tracked.

10 Jul 06 (By Flt Lt Tillyard)

The weather on EXERCISE JURASSIC SHARK's penultimate diving day again rendered the risk of sunburn negligible. The last wave of the previous day had badly violated the skipper's limit of departing by 1500hrs, so to ensure the expedition had plenty of daylight the first wave of the day was ready to depart by 0700hrs. This meant

an early start with a light breakfast, and the promise that the chef would have a feast ready for the team's return.

The Blue boat's divers headed for Alcyone, where they found a stunning spectacle of hammerheads, a spiralling shoal stretching from the sea mount's summit towards the surface, worthy of the *Blue Planet*. WO1 Bartholomew starred by tagging 2 sharks, whilst on open-circuit SCUBA, rather than a re-breather (this definitely proves that patience is everything when tagging sharks). For an additional bonus, the team also recovered a receiver that had been positioned by a previous expedition. Badly encrusted with barnacles, Dr Antoniou would subsequently expend a great deal of effort cleaning it ready for re-deployment.

The Yellow boat headed back to one of the Expedition's most fruitful tagging grounds, Dirty Rock. Cpl Badham again achieved a coup for the open-circuit SCUBA divers using the welded spear. Despite the best efforts of *Undersea Hunter's* engineer, the spear had consistently tried to shoot around corners, making Cpl Badham's shot all the more remarkable. The team then headed north to a rock pinnacle, viewed an outstanding vista of marine life and then swam off into the blue to float with the oceanic current. A huge shoal of Bigeye Jacks hove into view, and soon encircled the divers. As the team ascended to carry out their safety stops, they were joined by a pair of inquisitive Wahoo and a few Needle Fish, amongst which could just be spotted a fleeting glance of a Dolphin.



Cpl Nick Badham takes aim.

The second dive simply involved the boats swapping locations; the Blue boat headed to Dirty Rock and the Yellow to Alcyone, though with the expedition now down to its last 2 satellite tags, neither group had any radio tags or carried a spear gun. The Blue group swam along the reef, watching the marine life and then headed out beyond the pinnacle to swim amongst a large shoal of jacks; this was almost certainly the same shoal encountered earlier by the Yellow group. Half the group also

spotted a Galapagos shark swimming below the shoal and commented that it focussed the mind, seeing such a large shark whilst swimming amongst its food!

The Yellow group quickly repositioned the receiver collected earlier by the Blue group, which had been cleaned by Dr Antoniou, and downloaded and re-initiated by Mr Arauz. Having been given a quick coat of anti-foul paint by Cpl Badham, POA(SE) Paris-Hunter returned the receiver ready to start collecting further data. Prior to entering the water, Sqn Ldr Edmondson lowered the hydrophone to identify whether any sharks that had been tagged before were still in the area; the processor immediately confirmed that a number of tagged sharks were in the vicinity, including those that had been tagged at locations other than Alcyone. The dive was characterised by the huge number of Hammerhead Sharks immediately obvious on the sea mount's main cleaning station. For much of the dive, the team simply lay on the rocks and watched a never-ending succession of sharks come into the cleaning station to be attended by the resident barber fish. In the clear water, there would have been many opportunities to tag sharks had there been sufficient remaining tags and spears. After being safely recovered to

the skiff, the group's usual routine was interrupted when José (the skiff coxswain) spotted a fishing boat about a mile out to sea from the dive site, clearly within the 12 mile limit imposed by the Costa Rican government. With encouragement from Mr Arauz, the skiff intercepted and photographed the vessel, collecting sufficient evidence (including a GPS position derived from the hydrophone processor) for PRETOMA's lawyers to pursue prosecution.

Both skiffs returned to *Undersea Hunter* at the same time as the sun made a fleeting appearance, and a series of eye-squinting team photographs were taken before Pipi sounded the bell for lunch. The usual stampede for food led by LCpl Prevett was delayed by the sighting of a whale in Chatham Bay, around 300m from the vessel's anchorage. The animal could clearly be seen spouting spray some distance into the air; its dorsal fin and distinctive back-arching movement confirmed it to be a humpback.

After lunch a small team made a brief trip to Cocos Island, paying a visit to the Cocos Island Rangers and a group of men arrested for suspected drug smuggling in a ramshackle fishing boat. It was noted that the state of the guard's AK-47 would not be tolerated in the British Army, though the prisoners clearly considered it to be sufficiently effective to dissuade and any attempt at escape.

After an extended surface interval, the Blue boat headed to Lobster Rock and the Yellow to the western side of Manuelita. Lobster Rock was a new site to the Expedition, and was considered unchallenging and relaxing; beyond a number of moray eels, the team found no marine wildlife of significant note. The team in the Yellow boat had a similarly benign dive, notable only for a brief glimpse of a speeding yellow-fin tuna and the sudden appearance of a large shoal of hammerheads which swam along the reef and vanished into the blue. The group ascended to carry out their decompression stop and drifted above a huge shoal of Bigeye Jacks; one of the team lowered his Delayed SMB reel into the shoal – the fish moved in harmony to form a swirling cauldron-shaped depression, just as they would avoid something more predatory than a weighted string.

A night dive had been considered as a final opportunity to witness the reef sharks hunting, but in light of the nitrogen-loading all the divers had built up during the previous week's activities, safety dictated otherwise. Instead, Sqn Ldr Edmondson led a small party in a skiff to search for tagged sharks using the hydrophone. By the time they reached their target area, the sharks had departed, confirming an assumption that sharks only remain around sea mounts during the day. During the night, they migrate to deeper water, hunting for squid and other prey outside the range of the hydrophone. While dinner was being prepared, the team relaxed, wrote up their dive logs and watched *Jurassic Park III* – the final chapter in the film trilogy that gave the expedition its name.

11 Jul 06 (By Cpl Badham)

The Expedition's last day of diving started early with both boats away at 0700hrs in a torrential downpour. The Blue boat headed to Punta Maria where the team encountered a large Galapagos shark as well as a small shoal of hammerheads, allowing Mr Arauz to tag his first shark. The Yellow boat headed to Alcyone, but there were fewer sharks there than on previous dives and none were tagged.

The second dive of the day saw the Blue boat going to Alcyone, where Dr Antoniou tagged his second hammerhead with a satellite tag. He fired it straight through the

dorsal fin - a perfect shot with the Expedition's last tag. The Yellow boat dived at Punta Maria with few hammerheads evident but there was a lot of other marine life.

The third and final dive of the day and also of the expedition saw the Blue boat dive at Silverado. This site was a rock sitting in 14m with a sea bed of sand and shale. Visibility was quite poor compared to previous dives with torrential rain on the surface which darkened the water. All these factors combined to give an eerie feel to the dive. After 20 mins, Sgt Thomas deployed a White Ensign for some photos and, at the same time, a 2m long Silvertip Shark appeared. The shark swam around the rock being cleaned by the resident cleaning fish for about 15 mins, giving a fantastic display and coming very close to the team. The team then started looking for a Red Lipped Bat Fish. We considered it to be the Duckbilled Platypus of the fish world, as it looked like a lizard's tail with a head on one end with big red lips and feet. The Yellow boat dived at Dirty Rock which was again quite gloomy due to the torrential rain on the surface which reduced visibility and scared the Hammerheads away.

At 1630 *Undersea Hunter* weighed anchor and set sail for the 36-hour passage back to Puntarenas, on the Costa Rican mainland.

12 Jul 06 (By Cpl Badham)

The team members woke up to a large expanse of open ocean, confirming that the journey home was well underway. Although spirits were high due to the trip's successes, there was a slightly subdued undertone as the expedition was coming to an end.

The day started with a welcome extra few minutes in bed but also to the realisation that the diving was now over. The boat was a hive of activity all day with the team working their way through the tasks to be completed; the few laptops that were brought out were in constant use as everyone frantically tried to finalise their reports, collate data and complete summaries. When VDU eye strain kicked in, the team packed equipment and enjoyed the sunshine! It appeared that now the expedition had left the "300 inches of rain a year capital of the world" it was finally to be blessed with a spot of sunshine to initiate the panic tanning process.

The journey homeward thus far has been a far cry from the outward leg with *Undersea Hunter's* motion being much calmer due to following seas and more favourable winds, which was a welcome relief to the sea sickness sufferers. As the day progressed, the dive kit strewn all over the deck to dry slowly disappeared into bags. All this activity was only halted when 3 dolphins entertained the expedition by playfully riding the bow wave of the boat, occasionally rolling onto their sides to check that they were still being watched.

The final evening meal was excellent and there was much discussion and debate on diving related issues, answering questions that had been thrown up by a few of the members of the team following a day of Advanced Diver lectures given by the BSAC Open Water and Advanced Instructors (Maj Foster, Lt Cdr Fleisher, Flt Lt Tillyard and Cpl Badham).

13 Jul 06 (By Lt Cdr Fleisher)

Undersea Hunter arrived back alongside in Puntarenas early in the morning but the Expedition were granted the luxury of a lie-in until breakfast at 0700hrs before saying

our final goodbyes to the crew who had been so helpful and friendly throughout the journey to Cocos Island and back. *En route* back to San José, the expedition members (minus Dr Antonio) stopped to visit the Costa Rican rain forest. After an exhilarating 2 hours in the lush, green trees in the tropical rain forest, the team departed for the final land phase of the journey home – the coach ride back to San José.

For the final evening, the expedition (including Dr Antonio and Mr Arauz) enjoyed a meal out together to celebrate their success in tagging 15 sharks and to lay the foundations for a possible follow-on expedition back to Cocos Island, Malpelo and the Galapagos Islands in 2008 to continue the work.



The team.

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**ANNEX R TO
JURASSIC SHARK PXR
DATED 01 DEC 06**

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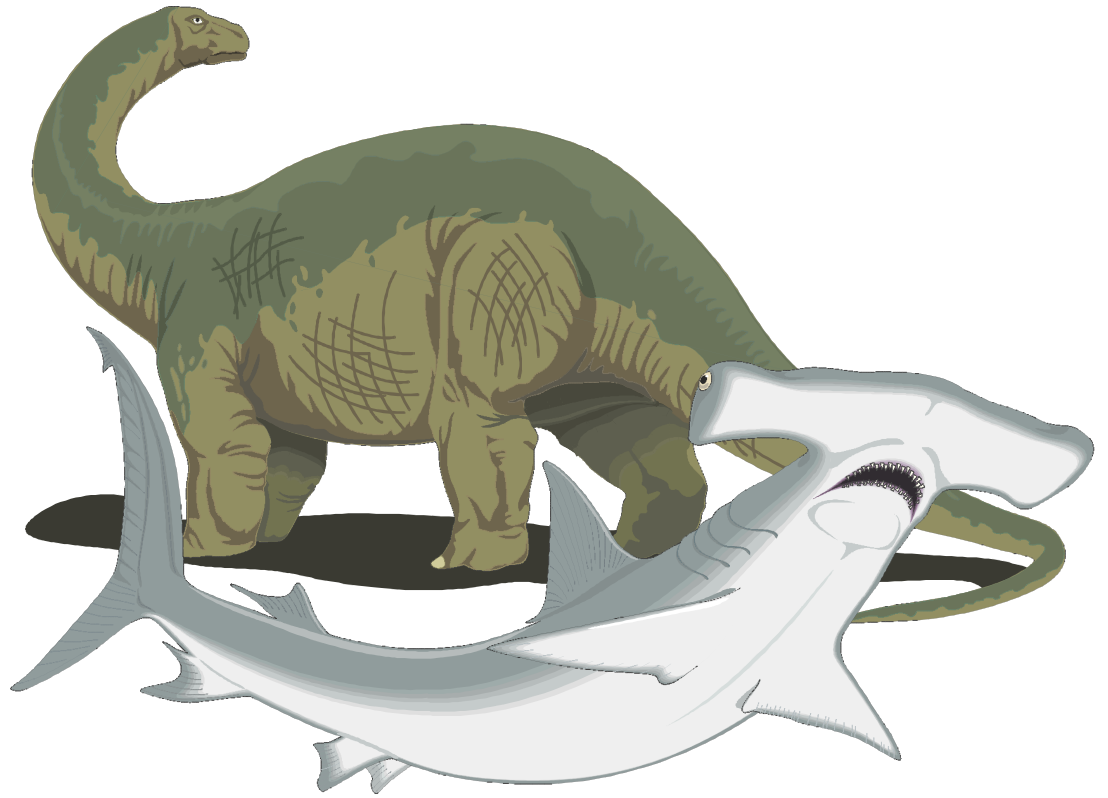
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Scalloped Hammerhead Shark



Major Reid with spear gun and re-breather.



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