

BLAST FISHING DETECTION AND MONITORING SYSTEM

1. INTRODUCTION

1.1 Understanding the Problem

Blast fishing is considered to be one of the most significant human threats to reefs in Southeast Asia. Blast fishing is also a significant management issue along parts of the East African coast. Since blast damaged reefs recover very slowly (e.g. Fox et al., 2003), this fishing technique is highly unsustainable because it destroys the life support system that underpins reef fisheries. In addition to the high environmental costs, there are high social costs arising from blast injuries inflicted during the manufacture and use of homemade explosives.

Underwater blasts cannot be easily heard in air as nearly all of the sound from the blast is reflected back into the water from the surface. Poor detection rates, large sea areas and low conviction rates all conspire to make the existing approach to enforcement ineffective. The lack of a real deterrent and high catch per unit effort makes blast fishing an attractive option, particularly in remote areas and areas where remaining fish stocks are less susceptible to conventional gears because of chronic overfishing.

Accurate assessment of the situation is extremely difficult because of the lack of an objective method for measuring incidence of blast fishing. Without such a tool it is difficult to focus resources in areas where the problem is concentrated, or to measure the degree of control that improved management exerts. Objective information of this sort is critical to improve the approach to management as well as raising awareness of the scale of the problem amongst the general public, government and the international community.

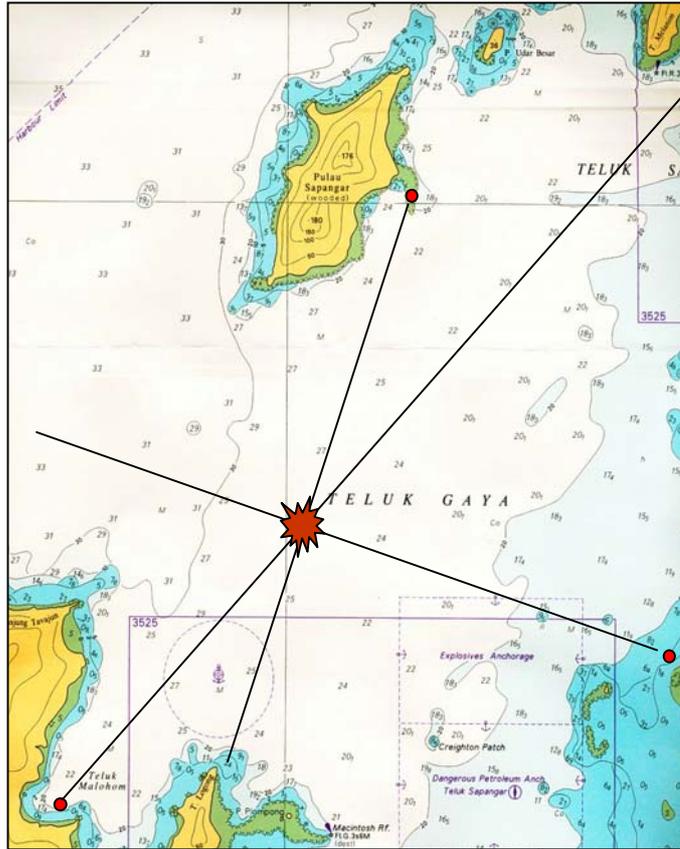
The main constraints to managing blast fishing are the lack of information about the scale of the problem, the lack of an effective deterrent, and the lack of feedback as to what sort of socio-economic intervention is required to remove fishermen from the blast fishery. The development of a device that can detect and locate blast events will make a significant contribution to removing all three constraints.

1.2 Technical solution to the blast rates and location problem.

Noise from underwater explosions travels rapidly underwater and is detectable at considerable ranges using hydrophones. Through a series of field trials conducted between 1999 and 2002, we have shown that blasts can be detected at ranges of tens of kilometers and are readily distinguished from background sounds such as snapping (alpheid) shrimp and propeller noise (Woodman et al., 2003). An automated detection system similar to that used in field trials offers the potential to detect blasts at ranges estimated to be more than 30 km, based on background noise measurements. With a range of 30 km, a single detector could monitor a sea area of up to 3000 square km. Shadow zones created by islands and other obstacles reduce this ideal figure, but it is clear that a modest number of well-placed detection systems can monitor large sea areas.

Work conducted in June 2002 for the Sabah Parks Authority demonstrated that an array of 3 hydrophones spaced one meter apart could determine the direction of travel of a blast wave to within a precision of 0.2° (paper in preparation, see Woodman *et al.*, 2003b and Knott 2003). Such an array mounted on a fisheries patrol vessel would improve detection while a network of shore mounted, directionally sensitive detection arrays offers the ability to locate blasts with high precision (a resolution of about 30 m at a range of 10 km) in real time, as shown in Figure 1.

Figure 1: Triangulation of direction data from 3 stations allows secure confirmation of a blast event.



1.3 Towards a solution

The development of a low-cost blast detection system suitable for use to combat the blast fishing problem in the long term requires partnerships between stakeholders, NGOs, governments and the private sector. The first step is to develop the existing technology, which has a proven scientifically-sound track record, and produce a single prototype detection system to be tested in the field. This project aims to complete these requirements using a 2-month development phase and 1-month field trial phase. The project has been designed to deliver outputs that will promote future development and investment. It has also been designed to minimize costs as far as possible: existing hardware from previous field trials, and the blast detection software that has already been developed will be used as the foundation to build a robust prototype that can be deployed from a boat. The same team members and host country counterparts that have worked on development and the most recent field trials are included in this project team.

Due to the constraints of budget and time, there are insufficient resources available to construct a number of detection systems in order to demonstrate the capability of pinpointing individual blasts that a network offers. Nevertheless, a single detection system operating from a patrol boat will demonstrate the capabilities of the system to provide immediate warning of blast activity and determine the precise direction from where the blast came, as well as an estimated range. The next step of using a network of detectors will form a future project.

2. LINKAGES TO THE ICRI FRAMEWORK FOR ACTION

The ultimate purpose of developing a tool to detect blast fishing is to assist governments and a wide range of other stakeholders in managing reefs in a sustainable way, in line with the objectives of Agenda 21 of UNCED, the Convention on Biological Diversity (Jakarta Mandate), UN Convention on the Law Of the Sea, and the FAO Code of Conduct for Responsible Fisheries, as well as numerous regional agreements (e.g. SEAFDEC).

Through the development of a new tool to address a number of major constraints to the management of destructive fishing, the outputs of this proposal contribute to three of the four main elements of the ICRI Framework for action (FFA): management, capacity building, and research & monitoring. The anticipated development path for the project requires multiple-sector involvement, and the major sectors have already expressed their interest. The project's output will increase the options available to manage human activities that affect coral reefs, including the

implementation of strategic research and monitoring programs relating to blast fishing. These elements of the project incorporate the principles of ICRI's FFA. Ultimately the management of destructive fishing practices will have significant tangible benefits for reefs as well as the communities that depend on them.

In terms of management, the project specifically addresses illegal fishing practices that will contribute to the protection of life support systems that underpin reef fisheries. The mechanism by which this will be achieved is principally through the improvement of enforcement of regulations and so increasing their deterrent value, but also by contributing to the assessment of projects that seek to improve the condition of local communities through the development of sustainable alternative livelihoods. This project also contributes to the research and monitoring element of the FFA since it aims to improve the methods by which research and monitoring are conducted to assess the status of coral reefs, evaluate the success of management and conservation actions and develop more effective management practices. This sensor will allow for rapid assessments of baseline conditions to be established and will generate data that can be used in geographic information systems (GIS). Once developed, the sensor can then be used to investigate the relative reef conservation priorities of countries in regions where blasting is a significant issue, synergies between human impacts and natural variations as causes of degradation of coral reefs, the impact of blast fishing on reef-related tourism, the socio-economic impact of habitat destruction, and methods for mitigating the impacts of this form of destructive fishing. Of course, the data generated from surveys and assessments can then be used to develop material that increases the awareness and perception of various stakeholders to the issue.

In addition to the ICRI Framework for Action, this proposal will contribute to the implementation of resolutions, recommendations and decisions recently published by ICRI, namely:

- Seeking mechanisms and partnerships appropriate to the achievement of sustainable management of coastal fisheries resources (recommendation for coral reef sustainable fisheries, ICRI CPC Meeting, Noumea 2000)
- The application of research to investigate the widespread and serious over-exploitation of coral reef fisheries and the prevalence of destructive fishing practices through i) the application of biophysical research to determine parameters of sustainable use, and the nature and spatial extent of natural anthropogenic pressures and risks, ii) monitoring of ecological baselines and trends, and the effectiveness of current regimes of use, abuse or management. (resolution in support of balance in research funding, ICRI CPC Meeting Bali 2000)
- The call to governments, their development assistance agencies, multilateral development banks, non-governmental organizations and the private sector to support projects implementing the ICRI Framework for Action (resolution on funding and collaboration, ICRI CPC Meeting Bali 2000)
- Halt activities that may damage remaining live corals, such as destructive and other unsustainable fishing practices and anchoring on reefs as outlined in the ICRI "Renewed Call to Action" having recognized that in some regions, destructive fishing practices that directly damage coral reefs and associated ecosystems (such as blast and cyanide fishing) are a primary threat to coral reefs and have a significant negative economic impact upon those who depend on coral reef ecosystems (Resolution on Priority Actions Arising from the New Findings Presented at the 9th International Coral Reef Symposium, ICRI CPC Meeting Bali 2000)
- The urging of ICRI partners who are members of APEC to support the work of the APEC Fisheries and Marine Resources Conservation Working Groups, and to adopt the APEC Strategy on Destructive Fishing at their May 2001 meeting in Hong Kong (Decision in support of APEC strategy on destructive fishing, ICRI CPC Meeting Cebu 2001)
- Calls upon ICRI Partners to provide assistance to the relevant implementing agencies and organisations to develop such sustainable fisheries management practices in coral reefs and related ecosystems (Resolution on sustainable fisheries and food security, ICRI CPC Meeting Cebu 2001)

3. DELIVERABLES

Items 1, 4 and 5 would be directly funded by an ICRI grant. The field trials funded by third parties are however essential for the content of items 2 to 5.

1. Progress report of development phase outlining the achievements to date, constraints and difficulties encountered during the project (month 3, in digital format)
2. Draft final report (Month 6, in digital format) with the anticipated contents specified below:
3. Final report (Month 7, in digital format)
4. Scientific paper published in appropriate journal

5. Scientific paper presented in an appropriate international conference

Final Report Contents

Introduction

Background to Sabah

- Review of blast fishing techniques
- Impacts of blast fishing
- Legislation and jurisdiction relating to blast fishing
- Enforcement

Methods

- Study sites
- Materials
- Hardware
- Software
- Analysis
- Consultations

Results

- Observed blasts referenced to time of occurrence and estimated location
- Detection system technical performance
- Enforcement assessment

Discussion

- Application for enforcement
- Technical issues
- Evidence

Recommendations

- Future developments
- Application opportunities

4. PERSONNEL AND RESOURCES

Principal Investigator, Dr George Woodman.

Dr Woodman has been working on the blast detection concept since 1994 and has managed and led active field research on blasting in 1999, 2000 and 2002. He has presented the results of blast detection monitoring work for Sabah Parks to a government workshop in Sabah (SITE, 2002), and presented an overview of the technology to the fisheries working group of the UNEP/GEF South China Sea programme, '*Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand*' (UNEP, 2002). Dr Woodman will be responsible for coordinating the overall project and specifically developing the additional software required for the project.

Co-investigator, Mr Simon Wilson.

Mr Wilson has taken part field work on blast detection with Dr Woodman since 1999 and has been involved from the inception of the project in 1994. Together Mr Wilson and Dr Woodman have co-authored a published paper on the system, (Woodman et al., 2003), and another in the final preparation before submission (results of July 2002 monitoring work for Sabah Parks). Mr Wilson has invaluable experience in coastal resource management from eight years of consultancy work largely in the Middle East, important technical experience with remote sensing of data in the marine environment as well as considerable coral survey work experience in Sabah. Mr Wilson will manage various components of data collection in the field, liaise with counterparts in Sabah, and assist with analysis of data and production of reports and papers.

Hong Kong University of Science and Technology (HKUST). Professor Reinhard Renneberg and Dr Vincent Li have provided invaluable support and technical backup for the blast detection work since 1998. Dr Li is the Project Manager of the Design and Manufacturing Services Facility at HKUST that has the technical resources to undertake the electrical and mechanical work required for this project. HKUST will construct the hardware required for the project.

Mr Eddie Lui. Mr Lui is a Hong Kong based businessman with an interest in the long-term development and production of an acoustic system suitable for blast detection. Mr Lui has invaluable expertise in communications and a variety of technical fields since the 1980s and has been closely involved in the successful development and manufacture of numerous technologies.

5. COUNTERPARTS FOR FIELD WORK

The field work for this pilot study will be undertaken in close collaboration with the Sabah Department of Fisheries, Sabah Parks and Sabah Marine Police. Blasting activity will be monitored in a number of locations, including the vicinity of the Tunku Abdul Rahman National Park near Kota Kinabalu (where frequent blasting was detected in July 2002 during a trial for Sabah Parks), and near the Shell Sabah oil rigs and Mantanani Resort in the north west of the state where significant blasting is reported. Personal contacts have been developed with key representatives of most of these organizations from our previous work in the state.

Operating and financial support as well as support in kind will be obtained from partners in Sabah, including WWF Malaysia and Shell Sabah.

Sabah was selected as the location for the field trial because of the number of partners and support that has been offered for this project as well contacts that have been developed from previous work. In addition there exists political will to tackle the problem: the former Chief Minister recently described blast fishing as one of the three most important issues that face the state, alongside illegal immigrants and illegal logging.

6. WORK PLAN

From previous work the following resources are available:

- Software that will automatically filter blast signals from noise (shrimp, boat noise etc) at large ranges (estimated to be over 30 km)
- Software that will determine the direction of travel of a blast wave to better than 0.2° precision.
- High specification, calibrated hydrophones and industry-standard National Instruments data acquisition equipment.

The project workplan can be separated into hardware and software development, and the field operations

6.1 Hardware development:

- Addition of an electronic compass and GPS chartplotter so that the direction of the hydrophone array and its geographical position can be determined.
Both can be bought as standard off-the-shelf components.
- Development of a suitable deployment system from a patrol boat.
The hydrophones can be mounted on a framework attached to the boat. This needs to be designed for rapid deployment when blast monitoring and redeployment when moving at speed. Initial tests have confirmed that there are problems from boat movement and mechanical noise transmitted to the hydrophones from the framework that would need to be overcome. Another design is to mount the hydrophones onto a floating buoy that is similarly deployed for listening operations and retrieved when the boat needs to move off at speed. The buoy would then need to communicate with the boat through floating cables or a wireless system. The wireless system is preferable and the development of a suitable prototype is being sponsored by Eddie Lui.

It is planned to develop these systems in parallel and choose the best option at the end of the development period.

6.2 Software development:

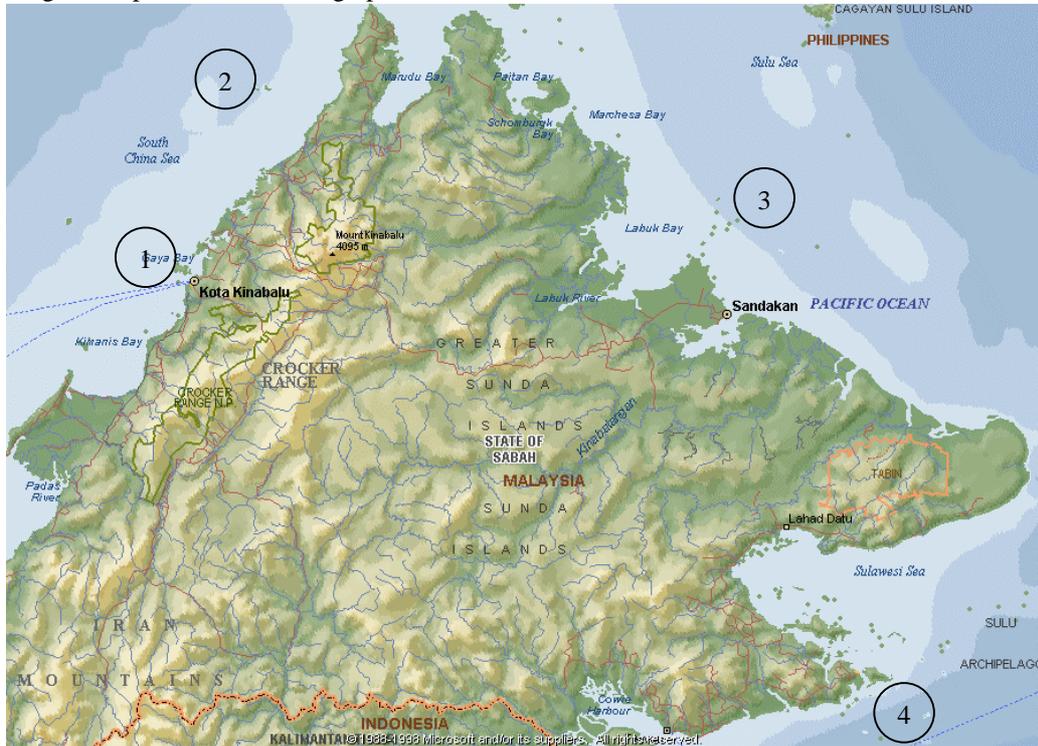
Additional routines have to be written to monitor the electronic compass to determine the direction in which the array is pointing and its tilt, incorporating tilt correction into the direction finding software. The GPS also needs to be logged so that the hydrophone array position is known in real time. The software routines need to be operated in parallel through the development of a suitable front end. This would display blast events in real time to show the time and direction of the event and its approximate location through analysis of the detected blast signal strength. The software will be developed using the industry standard data acquisition and control environment of Labview, produced by National Instruments.

6.3 Field operations:

Refer to Fig 2. The system will be set up and used for one week near the Sabah state capital Kota Kinabalu. The marine areas adjacent to the Tunku Abdul Rahman National Park will be monitored in collaboration with Sabah

Parks authority (1). Ease of access to town will allow meetings with counterparts, other agencies and officials to take place in parallel, as well as allow quick solutions to simple technical problems. After 7-10 days the system will be transported to the Mantanani Resort in Northwest waters near Shell Sabah’s oil rigs (2). Boat operations will be based at the resort for 7 days. The region surrounding the Mantanani islands is known to suffer significant fish blasting based on reports from the dive resort. Further locations on the East side of Sabah (Lankayan resort (3) or Semporna area (4)) will also be monitored, with access to boats and the support of local dive resort management. A final phase of data analysis, report writing, consultation and gathering of feedback from counterparts will take 7 days back in Kota Kinabalu.

Fig 2: Map of Sabah showing operational locations



6.4 Tabulated Workplan

Jan 2004	<ul style="list-style-type: none"> • Procure hardware, electrical/mechanical parts, GPS chartplotter, electronic compass, flash hard disk for laptop PC • Start development of software front end • Start development of hydrophone deployment system (options in parallel) and waterproofing electronic systems, power supplies etc • Integrate compass and GPS interface and data into detection software
Feb 2004	<ul style="list-style-type: none"> • Complete software interface and test data acquisition. Test analysis routines on blast data recorded in 2002. • Test hydrophone deployment system off a boat in Hong Kong • Test wireless data communication system of buoy system developed by Eddie Lui • Complete modifications and all parts required for a transportable system.
March 2004	Contingency technical development time.
April 2004	Field operations in Sabah: 6-8 working days in location 1, 6 working days in location 2, 6 working days in location 3 or 4. 6 days of report writing, final meetings and presentations.

7. Budget

The ICRI budget would be handled through Otolith, a registered business in Hong Kong. The funded items are clearly separated in the table below. Full audited accounts would be submitted to ICRI on completion of the project.

Cost GBP	Item	Notes
ICRI BUDGET		
9 620	Personnel fees	3 months of full-time input from George Woodman (GW)
2 370	Personnel fees	1 month of full-time input from Simon Wilson (SW)
980	Flights to Sabah	GW from Hong Kong, SW from Muscat
1 480	ICRS costs	Flights, conference registration, hotel, subsistence for GW at ICRS in Okinawa, Japan
1 180	Fees for HKUST technicians	2 week's input from Mr Kelvin Cheung and Mr Anthony Tam, both with experience in development for earlier field trials
15 630	SUBTOTAL	ICRI Grant Request
HK DEVELOPMENT BUDGET		
300	GPS chartplotter	Blast detection system
460	Electronic compass	Blast detection system
1 300	Flash hard disk	Used for laptop on boat for shockproofing
3 550	Electrical and mechanical fixings	Parts for construction of boat mounted detection system including power supplies, water proofing, deployment systems
5 610	SUBTOTAL	Private funding from Eddie Lui in Hong Kong ⁽¹⁾
SABAH OPERATIONS BUDGET		
2 370	Boat fuel	Up to 12000 litres of petrol for monitoring and enforcement boats
1 180	Boat hire	Hire of monitoring boat in 3 locations
890	Subsistence	Per diems for GW and SW towards food and accommodation
300	Transport	Internal flights and road transport in Sabah
300	Communications	Communications, report writing and reproduction
5 040	SUBTOTAL	Funding from sources in Sabah, including WWF Malaysia, Shell Sabah, government agencies and private sector donors.
26 280	TOTAL	

(1) See attached support letter

8. References

Fox, H. E., Pet, J. S., Dahuri, R., Caldwell, R. L. 2003. Recovery in rubble fields: long-term impacts of blast fishing *Marine Pollution Bulletin* **46**, 1024-1031

Knott, 2003. New Scientist. 13 Januray 2003 (<http://www.newscientist.com/news/news.jsp?id=ns99993237>)

Woodman, G. Wilson, S., Li, V., Renneberg, R. (2003), "Acoustic characteristics of fish bombing: potential to develop an automated blast detector" *Marine Pollution Bulletin* **46**, 99-106

Woodman, G. (2003): Marine Sensors and Biosensors website at Hong Kong University of Science and Technology, URL http://www.amce.ust.hk/blast_web_page/frameset.htm

UNEP 2002: <http://www.unepscs.org/> (Regional Working Group – Fisheries minutes available in pdf format and attached to this application. Section 9 pertains to blast fishing).

SITE 2002: 7th Sabah Inter-Agency Tropical Ecosystems (Site) Research Seminar, 2-4th November 2002, Semporna, Sabah, session IId #20 (attached pdf file, not available on internet).