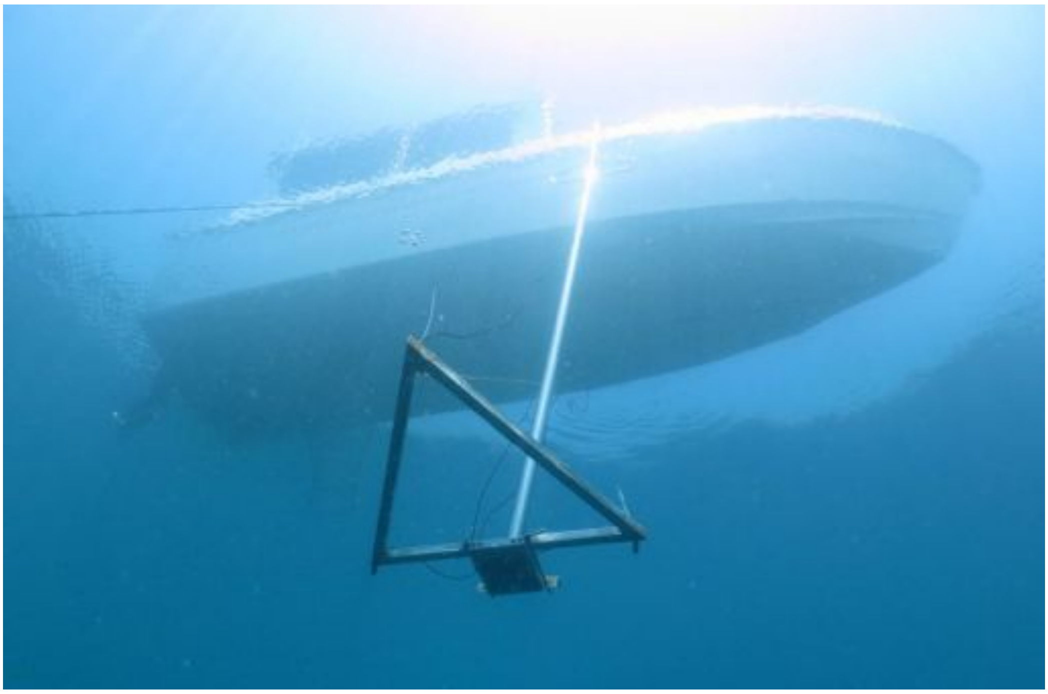
Progress Report November 2014

Acoustic detection of fish bombing



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CONTENTS

Introduction	1
Phase 1. Research and development	
1. Training at St Andrews	2
2. Collection of acoustic data	2
2.1. Purpose	2
2.2. Design and construction of hydrophone frame	3
2.3. Deployment of the hydrophone frame	4
2.4. Data recording	7
2.5. Sites and results	8
Phases 2 and 3: activities and next steps	13

Introduction

Background and rationale

Fish bombing causes significant habitat destruction, loss of biodiversity and negative impacts on fisheries, tourism and economic development. Despite being illegal, it still persists in Sabah because it yields a relatively large 'catch' in a short time and with little effort. Fish bombers use stealthy tactics to avoid being caught and increased surveillance and enforcement are urgently needed to halt this practice.

Objectives

The aim of this project is to develop and deploy an acoustic system that will detect and locate fish bombs in real time and allow immediate action to be taken to apprehend the perpetrators.

Sabah Parks staff will be involved and trained in all data gathering and operational procedures and the findings will be widely disseminated, so enabling use of the methodology in other problem areas.

Location and duration

The acoustic detection programme is taking place in and around the Tun Sakaran Marine Park, Sabah. This area is famed for its high marine biodiversity but coral reefs in the Park have, and continue to be, badly damaged by fishermen who use explosives. The research and development phase began in July 2013 and the project is scheduled to end in July 2015, when the system will be fully operational.

Activities to achieve objectives

Phase 1
Research and development: capture acoustic data through hydrophone mobile unit deployed at various locations within the Park.

Phase 2
In the laboratory, isolate the sounds of fish bombs from other ambient noises and configure the system software.

Phase 3
Assemble the system hardware and software and deploy the 'listening unit' in fish bombing hotspots.

This progress report covers Phases 1, 2 and the start of Phase 3.
Phase 3 will be covered in detail in the final report, scheduled for June 2015.

Phase 1: Research and development

1. Training at University of St Andrews

Introduction to the equipment and familiarisation

The initial plan was to bring research staff over from St Andrews University Sea Mammal Research Unit (SMRU) to collect acoustic data and train project and Sabah Parks staff. However, this proved impossible due to the security situation in Sabah (armed invasion in the Semporna area from Sulu militants, followed by kidnappings) which resulted in official advice from the UK government not to travel to Sabah's east coast. After waiting for several months, during which time the security situation did not improve, Jamie Ng (SIP, project co-ordinator) and Boni Antiu (Tun Sakaran Marine Park Manager) travelled over to University of St Andrews for training and to collect equipment necessary for data collection. This was accomplished in September 2013.

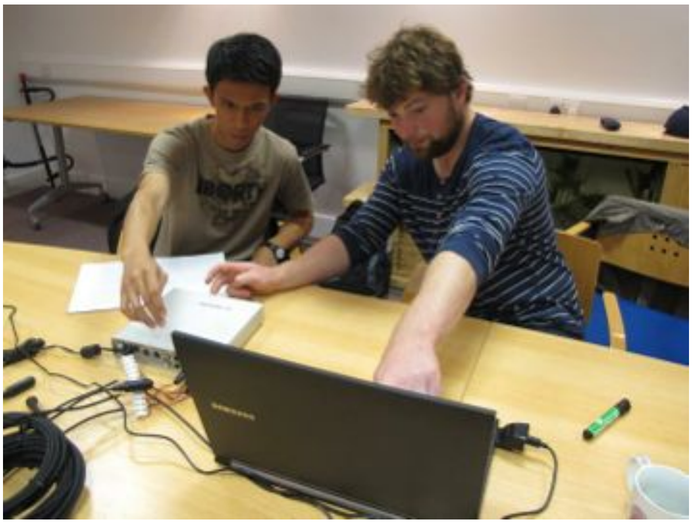

Figure 1. Jamie Valiant Ng being trained to set up the acoustic system by Jamie MacAulay at St Andrews University.

2. Collection of acoustic data

2.1. Purpose

For the first phase in the work, it was necessary to make underwater recordings of fish bomb explosions and other ambient sounds such as boat engines, divers and noises from the reef itself, such as snapping shrimps. This acoustic information is needed in order to be able to isolate and 'classify' the signal generated by fish blasts and then build the software and hardware system that will be set in place to detect fish bombs in real time.

2.2. Design and construction of hydrophone frame

A cluster of three individual hydrophones was required In order to ensure that the underwater sounds provided acoustic data that could be effectively analysed. The hydrophones (purchased from SA Instrumentation (SAIL - St Andrews, UK) had to be arranged and deployed in a particular way, as specified by SMRU.

Specifically, the hydrophones needed to be at an equal distance from each other and at least 1m apart. They also needed to be maintained at the same level in the water, at an angle of 90^{o} to the sea surface. In order to meet these criteria we designed a sturdy metal frame which was made to our specifications by a workshop located in Semporna (Figures 2 and 3).

Figure 2. Drilling holes for the clamp

Figure 3. Welding the frame

The frame was in the shape of a triangle and a clamp was added to one side (Figure 2). This was fixed with bolts and could be tightened up against a jetty leg or other fixed object (Figure 4).

Figure 4. Testing out the clamp at the workshop.

2.3. Deployment of the hydrophone frame

In the first instance, the frame was deployed by fixing ropes at each corner that were then attached centrally to a rope that led to the surface. This method enabled the team to manage the depth of the hydrophones by adjusting the length of the rope. It proved possible to control the frame provided the water was perfectly still, but if there was any current then it was quickly pulled out of line, as shown in the Figure 5. It was noted that the sound clarity improved the deeper the hydrophones were deployed.

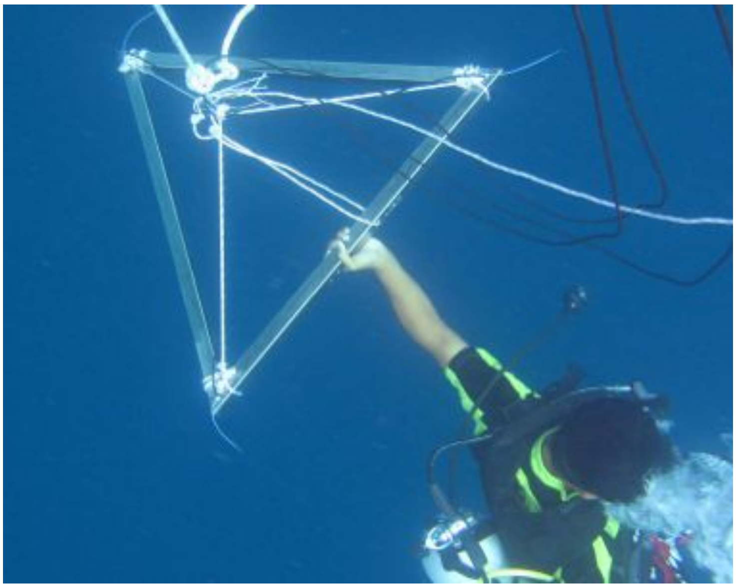

Figure 5. Diver trying to steady and level the frame as it hangs free from the boat.

It was clear that the frame needed to be attached to a structure that held it firmly at an angle of 90^{o} to the sea surface and jetty legs were initially considered to be ideal because they were very secure. Unfortunately, the water depth at Pom Pom Island (the only jetty that overlooks TSMP) was too shallow at low tide. The jetties at Boheydulang and Selakan were unsuitable because sounds from the outer reefs (where fish bombs are used) would be blocked by islands and reefs. Thus the only option was to deploy the frame beyond the reef edge by some other means.

The first method used was to bolt the frame to T-bars that were attached to and weighted down by concrete blocks that held the hydrophones about 50cm from the seabed (Figure 6). This method of frame placement worked, but was laborious to set up because several divers were needed to get the apparatus in place and the heavy concrete blocks were difficult to manage underwater.

Figure 6. Attaching the acoustic frame to the concrete blocks

The second method entailed designing and making a metal, single-pole, 'ladder' to hold the triangular hydrophone frame.

The hydrophone frame was first clamped to the end of the metal pole (Figures 7 and 8) and then the pole and frame were lowered into the water (Figure 9) and the top of the pole hooked on to the edge of the boat. The 'ladder' could be deployed and retrieved quite easily by one or two people. The only problem encountered was when the sea was rough and it rubbed against the side of the boat, producing scraping noises that were picked up by the hydrophones.

Figure 7 (left). Hydrophone frame being clamped onto a horizontal plate welded onto the bottom end of the pole

Figure 8 (above) Pole and frame ready to be deployed.

Figure 9.

Hydrophone pole and frame being lowered into the water. The hook and support at the top fix the pole to the side of the boat.

For further stability, a rope was attached to the frame, run up to the boat and then pulled in the appropriate direction to ensure that the frame was lying horizontal in the water (Figure 10).

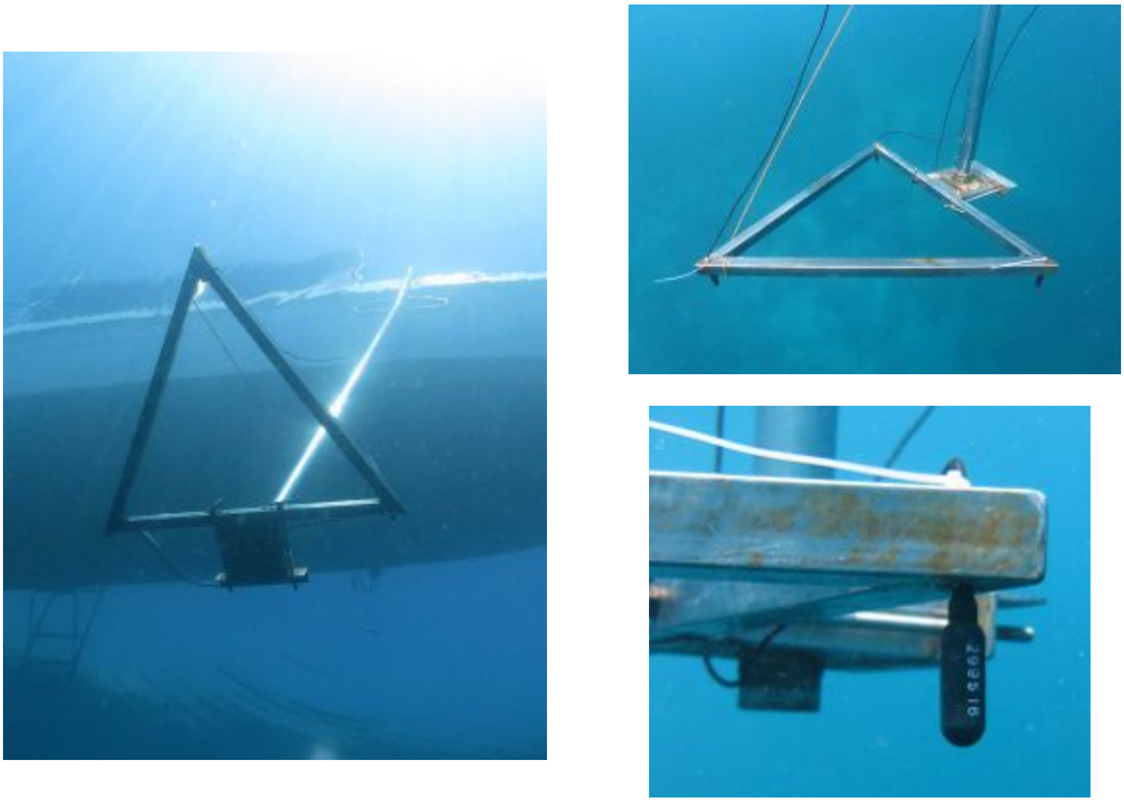

Figure 10. Above: Frame in position for recording. Top right: Frame showing the orange adjustment rope attached to one corner. Below right: Close-up of one of the three hydrophones.

2.4. Data recording

An 8m-long cable ran from each of the hydrophones to the boat where the recording equipment was set up. The cables were connected to a sound card (konnekt 24d) which recorded the high quality audio input and digitised the signals so they could be read by the laptop computer (Figs 11 & 12).

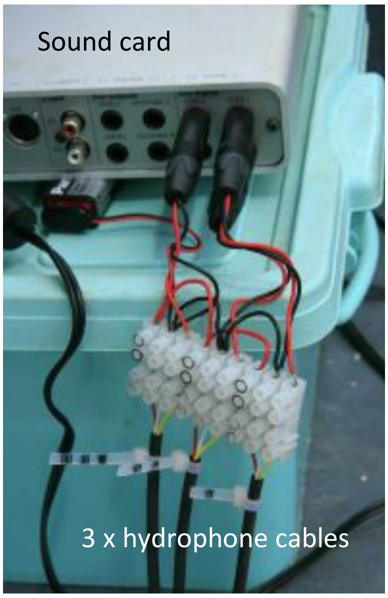

Figure 11. Hydrophone cables Attached tote sound card

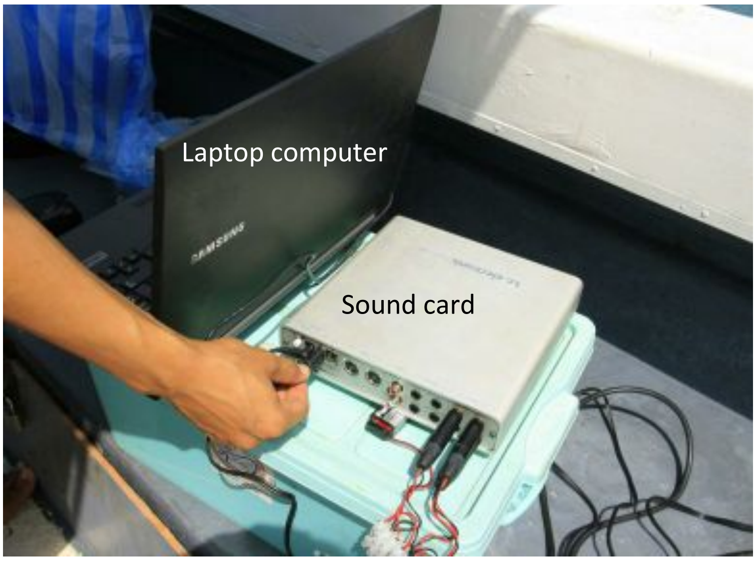

Figure 12. Recording equipment set up on the boat, powered by a car battery.

Konnekt 24d was connected by a firewire cable to an express card inserted in the laptop. Dedicated software loaded onto the laptop converted and displayed the sound as a spectrogram image that was displayed on the screen. The three tracks represent the 3 separate hydrophone channels and the visibly high frequency sounds shown in Figure 14 are the signal of an exploding fish bomb.

The hydrophones provided a continuous stream of acoustic data and this was saved in segments that lasted 9 minutes and 45 seconds. Each segment was recorded as a separate file of approximately 640 megabytes and was automatically saved onto the hard drive.

Stabilised DC current for the laptop and sound card was delivered by an inverter connected to a car battery. If fully charged, the battery lasted 4-5 hours. It was then re-charged overnight, ready for the next day's fieldwork.

2.5. Sites and results

The hydrophone frame was deployed at various localities both inside and outside the Park in an effort to pick up fish bomb sounds. Without prior knowledge of when and where bombs might be used, the only option was to set up the unit at localities where the hydrophones would cover as big an arc of water as possible without being blocked by reefs or islands. The hydrophones needed to be at a depth of around 4m or more where the temperature was reasonably consistent.

The hydrophones were deployed mainly at Sebangkat and Sibuan but also at Pulau Pom Pom jetty and Larapan (Figure 13 and Table 1). Most of the recordings were made using the frame suspended from the boat (Fig 10).

Recording was carried out for a total of 102 hours 01 minutes hours (total time hydrophones connected up and recording) at six localities (Table 1). During this time 23 bomb sounds were heard (Tables 1 and 2). This is equivalent to one every 4.4 hours.

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Figure 13. Locations where the hydrophone frame was deployed (full details are in Table 1).

Table 1. Site and recording details for the hydrophone frame

Date/ 2014	Time	Location	GPS	Summary	Number of hours
11 Feb	1018 - 1321	Pom Pom	N 04 35 409 E 118 51 874	No fish bomb sounds detected	3 hours 03 minutes
12 Feb	1010 -1220	Pom Pom	N 04 35 409 E 118 51 874	No fish bomb sounds detected	2 hours 10 minutes
13 Feb	1002 - 1245	Maiga-Selakan	No coordinates taken.	No fish bomb sounds detected	2 hours 43 minutes
15 Feb	0943 - 1400	Sibuan	N 04 39 233 E 118 39 410	Fish bomb sound recorded	4 hours 17 minutes
26 March	1539 - 1737	Sibuan	N 04 38 891 E 118 39 327	No fish bomb sounds detected	1 hour 58 minutes
27 March	0659 - 1148	Sibuan	N 04 38 891 E 118 39 327	Fish bomb sound recorded	4 hours 49 minutes
01 April	0651 - 1204 1417 - 1624	Sibuan	N 04 38 850 E 118 39 347	No fish bomb sounds detected	5 hours 13 minutes 2 hours 07 minutes
02 April	0708 -1211	Sibuan	N 04 39 233 E 118 39 410	Fish bomb sound recorded	5 hours 03 minutes
05 April	0713 -1105 1403 - 1632	Sibuan	N 04 39 233 E 118 39 410	No fish bomb sounds detected	3 hours 52 minutes 2 hours 29 minutes
06 April	0617 –1144	Sibuan	No coordinates taken.	No fish bomb sounds detected	5 hours 27 minutes
08 April	1256 –1559	Sebangkat	N 04 33 090 E 118 39 576	Fish bomb sound recorded	3 hours 03 minutes
09 April	0637 –1400	Sebangkat	N 04 33 154 E 118 39 765	Fish bomb sound recorded	7 hours 23 minutes
10 April	1312 –1522	Larapan	N 04 32 984 E 118 36 797	No fish bomb sounds detected	2 hours 10 minutes
11 April	0650 –1344	Larapan	N 04 32 841 E 118 36 674	No fish bomb sounds detected	6 hours 54 minutes
13 April	1038 –1523	Sebangkat	N 04 33 095 E 118 39 422	Fish bomb sound recorded	4 hours 45 minutes
15 April	1050 - 1501	Sebangkat	N 04 33 054 E 118 39 422	Fish bomb sound recorded	4 hours 11 minutes
10 July	1000 - 1350	Sibuan	N 04 38 891	No fish bomb sound	3 hours 50

			E 118 39 327	detected	minutes
12 July	0825 - 1223	Sibuan	N 04 38 891 E118 39 327	No fish bomb sound detected	3 hours 58 minutes
12 August	1027 – 1244	Sebangkat	N 04 33 095 E 118 39 422	Fish bomb sound recorded	2 hours 17 minutes
13 August	1114 – 1400	Sebangkat	N 04 33 095 E 118 39 422	Fish bomb sound recorded	2 hours 46 minutes
15 August	0926 – 1254	Sebangkat	N 04 33 612 E 118 39 195	Fish bomb sound recorded	3 hours 28 minutes
16 August	1341 – 1504	Sebangkat	N 04 33 612 E 118 39 195	No Fish bomb sound recorded	1 hour 23 minutes
17 August	0956 - 1422	Sebangkat	N 04 33 612 E 118 39 195	Fish bomb sound recorded	4 hours 26 minutes
26 August	1105 – 1328	Sebangkat	N 04 33 095 E 118 39 422	Fish bomb sound recorded	2 hours 23 minutes
27 August	1144 – 1404	Sibuan	N 04 38 851 E 118 39 333	No fish bomb sound recorded	2 hours 20 minutes
29 August	0900 – 1213	Sebangkat	N 04 33 612 E 118 39 195	Fish bomb sound recorded	3 hours 13 minutes

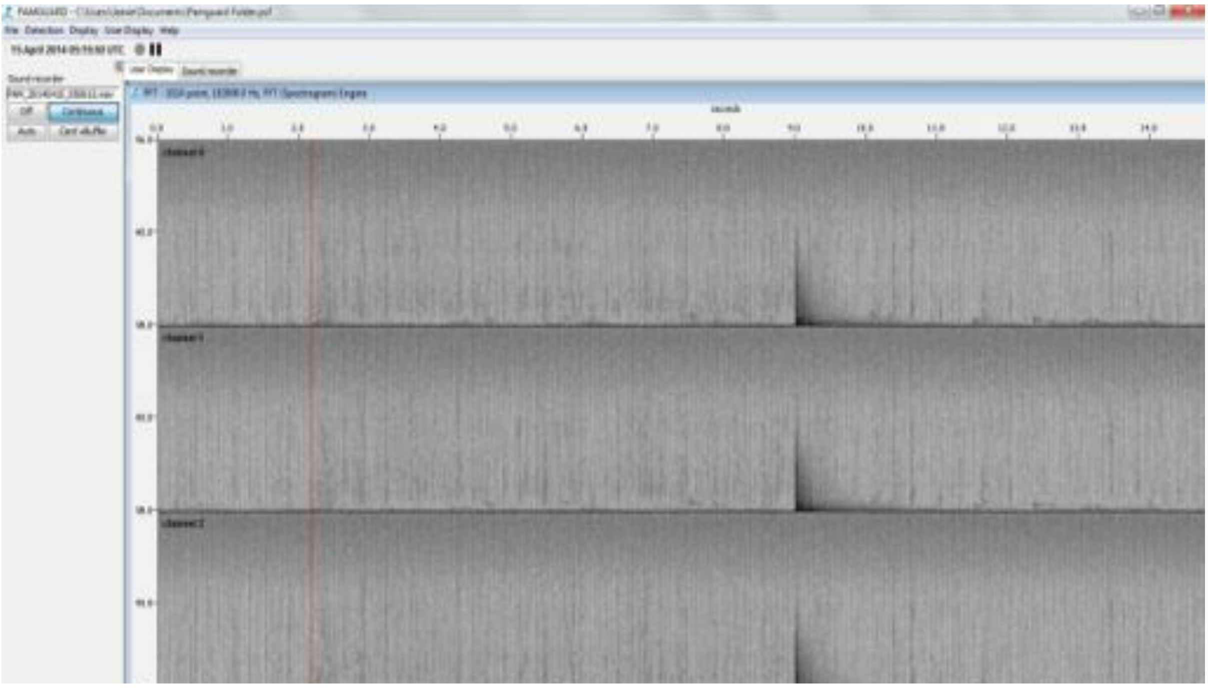


Figure 14. Example of the digitised acoustic data showing the 3 separate hydrophone channels and the visibly high frequency signal of an exploding fish bomb recorded simultaneously by each unit.

Table 2. Details of the locations where fish bomb sounds were recorded

Date 2014	Location	Recording time	GPS	Map Reference (Figure 1)	Time of Fish bomb recorded	Audio reference
15 Feb	Sibuan	1000 - 1400	N 04 39 233 E 118 39 410	A	1322 1329	PAM_20140215_ 052031
27 March	Sibuan	0700 - 1730	N 04 38 891 E 118 39 327	B	0936	PAM_20140327_ 013124
02 April	Sibuan	0710 – 1215	N 04 39 233 E 118 39 410	A	0950 Two fish bomb sound recorded in one minute.	PAM_20140402_ 014131
08 April	Sebangkat	1300 - 1550	N 04 33 090 E 118 39 576	C	1518 1521	PAM_20140408_ 070255 PAM_20140408_ 071237
09 April	Sebangkat	0630 - 1410	N 04 33 154 E 118 39 765	D	1156 1350	PAM_20140409_ 035035 PAM_20140409_ 053757
13 April	Sebangkat	1030 - 1534	N 04 33 095 E 118 39 422	E	1153	PAM_20140413_ 034653
15 April	Sebangkat	1050 - 1502	N 04 33 054 E 118 39 422	E	1228 1316	PAM_20140415_ 041739 PAM_20140415_ 050612
12 August	Sebangkat	1027 – 1244	N 04 33 095 E 118 39 422	E	1204 1229	PAM_20140812_ 035756 PAM_20140812_ 042402
13 August	Sebangkat	1114 – 1400	N 04 33 095 E 118 39 422	E	1218 1240 1343	PAM_20140813_ 041243 PAM_20140813_ 043208 PAM_20140813_ 053838
15 August	Sebangkat	0926 – 1254	N 04 33 612 E 118 39 195	F	1036	PAM_20140815_ 022449

17 August	Sebangkat	0956 – 1422	N 04 33 612 E 118 39 195	F	1259	PAM_20140817_ 044206
26 August	Sebangkat	1105 – 1328	N 04 33 095 E 118 39 422	E	1228 1252	PAM_20140826_ 042405 PAM_20140826_ 045131
29 August	Sebangkat	0900 - 1213	N 04 33 612 E 118 39 195	F	1132 1215	PAM_20140829_ 031532 PAM_20140829_ 040405

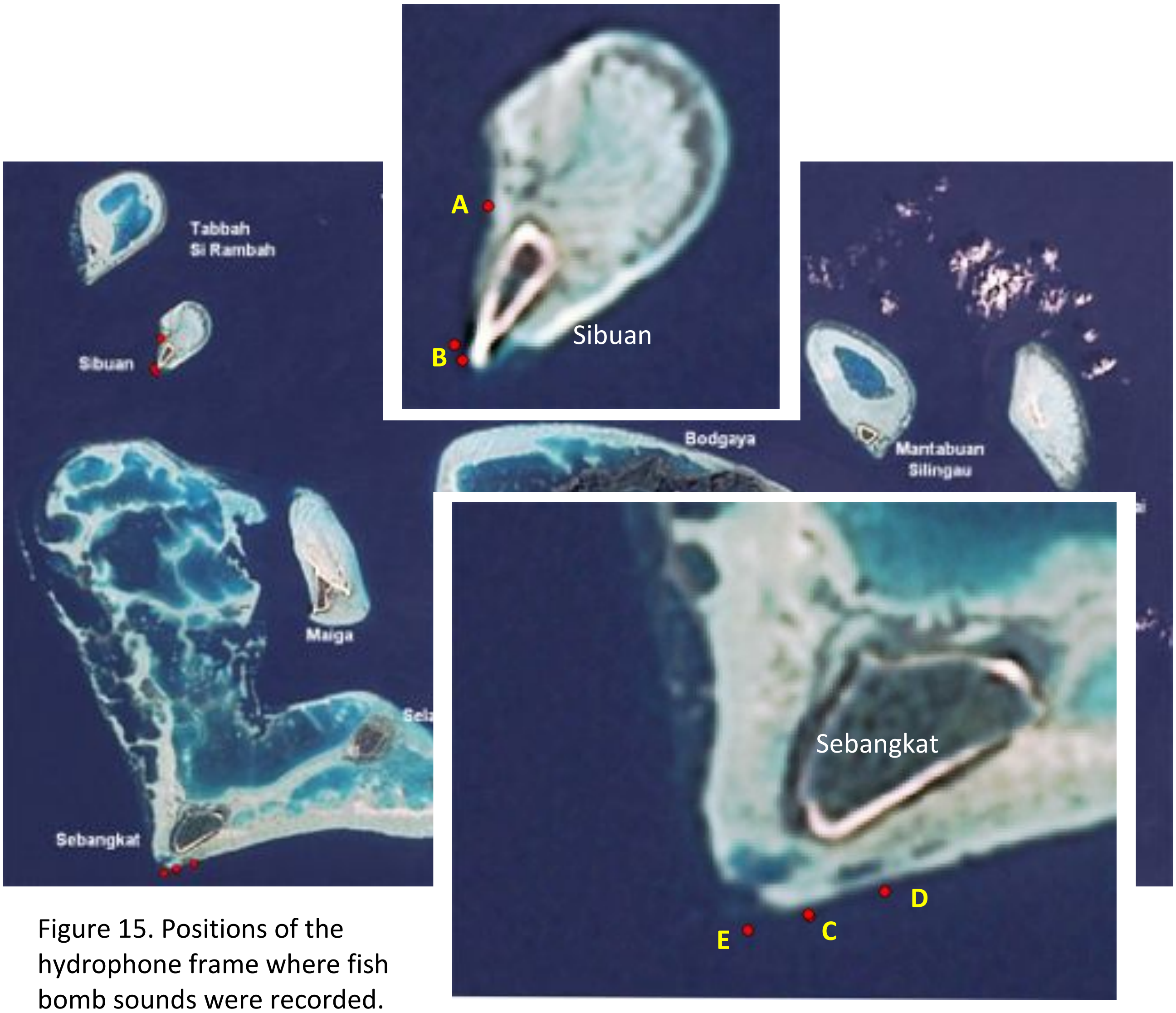
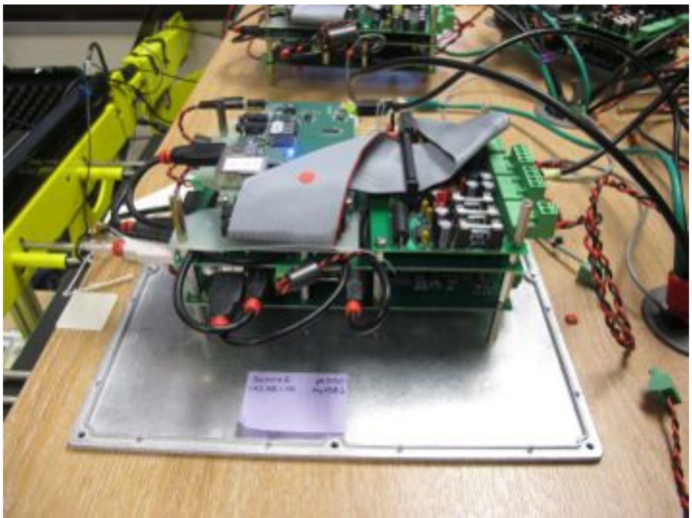


Figure 15. Positions of the hydrophone frame where fish bomb sounds were recorded.

PHASES 2 AND 3: ACTIVITIES AND NEXT STEPS

The acoustic data files incorporating the 102 hours of recording were delivered to the research team at the University of St Andrews for analysis and to enable configuration of the software.

Some of the hardware was acquired in late 2013 for the preliminary data collection phase and the rest was assembled during the research and development phase at St Andrews (Sept-Nov 2014). This has been shipped to the Hong Kong office of St Andrews Instrumentation (SAIL) where training is scheduled for Dec 8th – 12th 2014. The total acoustic equipment acquired during 2013/2014 is shown below:

Number	ITEM
3	Decimus passive acoustic detection system complete with 2.4GHZ communications option; enclosed in pelicase  

3	Sets of 3 x HTI -90-U-PA-001 hydrophones with 8 meter cables.
3	Portable 12v 100watt Solar battery charging system complete with regulator, cables and battery connectors. 
3	Micromark 2.4GHZ Collinear antenna complete with pre terminated 6 meter coaxial cables (see photo above)
1	Microhard 2.4GHZ wireless modem receiver complete with power supply for base station
1	Laptop with configured software
1	Training Manual

Following systems training in Hong Kong, the equipment will be shipped to Sabah for installation.

Three recording stations will be established, with the base (receiver) unit at Sabah Parks Sibuan substation.

BUDGET AND EXPENDITURE FOR 2014

	Budget GBP	Expenditure up to 30/11/2014		
	2014	From other sources	From Lighthouse	
STAFF COSTS				
Technical team SMRU: 6 people weeks	3,232	2054	1178	
Project leader MCS 4 weeks	2,134	850	750	
Local team: 6 people weeks	1,220	760	550	
TRAVEL				
UK travel + International flights UK to Sabah x 4	4,268	2,950	850	
Domestic flights, taxis and other travel within Sabah	915	287	500	
FIELD COSTS				
Boat including fuel and crew	3,049	2860		
Daily-paid assistance during testing/installation	1,305	550	480	
Accommodation & subsistence for project team	3,049	2250	230	
Training workshops/courses	3,573	2,400		
CAPITAL ITEMS				
PAMBuoy™ units in Peli format with 3 hydrophones, 2.4GHZ communications packs, antenna and mounts. One unit	18,293	11443	6,850	
Solar panel systems with solar regulators and fixings x 3 units	976	476	500	
GEL battery 120AmpH x 2 units	183	200		
PAMBuoy™ Base Station complete with 12.5" i5 and all software in Pelicase format, 1 off 2.4GHz receiver, 1 off antenna and mount	1,829	1829		
Mobile phones x 2	183			
CONSUMABLES				
Miscellaneous items for installation e.g. buoys, ropes, attachment fixtures	1,220	522	392	
Miscellaneous consumables including paper, files, phone cards, batteries, external hard drives.	610	384	98	
ADMINISTRATIVE AND MISCELLANEOUS COSTS				
Project administration and financial audit	1,220	1220		
Insurance	305	305		
Contingency (e.g. for equipment maintenance, repairs)	1,220	286		
	Budget 48,784	**Other sources spend 31,626**	**Lighthouse spend 12,378**	**Total spend to 30/11/2014 44,004**