



Australian Government

Department of the Environment, Water, Heritage and the Arts

Marine and Tropical Sciences Research Facility (MTSRF) Project Milestone Report, 10 June 2008

Program 4:	Species and Communities of Conservation Concern
Project 1.4.2:	Sustainable use of marine species of conservation concern http://www.rrrc.org.au/mtsrft/theme_1/project_1_4_2.html
Led by:	Professor Helene Marsh, James Cook University

Report Summary

This project has three components, each aligned with a specific objective. Progress on each of these objectives is reported separately below.

Objective (a):	Evaluate the effects of acoustic alarms on behaviour of wildlife bycatch
Task Leader:	Alvaro Berg Soto, PhD Candidate
Supervisors:	Prof H. Marsh (JCU), Dr G. Parra (UQ), Dr M. Noad (UQ)

Summary

Fieldwork in Moreton Bay to test the response of the Indo-Pacific humpback dolphin, *Sousa chinensis* to Fumunda pingers, one of the acoustic alarms currently used by Queensland Shark Control Program has been completed successfully.

Milestone extracted from Project Schedule

- Progress report on evaluation of the capacity of acoustic alarms to minimise the bycatch of coastal dolphins in commercial gill nets without alienating the bycatch species from critical habitats.

Project results

Coastal dolphins in Queensland are genetically distinct and under threat from human disturbances, such as pollution, the over-exploitation of resources, and bycatch. As the populations of coastal dolphins in the Great Barrier Reef are small, threats such as even low levels of incidental bycatch can lead to stock declines requiring management intervention. To ensure that management interventions are based on the best available science, we need to: (1) learn more about the behavioural ecology of these dolphin species (*Sousa chinensis* and *Orcaella heinsohni*); and (2) study their behavioural responses to bycatch mitigation measures such as acoustic alarms (pingers). This PhD study is investigating the acoustic and surface behaviour of Indo-Pacific humpback and Australian snubfin dolphins and their responses to pingers used by the Queensland Shark Control Program to reduce the risk of cetaceans tangling in shark nets set for bathers protection. Two sites have been chosen for the study: Moreton Bay and Cleveland Bay. During vessel-based observations of *Sousa chinensis* in Moreton Bay, the dolphins' acoustic and surface behaviours were recorded with and without active pingers in the water. Preliminary results suggest that the pingers have little effect on the behaviour of Indo-Pacific humpback dolphins. In addition, during the day

the dolphins were found not to vocalise ~25% of the time indicating that sound may be an unreliable index of dolphin presence. A full report of Objective A is at Appendix 1 to this report.

Schedule of planned activities for Year 4 (2009/2010)

Fieldwork in Moreton Bay was extended to April 2008 in order to obtain a robust data set for the experiments using Fumunda pingers. Preparations for fieldwork in Cleveland Bay are currently in progress to test the response of Australian snubfin dolphins to the pingers. Fieldwork at Cleveland Bay is scheduled to begin by June 2008, as forecast in last the progress report and will continue for the remainder of 2008. The data analysis, including spatial risk assessment, should be completed during the first half of 2009.

Communication, major activities and events

Initial findings from the research were presented at the MTSRF Annual Conference held in Cairns, April 2008.

Objective (b):	Evaluate the economic factors related to Indigenous hunting and its management
Task Leader:	Aurélie DeLisle, PhD Candidate
Supervisors:	Dr N. Stoeckl and Prof H. Marsh (JCU)

Summary

Aurélie DeLisle commenced her PhD on this topic in early March 2008. A detailed outline of the project has been developed and a desktop review (based on literature survey and archives) is currently being undertaken as part of the requirements of the PhD Confirmation of Candidature process at James Cook University.

Milestone extracted from Project Schedule

- Progress report on the evaluation of economic factors related to Indigenous hunting and its management.

Project results

Since commencing her PhD project, Aurélie has been devoted her time to several, related activities:

- Attending relevant workshops/training sessions, identifying forthcoming workshops and training sessions, as listed below:
 - The School of Indigenous Australian Studies (JCU) Introduction to Aboriginal and Torres Strait Islander Cultural Awareness Program;
 - Market-based instruments for NRM change training workshop;
 - ASCPRI Introduction to Qualitative Research Techniques; and
 - NVivo (qualitative data analysis software) training workshop.
- Conducting a comprehensive review of the current literature pertaining to appropriate methodological approaches for the project, costs and benefits associated with hunting, management regimes and valuation techniques used to measure both market and non-market costs and benefits with hunting in other cultural settings and with other species is currently being undertaken as part of the requirements for her Confirmation of Candidature at James Cook University.

- Planning for a 'first run' at estimating some of the priced (market) costs and benefits associated with hunting.
- Planning for a participatory mapping exercise that will be undertaken in a number of Torres Strait Island communities has begun. These exercises aim to identify the values held by Torres Strait Islanders with the use of sea country. They follow a five-step approach. First, participants will be asked to list all their values associated with sea country. Second, using sea maps or drawing their own maps, participants will identify significant sites or areas of benefits to them. Third, values associated with each site will be recorded. Fourth, participants will rank all their values associated with sea country according to their importance to them. Fifth, they will then rank the identified significant places according to the importance of each site to them. All these exercises will take place during focus group sessions where participants will be divided into groups according to gender, age and experience with hunting or other pertinent criteria.
- The values recognised during those participatory mapping exercises will provide some preliminary data on the types of costs and benefits that are associated with the use of sea country and hunting. Those costs and benefits will be divided into market and non-market values. Data gathered on the priced (market) costs and benefits of hunting and food will partly contribute to the evaluation of market values and information gleaned from the literature review, workshops and training sessions will allow Aurélie to assess the appropriateness of alternative techniques for valuing the other costs and benefits in the particular context of Indigenous hunting in the Torres Strait.

Communication, major activities and events

Aurélie held Informal discussions with Torres Strait Liaison Officer Vic McGrath at the MTSRF Annual Conference in April 2008 and discussed options for fieldwork in Torres Strait. The project was discussed with Torres Strait Dugong and Turtle project officers at a workshop in August 2007 at JCU. An information sheet on the project was prepared and circulated to relevant TSRA staff at a Dugong and Turtle hunting management meeting on Thursday Island in May 2008 (see Appendix 2).

During the next milestone reporting period, A MTSRF / TSRA funded workshop will be convened to explore the links between spatial management and Islanders' values. The workshop will be attended by PhD student, Aurélie Delisle, her supervisors, Dr Mark Hamann and project officers from the Land and Sea Management Unit of the Torres Strait Regional Authority. One of the planned exercises will involve testing the applicability of participatory mapping to the seascape as a means of exploring spatially the values associated with hunting in Torres Strait.

Table: Project timetable for Objective (b) *Evaluate the economic factors related to Indigenous hunting and its management.*

Activity	Period
Literature review	March – September 2008
Confirmation seminar	September 2008
Ethics approval	September 2008
Community consultation	October to December 2008
Research agreement	December 2008 to January 2009
Field work	January to December 2009
Data analysis	March 2009 to May 2010
Thesis writing	January 2010 to March 2011
Report back to communities	December 2009 to February 2011
Submission of thesis	March 2011

Objective (c):	Delivery of information on marine species of conservation concern into the Integrated Report Card framework for the MTSRF, using a spatial risk assessment approach
Task Leader:	Alana Grech, PhD Candidate
Supervisors:	Prof H. Marsh (JCU)

Summary

A spatial model of dugong distribution and relative density in Torres Strait has been created, and a similar model for the northern Great Barrier Reef updated using information from the 2006 dugong aerial survey conducted by Helene Marsh of JCU.

Alana Grech and Ray Wallis, a Traditional Owner (Wuthati) of Shelburne and Temple Bays, have discussed plans for the project on the ecological consequences of various mutual obligation scenarios to manage hunting and commercial gill netting in the northern Great Barrier Reef, and analysis is in progress.

Training in GPS and GIS was conducted at eight communities in the Torres Strait between February and April 2008.

Milestones extracted from Project Schedule

- A spatial model of dugong distribution and relative density in Torres Strait from data integrated across six aerial surveys from 1987-2006, including the dugong survey conducted as part of Project 1.4.1 (with co-funding already obtained from ACAMMS via JCU).
- An upgraded spatially explicit dugong distribution and density model of the northern GBR using data from the dugong survey conducted as part of Project 1.4.1 (with co-funding from JCU and GBRMPA already obtained through the JCU Collaborative Grant Scheme).
- A spatial risk assessment of the ecological consequences of various mutual obligation scenarios to manage hunting and commercial gill netting in the northern GBR to inform discussions between GBRMPA and the communities, and GBRMPA and the Queensland Fisheries Service (with co-funding from JCU and GBRMPA already obtained through the JCU collaborative grant scheme).
- A report on a workshop to train Torres Strait Islanders in community GIS.
- A report on progress with the Torres Strait GIS-based Decision Support System to be used in developing adaptive solutions to natural resource management problems.
- Input to the regional Data Integration and Synthesis for northern GBR and Torres Strait.

Project results

- GPS, GIS and computer mapping training was conducted in eight Torres Strait communities involved in the NAILSMA dugong and turtle project. Dugong and Turtle project officers arranged the two day workshops on Mabuiag, Boigu, Iama, Masig, Erub, Mer, Badu and Hammond Islands.
- A total of 136 Torres Strait Islanders attended the workshops. The workshops were conducted by Alana Grech and Stephan Ambar (community ranger from Hammond Island). Community members were very positive about the GPS and computer mapping training, and said that it will assist them with boat navigation, fishing, dugong and turtle management, community planning, mapping traditional sites, pest and weed management, and search and rescue.

- The workshops had two major outcomes: (1) they increased the capacity for 136 Islanders (126 men and 10 women) to collect spatial information; and (2) they increased the capacity of the attendees to interpret and apply the spatial information collected by western scientists.
- Participants learned how to integrate their Indigenous Knowledge with Western Scientific Knowledge using GIS. Most of the Indigenous Knowledge collected at the workshops is confidential to the communities in accordance with the data sharing agreements that were integral to the acceptability of the workshops to the Islanders.
- Workshop participants came from nineteen occupations, demonstrating the potentially wide range of applications of these technologies for Torres Strait Islanders. The involvements of Indigenous counterpart Stephen Ambar was integral to the overall positive response to the workshops
- The diversity and number of participants who gave up their time to attend a workshop highlights the demand for adult education and capacity building in technologies such as GPS, GIS and community mapping from Torres Strait Islanders. The workshops also provided an opportunity for building trust and improving communication between Indigenous communities and western scientists.
- Digital and hard-copy versions of the spatial model of dugong distribution and relative density were provided to Dugong and Turtle Project Officers, workshop participants and TSRA to inform their regional resource management initiatives.
- The model of dugong distribution and relative density to each community developed from the times series of dugong aerial surveys under the aegis of this project was delivered through the workshops providing an opportunity for community members to have their concerns addressed directly and learn how to use the model in conjunction with their own Traditional Ecological Knowledge via a GIS-based Decision Support System. Results from the 2006 dugong aerial survey conducted by Helene Marsh and her Group (MTSRF Program 4 – Project 1.4.2) were also discussed with community members.
- The spatial model of dugong distribution will inform the ongoing negotiations about shared responsibility strategies for ensuring that the Torres Strait dugong fishery is sustainable.
- The spatial model confirms that:
 - A greater proportion of the Torres Strait region is comprised of high value dugong habitats than the inshore Great Barrier Reef region or south-east Queensland;
 - Dugong habitats in the Torres Strait are the most important along the east-coast of Queensland, and almost certainly the world;
 - The areas of highest relative dugong density in the Torres Strait are between Buru and Mabuiag Islands and along the Warrior Reefs;
 - The Torres Strait dugong sanctuary encompasses a large region of high and medium conservation value to dugong indicating the potentially significant value of the spatial closure of this region, provided it is effectively enforced;
 - Dugong aerial surveys do not cover the entire distributional range of dugongs in the region; and
 - A significant proportion of high value dugong habitat in Torres Strait probably already functions as a de facto spatial closure because it is beyond the range of Indigenous hunting.

A full report with recommendations is at Appendix 3.

Communication, major activities and events

Alana Grech worked closely with the TSRA Land and Sea Management Unit and Dugong and Turtle project officers to organise GIS and computer mapping training workshops on various communities in Torres Strait. Alana is also in regular communication with Ray Wallis

(Traditional Owner (Wuthati) of Shelburne and Temple Bays) to develop a spatial risk assessment of the ecological consequences of various mutual obligation scenarios to manage hunting and commercial gill netting in the northern Great Barrier Reef. The results of the spatial model of dugong distribution in Torres Strait and of the 2006 dugong survey of Torres Strait were presented back to the Islanders during the workshops.

Results from this project were presented at the 2008 MTSRF Annual Conference.

The Torres Strait GIS workshops were featured in the Torres News, the local Torres Strait newspaper. The dugong aerial survey results were featured in the Australian newspaper on dates (see Appendix 4). The policy implications of the work have been communicated to the Federal Minister of the Environment (Appendix 5).

The following paper has been published:

Grech, A. and Marsh, H. (2008). Rapid assessment of risks to a mobile marine mammal in an ecosystem-scale marine protected area. *Conservation Biology*. Published article online: 10-Apr-2008 doi: 10.1111/j.1523-1739.2008.00923.x

Throughout the next milestone reporting period, Helene Marsh will continue to be in regular contact with GBRMPA via Dr Kirstin Dobbs, and her membership of the Conservation, Heritage and Indigenous Partnerships Reef Advisory Committee, and with Damien Miley of TSRA. Helene will also attend a workshop on Thursday Island to review the Dugong and Turtle Management Plans developed by eight communities in Torres Strait in May 2008.

Articles on the project are being developed for the following stakeholder magazines and newsletters:

- Marine and Coastal Community Network (Newsletter); and
- Publication for scientific journal.

A MTSRF / TSRA funded workshop to explore the links between spatial management and Islanders values is scheduled for early October 2008. The workshop will be attended by Alana Grech and Professor Helene Marsh and co-workers and project officers from the Land and Sea Management Unit of the Torres Strait Regional Authority. The workshop will include sessions on how the information relevant to designing spatial closures to dugong and turtle hunting could be combined in a GIS and further training for Islanders on GIS tools for spatial management.

Appendices

Appendix 1: Project Overview: The acoustic and surface behaviour of coastal dolphins in Queensland: Implications for management (Alvaro Berg Soto, PhD Candidate)

Appendix 2: Project Overview: The economics of hunting: An investigation of the market and non-market costs and benefits of traditional dugong and marine turtle hunting (Aur lie Delisle, PhD Candidate)

Appendix 3: Torres Strait Community GIS (Report): Building the capacity of Torres Strait Islander communities in Natural Resource Management through integration of Traditional Ecological Knowledge and Western Scientific Knowledge (Alana Grech *et al.* 2008)

Appendix 4: Dugong aerial survey results featured in popular media

Appendix 5: Communication of policy implications to the Australian Minister for the Environment, Heritage and the Arts, The Hon. Peter Garrett MP AM.

Appendix 1: MTSRF Project 1.4.2 Objective (a)
Evaluate the effects of acoustic alarms on behaviour of wildlife bycatch
Project Overview

The Acoustic and Surface Behaviour of Coastal Dolphins in Queensland: Implications for Management

Alvaro Berg Soto
PhD Candidate
School of Earth and Environmental Sciences
James Cook University

Executive Summary

- Coastal dolphins in Queensland are genetically distinct and under threat from human disturbances, such as pollution, the over-exploitation of resources, and bycatch. As the populations of coastal dolphins in the Great Barrier Reef are small, threats such as even low levels of incidental bycatch can lead to stock declines requiring management intervention.
- To ensure that management interventions are based on the best available science, we need to: (1) learn more about the behavioural ecology of these dolphin species (*Sousa chinensis* and *Orcaella heinsohni*); and (2) study their behavioural responses to bycatch mitigation measures such as acoustic alarms (pingers).
- This PhD study is investigating the acoustic and surface behaviour of Indo-Pacific humpback and Australian snubfin dolphins and their responses to pingers used by the Queensland Shark Control Program to reduce the risk of cetaceans tangling in shark nets set for bathers protection.
- Two sites have been chosen for the study: Moreton Bay and Cleveland Bay.
- During vessel-based observations of *Sousa chinensis* in Moreton Bay, the dolphins' acoustic and surface behaviours were recorded with and without active pingers in the water.
- These preliminary results suggest that the pingers have little effect on the behavior of Indo-Pacific humpback dolphins. In addition, during the day the dolphins were found not to vocalise ~25% of the time indicating that sound may be an unreliable index of dolphin presence.

1. Introduction

The Great Barrier Reef (GBR) is one of the world's most important natural ecosystems. It is the largest natural coral reef on earth stretching more than 2,300km along the northeast coast of Australia. The GBR supports significant biodiversity at a global level and it is recognized as a World Heritage Area. Protecting the diverse species and habitats found in the Great Barrier Reef Marine Park is the major responsibility of the Great Barrier Reef Marine Park Authority (GBRMPA). Although the GBR is one of the most well protected marine parks in the world its biodiversity is currently under threat from anthropogenic impacts such as habitat degradation, fisheries, and pollution.

The marine wildlife values of the Great Barrier Reef World Heritage Area are a major reason for the region's World Heritage Listing. These values include internationally significant populations of two species of coastal dolphins: (1) the Indo-Pacific humpback dolphin (*Sousa chinensis*), the Australian stocks of which may be a new species of cetacean (Frere *et al.* in

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press; Hale *et al.* 1998); and (2) the Australian snubfin dolphin (*Orcaella heinsohni*) which was first described in 2005 and currently is Australia's only recognised endemic cetacean (Beasley *et al.* 2005). As top predators, coastal dolphins play an important role in the function and structure of marine communities. Despite the importance of these populations, the scientific information required to inform their conservation management is inadequate (Corkeron *et al.* 1997; Parra *et al.* 2006). For the Indo-Pacific humpback dolphins and the Australian snubfin dolphins, this lack of data affects their conservation status, as contrary to expert opinion they are currently classified as 'rare' (*Queensland Nature Conservation Act*) or 'data deficient' (IUCN) rather than 'threatened'. Marsh *et al.* (2007) developed a system to optimise the allocation of resources to species of wildlife, which forms the scientific basis of the Queensland government's *Back on Track* species conservation policy. Marsh *et al.* emphasize that data deficient species should be priorities for research as their conservation status reflects a lack of information rather than an informed evaluation. The Australian Government recognises the lack of sufficient information on coastal dolphins as a problem in the most recent revision to the Action Plan for Australian Cetaceans (Ross 2006). To address this lack of information, this research project will increase knowledge of the behavioural ecology of both Indo-Pacific humpback and snubfin, by studying both their acoustic and surface behavioural repertoires.

The distribution of these two species of coastal dolphins in Queensland overlaps with areas where commercial gillnets are deployed (Fisheries 2006; Parra *et al.* 2002; Parra *et al.* 2004). Incidental bycatch from fisheries and shark-control programs is among the most serious dangers to marine wildlife (Cockcroft and Krohn 1994; Hall 1996; Hoffman 1990; Marsh *et al.* 2003; Perrin *et al.* 1994; Silvani *et al.* 1999). Marine megafauna become entangled in fishing gear and drown (Brothers *et al.* 1999; Chan *et al.* 1989; Julian and Beeson 1998; Read 1994). Great Barrier Reef Marine Park Authority and other governmental agencies in Queensland, particularly the Queensland Department of Primary Industries and Fisheries, are taking pro-active initiatives to reduce bycatch levels of wildlife including marine species of conservation concern in the Great Barrier Reef.

Area closures included within the rezoning of the GBR are the most well known example of these initiatives. Such closures reduce the bycatch risk by closing off important habitat areas from commercial fisheries and netting (Great Barrier Reef Marine Park Authority 2003). Gear modification is another mitigation measure used to reduce incidental mortality of marine megafauna in Queensland. Important examples of that approach include: (1) the replacement of some of the shark nets set for bather protection in Queensland's Shark Control Program (QSCP) with drumlines, and (2) the mandatory use of turtle excluder devices or TEDS in the East Coast Trawl Fishery (Department of Primary Industries 2001). Other approaches to the bycatch problem being trialled by the Queensland Department of Primary Industries & Fisheries include: (1) attempts to change the behaviour of the fishers (e.g. using acoustic tracking and detection systems to alert them to the presence of dolphins) and (2) attempts to change the behaviour of the bycatch species (e.g. using acoustic alarms or pingers to alert the dolphins to the presence of nets).

Pingers are sound-emitting electrical devices attached to fishing gear that are designed to reduce entanglement and death from bycatch by driving marine wildlife, especially marine mammals, away from gillnets, or by warning them of the presence of these potentially dangerous barriers, (Dawson *et al.* 1998; Reeves *et al.* 1996). Pingers have been successful in reducing the bycatch of harbour porpoises in populations throughout their range (Barlow and Cameron 2003; Kraus *et al.* 1997; Trippel *et al.* 1999). The deterrent mechanisms are

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not well understood (Kraus *et al.* 1997), but in field trials and captive studies the sounds produced by pingers appear to be aversive to harbour porpoises (Culik *et al.* 2001; Kastelein *et al.* 2000; Laake *et al.* 1998), leading to concern that bycatch is reduced by displacing the animals from critical habitats

Despite their success in reducing the bycatch of harbour porpoises, pingers may not elicit the same response from other cetacean species (Dawson 1994). For instance, active and passive acoustic deterrents had little to no effect on net entanglement of Dall's porpoises (Hatakeyama *et al.* 1994). On the other hand, *Tursiops* tend to explore new acoustic stimuli (Cox *et al.* 2003), so it is possible that this species might learn to associate pingers with a food source, in a response similar to Pavlov's "dinner bell" effect (Richardson *et al.* 1995). Some pinnipeds off the northwest coast of the United States are also attracted by acoustic alarms (Mate and Harvey 1987). This variation in behavioural responses among species indicates that fisheries cannot regard pingers as a universal solution to a multi-species incidental bycatch problem. It is clear that potential solutions such as pingers, should only be considered effective if they both: (1) reduce entanglements at least one species, and (2) have no adverse effects on population of any other species of concern (Hodgson *et al.* 2007).

To date, there is no knowledge of how Australian snubfin dolphins respond to pingers. South African stocks of Indo-Pacific humpback dolphins, showed a limited response in South Africa (Peddemors *et al.* 1999) and humpback dolphins have been caught in nets fitted with pingers in Queensland (McPherson *et al.* 2004).

The present research project aims to fill this knowledge gap and inform conservation management agencies in Queensland of the potential effectiveness of acoustic alarms as bycatch mitigation measures for populations of the Indo-Pacific humpback dolphin (*Sousa chinensis*), and the Australian snubfin dolphin (*Orcaella heinsohni*). I plan to : (1) develop a comprehensive description of the acoustic behaviour of Indo-Pacific humpback and snubfin dolphins and relate it to their surface behaviour; (2) investigate and quantify the behavioural responses of dolphins to acoustic alarms to reduce bycatch in gillnets; (3) compare dolphin movement tracks around active and inactive pinger arrays simulating a net arrangement; and (4) use a spatial risk assessment approach to assess the likelihood of effectively implementing avoidance techniques (dolphin acoustic detection devices) and/or minimisation systems (acoustic alarms alerting dolphins) to reduce bycatch in gillnets by Queensland fisheries

2. Research Protocol

My PhD project is being conducted at two main study sites:

1. Indo-Pacific humpback dolphins occur at relatively high density in the waters of North Stradbroke Island. The University of Queensland's Moreton Bay Research Station provided logistical support to my field studies. A mixture of land-based observations and vessel-based opportunistic experiments on Indo-Pacific humpback dolphins was conducted at Amity Point (27°24' S, 153°26' E) from September 2007 to April 2008
2. Australian snubfin dolphins do not occur in South East Queensland and no sites for predictable land-based observations have been identified along the east coast of Queensland. Cleveland Bay (19°15' S, 146°50' E) near Townsville supports an important

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population of Australian Snubfin dolphins (Parra *et al.* 2002). I will use the boat-based approach initiated during the Moreton Bay field season, to study this species with logistical support from James Cook University during 2008/2009.

2.1 Relating acoustic and surface behaviour

To develop a comprehensive description of the acoustic behaviour of both coastal dolphins in the study, I need to use a vessel-based approach to maximise encounters with the animals and record their acoustic and surface behaviours. A four-metre hard-hull inflatable boat (60hp outboard engine) was used during the Moreton Bay field season, while a 5.2-metre pontoon boat (40hp outboard engine) will be used for the upcoming Cleveland Bay field season, where we will target areas identified as heavily used by both species of dolphin (Parra *et al.* 2006).

During the vessel-based approaches, a behavioural observer scans for dolphin pods, while the vessel traverses areas where previous experience indicates there is a high likelihood of encountering dolphins (Parra 2005). Once a pod is detected, the vessel engine is turned off, the boat secured, and the observer begins recording observations by stating the current GPS position. The dolphins are photographed using a digital camera (Nikon DS 200) with a 70-300mm zoom lens at high shutter speeds in an attempt to obtain individual photo-identifications following the procedure described by Parra and Corkeron (Parra and Corkeron 2001). Photographs are taken as perpendicular as possible to the dolphin's body axis, to capture its dorsal fin, recognised as the best diagnostic feature for dolphin photo-identification. All photographs obtained during the study will be classified in terms of their quality, on the basis of focus, contrast between dorsal fin and background, and its size relative to the frame. Only photographs deemed good or excellent will be used to catalogue identified individuals for each species.

Concurrently with the photography, one of my observing team records species identification, group size, school composition and all visible behavioural events using reticle binoculars (Fujinon Mariner 7x50). Behavioural states are recorded every five minutes during these group follows to record changes in behaviour. The surface behaviour of the dolphins will be analysed and categorised into four main behavioural states, based on Parra (2005): foraging, socialising, travelling and milling.

To relate surface behaviour to acoustic behaviour I also record dolphins' vocalisations, by lowering a single High Tech Inc. hydrophone (model HTI-96-MIN) from the side of the vessel into the water. The hydrophone is connected to a Micro Track (M-Audio 24/96 digital recorder). Acoustic recordings will be analysed as spectrograms in the laboratory using an acoustic analysis program (Adobe audition). Only medium to good quality samples will be analysed and categorized into vocalization types, based on Van Parijs and Corkeron (2001). These vocalisation types will then be matched to the surface behaviours concurrently recorded by the observer. This approach will provide with a complete description of the dolphins' behavioural repertoire.

2.2 Investigating behavioural responses to pingers

During the field seasons in Moreton Bay and Cleveland Bay, vessel-based surveys are being used to investigate the acoustic and surface behavioural response to acoustic alarms by using a pre-post observation protocol, following Hodgson and Marsh (2007). Once animals are detected, I follow the observation approach discussed in Section 2.1. Behavioural

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observations are conducted for ten minutes. Once this period is over, a single pinger is introduced in the water. Observational recordings continue for another ten minutes, before the stimulus is removed to record another ten minutes of observations without the pinger. Both acoustic and surface behavioural responses of dolphins to the active pingers will be quantified by comparing frequency of behavioural events and duration rates for behavioural states in the absence and presence of the stimuli.

2.3 Comparison of dolphins' movement tracks around a pinger array

During 2007/8, I conducted 280 hours of land-based observations in Moreton Bay from a 4m x 2m wooden platform on the shoreline at Amity looking Northwest onto the Rainbow Channel. Perpendicularly in front of this platform and across the channel, acoustic alarms were positioned in a line emulating their distribution in a gillnet. Sound sources were deployed as follows on alternate days: (1) on odd days, three Fumunda pingers operating at the same frequency were deployed approximately 50 metres apart from each and lowered to an estimated depth of 5 metres; (2) on even days inactive pingers were deployed in the same manner as controls. The movements of dolphin pods around the acoustic stimuli array (Fumunda pingers and controls) were tracked with the use of a *viodolite* positioned on the platform to study the potential aversion and/or attraction of *Sousa chinensis* to the pingers. The *viodolite* was developed for this project with assistance from the creator of the tracking software, Dr. Eric Kniest from the University of New Castle. The *viodolite* combines both a video camera (Canon XM2) and a theodolite (Leica TC407) to obtain an accurate position of any surfacing dolphin within camera range. The theodolite communicates in real time with the computer to measure the horizontal angle or bearing in which the camera (attached to the top of the theodolite) is recording the animals. By using movement-tracking software (Cyclopes), the angles obtained by the theodolite are matched to exported frames from the video footage, showing the dolphins recorded at the same time the theodolite angle was captured. The software then calculates the vertical angle of the surfacing dolphin by taking the difference between the animal and the horizon on the exported frame. By keeping a constant depth of field, it is possible to obtain an accurate picture of dolphin surface behaviour, irrespective of its duration. I am using this system to measure any differences in the dolphins' movements in the presence of active and non-active pingers.

I have also deployed an in-water acoustic recording system to record vocalisation changes that may be linked to changes in the dolphins' movements during land-based observations. This system has been adapted from the experimental protocol used by HARC (Humpback Whale Acoustic Research Collaboration, based at the University of Queensland). Two custom-made sonobuoys (frequency response of 0Hz–20kHz), were placed in a straight line, parallel and close to the shore, 150 metres apart and equidistant to the land-based observational platform. These sonobuoys sent sound data gathered by attached High Tech Inc. hydrophones (model HTI-96-MIN) via FM transmission to two receivers located on land. Each of these signals was then transmitted into a computer, which recorded the sound obtained by both sonobuoys, with the aid of acoustic software (Ishmael). As vocalisations are captured by the sonobuoys, the time delays in the signals reaching each of the instruments can be interpreted by Ishmael to provide a bearing with respect to the station from where the sound is estimated to be coming from. In this way I can verify that the sound is coming from the surfacing pod being followed with the *viodolite*. To date I have obtained 36 hours of recordings with the video-lite and 80 hours with the in-water acoustic recording system.

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2.4 Spatial risk assessment

I plan to complete my fieldwork and the resultant data analysis by April 2009. I will then assess the likelihood of: (1) effectively implementing avoidance and minimisation techniques to reduce the bycatch of inshore dolphins in gillnets by Queensland fisheries and (2) habitat displacement by acoustic alarms used in gillnets and acoustic modems used by marine scientists. To achieve this aim, I will use a spatial risk assessment approach to integrate models of fisheries distribution and key habitats for the three species dolphins in this study to determine what regions are at greatest risk of dolphin bycatch and/or displacement. For pingers, the relevant spatial layers include the distribution of commercial netting in the GBR (QDPI&F), management plans that control the distribution of netting including the GBRMP (GBRMPA), GBRCMP (QLD EPA) Zoning Plans and Dugong Protection Areas (DPAs and QDPI&F), spatial distribution of key habitats for dolphins, and a model of the likelihood of alerting or alienating dolphins with acoustic alarms.

3. Results to Date

Field work has been completed in Moreton Bay and is schedule to commence in Cleveland Bay in June 2008

3.1 Acoustic and surface behaviour

Both behavioural states (general behaviour as a whole) and events (detailed surface actions), were recorded for *S.chinensis* during two hundred hours of boat surveys in Moreton Bay in 2007/2008.

I will begin the resultant acoustic analysis by creating an appropriate vocalisation catalogue for this dolphin population, as I have recorded a series of new whistles and sounds for this species which will require detailed description and categorisation.

My initial findings show that the dolphins' acoustic and surface behaviours do not always occur together during the day. I recorded the dolphins on 36 occasions; both behaviours were observed simultaneously on only 22 of these (61%). On five occasions, the dolphins were heard but not seen; on nine occasions the dolphins were seen and not heard (Table 1). I conclude that relying on hydrophones to warn fishers of the presence of dolphins is likely to be unreliable ~25% of the time during the day.

Table 1: Number of occasions (days) on which the Moreton Bay dolphins were detected visually or acoustically.

	Heard	Not heard
Day time observations		
Seen	22	9
Not seen	5	-
Night time observations		
Seen	7	1
Not seen	1	2

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I also attempted to record the dolphins from the end of a fishing peer on Stradbroke Island over eleven nights, under an intense light source that created a wide focal area. Dolphins were detected in nine occasions, on seven of which acoustic and surface behaviours were observed simultaneously (78%). In addition, the dolphins were heard and not seen on one occasion and seen and not heard on another (Table 2), again indicating that relying on a hydrophone to detect the dolphins is not always reliable. Other silent pods may have been present in the vicinity but outside the focal arena. These pods would have been undetectable to our instruments. Although limited visibility during the night reduces the focal area where dolphins can be observed, the animals may exhibit acoustic and surface behaviour together more frequently during our night experiments than during the day, suggesting the *S. chinensis* may vocalise more during the night, as sound may become a more reliable communication system under reduced light conditions. However, these preliminary results should be treated with caution as sample sizes are small and the differences are probably not significant. More data are required to test this result. If vocalisation is a more reliable index of dolphin presence during the night than during the day, relying on hydrophones to detect the dolphins may be more reliable than my day-time observations suggest. This result would be fortuitous as most gill netting occurs at night.

3.2 Behavioural responses to acoustic alarms

Data were obtained from the Indo-Pacific humpback dolphin population present off Amity Point. Although data set is small due to irregular dolphin presence, adverse weather conditions and equipment difficulties, it provides the first descriptions of the behavioural responses of Australian *S. chinensis* to acoustic alarms. I still have to complete my analysis of the pinger experiments. But my initial analysis of the observations of the behavioural states of dolphins in the presence or absence of pingers suggests there is no significant response by the dolphins to the active presence of one type acoustic alarms currently in use by Queensland Shark Control Program, apart from some increase in travelling in the presence of active pingers (see Table 2).

Table 2: Proportion of time dolphins recorded in various behavioural states in the presence and absence of pingers.

Pinger	Proportion of time dolphins recorded in various behavioural states		
	Foraging	Socialising	Travelling
Absent	60%	27%	12%
Present	57%	23%	20%

I recorded some acoustic responses by the dolphins to the pingers; the significance of these responses requires further analysis. There seems to be an increase of whistle vocalisations around single pings emitted by the Fumunda pingers. Spectrograms (frequency vs. time) show a similar whistle arrangement during whistle interactions among different dolphins suggesting that whistle vocalisations are used to establish contact with novel sounds among different individuals.

The only definite aversion response to pingers recorded from *S. chinensis* during the field study was a series of encounters with an identified individual that was trying to steal the bait from drum-line buoys in the Rainbow Channel deployed by the Shark Control Program. On

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the first five test occasions, the individual left the buoy immediately upon deployment of an active pinger. Some weeks later, the same dolphin did not respond to the pinger under the same experimental conditions. Although I am cautious about interpreting results based on one individual, these anecdotal observations confirm that dolphins can hear the acoustic alarm and suggests that their reaction may be individualistic.

3.3 Movement tracks

My preliminary analyses of dolphin movement tracks around and active/inactive pinger arrays during land-based observations on Amity Point are nearly complete. After frame processing, only tracks containing two or more fixed positions were included on the Cyclopes outputs displayed for each day. Fumunda acoustic alarms were active fifty percent of field days. Summary data suggest that the active pingers did not affect the behaviour of the dolphins, except with respect to the percentage of days when pods crossed the array (which is conceptually similar to attempting to cross a fishing net). I plan to conduct statistical analyses on these data in 2009/10.

Table 3: Preliminary analyses of the movement tracks of *S.chinensis* around and active/inactive pinger arrays during land-based observations on Amity Point.

Averages	Pingers on	Pingers off
Number of pods / day	3 pods	5 pods
Minimum distance from dolphin to pinger	31 metres	31 metres
Percentage of days with array crossings	29% cross	86% cross

3.4 Spatial risk analysis

I have not commenced this component of the project.

4. Discussion

4.1 Behavioural repertoire

Field work in Cleveland Bay will provide comparative data on the vocalisations of Australian snubfin dolphins' and recordings of second Australian population of Indo-Pacific humpback dolphins. This information will improve the existing knowledge on the behavioural ecology of both species.

Initial findings suggest that Indo-Pacific humpback dolphin may vocalise more frequently at night than during the day, a result which needs to be checked with larger sample sizes. If true, such behaviour may improve the chances of detecting such animals from a fishing vessel during nocturnal gear deployment. Therefore, nocturnal dolphin acoustic detection systems may prove a useful mitigation measure to reduce bycatch of these dolphins.

4.2 Behavioural responses to pingers

My preliminary analysis of the field data I obtained in 2007/2008 suggests that pingers do not substantially change the behaviour of *S.chinensis*. However, my data require more sophisticated analysis to obtain a more complete understanding of their behavioural responses to acoustic alarms.

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The anecdotal observation of the dolphin grabbing bait from a shark buoy suggest that the dolphins' responses to pingers may be individualistic and situation dependent.

4.3 Movement tracking

Although preliminary analysis shows very little difference between different settings (i.e. active/inactive pinger), the presence of active pingers may reduce the likelihood of dolphins crossing a net. Dolphins may avoid a sound emitting array, though they are not repelled from an area. Further analysis is required to extract more information from this data. The acoustic tracking data must also be analysed to ratify the results found with the viodolite.

5. Conclusion

My preliminary assessment suggests that acoustic alarms alone will not be sufficiently adequate to solve the bycatch problem for Indo-Pacific humpback dolphins. They may have some value in combination with other mitigation measures.

6. Acknowledgments

I appreciate the financial contribution from the different funding institutions that have made this research project possible, including the Marine and Tropical Sciences Research Facility, the Great Barrier Reef Marine Park Authority and the Sea World Research and Rescue Foundation. Support from James Cook University and University of Queensland have been invaluable to the project, as well as the academic assistance from my supervisors, Professor Helene Marsh (JCU), Dr Michael Noad (UQ), Dr Guido Parra (UQ) and Dr Ivan Lawler (JCU). Collaboration from Dr Wayne Sumpton and Dr Neil Gribble from Queensland Department of Primary Industries and Fisheries has greatly contributed to the development of this research, as well as logistic support from Moreton Bay Research Station and Straddie Holiday Parks. Finally, I must acknowledge the helpful assistance of all volunteers involved in the project.

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Appendix 2: MTSRF Project I.4.2 Objective (b)
Evaluate the economic factors related to Indigenous hunting and its management
Project Overview

**The Economics of Hunting:
An investigation of the market and non-market costs and
benefits of traditional dugong and marine turtle hunting**

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About Me

- I am originally from France where I completed a BSc in Biology at the University of Montpellier.
- The travel bug took me first to Canada and to warmer climates in Townsville where I have been living since 2003.
- I worked on a research project entitled “Understanding the links between wild resources and Aboriginal well-being” for my Masters in Economics.
- I love discovering new places, cultures and languages not as a visitor but as a local. In my spare time, I enjoy time with friends, playing the piano, reading and eating cheese and chocolate.



Research Aim

To improve the understanding of the market and non-market costs and benefits associated with traditional dugong and marine turtle hunting.

Background

Traditional hunting is a topical issue and one over which there are differences in the interests of Indigenous communities, management agencies and the wider community. But all costs and benefits associated with this activity are not completely understood. This project will not only focus on the financial costs and benefits of hunting but will consider these costs and benefits in a wider context. Cost refers to the choices that individuals and society must make between the uses of resources. Costs and prices are often thought to be identical. But cost is better defined as any “benefits foregone”. This can involve money, time and other resources, or the loss of an opportunity to enjoy benefits (see the example of owning a dog).

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The costs and benefits of owning a dog

You can buy a dog for a high or a low price, or even get one for free. But a dog imposes many other costs on its owner. The owner buys dog food at the store – a market cost. Cleaning up after the animal is a non-market cost. Dogs can impose costs on other people, including noise and fear – these are non-market costs as well. Dogs can provide market benefits – the pride an owner feels when it wins a prize at a competition or money saved by not having to install a burglar alarm – and non-market benefits such as providing company and pleasure.

There are also both market and non-market costs and benefits associated with traditional hunting. Time spent hunting rather than earning income from commercial fishing and the costs of fuel and boats are market cost. Adverse publicity and the effects on reputation resulting from perceptions that hunting is not sustainable are non-market costs. The capacity to preserve traditional hunting practices and teach them to the next generation and the health benefits of consuming traditional foods are non-market benefits. There are also potential costs and benefits associated with the management of hunting to ensure it is sustainable. Benefits might include employment as rangers and guaranteeing animals for the next generation to hunt; costs might include limitations on when and where the hunters are allowed to hunt.

Objectives of my research

- To work with Indigenous communities to identify and evaluate economic factors related to Indigenous hunting of dugongs and marine turtles; and
- To evaluate both the market and non-market costs and benefits of dugong and marine turtle management arrangements.

Outcome

Information about all the costs and benefits (non-market and market) of traditional hunting activities in Northern Australia that will help people think about the full impact of different management arrangements.

Methods

- Develop research agreements between researcher and several Indigenous communities;
- Work with communities to determine:
 - Costs and benefits of traditional hunting; and
 - Costs and benefits of different management alternatives.
- Write up the results – for PhD and for communities; and
- Give the results back to the communities.

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Benefits

Who	Benefits
Indigenous communities involved in traditional hunting	Documentation of costs and benefits associated with traditional hunting activities which communities can use to design sustainable management arrangements
Aur�lie Delisle, PhD student	Working in a cross-cultural setting, acquiring new knowledge, contributing to the management of marine resources and obtaining a PhD, publishing articles
Dr Natalie Stoeckl and Professor Helene Marsh	Acquiring new knowledge, co-authorship of articles in professional journals
Management agencies	Information to inform the developments of sustainable management arrangements for dugongs and turtles

Confidentiality

This project will be conducted by following all JCU ethics and research requirements.

I will collect research agreements from each participant and make sure that all participants understand the nature of my study and their role in it.

All research agreements, interview data, and other participant documents will be kept in a locked cabinet in my office at James Cook University.

All interview quotes, commentary, etc. that are used in this project will be kept completely anonymous; participant names and personal information will be removed so as to protect privacy.

Participants will be given the opportunity to review their interview transcripts before I use them in any publications and will be given the chance to review drafts before publication.

For further information

Feel free to email me at aurelie.delisle@jcu.edu.au. Please feel free to approach me with any other concerns you have and I will make every attempt to address them.

Torres Strait Community GIS

Building the capacity of Torres Strait Islander communities in Natural Resource Management through integration of Traditional Ecological Knowledge and Western Scientific Knowledge

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Australian Government

**Department of the Environment,
Water, Heritage and the Arts**

Supported by the Australian Government's
Marine and Tropical Sciences Research Facility
Project 1.4.2 Sustainable use of marine species of conservation concern

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This report should be cited as:

Grech, A., Ambar, S. and Marsh, H. (2008) Torres Strait Community GIS: Building the capacity of Torres Strait Islander communities in Natural Resource Management through integration of Traditional Ecological Knowledge and Western Scientific Knowledge. Report to the Marine and Tropical Sciences Research Facility. Reef and Rainforest Research Centre Limited, Cairns (30pp.).

Published by the Reef and Rainforest Research Centre on behalf of the Australian Government's Marine and Tropical Sciences Research Facility.

The Australian Government's Marine and Tropical Sciences Research Facility (MTSRF) supports world-class, public good research. The MTSRF is a major initiative of the Australian Government, designed to ensure that Australia's environmental challenges are addressed in an innovative, collaborative and sustainable way. The MTSRF investment is managed by the Department of the Environment, Water, Heritage and the Arts (DEWHA), and is supplemented by substantial cash and in-kind investments from research providers and interested third parties. The Reef and Rainforest Research Centre Limited (RRRC) is contracted by DEWHA to provide program management and communications services for the MTSRF.

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June 2008

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Acronyms Used In This Report

AQIS	Australian Quarantine and Inspection Service
CDEP	Community Development Employment Projects
DMU	Dugong management unit
DSS	Decision support system
ESRI	Environmental Systems Research Institute
GBRWA	Great Barrier Reef World Heritage Area
GIS	Geographical Information System
GPS	Global Positioning System
IUCN	International Union for the Conservation of Nature
JCU	James Cook University
MTSRF	Marine and Tropical Sciences Research Facility
NAISMA	North Australian Indigenous Land and Sea Management Alliance.
RRRC	Reef and Rainforest Research Centre Limited
SEQ	South East Queensland
TSRA	Torres Strait Regional Authority

Acknowledgements

This research was funded by the Australian Government's Marine and Tropical Sciences Research Facility via a grant administered by the Reef and Rainforest Research Centre Limited; and the Australian Centre for Applied Marine Mammal Science.

We gratefully acknowledge the assistance of the following people and organisations: Frank Loban, Lachlan Sutherland and Damien Miley (Land and Sea Management Unit, Torres Strait Regional Authority); Terrence Whap, Ishmael Gibuma, Charles David, Michael Morris, Lota Warrior, Kenny Bedford, Moses Wailu, and Pearson Wigness (Dugong and Turtle Project Officers); Solomon Nona (Badu Island Council); Mabuiag Island Council; Boigu Island Council; Yam Island Council; Yorke Island Council; Darnley Island Council; Murray Island Council; Badu Island Council; Hammond Island Council; Horn Island Council; Jillian Grayson and Mark Hamann (James Cook University); and the 136 workshop participants.

Executive Summary

- GPS, GIS and computer mapping training was conducted in eight Torres Strait communities involved in the NAILSMA dugong and turtle project. Dugong and Turtle project officers arranged the two-day workshops on Mabuiag, Boigu, Iama, Masig, Erub, Mer, Badu and Hammond Islands.
- A total of 136 Torres Strait Islanders attended the workshops. The workshops were conducted by Alana Grech and Stephan Ambar (a community ranger from Hammond Island). Community members were very positive about the GPS and computer mapping training, and said that it will assist them with boat navigation, fishing, dugong and turtle management, community planning, mapping traditional sites, pest and weed management, and search and rescue.
- The workshops had two major outcomes: (1) they increased the capacity for 136 Islanders (126 men and 10 women) to collect spatial information; and (2) they increased the capacity of the attendees to interpret and apply the spatial information collected by western scientists.
- Participants learned how to integrate their Indigenous Knowledge with Western Scientific Knowledge using GIS. Most of the Indigenous Knowledge collected at the workshops is confidential to the communities in accordance with the data sharing agreements that were integral to the acceptability of the workshops to the Islanders.
- Workshop participants came from nineteen occupations demonstrating the potentially wide range of applications of these technologies for Torres Strait Islanders. The involvements of Indigenous counterpart Stephen Ambar was integral to the overall positive response to the workshops.
- The diversity and number of participants who gave up their time to attend a workshop highlights the demand for adult education and capacity building in technologies such as GPS, GIS and community mapping from Torres Strait Islanders. The workshops also provided an opportunity for building trust and improving communication between Indigenous communities and western scientists.
- Digital and hard-copy versions of the spatial model of dugong distribution and relative density were provided to Dugong and Turtle Project Officers, workshop participants and TSRA to inform their regional resource management initiatives.
- The model of dugong distribution and relative density to each community developed from the times series of dugong aerial surveys under the aegis of this project was delivered through the workshops providing an opportunity for community members to have their concerns addressed directly and learn how to use the model in conjunction with their own Traditional Ecological Knowledge via a GIS-based DSS. Results from the 2006 dugong aerial survey conducted by Helene Marsh and her Group ([MTSRF Program 4 – Project 1.4.2](#)) were also discussed with community members.
- The spatial model will inform the ongoing negotiations about shared responsibility strategies for ensuring that the Torres Strait dugong fishery is sustainable.
- The spatial model confirms that:
 - A greater proportion of the Torres Strait region is comprised of high value dugong habitats than the inshore Great Barrier Reef region or southeast Queensland;
 - Dugong habitats in the Torres Strait are the most important along the east-coast of Queensland, and almost certainly the world;
 - The areas of highest relative dugong density in the Torres Strait are between Buru and Mabuiag Islands and along the Warrior Reefs;

- The Torres Strait dugong sanctuary encompasses a large region of high and medium conservation value to dugong indicating the potentially significant value of the spatial closure of this region, provided it is effectively enforced;
- Dugong aerial surveys do not cover the entire distributional range of dugongs in the region; and
- A significant proportion of high value dugong habitat in Torres Strait probably already functions as a de facto spatial closure because it is beyond the range of Indigenous hunting.

Recommendations

1. That capacity building in the use of GPS and GIS technology is continued as an integral part of the National Partnership Approach for managing the turtle and dugong harvest of Indigenous Australians.
2. That consideration is given to developing a comprehensive and long-term capacity building program that encompasses all communities of the Torres Strait and involves GPS and GIS education and training and community (Indigenous Knowledge) mapping exercises. Indigenous knowledge is being lost at an alarming rate and communities require technical support to assist them in maintaining and actively conserving this information. Such a program would require the development of formal data protocols, will take many years to complete, and requires major financial investment. The program currently in operation with the Rainforest Aboriginal people of the Wet Tropics World Heritage Area could be investigated as a possible model.
3. That Indigenous people be integrally involved in the design and presentation of adult education programs on natural resource management in the Torres Strait.
4. That MTSRF adopt a policy of requiring information collected by researchers to be returned to Torres Strait Islanders through workshops in Torres Strait communities to provide opportunities for informal discussions between community members and researchers.
5. That MTSRF and TSRA discuss ways of ensuring that Torres Strait Islanders are given the opportunity to assist in the organization and delivery of such workshops.

Introduction

The importance of northern Australia to the conservation of the world's biodiversity is increasingly important as other mega diverse areas become degraded. Much of northern Australia is under Indigenous tenure. Thus empowering Indigenous Australians, including Torres Strait Islanders, to make informed decisions about how to manage their natural resources is of local, national and international significance and accords with government policy.

Building the capacity of Torres Strait Islander communities through community GIS

In partnership with governments, remote Indigenous communities in the Torres Strait are challenged with making a variety of decisions about natural resource management, including the management of dugongs. Because of the primacy of Traditional Ecological Knowledge to Indigenous peoples and the primacy of Western Scientific Knowledge to governments, management of Indigenous country must be based on both knowledge systems. The capacity of these knowledge systems to better inform such decision making is enhanced if both types of information are presented in compatible formats. Unfortunately, in many areas Indigenous knowledge is being lost at an alarming rate and communities require technical support to assist them in maintaining and actively conserving this information.

Decision support systems (DSS) are computerised systems that can assist in making decisions between alternatives based on estimates of the values of those alternatives. Geographical information system (GIS)-based DSS have the benefit of being able to incorporate many different kinds of data spatially to support the estimation, evaluation and comparison of alternatives. A GIS-based DSS is a visual representation of information, and can provide a simple and clear way of creating, communicating and analysing data in a manner accessible to audiences of different cultural backgrounds. Thus, GIS-based DSS have great capacity to incorporate communities in their development

Community developed solutions to problems that concern them tend to be reasonable, realistic and sustainable (Craig *et al.* 2002). A community's decision making process can be enhanced by GIS-based DSS as such systems provide information to help develop appropriate responses, and support the creation of map products and analysis. As a result of differential access to data and technology, remote communities often lack the advantages of GIS-based DSS to assist them in managing their natural resources

GIS-based DSS are able to bridge the gap between Indigenous Knowledge and Western Scientific Knowledge by collating a variety of information into a common format. An additional benefit of GIS-based DSS is their ability to store information and so support, maintain and conserve Indigenous Knowledge.

Spatial models of dugong distribution and relative density

The dugong is of the highest cultural value to the Indigenous peoples of Torres Strait where the globally significant dugong population supports an important Indigenous fishery for meat and oil. The fishery is protected by the *Torres Strait Treaty* between Australia and Papua New Guinea which obliges the signatories to 'minimise any restrictive effects on the traditional activities of traditional inhabitants'.

The dugong is listed as vulnerable to extinction at a global scale by the IUCN, on the Convention of Migratory Species of Wild Animals and on Appendix 1 of the Convention on the International Trade in Endangered Species. As a signatory to these conventions and to

the Convention on Biological Diversity, the Australian government is obliged to protect dugong stocks in northern Australian waters. The dugong is listed both as a migratory species and as a listed marine species under the *Environment Protection and Biodiversity Conservation Act 1999* (C'th), and as vulnerable under the *Queensland Nature Conservation Act 1992*. The *Native Title Act 1993* (C'th) states that Indigenous peoples with a Native Title right do not need a permit to hunt under contemporary commonwealth and state/territory legislation. The Department of Environment and Heritage is now coordinating the implementation of policy entitled *Sustainable harvest of marine turtles and dugongs in Australia - A national partnership approach 2005* with the aim of working with Traditional Owners to ensure that hunting is sustainable.

Aerial surveys conducted since the mid 1980s using standardised methodology have provided the basis of the management of dugongs in the Torres Strait region. Population modelling based on the aerial survey data using two independent techniques, Population Viability Analysis (Heinsohn *et al.* 2004) and Potential Biological Removal (Marsh *et al.* 2004) suggests that the dugong fishery is not sustainable; a conclusion supported by the Draft Strategic Assessment of the Torres Strait Turtle and Dugong Fisheries (2006). The draft report recommends that a study be undertaken in association with Islander communities to identify/evaluate alternative mechanisms available at the community level to limit and monitor catch. Spatial models of dugong distribution and relative density developed by Grech and Marsh (2007) inform such a study by providing Islanders and management agencies with scientifically robust information on the spatial distribution of dugongs that take into account the large scale dugong movements resulting from changes in seagrass habitats, because their models are based on integrated data from multiple aerial surveys spanning more than two decades. Spatial models of dugong distribution and abundance can also provide the science base for assessing management options such as spatial closures to hunting or limiting the hunting of each community to their own sea country, through a spatial risk assessment approach (Grech and Marsh, 2008).

Objectives

Our first objective was to empower communities in the Torres Strait to work with government in accordance with the National Partnership Approach and make decisions about the management of natural resources by increasing their capacity to integrate their Indigenous Knowledge with information collected by western scientists. To achieve our objective, we conducted GIS and GPS training and community mapping workshops with eight communities participating in the NAILSMA and Torres Strait Regional Authorities (TSRA) Cross-regional Dugong and Marine Turtle Management Project: Mabuiag, Badu, Murray (Mer), Darnley (Erub), Yorke (Masig), Yam (Iama), Boigu, and Horn (Ngurapai) Islands (Figure 1). A workshop was also conducted for rangers of Hammond Island.

Our second objective was to produce spatial models of dugong distribution and relative density in Torres Strait from data integrated across six aerial surveys from 1987-2006. The resultant maps were provided to Islander communities and management agencies (such as TSRA) to inform negotiations about shared responsibility strategies for ensuring that the Torres Strait dugong fishery is sustainable as part of the *National Approach to Sustainable Harvest of Marine Turtles and Dugongs in Australia*.

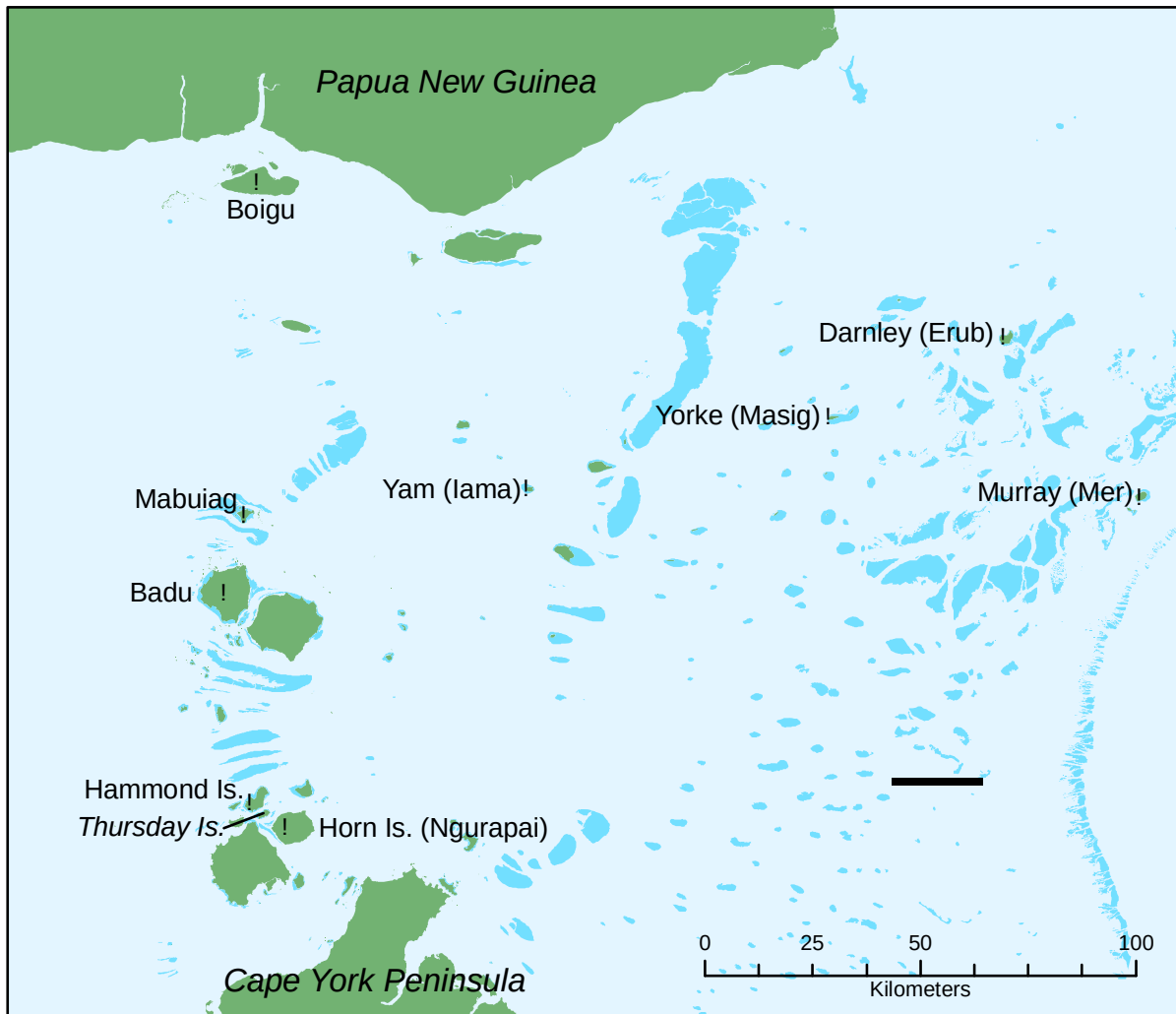


Figure 1: Locations of GIS and GPS training and community mapping workshops with eight communities participating in the NAILSMA and Torres Strait Regional Authorities (TSRA) Dugong and Turtle Project, and Hammond Island.

Methods and Results

Community GIS workshops in Torres Strait

With the assistance of TSRA's Land and Sea Management Unit, NAILSMA and TSRA's Cross-regional Dugong and Marine Turtle Management Project Dugong and Turtle Project Officers (Table 1), and local councils, community GIS workshops were arranged at Mabuiag, Boigu, Yam (Iama), Yorke (Masig), Darnley (Erub), Murray (Mer), Badu, and Horn (Ngurapai) Islands. Rangers from Hammond Island attended the Horn Island workshop. Workshops were conducted by PI Alana Grech, Indigenous counterpart Stephen Ambar of the Hammond Island Council, and Dugong and Turtle Project Officers.

Workshops were held in February, March and April 2008 (Table 1). The duration of the workshops varied depending upon the size of the community and the number of participants. The minimum duration of a workshop was one day, and the maximum three days (Table 1). Participants at the workshops were recruited by Dugong and Turtle Project Officers and local councils. In total, the number of participants at the workshops was 136 (Table 1). Workshop *participants* had a variety of occupations, as summarized in Appendix 1.

Table 1: Itinerary of GIS and GPS training and community mapping workshops, including the name of Dugong and Turtle Project Officers and the number of participants recorded at the workshops. The total number of participants was 136.

Community	Dugong and Turtle Project Officer	Workshop duration	Number of participants
Mabuiag	Mr. Terrence Whap	6-8 February	28
Boigu	Mr. Ishmael Gibuma	11-12 February	21
Yam (Iama)	Mr. Charles David	18-19 February	17
Yorke (Masig)	Mr. Michael Morris	21-22 February	12
Darnley (Erub)	Mr. Kenny Bedford	25-26 February	32
Murray (Mer)	Mr. Moses Wailu	28-29 February	8
Badu	Mr. Solomon Nona (Council Secretary)	3-4 April	10
Horn Is. (Ngurapai)	Mr. Pearson Wigness	9-10 April	4
Hammond Is.	Mr. Stephen Ambar	9-10 April	4

At the beginning of each workshop, all participants were given an Information Page and Informed Consent Form to read and sign. Participants were encouraged to discuss the contents of the Information Page and Informed Consent Form with PI Alana Grech, Indigenous counterpart Stephen Ambar and Dugong and Turtle Project Officers before agreeing to participate in the workshop. Intellectual property and access to information (data sharing) protocols needed to be established to facilitate authorisation of data to be transferred or shown within a community and to external agencies, including other communities. At the beginning of each workshop, concerns regarding safe storage of spatial information, intellectual property and data sharing were discussed in an open forum. During

the open forum, community members were asked to discuss: (1) spatial datasets collected by an individual or community during the workshop; (2) who should have access to these datasets (individual/community/TSRA/JCU etc.); and (3) how can those who access the dataset use it (eg. can it be used for research, fisheries management etc).

PI Alana Grech produced a GIS and GPS training manual for participants prior to the commencement of the workshops. All participants were provided with a hard copy version of the training manual; Dugong and Turtle Project Officers were provided with hard copy and digital versions. PI Alana Grech and Indigenous counterpart Stephen Ambar supplied GPS units, GIS software, laptops, and spatial data layers to workshop participants in the context of a comprehensive introduction to all aspects of GIS and GPS, as well as hands-on experience using GIS/GPS to address and solve natural resource management problems that affect Torres Strait Islanders.

There are many GIS software options available. Training was conducted using ESRI's ArcGIS® 9.2 which is the most popular GIS software available on the market. There are also many types of GPS units. Training was conducted using Garmin eTrex®, a physically robust GPS unit that is commonly used in Torres Strait.

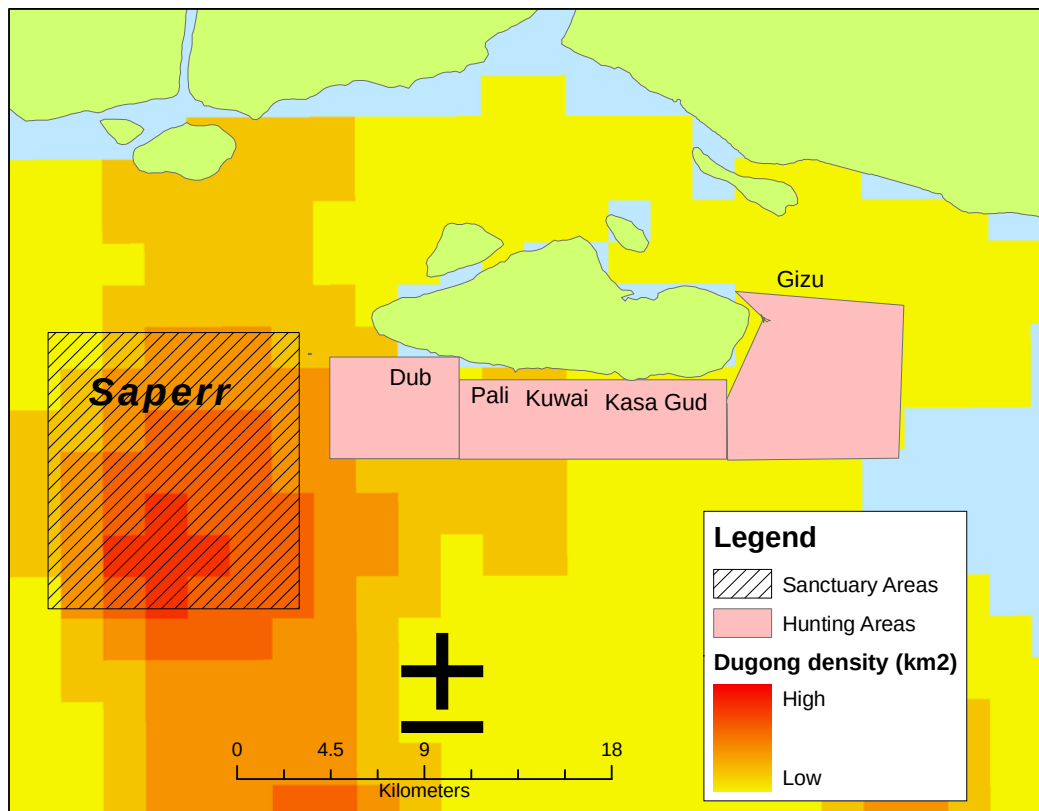


Figure 2: An example of a digital map that combines Indigenous Knowledge with information collected by western scientists created by a workshop participant from Boigu (and published with permission). Dugong sanctuary and hunting areas were mapped and identified using traditional names. This information was overlaid with the spatial model of dugong distribution and relative density (Grech *et al.*, this report).

Each workshop had two components: GPS training was conducted during the first half of the workshop, followed by GIS and community mapping training. GPS training consisted of an introduction to the Garmin eTrex and field exercises. During field exercises, participants were encouraged to record (with GPS units) information they consider relevant to the management of natural resources in their community, including sites of high marine turtle and dugong density, community infrastructure, weeds, and areas of habitat destruction. GPS and community mapping training consisted of exercises in ArcGIS® 9.2 as described in the training manual. *Participants* used their own data collected in GPS training during GIS and community mapping training. Hard-copy maps were provided to participants to assist in the recording of spatial information. *Participants* learnt how to record spatial information in a digital format using ArcGIS® 9.2. *Participants* also learnt how to integrate their information with spatial information obtained from scientific organizations including James Cook University, Geoscience Australia, and the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO). This information will form the GIS-based DSS that integrates Indigenous Knowledge with Western Scientific Knowledge for communities in Torres Strait. An example of a digital map that combines Indigenous Knowledge with information collected by western scientists created by a workshop participant from Boigu is given in Figure 2.

On the completion of the workshop, Indigenous counterpart Stephen Ambar and Dugong and Turtle Project Officers hosted a group forum giving *participants* an opportunity to discuss what they learnt during the workshop and provide PI Alana Grech with information to assist in improving the standard of future workshops. Participants were asked: what they liked about the workshop; what they didn't like; how they think it could be improved; and how they will use the skills they have learnt in the future. Indigenous counterpart Stephen Ambar recorded participant's responses, and a summary of each community's group forum is given in Appendix 1. No names, addresses or any other identifying information were recorded so responses to the questions cannot be traced to an individual.

Raw data (including responses of individuals during the group forum, and map outputs) were stored on a password protected laptop during the workshops, and are currently stored on a password protected PC in a locked office at School of Earth and Environmental Sciences of James Cook University in Townsville. This data will be retained for at least five years. A copy of all outputs (hard-copy and digital) derived from the workshops was given to Dugong and Turtle Project Officers and local councils who can distribute this information to participants. *Participants* who gave consent were photographed during the workshops. Copies of all photographs were given to Dugong and Turtle Project Officers and local councils. All participants were given a certificate acknowledging their presence at the workshops (Appendix 2). Dugong and Turtle Project Officers were also given a GPS unit (Garmin eTrex® h series) and multiple licenses to the GIS software ArcGIS® 9.2.

Spatial model of dugong distribution and relative density in Torres Strait

Dugong aerial surveys of Torres Strait

Aerial surveys conducted by Marsh and her group at James Cook University have systematically monitored dugong abundance and distribution in Torres Strait since the mid 1980s, providing empirical data on patterns of dugong distribution and abundance (Marsh and Saalfeld 1989, 1990; Marsh *et al.* 1993, 1996; Marsh and Lawler 2001, 2002).

Aerial surveys were conducted using the strip transect method described by Marsh and Sinclair (1989). The survey region was divided into blocks containing systematic transects of varying length, which were typically perpendicular to the coast across the depth gradient which supports seagrass in the region. Tandem teams with two observers on each side of the aircraft independently recorded sightings of dugongs, including information on group size

and calf numbers, and the number at the surface. Transects were 200m wide at the water's surface on either side of the aircraft. These surveys have been used to estimate absolute dugong abundance by correcting sightings for perception bias (animals that are available to but missed by observers) and availability bias (animals that are unavailable to observers because of water turbidity) *sensu* Marsh and Sinclair (1989) and Pollock *et al.* (2006). The corrections for these biases were applied at the spatial scale of entire surveys (thousands of square kilometers), an inappropriate spatial scale for our research. As a result, our model of dugong distribution and abundance is based on relative rather than absolute total density. Nonetheless, the relative densities among regions should be approximately comparable.

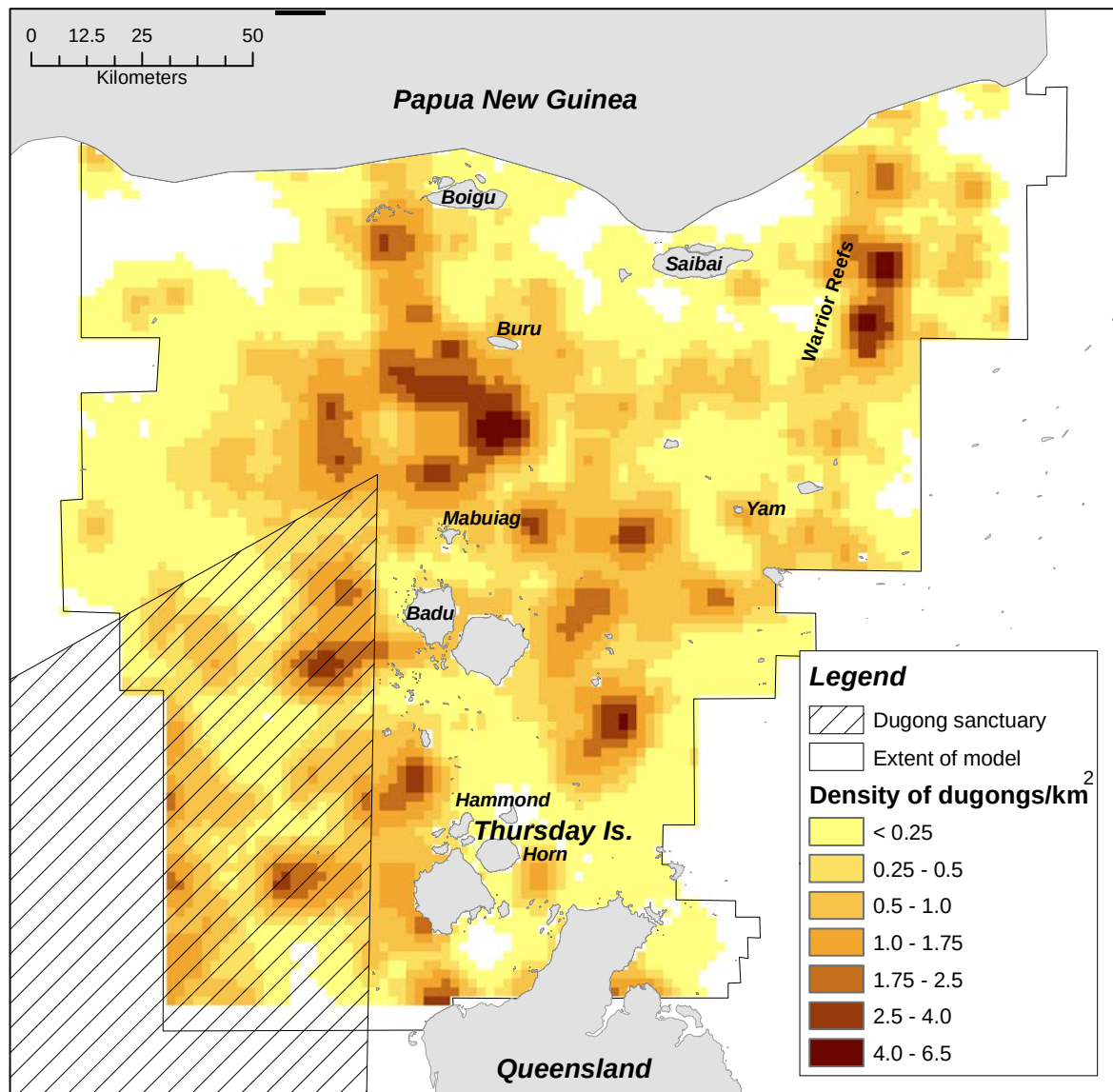


Figure 3: Model of dugong distribution and relative density in Torres Strait based on the dugong sightings from aerial surveys conducted in 1987, 1991, 1996, 2001, 2005 and 2006.

Data analysis was conducted as outlined in Grech and Marsh (2007). Dugong density was calculated at a grid size of 2km × 2km. This scale was chosen as (1) it corresponds with the scale of the aerial survey data allowing us to account for (a) slight changes in altitude of the aircraft (which affects transect width at the surface); and (b) the blind area under the aircraft.; and (2) it is the scale recommended for use by managers of wildlife under Criterion B of the *International Union for Conservation of Nature and Natural Resources Red List* (IUCN 2001). The results of six aerial surveys are available in digital format: 1987, 1991, 1996, 2001, 2005 and 2006.

The sampling intensity of each survey block was determined by calculating the proportion of area surveyed. There are some (relatively minor) differences in sampling intensity per block and area sampled between surveys. The sampling intensity within surveys varies between survey blocks because the survey intensity was stratified depending on dugong abundance, ranging from approximately 4% to 10%. In our analysis, four computations were required to correct for these differences as outlined in Grech and Marsh (2007). The resulting value was divided by the number of surveys conducted on each transect to obtain a mean index of dugong abundance that was then used in our geostatistical analysis.

Geostatistical Analysis

The analysis was conducted in the following sequence. (1) The spatial autocorrelation of the dugong data was investigated by a variogram analysis using the Geostatistical Analyst extension of ArcGIS® 9.1 and a circular model chosen to estimate semivariance. (2) The data was interpolated using a geostatistical interpolation technique (universal kriging). Universal kriging is robust to common attributes of ecological data (Ver Hoef 1993, McKenney 1998) as it returns unbiased linear estimates of point values where trends in data vary and regression coefficients are unknown. The Spatial Analyst® extension of ArcGIS® 9.1 was used to spatially interpolate the data to a 2km × 2km grid (Figure 3). Each grid cell in the final models is regarded as a dugong management unit (DMU). (4) A re-substitution approach was used to validate the model resulting from the geostatistical analysis.

Categorising dugong management units

We used the same range of values of dugong density as Grech and Marsh (2007) to categorise dugong management units as low, medium or high ecological value for dugongs in Torres Strait (Figure 4). Our approach assumes that dugong density is a robust index of a region's conservation value for dugongs. This assumption is justified because: (1) density estimates are regarded as suitable surrogate measurements of habitat use, and (2) no critical habitats for dugongs have been identified other than the seagrass meadows where they spend most of their time. By using the time series of data collected over 19 years, the model accounts for temporal changes in the use of various regions by dugongs including movements resulting from events such as seagrass dieback.

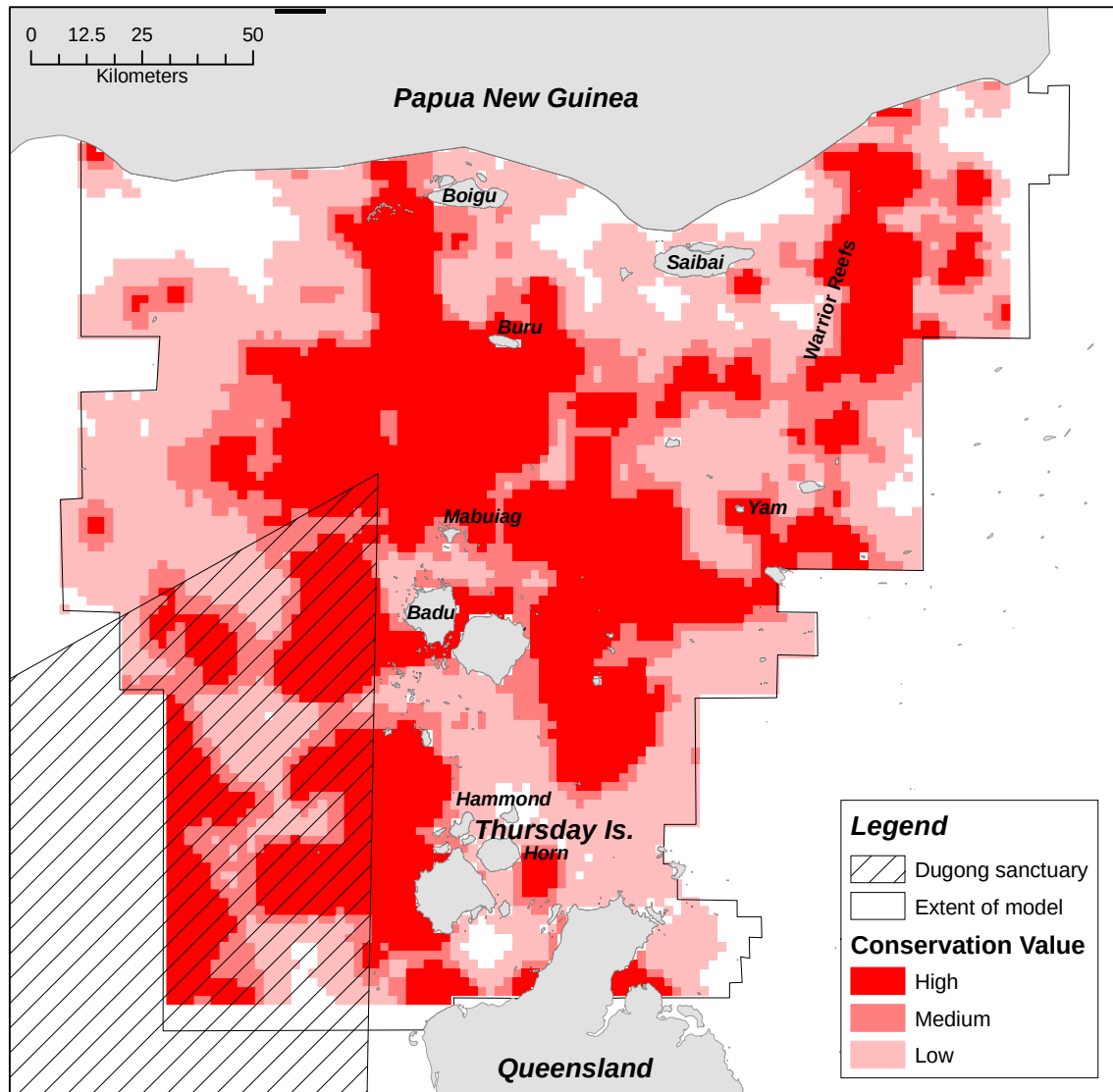


Figure 4: Model of the ecological value of dugong habitats in Torres Strait based on the dugong sightings from aerial surveys conducted in 1987, 1991, 1996, 2001, 2005 and 2006.

Dugong distribution and relative density in Torres Strait and eastern Queensland

The areas of highest relative dugong density in the Torres Strait are between Buru and Mabuiag Islands and along the Warrior Reefs (Figures 3 and 4). In contrast to previous assessments, our model indicates that the Torres Strait dugong sanctuary encompasses a large region of high and medium conservation value to dugong (Figure 4), indicating the potentially significant value of the spatial closure of this region, provided it is effectively enforced. Nonetheless, it must be noted that a potentially significant proportion of the sanctuary (54%) has not been surveyed as the region cannot be safely surveyed using light aircraft. The remaining 46% of the sanctuary that are within the limits of the spatial model include 2,460, 1,337 and 1,254km² of high, medium and low conservation value areas respectively. High conservation value areas encompass 45 % of the sanctuary that are within the limits of the spatial model. The dugong model shows areas of high and medium conservation value at the western limits of the survey region including parts of the sanctuary (Figure 4). This suggests that there are more high and medium conservation value areas

within the sanctuary that are not identified in the model. Thus, we believe that: (1) dugong aerial surveys do not cover the entire distributional range of dugongs in the region, and (2) a significant proportion of high value dugong habitat probably already functions as a *de facto* spatial closure because it is beyond the range of Indigenous hunting. It will be important for the Australian government to ensure that dugong poaching by foreign fishing vessels does not occur in this region.

We have previously developed models of dugong distribution and relative density for the Great Barrier Reef World Heritage Area (GBRWHA) and south-east Queensland (Moreton Bay and Hervey Bay). We combined these models with the Torres Strait model to create a continuous distribution map for the east coast of Queensland (Figure 5). We compared the amount of dugong habitats of high, medium and low conservation value along the east coast of Queensland and found the Torres Strait comprises 74% of the total high conservation value dugong habitats and 63% of the total medium value habitats (Table 2). A greater proportion of the Torres Strait region is comprised of high value dugong habitats (36%; Table 3) than in the inshore Great Barrier Reef region or south-east Queensland. This analysis shows that dugong habitats in the Torres Strait are the most important along the east-coast of Queensland, and almost certainly the world.

Table 2: Proportion (%) of the area surveyed for dugongs on the east coast of Queensland, which was classified as high, medium or low ecological value to dugongs, and that occurs in Torres Strait, inshore Great Barrier Reef World Heritage Area (GBRWHA) and southeast Queensland (SEQ) respectively.

	Total Area (km ²)*	High	Medium	Low
Torres Strait	27,232	74	63	26
GBRWHA	32,066	16	23	67
SEQ	5,496	9	14	7

* Areas surveyed and rated as high, medium and low ecological value for dugongs, respectively.

Table 3: Proportion (%) of Torres Strait, inshore Great Barrier Reef World Heritage Area (GBRWHA) and southeast Queensland (SEQ) habitats that have been surveyed for dugongs and classified as high, medium and low conservation value dugong habitats.

	Total Area (km ²)*	High	Medium	Low	No Value
Torres Strait	30,482	36	19	34	11
GBRWHA	70,355	3	3	39	54
SEQ	6,715	20	19	43	18

* Total area surveyed.

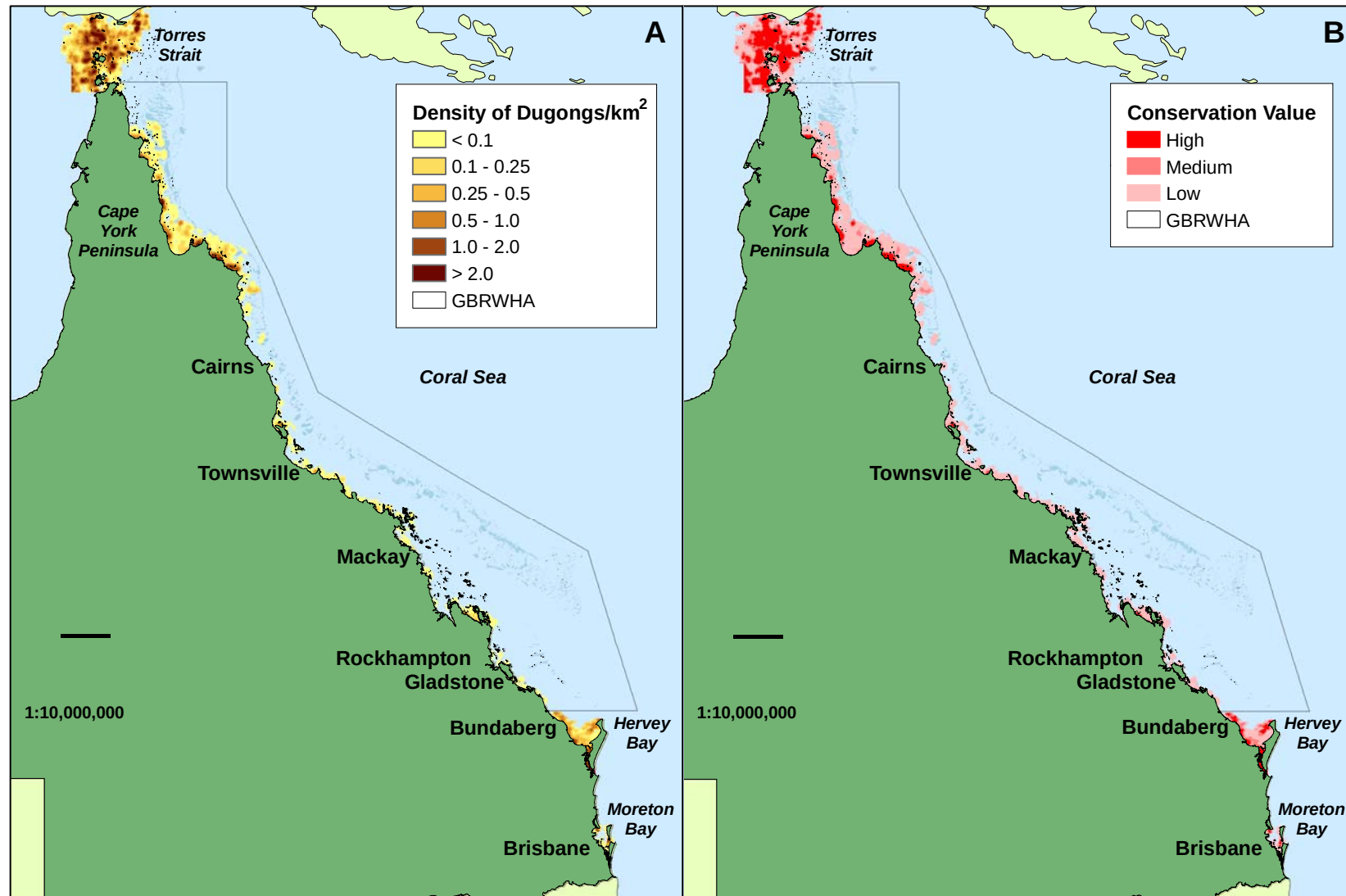


Figure 5: Models of dugong distribution and relative density (A) and ecological value (B) based on dugong aerial surveys conducted since the mid 1980s along the east coast of Queensland.

Discussion, Conclusions and Recommendations

The workshops we conducted on using GIS and GPS and community mapping in nine Torres Strait communities had two major outcomes: (1) they increased the capacity for 136 Islanders (126 men and 10 women) to collect spatial information; and (2) they increased the capacity of these people to interpret and apply the spatial information collected by western scientists. A comprehensive introduction to collecting and storing information using GIS and GPS was provided to workshop participants. Participants also learnt how to integrate their Indigenous Knowledge with Western Scientific Knowledge using GIS. Spatial information collected by government organizations was provided to Dugong and Turtle Project Officers and workshop participants to produce components of a preliminary GIS-based DSS that integrates Indigenous Knowledge with Western Scientific Knowledge for each of the participating communities in Torres Strait. Most of this information is confidential to the communities in accordance with the data sharing agreements that we developed and which were integral to the acceptability of the workshops to the Islanders.

Workshop participants came from nineteen occupations and included rangers, Landcare officers, AQIS officers, Environmental Health officers, SES officers, Council members, and fisherman (see Appendix 1), demonstrating the potentially wide range of applications of these technologies for Torres Strait Islanders. Participants identified multiple ways in which they can use the training provided to them during the workshops including: navigation, fishing, dugong and turtle management (including the design of spatial closures), weed management, mapping of sacred sites, safety, pest management, town planning, and presentations and communication of information (a comprehensive list is provided in Appendix 1).

The involvements of Indigenous counterpart Stephen Ambar was integral to the overall positive response to the workshops because of his: (1) understanding of cultural protocols; (2) enthusiasm for both the technology and opportunities provided by holding such training in Torres Strait communities; and (3) ability to communicate with Torres Strait Islanders in their own language. The major limitation to the success of the workshops was equipment availability: the small number of laptops (2) and GPS units (4) available for training. Equipment availability and maintenance would be the major impediments to the long-term use of such technology in the outer islands of Torres Strait.

The diversity and number of participants who gave up their time to attend a workshop highlights the demand for adult education and capacity building in technologies such as GPS, GIS and community mapping from Torres Strait Islanders. The workshops also provided an opportunity for building trust and improving communication between Indigenous communities and western scientists. The long-term effectiveness of the workshops was undoubtedly limited by time and financial constraints, but we believe that they were very cost-effective as a small contribution to what needs to be a very significant and long-term capacity building program for adults in the Torres Strait. Participants were generally very positive about the GPS and GIS training (see Appendix 1), and many communities requested additional training.

Digital and hard-copy versions of the spatial model of dugong distribution and relative density were provided to Dugong and Turtle Project Officers, workshop participants and TSRA to inform their regional resource management initiatives. It was appropriate to deliver the model of dugong distribution and relative density to each community through our workshops as they provided an opportunity for community members to have their concerns addressed directly and learn how to use the model in conjunction with their own Traditional Ecological Knowledge via a GIS-based DSS. Results from the 2006 dugong aerial survey conducted by Helene Marsh and her Group (MTSRF Program 4 – Project 1.4.2) were also discussed with

community members. We found that presenting the results of the dugong aerial surveys as a continuous spatial model was an effective method of communicating the aerial survey results. Islanders found the maps of dugong distribution and relative density very easy to understand and many attendees confirmed that the Western Science information on dugong distribution and abundance was congruent with their Indigenous Knowledge. The Islanders' positive reactions to the maps of our continuous spatial model contrasted with their much less positive reactions to our previous presentations of the aerial survey results as maps showing dugong sightings as point data, a format preferred by some western environmental managers. In our experience, Indigenous people find the point data difficult to comprehend and to relate to their own knowledge.

The spatial model will inform the ongoing negotiations about shared responsibility strategies for ensuring that the Torres Strait dugong fishery is sustainable. Eight communities are in an advanced stage of preparing Dugong and Turtle Management Plans. The draft Strategic Assessment of the Torres Strait Turtle and Dugong Fisheries Report (2006) commissioned by the Australian government, recommends that 'a study be undertaken in association with Islander communities to identify/evaluate alternative mechanisms available at the community level to limit and monitor catch' (Kingston, 2006). Our spatial model of dugong distribution in Torres Strait contributes to the fulfillment of this recommendation by providing Islanders and management agencies with scientifically robust information on the spatial distribution of dugongs in Torres Strait, as the part of the science base for assessing management options such as spatial closures to hunting or limiting the hunting of each community to their own sea country.

We plan to extend this work on the spatial distribution of dugongs in Torres Strait and the associated training in the use of GIS at a workshop on Thursday Island scheduled for October 2008, which will explore the benefits of and challenges associated with using spatial closures as one of the tools for community-based management of dugongs and turtles in Torres Strait. If funding is available, we plan to develop spatial models of turtles for Torres Strait from CRC Torres, MTSRF and JCU historical aerial survey data prior to the workshop and to present the results at the workshop. The workshop will further develop the collective capacity and mutual understanding of TSRA Land and Sea Managers, Dugong and Turtle Project Officers, Government agency staff and researchers conducting projects on dugongs and turtles in Torres Strait.

Recommendations

6. That capacity building in the use of GPS and GIS technology is continued as an integral part of the National Partnership Approach for managing the turtle and dugong harvest of Indigenous Australians.
7. That consideration is given to developing a comprehensive and long-term capacity building program that encompasses all communities of the Torres Strait and involves GPS and GIS education and training and community (Indigenous Knowledge) mapping exercises. Indigenous knowledge is being lost at an alarming rate and communities require technical support to assist them in maintaining and actively conserving this information. Such a program would require the development of formal data protocols, will take many years to complete, and requires major financial investment. The program currently in operation with the Rainforest Aboriginal people of the Wet Tropics World Heritage Area could be investigated as a possible model.
8. That Indigenous people be integrally involved in the design and presentation of adult education programs on natural resource management in the Torres Strait.
9. That MTSRF adopt a policy of requiring information collected by researchers to be returned to Torres Strait Islanders through workshops in Torres Strait communities to

provide opportunities for informal discussions between community members and researchers.

10. That MTSRF and TSRA discuss ways of ensuring that Torres Strait Islanders are given the opportunity to assist in the organization and delivery of such workshops.

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Appendix 1

Responses from participants to questions asked by Indigenous counterpart Stephan Ambar on GPS and GIS training and community mapping workshops. The various occupations of participants are also given.

Community	What did you like about today?	What didn't you like about today?	What would have made today better?	How will you use the skills you learnt today in the future?	Participant's occupations
<i>Mabuiag (GPS)</i>	Learning GPS. Simplicity of the GPS units and learning. Training compatible with other GPS units. Fun and exciting. Team work.	Wasting time. Sun was hot outside when collecting waypoints. There was no GPS units for sale. Liaison worker (Stephen) needs to explain more clearly.	There should have been GPS units to sell because it is hard for us to get them.	Find fishing spots and cray stones. Using GPS will help in navigation and help to cut down fuel use. Community planning.	Dugong and turtle project officer Environmental Health officer Sports and Recreation officer Council office administrator
<i>Mabuiag (GIS)</i>	Get to use laptop. Learning how to use ArcMap. Figuring out how to use laptop.	Not good catering. Too much breaks. Need more laptops (need to do training at a place with more laptops).	Bigger projector to the white board. Shorter break periods.	Will need for cray fishing Land site planning Dugong and turtle management Map traditional sites Community planning (land divisions)	Rangers Cray fisherman Community members
<i>Boigu (GPS)</i>	Leant to use GPS – this was the first time for everyone. Good and new experience.	Need to break down explanation more and make it clearer.	More computers and more GPS. Need to go out on the water to practice marine GPS Course needs to be longer – teacher needs to come back to Boigu	Working in the bush Fishing Travel to Thursday Island	Dugong and turtle project officer Police officer Fisherman Librarian Ladies (CDEP workers)
<i>Boigu (GIS)</i>	It was good creating maps and identifying the tools.	The course was too short – because of the current education status of the community, the teacher needs to return and run the course for a longer period of time (two weeks – month).	If there were more GPS waypoints collected on Monday – more of Boigu could have been mapped.	Fishing Mapping the island Gardens Wet area Use in travelling from island to island	Community members Elders

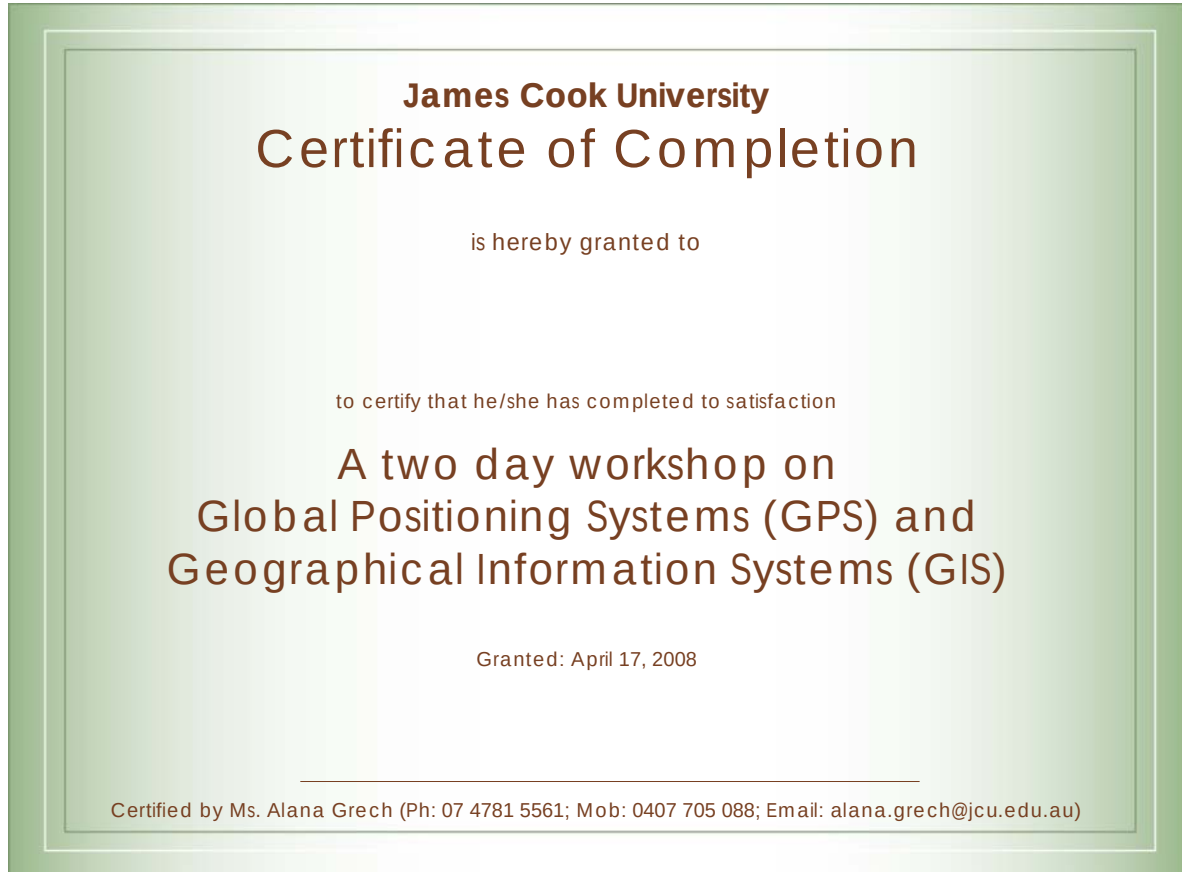
Community	What did you like about today?	What didn't you like about today?	What would have made today better?	How will you use the skills you learnt today in the future?	Participant's occupations
<i>Yam (GPS)</i>	Learnt how to operate GPS. Teaching was nice and clear – we could understand the answers to our questions. Good to have hands on experience with GPS.	Computer error. We needed to collect more GPS waypoints (marine GPS and outside the community).	Bigger projector whiteboard. More laptop and GPS. More planning would have allowed us to use the workboat to go out and collect waypoints on the water.	Safety At work (water officer) Helping each other (liaise with one another) Children will learn how to use it. AQIS officer said when he sets fly trap; he could collect fly trap and bricks for dengue mosquito's waypoints. Help cray fishing. Mapping sacred sites.	Dugong and turtle project officer Water officer Environmental Health officer AQIS officer Landcare officer Policeman SES officer Cray fisherman
<i>Yam (GIS)</i>	Learning how to use a computer. Learning how to put a legend on a map. Community liked the way teachers conducted the course – they made it very simple and easy to learn. Training was very good (best ever on the island).	Everything was good about today.	More computers (5 or 6).	Everyday life Work Trying to get the young kids interest GIS knowledge will be handy for future SES officer said GIS knowledge would be handy for future jobs (cargo boats) Land division	
<i>Yorke (GPS)</i>	We liked the GPS course because we found out how easy using GPS is.	Everything was ok. Not many GPS.	More GPS – bring some to sell.	Plotting fishing spot. Save petrol Manage tourism. Save fuel when taking visitors out.	Second dugong and turtle project officer SES officer/councillor Pastor School teacher Cray fisherman
<i>Yorke (GIS)</i>	Interesting. Using a computer was exciting. Questions were answered clearly. Happy with the number of	Time was too short – need a longer period. Bring more laptop. Come more often to refresh the mind.	Four days training. Planning full days. Planning not to interfere with other trainers visiting.	Map the reef and fishing spots. Mapping safe route from island to island. Implement in sponge project. Use as a management tool	

Community	What did you like about today?	What didn't you like about today?	What would have made today better?	How will you use the skills you learnt today in the future?	Participant's occupations
	people that turned out. Excellent catering.			Management of SES emergency.	
<i>Darnley (GIS)</i>	GPS was interesting. GPS was clear to understand. Working in groups was effective.	Hot.	More information about GPS and how to use it. More GPS and different models of GPS.	Fishing Exercise Travelling to other islands safely Landcare Sacred site management AQIS for trapping fruit fly Marking traditional owner boundaries	Dugong and turtle project officer Environmental Health officer Fisherman (professional) Construction workers/road workers Ergon person Landcare officers AQIS
<i>Darnley (GPS)</i>	GIS program interesting. It was good experience. Good (Stephen and Alana working with indigenous people –liked how they projected themselves and their teaching style). Very good to learn about computers. Beautiful catering.	Not enough computers. Air-con needed. Time on computers wasn't long enough. Smaller group required – one day per group. Need more time on computers. Need more basic computer training before GIS workshop starts.	More computers. Smaller groups. Need to have workshop on lat and long. Bring a map with lat and long to explain.	Cray fishing Exercise Use to manage land boundaries Town planning Landcare work Ergon work Navigating reefs Search and rescue	
<i>Murray (GPS)</i>	Got experience with GPS. Very clear explanations about GPS.	GPS 1 wasn't working very well. Time was too short. Didn't accomplish GIS mapping. One participant had asthma and didn't want to walk.	Some support from local council (transport). More GPS units. Up to date GPS units. Longer period (couple more days).	Fishing. Using with other skilled jobs in the community.	Dugong and turtle project officer Fisherman (professional) Water officer Landcare
<i>Badu (GPS)</i>	Learnt something new. Makes life easier. Nice catering for food. Alana and Stephen were very good at explaining.	Nothing – everything was good about today.	More council support (at least one attendant). Need transport to go out and get waypoints. More up to date GPS. More GPS units.	Work. Travelling to and from islands. Safety. Animal management work.	Animal management (2 officers) Fisherman Pastor Lang and sea ranger

Community	What did you like about today?	What didn't you like about today?	What would have made today better?	How will you use the skills you learnt today in the future?	Participant's occupations
<i>Badu (GIS)</i>	Learnt about GIS technology. It's a good technology for us. It was interesting – first time on GIS. Catering was excellent. Alana and Stephen were very good at explaining the GIS.	Everything was ok.	More days training. Have GPS units to sell.	Diving Cray fishing Travelling to other island Pig hunting Town planning	CDEP workers
<i>Hammond/Horn (GPS)</i>	A good refresher course in GPS. Good to use different types of GPS. Catering was very good. Everything was very well planned.	No air conditioning. Better to have hot food for lunch.	We should have been told more about what we were going to do today. We would like to go out in the field to plot more waypoints. Longer workshop.	Conservation land management Recreation Fishing SES	Rangers from Horn and Hammond Islands
<i>Hammond/Horn (GIS)</i>	The GIS program was very interesting. Alana's teaching was very good and clear and slow – easy to understand		Need finger food. Small space were we did training More laptops Longer workshop More detail on some of the exercises.	Weed management Ghost net Presentations Local news letter Water line management Ergon pole Land management Planning for the future Help for funding applications Mapping of sacred sites Fire management Emergency management (SES) Management of bush tucker	Rangers from Horn and Hammond Islands

Appendix 2

Certificate acknowledging completion of the two day training course given to participants who attended the workshops.



Appendix 4: MTSRF Project 1.4.2
Dugong aerial survey results featured in popular media.



GPS/GIS Training for the Torres Strait

On 6 February to 4 March 2008, Global Positioning System (GPS) and computer mapping training was held at seven communities involved in the NAILSMA Dugong and Turtle Project.

Dugong and Turtle project officers arranged the two day workshops on Mabuiag, Boigu, Iama, Masig, Erub, Mer and Badu Islands.

The workshops were conducted by Alana Grech, a GPS and computer mapping expert from James Cook University in Townsville and Stephan Ambar, a community ranger from Hammond Island.

Participants in the workshops learnt how to use GPS to record geographic information

(waypoints) and how to navigate using GPS. Participants also learned how to make their own maps using information they collected using GPS and computer mapping programs.

Community members gave positive feedback about the GPS and computer mapping training, saying that it will assist them with boat navigation, fishing, dugong and turtle management, community planning, mapping traditional sites, pest and weed management, and search and rescue.

Alana and Stephen will be conducting a GPS and computer mapping training workshop for

Horn and Hammond Island community rangers in early April.



Stephen Ambar teaching Erubam le how to use the GPS for mapping. Photo by Alana Grech.

Appendix 4: MTSRF Project I.4.2
Dugong aerial survey results featured in popular media.



Weekend Australian
Saturday 26/4/2008
Page: 19
Section: Inquirer
Region: National Circulation: 303,000
Type: National
Size: 1,086.99 sq.cms.

Brief: JCU
Page 1 of 3

Hunting towards oblivion

Indigenous hunters are taking a heavy toll on the country's wildlife, writes **Greg Roberts**

PETER Guivarra recalls how the sky would thicken at this time of the year with vast numbers of magpie geese that nested in swamps near his home settlement, Mapoon, on Cape York Peninsula's western side.

With thousands of geese being shot annually by indigenous hunters, Guivarra, chairman of the Mapoon Aboriginal Shire Council, says the bird population is a fraction of what it was 10 or 15 years ago.

Says Guivarra: "There were hundreds of thousands, but now it's thousands and the numbers get smaller every season. I want my sons and grandsons to be able to hunt, but at this rate they won't be able to."

Across the Gulf of Carpentaria, in the wetlands of Kakadu National Park in the Northern Territory, indigenous hunting of magpie geese with shotguns is so prolific that untargeted wildlife are suffering lead poisoning from spent lead shot ingested while foraging for food.

Guivarra is among a growing band of indigenous leaders that believes hunting by their people is excessive and no longer sustainable. The leaders argue that a combination of increased human populations and the use of firearms, vehicles and motorboats has distorted traditional notions of hunting.

"It is easy these days for too many animals to be killed," Guivarra says. He adds that hunting is jeopardising plans by the Mapoon

people to emulate Kakadu's success as an ecotourism destination. "We have the same wetlands and waterbirds, but soon there won't be anything for people to come and see," he says.

Debate over indigenous hunting has been ignited by Japan's move to attack as hypocritical Canberra's support for the indigenous harvesting of dugongs in Australian waters. While Australia leads the charge against Japanese whaling, the number of minke whales killed annually by the Japanese - ostensibly for scientific research

is similar to the number of dugongs killed each year for food in the Torres Strait, about 1000. The Japanese point out that the world population of the minke whale is several times that of the dugong.

Dugongs and sea turtles are traditional mainstays of the diet of Torres Strait Islanders and coastal Aboriginal communities in northern Australia, but on Palm Island, off Townsville, indigenous elder De Nice Gaia says her family refuses to hunt or eat

them. Gaia says numbers of dugongs and turtles in local waters have fallen sharply. As elsewhere, they can be hunted only with harpoons, but there are no bag limits, set hunting seasons or other restrictions.

"It's not traditional hunting when you're chasing an animal in a dinghy with a 40-horsepower motor, and there's no way it can escape," Gaia says the killing is cruel; for

Appendix 4: MTSRF Project 1.4.2
Dugong aerial survey results featured in popular media.



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Size: 1,086.99 sq.cms.

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instance, turtle carapaces are removed while animals are alive in the mistaken belief the meat will be more tender using this process. It is also wasteful. "I find turtles dead on the beach with holes in their shells that have been used as target practice."

Gaita says hunting is culturally significant, but technology has reduced its relevance to the community's cultural fabric.

"There is plenty of other meat available these days. Hunting has become a status symbol. Everyone wants the biggest turtle. If someone comes in with a big turtle, three or four boats go out the next day trying to get a bigger one."

In the Torres Strait, Badu Island Council manager Manai Nona explains the cultural significance of hunting to islanders. Killing a dugong or turtle is part of the rite of passage to manhood for teenage boys. A feast of dugong and turtle is regarded as essential to the success of an important occasion, such as a wedding, funeral or tombstone unveiling. Hunting from boats is how islanders develop seamanship skills. Hunts and feasting ceremonies feature prominently in relationships between island communities. "Hunting is very important to our culture," Nona says.

Dugong and turtle are a leading source of protein and fresh meat in often isolated communities where frozen meat imports are expensive and unreliable. "One dugong can feed an extended family of 10 or 12 people for a fortnight," Nona says. "Dugong and turtle is the best meat. I'll have it any day if the choice is rump steak or lamb chops."

However, Nona agrees that too many dugongs and turtles are killed. "We know there shouldn't be so many taken. The last thing we want is to wipe them all out."

Central to the indigenous hunting debate is whether the harvesting of native animals is sustainable. Does it threaten the survival of species being targeted?

In the Iron Range area of eastern Cape York Peninsula, cassowaries — large, flightless birds found in the rainforests of north Queensland and New Guinea — have long

been valued as food by the Lockhart River people. The wary cassowaries are difficult to stalk and kill by traditional means, but they are easily shot.

Large numbers of the once numerous birds were shot by indigenous hunters; today, cassowaries — an endangered species in Australia — are rarely seen and the future of the Iron Range population is uncertain.

Federal and state authorities are working to avoid a similar fate for dugongs and turtles. Federal Environment Minister Peter Garrett says the Government is undertaking a strategic assessment of the Torres Strait turtle and dugong fisheries. Meanwhile, the available scientific evidence suggests that present levels of harvesting the sea animals are not sustainable.

Australia is home to 80 per cent to 90 per cent of the estimated world population of 100,000 dugongs. While the large sea

mammals listed by the International Union for Conservation of Nature as "vulnerable to extinction in the medium-term future" — range widely in the Indian and southwest Pacific oceans, their numbers have crashed due to hunting pressure and the loss of the seagrass meadows on which they feed. The species is especially vulnerable because it is slow-breeding; a female gives birth to a calf every five years on average.

A new study from James Cook University researchers, commissioned by the federal Environment Department's Marine and Tropical Sciences Research Facility, reports that surveys in 2006 estimated a population of 23,500 dugongs in the Torres Strait and northern Great Barrier Reef, about 25 per cent of the world total. This is close to the number estimated in surveys in 2000 and 2001, but substantially lower than numbers noted in 1996.

Modelling for the study suggests that killing more than 100 to 200 dugongs annually in the Torres Strait and 56 in northern reef waters — a fraction of the present harvest — is not sustainable. The study also says climate change may be affecting dugong numbers by increasing the incidence of seagrass dieback.

JCU dugong expert Helen Marsh says it is difficult to accurately measure dugong numbers because the animals roam over large areas in search of seagrass, but there are concerns about the harvest level in the Torres Strait. Says Marsh: "Scientific evidence suggests dugongs may be over harvested by some Cape York communities and in the Torres Strait. The important thing is to work with indigenous people to ensure the harvest is sustainable."

Marsh adds that she disagrees with Japan's use of the dugong catch to defend its whaling practices. "Their whaling is a commercial harvest done under the guise of research. This is an indigenous harvest that goes back 4000 years."

Surveys indicate that about 5000 green turtles are killed annually for food in the northern Great Barrier Reef, the Torres Strait and adjoining Indonesian and Papua New Guinean waters. Queensland turtle research program manager Colin Limpus, one of the

world's leading turtle authorities, says the regional breeding population, concentrated on Raine Island, was estimated at 50,000 10 to 20 years ago. Limpus says numbers have fallen significantly since then, with hunting accounting for more than half the loss.

"When you can have a single village taking 100 to 200 turtles a year, it adds up to a lot of turtles," he says. "We have concerns for the population's viability."

Nonetheless, Marsh and Limpus are encouraged that indigenous leaders have begun to address the sustainability issue. Six

Torres Strait communities are preparing management plans to limit dugong catches under a program funded by a \$4.6 million

Appendix 4: MTSRF Project I.4.2
Dugong aerial survey results featured in popular media.



Weekend Australian
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Section: Inquirer
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Size: 1,086.99 sq.cms.

Brief: JCU
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commonwealth grant, although Marsh says more funds are needed to expand the program. Other communities are co-operating with authorities to control turtle harvesting. South of the Torres Strait, the Giringun people of the Cardwell area and the Woppaburra people of the Keppel islands have reached agreements with the Great Barrier Reef Marine Park Authority to ban the

hunting of dugongs and restrict turtle catches. Hunting critics want to go further.

Legal researcher Rebecca Smith, who was commissioned to prepare a review last year on laws affecting dugongs for the Torres Strait Regional Authority, believes hunting is cruel: "Harpooning, a hideous death for whales, is no less hideous for dugongs and turtles. An adult male dugong takes up to two hours to die. People know these things, but they're afraid to tackle the issue."

The conservation movement, always sensitive about its relationship with the indigenous community, finds itself in a quandary over the hunting row. The Wilderness Society's northern Australia campaigner Lyndon Schneiders says the society does not oppose indigenous hunting in national parks when it complies with park management

plans. However, as most plans allow hunting, Schneiders contradicts himself when he says the society opposes the use of guns and vehicles for hunting in all national parks.

Indigenous hunting in national parks and other reserves is especially contentious, and management solutions are not easily recognisable when policies vary widely.

In the Karijini National Park in Western Australia, Aborigines can shoot wildlife for food "for themselves and their families". In Katherine Gorge National Park in the NT, the Jawyn people can hunt freely with guns as long as visitor safety is not compromised. In Queensland's Barron Gorge National Park, no firearms can be used without permission and no endangered or vulnerable species can be hunted.

Says Queensland National Parks Association president John Bristow: "National parks are special areas that should be recognised by everyone. Nobody, including indigenous people, should be able to kill wildlife with firearms in national parks."

Mapoon's Guivarra says the crucial issue is not where hunting is restricted but whether it is sustainable. "Our people know that we have to get it right," he says. "We have been managing the country for a long time."

'The numbers get smaller every season . . . It's easy these days for too many animals to be killed. We have the same wetlands and waterbirds (as Kakadu), but soon there won't be anything for people to come and see'

Peter Guivarra, chairman of the Mapoon Aboriginal Shire Council



Bill of health: An endangered magpie goose



It's so, he says, being a conservationist, he'd like to see a ban on the hunting of dugongs, and a restriction on the hunting of waterbirds.

Appendix 4: MTSRF Project 1.4.2
Dugong aerial survey results featured in popular media.



Weekend Australian
Saturday 26/4/2008
Page: 10
Section: General News
Region: National Circulation: 303,000
Type: National
Size: 83.87 sq.cms.

Brief: JCU

Call to safeguard dugongs

Greg Roberts

ABORIGINAL leaders are calling for controls on indigenous hunting in response to mounting scientific evidence that the targeting of dugongs and turtles is not sustainable.

A new study suggests that dugongs in the Torres Strait and northern Great Barrier Reef are under threat because of hunting. Previous reports indicated that populations of green turtles in the same region had also been sharply reduced.

The debate over indigenous hunting has been ignited by a move by Japan to accuse Canberra of hypocrisy for leading the charge against its whaling while condoning the harvesting of dugongs.

Modelling for a new study commissioned by the federal Environment Department's Marine and Tropical Sciences Research Facility was based on surveys of

dugong populations over the past 20 years. The modelling concludes that the killing of more than 100 to 200 dugongs a year in the Torres Strait is not sustainable.

Previous surveys indicated between 1000 and 1200 dugongs were killed in the Torres Strait every year.

The new study estimates the dugong population in the Torres Strait and the northern Great Barrier Reef at 23,500 — about a quarter of the world population of the endangered sea mammal.

James Cook University dugong expert Helene Marsh, one of the study's authors, said scientific evidence suggested too many dugongs were being taken. "I consider that there is time to work with indigenous communities throughout northern Australia to develop community-based management of their dugong and turtle harvests," she said.

Appendix 4: MTSRF Project I.4.2
Dugong aerial survey results featured in popular media.



Australian
Monday 28/4/2008
Page: 9
Section: Letters
Region: National Circulation: 133,000
Type: National
Size: 130.55 sq.cms.
Published: MTWTF

Brief: JCU

Sustainable hunting could provide valuable jobs

THE *Weekend Australian* (26-27/4) carried several articles on indigenous matters, including "Hunting towards oblivion" (Inquirer) and "People's lives 'must come before treaty'" (The Nation). The first expresses concern about the sustainability of indigenous hunting; the second quotes Indigenous Affairs Minister Jenny Macklin as saying that lifting standards of health, education and employment will remain the Rudd Government's "No 1 focus" in indigenous affairs.

These themes should be explicitly linked. Sustainable management of hunting by indigenous communities could provide valuable jobs, help address the social problems in remote communities and protect Australia's biological and cultural diversity. Programs to train and employ indigenous rangers should be the primary mechanism for ensuring local management of sustainable indigenous hunting. Such programs would also increase Australia's capacity to meet its international responsibilities for conserving both biodiversity and cultures.

The Australian government should make long-term commitments to community-based management of indigenous land and sea by implementing innovative and effective government programs with cross-portfolio support. Recurrent and stable funding for community based programs in the remote regions of Australia is essential if such programs are to be successful. The \$90 million already committed over five years to train

and employ up to 300 indigenous rangers could be expanded by cross-portfolio funding to help to address a range of social problems.

Helene Marsh
Professor of environmental science
James Cook University
Townsville, Qld

As an indigenous Australian, I wholeheartedly support Jenny Macklin's comments. While a treaty between black and white Australia, land rights and constitutional recognition of indigenous Australians are important and noble goals, there are more urgent issues to attend to.

When I run the half marathon on the Gold Coast in July, I want to dedicate my run to all abused, neglected and poverty-stricken indigenous children. Like my four younger sisters, I'm a victim of the same abhorrent life. Like most indigenous people, we struggle to have our voices heard because they have been drowned out by indigenous politics. Child sexual abuse, neglect, poor health, lack of education, alcoholism and abject poverty are the only real issues on the political agenda. Address these problems and the rest will follow. For all our sakes, do not let indigenous politics get in the way of substantial progress. We want our lives to change. We want a better future for all indigenous people.

Debra O'Regan
Legana, Tas

Appendix 5: MTSRF Project 1.4.2
Communication of policy implications to the
Australian Minister for the Environment, Heritage and the Arts, The Hon. Peter Garrett MP AM



Graduate Research School
James Cook University

April 2 2008

Hon. Peter Garrett MP AM
Minister for the Environment, Heritage and the Arts
PO Box 6022
Parliament House
Canberra ACT 2600
Peter.Garrett.MP@aph.gov.au

Dear Minister

Australia's policies on whaling and dugong harvesting: inconsistency or opportunity?

Over the last few months, the apparent inconsistency between Australia's positions on whaling and dugong harvesting has received persistent media attention. The issue was raised on Radio National by Dr Jennifer Marohasy, Director of the Environment Unit at the Institute of Public Affairs, and has been kept alive on the internet and in the press. As a dugong expert, I have had inquiries from journalists as far away as Germany. As you are undoubtedly aware, the *Australian* of April 2 2008 claims that Japan intends to raise the issue at the IWC meeting in Santiago later this year.

Some commentators have stridently demanded that the Australian government invest in quantifying the Indigenous dugong harvest. I believe that this would be a very expensive and counterproductive exercise for several reasons including: (1) the large number of communities involved, (2) their remoteness, (3) the intermittent and unpredictable nature of dugong harvesting by most communities, (4) the lack of transparency of the dugong harvest in most communities – dugongs are often butchered far from communities, (5) the lack of estimates of dugong population size in many areas to provide a scientific context for the harvest, and (6) the risk of damaging the fragile partnerships that exist between Indigenous communities and government, especially in view of (7) the absence of data – or attempts to gather data - on most other sources of human-induced dugong mortality particularly bycatch in commercial gill nets.

There is scientific evidence that suggests that dugongs may be over-harvested by some Cape York communities and also in Torres Strait where the dugong harvest by Indigenous Australians and Papua New Guineans is classified as a fishery under the Torres Strait Treaty between Australia and Papua New Guinea. Some Traditional Owners share the scientists' concerns about the situation in these areas. The sustainability of the harvest is uncertain in most other parts of northern Australia

Nonetheless, the Australian dugong population is large (particularly in Torres Strait), relative to all other parts of the dugong's range. I consider that there is time to work with Indigenous communities throughout northern Australia to develop community-based management of their dugong (and turtle) harvests as advocated by the 'National Partnership Approach'. Nonetheless, I am concerned that the dedicated funding to support this approach appears inadequate. I am also concerned that the government is not maximizing the returns on its investment in research to support this approach as such research is funded from a diversity of sources and is largely uncoordinated.

The Dugong and Turtle Project conducted by the NAILSMA in association with the Torres Strait Regional Authority has made significant progress in working with some communities to develop community-based dugong and turtle hunting management plans.

Appendix 5: MTSRF Project 1.4.2
Communication of policy implications to the
Australian Minister for the Environment, Heritage and the Arts, The Hon. Peter Garrett MP AM

But the initiatives to date have not had the funds to cover nearly all hunting communities. In addition, developing plans is just the first step in effective community-based management. The real challenge is plan implementation which will require long-term investment in supportive policies, employment, capacity building, and infrastructure. On several occasions, previous governments have made the mistake of limiting their investment to planning and such exercises have invariably failed to make a difference and have left concerned Traditional Owners frustrated and disillusioned.

I believe that rather than investing in quantifying the dugong harvest per se, the Australian government should make long-term commitments to implementing community-based management of dugong and turtle hunting through 'Caring for Country' programs as part of its strategy of 'Closing the Gap'. I note that the government has made a \$10 million commitment to the development of Traditional Use Resource Management Agreements in the Great Barrier Reef Region. I also applaud the commitment by the government to invest \$90 million over five years to train and employ up to an additional 300 Indigenous rangers on Indigenous lands and waters but am uncertain about how much of this money will be spent in dugong and turtle hunting communities.

Recurrent and stable support for community-based ranger programs in the remote regions of tropical Australia will provide valuable employment opportunities for Indigenous Australians. These employment opportunities could help address the social problems in these communities while helping to protect Australia's tropical biodiversity (including dugongs and turtles) and cultural diversity. Such programs would also increase Australia's capacity to meet our international responsibilities for conserving both biodiversity and cultures.

I believe that concerns about the sustainability of the dugong and turtle harvest should be regarded as an opportunity for the Australian government rather than a problem.

However, I consider that in order to maximize this opportunity the government needs to:

- Provide the National Partnership Program with the funding required for it to play an effective national coordination role and allow it to work with DFAT attempt to influence the situation in the Western Province of PNG;
- Fund the development and implementation of community-based management plans in all dugong and turtles hunting communities in northern Australia, not just the development of plans in a few communities as at present;
- Give priority to the communities in the Torres Strait region where the level of hunting is apparently higher than anywhere else and where considerable progress has been made in developing hunting management plans;
- Develop a co-coordinated research plan to ensure that these initiatives are evidence-based.

Along with the other members of my research group, I look forward to working further with your Department on this important matter.

Yours sincerely,



Professor of Environmental Science