

# Developing collaborative marine turtle monitoring in the Kimberley region of northern Australia

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*Contemporary land and sea management – driven by community-based planning and informed by traditional and local knowledge and scientific research – can significantly improve both biodiversity and cultural outcomes. Here, we describe the context and process of developing a boat-based survey approach to marine turtle monitoring by Indigenous rangers using a collaborative partnership model that supports Traditional Owner aspirations and conservation objectives.*

**Key words:** boat-based marine wildlife survey, community-based planning, Indigenous land and sea management, I-Tracker, marine turtle.

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## Introduction

Participatory, community-based approaches to monitoring the health of wildlife populations, especially when led by Indigenous people holding traditional and local expert knowledge, are fast gaining support



**Figure 1.** Uunguu Rangers and researchers completing boat-based marine turtle surveys (photograph: Michael Lawrence-Taylor).

## Box 1. Contemporary land and sea management by Indigenous people in Australia

Recent decades have seen a significant increase in the area of land in Australia that Indigenous (Aboriginal and Torres Strait Islander) people have formal ownership over and/or recognised rights to (Altman and Whitehead 2003). This has occurred largely through decisions under the Commonwealth *Australian Native Title Act 1993* and the *Aboriginal Land Rights (Northern Territory) Act 1976*, which have granted both exclusive rights (rights to possess and occupy an area to the exclusion of others) and nonexclusive rights (a defined set of rights to use the area for activities including hunting, fishing and practising of customary law) to terrestrial and coastal areas. Resourcing Indigenous communities has subsequently developed into a cost-effective approach to natural resource management and biodiversity conservation over large tracts of land, particularly in northern Australia (Altman & Whitehead 2003; Morrison 2007). Various approaches have been taken including establishment of Indigenous ranger groups (Commonwealth of Australia 2009); co-management of national, state and marine parks; conservation partnerships with nongovernment organisations (NGOs); commercial acquisition of freehold and leasehold land; and establishment of Indigenous Protected Areas (IPAs). IPAs are Indigenous-owned terrestrial and/or marine areas where Traditional Owners have made a declaration acknowledged by the Australian Government to manage the area for biodiversity and cultural values, and now comprise over one-third of Australia's National Reserve System (Department of the Environment 2013).

Employment of local people in environmental management facilitates the integration and use of traditional ecological knowledge (TEK), which can be defined as 'a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment' (Berkes *et al.* 2000: 1252). TEK has been effectively used in science, conservation and natural resource management (e.g. Parlee *et al.* 2014) and has been compared with aspects of adaptive management because of its responsiveness to change over time (Berkes *et al.* 2000). Use of TEK reflects Indigenous peoples' customary rights and responsibilities to manage the landscape, often referred to in Australia as 'caring for country' (Morrison 2007). Additional social and health benefits to Indigenous communities in Australia resulting from engagement in environmental work have also been demonstrated (Burgess *et al.* 2005; Vigilante *et al.* 2013).

and recognition. Consistent with international agreements such as the United Nations Declaration on the Rights of Indigenous People (2007), they build local management capacity and commitment. Using local knowledge to estimate wildlife population trends can also be as or even more accurate and cost-effective when compared with other more traditional scientific survey methods (e.g. Anadón *et al.* 2009; Parlee *et al.* 2014).

In Australia, growing numbers of Indigenous peoples (generally referred to as Traditional Owner groups) are regaining legal control of traditional estates from which they were displaced by European colonisation and over which they are asserting cultural authority and contemporary management control (Box 1). In this context of increased formal recognition and land ownership, participatory techniques are being used to create sophisticated local plans that document the values, goals and

priorities that Traditional Owners hold for their lands and seas (e.g. Dhimmurru 2006; WGAC 2010; DAC 2012). Some plans have been termed 'country-based plans' (CBPs), reflecting both the use of the word 'Country' by Indigenous people throughout Australia as an English approximation for their deep and complex connection to traditional lands and waters, and the scale at which these plans consider targets and threats (Smyth 2011). Some Traditional Owner groups have specifically adapted Conservation Action Planning methodology (TNC 2010) to create 'healthy country plans' (HCPs) (Moorcroft 2012).

Indigenous land and sea management plans often differ from non-Indigenous natural resource management plans because they highlight the importance to Indigenous land owners of integrating biodiversity and conservation outcomes with cultural, social and economic outcomes. In many

cases, these plans have also informed the declaration and management of Indigenous Protected Areas (IPAs) (Box 1). Davies *et al.* (2013) illustrate how the requirement for each IPA to develop a management plan has led to innovations in planning, for example incorporating customary institutions in reserve governance, reflecting the relationship between people and the landscape in planning, and using creative communication tools to articulate planning.

Common to Indigenous land and sea management plans is the value placed on traditional ecological knowledge (TEK) and the articulation of how TEK and scientific methods can be brought together for better management (Box 1). Livelihood opportunities based on natural resources are also an aspiration common to many communities, and goals aimed at overcoming economic, technical and/or educational disadvantage typical of remote communities appear in these

plans. Their implementation thus requires long-term investment in the achievement of both conservation outcomes (such as those arising from scientific surveys, research and ongoing management actions) and community development outcomes (including infrastructure, education and governance), as well as support for maintenance of cultural practices and knowledge.

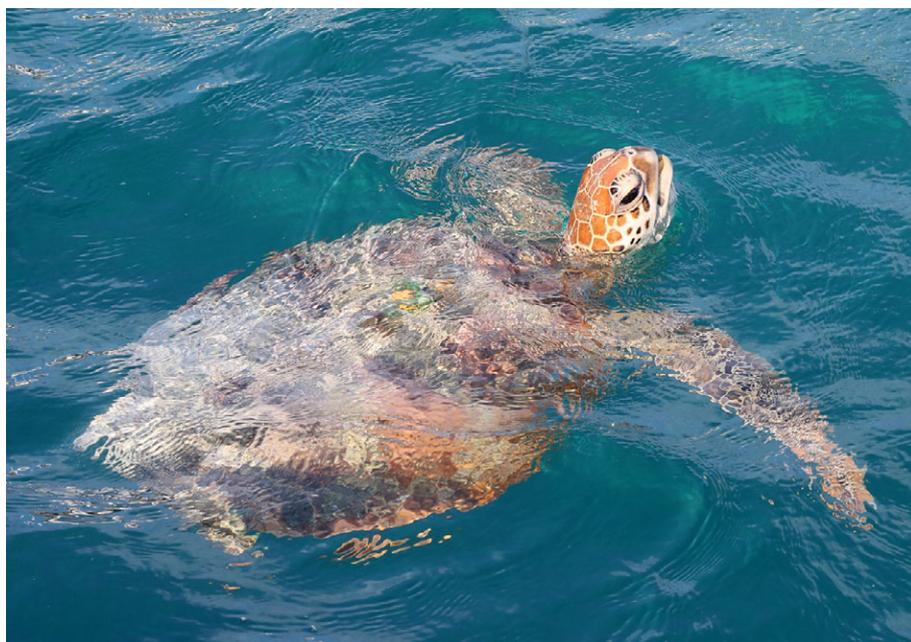
Community-based management and monitoring can face significant challenges in meeting community aspirations and conservation goals (e.g. Blaikie 2006). In particular, Fernandez-Gimenez *et al.* (2008) identify maintenance of community participation in longer term projects and access to technical and scientific advice to legitimise monitoring efforts as two main challenges for communities in successful implementation of long-term community-based management. In northern Australia, implementation of Indigenous land and sea management plans is often the responsibility of local Aboriginal Corporations and/or regional land councils (Native Title Representative Bodies) and their associated Indigenous ranger groups, who carry out the operational aspects of management and facilitate evaluation and adaptation of planning goals (Commonwealth of Australia 2009; Davies *et al.* 2013) (Fig. 1). Increasingly, organisations administering Indigenous ranger groups are engaging formally and informally with government and research organisations to access information and expertise (Dhimurru 2006; Moorcroft 2012; NAILSMA 2014). The growth in number of Indigenous ranger groups working to local plans coupled with the increase in ranger capabilities, infrastructure and interest in accessing research expertise provides an important opportunity for addressing some of the challenges faced by community-based management in other settings. In this context, recognising both Indigenous and non-Indigenous viewpoints, fostering genuine collabo-

ration through all stages of projects and research and ensuring appropriate resourcing are all important aspects in successfully implementing natural and cultural resource management (Ens *et al.* 2012).

### Need for community-based marine turtle monitoring in northern Australia

Marine turtles are of cultural and conservation significance to both Indigenous and non-Indigenous people in Australia. Six of the world's seven marine turtle species inhabit Australian waters. In the north-west of Australia, Green Turtles *Chelonia mydas* (Fig. 2), Hawksbill Turtles *Eretmochelys imbricata* and Flatback Turtles *Natator depressus* all breed extensively, with Greens being the most common breeder (DSEWPac 2012). The state of Western Australia supports one of the largest remaining populations of Green Turtles in the world and they are associated with seagrass and algae in estuarine, rocky reef, coral reef and seagrass habitats, yet there have been very few studies of feeding areas (DSEWPac 2012).

Indigenous people in Australia have significant land rights that include ownership and/or use rights to coastal areas and resources (Box 1). Marine turtles are actively managed by coastal Indigenous people and appear widely in local plans (e.g. Kennett *et al.* 2004; Dhimurru 2006), reflecting their value as a food source, and their important role in spiritual and cultural stories, beliefs and practices (Kennett *et al.* 2004; Smyth 2006). All marine turtle species found in Australian waters are listed nationally as protected species under the *Environment Protection and Biodiversity Conservation Act 1999*, and any potential impact upon populations is therefore scrutinised under this regulatory framework. While their conservation status differs across Australian jurisdictions, public interest in marine turtle conservation often stems from social perceptions about them as charismatic species (Tisdell 2011), ensuring they receive a high level of media attention, which often highlights negative perceptions of Indigenous harvest (Walter 2012).



**Figure 2.** Western Australia supports one of the largest populations of Green Turtles *Chelonia mydas* left in the world (photograph: Micha Jackson).

Yet there is a serious paucity of long-term data on trends in abundance, recruitment and mortality for many marine turtle stocks (Environment Australia 2003; Limpus & Chatto 2004; Seminoff 2004). In this context, better information on the status of marine turtle stocks has become an imperative for Indigenous and non-Indigenous natural resource managers alike.

Conventional methods for monitoring the abundance of marine turtles involve beach nesting surveys and tagging studies that typically span several weeks each season (Limpus 1996; Whiting *et al.* 2008), and decadal-scale data sets are generally required to discern long-term trends against high annual variability in nesting numbers (Seminoff 2004; SWOT Scientific Advisory Board 2011). Such studies can therefore be expensive and logistically challenging, beyond the available resources for management agencies, especially those responsible for large remote areas. Furthermore, marine turtles may be locally most abundant at feeding grounds; the species found at local feeding and hunting areas may not be the species that nests locally; and nesting counts provide no data on male turtles or non-nesting animals. Therefore, methods for studying and monitoring local marine turtle populations that complement existing nesting studies could add considerably to the collective knowledge of these species across their range and be particularly relevant in remote settings such as the one discussed in this study. Additionally, as wide-ranging migratory species, management of marine turtle populations spans multiple jurisdictions, requiring collaboration and data sharing across regional and even international boundaries.

## Our Project

In response to these local and national needs for improved population data, in 2011 the North Australian Indigenous Land and Sea Management Alliance

Limited (NAILSMA) initiated a research project with Indigenous and non-Indigenous partner organisations to develop an alternative method to monitor marine turtle populations. The survey method needed to incorporate Western science and TEK and be suitable for use in remote locations by Indigenous rangers. Project development was informed by the following:

- 1 Previous work with Indigenous ranger groups through the I-Tracker program (NAILSMA 2014) that involved rangers using digital data collection and mapping tools, including to opportunistically record turtles, dugongs and other marine wildlife; and
- 2 A 3-day forum hosted by NAILSMA in August 2011 that brought together representatives from Indigenous ranger groups, researchers and other stakeholders from across northern Australia (WA, NT, Qld). The forum concluded that the presence of marine turtles and dugongs as target species in many Indigenous land and sea management plans reflected their importance to communities and in contemporary management regimes, and that expanding on existing I-Tracker tools to develop dedicated survey tools was desirable. Potential survey designs were discussed and several ranger groups expressed interest in participating in future research.

Further discussions with interested ranger groups and researchers solidified the idea that a boat-based approach to marine turtle monitoring on local feeding grounds to complement existing nesting methods would be well suited to community needs. Boat-based transect surveys have been used successfully in northern Australia for studies of other species including coastal dolphins (e.g. Palmer *et al.* 2014), and growing numbers of Indigenous ranger groups have boats and trained per-

sonnel capable of undertaking marine surveys (Commonwealth of Australia 2009; NAILSMA 2014). Thus, a boat-based approach to monitoring suited to Indigenous communities (and remote localities) would also have the potential to be implemented across a network of sites to develop a regional-scale picture of feeding populations of these migratory species.

This study describes the process of establishing, in two sites in the Kimberley region of northern Australia, a participatory research project combining traditional, local and scientific knowledge to monitor marine turtles. While a detailed evaluation of the transect method and analysis of data collected during this project is beyond the scope of this study (and will be reported elsewhere), here we outline the steps taken to design the project and develop the survey method. We discuss potential future applications and how our overarching project approach may inform a growing community of practice (Wenger 1998) in cross-cultural scientific research. Animal ethics clearance for project activities was provided by the Charles Darwin University Animal Ethics Committee.

## Designing the collaborative research project with traditional owners

The project commenced in late 2011 following the forum discussed above. NAILSMA took on a project leadership and coordination role and recognised that the key success indicators for the project would need to be (i) *utility* of project tools and outcomes to Traditional Owners and ranger groups; (ii) *acceptability* of the project approach and methods by both Indigenous and government managers as scientifically sound and culturally appropriate; and (iii) *transferability* of project tools and learnings to other Indigenous land

and sea management groups and the wider public. To further these aims and produce a survey protocol within an acceptable timeframe, the following general project design was established:

- 1 A research team comprised of Indigenous rangers, senior Traditional Owners and recognised scientific and technical experts with relevant skills and suitable experience in working collaboratively with Indigenous people;
- 2 Monitoring tools based on I-Tracker methods (see NAILSMA 2014);
- 3 Involvement of Indigenous ranger group(s) that have the following:
  - a Responsibility for implementing an Indigenous land and sea management plan that clearly articulates Traditional Owner interests in marine turtle management, including monitoring;
  - b Cultural and management responsibility for feeding habitat supporting marine turtles in sufficient numbers to test the survey methods;
  - c Adequate logistic capacity and personnel to undertake boat-based research in remote areas; and
  - d Preferably prior experience in using I-Tracker data collection tools.
- 4 Documented project governance arrangements that identified the roles, responsibilities and contributions of each project partner; data ownership and intellectual property arrangements; and protocols for project communications (the importance of such arrangements in collaborative projects involving Indigenous communities is well presented in Hoffmann *et al.* (2012)).

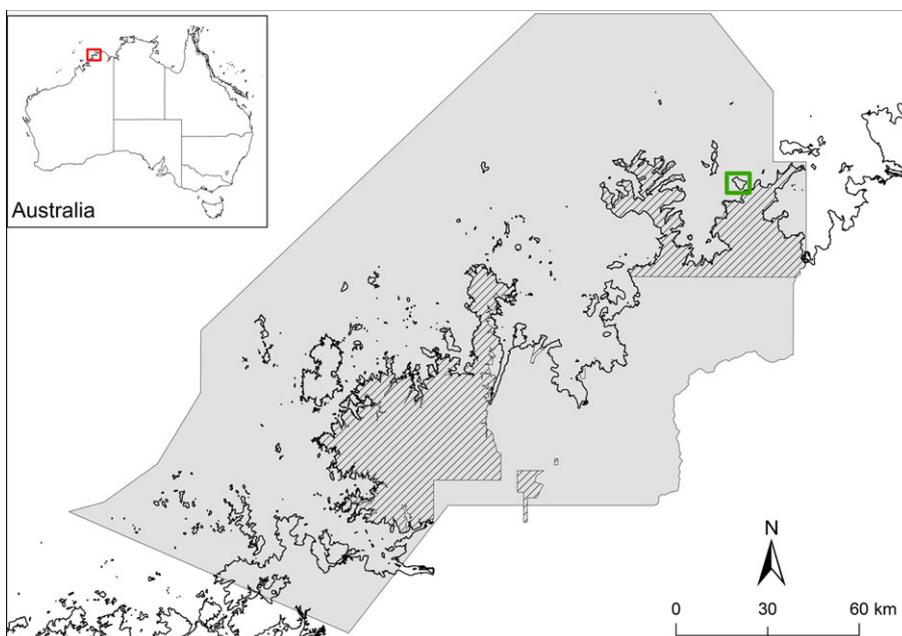
These general parameters and previous on-ground work and discussions

were used to identify the Wunambal Gaambera Aboriginal Corporation's (WGAC) Uunguu Rangers and the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia's national science agency, as the primary project partners along with NAILSMA.

The WGAC, based in Kalumburu, Western Australia, has management responsibilities for the Wanjina Wunggurr Uunguu Native Title area, which was determined in 2011 (see Bartlett (2014) for an explanation of Native Title) and includes the Uunguu IPA, which was declared in 2011 and currently covers 832,000 ha of land (Fig. 3). Local Traditional Owners intend to add a further 1.6 M ha of sea country to the IPA (WGAC pers. comm.). Vigilante *et al.* (2013) gives background on the history, tenure and Aboriginal connections, values and knowledge of the Wunambal Gaambera country region. Previous preliminary studies indicated the presence of substantial feeding aggregations of marine turtles accessible by small boat in waters

adjacent to the IPA (Jackson *et al.* 2009).

Traditional Owner aspirations for management are articulated in their plan titled *Wunambal Gaambera Healthy Country Plan 2010–2020* (WGHCP) (WGAC 2010; Moorcroft *et al.* 2012); the Uunguu Rangers work to the direction of the WGAC directors to implement it. The Uunguu Monitoring and Evaluation Committee (UMEC), comprising both Traditional Owners and non-Indigenous representatives with relevant expertise, meets regularly to review progress in WGHCP implementation. The WGHCP is organised around ten 'conservation targets' that reflect both natural and cultural values of highest importance to Traditional Owners, one of which is 'Mangguru and Balguja', meaning marine turtles and dugongs in local language, respectively. The WGHCP states: 'We need to know more about where [turtles and dugongs] travel, their habitats in our country and how to look after them. Working together...using our traditional



**Figure 3.** Uunguu Native Title Determination (shaded) and Indigenous Protected Area (thatched). Box shows Mary Island survey area (detail Fig. 6); Traditional Owners plan to add this area to the IPA in future (WGAC pers. comm.).

knowledge, doing surveys...will help us keep these animals healthy in our country as well as keeping our saltwater traditions strong' (WGAC 2010). Unguu Senior Ranger Jason Adams explains '[The WGHP is] a document for us to see what we can do in the next 10 years, and one of our targets in [the plan] is about turtles and dugongs, and turtles and dugongs [are] really important to us, for our saltwater people, because they come and play in our cultural stories and especially for cultural ceremonies'.

CSIRO advised on marine wildlife data collection protocols used in the I-Tracker program and was involved in the 2011 forum where the concept of this research approach was discussed. CSIRO staff with skills in marine survey design and experience working with Indigenous communities were identified to provide a leading science and research role in the project.

Following initial use of the survey method by the Unguu Rangers, Dambimangari Aboriginal Corporation's (DAC) Dambimangari Rangers

also expressed interest in trialling the boat-based survey approach, which was ideal given the project aim of transferability to other communities. DAC has management responsibility for the Wanjina Wungurr Dambimangari Native Title claim area, which was determined in 2011 and comprises 2.7 M ha of land and sea. The Dambimangari IPA was declared in 2013 over Aboriginal reserves where exclusive possession native title has been determined, and covers more than 600,000 ha (Fig. 4). Vigilante *et al.* (2013) gives background on the history, tenure and Aboriginal connections, values and knowledge of the Dambimangari country region. Traditional Owner aspirations for management are articulated in their plan titled *Dambimangari Healthy Country Plan 2012–2022* (DHCP) (DAC 2012); the Dambimangari Rangers (operating since 2010) work to the direction of the DAC to implement it. The Dambimangari Healthy Country Advisory Group reviews progress in DHCP implementation. Marine turtles and dugongs are one of the nine

targets in the DHCP, which also refers to the need for better monitoring: 'So far only small parts of our country have been properly surveyed and we need to make sure we record our old peoples knowledge and at the same time do research jointly with scientists to get a better understanding of the health of our targets' (DAC 2012).

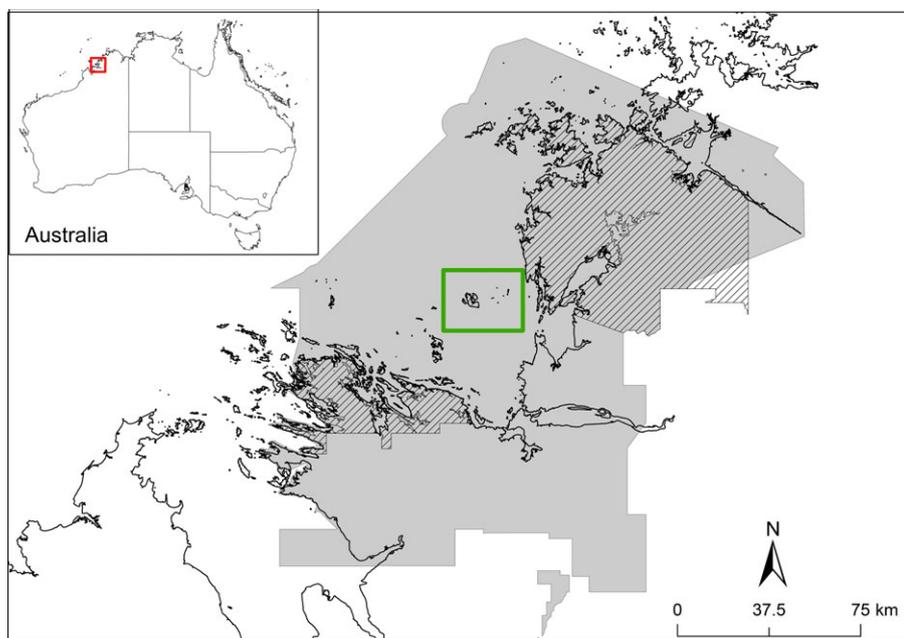
## 2012 Unguu participatory research camp

Planning and field camps held on country involving all project partners and Indigenous community members and Traditional Owners were critical to incorporating local expert knowledge into project design, in fostering a sense of community ownership of the project, and from a logistical perspective given the remoteness of the study areas.

An initial 4-day project camp involving NAILSMA, CSIRO, Unguu Rangers and additional community members was held on country in May 2012 (Jackson *et al.* 2015a) with the Unguu Rangers planning camp and boat logistics. A project planning workshop prior to the commencement of fieldwork provided an opportunity for open discussion about the project, particularly its relation to the aims of the WGHP. Expected project outcomes, roles and responsibilities, project timeline, expected benefits to the community and processes for collaboratively producing communications outputs were reviewed and subsequently documented in project agreement documents involving all partners.

Local participants marked known locations of turtles and dugongs, associated habitats (reefs and seagrass) and boat launch sites on large maps and agreed on suitable sites for preliminary surveys. The maps were later digitised, and originals and copies are held by the WGAC.

Survey data collection and mapping tools were developed collaboratively using CyberTracker™ (Liebenberg



**Figure 4.** Dambimangari Native Title Determination (shaded) and Indigenous Protected Area (thatched). Box shows Montgomery Reef survey area (detail Fig. 9).

2003) software and using participatory methods established in NAILSMA's I-Tracker program (NAILSMA 2014). CyberTracker™ is well suited to Australian Indigenous communities (Ansell & Koenig 2011; NAILSMA 2014) because of its user-friendly touch screen approach and image and icon-driven interface, which supports low-literacy and numeracy users. It is also free to download, includes mapping and analysis functions and can be designed by the user to suit a wide range of purposes.

A survey design based on standard line transect methods (Buckland *et al.* 2001) was used by NAILSMA and CSIRO staff as the basis for drafting a survey protocol and I-Tracker data collection application (using CyberTracker™ software) prior to the field camp. The survey involves a boat travelling at slow speed along preset transects through known feeding grounds, while two observers and one data recorder record details of animal sightings and relevant environmental variables (Fig. 5). This draft application was reviewed during the planning workshop and improvements to language and general usability made based on suggestions from community members and rangers. Transects would be established collaboratively following initial fieldwork.

Trial surveys were conducted over 3 days to train observers and test the data collection application. Nightly feedback sessions were held where rangers, community members and project staff viewed and discussed maps of the day's results and modified survey methods or the data collection application as required. For example, an 'underwater' turtle sighting category and a measure of water clarity were added to the survey protocol when their importance became obvious in the field. Appendix S1 describes the final survey protocol established.

The trial surveys confirmed the presence of a large feeding aggregation of Green Turtles (and some



**Figure 5.** Uunguu Rangers completing a transect survey: two observers call out turtle sightings and a recorder uses the I-Tracker digital data collection application (Appendix S1) (photograph: Michael Lawrence-Taylor).

Hawksbill Turtles) adjacent to Mary Island ( $13^{\circ}59'38''\text{S}$ ,  $126^{\circ}23'01''\text{E}$ ) (Fig. 3) and that dugong observations were too infrequent for the transect survey method to be sensibly applied to dugong surveys. Dugong sightings were still recorded throughout the project to improve local knowledge, but the survey became primarily focused on marine turtles.

Mapping functions in CyberTracker™ allowed transects adjacent to Mary Island to be discussed and established collaboratively at the field camp by digitally 'drawing' transects onto a satellite map. A 'field map' function could then access this map using the I-Tracker application in the field to show current position and all transects, thus allowing the boat driver to follow transects very accurately (Fig. 6). After successful testing during the field camp, the general survey protocol (Appendix S1) and transect regime (Fig. 6) were accepted as the agreed standard for future project surveys.

During 3 days of the May 2012 field work, a total of 94 turtles were recorded, including 39 during trial transect surveys: 80% (of the total)

were Green Turtles and 6% were Hawksbill Turtles (remaining turtles could not be identified to species level). At the conclusion, project staff and Uunguu Rangers reviewed the survey process and data and agreed on guidelines for future surveys to be conducted by rangers without NAILSMA or research staff present.

## 2012 Dambimangari participatory research camp

The participation of the Dambimangari Rangers allowed the survey method to be tested in a different habitat and with a ranger group who had little previous experience using I-Tracker tools. In August 2012, a 7-day field camp based at Freshwater Cove (Fig. 7) supported trial surveys on Montgomery Reef ( $15^{\circ}56'34''\text{S}$ ,  $126^{\circ}23'01''\text{E}$ ; Fig. 4), known locally as a large feeding ground for Green Turtles (Jackson *et al.* 2012) but differing from Mary Island in that daily tidal movements (~11 m) cover and then expose its rocky reef and central lagoon with dramatically high-velocity water flow (Wil-



**Figure 6.** Transect survey regime established at Mary Island.



**Figure 7.** 2012 field camp at Freshwater Cove from which fieldwork at Montgomery Reef was conducted (photograph: Rod KennetD).

son & Blake 2011). NAILSMA, CSIRO, the Kimberley Land Council, Dambimangari Rangers and community members participated, with the rangers leading the organisation of camp and boat logistics. A project Terms of Reference document developed prior

to the trip outlined roles and responsibilities of participating organisations and communications protocols.

A project planning workshop was held on the first evening where the boat-based survey protocol trialled with Wunambal Gaambera was

reviewed and project aims for Dambimangari discussed. Local participants marked known locations of turtles, dugongs and seagrass on printed maps and these, combined with local knowledge of distance from base camp, water depths, tidal movement and navigation hazards were used to identify potential survey locations on the eastern portion of the reef.

Four days of field work included training, scoping of selected sites and completion of transect surveys (Fig. 8). A total of 2,363 turtles were recorded over 4 days of which 97% were Green Turtles and 1% were Hawksbill Turtles (remaining turtles could not be identified to species level). As at Mary Island, relatively few dugongs were sighted. The surveys verified community knowledge discussed at the planning workshop that the structure of the reef supports high turtle numbers along the reef edge and within channels inside the reef complex and that the distribution of turtles at the reef changes significantly with tidal movement. Surveys showed that at the top of the tide, turtle sightings are sparse because they are spread over a larger area, and visibility decreases when the tide washes over the sandy/silt substrate. Parallel transect lines placed at any significant distance seawards from the reef did not result in additional turtle sightings, as turtle numbers decline rapidly with distance from the reef. Survey transects for Montgomery Reef were therefore focused on the edge of the reef and its internal channels, rather than a regime of parallel transects like that established at Mary Island. Daily feedback sessions informed development of the transect regime developed (Fig. 9), which was also digitised using the CyberTracker™ 'field map' function.

### Subsequent surveys and field camps

Following the initial project field camp, additional 1-day surveys were completed by the Uunguu Rangers



**Figure 8.** 2012 Dambimangari field camp participants conduct a scoping trip at Montgomery Reef (photograph: Rod Kennett).

in June 2012, August 2012, October 2012 and March 2013 at Mary Island (Table 1). Major project camps involving all partners were then held in August 2013 and August 2014 on Wunambal Gaambera country at Gambermirri (in the vicinity of the Mary Island study site) with logistics organised by the rangers. During these camps, surveys were completed at Mary Island (Table 1); project participants worked to develop communications materials based on project learnings (discussed below); and other activities relating to turtle and dugong studies were conducted including subtidal seagrass surveys, sediment and water quality testing, and use of aerial photography to supplement survey results (Jackson *et al.* 2015b). Ongoing surveys using the I-Tracker application are planned by the Unguu Rangers as time and resources allow.

The Dambimangari Rangers independently completed subsequent field surveys at Montgomery Reef in August 2013 and September 2014 (Fig. 10), and similar numbers of turtles (>2,000) were recorded (Table 1). Ongoing surveys using the I-Tracker application are planned by the Dambimangari Rangers as time and resources allow.

### Project communication

The work of Indigenous rangers receives popular media coverage, and the social, cultural and environmental benefits of ranger programmes are discussed in the scientific and policy literature (e.g. Ansell & Koenig 2011; Ens *et al.* 2012; Vigilante *et al.* 2013). However, the value and potential of Australian Indigenous ranger programmes to provide robust and regionally coordinated data sets to monitor environmental change is, arguably, yet to be fully appreciated (NAILSMA 2014). Further, ranger programmes generally rely on support from local Traditional Owners; funding and supportive policy decisions



**Figure 9.** Transect survey regime established at Montgomery Reef.

**Table 1.** Summary of results from Mary Island and Montgomery Reef surveys for Green and Hawksbill turtles. Data are survey observations recorded on systematic transects (Figs 6,9)

Date	Number of turtle sightings recorded	Km surveyed
Wunambal Gaambera surveys – Mary Island monitoring site (Fig. 6)		
May 2012	39	16.0
June 2012	9	5.7
August 2012	175	10.4
October 2012	56	11.7
March 2013	43	10.6
August 2013	123	10.1
August 2014	34	10.6
Dambimangari Surveys – Montgomery Reef monitoring site (Fig. 9)		
August 2012	2,363	80.9
August 2013	2,068	75.1
September 2014	2,050	73.0

**Figure 10.** A Dambimangari Ranger records information on a turtle sighting (photograph: Dambimangari Aboriginal Corporation).

from government; and sometimes funding and/or project support from external organisations (including NGOs), all of whom require a good working knowledge of ranger activities and achievements to remain engaged and supportive. Accordingly, all project participants collaborated on communicating project outcomes to local communities and Traditional

Owners, as well as the scientific community, government representatives, funders and the public. Communication activities (including authorship, agreed messages, content, use of images, media and participation in public presentations) were guided by the project agreement documents. A variety of mediums and approaches were utilised, including:

- 1 Local discussions with community members including through attendance at project field camps;
- 2 Written and verbal reports to the UMEC and the Annual General Meeting of the WGAC;
- 3 Written and verbal reports to the Annual General Meeting of the Dambimangari Aboriginal Corporation and the Dambimangari Healthy Country Advisory Group;
- 4 A plain English brochure and large poster aimed at and distributed to the Wunambal Gaambera community through WGAC networks;
- 5 Dedicated project web pages on the NAILSMA and National Environmental Research Program Northern Australia Hub websites (<http://www.nailsma.org.au>; <http://www.nerpnorthern.edu.au/>);
- 6 Detailed project reports available publicly (Jackson *et al.* 2012, 2015a,b);
- 7 A section in the book *Looking after Country: The NAILSMA I-Tracker Story* (NAILSMA 2014);
- 8 An online and DVD project video filmed during the 2013 Unguu field camp and featuring interviews with rangers and project staff;
- 9 Jointly authored conference presentations (regional, national and international) copresented by rangers and researchers (Fig. 11);
- 10 Invited presentations at research institutions and universities; and
- 11 Briefings to relevant Australian government agencies.

## Applications for Monitoring Results and Future Directions

Fieldwork at Mary Island and Montgomery Reef has enabled the development of a boat-based transect survey approach to marine turtle monitoring, shown that this approach and the



**Figure 11.** An Unguu Ranger and NAILSMA project staff present project learnings at the 2012 WA Marine Turtle Symposium, Perth, Australia.

tools developed are well suited to rangers groups and systematically documented local feeding assemblages of Green Turtles. Equally important is the integration of traditional knowledge roles and responsibilities with scientific methods. Unguu Head Ranger Neil Waina explains the project's significance with regard to traditional values concerning intergenerational equity: 'Our ancestors looked after country and [were] doing the right thing for us, and now it's time for us rangers to do the same'. 'This programme with NAILSMA and CSIRO helps us monitor turtle and dugong so that we can see there's plenty out there for generations to come'. Subject to the results of ecological analysis, the method is expected to have potential for long-term scientific monitoring by the Wunambal Gaambera and Dambimangari communities, thus allowing Indigenous rangers to respond to traditional responsibilities and into mainstream conservation and management frameworks.

Threats to turtles can occur at large scales, have complex causes and are

often distant from local communities that have responsibility for their protection (Environment Australia 2003; Limpus & Chatto 2004). Threats to marine turtles identified in the Wunambal Gaambera and Dambimangari Health Country Plans (WGAC 2010; DAC 2012) and the National Recovery Plan for Marine Turtles in Australia (Environment Australia 2003) are outlined in Table 2. Loss of traditional knowledge and the capacity for Traditional Owners to access the marine environment are of vital importance to the Wunambal Gaambera and Dambimangari communities. Table 2 shows that of 14 threats identified in the Wunambal Gaambera Health Country Plan, only six may reasonably be influenced through local direct management (i.e. measures that can potentially be implemented by the local community and/or local management body) when they occur locally. Of nine threats identified in the Dambimangari Healthy Country Plan, six may reasonably be influenced through local direct management when they occur

locally. Of seven mortality threats identified in the National Recovery Plan for Marine Turtles, only two may be addressed at a local scale.

The strongly stated aspiration for Indigenous people in Australia to actively manage marine turtles (as reflected in local plans) stems largely from their cultural importance; the occurrence of so many potential impacts to turtles outside of local management areas makes monitoring data specifically of critical importance in achieving this aim. Specifically, for Wunambal Gaambera and Dambimangari Traditional Owners, marine turtle monitoring data can be utilised in the following ways:

- 1 To inform local decision-making by Traditional Owners relating to potential local pressures such as hunting activity by enabling detection of changes in the status or behaviour of populations feeding locally (although data from additional sites may also be needed);
- 2 To provide the community with baseline data on occurrence and status, which is critical to determinations about the location, size and operation of coastal and offshore developments and may therefore assist in responding to proposals by industry;
- 3 To feed into wider regional assessments of the health of stocks (noting that the statistical power of data is greatly enhanced where information derived from regional networks of related community-based monitoring sites is aggregated); and
- 4 To gain access to and facilitate discussions in forums relevant to regional conservation and management requirements.

Both of the study sites have also been included in proposed Kimberley marine parks, which would be jointly managed by the Western Australia

**Table 2.** Threats to marine turtles identified in the Wunambal Gaambera Healthy Country Plan 2010–2020, Dambimangari Healthy Country Plan 2012–2022 and the Recovery Plan for Marine Turtles in Australia 2003

Threats identified in Wunambal Gaambera Healthy Country Plan	Threats identified in Dambimangari Healthy Country Plan	Mortality threats identified in the Recovery Plan for Marine Turtles in Australia
<i>Loss of Traditional Knowledge</i>	<i>Lack of culturally appropriate consultation with Traditional Owners</i>	Bycatch of Marine Turtles in Fisheries
<i>Families not on country</i> <sup>†</sup>	Climate Change	<i>Customary harvest by Aboriginal and Torres Strait Islander people</i>
Not being secure on country	<i>Lack of land and sea management capacity</i>	Marine Debris
Climate change	<i>Visitors not being respectful</i>	Shark Control Activities
<i>Lack of land and sea management capacity</i>	<i>Lack of infrastructure to access country</i>	<i>Boat Strike</i>
Rubbish, marine debris <sup>†</sup>	Mining/industrial development	Pearl Farming and Other Aquaculture Activities
<i>Visitors not being respectful</i>	<i>Weeds</i>	Defence Activities
Pests and diseases <sup>†</sup>	Gas/oil drilling	
Sedimentation of estuaries <sup>†</sup>	<i>Pigs</i>	
Bauxite mining (high)		
<i>Weeds</i>		
Commercial fishing		
Business and industry		
<i>Feral animals</i>		

<sup>†</sup>These threats were added to the Wunambal Gaambera Healthy Country Plan by the UMEC in 2014 using the adaptive process encouraged by the Healthy Country Plan model.

Threats shown in italics can potentially be addressed by local direct management when they occur locally.

State Government and Traditional Owners (Government of Western Australia 2014), so improved information on local turtle populations would also assist the development of protected area management and zoning in this context.

Nonetheless, given their widespread and migratory nature, a broad-scale picture of marine turtle populations will be needed to assess overall population health. Use of the method in the two very different areas outlined here suggests that it is highly transferable to other Indigenous ranger programmes in northern Australia; the establishment of a network of similar monitoring sites in additional communities would significantly add value to existing efforts to fill important information gaps on marine populations and provide greater statistical power to detect regional trends.

## Implications for Managers

This project represents a ‘proof-of-concept’ for the collaborative partnership approach taken that is widely relevant to wildlife research in Indigenous communities. Historically, many research programmes have failed to effectively engage Traditional Owners as partners; many Indigenous communities in northern Australia have experienced instances where Indigenous knowledge has been imparted to researchers without a resulting beneficial knowledge sharing back to the community (Ens *et al.* 2012). In addition, the establishment of long-term monitoring of wildlife and habitats necessary across many areas to inform biodiversity conservation (Magurran *et al.* 2010) can be difficult to sustain, particularly given resource constraints and a tendency towards short-term funding for environmental projects.

Adams *et al.* (2014) outlined a generalised framework and key steps for ‘community-engaged approaches to ecological research’ with a view to improving the engagement between academic and Indigenous community partners in Canada. In the Kimberley region of northern Australia, some principles of collaborative research have already been established, for example through the Kimberley Islands Biodiversity Survey (Vigilante *et al.* 2013). Hoffmann *et al.* (2012) presents key management attributes and lessons in achieving effective collaborations involving Indigenous and non-Indigenous organisations that are highly applicable across the northern Australian context.

This project built on existing approaches using a model for collaborative research in Australian Indigenous communities driven by locally identified priorities. The conceptual approach and design of the project can be usefully summarised as a potential resource for other projects utilising a 4-stage research framework derived from Adams *et al.* (2014) (shown in italics below).

- 1 Research conception* harnesses scientific methods and expertise to meet community priorities articulated through local plans (in this project the need to understand and monitor local marine turtle populations articulated as HCP targets);
- 2 Research design* utilises traditional and local knowledge for planning and implementation of project activities (in this project where and when to carry out boat-based surveys for marine turtles) as well as expert scientific and technical knowledge (in this project use of line transect methods and development of a community-friendly data collection application);
- 3 Research implementation* assists the local management body (in this project Indigenous ranger

groups) to deliver local plans developed by Traditional Owners (in this project the HCPs), provides a mechanism to adapt and improve planning over time by informing people on the health of a key target (in this project marine turtles) and provides robust data on local issues that has a clear use for the Indigenous Traditional Owners (in this project providing baseline data on local marine turtle populations that can be used as the basis for local and regional discussions relevant to marine turtle health); and

4 *Research knowledge dissemination* is targeted at local Traditional Owners at regular intervals through formal and informal means (in this project through presentations to UMEC, the WGAC AGM, DAC and Dambimangari Healthy Country Advisory Group meetings, and dissemination of information to the local community) and at the wider scientific community collaboratively (in this project through project partners including Indigenous rangers delivering presentations at conferences and preparation of jointly authored publications).

This general framework for developing collaborative research is an approach to achieving ongoing biodiversity monitoring that meets both community aspirations and national conservation priorities.

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## Supporting Information

Additional Supporting Information may be found in the online version of this article:

**Appendix S1.** Boat-based survey protocol for marine turtle monitoring.