NAILSMA

NORTH AUSTRALIAN INDIGENOUS LAND AND SEA MANAGEMENT ALLIANCE

# Knowledge Series

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Report

# Developing boat-based survey methods for dugong and marine turtles: Field trials at Montgomery Reef, Western Australia, August 2012

**Micha Jackson, Rod Kennett, Frank Weisenberger, Peter Bayliss and the Dambimangari Rangers**

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# Developing boat-based survey methods for dugong and marine turtles: Field trials at Montgomery Reef, Western Australia, August 2012

Micha Jackson, Rod Kennett, Frank Weisenberger, Peter Bayliss and the Dambimangari Rangers

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# EXECUTIVE SUMMARY

Dugong and marine turtles are species of conservation and cultural significance to Indigenous and non-Indigenous Australians. Tropical north Australia supports the largest and healthiest populations of these species, but data on size and trends in population and abundance are sparse for many areas. Accordingly, monitoring and mapping dugong and marine turtle distribution and abundance are priorities in national and regional species management, as well as in community-based management plans developed by Indigenous sea country managers.

Established methods to survey dugong and marine turtles include aerial surveys for dugongs and beach-based nesting counts or tagging studies for turtles. In the context of north Australia, these methods have limitations with regard to cost and feasibility; the level of community engagement in field studies; as well as community access, ownership and understanding of study results. In the case of marine turtles, some three decades of nesting census data are required to discern long-term trends against high annual variability in nesting numbers. An expensive, logistically challenging, decades-long commitment to a marine turtle tagging and nesting beach study is beyond the resources and capacity of most community-based organisations in north Australia.

Accordingly the North Australian Indigenous Land and Sea Management Alliance Limited (NAILSMA)'s I-Tracker program is working with Indigenous land and sea managers and scientists to develop tools that utilise and build on local Indigenous ranger capacity to monitor marine turtles and dugong. These tools include recording in-water observations, counts of nests and nesting turtles and stranded or entangled animals using the I-Tracker Saltwater Country Patrol application (see http://www.nailsma.org.au/i-tracker/saltwater-country-patrol-application). The toolbox also includes a dedicated boat-based I-Tracker application that uses line transect methods to estimate distribution and abundance of local populations.

This report presents results of a field trial conducted at Montgomery Reef, Western Australia in August 2012 of the dedicated boat-based I-Tracker Turtle and Dugong Survey application. The project is a collaboration between the Dambimangari Rangers, the Kimberley Land Council (KLC), NAILSMA and CSIRO. The survey method and I-Tracker application used were based on previous research and field trials conducted by NAILSMA, CSIRO, and the Wunumbal Gaambera Aboriginal Corporation and its Uunguu Rangers with funding from the National Environmental Research Program.

A total of 2,363 turtles and five dugong were recorded over four days at Montgomery Reef including 2,289 Green turtles and 18 Hawksbill turtles. The majority of turtles were observed at the reef edge on an incoming tide. Traditional Owners and hunters report that turtles move onto the reef flat with the rising tide to feed. On average 133 Green turtles were sighted per hour of effort on transect across both boats used. Whenever possible, for each turtle sighting, species, size, location and distance from the boat, and behaviour were recorded; however, in some areas turtle density was so high it was not possible to record all variables for each turtle. To accommodate this, a 'Green turtle counter' option was included in the I-Tracker application to record very high density groups of turtles. This counter was modified during the field trial so that even in these very high density areas, both distance from the boat and size class were captured, while side of the boat and behaviour were dropped. High rates of tidal flow (tidal ranges 8-9m) and water turbidity (and hence low sightability of animals) meant that survey transects were limited to shallow waters adjacent to or on the reef.

Survey participants demonstrated a high level of uptake of and competency with the survey method and in using the field personal digital assistants (PDAs) and computer to enter, upload and review survey data. The results of post-survey interviews with individual Dambimangari Rangers and Traditional Owners show a high level of satisfaction in the applicability and relevance of the method to Indigenous sea country management.

# INTRODUCTION

Dugong and marine turtles are species of conservation and cultural significance to Indigenous and non-Indigenous Australians. Tropical north Australia supports the largest and healthiest populations of these species, but data on size and trends in population and abundance are sparse for many areas (Commonwealth of Australia 2003; Parks and Wildlife Service, Department of Infrastructure, Planning and Environment, Northern Territory, 2003). Accordingly, monitoring and mapping dugong and marine turtle distribution and abundance are priorities in national and regional species management, as well as in community-based management plans developed by Indigenous sea country managers.

The Dambimangari people of the north west Kimberley are a saltwater people with specific cultural responsibilities for dugong and marine turtles. The Dambimangari Healthy Country Plan 2012-2022 was developed by the Dambimangari Traditional Owners with support from Kimberley Land Council, PEW Environment Group and The Nature Conservancy using a modified version of the Conservation Action Planning tool / Open Standards methodology (TNC, 2010) to set out a vision, identify conservation targets and threats and recommend management objectives and strategies. Target 4 of the Dambimangari Healthy Country Plan (HCP) specifically refers to dugong and marine turtles and states:

> *'All these animals are migratory animals. They move along our coastline and through our neighbours' country. Healthy saltwater country is important for them and we must work together to make sure that jurluwarra [saltwater turtles] and warliny [dugongs] are plentiful for many generations to come"*

The HCP specifically refers to the need for survey work to support understanding of the health of the target species identified, in order to assess their status over time:

> *'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'*

(Dambimangari Aboriginal Corporation 2012).

Established methods to survey dugong and marine turtles include aerial surveys for dugongs and beach-based nesting counts or tagging studies for turtles (Marsh and Sinclair, 1989; Eckert et al, 1999). In the context of north Australia, these methods have limitations with regard to cost and feasibility; the level of community engagement in field studies; as well as community access, ownership and understanding of study results. In the case of marine turtles, some three decades of nesting census data are required to discern long-term trends against high annual variability in nesting numbers (SWOT, 2011). An expensive, logistically challenging, decades-long commitment to a marine turtle tagging and nesting beach study is beyond the resources and capacity of most community-based organisations in north Australia including the Dambimangari Rangers.

Accordingly NAILSMA's I-Tracker program is working with Indigenous land and sea managers and scientists to develop tools that utilise and build on local Indigenous ranger capacity to monitor marine turtles and dugong. These tools include recording in-water observations, counts of nests and nesting turtles and stranded or entangled animals using the I-Tracker Saltwater Country Patrol application (see http://www.nailsma.org.au/i-tracker/saltwater-country-patrol-application). The

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Because the field study was a novel project, combining a trial of a new scientific method with training, logistical planning and community engagement and outreach, some broader objectives of the field study were agreed on prior to the trip. These included:

- to explore Dambimangari priorities with regard to dugong and turtle management in the context of the HCP;
- to record baseline data on marine turtle and dugong abundance for inclusion in the Dambimangari Indigenous Protected Area (IPA) management documentation;
- to train Dambimangari Rangers in how to plan and conduct marine boat-based surveys;
- to provide Dambimangari Rangers with insights into underlying scientific methods and approaches including survey design and data rigour and standardisation;
- to trial and modify as necessary the dedicated I-Tracker Turtle and Dugong Survey application;
- to train Dambimangari Rangers in the field use of the I-Tracker Turtle and Dugong Survey application as well as the I-Tracker Saltwater Country Patrol application; and
- to work with Dambimangari Rangers and Traditional Owners to share project outcomes with other Indigenous ranger groups.

# METHODS

The field trip took place from August 20-26, 2012 and involved two days of boat travel through remote coastal areas to reach the study site at Montgomery reef. Activities included a planning workshop before field work commenced, four days of field surveys, evening feedback workshops to review the day's survey and interviews conducted with all participants during the latter half of the survey period. Detailed reporting of the methods and results are included in this report to assist in planning future surveys and to support the creation of additional communication materials to inform the wider Dambimangari community (see Appendix 2).

## TRAVEL TO THE STUDY SITE

On afternoon of August 20, Dambimangari rangers Ethan Jungine, Edmund Jungine, Kirk Woolagoodja, and Graham Woolagoodja, Dambimangari ranger mentor Francis Lane, KLC staff Frank Weisenberger, and NAILSMA staff Micha Jackson and Rod Kennett departed from Derby in the two survey boats – Wandjina and a tender – and camped for the night at the barramundi farm at Turtle Island. The Wandjina is an 8m double-hulled aluminium boat powered by two 150hp motors. The smaller tender was a 4m aluminium dinghy powered by a 60hp motor. On August 21, the field crew travelled from Turtle Island and arrived at the field camp located at Freshwater Cove (see Figure 4).

Those involved with field work stayed at the Freshwater Cove camp from August 21-26. Logistical, camping and catering support were provided by Wandjina Tours and Dambimangari Aboriginal Corporation.

Dambimangari rangers, KLC and NAILSMA staff, and community members participated in various parts of the field trip and workshops (see Appendix 1 for a full list of individuals and their involvement).

## PLANNING WORKSHOP

Dambimangari rangers, community members, KLC and NAILSMA staff participated in a planning workshop on the evening of August 21, before field surveys commenced. Micha Jackson and Rod Kennett (NAILSMA) gave a presentation about the project, its background, and the methods and objectives of the field work. There was time for discussion during and after the presentation.

Participants discussed the decision to develop a boat-based transect survey for monitoring the distribution and abundance of turtle and dugong populations. Typically, dugong populations are monitored by aerial survey and marine turtle populations by undertaking beach-based surveys where they can be caught and tagged as they come ashore to nest (see Table 1). The advantages and disadvantages of both of these methods were discussed, and the reasons for developing a boat-based method were explored. In general, while boat-based survey methods have not been used extensively before, the workshop group identified several reasons why they may suit Dambimangari management requirements including:

- community members and rangers can participate and do this work as part of regular patrols;
- a local, resident feeding ground population can be examined in detail;
- doing surveys support will help achieve the objectives in the Healthy Country Plan; and
- a boat-based method can be used by many other Indigenous ranger groups, who collectively can provide a bigger picture story about what's going on with turtles and dugongs, which are both migratory species.

Likely survey transects were identified that took into account expected animal distribution and tidal movements and these were used to guide field work on Day 1 (August 22).

### Table 1: Comparison of turtle and dugong survey methods

| Method | |
|---|---|
| Beach-based (nesting) turtle survey | Pros:<br>• methods are well understood<br>• close contact with adult females<br>• can do other work while out on the islands (on country camp opportunity)<br>• can assess threats to nests (hard in the water, impossible from the air)<br>• easy to tag |

| Method | |
|---|---|
| Beach-based (nesting) turtle survey | Cons:<br>• expensive and logistically difficult<br>• takes at least 2-4 weeks per year<br>• crocodiles (major safety concern)<br>• requires a big team of people working through the night every night<br>• takes ~30 years to detect trends (because numbers naturally vary dramatically from year to year)<br>• doesn't provide any counts of small animals or males |
| Aerial dugong survey | Pros:<br>• provides good coverage of large areas<br>• it's quick to survey a lot of animals<br>• it's a lower cost way to cover a large area |
| Aerial dugong survey | Cons:<br>• not connected to animals<br>• it's sometimes too quick to pick up animals that move in and out of an area<br>• it's hard for Traditional Owners to participate<br>• realistically they are only done once every few years, which means that no on seasonal information is gained<br>• expensive |
| Boat-based turtle and dugong surveys | Pros:<br>• can be done regularly<br>• can be part of regular patrols in Indigenous ranger workplans<br>• easy to include community members<br>• can do across all seasons (depending on weather)<br>• can see all sizes and both sexes<br>• possible to tag<br>• habitat assessment possible concurrently<br>• provides ongoing information about a resident population |
| Boat-based turtle and dugong surveys | Cons:<br>• can spend a lot of time looking without seeing |

| Method | |
|---|---|
| | anything<br>• only works well at medium to high density populations<br>• requires regular access to a boat<br>• could be challenging to get a good population estimate, especially for dugongs<br>• not a well-tested method |

# Data collection and observer training

Data were recorded using hand held water proof PDAs loaded with a data collection application (called I-Tracker **Turtle and Dugong Survey_v4.2_Dambimangari**) created using CyberTracker software.

Data recorded for each survey day included: boat size; motor size; steering type; observer height above water; and people present on the boat. The following variables were recorded at the start of each transect: transect number; left and right observers; recorder; sea state; cloud cover; wind strength; glare; water clarity; tide condition; average depth on the transect; whether the transect was completed; and any change in environmental conditions. The following data were recorded for each individual turtle sighted: distance from the boat; species; size class; and behaviour. When turtles densities were too high to record all variables, distance from the boat and size class were recorded. The following data were recorded for each group of dugongs sighted (including individual sightings): number of individuals; distance of each individual from the boat; number of calves identified; number of bulls identified; and group behaviour. A detailed explanation of the I-Tracker application and the survey method are provided in Appendix 2. See Figure 1 for an example.

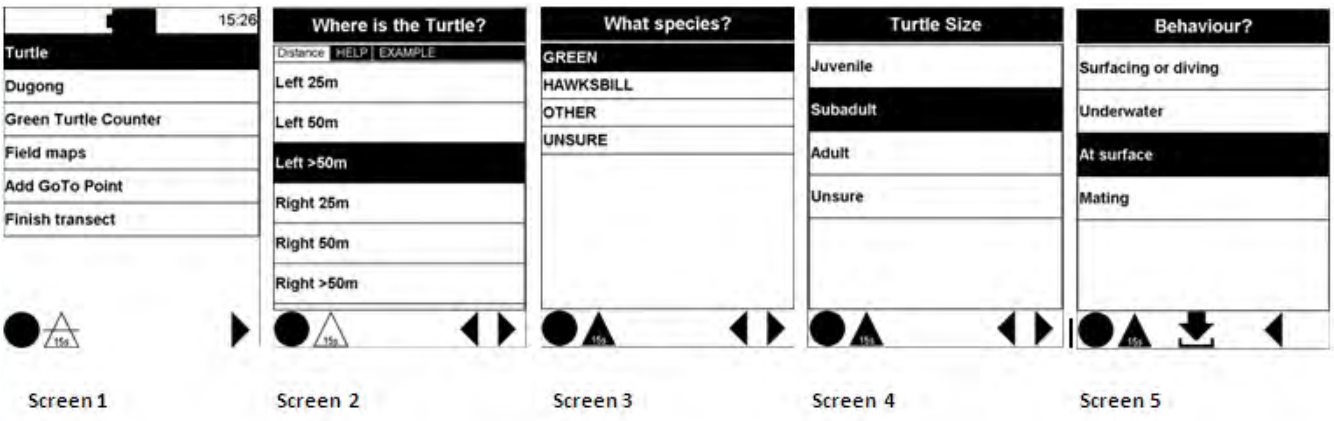
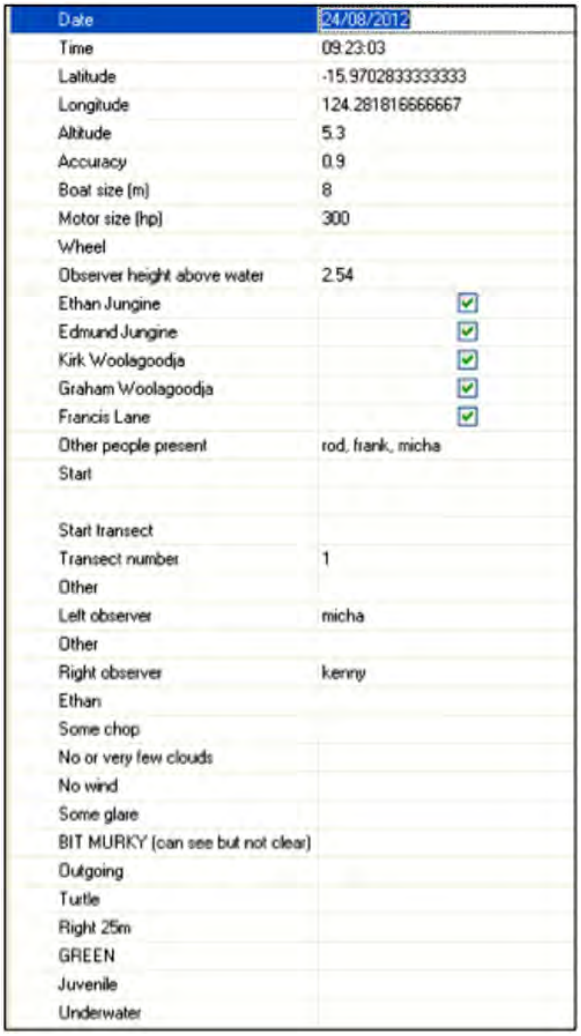



**Figure 1: Data recorded for an individual turtle sighting using the I-Tracker Turtle and Dugong application loaded onto a handheld PDA**

In summary, as animals are encountered along a transect, observers call out data. The recorder enters the data by responding to programmed questions on a touchscreen PDA loaded with the I-Tracker application. This creates a date, time and location stamped entry for each observation that is subsequently uploaded, viewed and analysed in the CyberTracker desktop application. See Figure 2

for an example of the data collected for an individual sighting using the I-Tracker Turtle and Dugong Survey application and viewed in the CyberTracker desktop application.



| | |
|---|---|
| Date | 24/08/2012 |
| Time | 09:23:03 |
| Latitude | -15.9702833333333 |
| Longitude | 124.281816666667 |
| Altitude | 5.3 |
| Accuracy | 0.9 |
| Boat size (m) | 8 |
| Motor size (hp) | 300 |
| Wheel | |
| Observer height above water | 2.54 |
| Ethan Jungine | ☑ |
| Edmund Jungine | ☑ |
| Kirk Woolagoodja | ☑ |
| Graham Woolagoodja | ☑ |
| Francis Lane | ☑ |
| Other people present | rod, frank, micha |
| Start | |
| | |
| Start transect | |
| Transect number | 1 |
| Other | |
| Left observer | micha |
| Other | |
| Right observer | kenny |
| Ethan | |
| Some chop | |
| No or very few clouds | |
| No wind | |
| Some glare | |
| BIT MURKY (can see but not clear) | |
| Outgoing | |
| Turtle | |
| Right 25m | |
| GREEN | |
| Juvenile | |
| Underwater | |

**Figure 2: Data collected for an individual turtle sighting using the I-Tracker Turtle and Dugong Survey application and viewed in the CyberTracker desktop application**

A key variable influencing sightability is the distance of an animal with respect to the boat. To ensure that observers were estimating distance accurately, a rope with two large white floats was trailed off the back of a boat with one buoy set 25m away and the second buoy set 50m away. Rangers then threw stones to different distances to simulate animal sightings. All participants called out the relevant 'band' where the stone landed -for example 'Right 50 plus!' to express that the stone landed to the right side of an imaginary line drawn through the middle of the boat and at a distance of greater than 50 metres. They then practiced calling out the whole sequence of variables for each turtle observation, for example 'Right 25! Green! Adult! Underwater!' corresponding to a sighting of an adult Green turtle seen at a distance of 25 metres or less from the boat below the surface (see Figure 3 and Appendix 2).

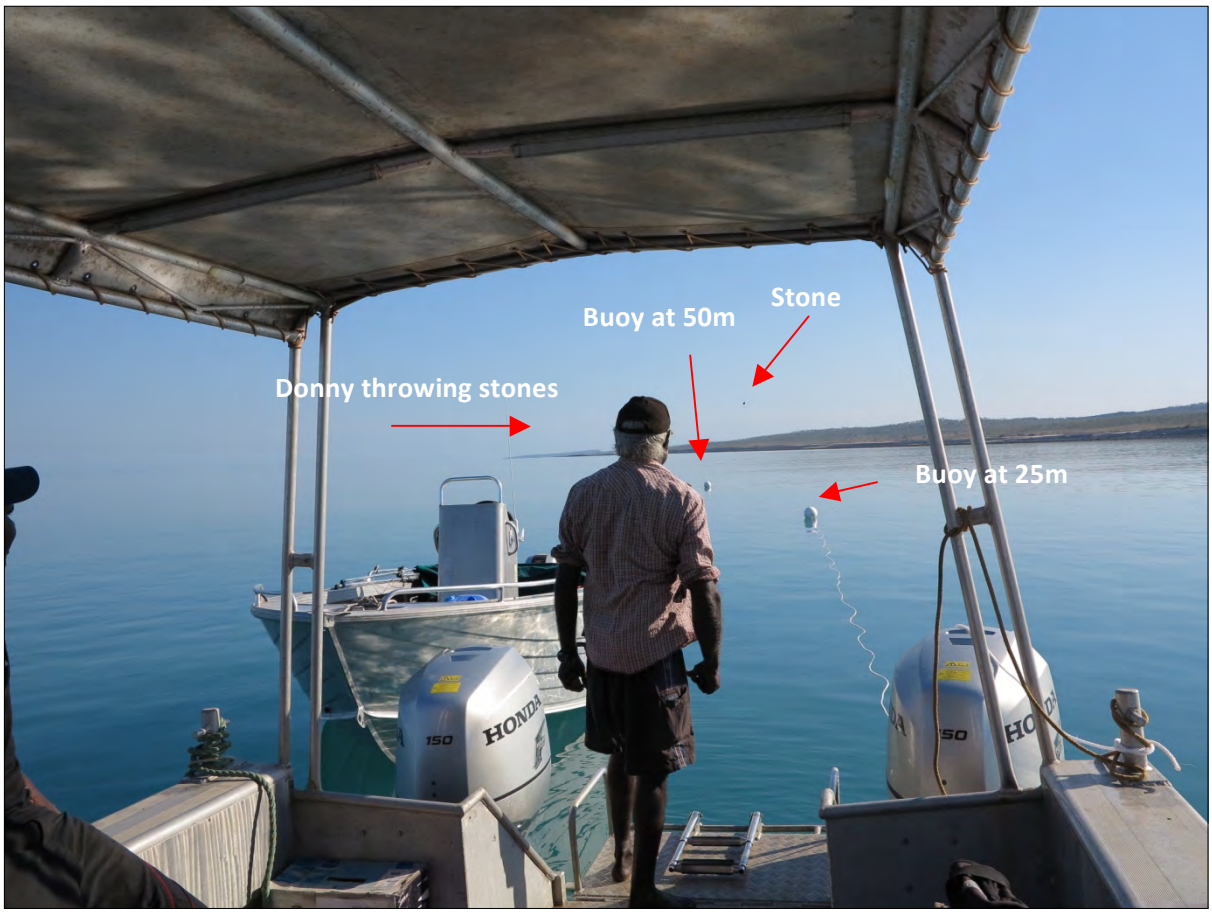



Figure 3: Participants practicing distance estimates

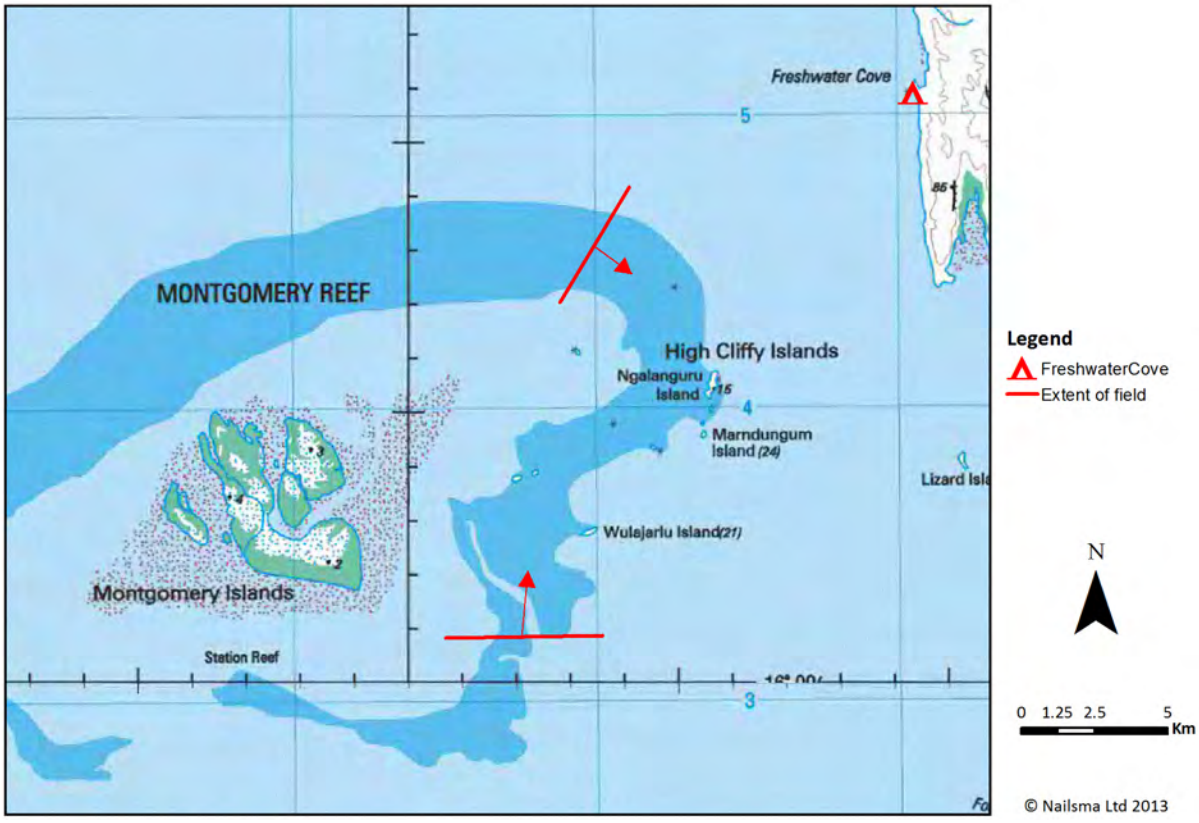



Figure 4: Study area of the Reef

## FEEDBACK WORKSHOPS

Feedback workshops were held on August 22, 23, and 24 in the late afternoon/early evening after fieldwork had been completed. Dambimangari Rangers and community members viewed and discussed maps of the day's survey results and any proposed changes to survey methods or the application.

On August 22, after the first fieldwork had been completed, data from the day was uploaded and viewed by those involved. The first set of transects around the east side of Montgomery Reef were drawn on the map and added to the application for use in the field the next day (see Figure 5).

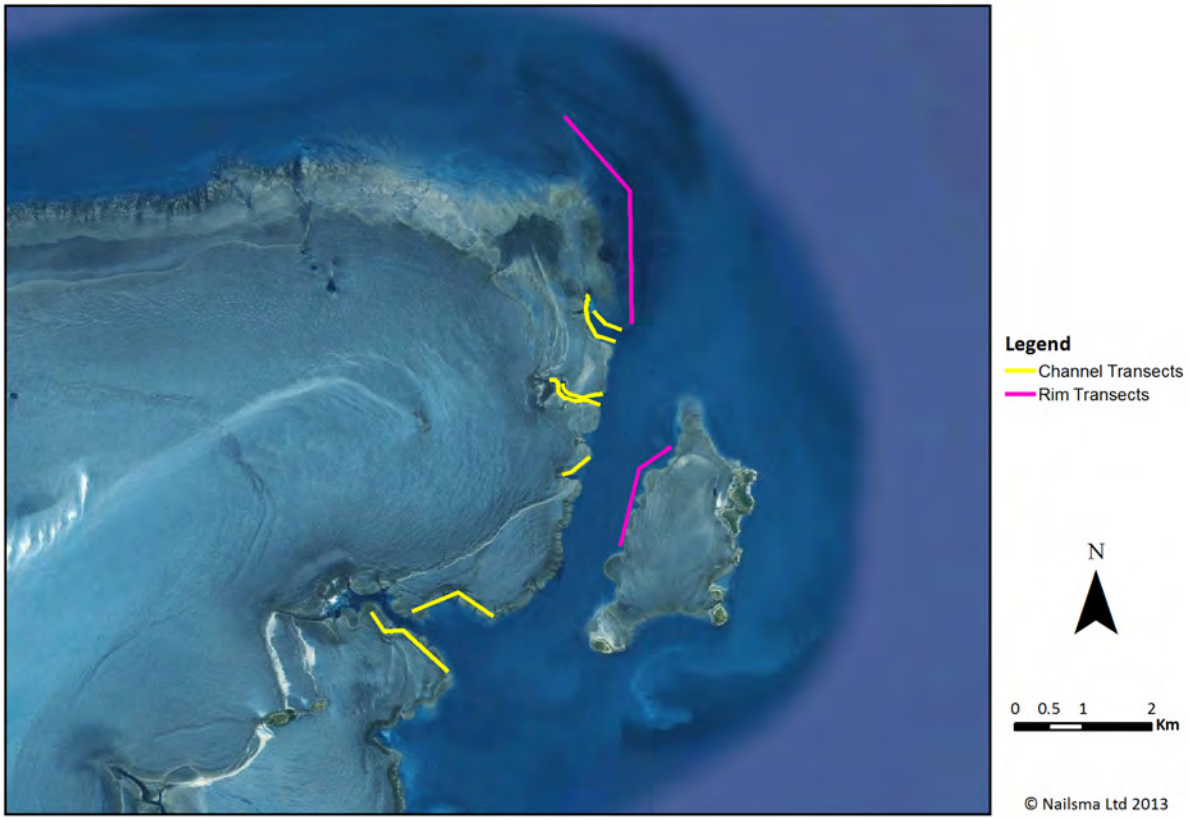



**Figure 5: Transect developed August 22**

On August 23, after fieldwork had been completed, data from the day was uploaded and viewed by those involved. Participants also had the opportunity to create some customised maps using CyberTracker software showing different aspects of the data. It was decided to repeat some transects the next day but also to explore a very large channel and several other channels on the south side of the reef.

There was also considerable discussion about the Green turtle counter feature of the I-Tracker application (see Appendix 2 for more detail). Participants felt that when very high numbers of Green turtles were seen, the distinction between the right and left observers' sightings became fairly meaningless because as turtles zigzag across the front of the boat at close distances, observers tend to help each other to come up with the total sightings rather than calling out distinct individual sightings. In addition, it was discussed that the size of the turtles seen in high density areas is important information to record, as some high density areas contained mostly juvenile turtles while others had a higher proportion of adults; this valuable information was not captured by the current

version of the Green turtle counter. Based on these discussions, the application was modified so that the Green turtle counter still captured the distance band for turtle observations, but location with respect to the boat (right or left side) was replaced by size classes. (see Appendix 2 Figure iii).

On August 24, after fieldwork had been completed, data from the day was uploaded and viewed by those involved. Transects around the channels on the south side of Montgomery Reef were drawn on the map and added to the application for use in the field the next day, and some transects on the east side of the reef were slightly modified (see Figure 6).

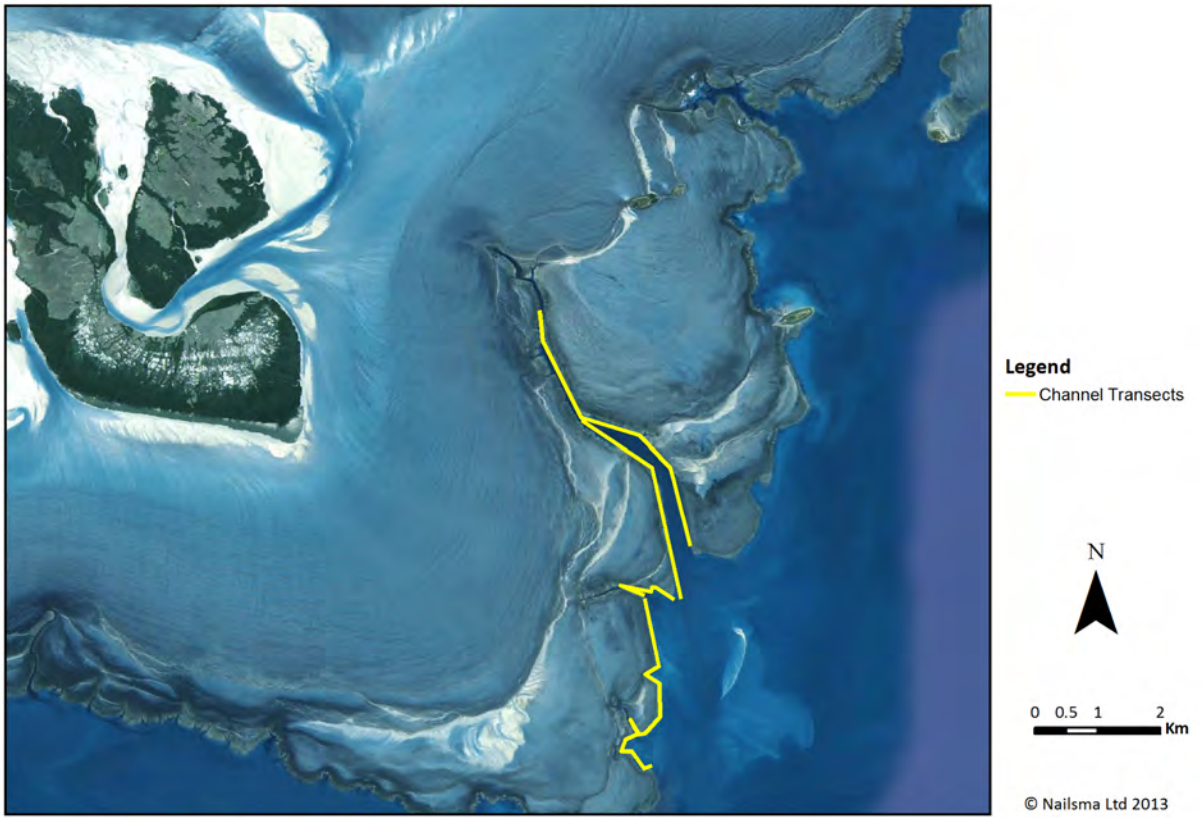



**Figure 6: Transect developed August 24**

## KNOWLEDGE MAPPING WORKSHOP

Maps of the survey area were printed by NAILSMA staff using Google Earth Pro and brought to the workshop on A0 sized colour posters. On August 21 and August 23, Donny Woolagoodja provided his expertise on where turtles are found in the highest densities, where there are significant areas of sea grass, and where dugong are sometimes seen, using the map as a reference. These large maps were also used to plan survey routes on the first day of the trip with advice from Donny and Peter Tucker from Freshwater Cove. A copy of the map was left with the Dambimangari Rangers at the end of the trip.

## SURVEYS

Surveys were conducted on each day from August 22 to 25 and commenced around 0630-0800 each morning, depending on tide conditions. Two survey teams and vessels were used - *Wandjina*, an 8m vessel, and a 5m tender (see Figure 7). Two observers (one left and one right) called out sightings of turtles and dugongs, and one recorder entered all sightings from both observers into the PDA. On

*Wandjina*, all three people went to the front of the vessel, with the two observers standing and the recorder generally seated. Although this vessel was optimal for sightings, communications with the skipper were sometimes difficult. On the tender, the two observers also stood while the recorder generally sat in a camp chair in front of the console. One PDA was used by the recorder of each vessel and one PDA was made available for the skipper of each vessel so that field maps[1] could be accessed and transects followed while driving the boat.

**Figure 7: Two boats were used for the surveys. The top photo is the *Wandjina*, an 8m vessel. The bottom photo is a 5m tender.**

[1] Note: field maps are maps that are loaded into the I-Tracker application so that they can be accessed on the PDA screen in the field. They can display layers – in this case the planned transects – and current location (provided a GPS signal has been acquired) as well as tracks for the day.

## Day 1

The focus area for the day was the northeast side of the reef, in particular a long stretch on the north side and several channels slightly further south (see Figure 8). People on board both Wandjina and the tender recorded turtle and dugong sightings using the **Turtle and Dugong Survey_v4.2_Dambimangari I-Tracker** application. The **Saltwater Country Patrol_v4 I-Tracker** application was also used on board both vessels to record other marine sightings. In general, the tender was able to access some shallower areas of the channels and therefore pick up additional turtle sightings at the crowded ends of these channels. While transects had not been drawn on a map prior to this trip, the boats generally followed straight lines so that transects could be planned based on the trip. The trip finished at approximately 1400.

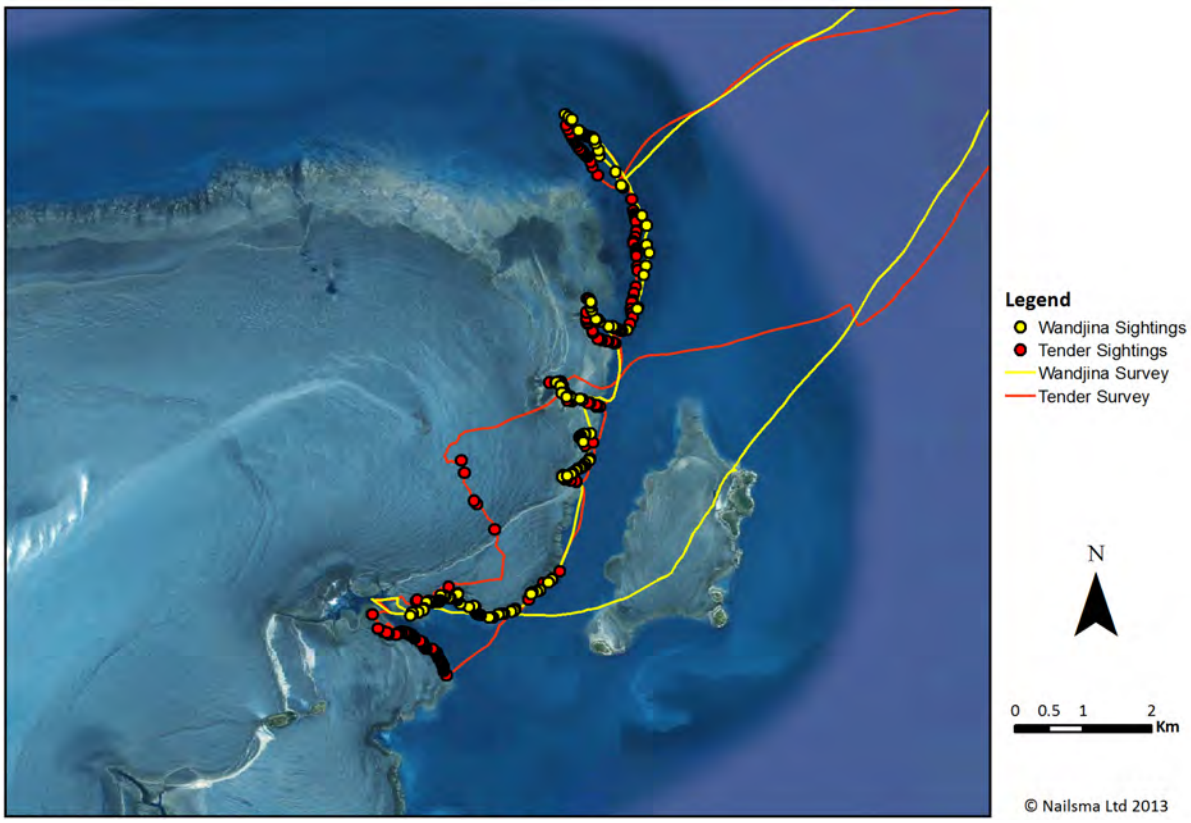



**Figure 8: Transect survey sightings and track August 22**

## Day 2

The focus area for the day was the same as the previous day, however it followed transects that had been drawn on a map the previous evening based on sightings from August 22 (see Figure 5 and Figure 9). An additional transect was also planned for the east side of High Cliff Island, which was not surveyed the previous day. The planned transects were added to a field map which could be accessed on the PDA by the skipper of each boat so that they could follow the planned transects while driving the boat. All planned transects were completed. Each vessel completed several transects, and no transects were covered by both vessels. In general the tender completed the transects in the channels because it could access additional shallow areas of the channels that could not be accessed by Wandjina. The trip finished at approximately 1330.

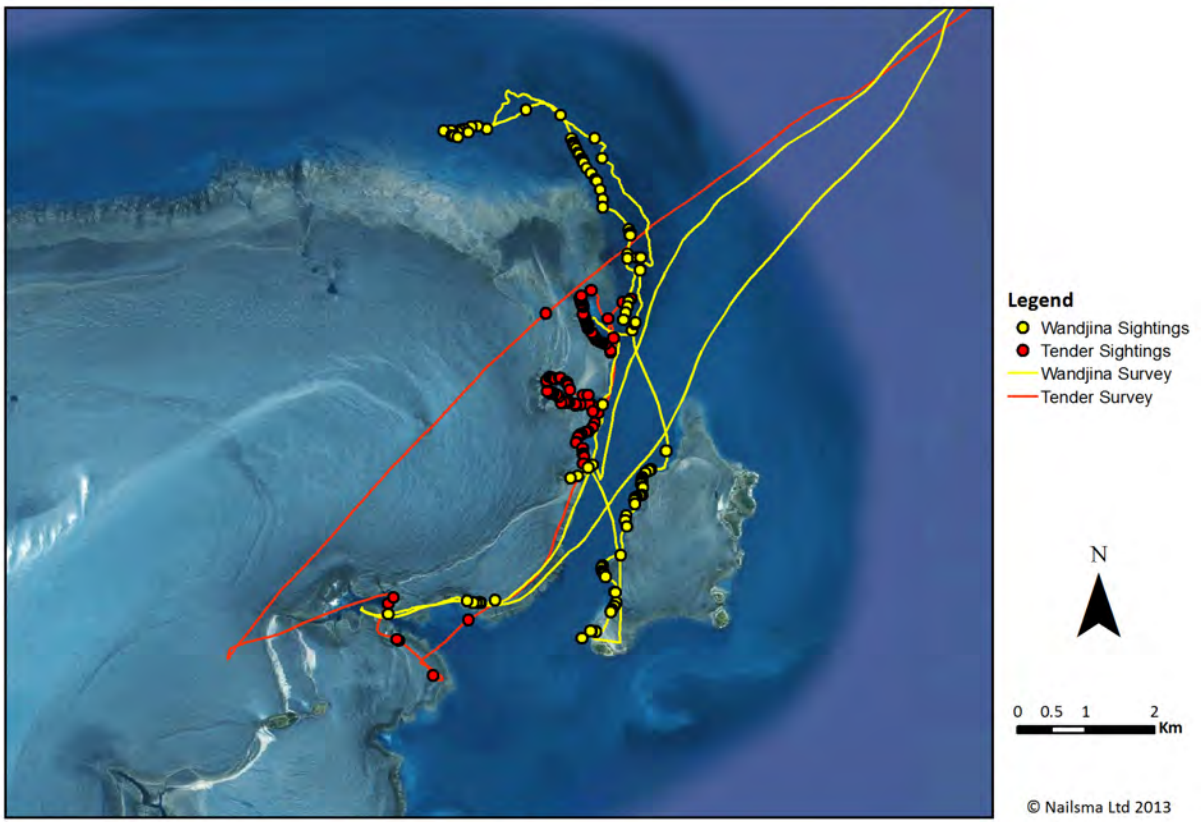



Figure 9: Transect survey sightings and track August 23

## Day 3

This trip expanded the survey area to include a large channel and several smaller channels on the southeast side of the reef. These areas were surveyed in the morning. In the afternoon, the transects in the channels on the northeast of the reef and the transect on the east side of High Cliffy Island that were completed the day before were also repeated (see Figure 10). It was noted that differences in the tidal state heavily influenced how many turtles were seen along the transects on the northeast side of the reef. For example, the transect at High Cliffy Island was quite unsuccessful because the higher water levels meant that very few turtles were sighted. The trip finished at approximately 1400.

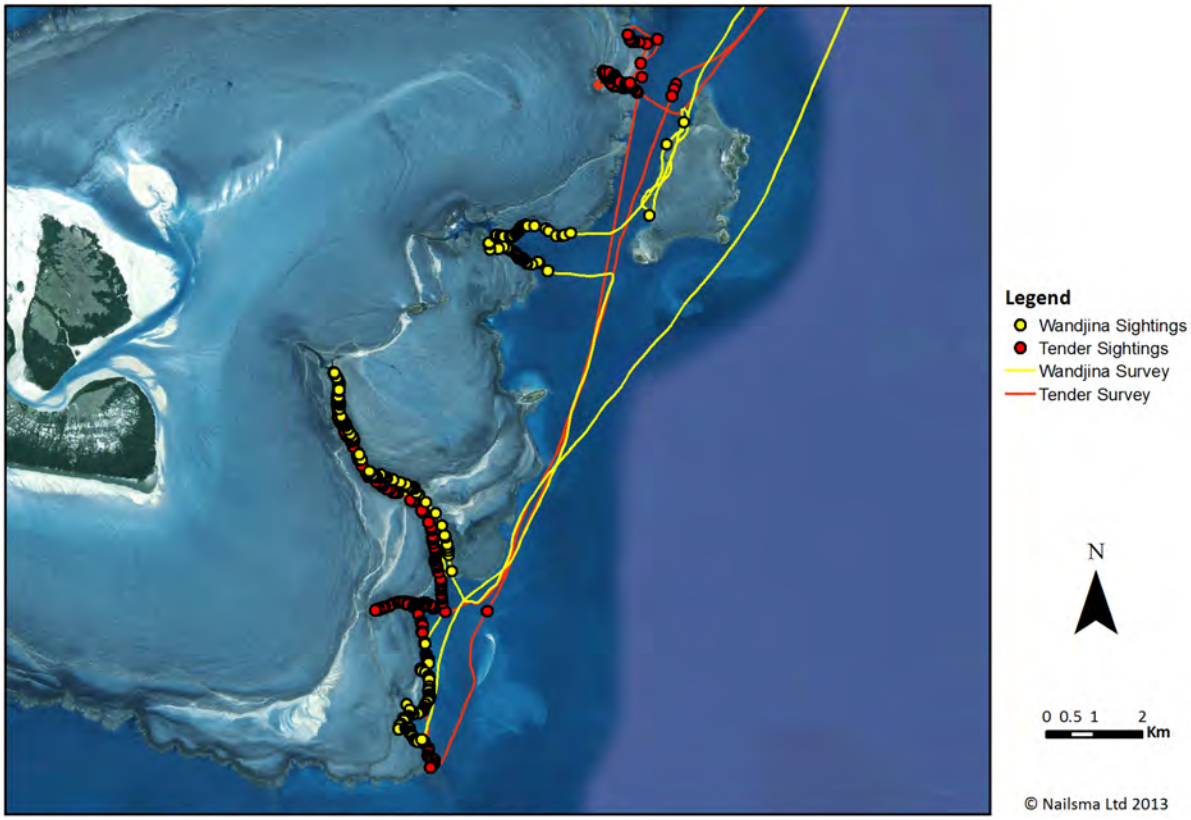



**Figure 10: Transect survey sightings and track August 24**

### Day 4

The transect in the very big channel on the southeast side of the reef was repeated, as were all planned transects on the northeast section of the reef (see Figure 11). The trip finished at approximately 1430.

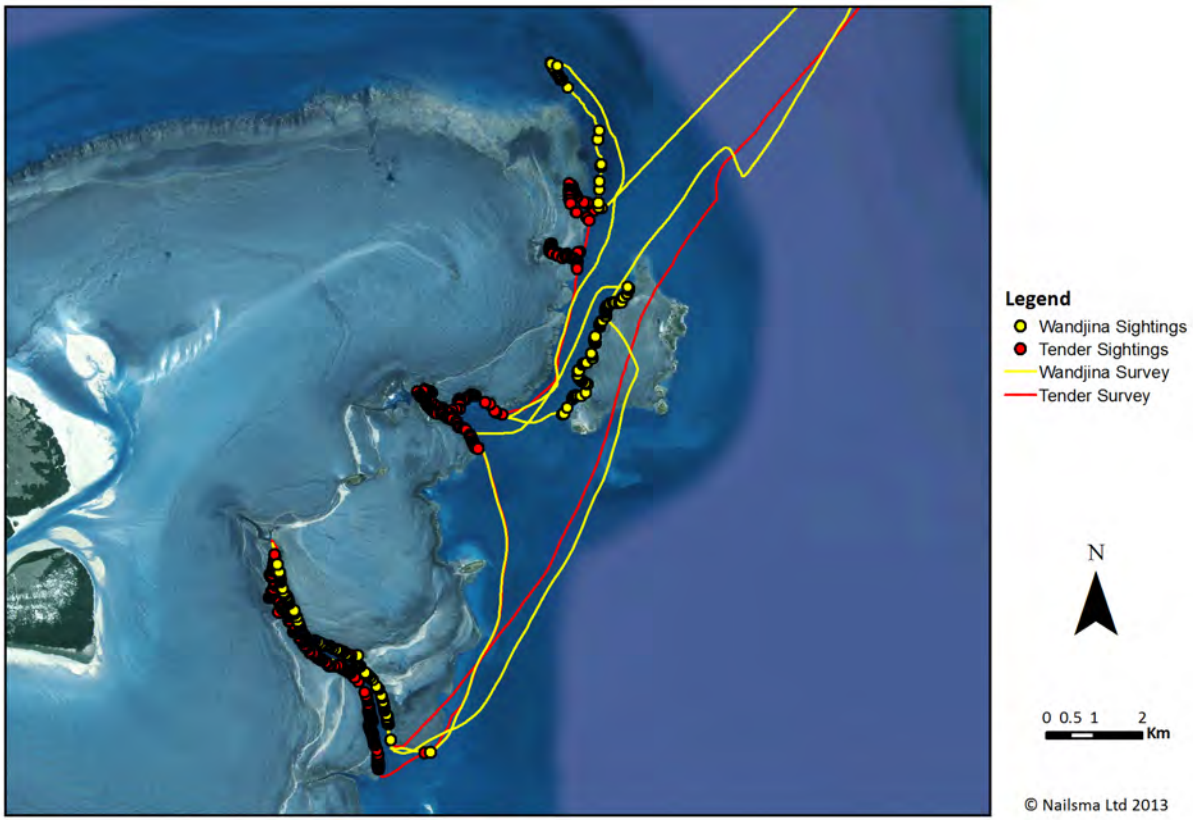



**Figure 11: Transect survey sightings and track August 25**

## PARTICIPANT INTERVIEWS AND EVALUATION

All participants were interviewed and asked questions about: their role in their organisation or community; their role in the surveys; the value of the surveys; and, how or if the surveys can contribute to meeting Dambimangari sea country management priorities. Digital recordings of responses were combined with digital still images taken during the field trip to provide a 'story report' (www.nailsma.org.au) of each person's experience in the field trip. Story reports provide an audiovisual record of an event that participants can use in presentations to community gatherings or steering committees for example.

# RESULTS

## TURTLE SIGHTINGS

A total of 2,363 turtles were recorded, with almost 97% (2,289) recorded as being Green turtles. A total of five dugongs were recorded, including one calf (see Figure 12 and Table 2).

1,461 turtles were recorded individually, of which 1,387 (~95%) were recorded as Green, 18 (~1%) were recorded as Hawksbill, and 56 (~4%) were recorded as unsure. Where size class was recorded

for individual Green turtle sightings (which was most of the time), it was heavily skewed towards younger individuals with 954 juveniles (~69% of total Green turtle individual sightings), 250 subadults (~18% of total Green turtle individual sightings) and 171 adults (~12% of total Green turtle individual sightings) recorded. Of the Hawksbill turtles recorded, 13 (~72%) were recorded as being juveniles (see Table 2).

The Green turtle counter was used 90 times on transect and 12 times off transect for a total of 902 turtles. On August 22 and August 23, the Green turtle counter was set up to record only distance bands (0-25m, 25-50m, and >50m) and whether the turtle was on the left or right side of the boat. For August 24 and 25 this the counter was altered to capture both distance bands and six class (juvenile, subadult, or adult) but not whether the left or right observer called out the turtle. For August 24-25, a total of 495 Green turtles were recorded on transect using the Green turtle counter. Of these, 316 (~64%) were recorded as being juveniles, 81 (~16%) were recorded as being subadults, and 98 (~20%) were recorded as being adults (see Table 2).

Total time spent on transect over the four day period was 15 hours, 38 minutes and 12 seconds across both boats used, so the catch per unit effort for Green turtle sightings was about one Green turtle sighted every 27 seconds of transect survey effort or about 133 Green turtles per hour.

## DUGONG SIGHTINGS

A total of 5 dugongs were recorded, with one lone calf identified.

**Table 2: Summary of all animal sightings August 22-25**

| Animals | Number recorded | Identified juvenile | Identified subadults | Identified adults |
|---|---|---|---|---|
| Total turtles | 2363 | 1327 | 349 | 292 |
| Individual Green turtles on transect | 1292 | 913 | 220 | 149 |
| Green turtles using Green turtle counter on transect | 759 | 316 | 81 | 98 |
| Individual Green turtles off transect | 95 | 41 | 30 | 22 |
| Green turtles using Green turtle counter off transect | 143 | 21 | 5 | 12 |
| Hawksbill turtles | 18 | 13 | 3 | 2 |
| Dugongs | 5 | 1 (calf) | N/A | N/A |

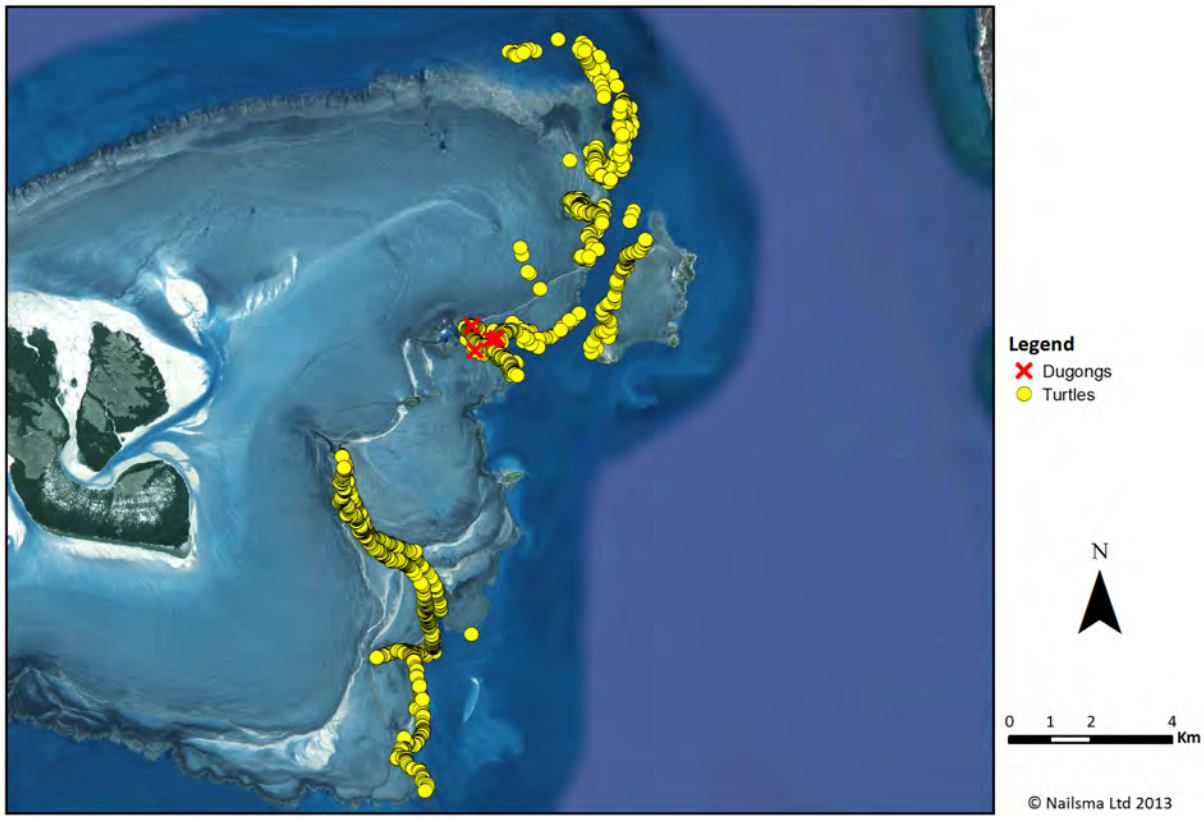



**Figure 12: Dugong and turtle sightings August 22-25**

## PARTICIPANT INTERVIEWS

Participants in the survey were all given the opportunity to give an interview about their experience of the trip. This was developed into a story report, a video of images from the week along with the audio from participant interviews, by KLC staff.

Overall, participants were very positive about the surveys and appreciated their importance in achieving Dambimangari aspirations. The value to the Dambimangari of 'owning' the process (designing and conducting the surveys), the outputs (the data and maps) as well as the outcomes (improved capacity, knowledge base and understanding or scientific methods) was a common theme. The quotes below highlight some of the experiences for the participants:

> *'It's been fun we're just sort of learning the whole how turtles how their movements with the tide coming in and out and just watching them as the tide coming in on the reef, they just all lining up on the reef to do their feeding and their mating' Francis Lane*

> *'It's really good this week doing it with the I-Tracker recording all the turtle and dugong we see with the I-Tracker.' Kirk Woolagoodja*

> *'We've come to do some surveys on Montgomery Reef. Turtle and dugong. Find out how much turtle and dugong we can find, and see where they're going, and how many are left, and learn more with the I-Tracker.' Graham Woolagoodja*

> *'It's good...seeing the boys learning new technology, modern technology and [pairing it] with Traditional Knowledge.' Kenny Gibson*

# CONCLUSIONS

*'This is our country. It's from the oldest to the youngest generation that will try to protect our country and look after the animals.' Donny Woolagoodja*

The results of the Dambimangari turtle and dugong survey at Montgomery Reef, along with other studies involving the Uunguu Rangers (Kimberley, WA) and the Gumurr Marthakal Rangers (NT), demonstrate that boat-based surveys conducted by Indigenous rangers in remote locations are technically feasible and yield robust data on distribution and abundance of turtles and dugongs. The inclusion of environmental variables as well as effort (distance, time and numbers of observers) in the survey method means that future surveys can build on these baseline data to examine temporal and spatial variation in distribution and relative abundance.

The surveys also demonstrate that local capacity (e.g. trained staff, equipment and governance arrangements) developed to provide a monitoring and surveillance presence is readily adapted for the purposes of marine wildlife surveys. Across much of north Australia Indigenous rangers are the only organised, local on-ground management presence. Standardised Indigenous-led surveys are therefore the only means to obtain distribution abundance data for dugongs, marine turtles and a plethora of other species and habitats across remote north Australia.

Indigenous ownership of the process (survey methods), outputs (data) and outcomes as evidenced by responses of Indigenous participants in interviews, means that survey results will directly inform decision making by local Indigenous communities. As Robyn Mungulu stated in her interview, 'It was really good to see the rangers linking modern knowledge with the Traditional Knowledge and we'd like to see more of the help we're getting from the survey group for keeping track of the turtle and dugong in Montgomery Reef.'

This has not always been the case in the past, where Indigenous people have held minor roles in research and monitoring projects and where project objectives aren't aligned with Indigenous priorities such as those identified in community-based participatory planning processes. The growing empowerment of Indigenous people to influence resource use decisions on enormous areas of traditional estates means that the outcomes of projects such as the Dambimangari survey will have increasingly greater regional and national implications for marine and coastal conservation efforts.

The study also points to some specific learnings about future Dambimangari engagement in boat-based surveys including:

- The presence of a base camp near Montgomery Reef provides a base for extended operations of the Dambimangari Rangers during the annual dry season. This effectively reduces costs and logistic challenges as it will require fewer trips from Derby and surveys can be included in a wider work program.
- The Dambimangari Rangers demonstrated a high level of proficiency in the use of the I-Tracker application, however follow up training and support is likely to be required for the rangers to undertake future surveys. Unlike other ranger groups, the Dambimangari Rangers are not using I-Tracker for other patrol work at present, and have less experience in the software and data management. Ideally NAILSMA, CSIRO and KLC support staff should be involved in the next surveys to provide refresher training and to demonstrate methods for mapping and analysing data. The rangers would also benefit from generalised

I-Tracker training when they have adequate technical and infrastructure capacity to develop an I-Tracker monitoring program.

- A total survey record of 2,363 turtles over four days of survey effort showed that turtle densities at Montgomery Reef are high enough to warrant investment in establishing an on-going survey program.
- The straight-line survey method used in the Wunambal Gaambera turtle and dugong surveys requires modification for surveys at Montgomery Reef. The structure of the reef and survey success shows that turtle numbers are high in direct vicinity of the edge of the reef and within the channels inside the reef complex. The distribution of turtles at the reef changes significantly with tidal movement due to the ~11m tidal range. The West-Kimberley sees the highest tides in the Southern Hemisphere, with the reef drying out at low-tide and being covered by high-tide. A full tide on top of the reef diminishes survey effort as turtles are spread over a larger area and visibility decreases with the high-tide washing over the sandy/silt substrate. A parallel transect line further seawards does not deliver additional sightings as turtle numbers decline rapidly further away from the reef (with depth) and visibility is too limited by water turbidity. Therefore, the line transects for Montgomery Reef need to follow the edge of the reef and its internal channels while incorporating tidal movements.

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# APPENDIX 1: INDIVIDUAL INVOLVEMENT IN THE FIELD TRIAL

| Name | Organisation | Activities |
|---|---|---|
| Francis Lane | Dambimangari Rangers | Planning workshop<br>Feedback workshops<br>Boat surveys (Days 1-4) |
| Ethan Jungine | Dambimangari Rangers | Planning workshop<br>Feedback workshops<br>Boat surveys (Days 1-4) |
| Edmund Jungine | Dambimangari Rangers | Planning workshop<br>Feedback workshops<br>Boat surveys (Days 1-4) |
| Kirk Woolagoodja | Dambimangari Rangers | Planning workshop<br>Feedback workshops<br>Boat surveys (Days 2-4) |
| Graham Woolagoodja | Dambimangari Rangers | Planning workshop<br>Feedback workshops<br>Boat surveys (Days 1-4) |
| Kallum Mungulu | Wandjina Tours | Planning workshop<br>Feedback workshops<br>Boat surveys (Days 1-3) |
| Donny Woolagoodja | Wandjina Tours | Planning workshop<br>Feedback workshops<br>Mapping exercise<br>Boat surveys (Days 1-3)<br>Logistics |
| Kenny Gibson | Wandjina Tours | Feedback workshops<br>Boat surveys (Days 3 |
| Frank Weisenberger | Kimberley Land Council | Planning workshop<br>Feedback workshops<br>Mapping exercise<br>Boat surveys (Days 1-4)<br>Logistics |
| Rod Kennett | NAILSMA | Planning workshop<br>Feedback workshops<br>Mapping exercise<br>Boat surveys (Days 1-4)<br>Logistics |
| Micha Jackson | NAILSMA | Planning workshop<br>Feedback workshops<br>Mapping exercise<br>Boat surveys (Days 1-4)<br>Logistics |
| Robyn Mungulu | Wandjina Tours | Logistics |
| Sandra Umbagai-Clarke | Wandjina Tours | Logistics |

# APPENDIX 2: TRANSECT METHOD

This project is designed to assist rangers to regularly monitor local turtle and dugong populations from a boat by completing regular surveys.

The primary focus of the survey is to complete targeted transects. However, off transect sightings are also recorded as additional presence-only information. The surveys involve using an I-Tracker application to collect the information on a PDA. It takes at least 4 people to do the survey (2 observers, 1 recorder and 1 boat driver).

The main features of the transect survey include:

- One observer is stationed on each side of the boat and observer height above water is recorded; the observers call out all sightings of turtles and dugongs.
- A recorder uses the PDA loaded with the I-Tracker application Turtle and Dugong Survey_v4.2 (created using CyberTracker software) to record all sightings of turtles and dugongs called out by the observers.
- The boat travels slowly at about 5-8 knots (10-15km/h) along transects approximately 1.0 - 2.5km long.
- Environmental conditions are recorded at the beginning of each transect, including: Sea state; Cloud cover; Wind Strength; Glare; Water Clarity; and Tide conditions.
- Whenever possible, turtles are recorded individually and a GPS point is taken after each sighting (see Figures i and ii):
    - The left observer calls out individuals seen to the left of an imaginary line drawn through the middle of the boat, and the right-hand observer calls out individuals seen to the right of the line.
    - Distance from the boat is recorded as a choice of three ‘bands’: 0-25m away from the boat; 25-50m away from the boat; and more than 50m away from the boat.
    - The species of the turtle is recorded.
    - Turtle size is recorded as Juvenile, Subadult, Adult, or Unsure.
    - Behaviour is recorded as Surfacing or diving; Underwater; At surface; or Mating.

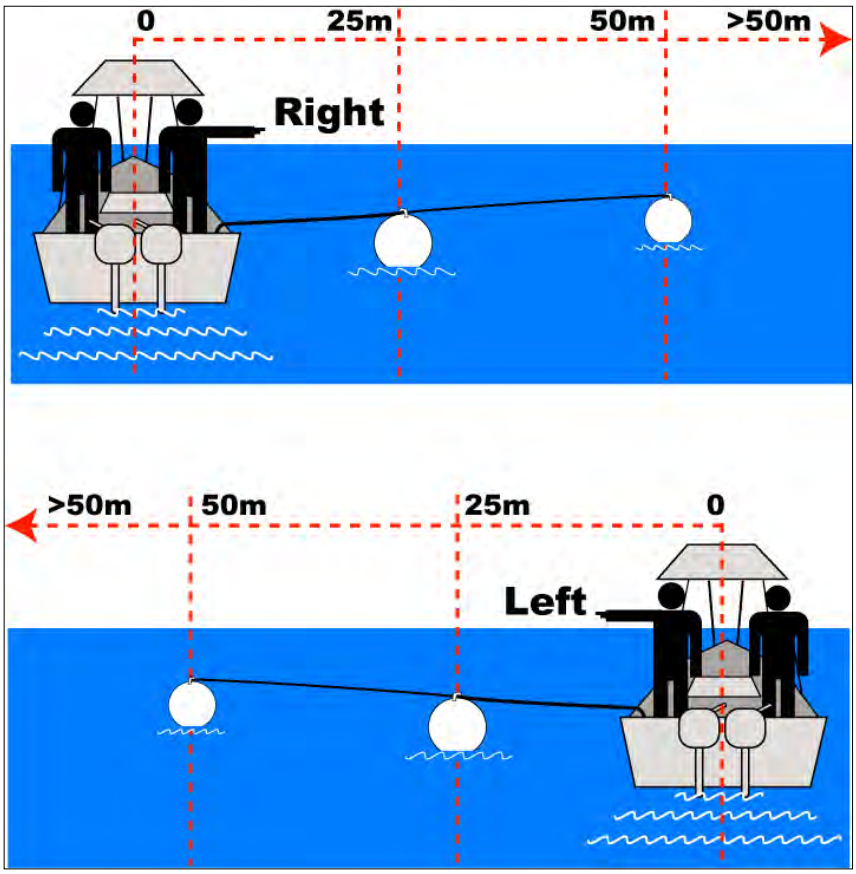


**Figure i: The three distance 'bands' that observers place all turtle and dugong sightings in.**

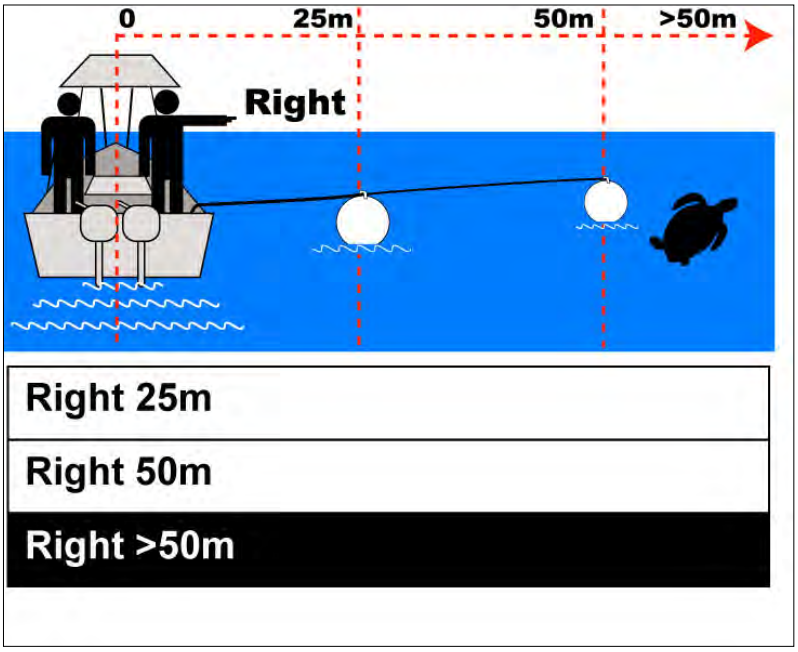


**Figure ii: Example of how a turtle sighting more than 50 metres away from the right side of the boat should be recorded by the right observer.**

- If turtles are appearing too fast to record all of the above information (in other words, the transect is going through a very 'high density' area), the Green Turtle Counter can be used to record multiple individuals (see Figure iii). However, this only captures the distance of the turtle from the boat and not size or behaviour. It is also assumed that all individuals counted are Green turtles. A GPS point is taken after all Green turtles in the high density area have been recorded (so each individual does not have a unique GPS location recorded). On August 22 and 23, the Green turtle counter was set up to record turtles in terms of which side of the boat they were sighted on(left or right) and in distance bands (0-25m, 25-50m, and >50m). However, it was noted by the rangers that in very high density Green turtle zones on Montgomery Reef, turtles tend to zigzag directly in front of the boat, making the left and right distinction somewhat meaningless. In addition, it was noted that in some areas, high density Green turtles areas contained many juveniles and few adults, while in other areas the spread contained significantly more adults. It was thought that capturing this size class information was potentially more important than the left/right distinction, and observers felt that they had time to capture only one or the other in high density situations. Thus for August 24 and 25, the Green turtle counter was modified to capture distance band (0-25, 25-50m, and >50m) and size class (juvenile, subadult or adult) (see Figure iii).

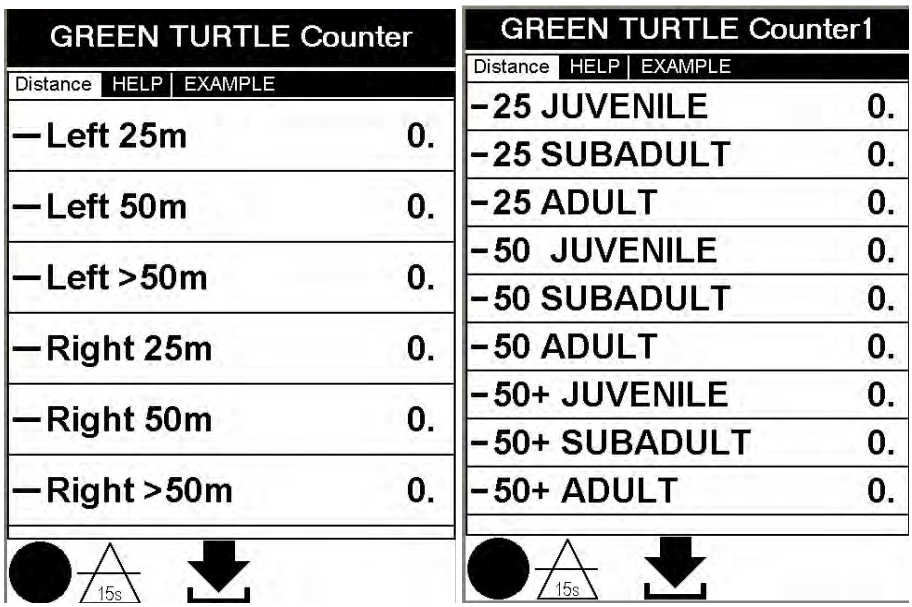


**Figure iii: left shows Green turtle counter used on August 23-24; right shows Green turtle counter used on August 24-25**

- Dugongs are recorded as a group to reflect the expectation that dugongs will often be sighted in groups rather than as individuals. If a dugong is sighted, the boat is stopped and all individuals visible in the group are recorded in their relevant distance bands (see Figure iv).

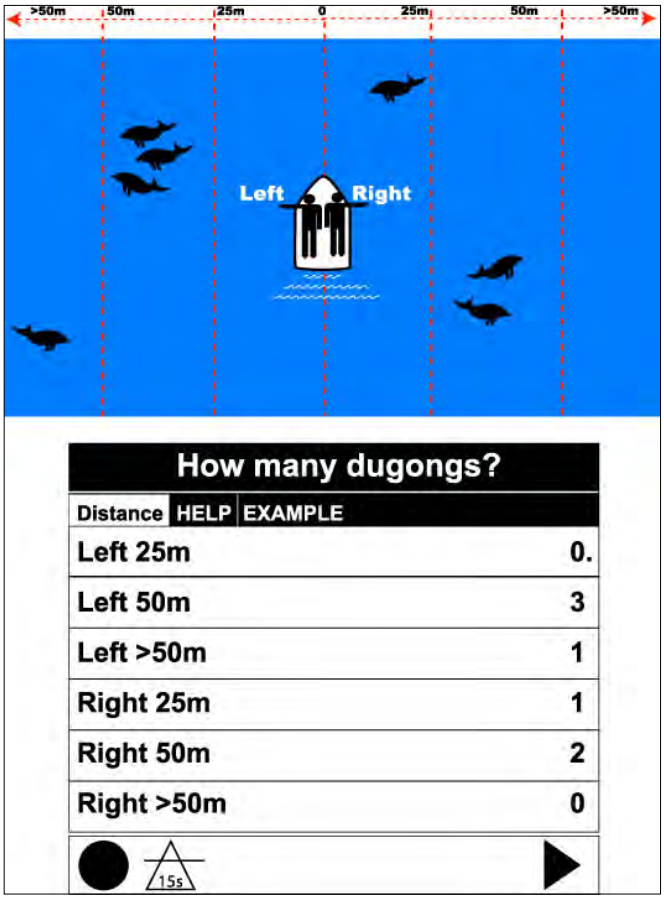


**Figure iv: Dugongs are recorded as a group, rather than individually, but still by the left and right observers and in the three distance 'bands'.**

'Help' screens that can be accessed at the time of sighting on the PDA are located throughout the application. Figures i, ii and iv are examples of the help screens.

From the start to the finish of the survey, all turtles and dugongs sighted are to be recorded. When systematic transect surveys are not being undertaken (such as when travelling to survey areas), sightings are recorded as 'off transect' to aid mapping distribution. The features recorded are identical to the above, although environmental conditions are not recorded.

Using CyberTracker software also allows effort data to be recorded with no extra work. As long as the PDA is turned on at the beginning of the survey and turned off at the end of the survey, CyberTracker records:

- the number of patrols completed;
- the distance covered during the day;
- total hours spent between the start and end of the patrol; and
- average speed.


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