



Student Progress Reporting Form WAMSI Top-up Scholarship

STUDENT:	Frazer McGregor	DATE:	NOVEMBER 2009
SUPERVISOR:	Dr Mike van Keulen		

PROJECT TITLE:	The trophic ecology and habitat requirements of the manta ray (<i>Manta birostris</i>) in lagoonal systems of Ningaloo Reef, Western Australia
NODE LEADER:	Chris Simpson
PROJECT NUMBER:	Node 3 - BHP Scholarship

PROGRESS REPORT FROM SUPERVISOR

Aims of the Research

The primary aim of this research is to determine the relative importance of certain habitats within the Ningaloo Reef system to the foraging requirements and life history of the manta ray *Manta birostris* (Donndorff 1798).

In Western Australia, manta rays are found predominantly along the north-west coast, with reports of them occasionally as far south as Rottnest Island, west of Perth. There are however only a few locations where large aggregations of animals have been reported. One of these is the Ningaloo coast, from Carnarvon to Exmouth where at several distinct locations manta rays regularly form either feeding or mating aggregations.

Whale sharks and manta rays both have a huge requirement for food and are likely to spend a large amount of their time engaged in foraging given the minute size and spatial patchiness of their planktivorous prey. The mostly planktivorous nature of the manta ray and whale shark make their place in the trophic food chain somewhat unique given their enormous sizes, and at a similar level to far smaller fish. Abundant food as a result of the yearly coral spawning in March and April is thought to catalyse the feeding aggregations of whale sharks which last for approximately three months. After June whale sharks are thought to migrate NW away from the Australian continent (DEC pers. comm).

Manta ray aggregations on the other hand, although reduced in numbers of individuals at any given location (from over 70 to 15+), occur throughout the year along the Ningaloo Reef tract, suggesting a degree of residency (F. McGregor unpublished data) as seen in a number of other localities around the globe.

This study aims therefore to fill in some of the blanks in our understanding of manta ray ecology, primarily their feeding ecology, as it pertains to Ningaloo Reef and provide benchmark data on which human interactions with manta rays and the need for tighter controls can be assessed.

The dependence of manta rays upon certain habitats within the reef will be determined by assessing seasonal planktonic food availability, its source, patchiness and scale as well as its longevity within the lagoonal system, as a result of the mixing of seaward and lagoonal waters.

Foraging behaviours, foraging effort, food intake, the nutritional value of planktonic assemblages and abundance and proximity of other key reef structures will also be investigated to determine why individual manta rays consistently return to specific localities along the Ningaloo Reef tract.

Progress made on the project

Frazer has completed all data collection and is currently finalising data analysis and compilation. Additional data from the acoustic tagging programme and photo-identification programme will be included as they become available (these are on-going programmes). Frazer has commenced the writing stage of the project and is anticipating submission of the thesis around the end of March 2010. Frazer has continued to make excellent progress on what is turning out to be an exceptional project, providing important information on local manta ray ecology and behaviour. I am very pleased with his progress.

Major risk issues

None to report.

PROGRESS REPORT FROM STUDENT

<i>Student Name</i>	Frazer McGregor
<i>Supervisors Name</i>	Mike Van Keulen
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This projects several concurrent themes (which aim to quantify the number of manta rays present along the Ningaloo reef tract and determine their dependence of certain lagoonal areas where they are targeted by a growing tourism industry) have all nearly been completed throughout 2009. **Final analysis of data and chapter compilations are currently being undertaken with an expected completion date and thesis hand in by the end of March 2010.**

Photographic identification of manta ray presence in Bateman Bay continued for its 5th complete year, with 518 individuals now identified as of July 2009, from over 1500 unique photographic records. Re-sighting ratios have stabilized at 1/3 of the population confirming the existence of a mostly transient population and a small semi-resident focal group of mostly mature females which are sighted almost year round. Sighting data collections, having been catalysed by this project, will be ongoing with the assistance of the local community ensuring that this aspect of the project will become a significant long term database. Mark/recapture analysis of database records up until July

2009 is being used to determine population estimates and associated demographics of the population visiting Bateman Bay. This estimate will be updated/re-analysed annually using community records.

To complement the sighting data paired laser photo-grammetry has been used to accurately size a proportion of the population. To date 30 animals have been accurately sized, indicating that visual size estimates whilst closely indicative of actual sizes, underestimate larger individuals especially females. The presence of claspers in males aids accurate size estimation.

The Ningaloo Manta Ray population is the 3rd largest globally recorded.

Stable Isotope Analysis. The final stable isotope samples were analysed in the latter part of 2009. A total of 50 manta ray tissue samples have been analysed together with 3 whale shark, 129 sedentary filter feeder tissue samples and 170 samples of various macro-zooplankton. These samples are currently being analysed to determine the trophic position of manta rays at Ningaloo, using stable isotope abundances of C and N.

Sub-samples of over 70 manta ray tissue samples have now been collected for collaborative genetic analysis of Ningaloo manta rays. This analysis has not yet been undertaken, but is planned for future collaborative work. Preliminary analysis has taken place as part of a speciation study by colleagues at UQ.

The Zooplankton Assemblage of Bateman Bay. The investigation of the zooplankton assemblages of Bateman Bay (where manta rays aggregate throughout the year) is complete. Results which are being compiled at present have shown an expected degree of seasonality, but importantly have shown that manta rays when feeding in lagoonal areas are primarily targeting a single species of possibly endemic copepods which are present year round in dense patches at spatially small locations within Bateman Bay. Investigations have shown that Manta rays are very prey specific whilst at the same time will avoid certain planktonic items even in preferential prey are present. Over 500 net tows have been made over a two year period, targeting specific areas and actively foraging manta rays. Over an 18 month period these tows were made concurrently with chlorophyll analysis confirming the presence of chlorophyll hot spots within the bay, which coincide with zooplankton swarms. Additional net tows made during 2008-2009 in the vicinity of actively feeding manta rays determined the foraging thresholds of manta rays in these lagoonal areas which are lower than other large obligate filter feeding elasmobranchs such as the basking shark. Further investigations are being undertaken to determine the reason for this difference including the energetic costs of foraging, foraging behaviours which concentrate prey, and the nutritional value of the prey items. Pulses of small <1000um copepods (*Centropages halinus*) are the main prey item within the lagoons of Bateman Bay, however semi resident animals also target temporally predictable short pulses of various crustacean larvae. The presence and number of manta rays present at key times of year is likely to be an indicator of lagoonal health and serve as a bio-indicator of overall reef health, given climatic pressures upon them.

Oceanography. No additional major biological and physical oceanography data was collected in 2009, other than ongoing water temperature at fixed stations. Investigations have taken place to determine the source of phytoplankton blooms, and give an understanding of changes which trigger the following zooplankton blooms. Water samples were taken from November 2008 through until

April 2009 spanning the period leading up to the largest annual aggregation of manta rays. Analysis of this water quality data has been completed and is currently being compiled. Results of this section further strengthen Bateman bay as a physically and biologically unique location along the Ningaloo coast.

Acoustic Tracking. In the last twelve months an additional 11 acoustic tags were deployed on Manta Rays as part of the NRETA program. Downloads of receivers occurred on 4 occasions in the last 12 months for the high detection receivers, and once in June/July for the remainder of the Bateman Bay array. A data download is due to occur in early December, which will give the final data installment for this part of the project. As the Australia wide acoustic tracking program (AATAMS) is planned to continue for at least the next 18 months, an additional 8 tags are to be deployed in the Exmouth Gulf with the addition of two new receivers to look at population segregation. Data from the entire Ningaloo array will be compiled for the two year period after December downloads providing 24 months of continuous data. As the transmitters (tags) have a twelve to 18 months battery life, only the eleven recently deployed tags are expected to still be transmitting. 8 of the early tagged animals have been resighted with no tag present and no visible scar, indicating minimal disturbance as a result of this section of the project. So far the number of manta ray detections on the array, totals over 8400 detections, at 41 receivers. Site fidelity has been confirmed amongst some females, as well as the possibility of several distinct focal groups along the ningaloo coast. In addition, movements of some individuals beyond Ningaloo Marine Park boundaries, and hence outside of protected areas, strengthens the need for greater protection of Manta Rays in State and Commonwealth waters.

Summary of major findings to date

The last twelve months have strengthened the major findings from last year, including that.....

- Now over 500 manta rays have been identified as visiting Bateman Bay within Ningaloo Reef. Mark recapture estimates based on photographic identification resights now estimate the population to be over 1200 along the Ningaloo Reef. Resights are becoming a larger proportion of overall sightings, with 'resident' animals confirmed as numerically very important to the tourism industry.
- Mature female manta rays are confirmed as having a higher degree of residence than other groups. They make up the focal groups and when few animals are present become the mainstay of the tourism industry. Mature males and juveniles are primarily seasonal (there are exceptions). They form the bulk of transient groups which target larger planktonic blooms along the Ningaloo Reef. Numerically more interactions occur with these transient animals, but they are often unsuccessful, brief or only occur once.
- Trophically, manta rays occupy a position equivalent to an omnivore, and most like sedentary oceanic filter feeders such as the barnacle. Analysis of faecal samples confirms the consumption and partial ingestion of organic debris whilst targeting specific assemblages of zooplankton.
- Manta rays are confirmed as being highly prey specific within Bateman Bay, targeting a single species of copepod on over 90% of observations.
- Resident manta rays have targeted lunar spawning crustaceans at very specific locations on each of the last 4 years, strengthening the case for site fidelity.
- Whilst mating is observed year round, 5 semi- resident females have been sighted pregnant at the same locations two years apart to the week, targeting crustacean spawning events.

- Foraging on these prey items is density and composition dependant, occurring at densities over 300 individuals per m³ and halted if less than this or if non-preferred prey items are present over a critical density.
- Bateman bay is physically unique, having several current convergence zones where conditions result in year round zooplankton blooms with seasonal changes in magnitude and duration. These blooms are predictable and lead to aggregations of over 100 manta rays.
- Acoustic tracking has confirmed high site fidelity by manta rays as well as seasonal use of the entire Ningaloo Reef tract. Tracking has also confirmed habitat use beyond that detected by photographic means alone.

Presentations made at workshops and conferences

2009

No formal presentations were made at workshops or conferences, however I attended both the IPFC in Fremantle and the Ningaloo symposium in 2009.

2008

McGregor, F., Van Keulen, M., Waite, A. and Meekan, M. Foraging Ecology and Population Dynamics of the Manta ray, *Manta birostris* in Lagoonal Waters of Ningaloo Reef, Western Australia. **Oral Paper** presentation at the Inaugural Devil Ray Symposium, American Elasmobranch Society, Joint Meeting of Ichthyologists and Herpetologists, Montreal Canada July 2008

Daw, B. and **McGregor F.** Management of Manta Ray (*M.birostris*) Interactive Tours in the Shallow Lagoonal Waters of Ningaloo Reef, Western Australia – A Global Benchmark for Tourism Interactions. **Poster** presentation at the Inaugural Devil Ray Symposium, American Elasmobranch Society, Joint Meeting of Ichthyologists and Herpetologists, Montreal Canada July 2008.