The Ecology and Biology of Stingrays (Dasyatidae) at Ningaloo Reef, Western Australia

This thesis is presented for the degree of Doctor of Philosophy of Murdoch University 2012

Submitted by

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Declaration

I declare that this thesis is my own account of my research and contains as its main content, work that has not previously been submitted for a degree at any tertiary education institution.

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Owen R. O'Shea **Date**

Publications Arising from this Research

- **O'Shea, O.R.** (2010) New locality record for the parasitic leech *Pterobdella amara*, and two new host stingrays at Ningaloo Reef, Western Australia. *Marine Biodiversity Records* 3 e113
- **O'Shea, O.R.,** Thums, M., van Keulen, M. and Meekan, M. (2012) Bioturbation by stingray at Ningaloo Reef, Western Australia. *Marine and Freshwater Research* 63:(3), 189-197
- **O'Shea, O.R**, Thums, M., van Keulen, M., Kempster, R. and Meekan, MG. (Accepted). Dietary niche overlap of five sympatric stingrays (Dasyatidae) at Ningaloo Reef, Western Australia. *Journal of Fish Biology*
- **O'Shea, O.R**., Meekan, M. and van Keulen, M. (Accepted). Lethal sampling of stingrays (Dasyatidae) for research. *Proceedings of the Australian and New Zealand Council for the Care of Animals in Research and Teaching*. Annual Conference on Thinking outside the Cage: A Different Point of View. Perth, Western Australia, 24th – 26th July, 2012
- **O'Shea, O.R.,** Braccini, M., McAuley, R., Speed, C. and Meekan, M. (In review). Optimising the estimation of growth parameters of difficult-to-sample species: an example for tropical stingrays. *PLoS One*
- Speed, C.W., **O'Shea, O.R.** and Meekan, M.G. (2013). Transmitter attachment and release methods for short-term shark and stingray tracking on coral reefs. *Marine Biology* DOI 10.1007/s00227-012-2151-y
- Cerutti-Pereyra F, Meekan MG, Wei NWV, **O'Shea O.R.**, Bradshaw CJA, Austin CM (2012) Identification of Rays through DNA Barcoding: An Application for Ecologists. *PLoS one* 7:e36479
- Kempster, R.M., Garza, E., Egeberg, C.A., Hart, N.S., **O'Shea, O.R**. and Collin, S.P. (In review) Sexual dimorphism in the electrosensory system: a quantitative analysis of nerve axons in the dorsal anterior lateral line nerve of the fantail stingray *Taeniura lymma* (Forsskål 1775). *Frontiers in Neuroanatomy*

Conference Presentations Arising from this Research

- **Australian Marine Science Association (AMSA), July 2011, Fremantle, Western Australia**
  Bioturbation by stingrays at Ningaloo Reef, Western Australia

- **International Coral Reef Symposium (ICRS), July 2012, Cairns, Queensland, Australia**
  Physical and biological effects associated with stingray foraging behaviour at Ningaloo Reef, Western Australia

- **Australia and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART) July 2012, Perth, Western Australia**
  Lethal sampling of stingrays for scientific research

- **American Elasmobranch Society (AES) August 2012, Vancouver, Canada**
  Physical and biological effects associated with stingray foraging behaviour at Ningaloo Reef, Western Australia

Abstract

Batoids make up a significant portion of the biomass in coastal and nearshore ecosystems, yet few data are available on the functional role and life history characteristics of rays in these environments. Given their conservative life history traits and vulnerability to extrinsic pressures, urgent information is required to further understand this little known group of fishes. The objectives of this research were to assess the biological and ecological characteristics of tropical stingrays at Ningaloo Reef, Western Australia. More specifically, I wanted to quantify the physical and biological impacts associated with predation by stingrays, prey specificity and trophic resource partitioning and age and growth of five sympatric species (*Himantura uarnak, Neotrygon kuhlii*, *Pastinachus atrus*, *Taeniura lymma* and *Urogymnus asperrimus*). A technical assessment for safe and ethical lethal sampling protocols for large dasyatid rays is discussed as a foundation to the research that was conducted for this degree. Strict codes of practice for the welfare of animals in scientific research demand up to date methodologies for ethical consideration, especially where death is an endpoint. Safe and humane techniques were developed as part of this study in order to sample the rays required using lethal methods. These techniques proved successful with both considerations met and it is hoped, will provide a framework for safe practices for any future work where lethal sampling of large, potentially hazardous demersal elasmobranchs is required. Age and growth parameter estimates were evaluated for these five species by sectioning and counting calcium band-pair deposition in vertebral samples. Due to less than ideal sample sizes on account of logistical constraints, a multi-analytical approach was adopted to optimise parameter estimates and generate

realistic results. This included using a Bayesian framework to approximate the posterior distribution of the growth parameters. Growth rates of smaller-bodied species were faster than for larger-bodied species, but longevity was shorter. The oldest recorded age from these samples was 27 years and although validation was not possible, annual deposition is assumed based on previous accounts of similar species. This is the first time that growth parameter estimates in dasyatid rays have been assessed using this approach, yet the application is highly relevant for other rare, vulnerable or endangered species where optimal sample sizes may not be possible. The characterisation of ray diets was assessed through stomach content analysis from 170 individuals of five species. Five broad taxonomic prey categories were common to all species of ray; however, *H. uarnak* is shown to be a crustacean specialist while the remaining four species showed high levels of overlap within their diets. Assessment of the physical impacts related to stingray foraging within an intertidal embayment, previously identified as an area of intense feeding by rays, demonstrated high levels of sediment excavation. As a direct result of bioturbation by stingrays over 21 days, 760 kg of sediment was excavated from an experimental area of 1,500 m^2. Predation effects by rays were examined by experimentally manipulating densities in fixed areas to prevent feeding. Results indicated that some, but not all prey-taxa differed significantly in abundance between treatment and controls. Sampling also allowed a quantitative assessment of infaunal taxa common within the Marine Park, and the potential importance as a prey source for rays, as well as other epibenthic predators. Throughout the course of this study, a new species locality record and parasite-host relationships was described for the parasitic leech *Pterobdella amara* and *Himantura leoparda* and *Urogymnus asperrimus*. This is the first time this leech has been encountered in Western Australia and in combination with a significant gnathiid isopod

larvae infestation; the effects on an individual stingray are documented. A methods paper is also included in this thesis detailing a cost-effective method of tag attachment and retrieval for short-term tracking in reef associated elasmobranchs. Field-testing of galvanic timed releases and the practical application in tagging two individual sharks (*Carcharhinus melanopterus*) and three large stingrays (*Pastinachus atrus* n = 2 and *Urogymnus asperrimus* n = 1) are discussed. Preliminary results of these short-term tracks demonstrated that these methods are a rapid and effective means of tagging elasmobranchs with limited impact on the animal's welfare. This research is the first of its kind at Ningaloo Reef and details critical functional processes and highlights the ecological significance of rays within coral reef environments. It also details current methodologies and techniques trialled for the first time within the context of ecological studies on tropical elasmobranchs. Data presented here can be used to develop or contribute to, conservation and management strategies for this overlooked, yet vulnerable group of fishes.

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Front cover of *Marine and Freshwater Reseach* Vol:63, Issue 3, 2012, highighting the research paper which formed the basis for chapter 5

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‘*An understanding of the natural world and what's in it, is a source of not only a great curiosity but great fulfilment*’

David Attenborough