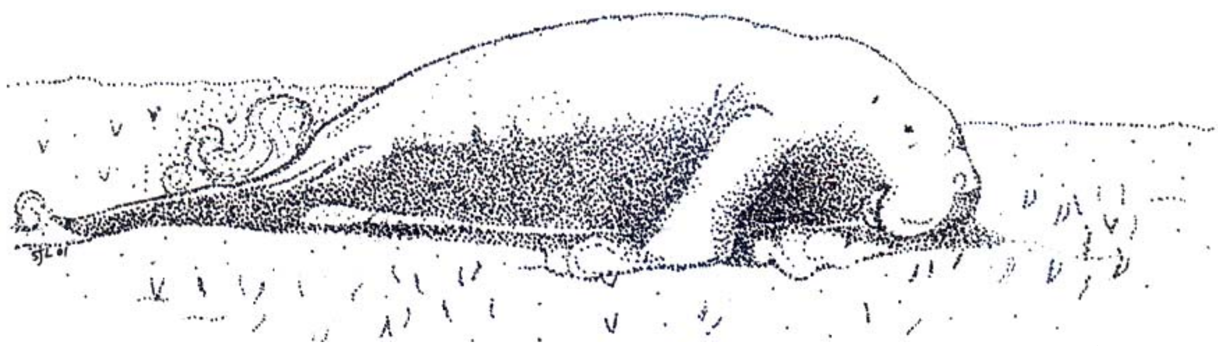
Dugong behaviour and responses to human influences

Thesis submitted by

Amanda Jane HODGSON BSc ECU, (Hons I) JCU

in November 2004

for the degree of
Doctor of Philosophy
School of Tropical Environment Studies and Geography
James Cook University
Townsville
Australia



STATEMENT OF ACCESS

I, the undersigned, author of this work, understand that James Cook University will make this thesis available for use within the University Library and, via the Australian Digital Theses network, for use elsewhere.

I understand that, as an unpublished work, a thesis has significant protection under the Copyright Act and I do not wish to place any further restriction on access to this work.

__________________________ ______________

Signature Date

STATEMENT OF SOURCES

DECLARATION

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

__________________________ _______________

Signature Date

STATEMENT ON THE CONTRIBUTION OF OTHERS

Project support	CRC Reef Research Centre
	Pew Foundation
	ARC SPIRT
	Sea World Research and Rescue Foundation
	Australian Defence Force
	Doctoral Merit Research Scheme, JCU
	Capalaba Lions Club
	Great Barrier Reef Marine Park Authority
	CRC Postgraduate Travel Award
	School of Tropical Environment Studies and Geography
	Digital Blue
Stipend	Australian Post Graduate Award & CRC Reef top-up
	CRC Reef Completion Scholarship
External infrastructure	Fieldwork support: Tangalooma Wild Dolphin Resort
Supervision	Prof. Helene Marsh
	Dr Louise Chilvers
Statistical support	Steve Delean
	Rohan Arthur
Editorial assistance	Chapters 3 & 4: Jillian Grayson
	Chapters 7 & 8: Dr Ivan Lawler
	Chapter 9: Dr Kirstin Dobbs
	Whole thesis: Tim Harvey
Research assistance	Log of dive times: Josh Smith

Acknowledgments

To my supervisor, Helene Marsh, I owe the greatest gratitude. I'm not sure that I can ever thank you enough for giving me such amazing opportunities. As a supervisor you manage to provide both astute guidance and enough rope, combined with enthusiasm, wisdom and understanding. During this project you often had more confidence in me than I did and I'm truly grateful for your continued support and friendship (but I don't think I could ever afford a fitting manager's fee!). To my associate supervisor and friend, Louise Chilvers, I am also sincerely grateful. Your constant positiveness and encouragement was exactly what I needed. Thankyou for showing me the ropes in the field and for all your insightful advise throughout this project.

My research was funded by CRC Reef Research Centre, Sea World Research and Rescue Foundation, Tangalooma Wild Dolphin Resort, James Cook University, the Pew Foundation, the Australian Defence Force, Capalaba Lions Club, the Great Barrier Reef Marine Park Authority, and Digital Blue. I received an Australian Postgraduate Award stipend and CRC Reef top-up scholarship to conduct this PhD. Permits for the fieldwork were issued by Queensland Parks and Wildlife Service in conjunction with the Quandamooka Aboriginal Land Council.

Tangalooma Wild Dolphin Resort provided in-kind support throughout both my field seasons, including accommodation, food, ferry transfers, fuel, a dinghy, space for the blimp tent, an office, and assistance from staff. This level of generosity is hard to come by and I am sincerely grateful to the owners of the resort, Brian and Betty Osbourne, for providing this invaluable support. I would particularly like to thank Trevor Hassard who made all this happen, and who was extremely accommodating throughout my (never-ending) fieldwork. A huge thanks also to the Club Toys guys for help with boat maintenance, skippering, and of course, rescuing us when the need arose (which was only a couple of times… three max… well, who can remember?).

I attribute the idea for the blimp-cam to Nick Gales, who's suggestion to Helene Marsh during a chat over coffee inadvertently changed the face of my PhD. I enlisted the help and advise of many people during the construction of the blimp-cam (being completely non-technically minded myself). Thankyou to Chris Bransgrove for introducing me to the world of blimps (and encouraging words that kept me uplifted – ha!); to Gavin Bunn, Daryl King, and Ron Brown for designing and building the electronics of the blimp-cam; and Edward Owen, Alan Gunders, Richard Fitzpatric, Greg Smith, Jan Aldenhoven and Glen Carruthers for loads of technical advise and encouragement.

Prior to my field experiments, a Pew Foundation project was conducted with Ken Baldwin and Greg Stone to determine the propagation of pinger sounds. Thankyou both for conducting this important work, allowing me to visit you in America to learn more about sound analysis, and your advise on my pinger experiments. Darlene Ketten, Bill Dolphin, Andrew Quick and Wendy Blanshard also conducted a preliminary ABR on a captured dugong which aided in designing and interpreting the pinger experiments. I also gained valuable advise for my project from Paul Anderson, who, together with his wife Donna, generously accommodated me in their home so I could compare notes with the only other person to conduct behavioural observations of dugongs.

My fieldwork relied completely on the help of volunteers, and lucky for me, I had a cast of wonderful people. They endured many days of waiting for functioning equipment and the right weather (while suffering through my constant anguish over the wind), but remained enthusiastic and most importantly, provided heaps of laughs. Many of you offered support and assistance beyond what was required (e.g., cooking, scraping hulls, fixing cables, towing the boat, designing BTODAS, knitting dugong beanies, making breakfast on the boat while doing yoga, fighting killer rats and most importantly, supplying chocolate). I'm enormously thankful for the support from my friends, and the new friendships I gained throughout my fieldwork. In order of appearance: Andrea Finch, Jean-Pascal Gillig, Imogen Jubb, Alex Gladding, Anne Williams, Carmel Cook, Helen Penrose, Sarah Lowe, Ann Biasol, Brenda McDonald, Edward Game, Nikolai Liebsch, Susan Hassard, Liz Johnson, Jeanie Heaslop, Emma Scragg, Kellie Wilson, Jessica Huybrechs, Karen Holman, Gemma Chapman, Mytel, Anna Lashko, James Shepperd, Isabelle Thiebaud, Maureen Hodgson, Fiona Marshal, Achim Stroeh, Cathryn Schuetze, Jenna Rumney, Wendy Blanshard and Fabiana Mourão.

In addition, Alistair Hutt supplied the remote control pinger, Fiona Macknight provided accommodation in Brisbane, Don Cameron helped with boat logistics, Max and Sherie provided (luxurious) emergency accommodation at Kooringal, and Rochelle Constantine offered invaluable support and advice (and Tim Tams) during the initial tricky stages of my fieldwork.

Thankyou to the administration staff in TESAG for (patiently) dealing with my complicated accounts; the computer guys, Clive Grant and Rob Scott, without whom nothing would get done; Jodie Kreugar for organising equipment and my boat; and Adella Edwards for her mapping expertise. I'm extremely grateful for help in analysing my data and experimental design from Steve 'the statistics guy' Delean, Rohan Arthur and Guido Parra. Josh Smith thankfully saved me from some video analysis by logging the diving behaviour. I also got great feedback on some of my chapters from Jillian Grayson, Kirstin Dobbs and Ivan Lawler (thanks also for many chats and your help with all things dugong), while Tim Harvey generously edited my entire thesis (in his own time).

Fortunately I had an amazing group of fellow TESAG PhDers to offer huge quantities of moral support. Thanks especially to Oli (okay, best office mate in the whole world - Vee he made me say it), Ameer, Rohan, James M, James S, and Donna. My awesome mates Bec and Kel, thankyou for helping me through the first year, and your incredible friendship. To my Townsville family: Anna (oirekonyortopsmate), thankyou for understanding, your patience, loving the same trashy tellie, and most of all, taking longer to obtain data than me (and willingly using that fact to reassure me); Guido, thanks for teaching me the three P's (procrastin… no, what was it again?), for being happy to help every time I knocked on your door, for endless lunches and so, so, so many laughs; and Vimoksalehi, thankyou for brightening every day in the office, for knowing me so well, for so many dinners and coffees and chats about *everything*.

Finally to my amazingly supportive family who rode every bump and celebrated every success along with me. I can honestly say that I hugely appreciated every word of encouragement, long phone chat, letter, email, and of course, holiday at home. In particular, Mum, it means so much to me that you were part of my fieldwork (and brought good weather each time!), Dad, I'm truly grateful for your insistence on positive thinking, Ryan, you have a way of making it all seem easy, and my late Nanna, thankyou for being so proud and enthusiastic about my work and encouraging me to make to most of every opportunity.

Abstract

Knowledge of the behavioural ecology of a species is important for the development of conservation initiatives. With an understanding of how behaviour has evolved under given environmental and phylogenic constraints, it is possible to predict the response of a population to novel circumstances such as anthropogenic disturbance. Little is known about many aspects of the behaviour of dugongs (*Dugong dugon*). This species is difficult to observe as dugongs are benthic feeders, usually occurring in turbid waters. They tend to be wary of boats or divers and individuals cannot easily be distinguished. As dugongs occur in shallow, coastal waters, they are particularly vulnerable to human impacts; however, these impacts have not previously been quantified through direct observations of dugong behaviour.

To overcome the difficulties in observing dugongs, I developed a blimp-cam, which allowed me to video dugongs from a blimp tethered to my research vessel. The use of the blimp-cam was facilitated by selecting Moreton Bay, Queensland, as my study site, where dugongs are readily located in clear, shallow waters. I used this technology to obtain baseline information about dugong behaviour, and investigated the function of the large herds persistently formed by dugongs in Moreton Bay. I then observed the response of dugongs to boats and pingers (acoustic alarms used on fishing nets to reduce marine mammal bycatch) to determine the risk of boat strikes and effects of disturbance from these two sound sources.

At a height of 50m the blimp-cam provided an overhead view of dugongs at water depths of up to 4m, and distances of up to 200 m via a monitor on board the research vessel. Using a remote control, I could scan large herds of dugongs or continually observe individuals. Through focal follows of individual dugongs I developed an ethogram and a daily time budget for dugongs in Moreton Bay.

Dugongs spent most of their time feeding (41%), travelling (32%), and surfacing (ascending to, and descending from, surface, 18%), and relatively little time resting (7%), socialising (6%) or rolling (1%). Environmental variables accounted for little of the variability in the proportion of time dugongs spent in each behavioural category. Time budgets did not differ significantly between single individuals and mothers with

calves. However, mothers spent significantly more time feeding and surfacing, and less time travelling than their calves. Calves were observed suckling for mean bout lengths of 87 s. The mean submergence time for all individuals was 75 s, but was significantly shorter for calves (72 s) in comparison to their mothers (82 s). Submergence times were not affected by depth (< or ≥ 1.5 m), but were affected by behaviour.

Dugongs spent 3.5% of the day resting at the surface of the water, during which time they are particularly vulnerable to boat strike. Mother-calf pairs appear most vulnerable to boat strike because they spend more time near the surface than single individuals. Calves are especially vulnerable as they rise or submerge by crossing onto their mother's back during a quarter of their dives, and spent 13% of their time travelling and resting over their mothers' back.

I found that individual dugongs spent significantly more time feeding while in large, dense herds than when in smaller groups or scattered, suggesting that these herds are formed primarily to facilitate feeding. Dugongs did not seek large herds for resting, and calves were less likely to be surrounded by dugongs other than their mothers, than single individuals. These observations suggest that dugongs do not shelter in herds when most vulnerable to shark attack, and that herds are unlikely to have a predatory defence function. Herd structure was fluid, with individuals changing nearest neighbours after an average of 1 min, and showing no obvious preference for nearest neighbour type (single individual or mother-calf pair). Thus there was no evidence of a social function for these herds. My results support the theory that seagrass distribution and seasonality, sediment type, a lack of other disturbance of seagrass beds, and a year-round presence of dugongs on the Moreton Banks facilitate cultivation grazing.

Observations of the response of dugongs to boats passing opportunistically provided information on the risk of boat strikes. Unlike controlled passes which were restricted to the below-planing speed limit of the study area, independent boats were often travelling above this limit. Only boats travelling above planing speed were observed passing directly over the top of dugongs. I hypothesise that the distance of the flight threshold for dugongs remains constant regardless of boat speed. Thus the speed of an approaching boat determines the time dugongs have to evade the boat, and speed is the main factor affecting the risk of boat strikes.

Controlled experiments were conducted to determine the effects of boats on dugong behaviour. The behaviour of focal dugongs during a 4.5 min time sample was not significantly affected by whether there was a boat passing, the number of consecutive passes made (1 to 5 passes), or whether the pass was continuous or included a stop and restart during the pass. During the subsurface interval of the focal dugong that corresponded with the control boat's closest approach time, the travel distance, travel direction and subsurface time were not correlated with the boat's approach distance. However, during this subsurface interval dugongs were less likely to remain feeding if the boat passed within 50 m than if it passed at a greater distance. Mass movements of dugong feeding herds in response to boats were obvious but only lasted an average of 122 sec. These movements occurred in response to boats passing at all speeds, and at distances of less than 50 m to over 500 m. Relatively low levels of boat traffic in Moreton Bay in winter mean that a maximum 0.8 – 6% of feeding time may be interrupted by boats. However, if the number of boats registered in Queensland continues to increase at the current rate, the rate of disturbance is likely to increase.

The response of dugongs to pingers was tested to determine whether these alarms may prevent dugongs from using important habitat areas. An array of two 10kHz 'BASA' pingers did not cause an observable response by dugongs. There was no significant difference in the rate of dugong movement away from the focal arena surrounding the pingers, orientation of the dugongs, or the presence or absence of feeding plumes, while the pingers were active compared to when inactive.

The observed responses suggest that boat strikes are currently a bigger threat to dugongs than disturbance from boats or pingers, and support speed restrictions for boats in areas commonly used by dugongs. My results also reflect the need for detailed risk assessments to be conducted in areas where dugong habitat overlaps with areas of high boat traffic, and prior to future developments that will increase boat traffic. Further studies that build on the fundamental knowledge of dugong behaviour gained through this research will provide an understanding of human impacts in a wide range of habitats and aid in developing appropriate anthropogenic mortality targets for dugongs.

Contents

List of Figures

List of Tables