# Australian Marine Mammal Centre

# Final Report

**(subclause 9 and Schedule Item 5 of the Funding Agreement)**

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- **Project No**. – 0809/1
- **Title** - Increasing the accuracy of dugong population estimates from aerial surveys by quantifying dugong diving behaviour
- **Chief Investigator** – Professor Helene Marsh
- **Organisation** – James Cook University

**Activity Period** – 29 April 2009 – 30 March 2010

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## 1. Activity Summary

| A clear summary of approximately 500 words outlining the work undertaken and any significant findings (for publication on the Department's web site) |
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| Since the mid 1980s, aerial surveys have been used to estimate the distribution and relative abundance of dugongs over the vast and remote coastal waters of tropical Australia. The probability of detecting the dugongs that are present in a survey area at the time of an aerial survey is composed of three components: 1) the probability that an area will be surveyed (sampling fraction); 2) the probability of an animal being near enough to the surface to be seen by an observer (availability bias), and 3) the probability of detecting an animal given that it is available (perception bias). Both availability and perception biases are heterogeneous both between and within surveys and methods have been developed to estimate the different components of dugong detection probability. Based on the analysis of Chilvers et al. (2004), the availability correction factors developed by Pollock et al. (2006) were based on dugong diving records across the diel cycle, despite aerial surveys being conducted only between 8am and 4pm. We analysed data from Timed Depth Recorders (TDRs) from dugongs tracked in Hervey Bay, Queensland in the context of fine scale telemetry, habitat mapping, and remotely sensed data to increase the capacity of aerial surveys to estimate dugong abundance by improving the correction factor for dugongs that are unavailable because of water turbidity. We analysed dive recordings from Mk 7 and 9 TDRs, Australia equipped with satellite PTT/GPS tags. The location fixes from the GPS tags were used to determine the water depths experienced by the tracked dugongs in order to examine the effect of water depth on the dugongs' use of the water column. We used logistic regression to predict the proportion of time a dugong would be available to observers in aircraft by estimating the effects of experienced water depth, time of day (0-8am/8-4pm/4-12am) and tidal direction (Incoming/Outgoing) using 1,403,248 TDR records for which all variables were available (~ 2 months of data for each of six animals). The dugongs were divided into two groups for the analysis depending on the water depth they occupied (0-6m; >7m). The logistic regression models indicated that all factors affected the availability of dugongs from survey aircraft. Once the effect of tide factor was removed, the effect of time-of-day was weak, although it was still significant for all cases. Water depth had the strongest effect; dugongs are significantly less available when in water 4-11m deep than in shallower or deeper water. Thus some of the differences between successive aerial surveys of the same area are likely to have resulted from dugongs being distributed differently across the depth gradient within a survey area between surveys. In shallow waters, availability is also influenced by tidal direction; dugong are understandably closer to the surface on outgoing tides. Prior to this analysis |

fluctuations in dugong abundance in a time series of surveys of the same area was attributed to dugongs migrating in and out of a survey area. The results indicate that the accuracy of the aerial survey estimates of dugong abundance could be improved by stratifying the aerial survey blocks by water depth and in shallow water correcting for incoming versus outgoing tidal conditions. The difference is likely to be considerable as the area of potential dugong habitat between 4-11m deep is vast e.g .~15,500 $km^2$ for the Great Barrier Reef region and is likely to be particularly important for Torres Strait. The reanalysis of the aerial survey data based on this research may lead to a significant reassessment of dugong population estimates from aerial surveys.

## 2. The Outcomes/Objectives

**The degree to which the Activity has achieved the objectives**

***Aim 1) Increase the capacity of aerial surveys to estimate dugong abundance by improving the correction factor for dugongs that are unavailable because of water turbidity by:***

*Objective 1:*
*Analyzing existing data from time-depth recorders (TDRs) from dugongs tracked in Hervey Bay, Queensland in the context of data available on fine scale telemetry, habitat mapping and remotely sensed data;*

The research to achieve this objective was divided into three stages: 1) preliminary analyses of depth records and development of methodology for analysing TDR data from shallow diving animals, 2) investigation of effects of depth, time of day, tides, location and animal and 3) time budgets. The first stage was completed by October 2009, and the results were presented at the Biannual Conference on the Biology of Marine Mammals in Quebec, Canada in 2009. A manuscript for submission to the journal of Experimental Marine Biology and Ecology is in advanced preparation. The second stage has also been completed and the results are summarized above. The last stage has not yet been attempted but will be examined shortly.

*Objective 2:*
*Developing a protocol for interpreting dugong TDR data from dugongs tracked in areas where such detailed habitat data are not available;*

*Objective 3:*
*Using this protocol to compare the diving behaviour of dugongs tracked in various areas in Western Australia, Queensland and the Arabian Gulf to determine whether the diel differences in behaviour observed by Sheppard et al. (2006) are robust across locations;*

Objectives 2 & 3 have not yet been achieved but will be addressed in subsequent work.

*Objective 4:*
*Using these data to improve the Pollock et al. (2006) method to correct for availability bias in dugong aerial surveys.*

The results above are being used to refine the Pollock et al (2006) corrections for availability bias in conjunction of a retrospective analysis of the exiting aerial survey data stratified by water depth.

## 3. Appropriateness

**The appropriateness of the approaches used in the development and implementation of the Activity**

The methods used were appropriate. We underestimated the challenge for developing a protocol for analysing TDR data for shallow diving marine wildlife but are confident that the method we have developed will have wide application.

**4. Effectiveness**

**The degree to which the Activity has effectively met its stated objectives**

The activity has met its primary objective of developing methodology to increase the accuracy of dugong population estimates from aerial surveys by quantifying dugong diving behaviour. An unexpected result is the need to further stratify, the aerial survey data by water depth. Ms Hagrihara now hopes to conduct this retrospective analysis by expanding her study into a PhD. It is expected that this analysis will increase the dugong population estimates for northern Australia and provide new insights into the likely sustainability of the Indigenous harvest.