

# Australian Marine Mammal Centre

## Final Report

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

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**Project No.** – 0809/8

**Title** - Review of existing sighting datasets to assess the spatial and temporal distribution of humpback whales within the Great Barrier Reef for identifying potential breeding/calving grounds.

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**Organisation** – University of Queensland

**Activity Period** – 23 April 2009 – 30 April 2010

Note: an extension was given to 11 June 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)**

In Australia, the breeding ground for humpback whales off the east coast is poorly defined, although is generally considered to occur somewhere within the Great Barrier Reef Marine Park (GBRMP) from latitudes 16°S - 24°S. A well defined humpback whale calving and mating area comparable to those seen in other parts of the world has not yet been identified in the GBRMP. The large size of the GBR has largely prohibited dedicated aerial surveys of humpback whales. This project adopted the approach of developing a predictive spatial habitat model for humpback whales in the GBRMP to identify areas that might be important for mating and calving. This approach was then assessed to determine whether it could be used to inform and direct future survey effort to define important breeding habitat areas for humpback whales in the GBRMP.

Predictive spatial habitat models were derived using topographic (depth, seafloor slope, seafloor rugosity), geophysical (distance from the coast, distance from the reef) and remote sensed data (sea surface temperature) along with occurrence data of incidental sightings of humpback whales from three independent datasets; 1) Border Protection Command (BPC) aerial surveillance program sighting data (1982-1996 & 2003-2009) 2) GBRMPA Eye on the Reef Monitoring Program (2007-2008) and 3) Dwarf Minke Whale Tourism Monitoring Program (2003-2008). The BPC sightings were derived from a systematic aerial surveillance program whereas the

two other datasets consisted of incidental sightings from boat-based reef tourism dive operators and were strongly spatially biased. Models were developed only for the months of July and August to focus on the peak period when both mating and calving is occurring rather than model the entire breeding season and represent the combination of potential calving and mating areas because it was not possible to model these separately.

The BPC data (systematic incidental sightings) had adequate spatial coverage throughout the GBRMP and produced a more reliable predictive spatial habitat model for humpback whales than those derived from the Eye on the Reef and Dwarf Minke whale program sighting data (non-systematic incidental sightings), even after accounting for bias in the data within the model. The resulting predictive spatial habitat model identified suitable breeding habitat at an ecosystem scale. The model indicates that most of the suitable breeding habitat (> 0.5 environmental suitability value) occurs south of 19°S. Two main areas in particular have been identified: 1) approximately east of Bowen south to Mackay and 2) the Capricorn and Bunker Groups of islands and reefs approximately 100km east of Gladstone.

Validation of the model with the movements of humpback whales satellite tagged in 2009 by Gales et al from the Australian Antarctic Division suggests good accuracy within the model. While further validation of the model needs to occur, the preliminary validation process using independent satellite tag data supports the use of the model for directing further survey work to determine the distribution of humpback whales within the GBRMP and the extent of the breeding grounds. It is recommended that a dedicated aerial survey of humpback whales should be designed based on the areas identified in the model for further model validation and to refine our understanding of the extent of the breeding grounds of humpback whales off the east coast of Australia.

## 2. The Outcomes/Objectives

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

**Objective 1:** *Collate contemporary data on areas of high concentrations of humpback whales in the GBR.*

This objective was achieved. Four independent data sets containing humpback whale sightings were obtained within two separate time periods; 1982 – 1996 and 2003 – 2009. These datasets were from the **1)** Border Protection Command (BPC) aerial surveillance program (1982 – 1996 & 2003 – 2009) **2)** GBRMPA Eye on the Reef Monitoring Program (2007 – 2008) **3)** GBRMPA Dwarf Minke Whale Tourism Monitoring Program (2003 – 2008) and **4)** James Cook Marine Mammal Sighting Program (1980-1987). The current data (2003-2009) from the BPC aerial surveillance program, Eye on the Reef and Dwarf Minke Whale Tourist Monitoring Program were all used to inform on the relative distribution of humpback whales during the breeding season (June-October) within the Great Barrier Reef Marine Park (GBRMP) in an attempt to identify important breeding areas. Predictive spatial habitat models were derived using this data.

**Objective 2:** *Develop a predictive spatial habitat model to identify potential reproductively important habitat within the GBR*

This objective was achieved. Four predictive spatial habitat models were produced, three of which were derived using BPC occurrence data and the fourth model using the combined Eye on the Reef and Dwarf Minke Whale Tourist Monitoring Program occurrence data. Of the three models that used BPC occurrence data, two used

current sighting data (2003-2007) at two different spatial scale resolutions (2.7 and 4.8 km square cell size) and the other used sighting data from 1982-1995. All models were derived using only sighting data in which species identification was determined. The BPC data (based on systematic incidental sightings) had good spatial coverage throughout the GBRMP and produced more reliable predictive spatial habitat models for humpback whales than those derived from the Eye on the Reef and Dwarf Minke whale program sighting data (non-systematic incidental sightings), even after accounting for bias in the data within the model. The present study suggests that incidental sighting data from systematic surveys is always more desirable than sightings from non-systematic surveys because they are more robust, particularly for the development of spatially explicit habitat models. Sighting data from the tourist programs could be useful in developing predictive habitat models, although the greatest problem with the data was that while the data was spatially biased, it was also highly clustered data from a restricted range of the entire distribution of humpback whales in the GBRMP. The main assumption using BPC sighting data was that the GBRMP has been adequately sampled both spatially and temporally, such that there is even probability of coverage in the GBRMP with no bias in the month or year sampled. Examination of the BPC data for both historic and contemporary time periods revealed consistent coverage of the entire GBRMP with whale sightings at various latitudes within any month for most years, supporting the assumption that there was adequate sampling of the entire GBRMP both spatially and temporally.

The predictive habitat model using BPC data at a 4.8 km square resolution indicates that most of the suitable breeding habitat (> 0.5 environmental suitability value) occurs south of 19°S. Two main areas in particular have been identified:

**1)** approximately east of Bowen south to Mackay, particularly around the Whitsunday Islands and outer Whitsunday reefs of Hook, Line and Block as well as east of Mackay around Credlin, Penrith and Bushy Redbill reefs and **2)** the Capricorn and Bunker Groups of islands and reefs approximately 100km east of Gladstone. Validation of the model with the movements of humpback whales satellite tagged migrating north into the GBR in 2009 support these areas as being potentially important breeding areas for humpback whales off the east coast of Australia, although further validation of the model needs to occur. This model can and should be used to direct future survey work to refine our understanding of the extent of the breeding grounds for humpback whales off the east coast.

**Objective 3:** *Assess whether using incidental sighting data and spatial modelling are effective decision process tools for identifying important breeding habitat areas and can help to direct further survey effort to identify critical breeding habitat for humpback whale Breeding Stock E(i).*

This objective was achieved. Overall, the predictive spatial habitat model that has been developed for humpback whales in the GBRMP has been successful in identifying areas that contain potentially important breeding habitat within the GBR. At the scale of the GBR, it is logistically difficult and costly to survey the entire area. Consequently, the development of predictive habitat models has shown to be a cost-effective approach for informing on species-environment relationships and generating spatially explicit models of humpback whale habitat preference within the GBRMP in aid to identifying important breeding areas. However, further validation of the model is required and the model should be used to inform the development of future surveys. Through a validation process with an independent satellite tagging dataset, it has been possible to show that this model does function as a good decision support tool to direct further survey work to determine the distribution of humpback whales during the breeding season and the extent of the breeding grounds in the

GBRMP.

### 3. Appropriateness

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

*Objective 1* – The use of incidental sightings can be very useful for determining species-environment relationships, although incidental sighting data from systematic surveys is always more desirable than sightings from non-systematic surveys because they are more robust. The systematic incidental sightings (BPC data) had good spatial coverage throughout the GBRMP and produced more reliable predictive spatial habitat models for humpback whales than those derived from non-systematic incidental sightings (the Eye on the Reef and Dwarf Minke Whale Tourist Monitoring Program sighting data), even after accounting for bias in the data within the model. Sighting data from the tourist programs could be useful in developing predictive habitat models. However, in the current study the greatest problem with the data was that while the data was spatially biased, it was also highly clustered data from a restricted range of the entire distribution of humpback whales in the GBRMP. Nevertheless, each dataset had contributions to the development of the models, although in different ways. The non-systematic tourism sighting data was more useful in determining the time periods for which to develop the models whereas the systematic sighting BPC data was used to build the model.

*Objective 2* – Predictive modelling of species' distributions through the use of predictive habitat models is an increasingly popular and widely used approach. In particular, the software used in this project (*Maxent*), has several advantages which include its ability to model presence-only data and account for spatial bias in the presence data which was directly relevant to the data used in this project. Furthermore, it has been found to perform extremely well, and in some cases outperform, other correlative species distribution methods in its predictive accuracy. Validation of the model with the movements of satellite tagged humpback whales suggests good accuracy within the model and supports the use of the model for directing further survey work to determine the distribution of humpback whales within the GBRMP.

*Objective 3* – The approach of developing a predictive spatial habitat model for humpback whales from incidental BPC sighting data has proven to be a cost-effective approach and suggests this approach could be a good decision support tool for identifying important breeding habitat for humpback whales in the GBRMP. It is recommended that a dedicated aerial survey of humpback whales should be designed based on the areas identified in the model for further model validation and to refine our understanding of the extent of the breeding grounds of humpback whales off the east coast of Australia.

### 4. Effectiveness

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

This activity has effectively met its objectives by successfully collating sighting data from four independent data sources that have been assessed and used to develop predictive spatial habitat models for humpback whales in the GBRMP, informing on species-environment relationships and generating spatially explicit models of humpback whale habitat preference within the GBRMP in aid to identifying important breeding areas. The predictive spatial habitat model that has been developed for humpback whales in the GBRMP has been successful in identifying areas that contain potentially important breeding habitat within the GBR. The preliminary validation process using independent satellite tag data supports the use of the model

for directing further survey work to determine the distribution of humpback whales within the GBRMP and the identify the extent of the breeding grounds.