

**Australian Marine Mammal Centre Grants Program**  
**Final Report**  
**(subclause 9 and Schedule Item 5 of the Funding Agreement)**

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- **Project No.** – 13/37
- **Title** - Genetic distinctiveness and fine-scale population structure of the southeast Australian southern right whale wintering ground.
- **Chief Investigator** – Rob Harcourt & Emma Carroll
- **Co-Investigators** Mandy Watson and Rachael Alderman
- **Organisation** – Macquarie University

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**1. Project Summary**

A clear, plain English summary of approximately 500 words outlining the work undertaken and any significant findings (for publication on the Department's web site). Include what was done, why and the key findings resulting in recommendations summarised from the sections below.

In Australia, the Endangered southern right whale (*Eubalaena australis*) is managed as two distinct populations or stocks. This action is based on spatially variable patterns of recovery and tentative, preliminary evidence showing significant differentiation in mitochondrial DNA (mtDNA) haplotype frequencies (maternally inherited markers) between the southeast (SEA) and southwest (SWA) Australian stocks.

In this project we assess stock structure across Australia using not only mtDNA haplotypes (500 bp), but also using biparentally inherited microsatellite genotypes (17 loci) and stable isotope profiles ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) from 77 individually-identified whales, sampled on both calving grounds and in migratory areas.

We tested the hypotheses that there is genetic differentiation between (1) southern right calving grounds and (2) SEA and SWA stocks. We found significant differentiation between calving grounds in SEA and SWA based on both mtDNA haplotype and microsatellite allele frequencies, consistent with long-term fidelity to calving areas. However, we found a lower degree of differentiation between the two stocks than previously reported, and we attribute this to increased sampling of migratory areas in SEA where whales from multiple calving areas are likely mixing, based on large scale migration patterns.

We combined genetic and stable isotope data to test the hypothesis that there is maternally-directed fidelity to feeding grounds. We found that whales with more similar  $\delta^{13}\text{C}$  profiles were more likely to share the same mtDNA haplotype and have

higher estimates of kinship derived from microsatellite loci.

Overall, our findings suggest that maternally-directed fidelity to migratory destinations and fine-scale habitat use differences between different demographic classes shape the population structure of southern right whales across Australia.

## 2. The Outcomes and Objectives – Key Findings

List the Project Objectives and address each one, noting the degree to which the objective was achieved through the research and issues that may have hampered its success. Describe the key findings as they relate to the objectives and the management questions identified in the initial application.

The project outcomes are to address the following objectives:

- a. Update the stock structure analysis of right whales in New Zealand and Australia with a larger sample size from southeast Australia (39 vs 13 previously analysed)

Outcome: Stock structure was updated successfully, new estimates have significantly higher confidence.

- b. Determine fine-scale population structure across southeast Australian southern right whale wintering grounds

Outcome: New information provides a more comprehensive assessment of stock structure, with significant differentiation between calving grounds in SEA and SWA based on both mtDNA haplotype and microsatellite allele frequencies, consistent with long-term fidelity to calving areas

- c. Estimate historical abundance of southern right whales in Australian waters using genetic data and Approximate Bayesian computing methods

Outcome: We haven't used any programs to estimate the historical abundance but are undertaking a coalescent-based analysis using mtDNA and microsatellite data in program LAMARC, a program that also estimates migration rates. This program was chosen as it is able to cope with scenarios that violate the assumption of constant population size through time, as is the case with the SRWs due to whaling. However, it is known to have problems when simulating populations that show low levels of genetic differentiation. To account for this we are also using Bayesian analysis program BiMR, which is able to estimate migration when gene flow is high. There is no guarantee these programs will converge to provide meaningful data, and the SRW populations violate assumptions of other programs, e.g. discrete populations or constant population size through time. Therefore we are consulting Prof O. Gaggiotti, an expert in the field, on the best way to interpret the data from LAMARC and BiMR and other potential coalescent or Bayesian approaches to estimate historical abundance and migration.

HOWEVER

We have included an analysis of Stable Isotopes that was not originally proposed (Value Adding) and by combining genetic and stable isotope data have shown that there is maternally-directed fidelity to feeding grounds – this has important implications for management as we can no longer assume random mixing on the feeding grounds.

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### 3. Implications for Management

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| What are the key recommendations for management based on the findings.   |
| <p><b>This project directly addressed the Very High Priority Action Understanding Population Structure within the Conservation Management Plan for the Southern Right Whale 2011-2021.</b> Specifically:</p> <ul style="list-style-type: none"><li>a) delineating southeast and southwest populations;-</li><li>b) ascertaining rates of genetic interchange amongst the southeast and southwest populations;</li><li>d) improving the understanding of interchange between populations within Australia and New Zealand waters.</li></ul> <p><b>Recommendation:</b> Manage the SEA and SWA populations as distinct entities with different population recovery trajectories. Undertake further sampling on calving grounds to further investigate fine scale population structure</p> <p>In addition the finding of maternally directed fidelity to feeding grounds has implications for management in the Southern Ocean. These findings strongly indicate non-random mixing at feeding grounds.</p> <p><b>Recommendation:</b></p> <p>Increased pressure on populations from new proposed developments are likely in the feeding grounds as well as at calving grounds (krill fisheries, seismic exploration) and assessment of Threat will need to be made on a population basis rather than ocean basin.</p> |

### 4. Other Benefits

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| How has this project advanced the field of research? (e.g. scientific discoveries, new methodologies)  |
| <p>This study combined genetic analysis with stable isotope analysis. The results indicate maternally-directed fidelity to feeding grounds. Stable isotope analyses are often conducted in the absence of concurrent genetic analyses, and are often opportunistic. These findings suggest caution in both sampling design and interpretation of SIA analyses conducted without taking into account the genetic relationships. The findings suggest that populations are not randomly distributed in feeding grounds (the extent of the area and the location is unknown for modern times)</p> |

### 5. Problems Encountered (if any)

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| Describe any major problems encountered during the Activity and how they were addressed.  |
| <p>This was an analysis of already collected samples. Some duplication (repeat sampling) was detected from different sites and years that was not apparent from photo-ID. This points to the importance of comprehensive sampling, as field</p> |

Identification can clearly be unreliable.

The delay in funding and contract realisation means that the final analysis is still running but we will have completed and submitted the paper by end of April 2015.

## 6. Communication

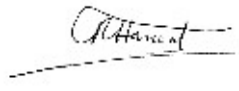

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| How will results be communicated to management   |
| <b>Results to be communicated to Department of Environment May 2015 at a stakeholder workshop on cetaceans and whale watching.</b>   |
| <b>Report to be submitted to Department of Environment</b>   |
| Stakeholder engagement feedback (plain English for feedback to stakeholders)   |
| <b>Relevant state agencies are partners in the project (NSW, VIC, TAS)</b>   |
| Students supported (if any)  |
| <b>Emma Carroll Postdoctoral Fellow</b>  |
| PhD Theses and dissertations (if any)  |
| <b>none</b>  |
| Publications (other than theses and dissertations)   |
| <b>One publication is in preparation and will be submitted to IWC and subsequently to an internationally peer reviewed journal</b>   |
| Planned publications   |
| Fine and broad scale population structure of South Pacific southern right whales revealed by genetic and stable isotope data: investigating the distinctiveness of southeast Australian wintering grounds<br>E. L. Carroll <sup>1,9*</sup> , C. S. Baker <sup>2,3</sup> , M. Watson <sup>4</sup> , R. Alderman <sup>5</sup> , J. Bannister <sup>6</sup> , O. Gaggiotti <sup>1</sup> , D. Glocke <sup>7</sup> , S. Childerhouse, N. Patenaude <sup>8,9</sup> and R. Harcourt <sup>9</sup> |
| Presentations  |
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## 7. Project Outputs

| A list of the actual outputs of the research including milestones, progress reports and data products such as models etc. | Proposed date of completion | Actual date of completion |
|---|-----------------------------|---------------------------|
| <b>Progress Report</b>  | <b>31 May 2014</b>          | <b>31 May 2014</b>        |
| <b>Data Analysis</b>  | <b>March 2015</b>           | <b>March 2015</b>         |
| <b>Final Report</b>   | <b>3 March 2015</b>         | <b>31 March 2015</b>      |

## 8. Financial Account of the Activity

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| Include reasons for any variation to the budget, underspends and difficulties |
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| Signature of Chief Investigator          |   |
| Name                                     | Prof Rob Harcourt  |
| Date                                     | 27 February 2015   |
| Signature of Organisation Representative |  |
| Name                                     | Prof Marie Herberstein, Head of Department   |
| Date                                     | 27 February 2015   |

Please forward 1 hard copy, and one electronic Word document of this report to:

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