Australian Marine Mammal Centre

Final Report

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

- **Project No**. – 0809/5
- **Title** - Quantifying trophic links in several Antarctic marine predators
- **Chief Investigator** – Professor Mark Hindell
- **Organisation** – University of Tasmania

Activity Period –

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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)
To date, this project has provided information on the relative trophic position of two important Antarctic pack-ice predators: the southern elephant seal (SES; *Mirounga leonina*) and Antarctic fur seal (AFS; *Arctocephalus gazella*). Evidence suggests a causal link between prey resource availability and recent declines

in some SES populations, whereby the availability or quality of food impacts on the survival and recruitment of juvenile seals into the breeding population and/or adult (female) fecundity (McMahon et al. 2005). Thus, the focus of this component of the project was to increase our understanding of the diet and trophic links of the juvenile SES population of which we know little about. Using stable isotope and satellite telemetry data, we examined the foraging habitat and diet of sub-yearling SES (n = 15) from Macquarie Island (MI; 54˚30'S, 158˚57'E) during their first trip to sea. Growth rates of whiskers, which act as a temporal record of feeding, were estimated using carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopic values along the length of the whisker. Seals were also equipped with satellite-relayed data loggers which measured seal location and foraging behaviour at approximate time of whisker growth (0.22 ± 0.07 mm d^{-1}). Analysis of consecutive sections of whisker allowed us to reconstruct a time series of isotope data for >7 months per seal. Most animals fed in southern waters around the Polar Front (PF) or along the Antarctic Circumpolar Current (ACC; 60–70˚S) as indicated by their lower $\delta^{13}C$ (<-20‰) values, and validated by tracking data. However, two pups had higher $\delta^{13}C$ (>-19‰) values. Tracking data confirmed that these seals travelled southwest of MI, feeding in waters north of the ACC Front (>60˚S) and close to the PF (~55˚S). Whisker $\delta^{15}N$ values ranged from 7.9 to 14.5‰ suggesting seals occupied a range of trophic levels within the two broad-scale foraging habitats identified. The combination of stable isotope analysis and satellite telemetry data revealed considerable spatial and temporal variation in foraging habitat and diet for these pups.

The Antarctic fur seal (AFS: *Arctocephalus gazella*) is one of the best studied Antarctic marine predators. However, core winter foraging habitats and diet preferences remain largely undocumented for this abundant top marine predator. By using a combination of stable isotopes in whiskers and blood and satellite telemetry data, we were able to document spatial and temporal variation in winter foraging habitat and diet of Antarctic fur seals from Cape Sherriff (CS, Antarctic Peninsula, 62˚28'S, 60˚46'W) and Marion Island (MI, Southern Indian Ocean, 46°54'S, 37°5'E) in 2008. Preliminary analysis indicates that whisker isotopic values reflect the winter

migration patterns of AFS seals between sites, as corroborated by tracking data. By comparing the isotope ratios along the length of the whisker with those of suspected prey items, changes in food sources and habitat can be surmised for the temporal span represented by the growth of the whisker. Seals which migrated north from Cape Sherriff (~ 62˚S) to forage in waters off the Chilean and Patagonian coasts, South America (~ 45-50˚S) showed substantial variation in both $\delta^{13}C$ and $\delta^{15}N$ along the length of the whisker corresponding to the winter foraging period. $\delta^{13}C$ values ranged from -23.4 to -17.3‰ and $\delta^{15}N$ values ranged from 7.4 to 11.0‰, reflecting both variation in foraging habitat (from high Antarctic to the subtropics) and prey (from Antarctic krill to mesopelagic fish and squid), respectively. In contrast, isotopic values along the length of the whisker from Marion Island seals reflected migration patterns south of Marion Island (~ 46˚S) to higher latitude waters (>60˚S). $\delta^{13}C$ values ranged from -18.2 to -23.7‰ and $\delta^{15}N$ values ranged from 11.2 to 7.0‰, reflecting variation in foraging habitat from subantarctic to Antarctic waters and prey from mesopelagic fish and squid to Antarctic krill, respectively.

2. The Outcomes/Objectives

The degree to which the Activity has achieved the objectives

1. **Determining winter diet of the southern elephant seal, Weddell seal, and the Antarctic fur seal**

(a) Data collection

Samples have already been collected from southern elephant seals and Weddell seals. Antarctic fur seal whisker and blood samples from the 2008 winter season from Marion Island (n = 14) and Antarctic Peninsula (n = 13) were received in mid-2009. Unfortunately, sufficient samples from South Georgia were not collected in 2008. Whisker and blood samples from the 2009 winter from Marion Island (n = 30), South Georgia (n = 30) and Antarctic Peninsula (n = 30) are yet to be received. It is anticipated that all outstanding samples will be in hand by September 2010.

(b) Analysis of samples

Southern elephant seals – SIA was performed on whiskers obtained from sub-yearlings (*n* = 15) during their first migration from Macquarie Island. A single whisker was analysed from each seal. Prior to isotopic analysis, each whisker was sectioned into ~ 2-3 mm segments (497 segments in total were analysed; 280 were analysed via funding, the remainder were analysed previously and data made available for this project). Growth rates of whiskers, which act as a temporal record of feeding, were estimated using carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopic values along the length of the whisker. SIA was performed on whiskers obtained from seals equipped with satellite relay data loggers (SRDLs), enabling location and foraging behaviour of individuals to be determined at the approximate time of whisker growth. Whiskers were analysed from seals collected in 1995/1996, 1996/1997 and 1999/2000 field seasons. Analysis of consecutive sections of vibrissae allowed us to reconstruct a time series of stable isotope data of seals in a period > 7 months.

Antarctic fur seal samples from 2008 – A total of 31 whiskers (from n = 27 animals) were sectioned into ~ 2-3 mm segments (total of 460 sections) and analysed. While a total of 27 blood samples were analysed. All seals were equipped with geolocation loggers (GLS) enabling location and foraging behaviour of individuals to be determined at the approximate time of whisker growth. Analysis of consecutive sections of vibrissae allowed us to reconstruct a time series of stable isotope data of seals (CS: n=13 & MI: n=14) over the winter foraging period, while blood isotopic values confirmed most recent dietary information.

***Weddell seal samples** – Weddell seal whisker samples have not been analysed yet. SIA of these samples have been included in the 2010 timetable for this project and will be analysed using other funding sources.

2. Integrating predator diet information into broader food web structure using numerical ecosystem models

Development of methodology for the modelling component of this project is currently

been undertaken. A range of prey samples, as detailed below, will be used to define energy flow through the trophic levels of Antarctic marine food webs. These isotopic prey values will be used in addition to published values already available for various sectors of the Southern Ocean (e.g., Atlantic and Indian Ocean sectors). Analysis of data will establish qualitative and quantitative predator-prey links that can be used to model energy flow through trophic systems. This study has the specific objective of focusing on several top predators and their prey. Hence, this project will form the first step in making a broader-based study, as other trophic components - e.g. crabeater seals and other penguin species - can be added subsequently. Through the utilization of multiple study species, and the application of novel, non-lethal stable isotope techniques to quantify their trophic relationships, it is anticipated that the degree of resource partitioning between this suite of predators can be quantified.

***Squid beaks collected from stomach lavages from southern elephant seals, Macquarie Island waters** – This part of the project was scheduled to be completed by the end of 2009, however it is now being carried out by an Institute of Marine and Antarctic Studies Honours student during 2010, under the supervision of Prof Mark Hindell. Samples (n = ~1,400) collected from 1998 to 2001 will be sorted, identified and prepared for SIA over the coming months by the student. Isotopic data resulting from this honours project will be used in conjunction with objective 2 of this project.

***North of Terre Adélie and George V Land of Eastern Antarctica** – Isotopic values of a range of samples, including crustaceans, squid and fish (n = 250) collected during the CEAMARC voyage in January/February 2008 (~140˚E) will be used to define trophic links for predators in the eastern Antarctic region of the Southern Ocean (e.g., SES sampled at Macquarie Island and Weddell seals sampled at Davis and Dumont d'Urville stations).

Ross Sea samples – Additional trophic samples were to be collected from the Prydz Bay region, but an opportunity has arisen for krill samples to be collected from the Ross Sea area and adjacent Southern Ocean, during the Australia-New Zealand Antarctic Whale Expedition, February/March 2010 instead. This region is used as feeding grounds by southern elephant seals and Weddell seals, and as such these

additional krill samples will help determine energy flow through lower trophic levels of the marine food web in which these Antarctic predators forage. These samples will also compliment krill samples collected further west (North of Terre Adélie and George V Land of Eastern Antarctica) for this project. It is anticipated that samples will be received by mid-2010 and processed for isotopic analysis shortly afterwards. This will be undertaken outside the Activity period specified and thus no funds will be allocated for this component of the project.

3. Appropriateness

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

4. Effectiveness

The degree to which the Activity has effectively met its stated objectives
***Difficulties experienced during Activity period of project** – Logistical and technical delays have unfortunately impacted on timeframes stipulated for the completion of objectives 1 of this project. We had anticipated to receive Antarctic fur seal samples from the 2008 winter by the end of 2008, but did not receive all samples until mid-2009. This meant that analysis of these and other samples due to be completed by the end of 2009 were delayed. Due to the logistics of Antarctic field research however, these delays were unavoidable. Difficulties were also experienced in securing a stable isotope laboratory. After seeking out laboratories interstate and overseas, the stable isotope laboratory at the Australian National University (ANU) agreed to process all samples for this project at a very competitive price. Unfortunately, delays in getting stable isotope data from the ANU laboratory have occurred. Subsequently, SIA of the remaining predator samples (Weddell seal whiskers) and prey samples, which were due to be completed by the end of 2009 have

been delayed until 2010. These delays have been factored into the 2010 timetable, and are therefore, not expected to have any effect on the successful completion of objectives 1 and 2 of the project.