Using Animal-Borne Cameras to Quantify Prey Field, Habitat Characteristics and Foraging Success in a Marine Top Predator

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Award Number: N00014-10-1-0385

LONG-TERM GOALS

To understand the factors which influence population dynamics in marine mammals, and the potential risks anthropogenic activities pose, knowledge of their habitat use and the environmental factors determining foraging success is required. While over the last decade great advances have been made in this area for pelagic foraging species, such information is largely lacking for benthic foraging marine mammals. Therefore, the long term goals of this project are to determine in a model species (the Australian fur seal) the key ecological characteristics of their benthic foraging habitat, the profitability (prey captured *versus* effort) of various habitats and the spatial distribution of critical habitat. The techniques and principles developed in this project will be applicable for a variety of benthic foraging seal species world-wide and will contribute to our understanding of the role of top predators in shaping marine communities.

OBJECTIVES

The specific aims of the study are to:

1) quantify the prey fields encountered by adult female Australian fur seals in various habitats using video footage recorded on the seals;
2) determine seal movements at the fine-scale appropriate to prey encounters using GPS loggers and 3-axis accelerometers;
3) quantify net energy gain while foraging in different habitats; and
4) establish the habitat characteristics and individual factors that influence these parameters.

APPROACH

The aims of this study will be achieved through a conceptually simple, yet highly effective, methodological approach. Animal-borne video recording equipment will be combined with high resolution tracking to characterise and map the benthic habitats in which Australian fur seals forage and to determine the relative profitability of these habitats as measured by foraging success (prey consumption/energy expended).

The study will be conducted on Kanowna Island, northern Bass Strait, which hosts a large breeding colony with an annual production of *ca*3000 pups. Individual adult females suckling pups will be selected at random, captured and instrumented with a digital video recorder data logger (Crittercam® V5.7, National Geographic Society, Washington, USA) encased in a water-proof aluminium housing (5 cm diameter, 25 cm length). The device will be glued to the dorsal fur along the mid-line posterior to the scapula using quick-setting epoxy (Fig. 1). The Crittercam is designed to record high resolution, wide angle, video footage in low ambient daytime light levels encountered at depths of up to 100 m and on-board red LED beams provide sufficient light to record video at night. To enable complete foraging trips (6-10 days) to be sub-sampled, the Crittercam will record video data on a duty-cycle of 1 h on:3 h off. In addition to storing video footage, data from on-board sensors (depth ± 0.5 m, 3-axis accelerometer ± 0.06 G, compass ± 1º) is recorded enabling accurate three-dimensional dive profiles to be reconstructed (Simpkins et al. 2001). From such profiles, linear distances travelled can be measured enabling the size of features along the sea floor to be calculated. As well as the Crittercam, a small VHF transmitter and a FastLoc GPS® data logger will also be attached to the animal to assist in relocating it at the colony for recapture and for recording at-sea movements, respectively. In total, all devices attached to the seals will represent <2% body mass and <1% cross-sectional surface area and, thus, negligible additional hydrodynamic drag (Wilson et al. 1986).

Fig.1: Adult female Australian fur seal (Arctocephalus pusillus doriferus) on Kanowna Island, northern Bass Strait, instrumented with a Crittercam® video data recorder, VHF transmitter and Fastloc GPS® logger.

To investigate potential individual factors influencing foraging behaviour, age and body size will be determined in the instrumented females. Once morphometric measurements have been collected and the animal has recovered from the anaesthesia, it will be released and left to forage for a single trip to sea before being recaptured and the devices removed by cutting the fur beneath them. Data from the loggers will be downloaded in the field onto portable computers and their batteries recharged so that they can be redeployed on additional animals.

In the laboratory, the at-sea movements of individuals instrumented with a Crittercam will be mapped using the data downloaded from the FastLoc GPS® logger concurrently deployed on them. The high accuracy of locations (± 10 m) and fast sampling interval (5 min) of these loggers, coupled with the 3-dimensional reconstruction of dive profiles using the accelerometer data, will enable foraging routes to be determined with very high resolution. The video recordings will then be analysed for the type, number and density (based on the length of foraging tracks) of prey encountered. The benthic habitats visited by seals will be categorised using the towed-video classification program developed for the Victorian Marine Habitat Mapping Program (Ierodiaconou et al. 2007). These analyses, which will be conducted with the assistance of Dr Daniel Ierodiaconou of Deakin University's Marine Habitat Mapping Facility, will enable statistical comparisons of prey fields, and capture rates, between various benthic habitat types.

WORK COMPLETED

Deployments of Crittercams in conjunction with dive behaviour recorders and GPS data loggers continued with a total of 21 animals instrumented throughout the reporting period (Oct 2010 – Sept 2011). However, deployments during the summer field season (January) were not successful with all deployed devices being lost at sea. Individuals returned to the colony with the deployed VHF transmitters, and in some cases the dive behaviour recorders and GPS data loggers, but the Crittercams had fallen off. It appears that by this time of the year (annual moult occurs March-April), the guard hairs are sufficiently brittle that they cannot hold the weight of large instruments such as the Crittercams and all initial deployments failed. Consequently, for ethical and logistical reasons, it was decided not to attempt any more summer deployments. Therefore, no video data were collected during the summer and further sampling will be restricted to the post-moult winter period for the remainder of the project.

The loss of devices during the summer field season resulted in less instruments being available for the winter sampling period. In addition, one of the Crittercams deployed in winter suffered a leak and another malfunctioned such that they both had to be returned to the manufacturer for repair, interrogation and downloading which prevented them being available for re-deployment. Consequently, fewer deployments than originally anticipated were possible. Nonetheless, video data have been recovered from 7 individuals during the reporting period (4 individuals have yet to be recaptured), with a total of 1240 dives (>80 h) now being available for analysis from this project.

Video analysis of benthic habitat structure and prey capture rates is progressing but is still in its early stages as data collection is still continuing. The process is also very time-consuming as the habitat types may change during the course of each dive and each type needs to be classified and mapped. In addition, identification of the prey species encountered requires repeated viewing in order to ensure correct classification. To date, initial processing has been completed for 420 dives.

RESULTS

Despite some minor differences in their composition, the data so far have shown relatively little variation in the benthic habitat types visited by the instrumented seals. The majority of dives reveal a sea floor of sandy substrate and sparse invertebrate communities, with the occasional reef or dense invertebrate community being visited (Fig. 2).

In addition to the discovery last year that one instrumented individual foraged along a gas pipe-line on the sea floor for 2.5 days, a second instrumented seal foraged around an offshore oil rig platform for several days and her video data recorded other seals in the area. It is clear from the video data that these man-made structures provide artificial reefs that promote habitats for fish and octopus in an otherwise barren seascape (Fig. 2). Furthermore, analysis of GPS tracking data collected over the last 5 years from 46 adult female seals indicates that >40% of individuals spend >5% of their foraging trips within close proximity to man-made structures on the sea floor (e.g. gas/oil pipe-lines, electricity cables, shipwrecks etc.). These results suggest some beneficial impacts from certain aspects of industrial development within the Australian fur seal marine habitat.

Analyses to date suggest some differences in individual foraging strategies exist, with some seals consistently hunting benthic fish species such as gurnards (Family Triglidae) and large octopus (e.g. *Octopus maorum*), while others target small rays or sharks (Fig. 3). Furthermore, a significant finding of the results is that the prey species commonly observed in the video data and representing the greatest biomass being consumed (octopus, gurnards), have not been reported as significant in conventional diet studies (i.e. scat analysis, Kirkwood et al. 2008). This discrepancy may be due to the fact that the seals bring large prey items to the surface where they are broken up and not fully consumed, often discarding sections with the identifiable hard remains (e.g. mouth-parts of octopus, heads of large fish and rays/sharks). These findings have very important implications for estimates of population prey consumption by Australian fur seals, understanding their role in the south-east Australia marine ecosystem, assessing their potential for direct and indirect fisheries interactions, and predicting how the species may respond to environmental variability.

Fig. 2: Examples of benthic habitats in central Bass Strait observed in the data obtained by Crittercam® video recorders on adult female Australian fur seals from Kanowna Island: a) sand/gravel benthos with sparse invertebrate community; b) reef with dense invertebrate community; and c) artificial reef habitat associated with oil-rig platform.

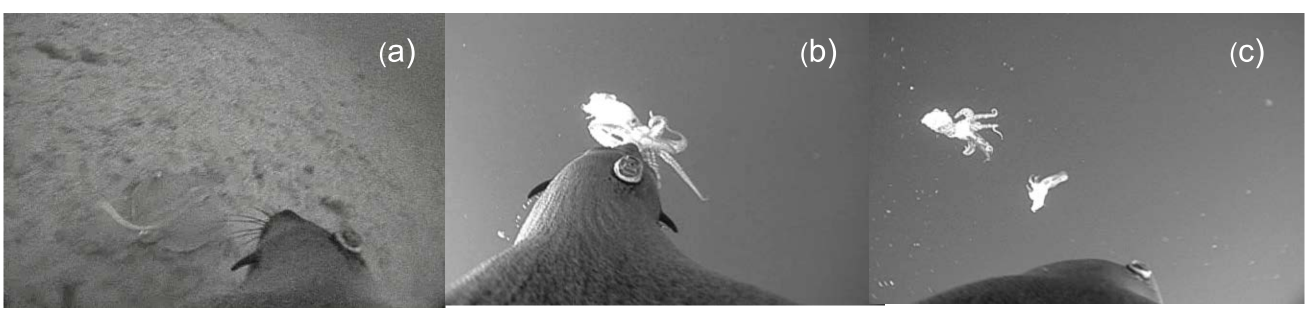

Fig. 3: Examples of common prey items: a) ray; and b) octopus, consumed by adult female Australian fur seals and c) how they consume fragmented items at the surface.

An interesting finding from the deployments conducted is this year is that three different individuals, in different areas of Bass Strait, were observed to forage in association with common dolphins (*Delphinus delphis*) during numerous dives (Fig. 4). Furthermore, in some of these dives, other fur seals were visible suggesting this may be a common occurrence. It appears from the video data that the seals follow the dolphins and may be exploiting their ability to detect or flush-out prey from hiding spots, with the seals being able to manoeuvre faster than the dolphins to capture the prey. This exciting finding will require further investigation to determine its significance and implications.

Fig. 4: Observations from adult Australian fur seal females instrumented with a Crittercam®: a) following a common dolphin; b) approaching a common dolphin and another fur seal foraging; and c) capturing a barracouta (Thyrsites atun) in the presence of common dolphins.

IMPACT/APPLICATIONS

The overall aim of the proposed research is to determine the factors which influence spatial and temporal foraging success in an important marine predator. In particular, by employing new biologging and telemetry technology we will be able to quantify three particularly elusive aspects of marine mammal foraging ecology: the prey field, foraging success and foraging costs. The project focuses on the Australian fur seal where this information is vital for predicting how the most significant marine predator biomass in south-eastern Australia, and its impact on the marine ecosystem, will respond to environmental variability. The project, however, has broader international significance in that it will contribute to our understanding of the role of top predators in shaping marine communities, which is of particular importance given anticipated global climate change and the world-wide ever-increasing human exploitation of marine resources.

This study has additional global significance as the underlying principals determining foraging success will be applicable for a variety of benthic foraging seal species whose populations are currently under threat and where the impacts of bottom/demersal trawls by commercial fisheries on their prey field are unknown. Furthermore, an important and novel spin-off from this research will be improved mapping of sea-floor characteristics in many parts of the world, for a range of uses (e.g. environmental assessment, ecosystem monitoring), on a scale not feasible using conventional methods (i.e. hydrographic surveys and benthic trawl sampling).

RELATED PROJECTS

There are currently no projects directly related to the one being reported here.

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