EAVESDROPPING ON ANTARCTIC PACK ICE SEALS – APPROPRIATENESS ACOUSTIC AND VISUAL SURVEYS?

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Abstract

The pack ice seals, the crabeater, Weddell, leopard, and Ross, seals, are an important group of animals within the Antarctic ecosystem. As large bodied, top order predators, their population levels are thought to react to large-scale climate changes. Visual surveys are conducted from both ship-based and air-based survey platforms. However seals are available for survey only when hauled out on the ice. This study aimed to investigate whether information from acoustic surveys augmented the visual surveys by effectively including animals underwater during the survey period. Three acoustic surveys were conducted from the icebreaker, Aurora Australis, during October 1996 and 1997 and between December 1997 and January 1998. Visual surveys were conducted coincident with the acoustic surveys. Although there were numerous sighting of crabeater seals, no crabeater seal vocalisations were heard. Weddell seals were neither sighted nor heard in the pack ice but were recorded at the fast ice. Ross and leopard seals, although rarely sighted, were highly vociferous in December but not in October. The December surveys coincide with their breeding seasons. At this time only a few seals were identified hauled out on the ice. This study suggests that the best time to conduct bi-modal (both visual and acoustic) surveys for pack ice seals are in December where crabeater seals are observed in visual surveys and Ross and leopard seals in acoustic surveys.

Introduction

Acoustic techniques have been used rarely to asses populations of marine mammals although they have been much discussed as offering enormous potential to improving visual surveys [1-3]. It has been found that population estimates of humpback whales migrating along the east coast of Australia correlated with estimates from visual surveys [4-5]. The Antarctic pack ice seals, the Weddell (*Leptonychotes weddellii*), crabeater (*Lobodon carcinophaga*), Ross (*Ommatophoca rossii*), and leopard (*Hydrurga leptonyx*) seals, a highly vociferous group, were used to explore whether acoustic surveys were beneficial when used in conjunction with traditional visual surveys.

A fundamental assumption underlying an acoustic survey is that the target species have distinctive species-specific call(s). In order to convert sounds into animal numbers, it is necessary to either locate where each different sound is made, to identify the location of each calling animal so that the spatial density can be estimated, or to calibrate the number of sounds detected with independent data on the number of sounds made per animal over a unit time (cue counting).

The logistical difficulties of working within the Antarctic pack ice meant that it would be impractical to identify the location of calling individuals over a large area. The approach to model sounds per animal over a unit time was used to give an estimate of minimum population size (as a relative index) for species where there is the information on: the production of vocalisations (Acoustic behaviour - including seasonal calling patterns, diurnal calling patterns, inter-individual stereotypy, inter-sexual stereotypy, audience effect and predictable calling rate over a unit of time); and the detection range of those vocalisations (Survey distance - empirical estimates and/or theoretical estimates calculated with call intensities). Some of this information is in hand for the leopard seal (TABLE I). Where there isn't this data (TABLE I) an acoustic survey can provide presence or absence information. In this paper we explore whether passive acoustic surveys improve traditional visual surveys in assessing Antarctic pack ice seal populations by examining whether presence/absence information from acoustic surveys augments visual surveys for the Weddell, crabeater, Ross and leopard seal**.**

Methods

Acoustic survey data collection - Underwater passive acoustic point-transect surveys were conducted across Eastern Antarctica in: October 1996 (64 fixed-point recordings between 65°05'S, 110°51'E through to 67°08'S, 75°32'E); October 1997 (50 fixed-point recordings between 64°03' S, 108°55' E through to 62°24' S, 66°13' E); and December 1997 (54 fixed-point recordings between 64°12.27'S, 107°32.25'E through to 66°50'S, 63°11'E). Recordings were made remotely using sonobuoys (Sparton Electronics AN/SSQ-57A). The hydrophone was lowered to a depth of 18 m below the water surface. Signals were received using two, 9 element Yaggi antennas (YH09, R F Industries Pty Ltd) secured to the mast at 30 m above sea level and using a custom multi-channel receiver. Signals were recorded onto a Sony Digital Audio Tape recorder (TCD-D8). The average frequency bandwidth range for all equipment was between 10 and 22, 000 Hz + 3dB. Thirty-minute recordings were made opportunistically. The G.P.S. location was recorded at the time a buoy was deployed.

Table 1. Acoustic behavioural and survey distance information reported for each of the Antarctic pack ice seals, U = Unknown.

Information needed	Weddell seal	Crabeater seal	Ross seal	Leopard seal
Species specific calls)	Yes [6-7]	Yes [8]	Yes [9-10]	Yes [8, 11-12]
Seasonal calling patterns	Yes [13-14]	U	U	Yes [15-16]
Diurnal calling patterns	Not sure [14]	U	U	Yes [15]
Inter-individual stereotypy	U	U	U	Yes [17]
Inter-sexual stereotypy	U	U	U	U
Audience effect.	U	U	U	U

Visual survey data collection - The visual survey data was collected concurrent with the acoustic surveys from the Aurora Australis in October 1996, 1997 and December/January 1997/98. During visual surveys, seals in the Antarctic pack ice can only be seen when they are hauled out on the ice. These surveys are timed to coincide with the period when the highest proportions of crabeater seals are hauled out, when females are pupping or moulting. Observations were made from above the ship's bridge at a height of 16 m. The transect lines followed the ship's cruise track and covered a 400 m area (200m on either side of the ship).

The number of Weddell, crabeater, Ross and leopard seal calls (TABLE I) was recorded within each 30-minute fixed-point recording. Call types were identified using Signal 3.1 (Engineering Design, Belmont, USA). Only recordings where the signal to noise ratio allowed clear identification of all calls for the duration of the 30-minute period were used. The sites where Weddell, crabeater, Ross and leopard seal calls were detected both acoustically and visually were plotted on the Antarctic Digital Database, version 4 (Scientific Committee on Antarctic Research) using GIS (ArcView 3.2, ESRI).

Results

Acoustic survey data did not augment visual surveys for the Weddell seal. Weddell seals were rarely observed in the pack ice, only once in an acoustic survey in December 1997, and never during the visual surveys. However Weddell seals were detected near the fast ice edge at the end of the survey both acoustically, in December 1997, and in the visual survey, in both October and December 1996.

The acoustic survey data did not augment visual surveys for the crabeater seal. Crabeater seals comprised 98.9 % of total seals sighted during the four visual surveys, whereas the acoustic surveys detected no crabeater seals.

Acoustic surveys conducted in December augmented visual surveys for the Ross seal. Ross seals were seen rarely in the October (six seals) or December (two seals) visual surveys and were not encountered at all in the October acoustic surveys. However, they were encountered frequently in 22 % (12 of the 54) of locations in the December acoustic survey. Their distribution tended to be clumped and concentrated in the western region of the survey range. Only the siren call was detected [10] and because there were several overlapping siren calls in both the near and far fields, it appeared that two or more seals were calling at any one position.

Acoustic surveys conducted in both October and December augmented visual surveys for the leopard seal. Leopard seals were seen rarely in the visual surveys conducted in either October (six seals across both years) or December (five seals) but were detected acoustically during these times. In the acoustic surveys leopard seals were encountered less frequently in October than December. In October leopard seals were acoustically detected in a few discrete locations in both 1996 (14% of locations - 9 of the 64) and 1997 (10% of locations - 5 of the 50). However in December, leopard seals were detected acoustically in an even distribution across the entire survey range in 1997 (98% of locations - 53 of the 54). All five of the leopard seal calls [16] described for Eastern Antarctica were detected. At any location several overlapping calls in both the near and far fields gave the impression that two or more seals were calling.

Discussion

Weddell seals were neither sighted nor heard in the pack ice but were recorded at the fast ice. During the timing of these surveys they are breeding within the fast ice which is supported by the data from these surveys. The acoustic survey did not improve detectability of this species.

There were numerous sightings of crabeater seals in the visual surveys conducted both in October and December but there were no crabeater seal vocalisations heard. This was surprising because Stirling and Siniff [8] had reported that crabeater seals were highly vociferous during October and November. We had anticipated that crabeater seal calls would have been heard particularly in the regions where seals were present in high densities. This may suggest that crabeater seals do not use long-range underwater calls as part of their breeding behaviour, like the other Antarctic pack ice seals, and that their calls have low source levels and do not propagate well. However this is speculative as there are currently no source level estimates for their calls. This is consistent with their breeding behaviour where males escort pre-estrus cows until they come into estrus. They may have relatively quiet calls used between conspecifics in close proximity rather than loud, long-range calls used as part of a long-distance display. Acoustic surveys did not improve the detectability of this species.

Ross and leopard seals, were both rarely sighted in the visual surveys, but were encountered significantly more often in the acoustic surveys conducted in December but not especially October. The December surveys coincided with the end of the breeding season for Ross seals and the peak of the breeding season for leopard seals [18] In the regions where Ross seals were heard it appeared as if many different individuals were calling however, because we know little about their acoustic behaviour we can infer that Ross seal(s) were present in these regions but nothing further. Acoustic surveys provided valuable addition to the presence-absence information for both the Ross and leopard seals.

For the pack ice seals, visual and acoustic surveys operate independently of one another each measuring different individuals. The visual survey encounters animals hauled out on the ice while the acoustic survey encounters animals calling underwater. This study suggested that the best time to conduct bi-modal (both visual and acoustic) surveys for pack ice seals are in December where crabeater seals are encountered in visual surveys and Ross and leopard seals in acoustic surveys.

Conclusions

The pack ice seal visual surveys conducted in December was greatly enhanced by having parallel acoustic surveys. During December the leopard and Ross seals were calling underwater as part of their breeding displays. December through to mid-January is the breeding season of the leopard seal [19] and is thought to be for the Ross seal [20]. The visual surveys alone underestimated encounters with these species. However by contrast, encounters with crabeater and Weddell seals were not enhanced by the acoustic surveys.

Without an understanding of a species vocal behaviour and the survey range of their calls, it is not possible to measure absolute (or relative) numbers of seals with an acoustic survey but it is possible to identify whether a species is present or absent which may have use for spatial and temporal comparisons.

Acknowledgments

Thanks to the crew and staff of the Australian Antarctic Division that assisted with the visual and acoustic onboard the Aurora Australis particularly the captain Murray Doyle. Thanks also to those that helped with putting up the antennae system in different years: Peter Mullen, Andrew Irvine, Damien Higgins, Rod Stevenson and 'Johnno'. The Data for the GIS maps was provided by the Australian Antarctic Data Centre in Hobart.

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