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PALAOA: A study on the acoustic repertoire and its geographic variation of the leopard seal (*Hydrurga leptonyx*)

Figure 1: The leopard seal hauled out

Introduction

• The Leopard seal is a circumpolar distributed top-predator in the Antarctic pack ice region. Knowledge on migration behaviour is sparse: The migration patterns of adults is largely unknown[1,2], and the knowledge about breeding populations and their mixing is only marginal. Visual observation of leopard seals to determine abundance and distribution is constricted by its solitary occurrence and limited accessibility of the Antarctic pack ice. However, leopard seals are known to be vocal during breeding season, so passive acoustic monitoring provides a valuable tool to study this species during this period.

• Currently there are 12 described calls for the vocal repertoire of the Leopard seal[3,4]. Observed geographic variation of leopard seal vocalization suggest the existence of different breeding populations[5] while there is no evidence for population structure based on genetics[6].

➔ In this study, PALAOA and two additional recording sites were investigated for differences in call repertoire and geographic variation of the leopard seals' underwater vocal behaviour.

Results

• Call repertoires at PALAOA and DIPS are identical and consist of eight different calls. At Prydz Bay only six of them are present.

• We found that the time slope of the pulse repetition rate (PRR) of the High Double Trill (HDT) is a robust feature, by which the three locations can be distinguished.

➔ With respect to this feature the closest locations PALAOA, and Drescher Inlet (500 km distance) differ strongly, while PALAOA and Prydz Bay with 4300 km distance show more similarity. The two locations most apart, Drescher Inlet and Prydz Bay show the largest acoustic difference.

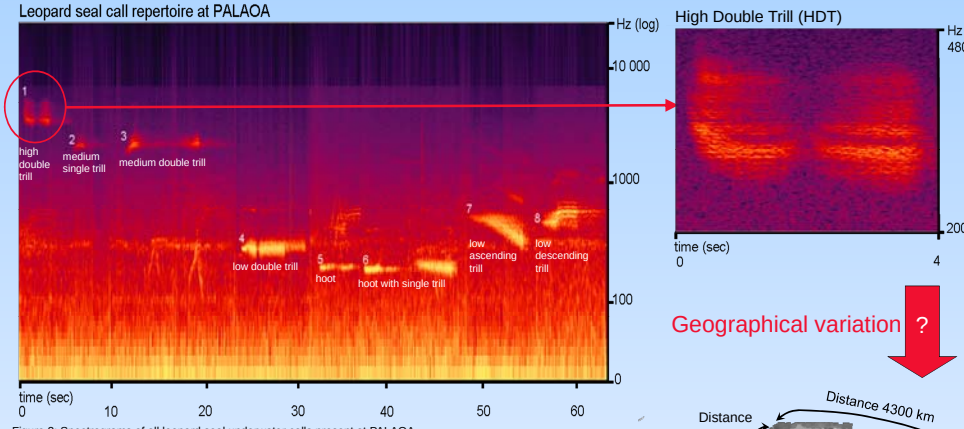

Figure 2: Spectrograms of all leopard seal underwater calls present at PALAOA.
1: High Double Trill (HDT) (excerpted right), 2: Medium Single Trill (MST), 3: Medium Double Trill (MDT), 4: Low Double Trill (LDT), 5: Hoot (H), 6: Hoot with Single Trill (HST), 7: Low Descending Trill (LDST), 8: Low Ascending Trill (LAST)

Geographical variation ?

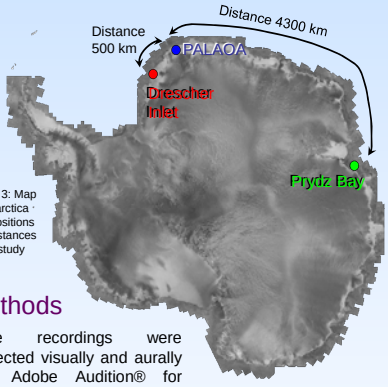

Figure 3: Map of Antarctica with positions and distances of the study sites

Discussion

• The repertoire at Prydz Bay misses two call types. However, these have a minor frequency of occurrence and the data collected at Prydz Bay only covers two days. More data is needed to draw conclusions about geographic variation in call repertoires.

• The PRR slope is most divergent between the closest locations. This contradicts intuitive assumptions of the pattern of clinal variation. Several explanations can be suggested:

• The observed acoustic differences in leopard seal vocalizations could be due to discrepancies in age, sex, condition or other factors of the calling individuals between the three locations.

• The Drescher Inlet could provide unique environmental characteristics compared to the other locations which encourage site-specific vocal adaptation.

• But the results of this study also coincide with observations from Weddell seals[7] and Fin whales[8], which both showed no positive correlation between the difference of vocalization characteristics and geographic distance. The Weddell seal study showed the very similar result by relating the greatest acoustic difference to the most proximate was recording locations: PALAOA and Drescher Inlet.

• Either a strong site fidelity or the phenomenon of "character displacement" could attribute to this observations. Character displacement is a concept of evolution theory which explains "differences between overlapping populations that are accentuated in the zone of sympatry and weakened or entirely lost in the parts of their ranges outside this zone" [9].

Material

• Long-term recordings (since December 2005) from the **P**erenni**AL** **A**coustic **O**bservatory in the **A**ntarctic Ocean (PALAOA) located near Atka Bay at the eastern Weddell Sea coast (70°31'S - 8°13'W). Time period covered by this study: December 2006

• Data from a short time (December 2003) acoustic recording study "the **D**rescher **I**nlet **P**ilot **S**tudy (DIPS)" in the Drescher Inlet, a 25 km-long crack in the Riiser Larsen Ice Shelf located at 72°50'S, 19°02'W.

• Data allocated by Tracey Rogers, were recorded during an acoustic survey of the RV Aurora Australis V4 in Davis Sea (65°S -90°E) near Prydz Bay December 1997.

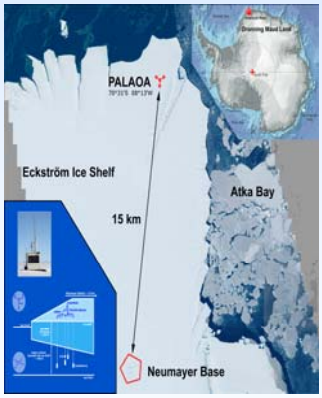

Figure 3: IKONOS-2-satellite image from March 2004 showing PALAOA located on the Ekström Ice Shelf around 15 kilometres north of Germany's Neumayer Base, with the Southern Ocean to the north and Atka Bay to the east.

Methods

• The recordings were inspected visually and aurally with Adobe Audition® for determining call repertoires.

• Then 150 HDT calls of each location were selected and analysed in fine detail. 19 parameters of each call were extracted using a special developed MATLAB program. It provided a graphical user interface (GUI) for simplified and accelerated call characterization. Using this GUI, call parameters can be entered by a point and click scheme, which speeds up analysis of big acoustic data sets by a large extend.

• The five parameters of the pulse repetition rate (Figure 4) were the most distinguishing features. These were mapped to a 3-dimensional space using for visualisation principal component analysis (PCA).

YES!

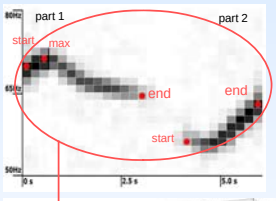

Figure 4: Example spectrogram of the HDT's pulse repetition rate and with parameters used in the analysis

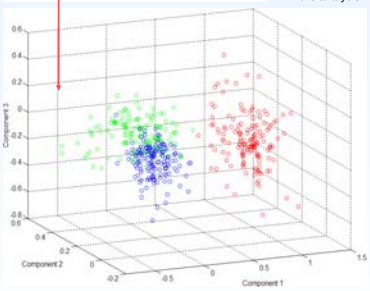

Figure 5: Scatterplot of the 3 most explaining principal components of a PCA applied to the PRR of 450 HDTs recorded at Atka Bay (blue), Drescher Inlet (red) and Prydz Bay (green)

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