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Underwater calls of the Ross seal (*Ommatophoca rossii*)

Introduction

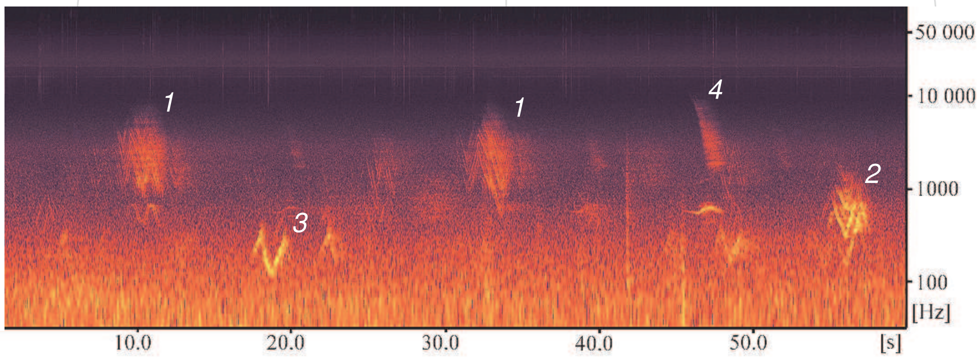
The Southern Ocean is largely unaffected by anthropogenic noise. It, therefore, provides the ideal location for long-term underwater recordings. These are obtained from PALAOA (**P**erenni**AL** **A**coustic **O**bservatory in the **A**ntarctic Ocean) located at Atka Bay, eastern Weddell Sea. Passive acoustic observations are a powerful tool to investigate inconspicuous species e.g. the Ross seal (*Ommatophoca rossii*).

The Ross seal exhibits a typical head-up posture when approached

Although Ross seal sightings are scarce around Atka Bay, their distinct siren-like calls[5,7] temporarily dominate the underwater soundscape.

Results

- 4 different call types observed: 3 distinct siren-like calls (High, Mid, Low) & the Whoosh
- Easily distinguishable by min & max frequency
- Acoustic presence of Ross seals at Atka Bay between December and February
- Distinct diurnal calling pattern with peak calling rates around midnight



Spectrogram of a PALAOA sound-file: According to their spectral positions and structure, four Ross seal call types were identified: High siren call, Mid siren call, Low siren call, & the Whoosh components.

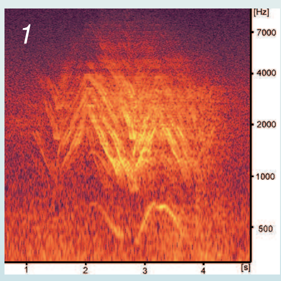
Discussion

For the first time, Ross seal underwater vocalizations are characterized in detail.

The results of this study provide the basis for further investigations on geographic variation within Ross seal vocalizations.

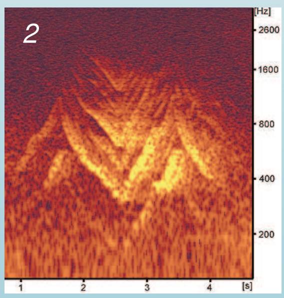
The acoustic presence of Ross seals in Atka Bay between December and February matches recent findings on the migratory behavior of the animals derived from satellite tags[3]. An increase in calling rate in mid January is probably caused by the arrival of seals[4], that were pelagic before. The striking drop at the end of January might correspond with the migration of most Ross seals northwards[3].

The nocturnal peaks in calling rates have also been found in other Antarctic seal species[4,6].



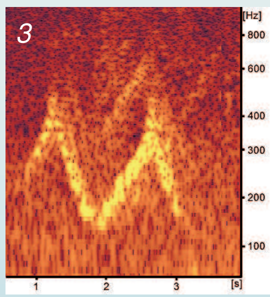
High siren call

Alternating up- (/) & downsweeps (\)
Approx. same distribution for start with / & \
Mostly subtypes /\/\ (36%), \/\/\ (34%), & \/\/\/ (14%)
Sweep rates: UP………3.02 oct s^{-1} (±0.59)
DOWN….2.12 oct s^{-1} (±0.41)
Min frequency:……..592.18 Hz (±145.47)
Max frequency:…….7129.38 Hz (±1803.55)
Duration:………………..3.37 sec (±0.68)
4-10 strong harmonics at relatively constant rate
40% of calls with attached Bowl component



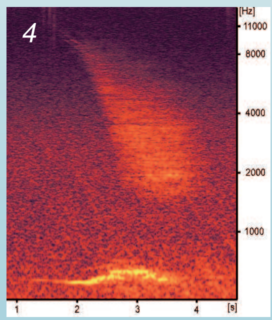
Mid siren call

Alternating up- (/) & downsweeps (\)
Almost all calls start with /
Mostly subtypes /\/\ (82%), /\/\/\ (8%), & /\/ (6%)
Sweep rates: UP………2.40 oct s^{-1} (±0.42)
DOWN….2.29 oct s^{-1} (±1.06)
Min frequency:………168.42 Hz (±35.45)
Max frequency:…….2010.38 Hz (±596.62)
Duration:………………..3.29 sec (±0.42)
4-9 strong harmonics at relatively constant rate
98% with distinct edges at upsweeps



Low siren call

Alternating up- (/) & downsweeps (\)
All calls start with /
Mostly subtypes /\/\ (68%), /\ (18%), & /\/ (12%)
Sweep rates: UP……..2.13 oct s^{-1} (±0.33)
DOWN….2.89 oct s^{-1} (±0.43)
Min frequency:…….132.54 Hz (±21.69)
Max frequency:……449.14 Hz (±60.85)
Duration:………………2.00 sec (±0.46)
Mostly only 1 harmonic visible

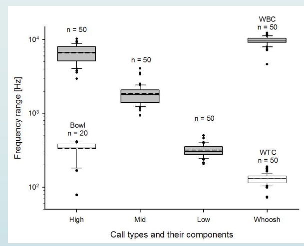


Whoosh

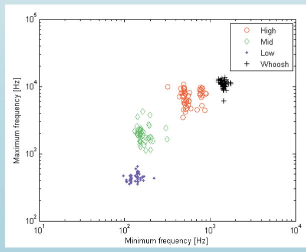
1) Whoosh broadband component (WBC)
Diffuse downsweep at relatively constant rate
Max frequency:…..10 996.54 Hz (±1305.36)
Min frequency:……..1439.26 Hz (±104.70)
Duration:…………………2.51 sec (±0.30)

2) Whoosh tonal component (WTC)
Single tonal sound ascending & descending at the end
Sweep rate:………………………0.60 oct s^{-1} (±0.17)
Min frequency:………………..574.18 Hz (±11.42)
Max frequency:.....................591.50 Hz (±47.31)
Duration:……………………….......2.33 sec (±0.44)
GAP between WBC & WTC:...883.18 Hz (±91.81)
Always associated with WBC

Call discrimination

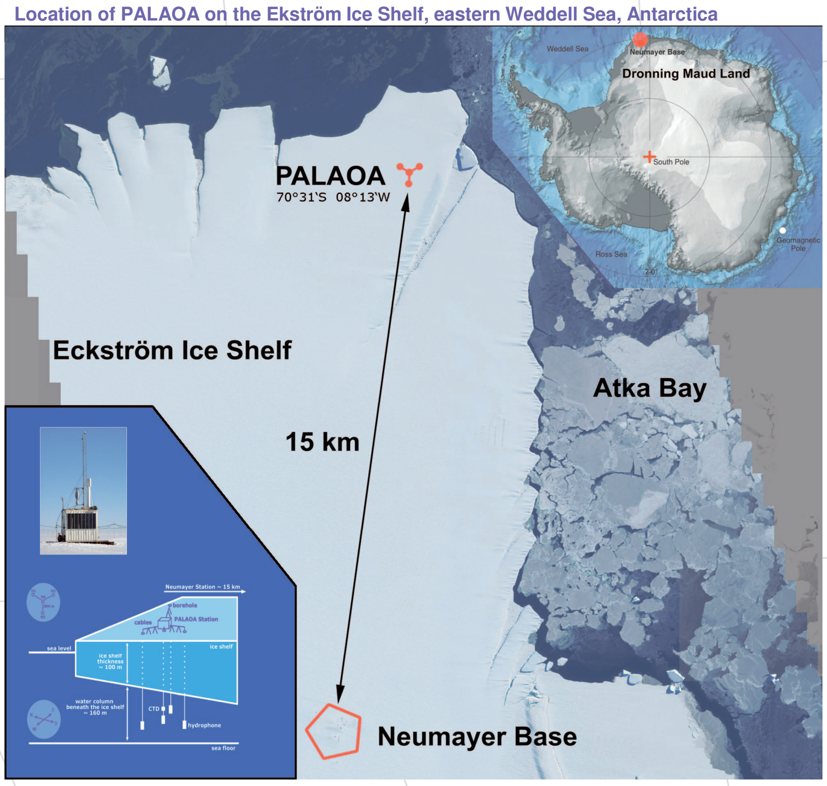


Boxplots of the frequency range (in Hz) of all four Ross seal call types show their relative spectral position among each other, which led to their initial differentiation.



Cluster analysis of min frequency (x-axis) plotted against max frequency (y-axis) precisely separates the four call types (here shown in different colours).

Location of PALAOA on the Ekström Ice Shelf, eastern Weddell Sea, Antarctica



The autonomous recording station consists of an array of four hydrophones (300m apart) deployed through the ice shelf (~170m depth). The ice edge is at a distance of 1-3km.

Materials & Methods

PerenniAL Acoustic Observatory in the Antarctic Ocean (PALAOA):

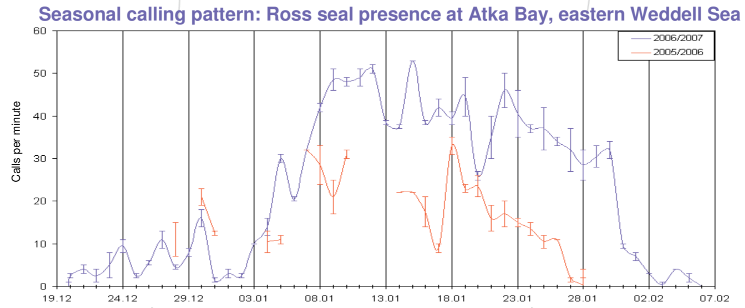
- located at 70.5°S, 8.2°E on the Ekström Ice Shelf at the eastern Weddell Sea
- in operation since December 2005
- designed for perennial, autonomous operation
- broad-band (15 Hz - 96 kHz), and high resolution (up to 24 bit) recordings
- real-time data access via satellite transmission
- multiple hydrophones deployed through ice shelf

Call measurements:

- visual and aural analysis using Adobe Audition 2.0
- 50 samples of each call type characterized in detail
- ~14.000 calls counted for diurnal call rate
- ~3.000 calls counted for seasonal call rate

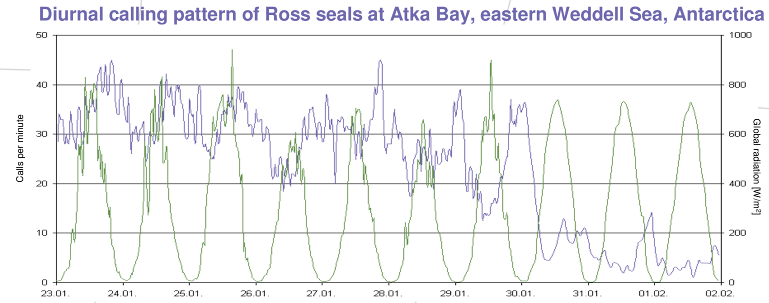
Calling patterns

Seasonal calling pattern: Ross seal presence at Atka Bay, eastern Weddell Sea



Number of calls per minute (y-axis) over the whole period (x-axis) when Ross seals vocalize in the vicinity of PALAOA recordings (red line in 2005/6, blue in 2006/7). The seals arrive in mid December and leave the area in the beginning of February.

Diurnal calling pattern of Ross seals at Atka Bay, eastern Weddell Sea, Antarctica



Number of calls per minute (blue line) between 23 Jan-1 Feb, 2007) are negatively correlated with daylight (global radiation in W/m^2, green line). Diurnal calling peaks occur around midnight (r = -0.18, $p < 0.005$).

References
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