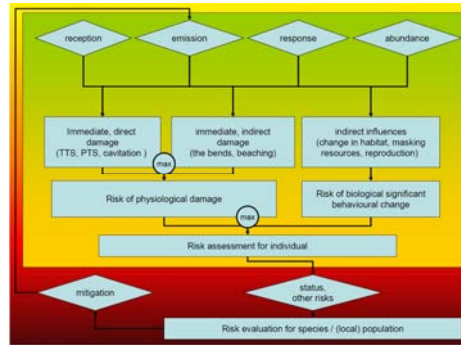


# Antarctic marine mammals and ocean acoustics

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Marine mammals rely on sound and hearing as their primary means of communication and sensing their world. Concerns that anthropogenic sound in the ocean could infer their sensing, cause stress or even damage their hearing physically rose a controversial discussion and triggered a worldwide boost in marine bioacoustic research. Innovative acoustic technologies and field methods are required to provide a basis for carefully designed and technically challenging research projects on free-ranging marine mammals, especially under the harsh environmental conditions of polar regions.



**Risk assessments** imply a comprehensive scientific approach, involve multidisciplinary research, and require corresponding data to be gathered in various field projects.

The *Ocean Acoustics* group within the *Marine Observing Systems* section endeavors multidisciplinary research of environmental scientists, geophysicists, oceanographers, physicists, physiologists, and biologists to investigate the need and scope of mitigation measures for the effects of man-generated sound in the ocean, develop acoustic census techniques, explore marine mammal responses to various anthropogenic sounds, and study the vocal behaviour and hearing physiology of Antarctic marine mammals.

## Scientific objectives

### Anthropogenic sound in the ocean

In order to quantify the intensity of various anthropogenic sounds and to analyze the respective risks to marine mammals, emission characteristics of the hydro-acoustic systems of RV Polarstern were quantified by means of models and in-situ measurements. The results are compiled in risk assessments and will be related to the natural underwater soundscape.

### Mitigation measures

To investigate the need and scope of mitigation measures, Marine Mammal Automated Perimeter Surveillance (MAPS) concentrates on the real time detection of marine mammals in the vicinity of a vessel by infrared imaging and passive acoustic systems, alerting the ship's nautical officer to the potential presence of marine mammals.

### Acoustic census techniques

Knowledge about the distribution and abundance of marine mammals in the Antarctic Ocean is patchy. Species specific vocalizations of marine mammals are registered by the Perennial Acoustic Observatory in the Antarctic Ocean (PALAOA) at Neumayer Station, the MAPS system onboard RV Polarstern, and the mobile DIPS acoustic station to infer the approximate number and migratory tracks of seals and whales inside the measuring range of the respective instruments contributing to distribution maps.

### Marine mammal response to anthropogenic sound

PALAOA and DIPS allow to study the acoustic behaviour of marine mammals and to observe the influence of occasional ship traffic near Neumayer Station in an otherwise undisturbed environment. MAPS can detect responses of animals to RV Polarstern by-passes.

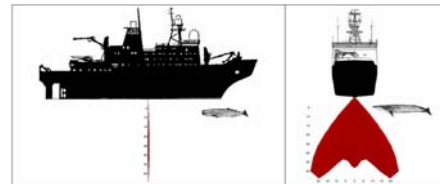
### Bioacoustics

Marine mammals use sound for communication, navigation and prey detection. The recordings obtained by PALAOA, MAPS and DIPS provide a rich database for bioacoustic studies, focusing on geographical and temporal variations in animal behaviour.

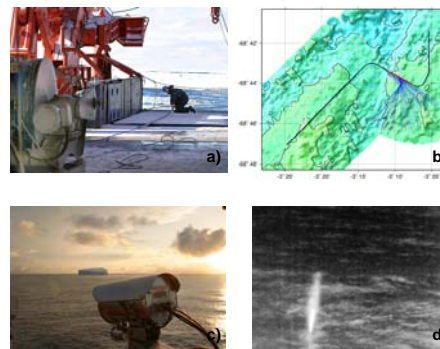
### Hearing physiology

For about 90% of marine mammal species including Antarctic seals, the fundamental hearing abilities have not yet been determined. Physiological studies focus on field measurements of audiograms of Antarctic seals to determine the frequencies and sound levels audible to them.

## Field projects



**Acoustic gauging of RV Polarstern** evaluates the hydro acoustic emission characteristics of the ship including echo sounders and air guns. Figure: Outline of the 203.2-dB contour of Hydrosweep echosounder beam pulses, a sound pressure level at which temporary threshold shift (TTS) is likely for whales.



**MAPS** (Marine Mammal Automated Perimeter Surveillance). Under water, vocalizing mammals can be detected by a passive acoustic streamer (a). Close to the surface, infrared cameras (c) can recognize whales by their warm blow, which stands out against the cold Antarctic environment. Signal and image processing methods are developed to automatically and reliably detect the presence of animals under varying environmental conditions. Figures: Acoustically tracked sperm whale, projected on a bathymetric map (b) and the image of a humpback whale spout (d) taken by an infrared camera in 2005.



**PALAOA**, the Perennial Acoustic Observatory in the Antarctic Ocean. A hydrophone array deployed through the 100 m thick Ekström Ice Shelf continuously monitors the underwater soundscape in front of Neumayer Station since January 2006. Recordings contain various marine mammal vocalizations as well as the permanent natural sound background, dominated by the motion of ice.



**DIPS**, Drescher Inlet Pilot Study. A mobile acoustic station in a cabin sledge was set up at the Drescher Inlet, Riiser Larsen Ice Shelf in 2003/04. Three hydrophones, lowered 100 m down through sea ice holes drilled in a 100 m baseline triangle obtained two weeks of underwater recordings, dominated by the local Weddell seal population and Polarstern passings.



**AEP** Auditory Evoked Potential measurements were performed on Weddell seals at Atka Bay in December 2005 to obtain basic audiograms. This neuro-physiological technique measures the brain's bioelectric responses to a given acoustic stimulus and allows to determine the audible frequency range and corresponding hearing thresholds of free ranging animals. Furthermore critical sound levels can be estimated from temporary threshold shift (TTS) measurements.