

WASHINGTON SEA GRANT

PROJECT COMPLETION SUMMARY REPORT

WSG Project Number: **R/Ac-15**

Project Title: Puget Sound Ambient Noise and its Relation to the Ecology of Marine Mammals

Principal Investigator(s) and Affiliation:
 Peter Hans Dahl, Univeristy of Washington, Applied Physics Laboratory

Project duration: 11/1/2006 – 9/30/08

PROJECT COMPLETION SUMMARY REPORT

The ambient noise environment in Puget Sound has changed over the past 150 years owing to anthropogenic noise contributions following population growth and industrial activity. Southern resident killer whales (SRKW) are now listed under the Endangered Species Act (ESA), and it is broadly accepted by the scientific and wildlife management community that SRKW habitat is compromised in three ways: (1) reduced fish prey stalks, (2) water quality issues (e.g., PCBs), and (3) changes in the underwater sound environment owing to anthropogenic noise contributions.

The goal of this project was to conduct a pilot study of the ambient noise environment at a site north of Smith Island and south of Lopez Island, in northern Puget Sound. The site (depth 100 m) represents important SRKW habitat (identified as marine sanctuary), and key auxiliary data on the environment and shipping activity were also available. The study, completed August 6-9th, 2007, was conducted with in-kind support from the Washington Department of Fish and Wildlife (WDFW), and partial funding support was also made available from University of Washington Applied Physics Laboratory.

A long-term, or so-called “longitudinal”, study of ambient noise within this region would be desirable to examine changes over time. However such a study was not feasible within the budgetary and time constraints of this WSG project. Instead, our study was more “cross-sectional”, taking place over a very short span of time but involving the measurement of several features of ambient noise at once and requiring multiple instruments. These features included: (1) contributions of air borne noise to underwater noise, (2) contributions vessel noise and naturally-occurring sources such as sea surface noise, and (3) the directional properties of underwater noise.

The following key results emerge from our study:

(1) The ambient noise pressure spectral density undergo temporary increases over the measurement period from a consistent low level background, referred to as the permanent noise level. The ambient noise pressure spectral density describes how ambient noise varies with frequency in an averaged sense.

(2) The directional properties of the ambient noise, i.e, from what the direction (in the vertical plane) does the noise primarily originate from, varies with frequency. At lower frequency (less than about 1000 Hz) the noise tends to come from a more horizontal direction and thus is associated with distant vessel and shipping traffic. At higher frequencies (greater than about 20000 Hz) the noise tends to come from the sea surface. In the middle frequency range (1000-20000 Hz) the directional properties represent a combination of these two. The basic directional properties of ambient are important if one is to fully understand how SRKW interact with their underwater acoustic environment.

(3) The main sources of noise involve vessel traffic and wind speed related noise associated with sea surface agitation. Additionally, there is some evidence that the ambient noise is influenced by aircraft over flights. This evidence comes in the form of the Doppler shift from over-flying aircraft.

In terms of the first result, the ambient noise environment of the Puget Sound is a dynamic process, a mixture of natural sea-surface noise, local boat traffic and intermittent shipping. It is impossible to characterize it by one estimate; however over the course of 4 days, a more consistent noise “floor” was observed and this is the permanent noise sound pressure level. It is important to document the permanent noise and determine whether or not it changes over long time scales. This brief pilot study successfully demonstrates the ability to estimate a permanent noise level and to assess the influence of changes in the ambient noise environment. This is of particular importance to assessing the health of marine mammals and to help develop better means of protecting them. Departures from the permanent noise levels correspond to a change in the angular distribution of noise, which in general corresponds to an angular distribution developing a significant component of horizontal noise. The mechanisms causing these increased levels are most likely anthropogenic sources. The major anthropogenic sources in Puget Sound are large ships and local boat traffic.

Airplane flyovers can also contribute but an exact quantification of this source to the overall noise budget is not possible with this limited data set. An assessment of the data shows that airplane flyovers play a role in the ambient noise environment, at times elevating the noise levels above the permanent noise levels. Further study of longer duration will allow for a development of statistical measures of these events that can be used for an impact assessment of anthropogenic noise sources.