Apr 6th, 11:15 AM - 11:30 AM

Characterizing underwater radiated noise from Pacific Whale Watch Association vessels

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Salish Sea Conference
Seattle, 6 March 2018

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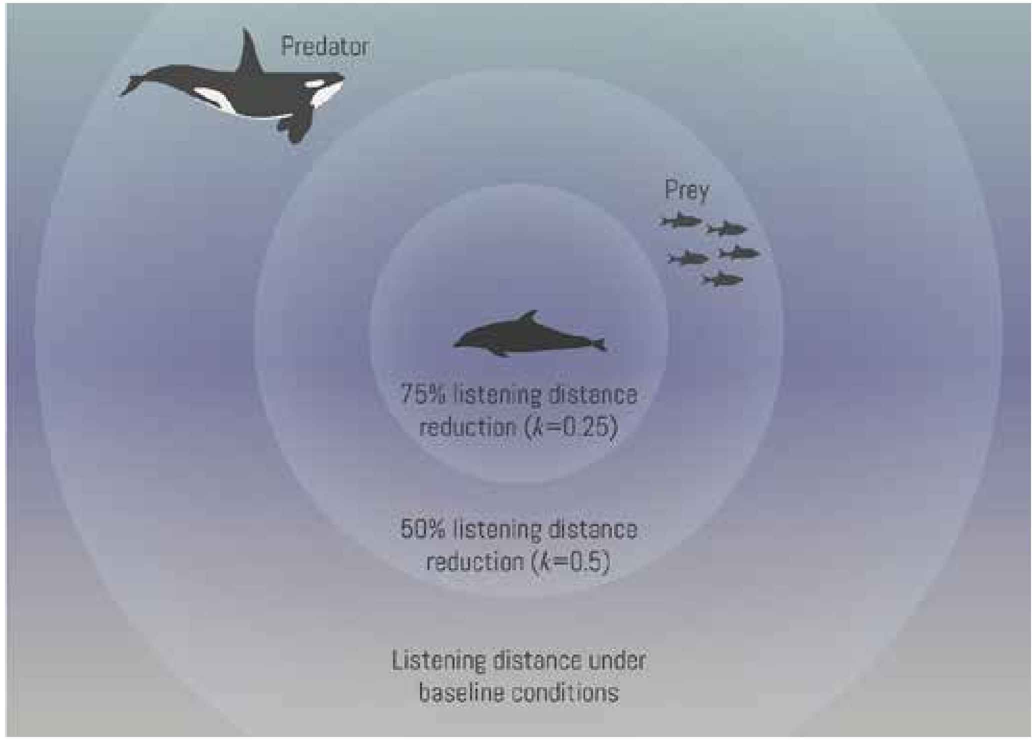
Overview

- Context: why do we need measurements of noise emission of small vessels?
- Experimental approach and locations
- Vessel types measured
- Comparison of noise emissions by small vessel type
- Variation of noise emissions with speed
- Relevance of noise measurement results to whale watch companies
- Proposed plans by PWWA to reduce noise exposures to animals

Context: why do we need to understand the noise emissions of whale watch vessels?

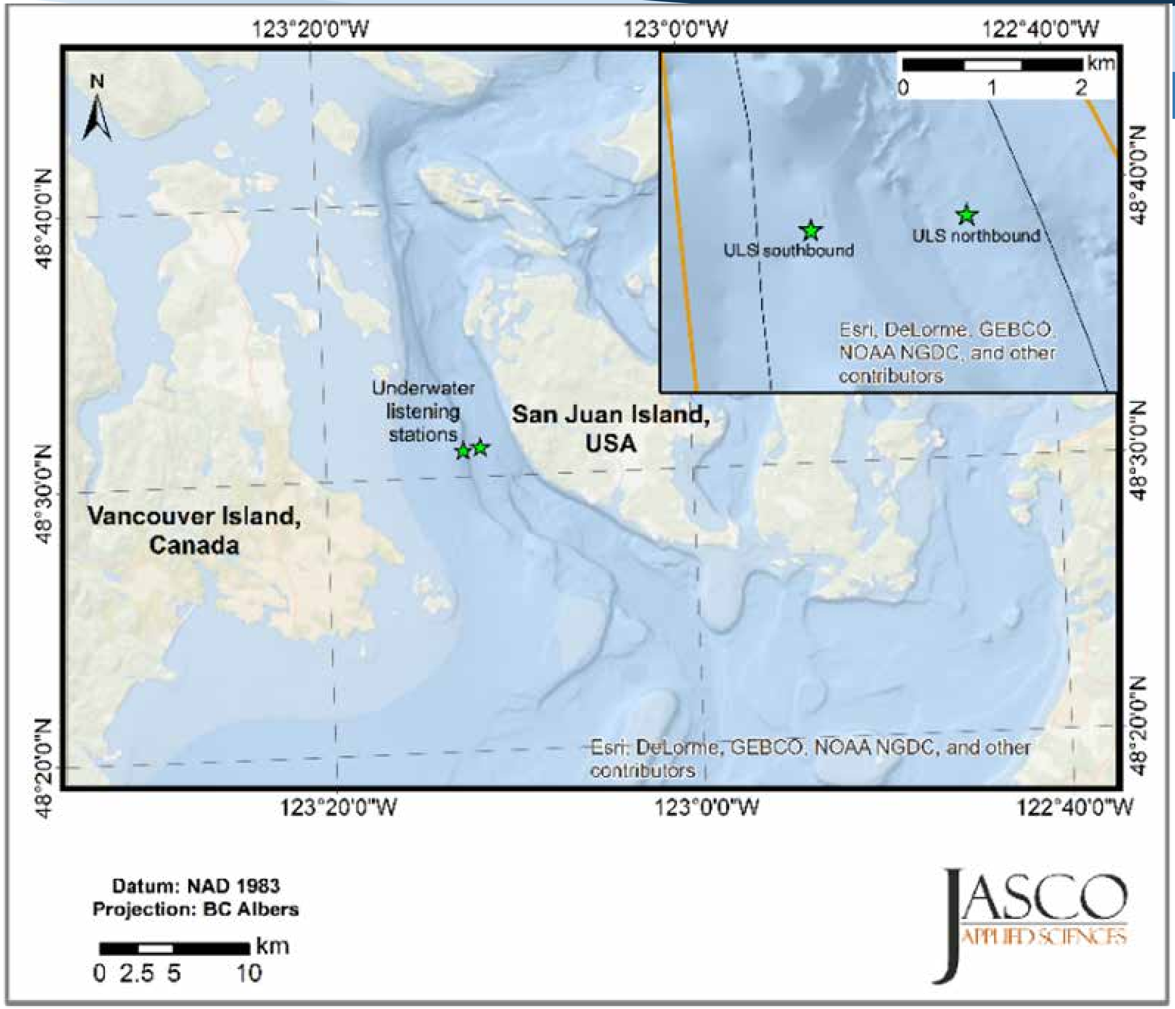
- Underwater Noise has been identified as an important stressor to marine fauna, including endangered Southern Resident Killer Whales (SRKW)
- Assessments of noise effects require understanding the exposures levels produced by vessels
- While whale watch vessels produce much less noise than large commercial vessels, they spend a greater time in vicinity of marine fauna, particularly whales
- Whale Watch companies need to understand the characteristics of their vessels' emissions to be able to operate in ways that reduce whale exposures



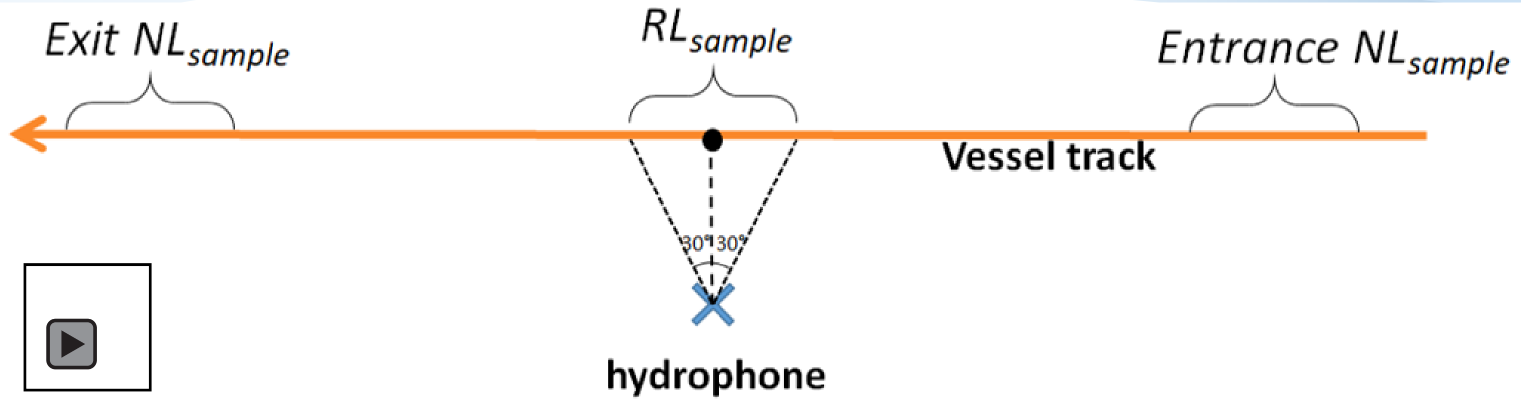
Acoustic Recorders and Locations

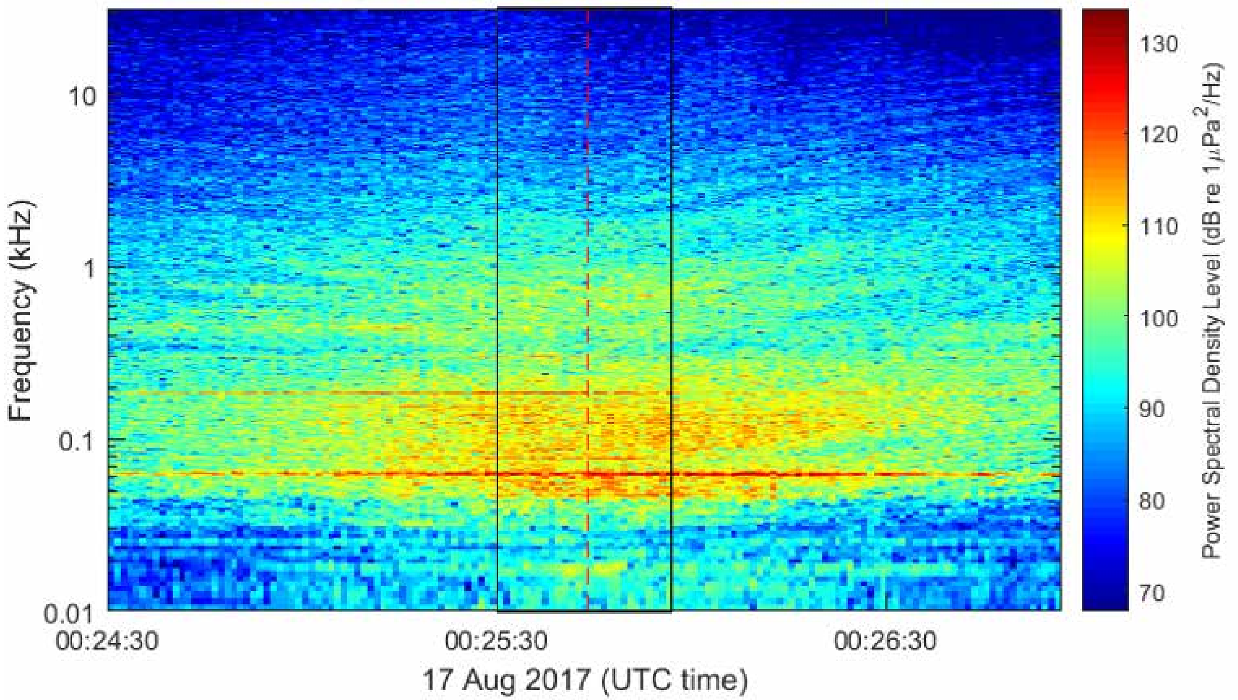
- Two calibrated AMAR recorders were deployed in Haro Strait from July to October 2018
- Water depths 250 m and 210 m
- Sample rate set to 128 kHz to capture acoustic frequencies up to 64 kHz

Photo credit: Krista Trounce, VFPA



Systematic Measurement Approach: ANSI S12.64





AMERICAN NATIONAL STANDARD

Quantities and Procedures for Description and Measurement of Underwater Sound from Ships - Part 1: General Requirements

Secretariat:

Acoustical Society of America

Approved September 30, 2009 by:

American National Standards Institute, Inc.

Abstract

This standard describes the measurement systems, procedures, and methodologies used for the beam aspect measurement of underwater sound pressure levels from ships for a given operating condition. The resulting quantities are reported as nominal source level values in one-third octave bands. It does not require the use of a specific ocean location, but the requirements for an ocean test site are provided. The underwater sound pressure level measurements are performed in the far-field and then corrected to a reference distance of 1 m. This standard is applicable to any and all surface vessels either manned or unmanned. This standard is not applicable to submerged vessels or to aircraft. Measurement systems are described for measurement of underwater sound pressure levels and also the distance or range between the underwater transducers and the subject vessel. Processing and reporting of the data are described, and informational guidance is provided. This standard does not specify or provide guidance on underwater noise criteria.

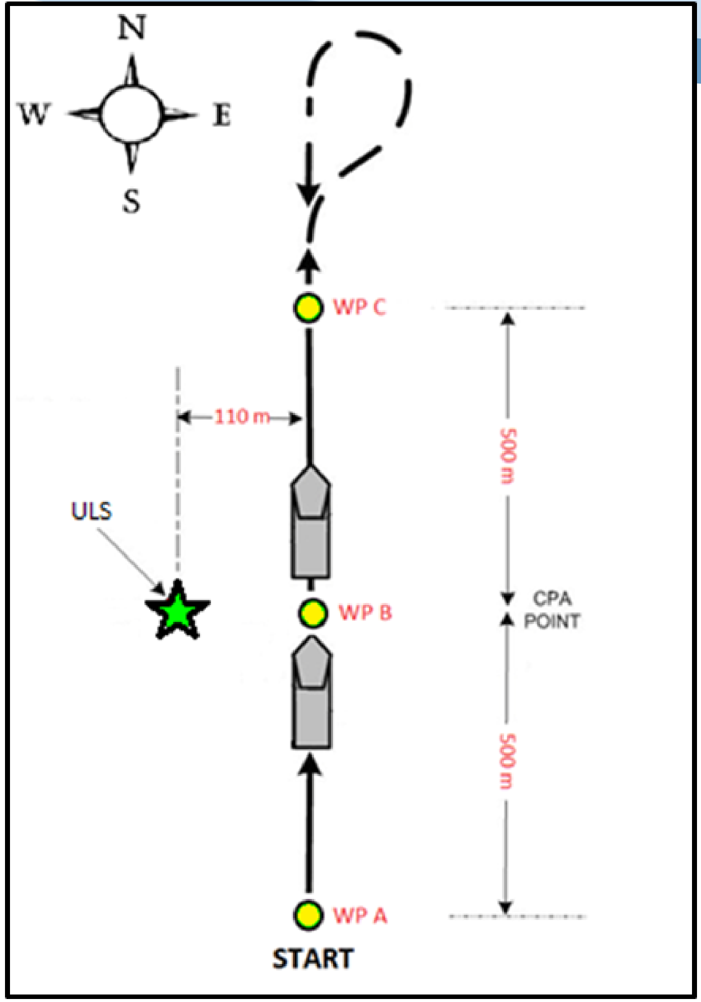
20 Vessels Measured

Vessel ID	Length (m)	Vessel type	Engine	Propulsion	Number of accepted measurements
V01	15.5	monohull	2 x 625 HP inboard diesel	Arneson*	8
V02	17.4	catamaran	2 x 435 HP inboard diesel	propeller	9
V03	11.5	catamaran	2 x 300 HP outboard (4-stroke) gas	propeller	8
V04	11.5	monohull	2 x 250 HP + 1 x 300 HP outboard (4-stroke) gas	propeller	9
V05	11.5	monohull	3 x 300 HP outboard (4-stroke) gas	propeller	10
V06	6.8	RHIB	2 x 350 HP V8 outboard (4-stroke) gas	propeller	6
V07	5.2	RHIB	1 x 150 HP outboard (4-stroke) gas	propeller	6
V08	9.4	monohull	1 x 300 HP inboard gas	propeller	6
V09	6.4	landing craft	2 x 90 HP outboard (4-stroke) gas	propeller	5
V10	9	sailboat	1 x 30 HP inboard (4-stroke) gas	propeller	7
V11	12.8	sailboat	1 x 44 HP inboard (4-stroke) diesel	propeller	5
V12	16.8	monohull	1 x 650 HP inboard diesel	propeller	5
V13	8.2	RHIB	2 x 225 HP outboard (4-stroke) gas	propeller	5
V14	17	monohull	2 x 770 HP inboard diesel	propeller	4
V15	9	monohull	1 x 350 HP outboard (4-stroke) gas	propeller	6
V16	7.6	RHIB	2 x 200 HP outboard (2-stroke) gas	propeller	8
V17	17	monohull	2 x 850 HP inboard (4-stroke) diesel	Arneson	6
V18	9.1	monohull	2 x 225 HP outboard (4-stroke) gas	propeller	5
V19	8.2	monohull	2 x 150 HP outboard (4-stroke) gas	propeller	6
V20	8.2	Small outboard	1 x 9.9 HP outboard (4-stroke) gas	propeller	4

- 10 monohull-type vessels

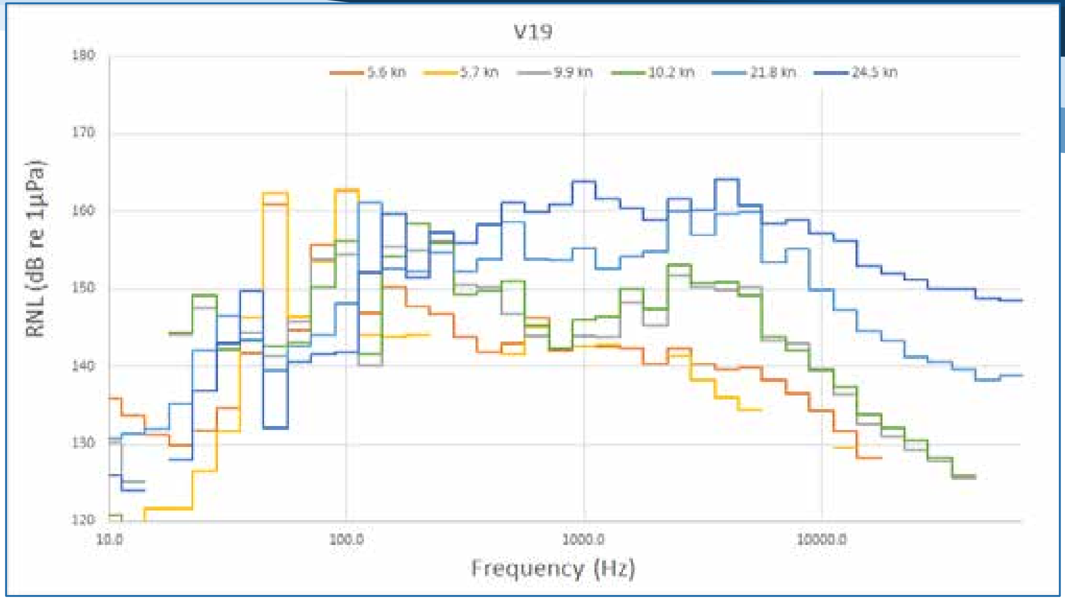
Sail track and speeds measured

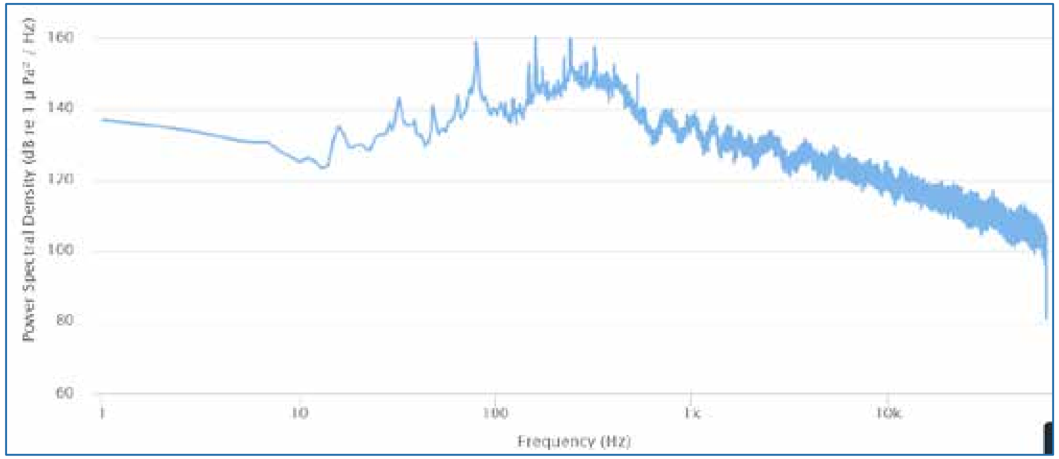
- Each vessel sailed a 1 km measurement track multiple times
- Measurements captured both starboard and port sides of the vessels
- All vessels attempted to sample at least 3 speeds:
  - Whale watch (4-6 knots)
  - Approach (8-10 knots)
  - Transit (15-35 knots)
- Vessel position and speed were tracked with a hand-held GPS on the vessel, sampling each second



Results

- Acoustic and GPS data were processed using JASCO’s ShipSound source level software
- For each vessel pass, the following metrics were calculated:
  - 1/3-octave band RNL
  - 1/3-octave band MSL
  - SPL source level power spectral densities

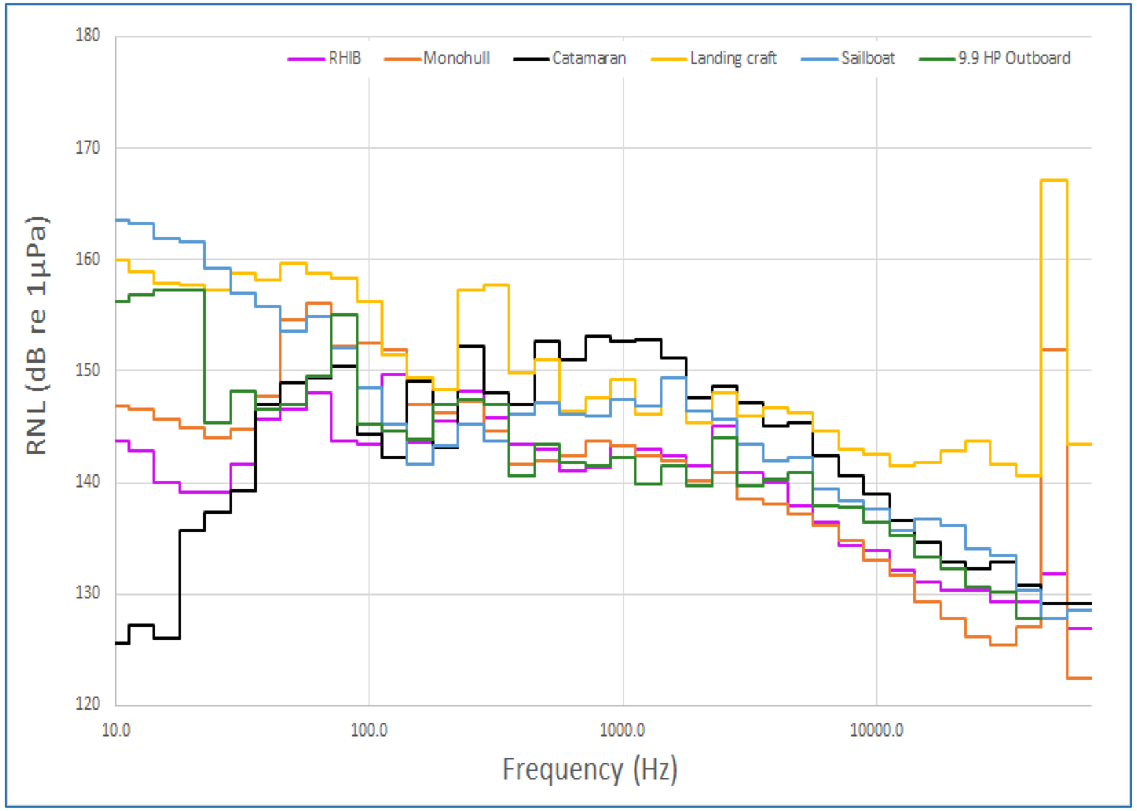




Comparison of Vessel Types

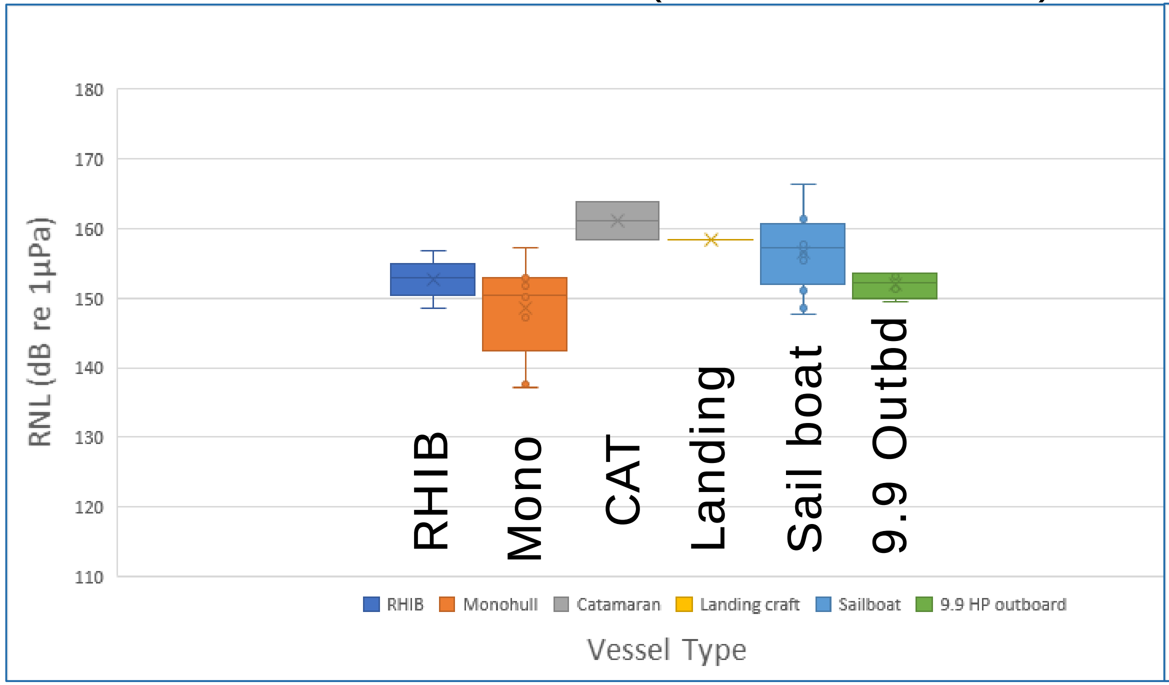
- At slow speeds, the RHIB and Monohull vessels produced lowest noise levels, similar to that of the 9.9 hp outboard
- The catamarans emitted approximately 5-12 dB more noise than the other whale watch vessels classes from 500 Hz to 50 kHz
- The landing craft and two of the monohull whale watch vessels had 50 kHz echosounders turned on

Average band source levels for slow speeds (<7 knots)

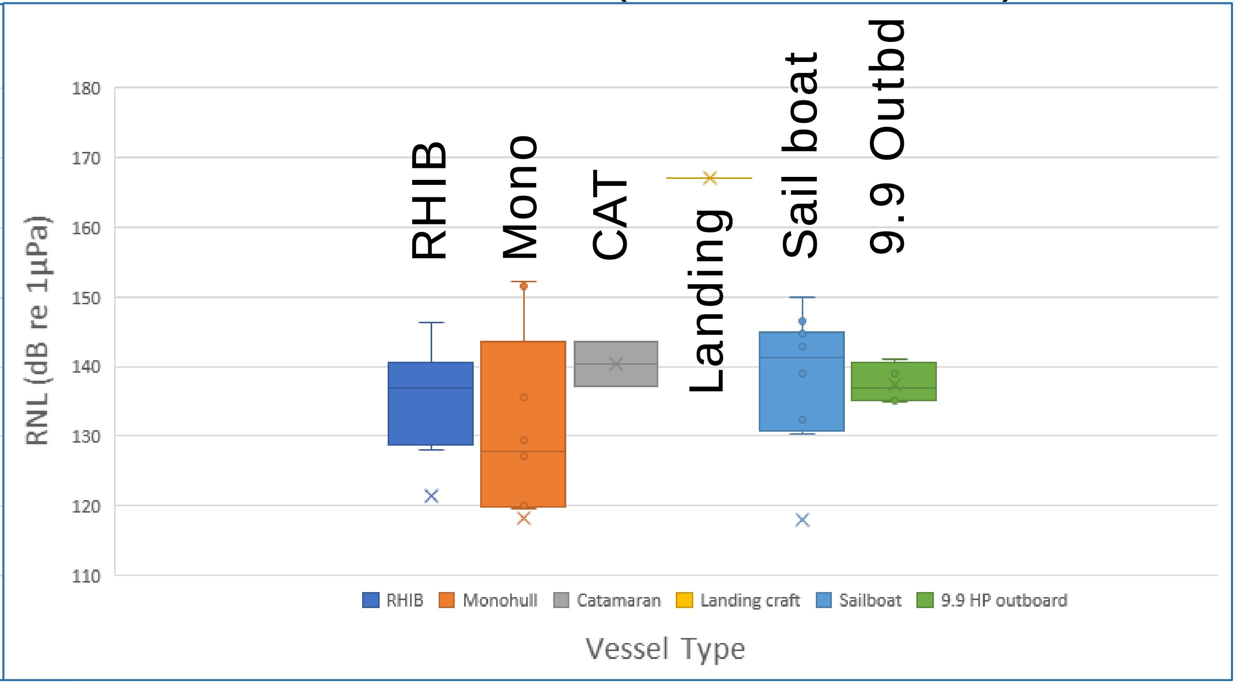


Comparisons of Noise Emissions at slow speed (< 7 knots)

SRKW Communication Band (500 Hz to 15 kHz)



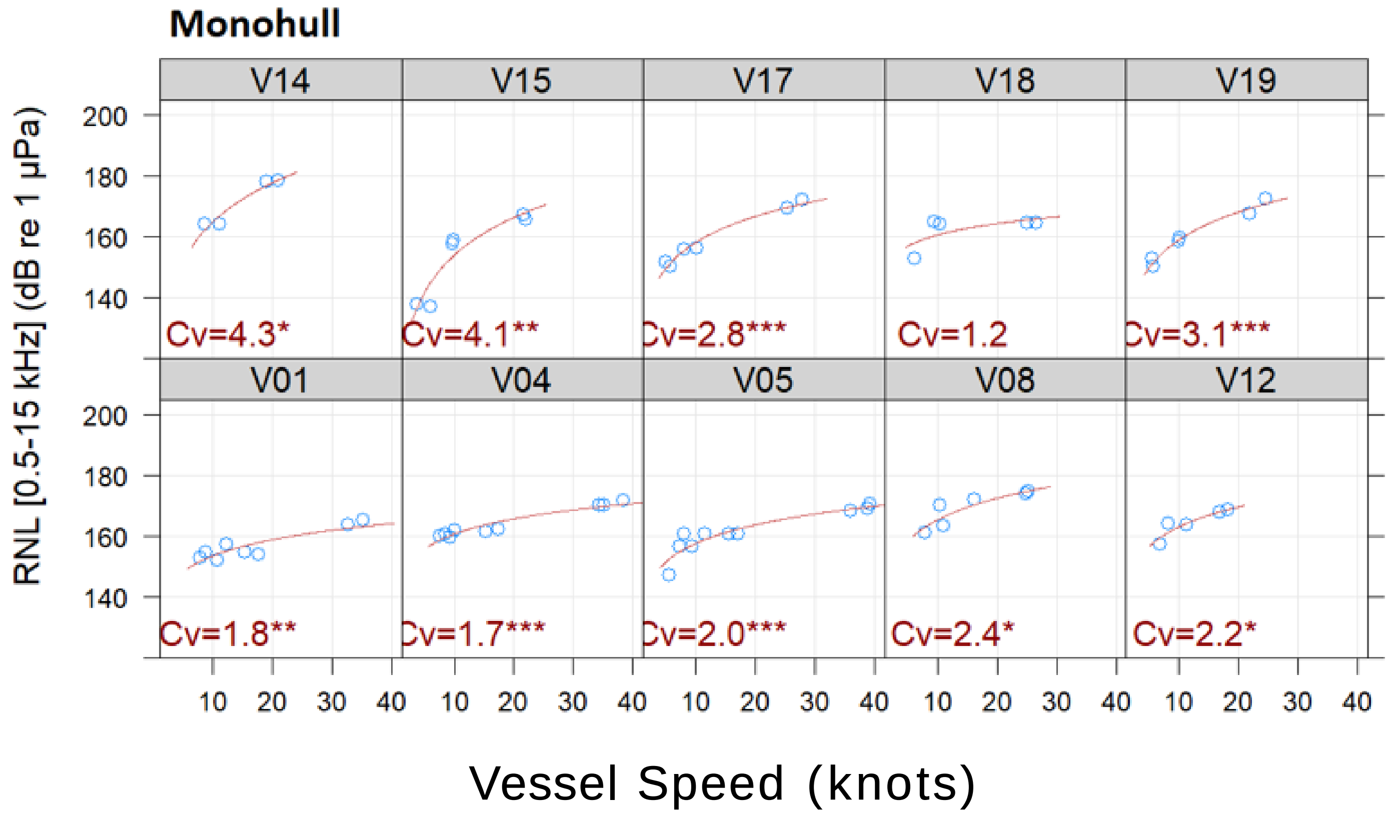
SRKW Echolocation Band (15 kHz to 64 kHz)



Noise emissions variations with vessel speed

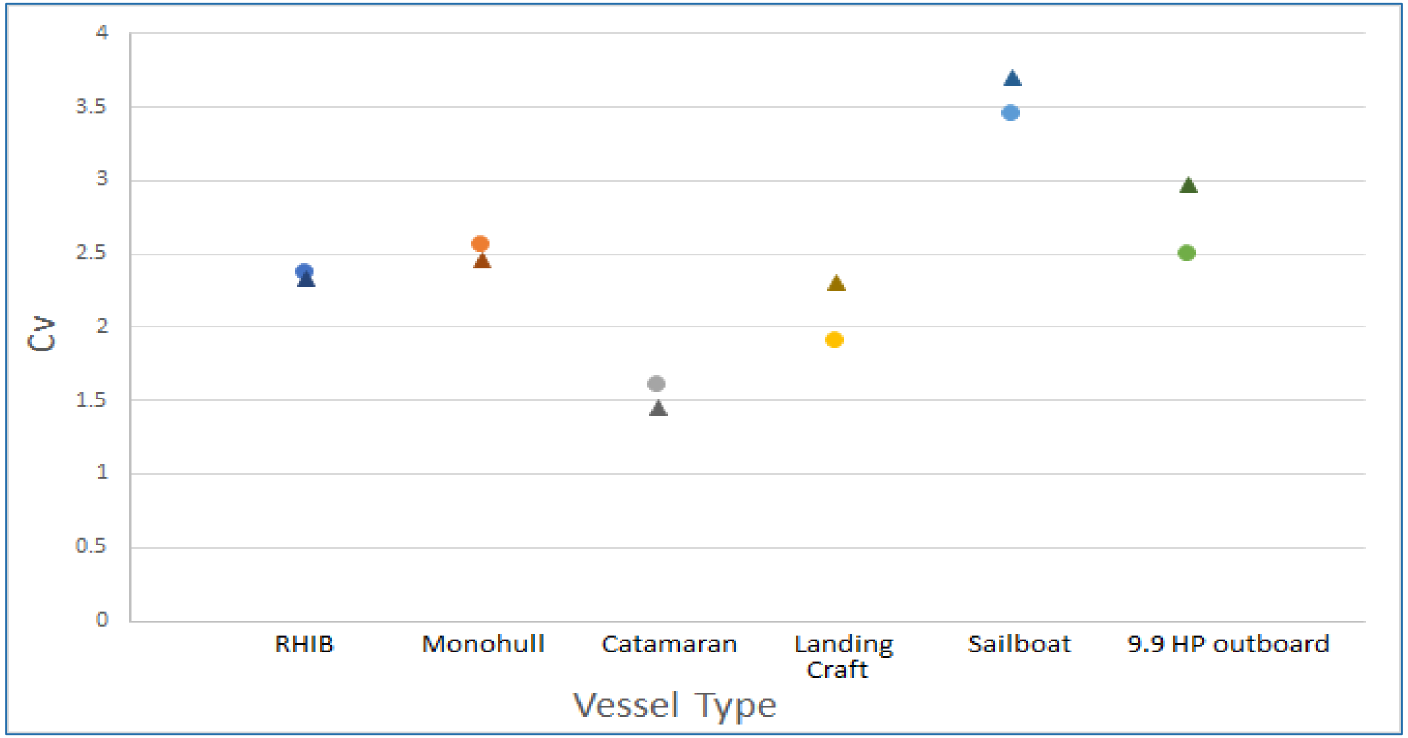
- Speed variation of noise emissions is characterized by the speed parameter Cv

- Change in Noise level = Cv * 10 log(speed2/speed1)



Speed variation by small vessel class

- Speed variations of these small vessel classes appears lower than of larger vessels
- That may be due to shallowing of propeller depth as vessels increase speed
- The two catamarans measured had very low speed dependence



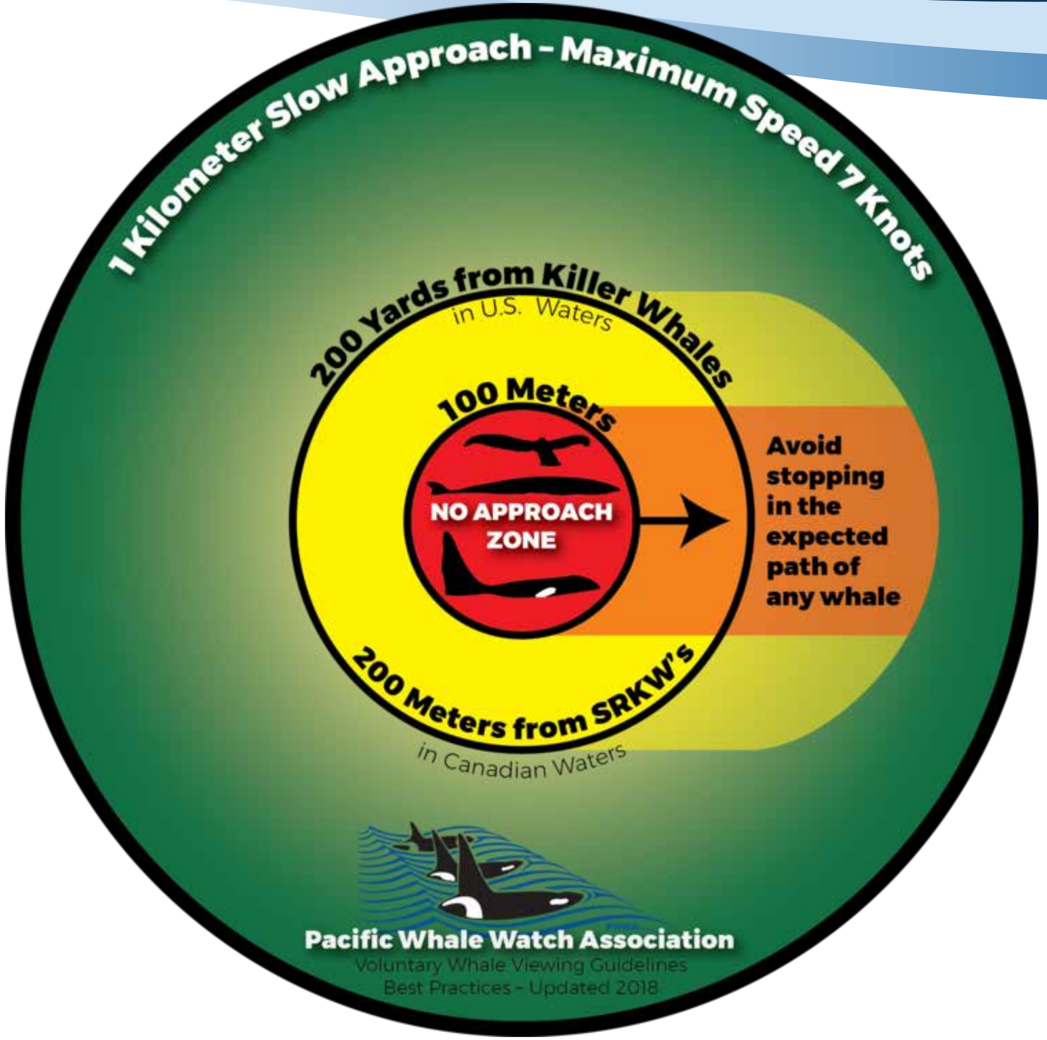
PWWA Draft plan for Staged slow-down on approach

- PWWA is considering a staged slow-down to reduce noise emission levels when approaching killer whales

- Speeds would be reduced to 7 knots at 1 km distance from the animals

- For monohulls, the reduction in noise emission level from 14 knots to 7 knots is 7.2 dB

- A further slowing from 7 knots to 4 knots (whale watch speed) provides another 5.8 dB noise reduction



Summary

- New systematic measurements of underwater noise emission levels of several whale watch vessels have been completed
- The results indicate quite low noise emission levels at low speeds, especially for monohull and RHIB type whale watch vessels
- These vessels also appear to have lower speed dependence than larger commercial class vessels
- The two catamaran vessels had higher noise emission levels than the smaller classes, but they had the smallest speed dependence
- The Pacific Whale Watch Association is using these results to define graduated speed reductions as they approach whales, to manage exposures

Photo credit: Krista Trounce, Port of Vancouver