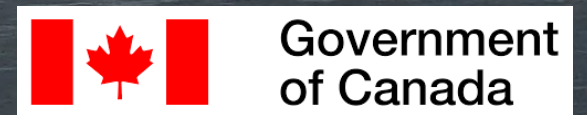


Real-Time hydrophone deployment in Boundary Pass

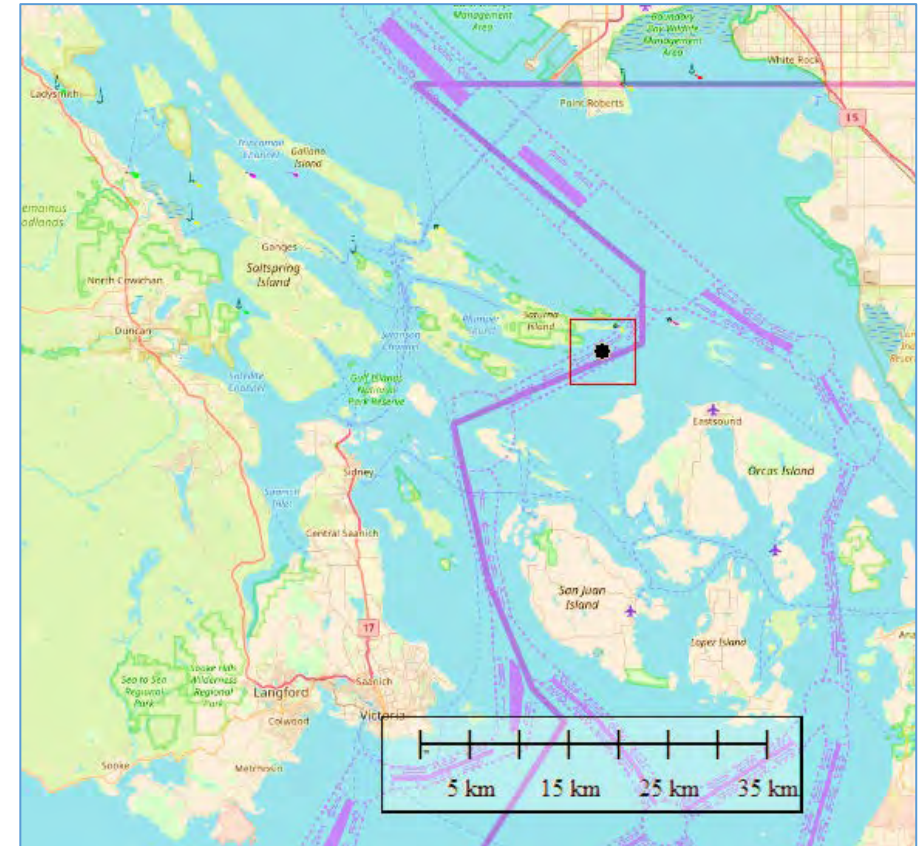


JASCO Applied Sciences
Contact: David.Hannay@Jasco.com



Boundary Pass Underwater Listening Station (ULS)

- Transport Canada system for ship noise measurements and marine mammal detection
- Successfully deployed between the in-bound and out-bound shipping lanes in May 2020
- Two compact tetrahedral hydrophone arrays on the seabed at 190 m water depth, separated by 300 m
- Capable of acoustic vessel and marine mammal tracking through individual array beamforming and cross-fixing
- Cabled to shore at Saturna Island via two 2.8 km fibre optic cables
- Planned operations through March 2023 with 4 year optional extension

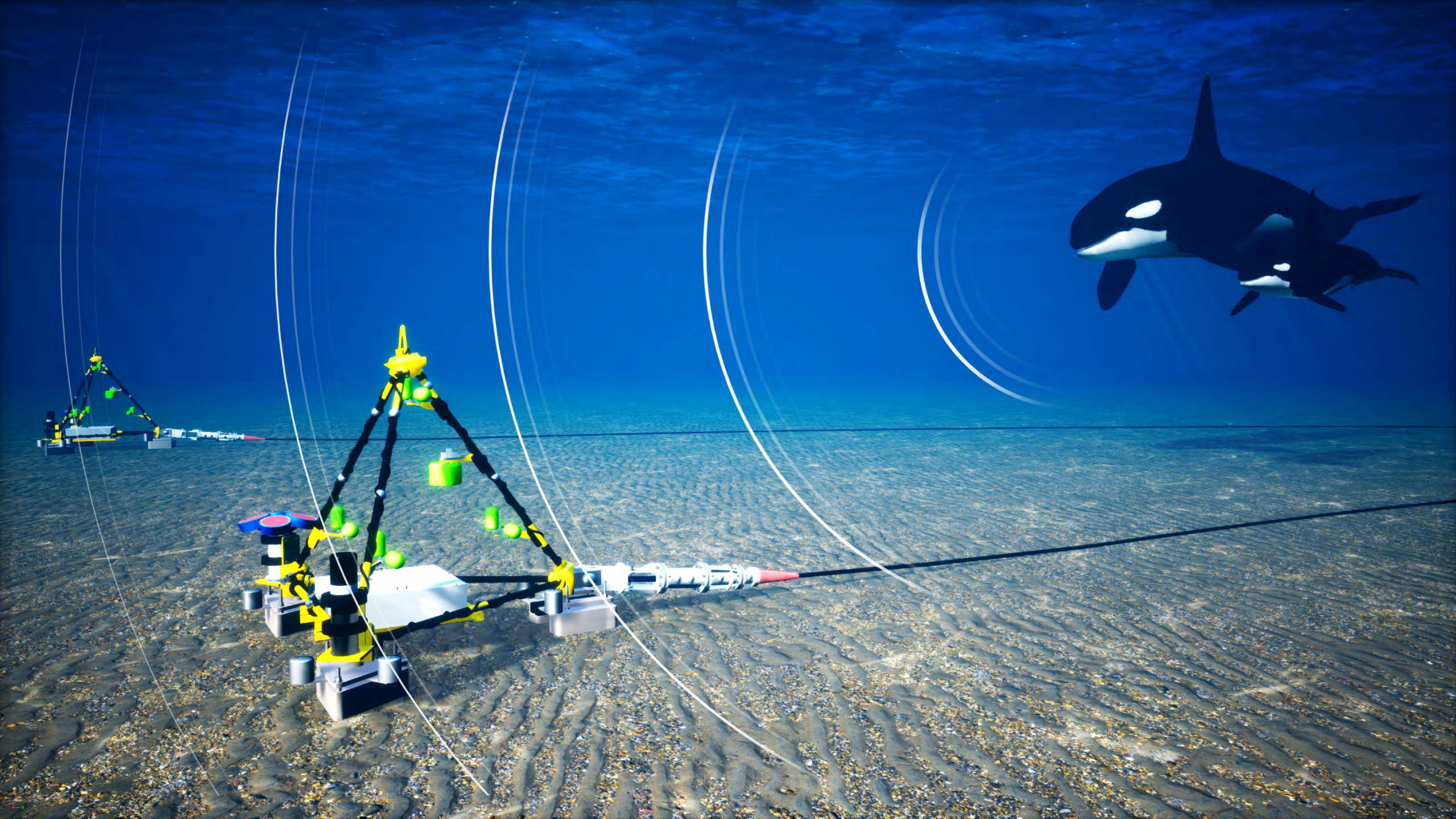


Boundary Pass system technical details

- Each array has four GeoSpectrum M36 hydrophones and four HTI-96 hydrophones. All spaced at 1.65 m.
- JASCO Observer™ data acquisition and processing system (512 kHz sampling all channels simultaneously at 24 bit)
- GeoSpectrum projectors controlled by JASCO AMAR-G4 for daily calibration at multiple frequencies
- Each array also includes CTD, ADCP, video camera and fully-redundant power supplies and acoustic acquisition systems
- All data streamed to Saturna Island data station where they are processed in real-time
- AIS and weather station data are automatically fed into the system database



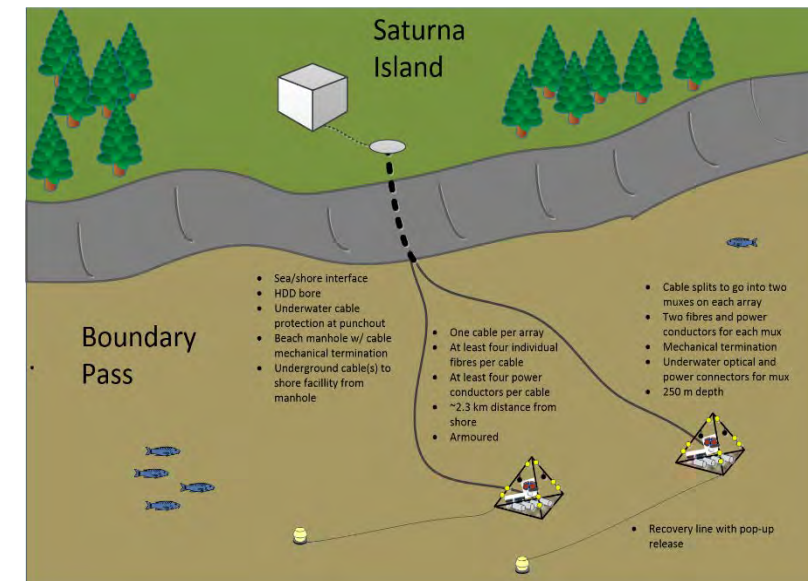




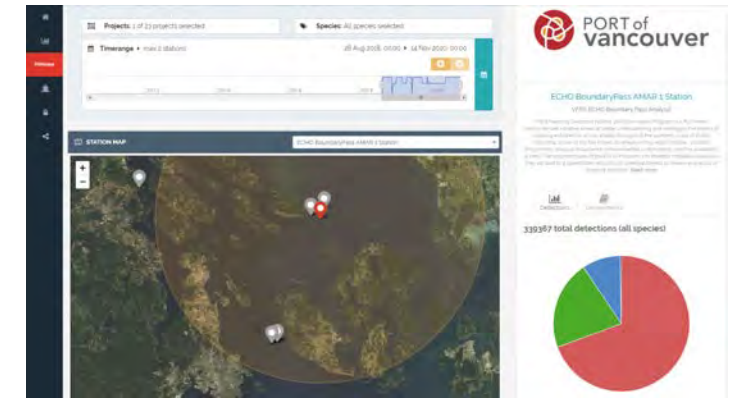
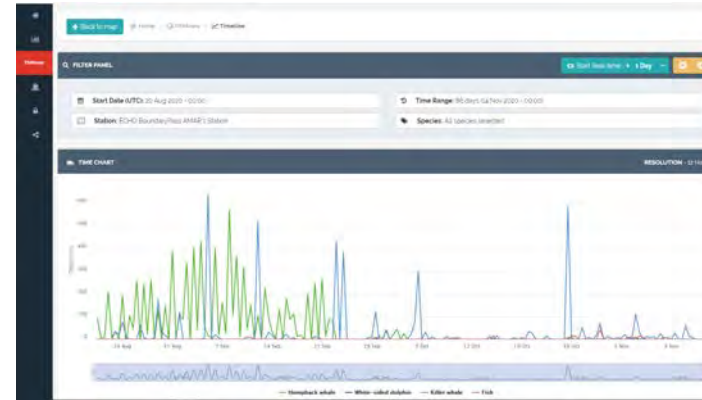
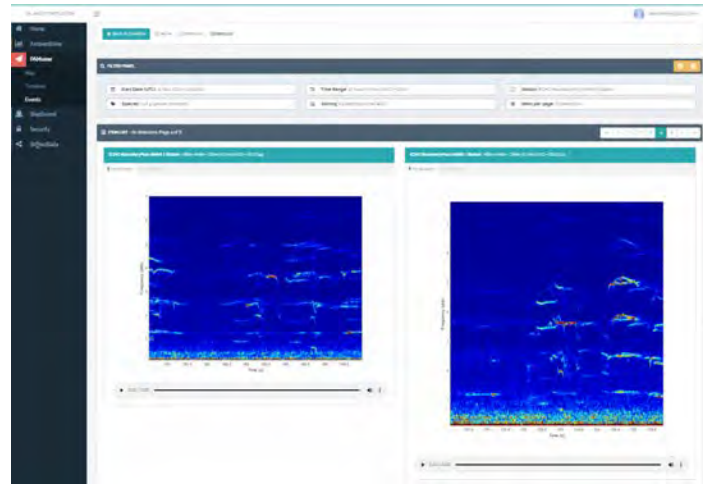


Saturna Island Shore Station

- The cables pass from underwater to land in holes drilled through the bedrock shore
- Cables are terminated in a professional server room with power conditioning and generator backup
- Due to relatively low internet bandwidth to the island, all data processing is done at the shore station



Data Analysis and Reporting



- Managed under a Vancouver Fraser Port Authority ECHO Program Project
- PortListen™ Application for real-time data analysis and web-based presentation

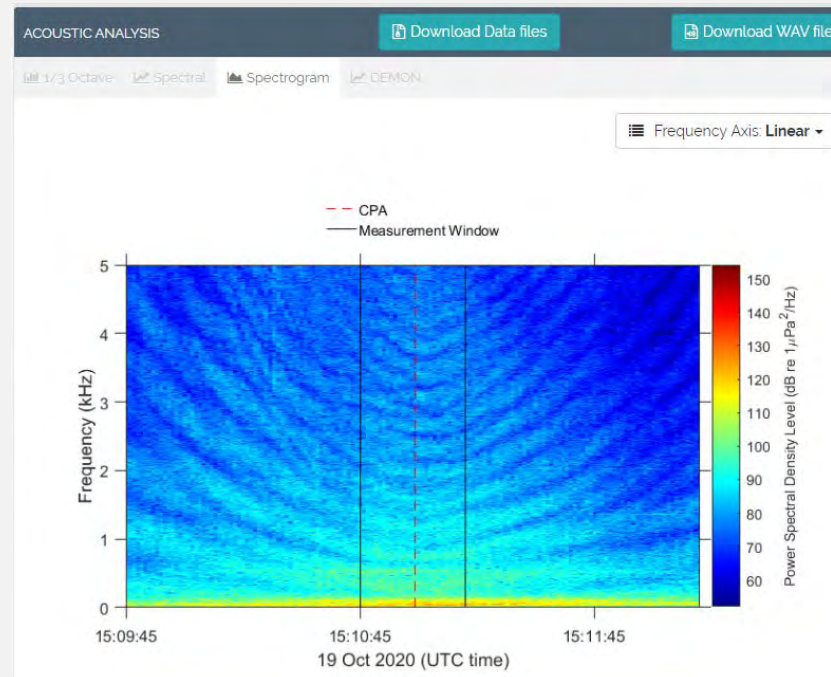
Three primary real-time data products

1. Marine mammal detections/notifications
2. Long-term Ambient Noise Analysis
3. Ship Noise measurements to ANSI S12.64

The screenshot displays the ShipSound software interface. At the top, it shows 'WISDOMACCEPTED!' and navigation options. The main area is divided into several sections:

- Map View:** Shows a satellite-style map with a yellow line indicating the vessel's path.
- Ship Photo:** A photograph of the 'WISDOM LINE' vessel.
- Acoustic Analysis:** A section with 'Download Data files' and 'Download WAV file' buttons, and a 'Frequency Axis: Linear' dropdown menu.
- Route Information Table:**

Measurement	Average	Minimum	Maximum	Range Span	Standard Dev.
Speed (knots)	20	20	20	0	0.0
Heading (degrees)	34	32	36	4	0.9
Classroom (m/s)	86.3	84.4	88.4	2.0	1.0
Turn rate (deg/s)	0.0	0.0	0.0	0.0	0.0
- Navigation Data:** A table with fields like 'Distance at Closest Point of Approach (m)', 'Navigation Status', 'Position Accuracy', 'Speed (knots)', 'Start Date (gmt)', 'Actual Water Depth (m)', 'Speed through Water (kts)', and 'Percent Power On'.
- Acoustic Analysis Graph:** A line graph showing '1/3 Octave - Substituted Noise Level' over 'Frequency (Hz)'. A red vertical line marks a 'Frequency: 710.00 Hz'.



The report is titled 'Vessel Underwater Acoustic Source Level Measurement Report'. It includes the following sections:

- Vessel Information:**

UNIQUE	00000000
RNO	000000
Name	WISDOM LINE
Flag	Paraguay
Vessel DWT (T20)	30000.0
Horizontal Vessel Type	Bulkers
Length (m)	241.0
Beam (m)	39.3
Minimum Draft (m)	14
Engine Power (kW)	7500.0
Number of Shafts	2
Prop Diameter (m)	3.2
- Measurement Information:**

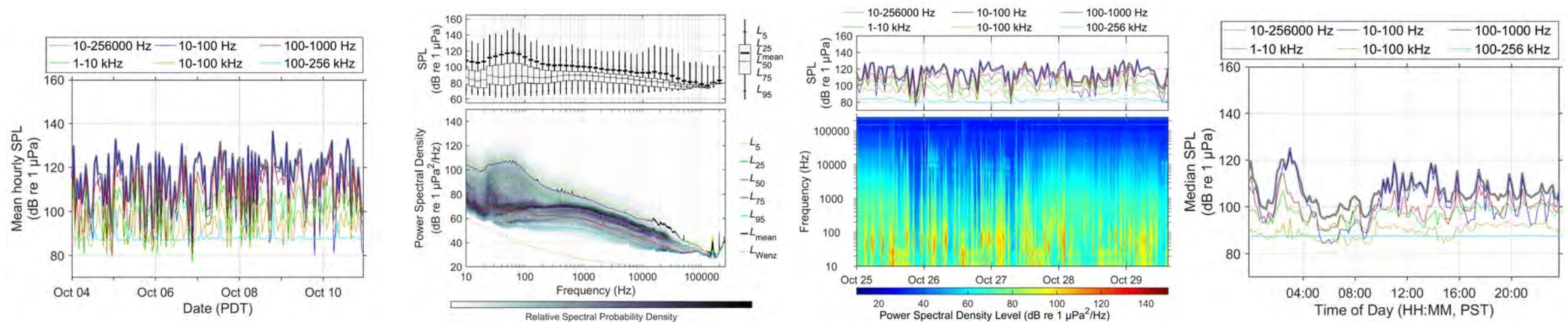
Measurement Date (UTC)	January 01, 2020
Closest Approach Time (UTC)	04:41:38
Closest Approach Distance (m)	33.0
Vessel Closest Speed (kts)	15.1
Full Distance from closest (m)	125.0
Vessel Water Speed (kts)	14.1
Shaft Rate (rpm)	302.0
Vessel Percent Power/Rich	N/A
Actual Vessel Draft (m)	6.3
Monopole Source Depth (m)	2.0
Monopole Source Level (MSL) (dB)	180.0
Radiated Noise Level (RNL) (dB)	147.0
- Graphs:** A line graph showing 'Radiated Noise Level (RNL) (dB)' versus 'Frequency (Hz)'. A color bar below the graph indicates 'Radiated Noise Level Marking within Vessel Class' with a scale from 140 dB (blue) to 160 dB (red).
- Text:** 'This vessel's underwater noise rating is better than 63.8% of other vessels in class. Bulkers, scaled for operating conditions. This rating is based on currently accepted, published scientific criteria and is relative to the measurements of comparable vessels reported by this system. The rating reported for a given vessel can therefore change over time as the statistics evolve and/or new scientifically advanced criteria are introduced. Details of the rating procedure are provided on the attached sheet.'

Ship Noise Analysis System (ShipSound)

- Advanced AI system for automatic ship noise measurements
- Produces ANSI S12.64 measurements (single pass)
- Calculates Radiated Noise Levels (RNL) and monopole source levels (MSL) in decidecade bands, and spectra
- Automatic shaft rate calculations using DEMON
- Full-featured interface with all results stored in searchable database

Results to Date

- Over 10,500 accepted vessel pass measurements, including during the slow-down trial from June-October this year
- Average 17 new accepted ship pass measurements each day (about 6000/year)
- These measurements are compatible with the ECHO program's ~7000 measurements made from 2015-2018 in Strait of Georgia and Haro Strait
- An additional 4450 rejected vessel pass measurements are stored in the database
- Real time marine mammal detections are being performed. Several thousand calls from humpback whales and killer whales have been detected
- Ambient noise results are available in daily, weekly, and monthly formats, allowing tracking of underwater noise in critical habitat of endangered SRKW



Octopus June 6, 2020

