WA Waters - existing hydrophone network

Scott Veirs, Orcasound hydrophone network

Ship noise workshop on Oct 3, 2019, in Seattle

▶ 0:00 / 0:11 🔊 ⋮

Slides at: orcasound.net/talks

Existing hydrophone network
Assets that could help implement Rec. #22

Outline (focus on real-time assets in WA):

1. Non-WA, Non-Orcasound assets you should know about

2. Orcasound: a tool for SRKW+ research, management, and education

3. Orcasound: a tool for characterizing underwater noise in SRKW critical habitat

4. Orcasound: a partner (with PSEMP and you!) in tracking Puget Sound wildlife

About me:

- UW Oceanography, PhD (2003)

- 15+ years SRKW bioacoustic research/teaching and coordinating Orcasound

- Chair of Marine Mammal Work Group within the Puget Sound Ecosystem Monitoring Program

Non-WA or Non-Orcasound assets...

...that may be relevant to implementing Recommendation #22

- Other cabled, real-time hydrophone assets in the Northeast Pacific
  1. Canadian whale tracking infrastructure ($10M ONC; DFO, ECHO, SIMRES++)
  2. Lime Kiln Lighthouse - SMRU and The Whale Museum
  3. Outer coast U.S. assets ($100M investments: e.g OOI Newport node, MARS, U.S. Navy)

- Autonomous recorders or other non-real-time hydrophones
  1. Critical habitat NOAA assets (PALs, EARS, etc.)
  2. Many past deployments in SRKW habitat (APL/PALs, MARUs, HARPs, JASCO/SMRU, SoundTraps, etc.)

- Other real-time sources of SRKW detections and/or non-cabled audio: wavegliders (humpbacks); SMRU CABs; Canadian radar, BC thermal cameras

- Vast and growing network of Salish Sea marine sensors, e.g. acoustic gliders (NANOOS/NVS)
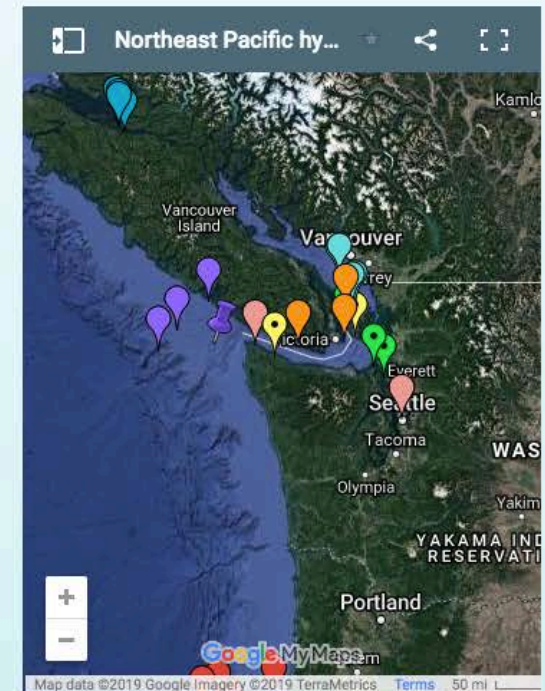
Orcasound

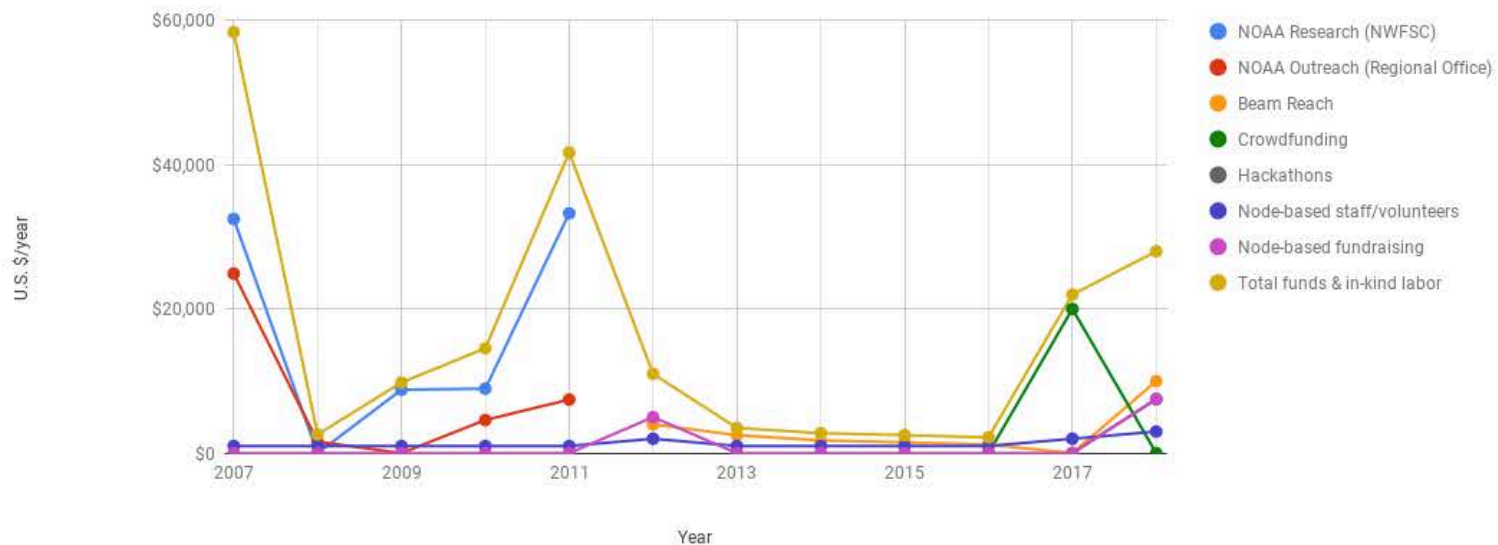## An evolving tool for SRKW conservation
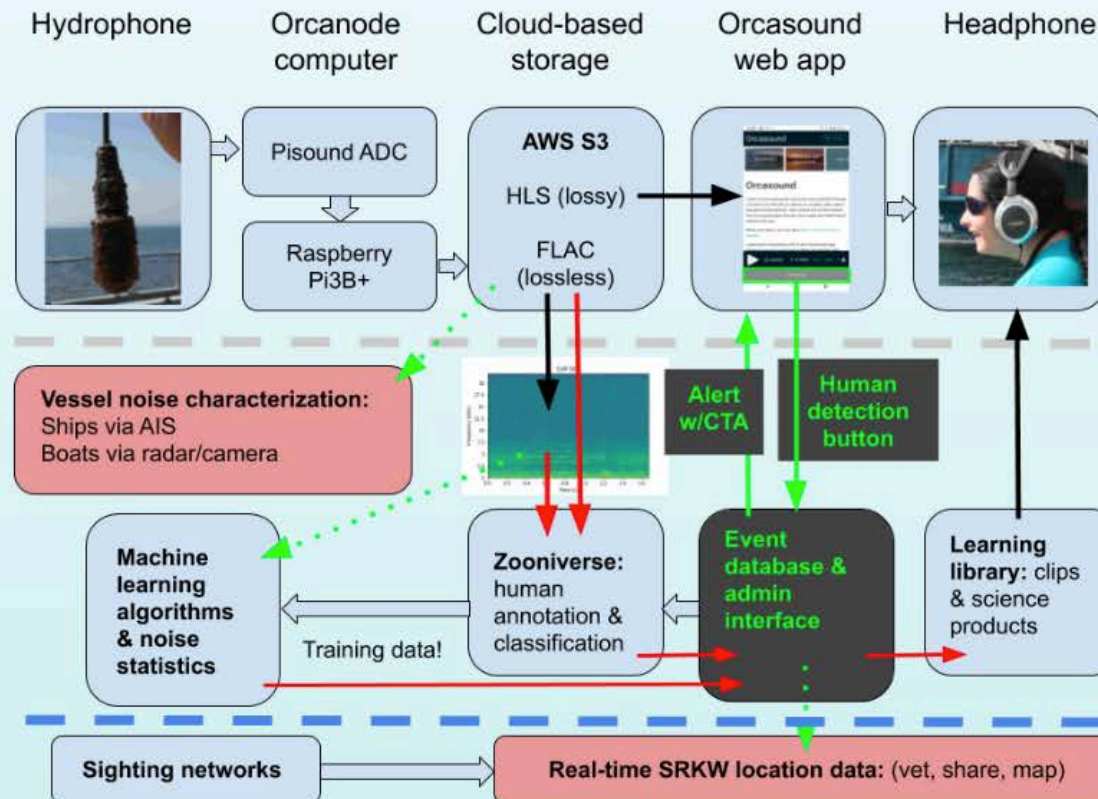
The product of 15 years of citizen scientists listening for whales, Orcasound is now a cooperative hydrophone network and an innovative open-source hardware/software project.

Orcasound funding history and future

From NOAA/WDFW contracts/grants to crowd-funding, philanthropy, and hackathons

Orcasound 2019-2020 map and membership

Cooperative of researchers, educators, & citizen scientists

1. Orca Network
2. Port Townsend Marine Science Center
3. Beam Reach & Colorado College
4. The Center for Whale Research
5. The Whale Trail
6. Oceans Initiative
7. Orca Behavior Institute
8. Whale Scout
9. Deep Green Wilderness
10. Friends of Lime Kiln Society (FOLKS)
11. Cetacean Research Technology

Physical exhibits include: Seattle Aquarium; Port Townsend Marine Science Center; Langley Whale Center; Lime Kiln Visitor's Center (via FOLKS)

You can join Orcasound, too! Just e-sign the MOA and heed the Creative Commons BY-NC-SA license.
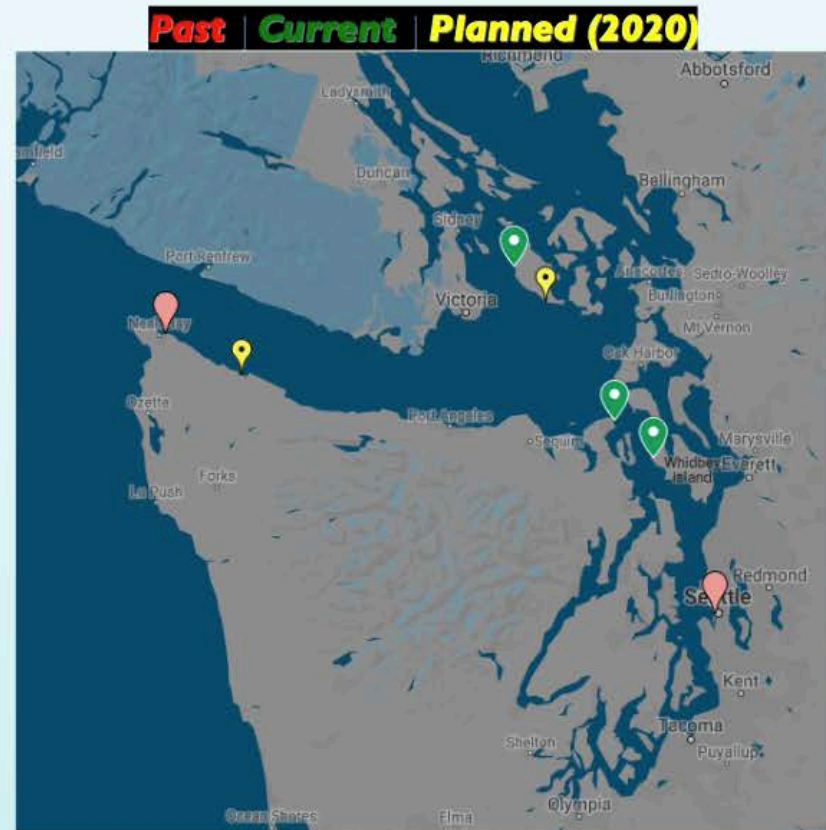
Orcasound hardware evolution

A listening node for less than $1000 (U.S.)!

Basic ingredients (and costs):

- ($ 50) DIY stand

- ($300 x2) Hydrophones -- dual for redundancy, stereo listening, & bearing

- ($125) Pisound board -- 48/96/192 kHz/channel, stereo 24-bit ADC

- ($ 35) Raspberry Pi 3b+/4 -- single board computer

- ($ 35) Audio cables & waterproof box installed near the shoreline

- ($ 75) Power over Ethernet -- from box to 24-hour UPS & Internet router

60% of cost is hydrophones! (>75-95% for research nodes)

DIY Guide: How to build your own hydrophone node!

Orcasound software evolution

**2017 challenge: Can we make it easy to listen, cloud-based, & scalable?**

Free open-source software to stream audio that "just works" on all devices/browsers

- Linux, Docker

- ffmpeg -- encodes audio data in two formats:
  - Compressed & lossy: HLS segments (HTTP Live Streaming)
  - Compressed, lossless: FLAC (Free Lossless Audio Codec)

Amazon S3 for archiving data in the cloud

- s3fs -- uploads data files and "manifest" to Simple Storage Services (S3)

- FLAC filenames contain UTC timestamp

Orcanode Github repository

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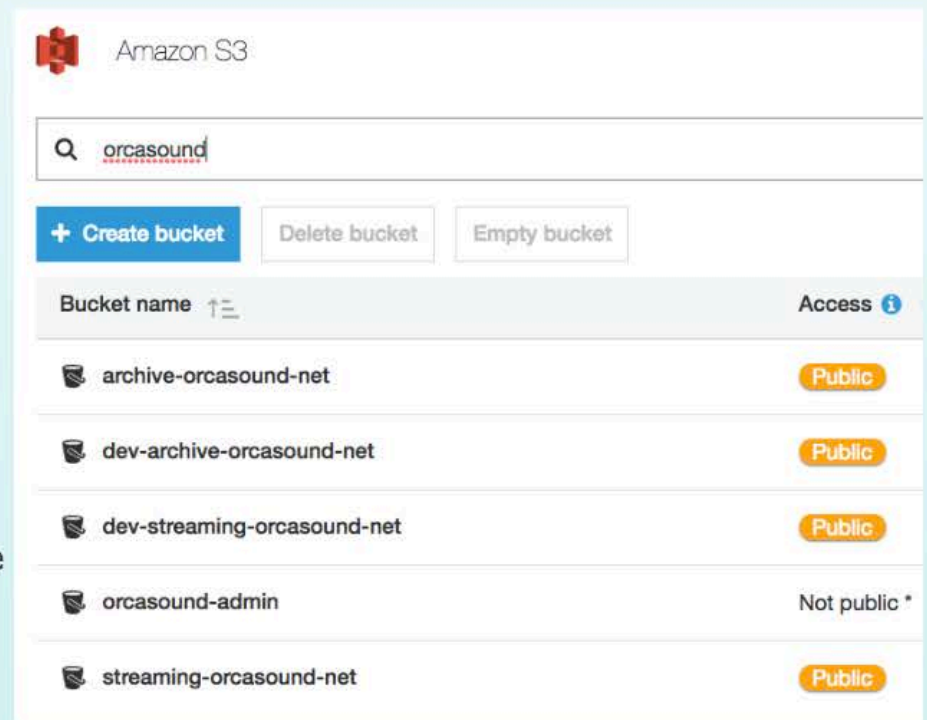
What's next for Orcasound?

Make "listening for whales" interactive and inform real-time end-users

For free live-listening, browse to: live.orcasound.net

Orcasound 1.0 player published Nov. 1, 2018. Orcasound 2.0 is in beta-testing & will launch in fall, 2019.
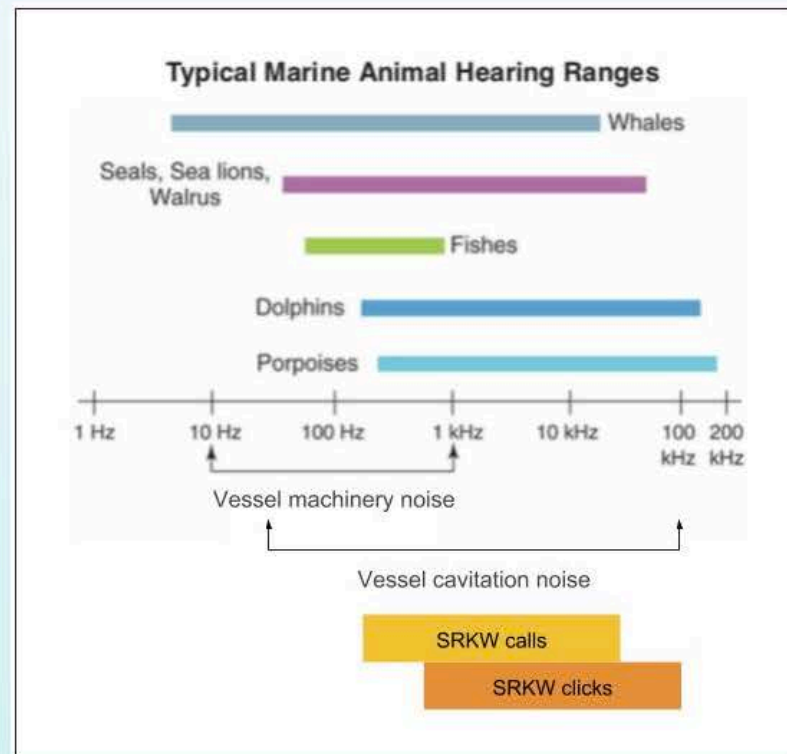
Orcasound for characterizing vessel noise

The bad news: Vessel noise can mask <u>both</u> calls & clicks
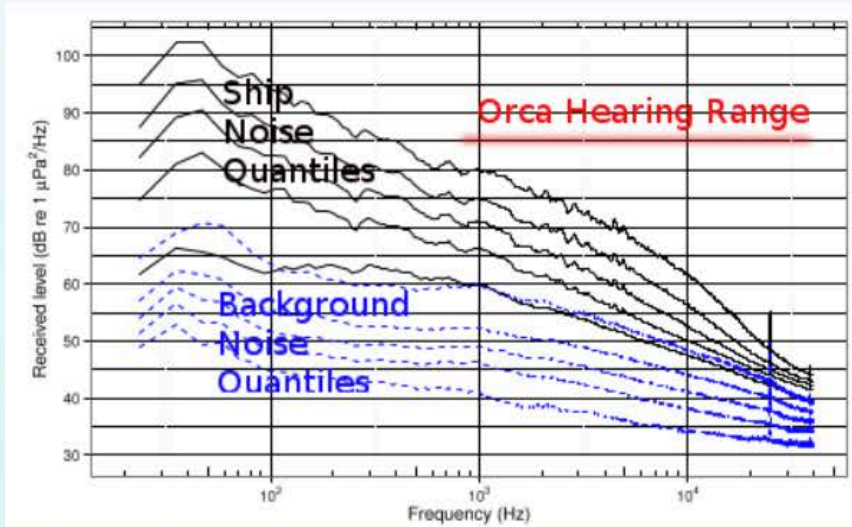
Frequencies of vessel noise overlap with SRKW hearing and signals

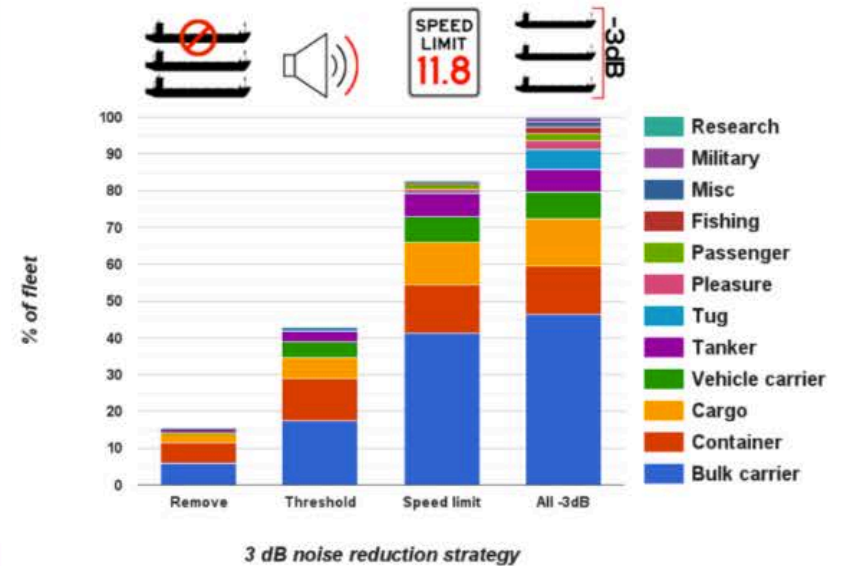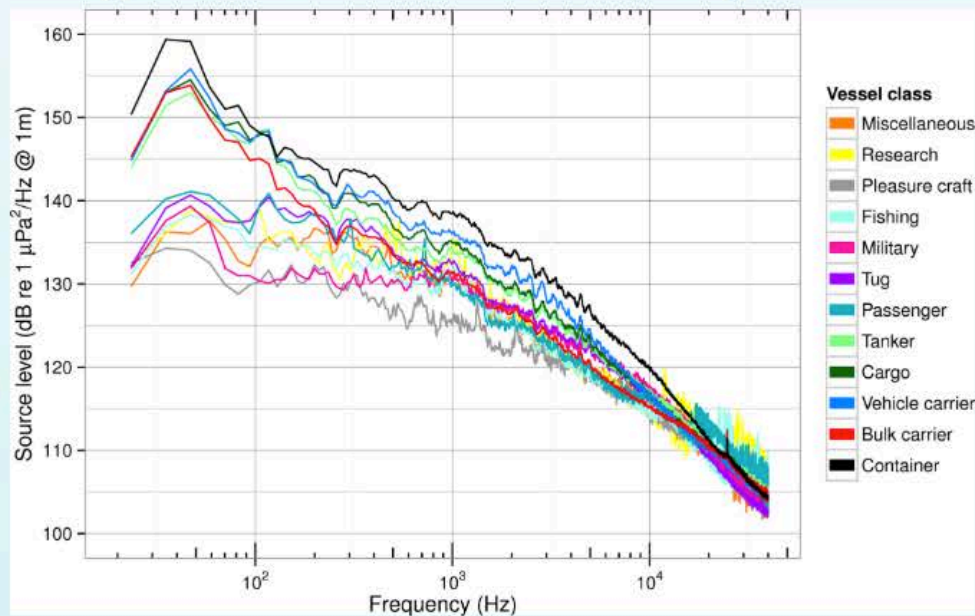Veirs, Veirs, & Wood (2016, PeerJ)

Typical ship: ▶ 0:00 / 2:02 ◀)) ⋮

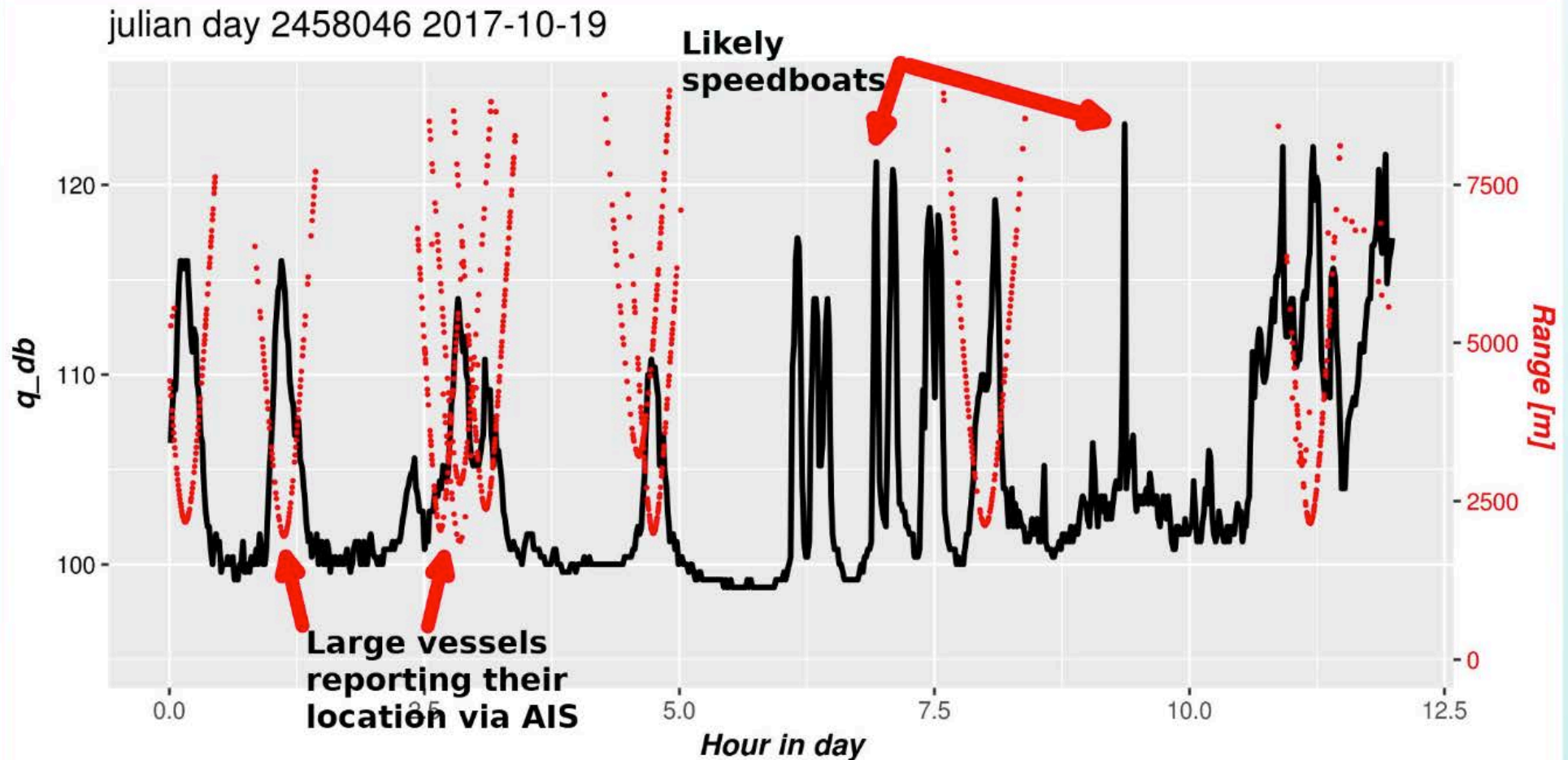Squeaky ship: ▶ 0:00 / 0:05 ◀)) ⋮

Vessel noise mitigation

The good news: there are many ways to "more than mitigate" vessel noise.

Operational (temporary) and technological (permanent) options (see Williams+2019)

Broadband received level peaks

Ships and boats have similar maxima, but ships last longer

Validating noise peaks & speed with AIS, cameras, and radar

Slow boats have lower maxima, but usually last longer than fast boats...

2017-09-27 07:11:59 Three averaging windows - 1200 sec (black), 100 sec (blue) & 32.5 sec (red)
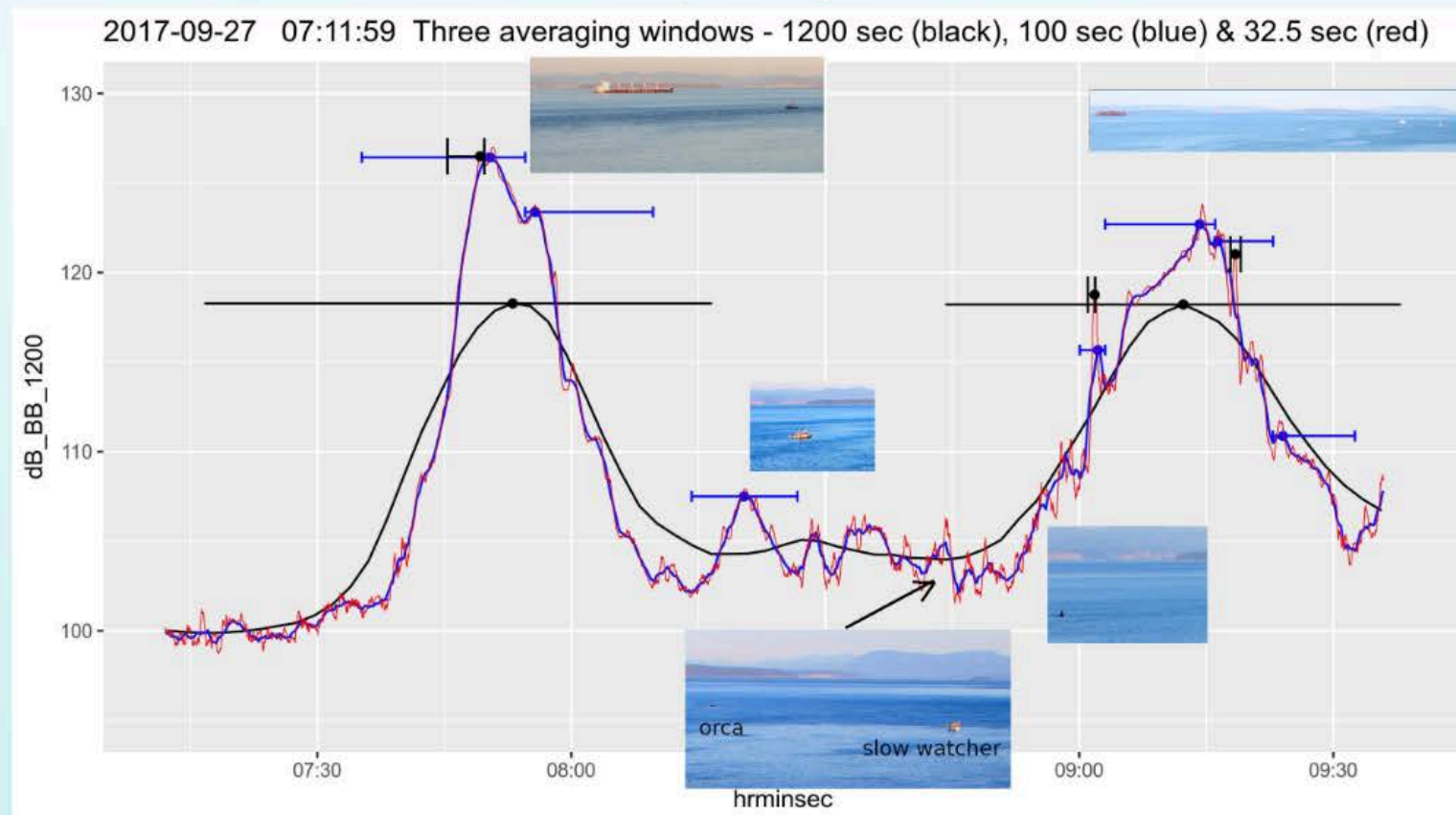
Images from the U.Vic./NEMES automated camera at Orcasound Lab. Smooth curve (black) is 1200-second running average broadband dB level. Now also tracking boat type & speed with M2 AIS/radar/camera system./p>

Monitoring ship noise in SRKW habitat

Urban ambient noise level: a baseline for "delta" noise metrics

Maximum received noise level vs duration

Boat (red) and Ship (black) Maximum dB vs width of each passby

105-110 dB range observed on orca (DTAG) while orca were being followed by whale watchers - Holt et. al.

Monitoring aircraft noise in Seattle
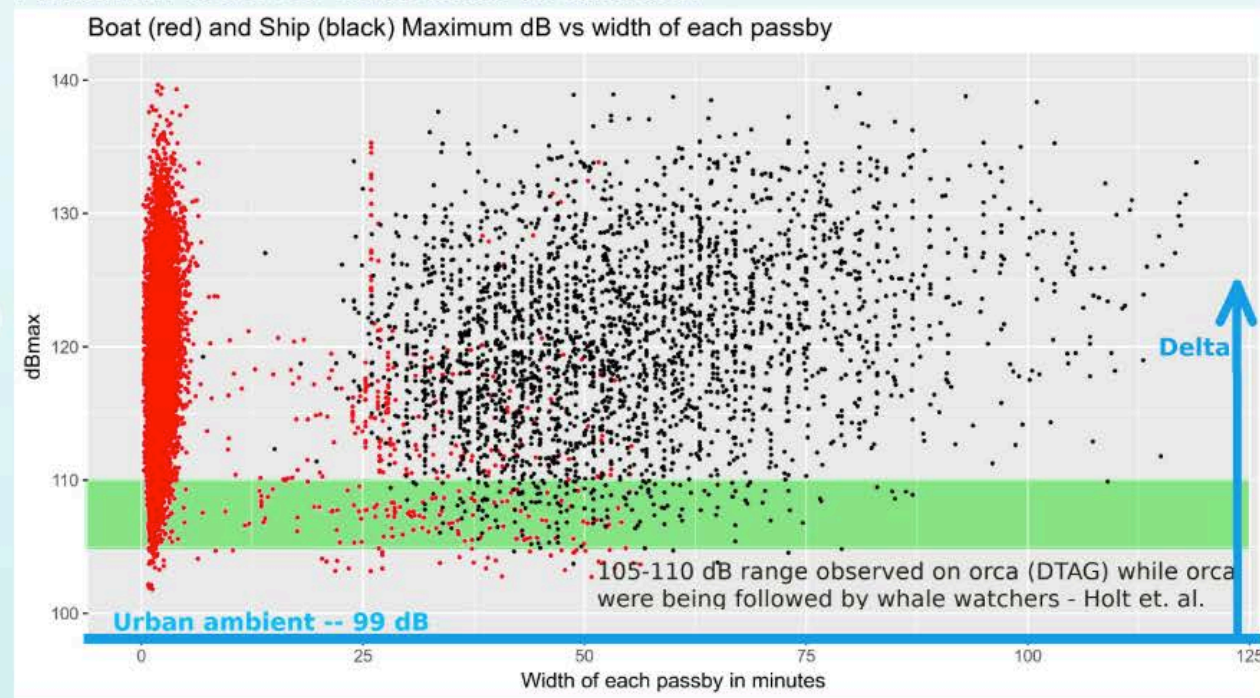
From ASA 2019 talk by V. Veirs with ref. to Holt et al., 2017, "Noise levels received by endangered killer whales..."
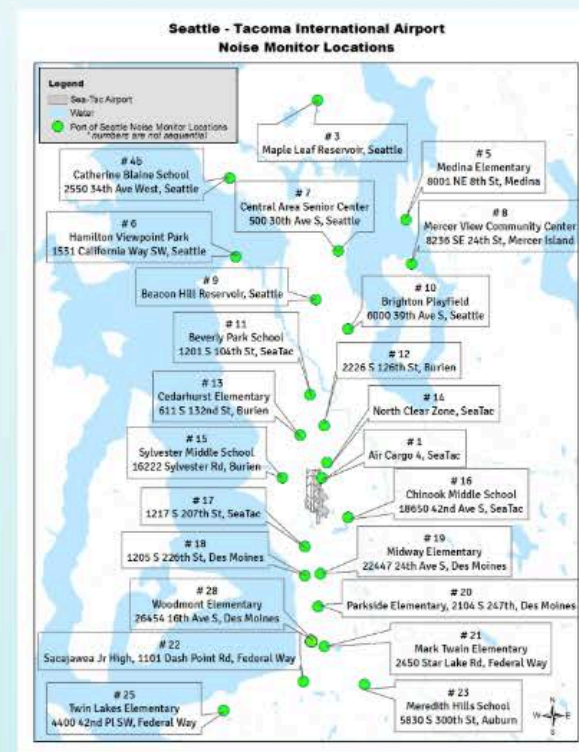
Orcasound: as a partner in tracking SRKWs

Together we can detect & protect SRKW (with cool tech, like... Localization)

▶ 0:00 / 0:10 ——— 🔊 ⋮

Mother-calf conversation!

SRKWs "speak up" in noise from nearby boats
(Holt, Noren, Veirs, Emmons & Veirs, 2009)

2008: ASA talk by V.Veirs

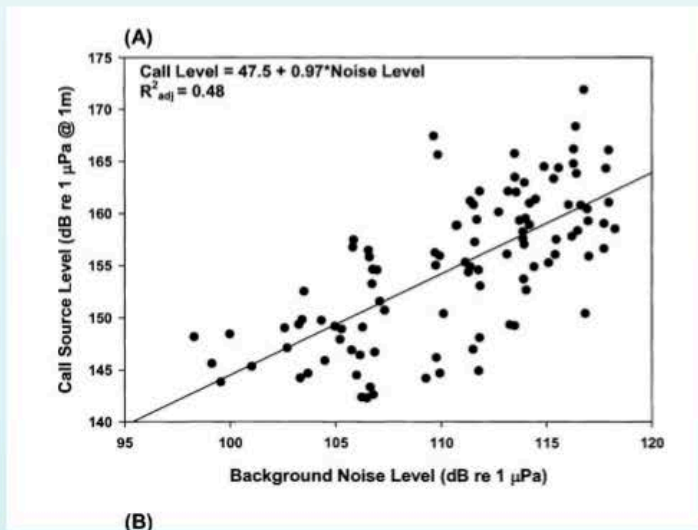# Orcasound for tracking SRKWs

Cool tech: machine learning
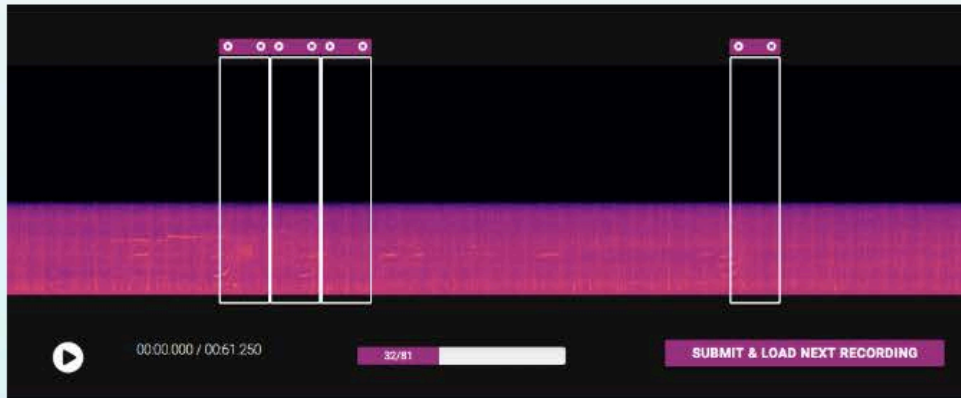
Emerging orca AI (in real-time?):

- Orcasound's archive of train/test data
- Orcasound collaboration with UW and Microsoft with Dr. David Bain
- Ocean Networks Canada workshops in November
- Meridian's Keta (open-source)
- ORCA-SPOT (trained on Orca Lab NRKW calls)
- DFO+Google?

Admiralty Inlet study (unpublished) -- Of 22 SRKW transits during local daytime, humans detect 45%, Wholistener 64%, combined 77%.

Orcasound as a partner in tracking SRKWs

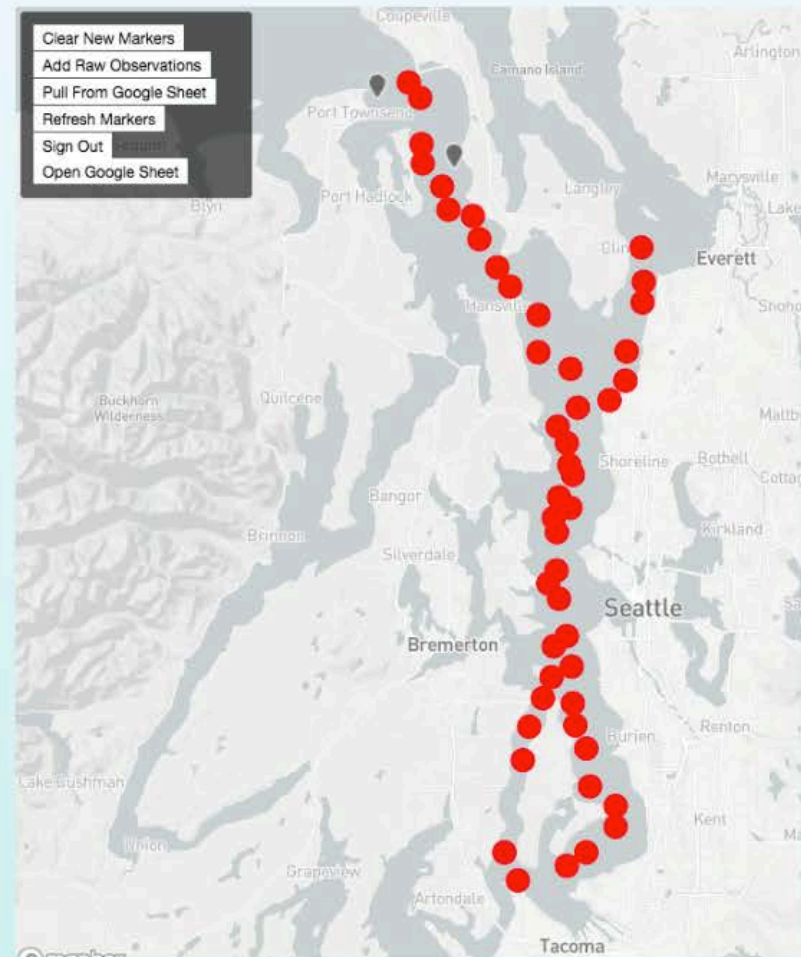## Synergy of real-time sighting and listening networks

Most recent SRKW "hearing"

- Faint calls heard at Orcasound's Port Townsend & Bush Point nodes

- Hearings anticipated through a heroic sighting effort of Orca Network & many Puget Sound citizen scientists

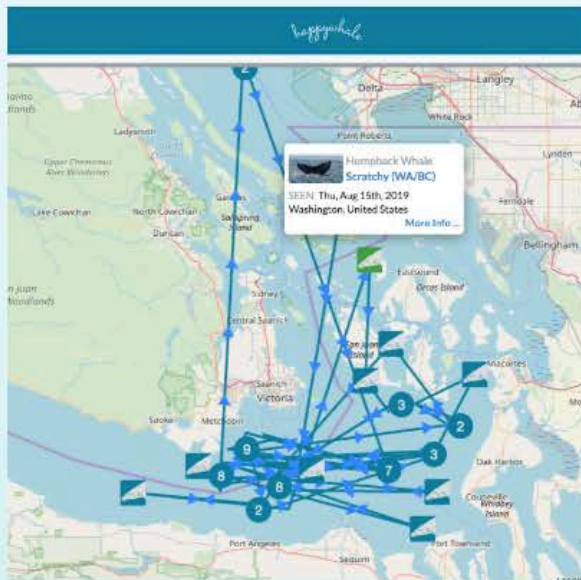- 9 continuous days tracked in Sept, 2019!

—> KEEP COMMENTS to SIGHTINGS UPDATES ONLY <—
Please include: Location; Time; # of orcas, any males (5 ft dorsal)?;
Direction of travel.
(Behaviors of orcas very much appreciated)

👍❤️😮 113   58 Comments 3 Shares

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Oldest ▾

Orca Network #BeWhaleWise - www.bewhalewise.org
SPEED:... See More

Orca Network has created a community
who shares a love & concern for the whales,
& a desire to take action to help

Clear New Markers
Add Raw Observations
Pull From Google Sheet
Refresh Markers
Sign Out
Open Google Sheet

h

Orcasound for tracking SRKWs

Cool tech: new apps to help track marine life

Happy Whale

Upload a fluke photo; AI yields an ID!

Members of the PSEMP Marine Mammal Work Group, and organizational members of Orcasound, will continue to study, test, and develop these apps and other pioneering ways to share marine mammal location data within Washington and across the Salish Sea.

PSEMP Spatial Data Workshop, Oct. 31, Edmonds

Through 2019, Orcasound 2.0 plans to provide real-time detections of SRKWs to the WRAS.