A decade of the NOAA/NPS Ocean Noise Reference Station Network – progress and achievements

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Project Overview

The NOAA/NPS Ocean Noise Reference Station (NRS) Network was established in 2014 to support the NOAA Ocean Noise Strategy by providing long-term, continuous recordings of underwater sound throughout United States waters

Passive acoustic recording technologies can be used to **monitor trends and changes** in ambient soundscapes (including anthropogenic, biological, and geophysical sources) while **minimizing human interference**

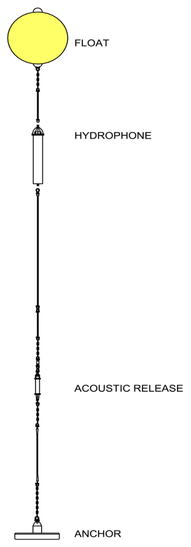

Figure 1. Ex. NRS mooring

Passive Acoustic Dataset

Instrumentation

- 13 moorings (ten deep- & three shallow-water)
- Each NRS contains a omnidirectional hydrophone & calibrated pre-amplifier
- Sample 10 Hz – 2 kHz continuously for 1-2 years

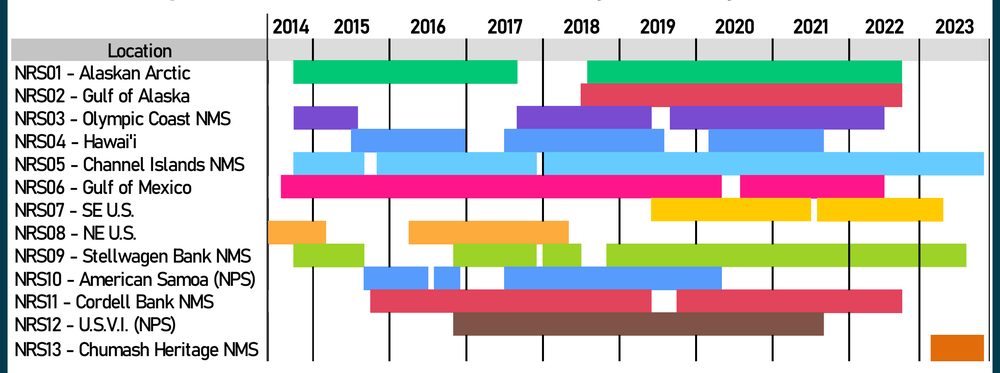

Figure 2. NRS data available for analysis

Data

- >600,000 hours of acoustic data as of 2024 (Fig. 2)
- On-going effort to archive raw data and hybrid milli-decade sound levels via NOAA National Centers for Environmental Information (NCEI) (Fig. 3)

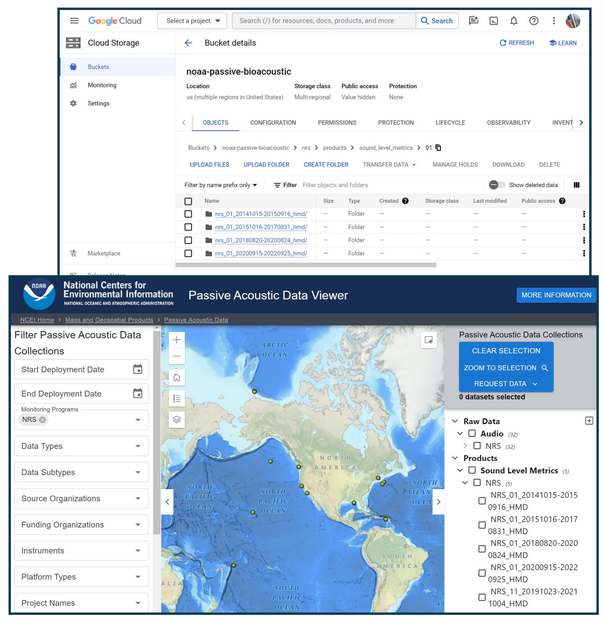

Figure 3. Example data available via the NCEI passive acoustic archive

Soundscape Monitoring Tools and Products

Seasonal sound level trends in the **Cordell Bank National Marine Sanctuary** near San Francisco, California

Seasonal sound level trends in the Western **Beaufort Sea** near Utqiagvik, Alaska

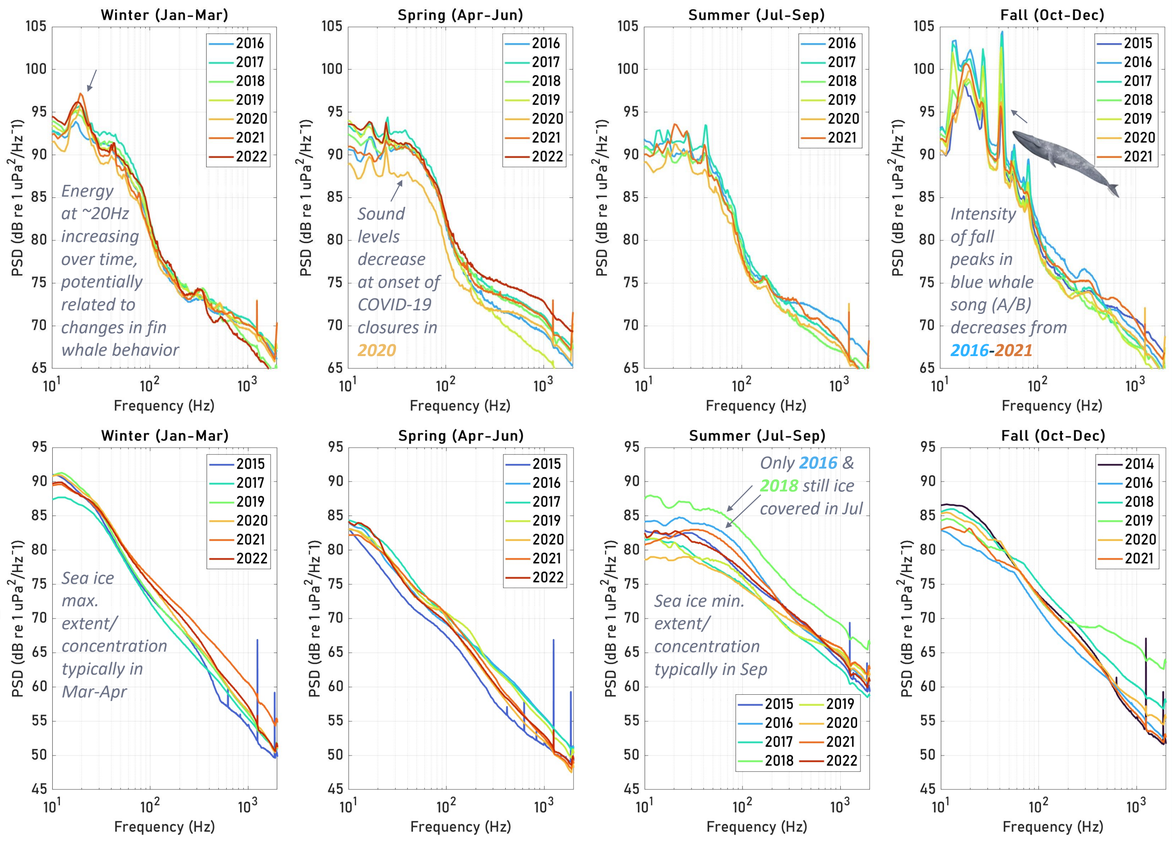

Figure 4. Seasonal median (L50) hybrid millidecade sound levels

Continuous NRS data can provide information to compare ambient sound conditions over time and space, including animal acoustic presence, vessel noise, and weather

Stability of multi-year sound levels at each site is driven by a combination of changes in anthropogenic activity, animal behavior, and climate

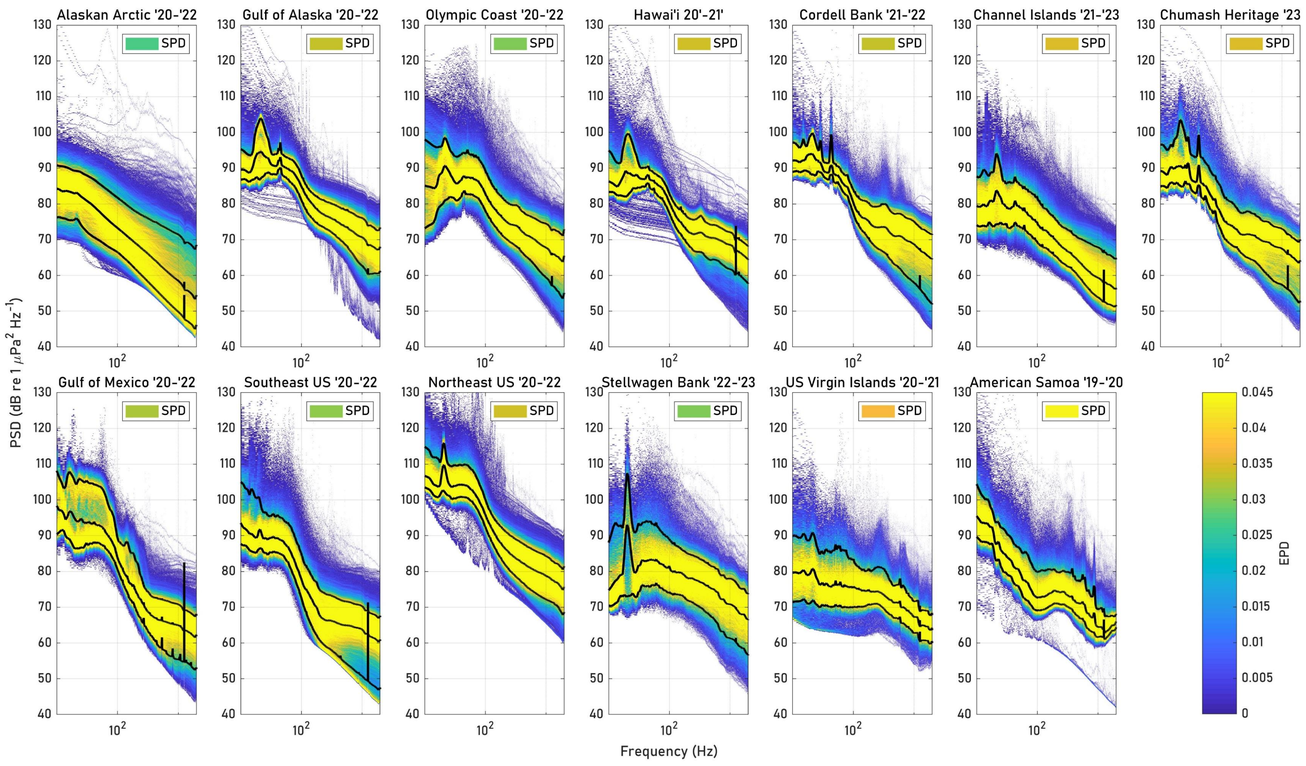

Figure 5. Distribution of 10 Hz – 2 kHz power spectral density (PSD) sound levels plotted as empirical probability density (EPD) within each frequency band. The spectral probability density (SPD) indicates the overall consistency of sound levels over time, increasing from blue to yellow.

Looking Ahead

- More hybrid millidecade products at NCEI in addition to raw audio data
  - netCFD (network Common Data Form) files that combine data & metadata
- Upgrade hydrophone components (WISPR2) to increase sampling rate for monitoring sound sources > 2kHz
- Add sites to expand capabilities for evaluating:
  - Potential impacts of **climate change** and **marine heatwaves**
  - Biodiversity and marine mammal distribution
  - Anthropogenic noise on ocean soundscapes in U.S. waters
  - Evaluation of **offshore wind energy** sites, supporting national **decarbonization** efforts (Fig. 6)

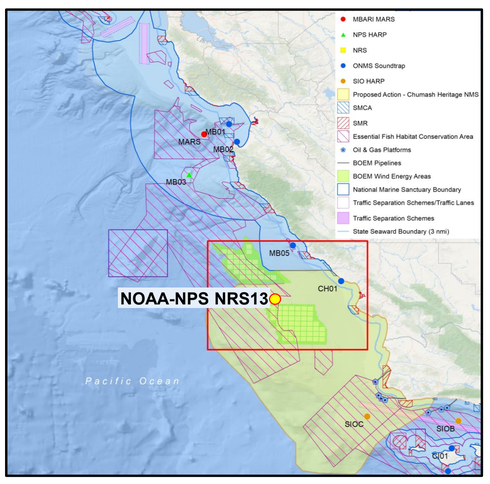

Figure 6. NRS13 location in the proposed Chumash Heritage NMS, near the Morro Bay wind energy area

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