

SoundCoop Passive Acoustic Monitoring Access Network

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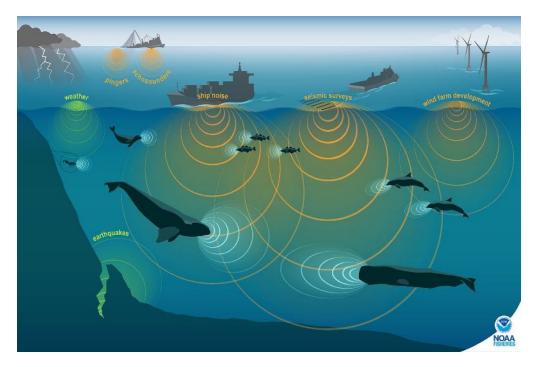
Federal acoustic monitoring and management:











Existing Portal Capacity to Compare or Access Standard Products across Projects

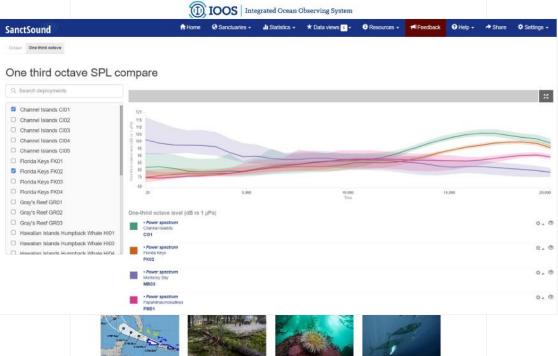
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★ PACM

★ NCEI



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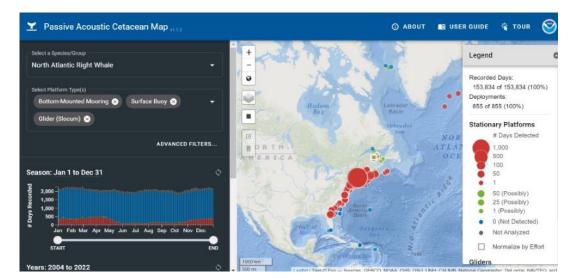


Existing Portal Capacity to Compare or Access Standard Products across Projects

★ SanctSound

★ PACM

★ NCEI

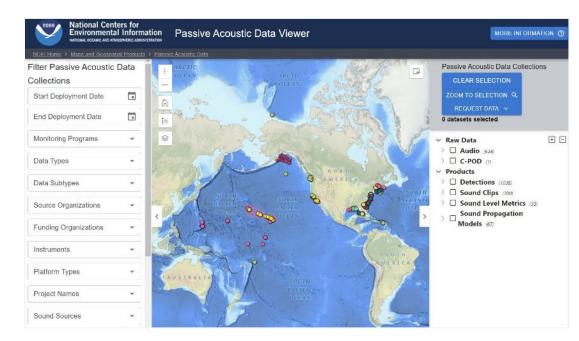




Existing Portal Capacity to Compare or Access Standard Products across Projects

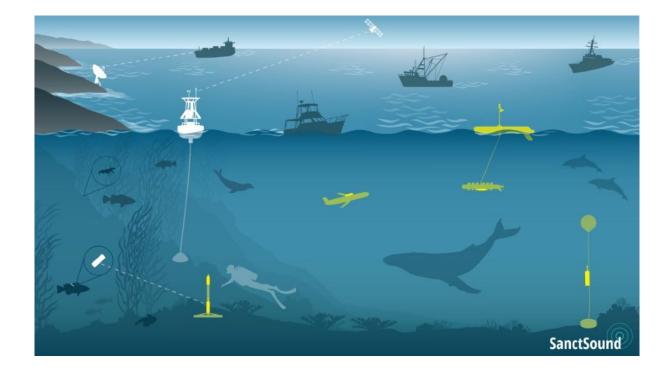
★ SanctSound

★ PACM





Advancing standards and community tools



Passive Acoustic Monitoring National Cyberinfrastructure Center (SoundCoop)

Pilot a community-focused, national cyberinfrastructure capability for passive acoustic monitoring data, technology, and best practices to promote improved, scalable and sustainable accessibility and applications for management and science.









Steering Committee











M B A R I



RWSC

Regional Wildlife Science Collaborative for Offshore Wind









SoundCoop Progression

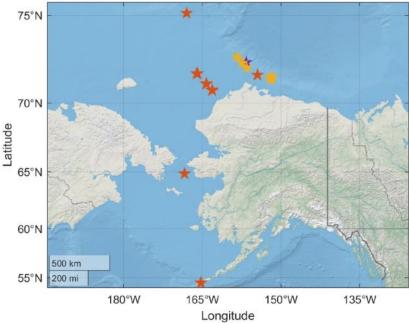
Continue to build national archive for federally- funded and interagency- prioritized PAM assets at NCEI Year 0	2. Integrated Access				
		3. Visualization Tools			
	Build infrastructure to discover and access existing raw files and data products across separate repositories Year 1	Visualize comparable data products from separate repositories in a single portal Year 2	4. Analysis & Assimilation		
			Enable users to apply the same processing routine on raw data from separate projects and visualize the results with complimentary environmental data		



Case Study 1 - Priority Federally-funded Datasets

Temporal sound level analysis in the Arctic Ocean

- SWAL Kait Frasier
 - Beaufort Sea: Jul 29, 2002 ~ Sep 30, 2004
 - Arctic: Sep 26, 2006 ~ Aug 27, 2011
 - NRS Samara Haver
 - Alaskan Arctic: Oct 15, 2014 ~ Sep 25, 2022
 - AFSC Catherine Berchok
 - W Beaufort Sea: Aug 8, 2008 Nov 11, 2021
 - Chukchi Sea: Sep 10, 2010 ~ Nov 27, 2021
 - Chukchi Plateau: Oct 9, 2016 Oct 7, 2020
 - Aleutian Islands: Oct 1, 2016 Sep 2, 2020
 - Bering Strait: Sep 24, 2016 Sep 9, 2020





Case Study 2 - IOOS Regional Datasets

Spatial sound level analysis of NERACOOS, CeNCOOS & SECOORA assets in 2021



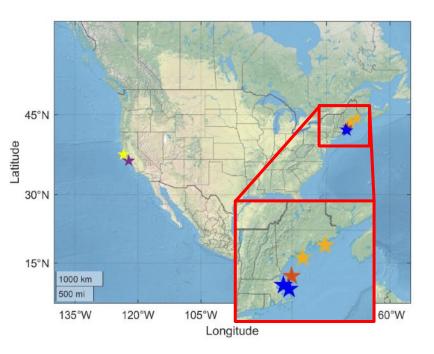
- MBARI MARS John Ryan
 - Monterey Bay



- NRS Samara Haver
 - Cordell Bank



- AEON 5
- NEFSC Tim Rowell
 - GoMaine Monhegan Island & Petit Manan
 SBNMS SB01 & SB03
- USC Eric Montie
 - May River



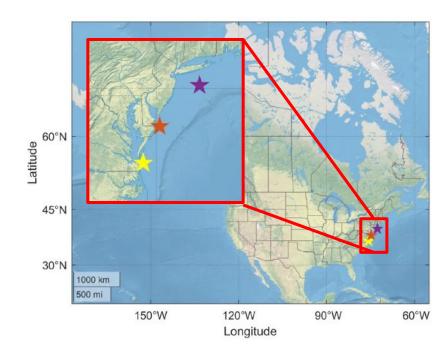


Case Study 3 - Offshore Energy Development Datasets

Integrate BOEM- and state-funded monitoring

- NEFSC Gen Davis
 - NYDEC-Cornell NARW detections: Oct 16, 2017 - Nov 1, 2020

Cornell - Aaron Rice
 BOEM-VA: Mar 10, 2016 - Mar 6, 2017
 BOEM-MD: Sep 17, 2015 - Jan 10, 2017

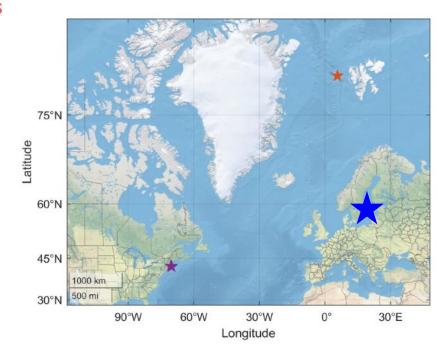




Case Study 4 - International Datasets

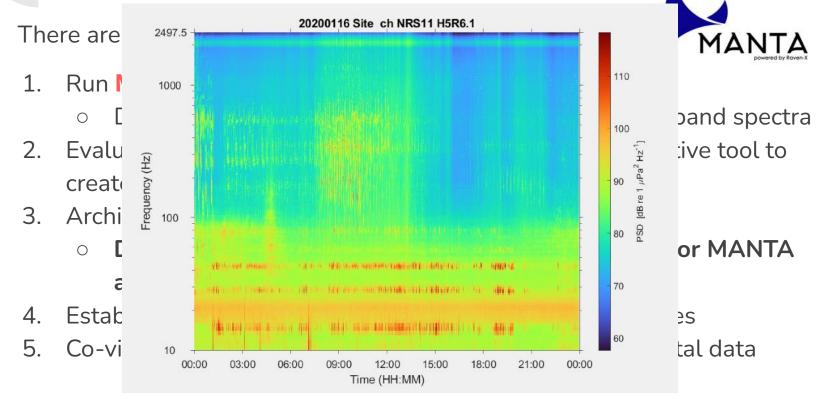
Demonstrate synergy with international efforts

- NEFSC Tim Rowell
 - SBNMS SB01: Jan 26, 2021 Feb 16, 2022
 - SBNMS SB03: Jan 26, 2021 Feb 16, 2022
 - AWI Karolin Thomisch & Olaf Boebel
 - OPUS-hosted FRAM: Sep 6, 2016 Jul 18, 2017
- JOMOPANS Niels Kinneging
 - Connect to JOMOPANS decidecade sound level netCDF files in ICES database





SoundCoop's Task





Developing netCDF Standard for Sound Levels

- What? netCDF is a self-describing, machine-readable data format that supports access and sharing of array-oriented scientific data
- Why? Metadata and hybrid millidecade results in a single file, facilitates development of scalable visualization and analytical tools
- How?

MANTA

Matrix of hybrid millidecade w/ time, freq and effort (# sec/min) Daily CSVs

Metadata containing processing and calibration information & plots Daily netCDFs

PassivePacker

Deployment metadata
 and additional
 processing details
 Deployment-level JSON

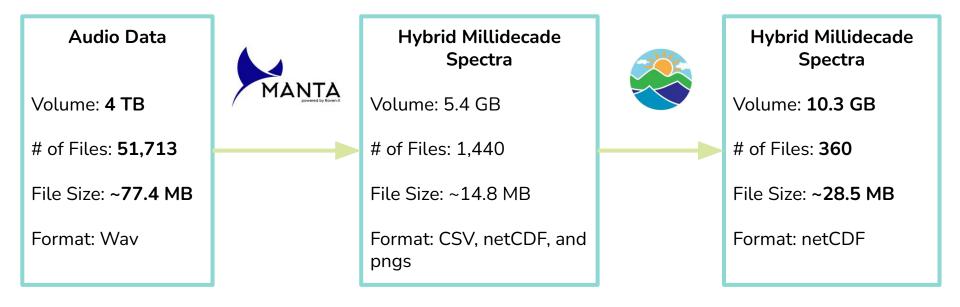


SoundCoop netCDF

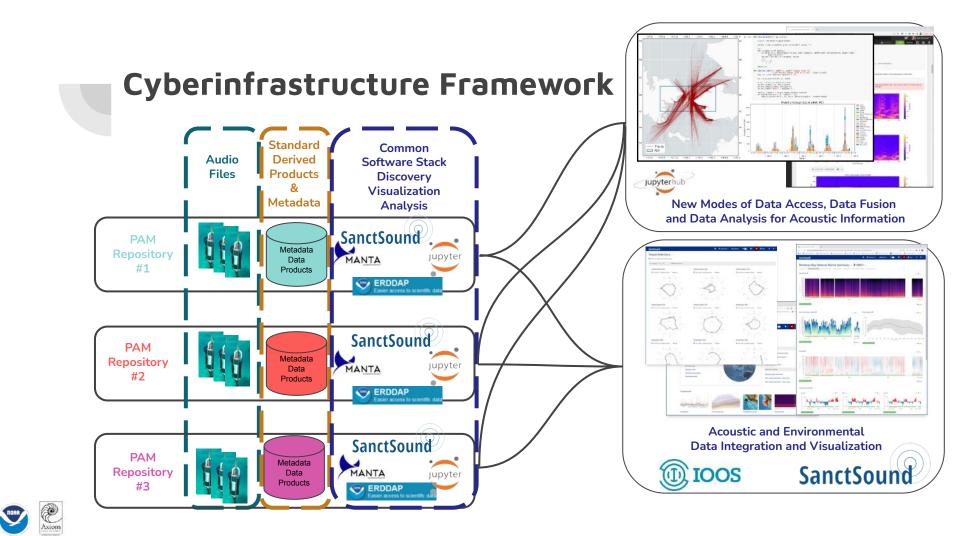
Standards-compliant file with complete metadata and hybrid millidecade Daily netCDFs

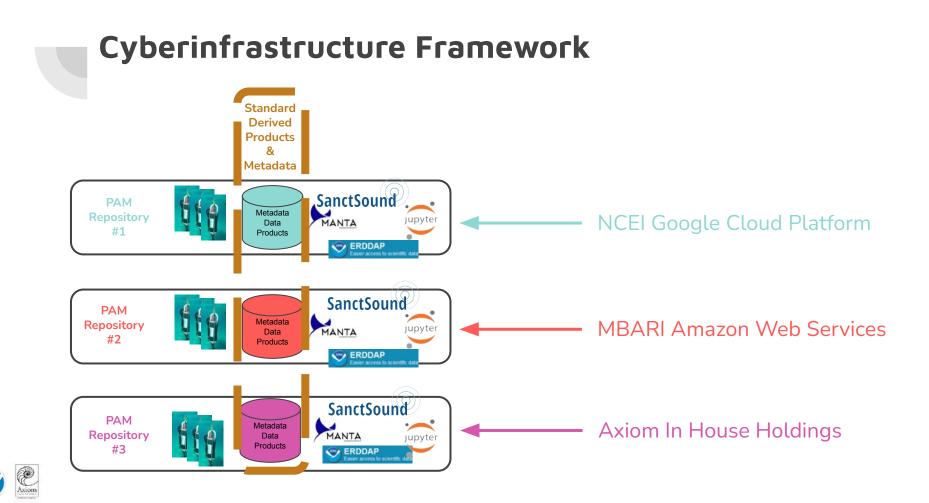
The Power of Millidecade and netCDFs

Journey of a SoundCoop dataset









Accessing Repositories of Hybrid Millidecade

- NCEI GCP
 - Hybrid millidecade results from 14 recording sites across 8 separate monitoring efforts processed using MANTA v9.6.14
 - Daily files: netCDF
- MBARI AWS
 - Hybrid millidecade results from 1 recording site processed using **pypam 0.2.0**
 - Daily files: netCDF
- Axiom In House
 - In Progress: Hybrid millidecade results from 1 recording site using MANTA



Visualizing Results

SoundCOOP

Q Datasets

Alaskan Arctic (NRS01)	No files
Aleutian Islands - Unimak Pass (UN01)	Notiles
Arctic Ocean - Eastern Fram Strait (ARKF05)	No files
Beaufort Sea (ARCTIC-A)	No files
Beaufort Sea (ARCTIC-B)	No files
Beaufort Sea (ARCTIC-C)	Notiles
Bering Strait Region - Chirikov Basin (NM01)	No files
Chukchi Plateau (CH01)	Nofiles
Chukchi Sea (IC01)	No files
Chukchi Sea (IC02)	No files
Chukchi Sea (IC03)	No files
Cordell Bank National Marine Sanctuary (NRS11)	1 files
Gulf of Maine Monhegan Island (Monh)	No files
Gulf of Maine Petit Manan (PManan)	1 files
JOMOPANS	No files
May River (37M)	No files
Mid Atlantic Ocean - Maryland	1 files
Mid Atlantic Ocean - Virginia	1 tiles
Monterey Bay (MARS)	2 files

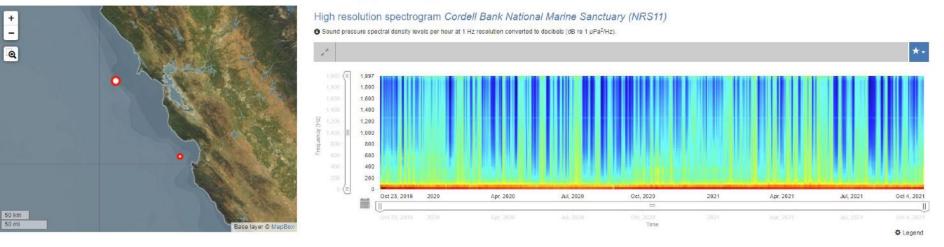


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SoundCOOP

Monterey Bay

Dataset: Cordell Bank National Marine Sanctuary (NRS11)





Development of Community Tools

⊙ Issues 📫 Pull requests ⊙ Actions 🗄 Projects 🖽 Wiki ③ Security	🗠 Insights 🔞 Settings		Preview Code Diame 1785 Lines (1785 Loc) - 483 KB	R#₩ [± / •
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soundcoop \mathscr{O} This repository contains Jupyter notebooks developed by the passive a	coustic community for the SoundCoop project.	Releases No releases published Create a new refease Packages No packages No packages published Publish your first package	plinition().	



Next Steps

- Finalize processing of all SoundCoop datasets
- Develop user environment to pull raw data from different repositories and create standard metrics
- Finalize SoundCoop portal, co-visualize results
- Finalize integration of environmental variables with acoustic data
- Finalize Jupyter notebooks so community to apply the same methods



Thank you!

carrie.wall@noaa.gov



Research Workspace & JupyterHub



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What is JupyterHub?

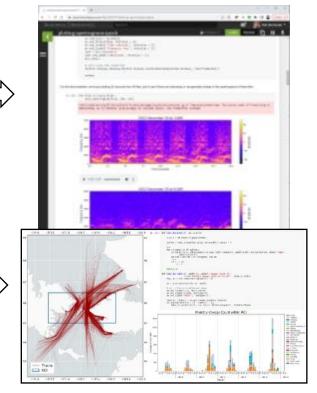
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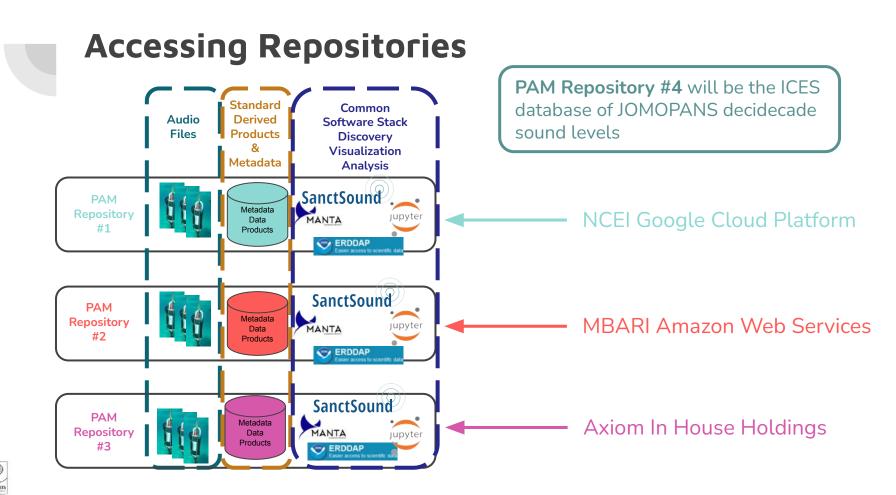
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Key features of JupyterHub

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Sound Level Metrics and this workshop: Balancing objectives

★ Nurture the long term objectives:

- Many fully open source PAM analysis tools that do many things.
 - At least one/a subset that can efficiently derive a common set of metrics from very large datasets collected using different instrumentation (different calibration)and representing long time series.
 - At least one/a subset that can operate in the same environment as other big data analytical routines (e.g., run remotely on large cloud-based repositories)
- ★ Based on what's available now, implement group-determined methods so that we have datasets that can support next integration/visualization steps NLT March 2023:
 - What we are <u>not</u> doing: standardizing soundscape metrics for the global community, nor are we developing new code
 - What we <u>are doing</u>:
 - Making decisions about what will work for the purposes of having standard datasets to compare for this project and what has the potential to be the most scale-able, so that our examples do their best to move things forward
 - Highlighting important gaps/areas for further investment



Sound Level Metrics and this workshop: Balancing objectives

★ Thoughts to keep in mind during this morning's presentation and discussion:

- Ideally, we move towards everyone using the same, open-source analysis tool for levels. This is not necessary for our workshop participants, but it is necessary for the community. However, we will have to talk about whether the tools are ready for this (it has to be efficient, able to be used across instruments and truly open-source.)
- Regardless of whether we use the same tool or not (but even more important if we don't) we need to agree on a common metric for this project's comparisons
 - Again, it does not need to be a forever answer, BUT our files need to be a size that is scalable and can be used easily in our additional sharing/visualization steps.
 - Current front-runners from global work are: decidecade/1 sec or 1 min or 1 hr or 1Hz/1 min or 1 hr. SanctSound did geometric means but the lower common denominator across projects is likely to be arithmetic means for time bins.
- For detectors, Sofie can speak to the lay of the land for deriving comparable L2 detection results for animals like whales across different detector output (PACM). We also did a lot of this work in SanctSound and these will be discussed as baselines moving forward.



Visualization/Portal Capacity: Balancing objectives

 \star Nurture the long term objectives

- Regional to global comparisons (spatial)
- Decades of data (temporal)
- User interaction, including both:
 - Seeing many, many canned/pre-processed products and being able to zoom in and out of them
 - Generating new visuals based on on-the-fly reprocessing across many, many raw datasets
- \star Reasonable steps for this project to take in our case studies
 - Implement/build on existing capacities to visualize standard levels and detections across projects
 - Build user interface for existing regional capacity to integrate ocean observing variables including sound-derived products



Visualization/Portal Capacity: Balancing objectives

 \star Focus points for our discussion and choices for case study advances:

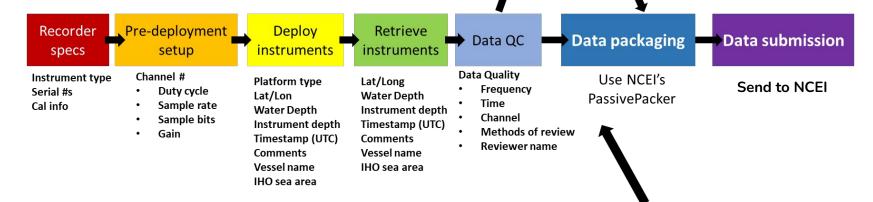
- We are interested in web enabling long term observational data over large spatial scales (<u>scalability is key</u>)
- We want to keep both technical and non-technical audiences in mind as users (lean towards more quickly interpretable visuals)
- Give premium to visualizations that lend themselves to integration with non-acoustic time series variables over similar scales (large, long), e.g.:
 - Histograms, lines/spectra are the basics
 - Clock plots can show cyclic trends across variables
 - Animations can help



For whole project

Lead Scientist(s) Organization Funding organization Deployment title Deployment purpose Abstract (full description of dataset) Metadata author/POC

Detectors and other data products



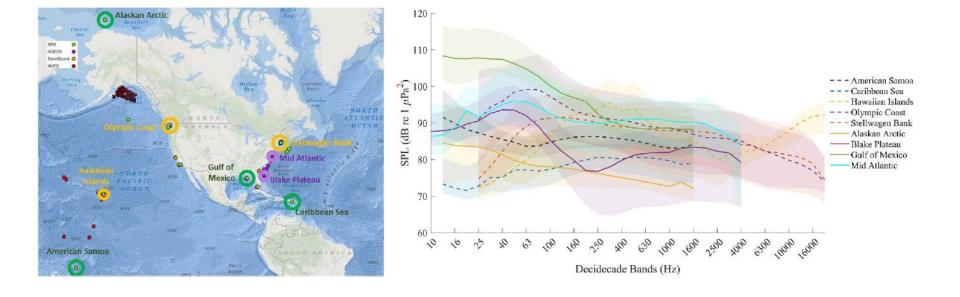
Archive Metadata

- Deployment

Navy clearance needed for sites/times of concern prior to packaging and sending data to to NCEI



Comparing sound levels across multiple projects ... for peer review



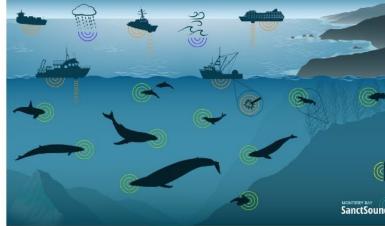


What did we learn?

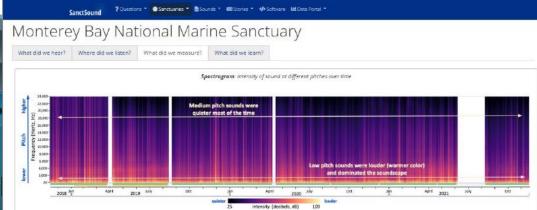
Monterey Bay National Marine Sanctuary

Click the icons in the scene below to listen and learn about the sounds we recorded in this sanctuary.

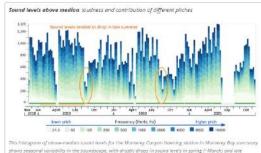
What did we hear? Where did we listen? What did we measure?



sanctsound.ioos.us

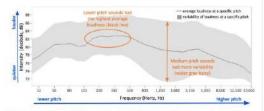


This example spectragram from a listening station on the edge of Monterey Caryon in Monterey Bay sanctuary shows that sound levels, were generally inuter (nammer colors) at low pitches and quieter (cooler colors) at medium and high pitches, likely reflecting contributions of local vestal traffic in and out of the neutry Monterey Harber, wind and works, and at a localizer such as baleen wholes and fish. Information about the quality of the sound data a included along the bottom of the plot with green indicating time periods of good quality data, yellaw indicating periods with compromised dura at time prior gave salars with a data portal you can get more information about what frequencies of data are compromised during a time periods phonemised during at time period by hovering over each yellow refor bar.



summer ("Aug) of all years sampled. Data quality is shown in color as described above

Power spectrum: variability of loudness across pitch



This power spectrum plot for the Monterry Carryon listening site in Monterry Bay sanctuory shows that lower shicked sounds (125-500 Herzt) had the highest medium intenshies (black line). Sounds with frequencies above 500 Herz were mark evenable over time (wider gray band) at the site.

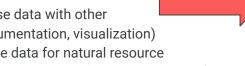
Leveraging SanctSound's Framework

- ★ Applied standardized processing to extract ambient sound levels and signal detections in large volumes of data, collected across large spatial area over 3 years
- ★ Developed visualization framework to handle a diversity of acoustic detections and sound level metrics
- ★ Established a workflow for data management, in connection with NCEI Passive Acoustic Archive
- ★ However, SanctSound project is now complete. It's not the only effort to have/currently executing these goals.

Setting the Stage

GOALS:

- Increase the **longevity** of and **access** to these data (archive)
- Increase the **usability** of these data (documentation, standardization, visualization)
- Increase the interoperability of these data with other observations (standardization, documentation, visualization)
- Increase the **interpretability** of these data for natural resource management (method and software development)





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PRIORITIES:

- Scalable solutions (hundreds of providers: national to international)
- Efficient solutions (petabytes of data running on standard fast computer, cloud-based computing)
 - Accessible solutions (freeware, ideally with user interface that supports lower entry level, cloud-based environments)
- Standard-compliant solutions (ISO documentation and supporting maturation and implementation of measurement standards)
- **Ecologically-relevant solutions** (stable derived indicators to detect ecosystem change)

- International Quiet Ocean Experiment and GOOS Sound EOV development
- ISO ambient sound measurement working group
- EU's TG Noise Working Group (Marine Strategy Framework Directive)
- NOAA Center for Artificial Intelligence