IRA Passive Acoustic Monitoring Strategic Initiative Workshop Report

La Jolla, California

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# Citation

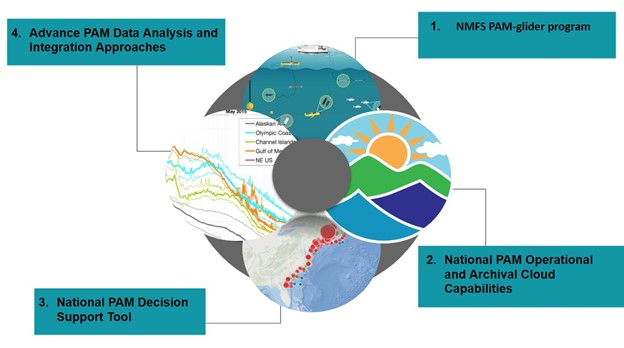
[PAM-SI Meeting Repository](https://github.com/SAEL-SWFSC/PAM-SI-Mtg-March2024)

# 1. Introduction

Introduction

NMFS’ Passive Acoustic Monitoring (PAM) programs focus on collecting underwater sound recordings of the marine environment. Identification of the sounds produced by protected marine mammal species, fishes, or humans allows for an understanding of marine soundscapes. PAM data collection provides information on changes in species distribution, behavior and/or density, in addition to assessing impacts of man made noise. The technological revolution in PAM over the past decade has allowed both acoustic recorders and analytical approaches to increasingly become an integral part of NMFS’s core science mission. PAM’s capacity for creating long term time series makes it an ideal approach for evaluating changes in species stocks, ecosystem interactions and climate change. There currently are 7 NMFS PAM programs including each NMFS Science Center and the S&T’s Ocean Acoustic Program. PAM data can be archival (recorder needs to be recovered at sea before data can be accessed) or real time (data is transmitted via cable or satellite as it is collected). Currently, NMFS PAM programs use all available acoustic platforms from stationary bottom mounted to mobile towed, drifting, or UxS platforms. However, each program varies in the level of technological development and operational capacity. Over the next 4 years we aim to work to resolve the core roadblocks that hold back PAM’s ability to be fully operational across NMFS.

The PAM SI projects focus on; 1) establishing a Pacific region glider program to mirror that in the Atlantic, 2) developing National PAM Cloud capabilities to cope with exponential growth in data and processing needs, 3) expand the existing PACM decision support tool to a National level tool, and 4) streamlining analytical and data integration to remove redundancy and increase across FMC efficiencies.



The PAM SI Workshop in March 2024 was a three-day gathering to identify synergies and common challenges across NOAA Fisheries passive acoustics groups and the agency more broadly as well as decide priority projects to accomplish during the Strategic Initiative. This workshop was an opportunity for folks from all NOAA Fisheries Regional Science Centers and our partners in the Office of Science and Technology, Office of National Marine Sanctuaries, and National Centers for Environmental Information to gather together.

The first day of the workshop focused on identifying synergies and getting to know each other and the ongoing passive acoustic research better. Day two was spent in two Round Table Discussion sessions, offering extended periods of time for detailed discussion to identify and define priority projects that address the SI objectives as well as common goals and challenges faced. The workshop culminated with a series of demonstrations of exising PAM tools and a discussion of the target management outcomes and tools of the PAM SI, specifically focused on stock assessments and climate change.



Workshop participants at the Southwest Fisheries Science Center in La Jolla, CA. Back row (left to right): Kourtney Burger, Candice Emmons, Becca Van Hoeck, Sofie Van Parijs, Shannon Rankin, Carrie Wall, Megan McKenna, Melissa Soldevilla, Genevieve Davis, Yvonne Barkley. Front row: Ludovic Tenorio, Erin Oleson, Catherine Berchok, Jennifer McCoullough, Marla Holt, Manolo Castellote, Jason Gedamke, Dan Woodrich, Taiki Sakai, Samara Haver, Annamaria DeAngelis, Ann Allen. Not pictured: Cory Hom Weaver.

# 2. National PAM Operational and Archival Cloud Storage Solutions

### 2.0.1 Target Outcome

Developing a National PAM Cloud operational repository for data processing and storage.

### 2.0.2 Project Team

| Sofie Van Parijs | Daniel Woodrich |  |
| --- | --- | --- |
| Ann Allen | Sofie Van Parijs | Ludo Tenorio |
| Taiki Sakai |  |  |

### 2.0.3 Summary

We will work collaboratively with NMFS OCIO to create our Google Cloud Project (GCP) architecture with data buckets for each FMC. We will have a phased approach to testing and growing the project depending on the hurdles, cost models and successes that we encounter. Once the GCP project is up and running we can have monthly check in calls. Along with our National PACM GCP project fulfills the PAM SI Operational Cloud objective.

### 2.0.4 Action Items

1. **Phase 1:** Stand up the GCP project (Dan/NMFS OCIO team). *Deadline: April 2024*
2. **Phase 2:**  Design performance evaluation metrics template (PAM SI GCP team). *Deadline: May 2024*
3. **Phase 3:** Upload 1 year long data sets for each of the following science centers: SEFSC, NEFSC, PIFSC, AKFCS (Dan w FMC data experts). *Deadline: June 2024*
4. **Phase 4:** Software phase I: Upload and test software that are ready for GCP transfer e.g. Google AI, PyPAM, PamGuard, Raven, INSTINCT  (NEFSC IT, Dan, Taiki). *Deadline: June - September 2024*
5. **Phase 5:** Flac revisit - Flac data and rerun all detectors for second time to evaluate difference between non Flac data (Dan, Ludo, Taiki). *Deadline: October 2024*
6. **Phase 6:** Evaluate software phase I cost model (Sofie). *Deadline: November 2024*
7. **Phase 7:** Software phase II - revisit other software needs and options, decide on cross PAM group software (web app, validation, metadata integration between PACM and this GCP repository)(Dan, PAM SI + broader team discussion, FMC data experts, Jeff Walker). *Deadline: November 2024 - March 2025.*
8. **Phase 8:** Rerun our evaluation tests from Phase 2 (all). *Deadline: March 2025*
9. **Phase 9:** Evaluate software phase II cost model (Sofie). *Deadline: April 2025*
10. **Phase 10:** Expand PAM data upload, expand to other groups/FMC (Dan w FMC data experts). *Deadline: May - August 2025*
11. **Phase 11:** Group effort to run software through the entire developed data pipeline (Dan w FMC data experts). *Deadline: September 2025 - March 2026.*
12. **Phase 12:** Report out on final established PAM GCP project and cost model (Sofie). *Deadline: April 2026*

# 3. NCEI Archiving

## 3.1 Project 1: National PAM Archival Storage: NCEI Archiving

### 3.1.1 Target Outcome

Building efficient workflows to archive large volumes of NMFS PAM data

### 3.1.2 Project Team

| Carrie Wall Bell | Jason Gedamke |  |
| --- | --- | --- |
| All Dataset POCs |  |  |

### 3.1.3 Summary

The NCEI Passive Acoustic Data (PAD) Archive team will work collaboratively with each NMFS FMC to develop configurable tools that will facilitate FMCs to prepare numerous datasets in a more automated way for archiving at NCEI. This will allow this collective group to meet the PAM SI goal of archiving 900 TB of data in three years (Objective 3) and make significant progress towards meeting NOAA PARR requirements.

### 3.1.4 Action Items

1. **Archive Breakdown:** FMCs are asked to update this [**spreadsheet**](https://docs.google.com/spreadsheets/d/1l-Dfh7DtM11FfrXrn1Ub9dqPl3uSQEd3yRSWiaK_eF0/edit#gid=0) with revised information based on the original table of datasets to archive found in [PAM SI proposal](https://docs.google.com/document/d/1BPkv6vRO97T9Vitud8Ng5ws7tudbtD-IF2NwzX4oRmU/edit) / [slide 12](https://docs.google.com/presentation/d/1TewDhV21FjX2ANAzedxMR5s_q94eciiu-iTafjJRUVM/edit#slide=id.g2c4705a5e9b_0_35). The request is to provide more details on prioritized datasets, target month(s) for data submission, identify POCs to work with the archive team, and describe how metadata are stored (e.g., spreadsheet, Oracle database). *Deadline: April, 2024.*
2. **FLAC Check:** Confirm FLAC conversion doesn’t alter audio values with Peter Dugan. *Deadline: April, 2024.*
3. **Kourtney’s Kode:** Kourtney will share her [Passive Packer process](https://sael-swfsc.github.io/SAEL-lab-manual/content/Data-Archive.html#ncei-data-archive) - using [semi automated code](https://sael-swfsc.github.io/adrift-analysis-methods/content/DataArchive/NCEI.html#passive-packer-resources) to convert [deployment metadata](https://docs.google.com/spreadsheets/d/1iyNaKKLbqSHK-iWLADO-YQMNaq4XVsIqYbaeHD2Z_AU/edit?usp=sharing) spreadsheet to Passive Packer ready database. *Deadline: April, 2024.*
4. **Metadata Madness:** Meeting with NCEI PAD team, Kourtney, Jeff Walker, and Gen Davis to review metadata fields and ensure alignment between NCEI Passive Packer / Kourtney’s code / PACM. *Deadline: May, 2024.*
5. **Bracing for the Data Tsunami:** NCEI PAD team assesses data prioritization and metadata information provided by the FMCs (Action 1) and outlines a plan for build the necessary capabilities into PassivePacker and the archive pipeline. *Deadline: June, 2024.*
6. **Call Me Maybe:** Establish bimonthly meetings with NCEI PAD team and POCs to ensure regular communication regarding progress of archive development tasks and FMC dataset preparation. *Deadline: July, 2024.*

List of PAM Projects to be provided to NCEI as outlined in the PAM SI proposal.

| FMC | **Project/Data Sets** | **Year of Delivery** | Data Type | Data Size | Data Location |
| --- | --- | --- | --- | --- | --- |
| NEFSC | AMAPPS | FY24 | Towed Array | 30 TB | Local Server |
| SWFSC | ETP (Digitize Analog) | FY24 | Towed Array | 5 TB | Analog Tape Drives |
| PIFSC | PacMAPPS - Pacific Islands | FY24 | Drifter, Towed Array | 100 TB | Local Server |
| SWFSC | ADRIFT (~100 datasets) | FY24 | Drifter, Soundscape metrics | 40 TB | Local Server |
| SWFSC | CCES (~20 datasets) | FY24 | Drifter, Soundscape metrics | 15 TB | Local Server |
| SWFSC | PASCAL (~30 datasets) | FY24 | Drifter, Soundscape metrics | 20 TB | Local Server |
| SEFSC | Rice’s whale Vessel Surveys | FY25 | Sonobuoy | 3 TB | External drives |
| PIFSC | Pacific Islands Passive Acoustic Network | FY25 | Bottom Mounted | 250 TB | Local Server |
| SWFSC | PacMAPPs - West Coast | FY25 | Drifter/Glider | 30 TB | Local Server |
| AFSC | All datasets | FY25 | Bottom Mounted | 65 TB | Local NAS and External drives |
| SEFSC | Rice’s whale moorings | FY26 | Bottom Mounted | 100 TB | Local Server |
| NEFSC | Southern New England Wind Energy Area | FY26 | Bottom Mounted | 300 TB | Local Server |
| OAP | NRS | FY26 | Bottom Mounted | 30 TB | Local Server |
| NWFSC | Outer Coast (Huff) | FY26 | Bottom Mounted | 30 TB | Local Server and External drives |
| NWFSC | PNW coastal recorder | FY26 | Bottom Mounted | 10 TB | Local Server and External drives |
| NWFSC | 2006 -2011 PODS | FY26 | Bottom Mounted | 5 TB | Local Server and External drives |

## 3.2 Project 2: Native to flac conversation

### 3.2.1 Target Outcome

A more time-efficient workflow that omits steps in the file conversion process prior to archiving.

### 3.2.2 Project Team

| Not Yet Defined |  |  |
| --- | --- | --- |

### 3.2.3 Summary

The goal of this effort will be to eliminate the time consuming step of converting native audio files into wav and then into flac by creating a workflow that directly converts native files into a flac format. It will also make progress on ensuring flac files will be accepted inputs from some of the most commonly used processing software.

### 3.2.4 Action Items

1. **Convert to FLAC:** Develop processing pipeline to save native data formats to flac. This will include three sub tasks:
   1. Establish a list of what the native file formats are that we want to evaluate going from native to flac. *Deadline: May, 2024*
   2. Determine the level of effort to convert the formats listed in subtask 1 to flac and who will complete that work. *Deadline: September, 2024*
   3. Create processing code to convert identified native file types to flac. *Deadline: Fall 2025*
2. **Process FLAC:** Update common analysis software to read flac. This will include three sub tasks:
   1. Establish a list of standard software to develop this capacity. *Deadline: May, 2024.*
   2. Determine what is needed to adjust the software list in subtask 1 to input flac files. *Deadline: September, 2024.*
   3. Issue contract to complete the work identified in subtask 2. *Deadline: Spring 2025*

# 4. PAM Data Integration for Climate and Long-Term Data Trends

### 4.0.1 Target Outcome

To advance data integration in support of creating tools for climate change applications with PAM data and to develop new tools for integration of PAM and environmental data to support climate change investigations.

### 4.0.2 Project Team

| Genevieve Davis | Catherine Berchok |  |
| --- | --- | --- |
| Candice Evans | Ann Allen | Melissa Soldevilla |
| Manolo Castellote | Shannon Rankin | Samara Haver |
| Taiki Sakai |  |  |

### 4.0.3 Summary

We will create a streamlined workflow to integrate PAM data with necessary ancillary datasets to address questions relevant to climate change and long-term species trends. This workflow will include: identifying PAM data to be included; identifying the climatological data to be included; creating tools for accessing, formatting, and integrating a subset of these data streams; and using these tools and approaches broadly across all regions and species of interest. The first goal of this project is a comparison of humpback whale occurrence trends nationwide. All regions will submit and format their humpback detection data into the Passive Acoustic Cetacean Map database.The second goal will be to identify and create tools to access and apply relevant climate data on the humpback whale dataset. This workflow will allow for a national comparison of one species to be able to identify and compare changes (or lack thereof) within and across regions. Once this structure has been established, these standardized data formats, tools, and environmental data needs can be applied across the range of project goals and regional needs, including regional-specific high-profile species. This project directly supports the PAM SI objective to advance PAM data analysis and integration approaches with an emphasis on addressing long-term trends.

### 4.0.4 Action Items

1. **Data Identification:** Identify existing humpback detection data sets to be included. *Deadline: May, 2024*
2. **Environmental data identification:** Identify environmental data (i.e. parameters, spatio-temporal range, source) to integrate with daily PACM output. *Deadline: May, 2024.*
3. **Format data to PACM:** Get humpback detection data formatted and submitted into PACM, on an hourly or daily scale. This phase includes meetings, as-needed tutorials, as well as identifying and developing the tools needed. *Deadline: December, 2024.*
4. **Access and aggregate detection data from PACM:** Pull humpback detection data from PACM in standardized format aggregated at daily scale. This phase includes meetings, tutorials, identifying and developing tools as needed. *Deadline: January, 2025.*
5. **Develop and refine workflow:** Develop and refine processing workflow that extracts identified environmental data from various sources and integrates with daily PACM outputs. Includes (Taiki) creating open source / github hosted repo that is tested and implemented across FMCs. *Deadline: May, 2025.*
6. **Identify additional data:** Identify which additional data (regional-specific or other species-specific data) we’d want tools for to help predict movements and move towards addressing climate-related questions. *Deadline: May, 2026.*
7. **Output products:** Identify and draft collaborative questions, papers, products to compare across FMC’s and regions. *Deadline: July, 2026.*
8. **Aspirational next steps:** Explore methods for incorporating additional PAM data into workflow from other platforms (mobile or drifting data) or from AI tools for species detection, as available. *Deadline: August, 2026.*

# 5. PAM Data Integration for Stock Assessments

## 5.1 Project 1: **Improving Sperm Whale and Beaked Whale Density Estimation from towed arrays**

### 5.1.1 Target Outcome

Expanding regional applications and improving functionality of an existing tool to support density estimation through application of a distance sampling framework.

### 5.1.2 Project Team

| Yvonne Barkey |  |  |
| --- | --- | --- |
| Melissa Soldevilla | Annamaria DeAngelis | Jennifer McCoullough |

### 5.1.3 Summary

Incorporation of passive acoustic information in stock assessment reports necessitates density estimation. Current methods for density estimation are time consuming or only tested in region- and species-specific datasets. This project will improve functionality of the existing multi-target tracking tool that is used by PIFSC to extract perpendicular distance information from data to support density and abundance estimation. Work will include testing, modifying, and validating the tool on Sperm Whale and Beaked Whale datasets from multiple regions (NEFSC, SEFSC). The outcome of this project would support the PAM SI objective of data integration to support stock assessments by advancing the technology readiness of PAM inclusion in Stock Assessment Reports in multiple NOAA Fisheries regions.

### 5.1.4 Action Items

1. **Identify challenges:** Yvonne and Jen gather possible array parameters that might break the multi-target tracking tool and meet with Pina to discuss the expected investment required to adapt the tool. *Deadline: April 2024*
2. **Prepare test datasets:** Gather test datasets from NE/SE/PI. *Deadline: May 2024*
3. **Training on Multi-target tracking tool:** Yvonne and Pina will train others on executing the tool in MATLAB. *Deadline: August 2024.*
4. **Test cases:** Basic assessment of the tool on NE and SE datasets to identify bugs *Deadline: December 2024*
5. **Resolve bugs:** Pina or others address usability needs of all users. *Deadline: July 2025*
6. **Aspirational step to improve tool:** If time and capacity allows, consider attempting to integrate depth estimation for more accurate horizontal distance estimation for deep divers based on Yvonne/Annamaria’s work. *Deadline: July 2026.*

## 5.2 Project 2: Incorporating glider data in a species distribution modeling framework

### 5.2.1 Target Outcome

Advancing the accuracy of stock assessments to capture seasonal and long-term changes using glider PAM datasets.

### 5.2.2 Project Team

| Yvonne Barkey | Janelle Badger |  |
| --- | --- | --- |
| Shannon Rankin | Selene Fregosi | Danielle Harris |
| Erin Heloise | Jason Roberts |  |

### 5.2.3 Summary

This project would support the PAM SI objective of advancing data integration by leveraging glider-based PAM data and visual data to improve the accuracy of stock assessments by capturing seasonal and long-term changes. This project would focus on developing a statistical framework for integrating a density model created with glider PAM data with existing visual-based SDMs to achieve more accurate models with seasonal context. This project is ideally leveraging OPR Climate IRA funding proposed by Badger & Whitney, if funded.

### 5.2.4 Action Items

1. **Evaluate state of the science:** Connect with CREEM and other colleagues to assess the state of the science. *Deadline: May 2024*
2. **Evaluate resources required:** Evaluate required funding depending on other proposals and staffing. *Deadline: May 2024*
3. **Identify datasets and species:** Collect and collate PI, SE, and SW glider data and identify priority species for modeling based on data availability and management needs (e.g., deep-divers). *Deadline: August 2024*
4. **Assess analytical next steps:** Establish working group to assess suitable modeling frameworks that fit glider data. February 2025

## 5.3 Project 3: Incorporating stationary data into a species distribution modeling framework

### 5.3.1 Target Outcome

Advancing the accuracy of stock assessments to capture seasonal and long-term changes using long-term PAM datasets.

### 5.3.2 Project Team

| Lance Garrison |  |  |
| --- | --- | --- |
| Melissa Soldevilla | Ann Allen | Genevieve Davis |
| Manolo Castellote | Marla Holt | Alba Solsona Berga |
| Jason Gedamke | Jason Roberts | Laura Feyrer |

### 5.3.3 Summary

This project would support the PAM SI objective of advancing data integration by leveraging stationary PAM data and visual data to improve the accuracy of stock assessments by capturing seasonal and long-term changes. This project would focus on developing a statistical framework for integrating a density model created with stationary PAM data with existing visual-based SDMs to achieve more accurate models with seasonal context. This project is ideally leveraging LISTEN GoMex funding to develop models for sperm whales and beaked whales.

### 5.3.4 Action Items

1. **Establish collaboration:** Meet with Lance Garrison to identify his interest and willingness to convene a working group to support his ongoing effort and work towards broader applicability of the outcomes. *Deadline: April 2024*
2. **Identify resources required:** Evaluate whether LISTEN GoMex requires more resources to make these methods broadly applicable. *Deadline: April 2024*
3. **Establish project team:** Establish working group to meet periodically with the LISTEN GoMex team to assess viability. *Deadline: May 2024*
4. **Expand capacity:** Advertise post-doc position to support this effort. *Deadline: June 2024*

# 6. PAM Data Integration for Soundscape Analyses, Metrics, and Tools

## 6.1 Project 1: Soundscape metric processing and archiving

### 6.1.1 Target Outcome

Identify, archive, and process soundscape metrics for priority SI PAM datasets to build capacity and consistency across FMCs.

### 6.1.2 Project Team

| Samara Haver |  |  |
| --- | --- | --- |
| Megan McKenna | Marla Holt | Catherine Berchok |
| Melissa Soldevilla | Carrie Wall Bell | Dan Woodrich |
| Karli Merkens | Becca Van Hoeck |  |

### 6.1.3 Summary

This project will add soundscape metrics for priority SI PAM datasets alongside audio files and other metrics to the NCEI Passive Acoustics archive. The soundscape metrics will be used to develop and demonstrate soundscape interpretation and visualization tools being developed as part of the SI. The datasets will also facilitate comparison of data sampled by multiple recording technologies and projects that are unique to select FMCs. A technical guide for processing and archiving PAM data will also be prepared as part of this project. This project will work with SI cloud computing projects to operationalize soundscape metric processing software in the cloud environment. Streamlining and documenting methods to process and archive soundscape metrics supports PAM SI objectives to advance PAM data analysis and integration approaches, and advance archival cloud capabilities.

### 6.1.4 Action Items

1. **Convene working group:** Establish data processing group, [Google doc folder](https://drive.google.com/drive/folders/1PBQbyajbFgidBvQER1vFL6e_WEQZSLm0?usp=drive_link), regular check-in schedule. *Deadline: March 2024*
2. **Establish software standards:** Standard software options available for use for use with test NRS dataset results from multiple softwares. *Deadline: May 2024 (MANTA, PyPAM), any other by Sept 2024*
3. **Identify priority datasets:** In coordination with Carrie Wall Bell and NCEI Archiving group decide on soundscape priority datasets for each FSC and flag in the overall SI priority [dataset table](https://docs.google.com/presentation/d/1TewDhV21FjX2ANAzedxMR5s_q94eciiu-iTafjJRUVM/edit#slide=id.g2c4705a5e9b_0_35). *Deadline: April 2024.*
4. **Prepare analyses:** For priority soundscape datasets: Prep metadata, Share QA/QC protocol/tools, PassivePack and archive audio data to NCEI. *Deadline: April 2024 - December 2024*
5. **Create supporting documents:** Develop technical reports and videos on processing, included data, minimum QA/QC in coordination with SoundCoop efforts. *Deadline: March 2024 - December 2024*
6. **Test in pyPAM:** Coordinate with PAM SI Cloud team to test pyPAM cloud processing from NCEI GCP on priority NRS audio data sets. *Deadline: June 2024 (pending pyPAM software development com*
7. **Compare soundscape software options:** Provide soundscape software options available (MANTA, pyPAM, updated Triton toolbox, etc.) with comparison documentation for example datasets (NRS or others if necessary). *Deadline: December 2024*
8. **Generate Hybrid milli-decade output:** FMCs will conduct HMD processing either locally or through the PAM SI Cloud computing and save to NCEI or internal PAM SI cloud environment. *Deadline: Jan 2025 - March 2025*
9. **NCEI archive data products:** All HMDs will be processed and sent to NCEI archive for level 2-3 data products. *Deadline: March 2025*
10. **Facilitate more complex soundscape analyses:** All priority soundscape datasets and HMD level 1 products will be cloud archived at NCEI or NODD for use in the Soundscape interpretation and visualization project. *Deadline: March 2025*
11. **Support comparison across platforms:** Comparison of soundscape metric results from simultaneously deployed platforms; develop tools to support this type of comparison (ie. PAMscapes). The data processing groups will establish methods for comparison, ongoing opportunistic evaluation will occur throughout the SI, and results will be added to the GitHub Soundscape Group and reported with example datasets. *Deadline: Dependent on participation*

| Lead | Platform 1 | Platform 2 |
| --- | --- | --- |
| Catherine Berchok | Aurals | SoundTrap |
| Melissa Soldevilla | HARP | SoundTrap |
| Marla | EAR | SoundTrap |
| Jason Gedamke/Samara Haver | Haruphone | SoundTrap |

1. **Support comparison across datasets with known differences:** Develop a format or tool to support comparison of datasets with known differences, such as perfect timing (MARS), dropped time (SoundTrap), duty cycled (AK, NW), frequency-dependent calibration (NRS, HARP), file format (XWAV). *Deadline: Dependent on participation*

## 6.2 Project 2: Soundscape metric interpretation and visualization

### 6.2.1 Target Outcome

Create a set of soundscape metric interpretation open-source processing pathways and visualizations for cross-FMCs comparisons and FMCs-specific soundscape priorities.

### 6.2.2 Project Team

| Samara Haver | Megan McKenna |  |
| --- | --- | --- |
| Becca Van Hoeck | Marla Holt | Catherine Berchok |
| Melissa Soldevilla | Carrie Wall Bell | Dan Woodrich |
| Karli Merkens | Genevieve Davis | Sofie Van Parijs |
| Jason Gedamke |  |  |

### 6.2.3 Summary

This project will build on existing tools in PAMscapes (R/CRAN) to create and document processing pathways for soundscape metric interpretation. NOAA Noise Reference Station soundscape metrics will be used to build the pathways and evaluate outputs. Additional soundscape metrics from SI priority data sets will be incorporated based on availability from priority project #1 for soundscapes. This priority supports SI objective #2 by creating decision-support tools that are relevant at regional and national scales. It also supports #4 by integrating PAM data with variables to provide context for different soundscapes (environmental data, species-detections, etc).

### 6.2.4 Action Items

1. **Establish working group:** Establish working group and create folder in shared Google doc folder. *Deadline: March 2024*
2. **Identify datasets:** Decide on priority Noise Reference Stations (NRS) datasets for metric development. *Deadline: April 2024*
3. **Data products to NCEI:** NRS Hybrid Milli-Decade (HMD) products to be included in initial comparison sent to NCEI. *Deadline: May 2024*
4. **Identify visualization options:** Organize and expand on options for HMD data visualizations as originally prepared for PAMscapes, share with working group via Google doc folder for discussion of level 1 visualization goals. Ideas and inspiration will be organized for project team brainstorm and feedback meeting*. Deadline: July 2024*
5. **Develop workplan:** Set-up work plan with Taiki Sakai to evaluate HMD QA/QC with visualizations in PAMscapes including level 1 visualizations such as percentiles, LTSA, and bringing together MANTA and pyPAM default output. *Deadline: June 2024*
6. **Present initial results:** Updated PAMscapes tool for HMD QA/QC level 1 visualization will be shared with project team for feedback and further development. *Deadline: December 2024*
7. **Level 2 data product planning:** In coordination with QA/QC tool development, and informed by ongoing collaboration with SoundCoop partners, the Soundscape group will develop level 2 visualization for HMD output by: integrating environmental data (currents, wind, ice, etc) and time/frequency bins for quantitative visualization (e.g., SPD). The option to integrate these visualization as additional PAMscapes functionality or publish as separate code on GitHub will be evaluated. *Deadline: March 2025 (discuss and gather feedback at 2025 SI Workshop)*
8. **Level 3 data product planning:** Plan the development level 3 products from HMD that prioritize and reflect the needs of SI and FMCs including: integration with PACM; noise budgets; sound propagation; automated soundscape analysis; co-variate for species models; categorization from HMD data; repository of labeled HMD data; integration of AIS data. . *Deadline: Working group meeting at 2025 SI Workshop*
9. **Cloud processing:** Following Cloud Computing project Phase 7 (Software phase II validation), conduct cloud processing for HMD and PAMscapes to apply relevant methods on FMCs priority datasets. *Deadline: 2025 -2026 in coordination with Dan/Cloud team, Taiki, PyPAM development team*
10. **Facilitate national comparisons:** Develop additional products orvisualizations for nationwide comparison of FMC priority soundscapes. *Deadline: Report out at March 2026 meeting for broader group feedback*
11. **Present project outcomes:** Present tested and functional cloud processing routines for level 1-3 products for all priority data sets for PAM SI reporting and additional science needs. *Deadline: End of project - 2026*

# 7. PAM Data Integration for Acoustic Detection Software

## 7.1 Project 1: Create a list of current tools

### 7.1.1 Target Outcome

Identify the passive acoustic tools currently used and in development as well as strategize what tools are needed to efficiently analyze passive acoustic datasets.

### 7.1.2 Project Team

| Annamaria DeAngelis (NEFSC) | Taiki Sakai (SWFSC/NEFSC) |  |
| --- | --- | --- |
| Jennifer McCullough (PIFSC) | Daniel Woodrich (AFSC) | Cory Hom-Weaver (SWFSC) |
| Candice Emmons (NWFSC) | Ludovic Tenorio (SEFSC) |  |

### 7.1.3 Summary

Create a National table in GitHub that describes what software/tools are available NOW (what species they cover, are they multi/single species, is it retrainable, is it single/cross platform, how stable/mature, where can you find the documentation on how to use them / is there documentation on them)? This supports the National PAM SI Data Integration objective.

### 7.1.4 Action Items

1. **Create table template:** Create a table template and share with PAM SI folks. Each FMC lead compiles a list of detectors/classifiers/ancillary tools used by their lab . Include which tools need to be Cloud compatible. POCs: Annamaria DeAngelis & Jennifer McCullough *Deadline: June, 2024.*
2. **Research Matlab compiler:** Learn how to use the Matlab Compiler Toolbox to create standalone Matlab executables for Matlab code. POC: Ludovic Tenorio *Deadline: June, 2024.*
3. **Tool conversion:** Identify which tools need slight modifications/conversion to open source programming language or wrappers, including which tools should go to R vs Matlab. POCs: Annamaria DeAngelis, Taiki Sakai, Ludovic Tenorio *Deadline: September, 2024.*
4. **Push to National GitHub:** Be sure that all documentation is in the correct spot in the National GitHub repository. POC: Annamaria DeAngelis *Deadline: Contingent on GitHub National Development.*

## 7.2 Project 2: Create a list of future long-term tool needs

### 7.2.1 Project Team

| Daniel Woodrich (AFSC) |  |
| --- | --- |
| Jennifer McCullough (PIFSC) | Annamaria DeAngelis (NEFSC) |
| Sofie Van Parijs (NEFSC) | Taiki Sakai (SWFSC/NEFSC) |

### 7.2.2 Summary

Create a cross FMC list of short term and long term software development needs. Create a table in GitHub to coordinate the software needs of the various centers in one location. This will include both short-term needs that might need development during the IRA funding window, as well as long-term needs that more serve to guide any potential free development time. This supports the National PAM SI Data Integration, archiving, and decision support tool objectives.

### 7.2.3 Action Items

1. **Create wish list:** Create and curate a living document of what it is that is needed for detector software. POC: Daniel Woodrich *Deadline: December, 2025.*
2. **Push to National GitHub:** Be sure that all documentation is in the correct spot in the National GitHub repository. POC: Annamaria DeAngelis *Deadline: Contingent on GitHub National Development.*

## 7.3 Project 3: Create a list of annotated datasets

### 7.3.1 Project Team

| Canidce Emmons (NWFSC) |  |  |
| --- | --- | --- |
| Jennifer McCullough (PIFSC) | Annamaria DeAngelis (NEFSC) | Jennifer McCullough (PIFSC) |
| Sofie Van Parijs (NEFSC) | Taiki Sakai (SWFSC/NEFSC) | Ludovic Tenorio (SEFSC) |
| Cory Hom-Weaver (SWFSC) |  |  |

### 7.3.2 Summary

Create a table in GitHub listing the annotated datasets available at various FMCs. The table will contain the species that are annotated, availability of the underlying data, and point of contact. Users will also be encouraged to upload these annotations when archiving data with NCEI if applicable. This supports our ability to develop and test new detection and classification algorithms by creating a centralized list of the potential training data that might be available, which is a key component of developing new tools. This supports the National PAM SI Data Integration and archiving objective.

### 7.3.3 Action Items

1. **Create dataset annotation table on GitHub:** Create table on GitHub listing annotated datasets at centers. POC: Candice Emmons *Deadline: July, 2024.*
2. **Keep up to date with NCEI:** When archiving with NCEI, include annotations if available/applicable. *Deadline: As needed.*

# 8. PAM Data Integration and SI Coordination through GitHub

## 8.1 Project 1: PAM SI Coordination

### 8.1.1 Target Outcome

Efficient and effective coordination of the PAM Strategic Initiative to support successful implementation.

### 8.1.2 Project Team

| Rebecca Van Hoeck | Sofie Van Parijs | PAM SI Working Group |
| --- | --- | --- |

### 8.1.3 Summary

The PAM SI consists of multiple objectives and priority projects with various subsets of the full PAM SI working group. Coordination of the PAM SI through GitHub will serve to create an easy to access record of PAM SI meetings, provide project management support, and facilitate learning of how to collaborate through GitHub.

### 8.1.4 Action Items

1. **Workshop Report:** Generate and finalize the March 2024 PAM SI Workshop Report. *Deadline: April 2024*

* **Identify Coordination Needs:** Define high priority coordination needs and workflows based on workshop discussion. *Deadline: April 2024.*

1. **Coordinate with UxS SI:** Check in on Pacific Glider objectives and develop a PAM Glider Repository to be shared with the PAM SI. *Deadline: June 2024 (start)*
2. **Ongoing Coordination:** Continue coordination of the PAM SI priority objectives through GitHub Issues, Project cards, and Discussions. *Deadline: ongoing throughout SI.*

## 8.2 Project 2: Create National PAM Sharing Structure

### 8.2.1 Target Outcome

Enhance National PAM collaboration among the NOAA Fisheries Science Centers through a common GitHub structure.

### 8.2.2 Project Team

| Rebecca Van Hoeck | Sofie Van Parijs | Kourtney Burger |
| --- | --- | --- |
| Science center representatives TBD |  |  |

### 8.2.3 Summary

A priority objective of the IRA PAM Strategic Initiative is to streamline analytical and data integration to remove redundancy and increase cross-FMC efficiencies. To achieve this objective, a framework for improved information sharing across the FMC’s is required. This project will create a standardized method of information sharing across the NOAA Fisheries science center PAM teams through GItHub. By hosting the sharing on GitHub we will create a foundation for sharing beginning with information sharing and building to more complex sharing of specific analysis protocols, data outputs, and other necessary tools.

### 8.2.4 Action Items

1. **GitHub training:** Kourtney will train Becca on how to create a GitHub lab manual. *Deadline: March 2024*
2. **Develop and demonstrate National PAM Sharing Structure:** Develop and demonstrate the National and Regional PAM Sharing structures with SWFSC and NEFSC use case examples. *Deadline: May 2024.*
3. **Establish NMFS PAM Team:** Establish NOAA Fisheries PAM GitHub Team on the Office of Science and Technology GitHub Organization. *Deadline: June 2024*
4. **Publish National PAM Github Lab Manual:** Publish a National PAM Github Lab Manual on Github. *Deadline: July 2024*
5. **Create Regional PAM Lab Manuals:** Support each science center in creating a lab manual that aligns with the National sharing structure. *Deadline: October 2024*
6. **Expand information sharing:** Add the lists created by the Acoustic Detection Software team to the National PAM GitHub. *Deadline November 2024*
7. **Convene GitHub working group:** Convene a working group of Pam SI members to continue discussing how to advance PAM sharing for analysis, QA/QC methods, and protocols, etc. *Deadline: January 2025*

## 8.3 Project 3: Participate in OpenScapes

### 8.3.1 Target Outcome

Facilitate learning and effective collaboration while creating the NMFS PAM Sharing structure.

### 8.3.2 Project Team

| Rebecca Van Hoeck | Shannon Rankin |  |
| --- | --- | --- |
| Science center representatives TBD |  |  |

### 8.3.3 Summary

OpenScapes is an open science initiative to support more efficient collaboration and better science. Through a cohort based short-term sprint, participants are provided resources and training to support open science collaboration. Pending finalization of the NOAA Fisheries OpenScapes contract, the PAM SI team plans to have one representative from each science center participate in the 2024 cohort to develop the NMFS PAM Sharing structure (see previous project) in real-time, while bringing the lessons learned back to their broader science center PAM group. Participation in OpenScapes would build foundational knowledge and practical experience collaborating to support successful implementation of all PAM SI objectives and priority projects.

### 8.3.4 Action Items

1. **Confirm OpenScapes cohort:** NOAA Fisheries in the process of establishing a sole source contract with OpenScapes for a May 2024 cohort, we will stay informed of the progress of this contract. *Deadline: April 2024*
2. **Sign-up for OpenScapes:** Pending confirmation of the OpenScapes cohort, Shannon will confirm that the PAM team is registered for the cohort. *Deadline: April 2024.*
3. **Identify cohort:** Each science center will recommend at least one participant for the OpenScapes cohort who can dedicate at least 3 hours a week to the collaboration. *Deadline: April 2024*
4. **Convene cohort:** The PAM team will convene a meeting prior to the start of the OpenScapes cohot to discuss and agree on project priorities. *Deadline: April 2024*
5. **Participate in OpenScapes:** OpenScapes is a 6-week sprint scheduled to begin in May 2024 *Deadline: June 2024*
6. **Report back to Science Centers:** Following conclusion of the cohort we will facilitate knowledge sharing between the science center representatives and the broader regional PAM teams. *Deadline July 2024*

Potential GitHub Uses for PAM

| Use | Urgency | Importance | Complexity | Barrier to Entry |
| --- | --- | --- | --- | --- |
| More efficient QA/QC | High | High | Med | Med |
| Standardized Analyses | Med | High | High | High |
| PAM SI Coordination | High | High | Med | High |
| Standardized data outputs & associated code | Med | High | High | Med |
| Hardware Uses/Methods | High | High | Low | Low |
| Lab Manuals | Low | High | Low | Med |
| Reporting templates | Low | Med | Med | Med |
| Analysis protocols | Med | High | High | Low |

# 9. Management Outcomes and Tools

### 9.0.1 Target Outcome

One of the primary goals of the IRA Climate Ready Fisheries Strategic Initiatives (SI) is to modernize stock assessments to account for climate change by investing in advanced technologies and data modernization. In support of this goal, the PAM SI held a brainstorming session centered around the target management tools, metrics, and strategies we strive to achieve through the SI. This session included two separate, but connected discussions, one on stock assessments and one on climate trends. The outcomes of both discussions highlighted numerous ways we can demonstrate the effectiveness and benefits of PAM for inclusion in stock assessments and monitoring long-term trends as well as areas for advancement of PAM methods and tools. We split the discussion into three parts, tools, metrics and strategies.

### 9.0.2 Discussion Leads

| Sofie Van Parijs | Jason Gedamke |
| --- | --- |

### 9.0.3 Summary

*Stock Assessments:*

**Priority tools** identified to advance incorporation of PAM data in stock assessments focused on visualizations that demonstrate changes in species distribution over time, where PAM data can fill gaps in existing traditional sampling efforts, and integrate multiple data outputs with existing visualization tools such as the Passive Acoustic Cetacean Map (PACM).

Relevant **management metrics** discussed highlighted the need for incorporation of soundscape metrics and noise budgets in Biological Opinions and other NMFS evaluations in order to provide species condition reports in addition to summarizing trends in relative density or abundance and other metrics to be used as a proxy for abundance.

**Identified strategies for management** outcomes focused on highlighting the value of PAM and soundscape monitoring to stock assessments, specifically through decision support tools (e.g. PACM), questions that could be answered with greater understanding of PAM data, co-benefits of PAM (ie. reducing vessel strike and entanglement risk), and expanding SARS to include PAM monitoring data.

*Climate trends:*

**Priority tools** discussed focused on the value of data integration - passive acoustics, environmental variables, soundscape metrics, AIS tracks, fishing metrics, species distribution model outputs - to support evaluation of long-term trends and cross-site comparisons as well as inclusion in visualizations or decision support tools.

Key **metrics to support management** included developing metrics of species distribution change, specifically a metric that aligns with oceanographic metrics of climate change, such as anomaly from an average. Additional key metrics included developing engagement reports for managers from decision support tools, such as PACM, and metrics of ambient noise, noise exceedance, and acoustic data for inclusion in site/regional condition reports.

**Strategies** to advance the management applications of PAM included expanding existing efforts to support regional functionality (ie. SoundCoop), engaging with users of PAM tools, contributing PAM Data to State of the Ecosystem reports, and calculating year-long noise exposure for an animal throughout its migration.

### 9.0.4 Management goals for the IRA PAM SI efforts

1. **Develop a National PAM Decision Support Tool:** Expand the Passive Acoustic Cetacean Map (PACM) to be a National tool, including evaluating need for additional functionality with the PAM SI and provide learning opportunities for PACM users to promote understanding and proper use of the tool.
2. **Expand inclusion of PAM data in management documents and requirements:** The PAM SI will identify NMFS management documents and requirements where PAM data can improve knowledge of stock assessments or climate change (ie. Biological Opinions, SAR, CEFI, State of the Ecosystem reports, etc.). We will work to add relevant PAM data and showcase the value added in several examples.
3. **Work towards an integrative environmental trends and PAM Decision Support tool:** The PAM SI working group will:
   1. Explore the creation of a portal-based tool following the examples of SoundCoop and SanctSound.
   2. Identify desired data sources - passive acoustics environmental variables, soundscape metrics, AIS tracks, fishing metrics, species distribution model outputs
   3. Develop several PAM metrics to support evaluation of long-term species or environmental trends and cross-site comparisons for inclusion in the tool. Including, calculating year-long noise exposure for an animal throughout its migration, and developing metrics for quantifying changes in species distribution relative to environmental change

# 10. List of Attendees

List of Attendees

| Names | Affiliation | Email |
| --- | --- | --- |
| Manolo Castellote | Alaska Fisheries Science Center | manuel.castellote@noaa.gov |
| Carrie Wall Bell | Cooperative Institute for Research in Environmental Sciences | carrie.wall@noaa.gov |
| Genevieve Davis | Northeast Fisheries Science Center | genevieve.davis@noaa.gov |
| Shannon Rankin | Southwest Fisheries Science Center | shannon.rankin@noaa.gov |
| Marla Holt | Northwest Fisheries Science Center | marla.holt@noaa.gov |
| Ann Allen | Pacific Islands Fisheries Science Center | ann.allen@noaa.gov |
| Taiki Sakai | Southwest Fisheries Science Center | taiki.sakai@noaa.gov |
| Sofie VanParijs | Northeast Fisheries Science Center | sofie.vanparijs@noaa.gov |
| Samara Haver | Cooperative Institute for Marine Ecosystem Resources Studies | samara.haver@noaa.gov |
| Rebecca Vanhoeck | Northeast Fisheries Science Center | rebecca.vanhoeck@noaa.gov |
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| Jennifer Keating | Pacific Islands Fisheries Science Center | jennifer.mccullough@noaa.gov |
| Jason Gedamke | Office of Science & Technology | jason.gedamke@noaa.gov |
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| Daniel Woodrich | Alaska Fisheries Science Center | daniel.woodrich@noaa.gov |
| Annamaria DeAngelis | Northeast Fisheries Science Center | annamaria.deangelis@noaa.gov |
| Cory Hom-Weaver | Southwest Fisheries Science Center | cory.hom-weaver@noaa.gov |
| Kourtney Burger | Southwest Fisheries Science Center | kourtney.burger@noaa.gov |
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| Candice Emmons | Northwest Fisheries Science Center | candice.emmons@noaa.gov |
| Ludovic Tenorio | Southeast Fisheries Science Center | ludovic.tenorio@noaa.gov |
| Erin Oleson | Pacific Islands Fisheries Science Center | erin.oleson@noaa.gov |

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