FOSSA

Free and Open-Source Software for Acoustics

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NOAA FISHERIES SERVICE

Key Benefits:

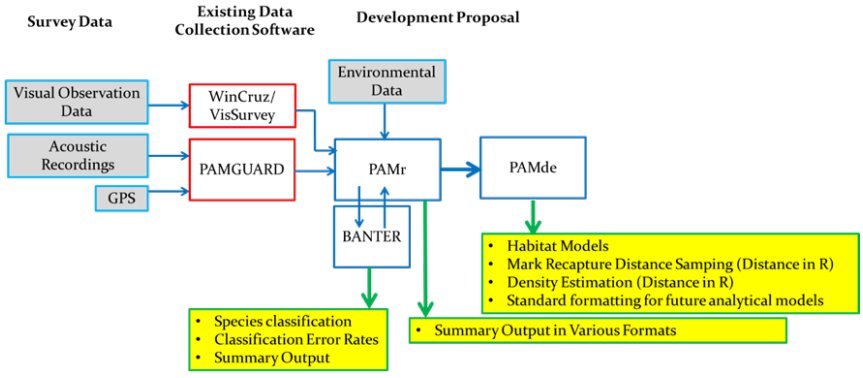
- *Free*
- *Transparent (open-source code)*
- *Reproducible Results*
- *Rapid Development*
- *Continuous Evolution*
- *Integrated Machine Learning*

Note: These products are in development and not yet publicly available. This document is for your information; details provided are subject to change.

Passive Acoustic Data Processing

An open-source, flexible, standardized approach to acoustic data analysis

Researchers at NOAA's Southwest Fisheries Science Center are developing FOSSA, a series of open-source software packages that can be used to efficiently process and analyze passive acoustic data. Built on the open source, multi-platform language, R, these three packages will consist of: (1) functions to extract acoustic metadata, integrate it with ancillary data, and generate summaries and output for downstream analyses (PAMr, in development), (2) a powerful and systematic method for cetacean species classification using passive acoustics (BANTER, complete), and (3) a package for the coordination of acoustic cetacean population assessment tools (PAMde, 2020). These will be designed to work seamlessly with acoustic data collected & analyzed with Pamguard software; however, its utility will apply broadly to acoustic data. Ultimately, the analytical advancements provided by BANTER, PAMr, and PAMde will allow for efficient, standardized results that can be quickly produced with minimal human intervention.



General flowchart showing how BANTER and PAMr work with existing data and software for acoustic analysis.

PAMr

The PAMr package serves as a toolbox for the extraction and formatting of acoustic detection data, integration of BANTER classifications and ancillary metadata for efficient data summary and advanced analyses. Functions provided by PAMr will include measurement of calls extracted from Pamguard software, integration of acoustic data with visual & environmental data, production of data summaries and reports, and formatting and export of data for downstream analyses.

The standard formatting provided by PAMr will facilitate addressing big data questions using machine learning and artificial intelligence.

BANTER

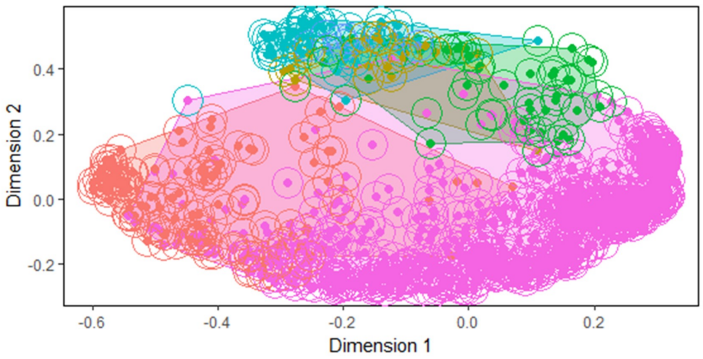
BANTER is a flexible, hierarchical machine learning algorithm for acoustic classification of marine mammal 'events' [https://doi.org/10.1111/mms.12381]. BANTER has been developed into a user-friendly and generalizable structure that could be applied to different regions and taxa. BANTER requires minimal human intervention, providing more consistent results with fewer biases and errors, and produces a classification error rate based on the probability of assignment to all species that the model was built on. BANTER has been developed to work seamlessly with PAMr and will permit incorporation of ancillary data, including visual sighting data and open-access environmental data. Future development will include consideration of additional visualizations to assess classifier performance and uncertainty.

PAMde

Beginning in 2020, we will develop PAMde, a package for applying acoustic data to cetacean population assessment, including density estimation and habitat modeling. Population assessment using acoustic methods is a new and rapidly advancing field. Each species has its own unique limitations and challenges, thus there is no single way to approach acoustic population assessments. The two greatest hurdles to applying acoustic data to appropriate population assessment methods is the process of compiling and formatting data (which will now be facilitated by PAMr) and acoustic species classification (now facilitated by BANTER). Our approach in the development of PAMde is to provide an integrated platform that will incorporate available methods while remaining flexible as the field matures in the future. Specifically, PAMde will be developed along three paths: (1) applying acoustic data to existing R packages, (2) integrating existing methods into R, and (3) collaborating on the development of novel population assessment methods.

Training

These software packages are currently under development and there is no documentation yet available. We will seek funding to develop training modules and perhaps provide training workshop at conferences (e.g., Society of Marine Mammalogy). We will advertise when this software is publicly available and when we have opportunities (or documentation) for training. *Please be patient!*



Visualizations provided by BANTER acoustic classifier include the Proximity Plot (above) for beaked whale events from Random Forest models.

More About Us…

This project has been funded by NOAA's Advanced Sampling Technology Working Group and the Southwest Fisheries Science Center.

The intention of this project is to develop a suite of open-source software packages that will allow for high quality systematic collection and analysis of passive acoustic data in an efficient and (relatively) easy user format. This software is very much in development, and all of the information provided is subject to change. In the near future, we hope to secure funding for develop training materials. ***We will advertise on the marmam listserv when this is available.***

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Note: This software is not yet ready for dissemination, so we are unable to field general (or specific!) inquiries. We will advertise when the programs are available for general use.