[1]UC Santa Barbara, Santa Barbara, California 93106
[2]Scripps Institution of Oceanography, 8622 Kennel Way, La Jolla, CA 92037

Navigating Waves of Data: Unifying Marine Mammal Surveys through Interactive Data Compilation and Analysis

Luis Barajas,[1] Sam Guimte,[1] Justin Kim,[1] Kaitlyn Lee,[1] Yoobin Won,[1] Ryan Yee,[1] Puyuan Zhang,[1] Michaela Alksne,[2] Lauren Baggett,[2] Julie Dinasquet,[2] Bryce Ellman,[2] Nastassia Patin,[2] Erin Satterthwaite,[2] Brice Semmens,[2] Simone Baumann-Pickering[2]

Summary

As new technologies emerge, traditional ship-based marine mammal surveys have been enhanced through a suite of measurements including environmental DNA (eDNA) and passive acoustic monitoring. Marine mammals are monitored on quarterly California Cooperative Oceanic Fisheries Investigation (CalCOFI) surveys using these methods contemporaneously. Long-term, contemporaneous multimodal datasets are rare yet critical for mapping species distribution and abundance, as well as for revealing the limitations of different sampling methods. Leveraging eDNA, visual sightings, and acoustic data from 2004 to 2023, this project aims to develop an interactive tool that consolidates CalCOFI marine mammal observations across space and time. In a collaboration between data science undergraduate students from UC Santa Barbara's Data Science Capstone program and researchers from Scripps Institution of Oceanography, this R Shiny App offers an interactive platform for researchers and technical users to explore, visualize, and gain insights into marine ecosystem data more effectively.

Interactive Shiny App

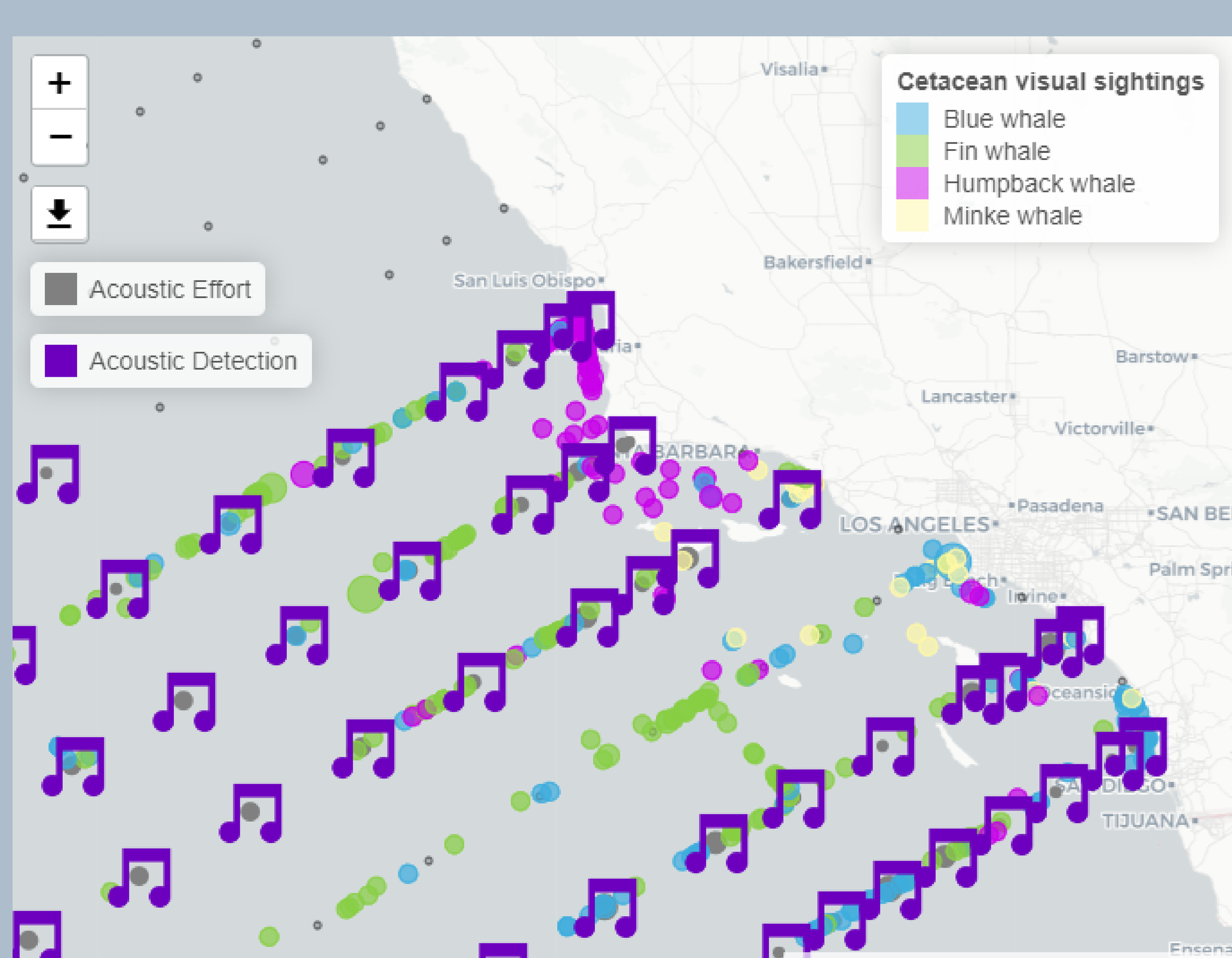

Figure 1a. Example of interactive species map displaying summer baleen whale visual sightings and acoustic detections between 2005-2012. Each colored circle represents a unique species-specific sighting event, scaled by the number of animals present. Purple music notes mark acoustic detections and gray circles mark acoustic recording, scaled by total effort. By clicking on acoustic or visual detections, a pop-up will display detection latitude and longitude, species or call name, as well as duration of calling activity for acoustic detections.

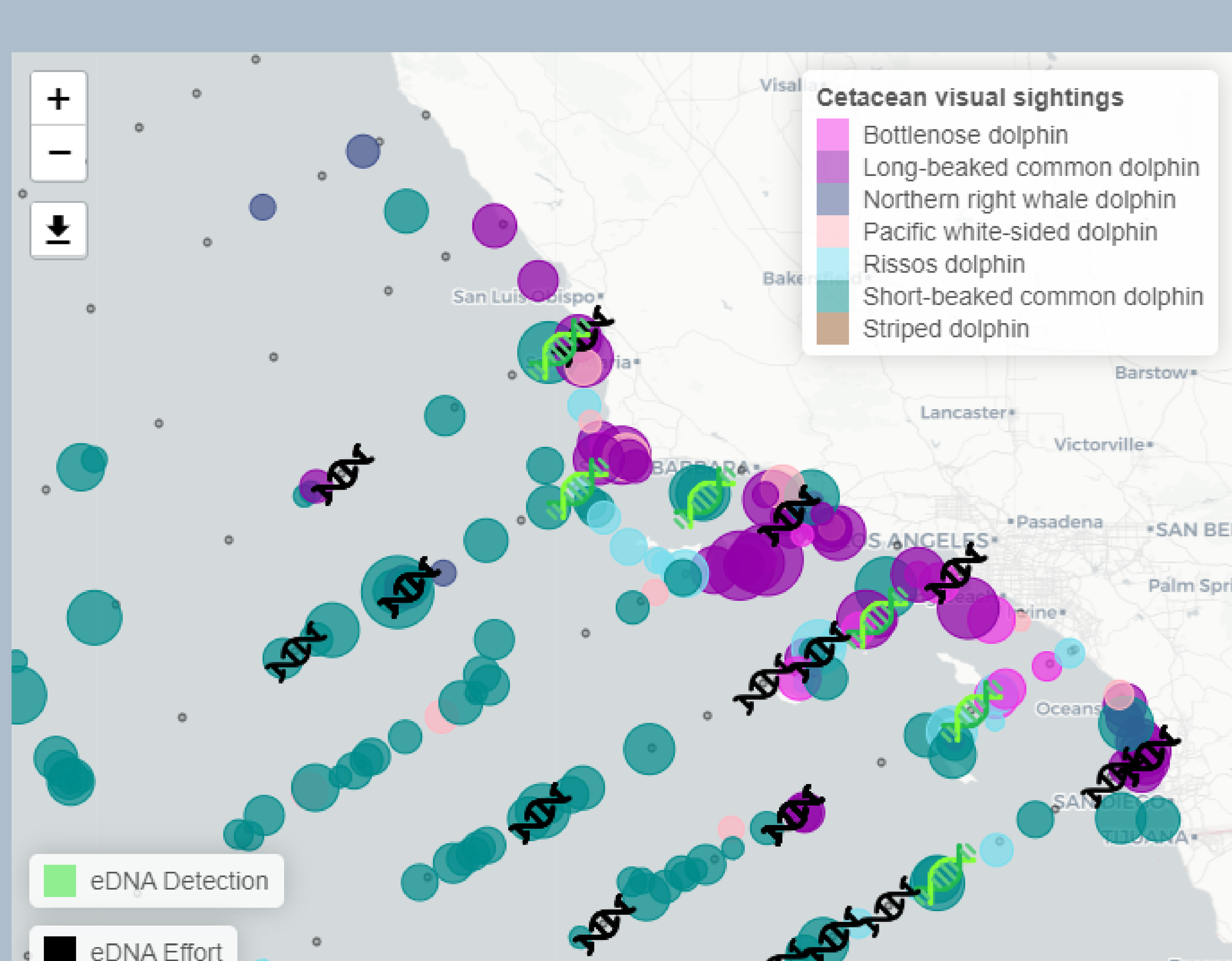

Figure 1b. Example of interactive species map displaying oceanic dolphin visual sightings and eDNA detections between 2014-2016. Each colored circle represents a unique species-specific sighting event, scaled by the number of animals present. DNA double helices represent stations with eDNA sampling effort (black) and marine mammal eDNA detections (lime green). By clicking on eDNA or visual detections, a pop-up will display detection latitude and longitude, species name, as well as sample station and depth for eDNA detections.

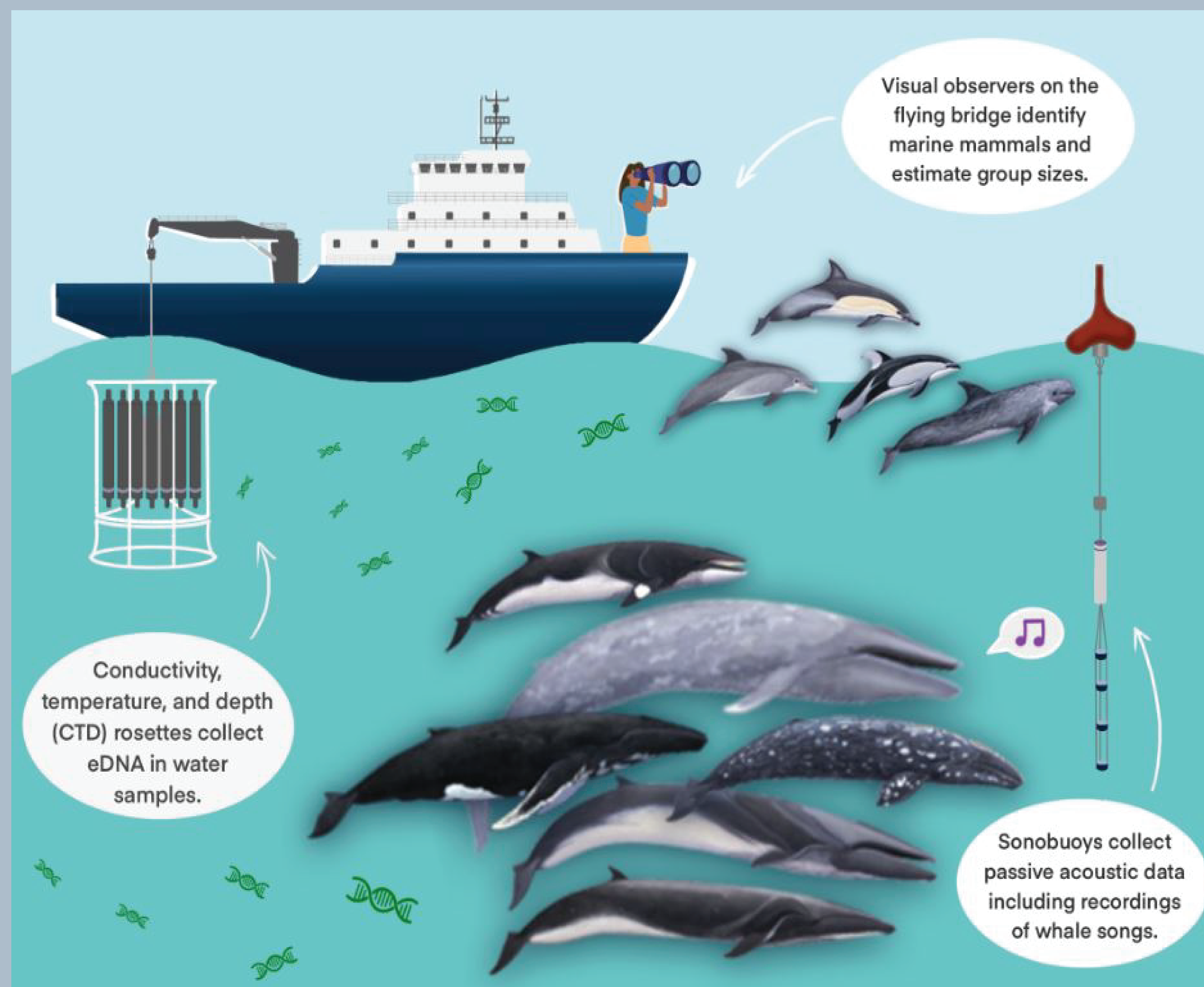

Figure 2. Infographic of CalCOFI marine mammal data collection methods. As marine mammals move through their environment, they shed DNA, make distinct sounds, and breathe air at the surface. Therefore, eDNA, acoustic, and visual surveys are conducted quarterly to detect marine mammals. This infographic is featured on the homepage of the application, where specific elements of data collection and sampling methods are hyperlinked to provide users with more information.

Raw and Preprocessed Spectrograms

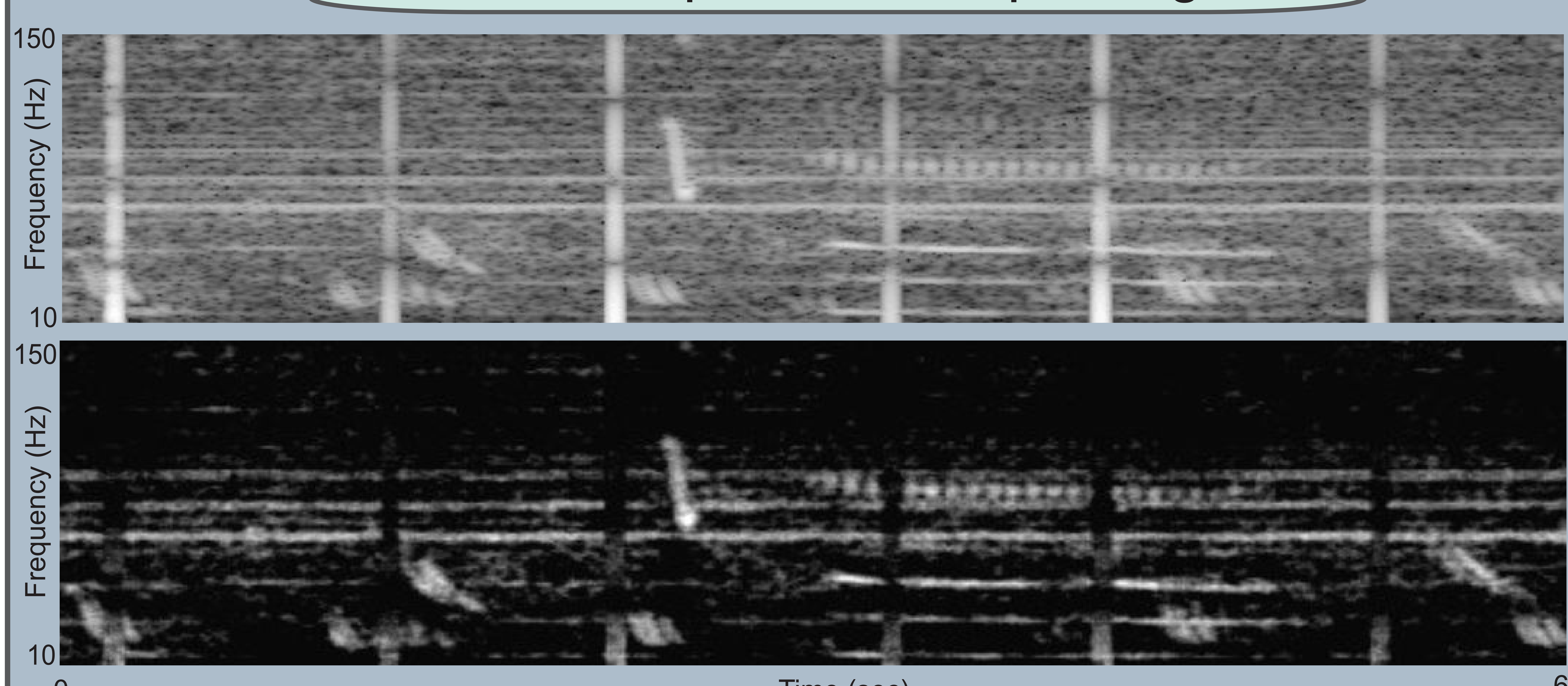

Figure 3. Original spectrogram (top) containing mulitple blue and fin whale call types in a 60-second window. Preprocessed spectrogram (bottom) highlights how our novel noise reduction technique improved the signal-to-noise ratio of the same image. Noise reduction included a Principal Component Analysis (PCA), median filtering, followed by column-wise subtraction.

Future Directions

Future developments to the app may include overlaying environmental data, such as sea surface temperature and salinity, which may offer greater insights into the drivers of biogeographic patterns of marine mammals.

We also hope to improve automated detection of whale calls in Sonobuoy data through the integration of novel acoustic preprocessing steps as displayed in figure 3.

By creating an interactive application for visualizing CalCOFI's multimodal marine mammal dataset, we aim to enhance awareness and engagement regarding the collection and use of marine ecosystem data for scientific inquiry.

Acknowledgements

This project was funded by the Office of Naval Research (#N000142212719). Thank you to the UCSB Data Science Capstone Program and to our mentor Laura Baracaldo for her support and guidance

RShiny QR Code

References