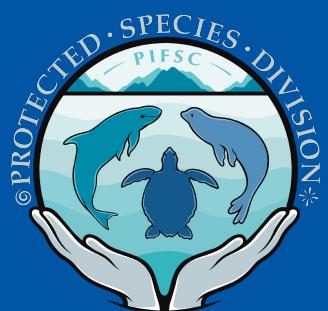




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Development of a Pacific-wide passive acoustic glider program to augment cetacean surveys

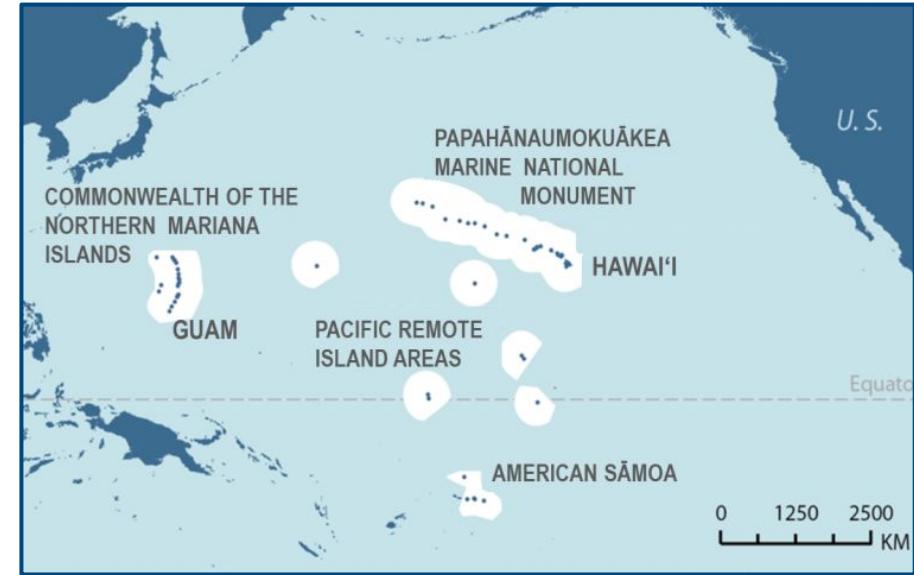
Selene Fregosi, Erin M. Oleson, Erik Norris, Shannon Rankin,
Kourtney Burger, Anthony Cossio, Jen Walsh, David K. Mellinger



Background

- Ship-based visual and acoustic surveys are crucial for stock assessment of protected cetacean species
- Ship-based surveys are limited in time and space
- PIFSC and SWFSC collectively responsible for largest area under NMFS jurisdiction

We need alternative
survey tools!

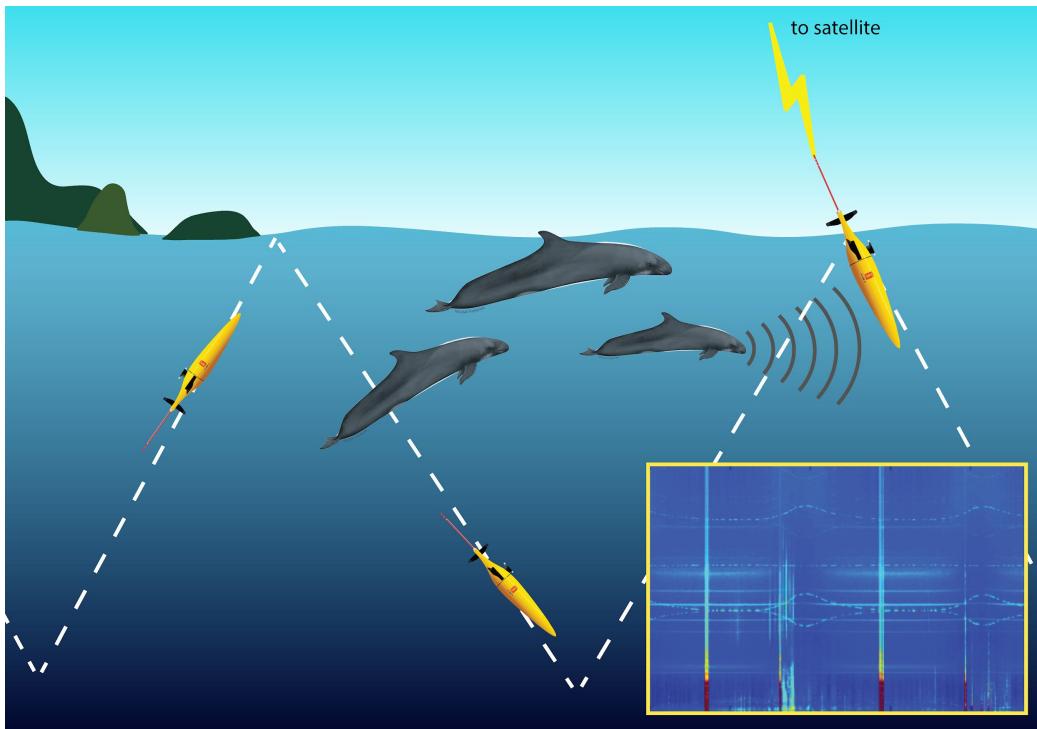


Pacific Islands Region
alone is 1.7 *million nmi²*



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Gliders as alternative survey tools



- Underwater gliders
 - Buoyancy driven, energy efficient
- Passive acoustics
 - Effective method to study cetaceans
- Underwater gliders + passive acoustics
 - Cost-effective method to augment existing ship-based surveys
 - Endurance 10+ weeks, 1500+ km
 - 24/7 operation in remote regions
- NMFS successes
 - Robots4Whales right whale research, U.S. East Coast, WHOI-led (Baumgartner et al. 2021)
 - PAM glider surveys for odontocetes, Main Hawaiian Islands, OSU collab
 - PAM glider surveys for cetaceans, U.S. Caribbean, UVI/Univ Miami collab



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Objectives



Credit: NOAA Fisheries/Genece Grisby

Develop a Pacific-wide NMFS passive acoustic glider program to accelerate the transition to operations for PAM glider surveys

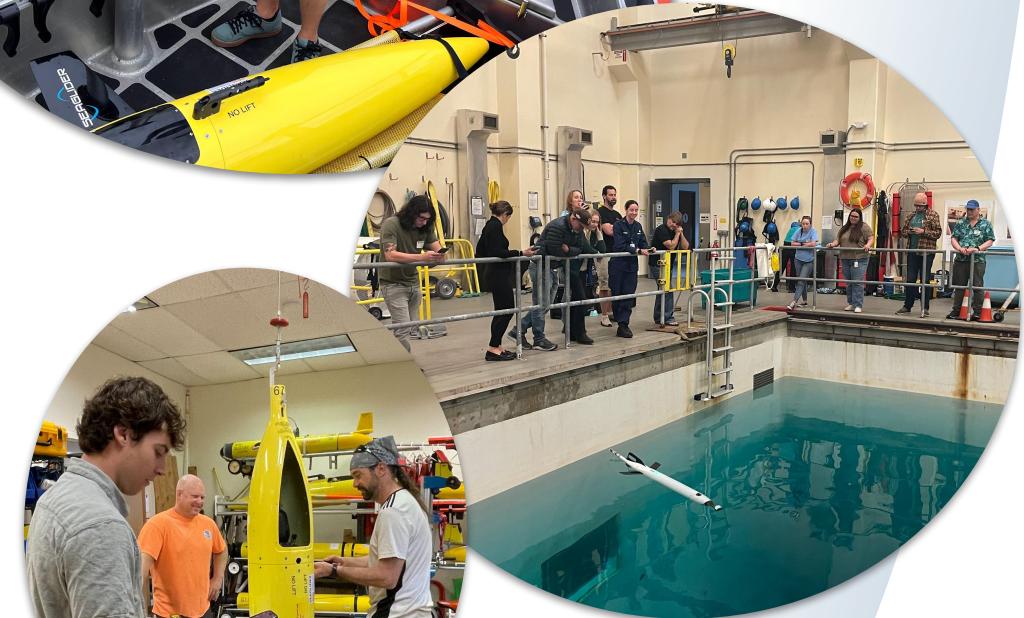
1. Build capacity for sustained PAM glider operations
2. In-water instrumentation testing of available PAM-glider systems
3. Concurrent glider and shipboard surveys
4. Integrate PAM glider into species distribution models



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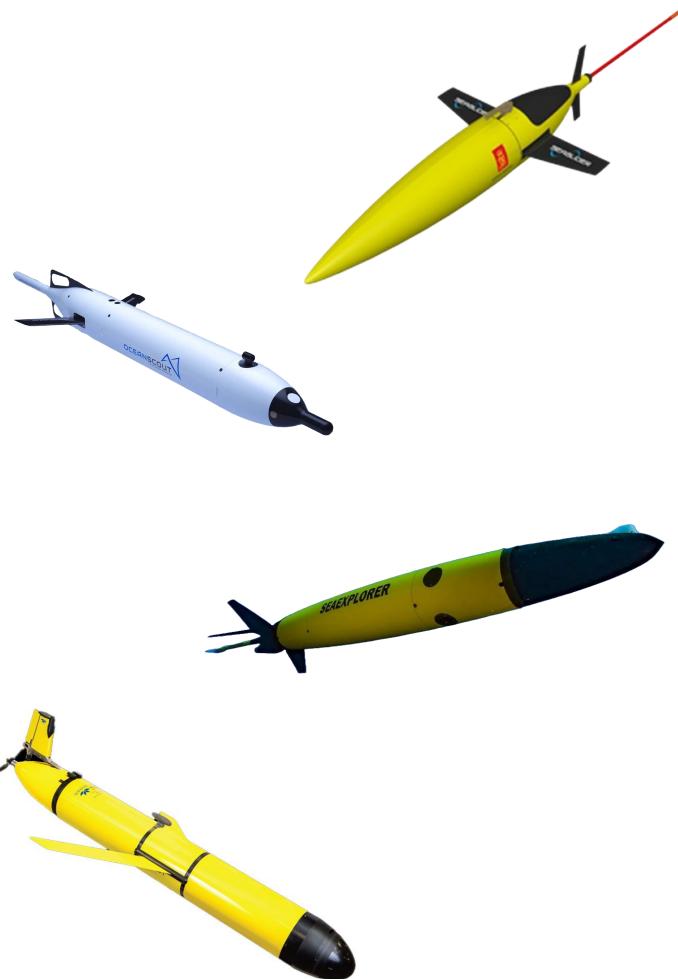
Build capacity

- Establish a PIFSC Glider Lab
 - Purchase Seagliders
 - Identify and build out lab space
 - Train staff and develop resources, protocols and data management plan
- Add PAM capabilities to existing SWFSC fleet
 - Installation PAM systems on existing Slocums
 - Purchase Hefring Oceanscout gliders
 - Adapt existing processing/analysis tools to new systems



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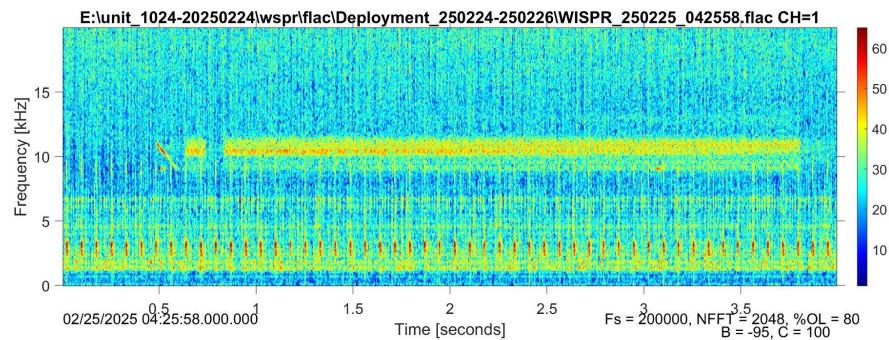
In-water system comparisons



aka

GLIDER RODEO

- Scheduled for January 2026 in Hawai‘i
- Four glider types
- Three acoustic systems
- Side-by-side measurement of operations, passive acoustic, soundscape, and resources metrics



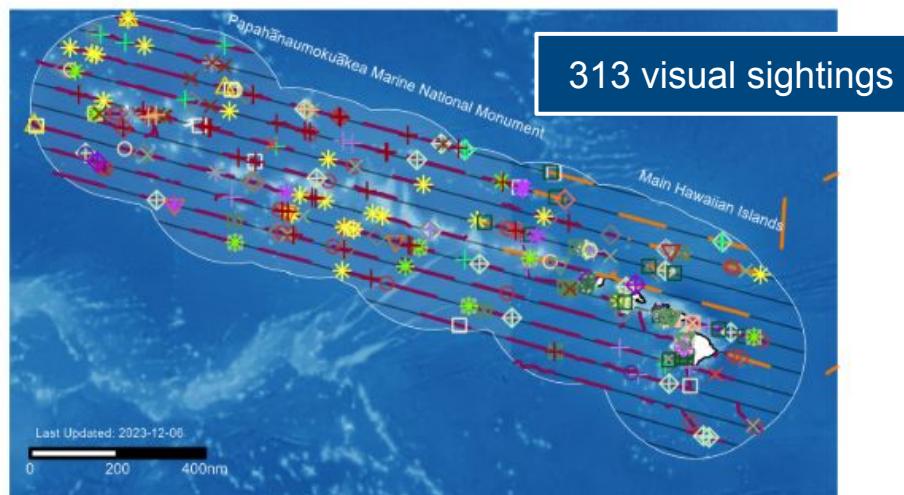
Example spectrogram
showing glider-generated
noise



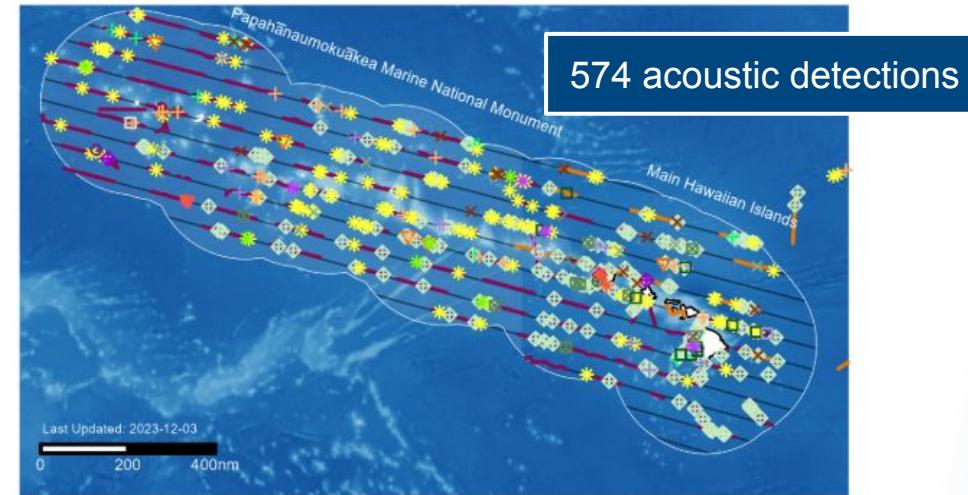
Concurrent ship and glider surveys

- Passive acoustics typically hears more than visuals will see
 - E.g., Visual vs acoustic towed array - Barlow & Taylor 2005, HICEAS 2023
- PAM gliders have similar detection rates to stationary/drifting acoustic platforms

What cetaceans have we seen during HICEAS 2023?



What cetaceans have we heard during HICEAS 2023?



How will PAM gliders compare to a visual survey?

Concurrent ship and glider surveys

- Test in two distinct operational regions - U.S. West Coast and Main Hawaiian Islands
 - Different oceanographic conditions
 - Different logistical constraints



Credit: NOAA Fisheries/Jonathan Reid (Permit #27867)

- Goal 1: Survey the same place at the same time with different survey modalities and compare encounter rates and distributions
- Goal 2: Collect survey data that can be used to develop population assessment models

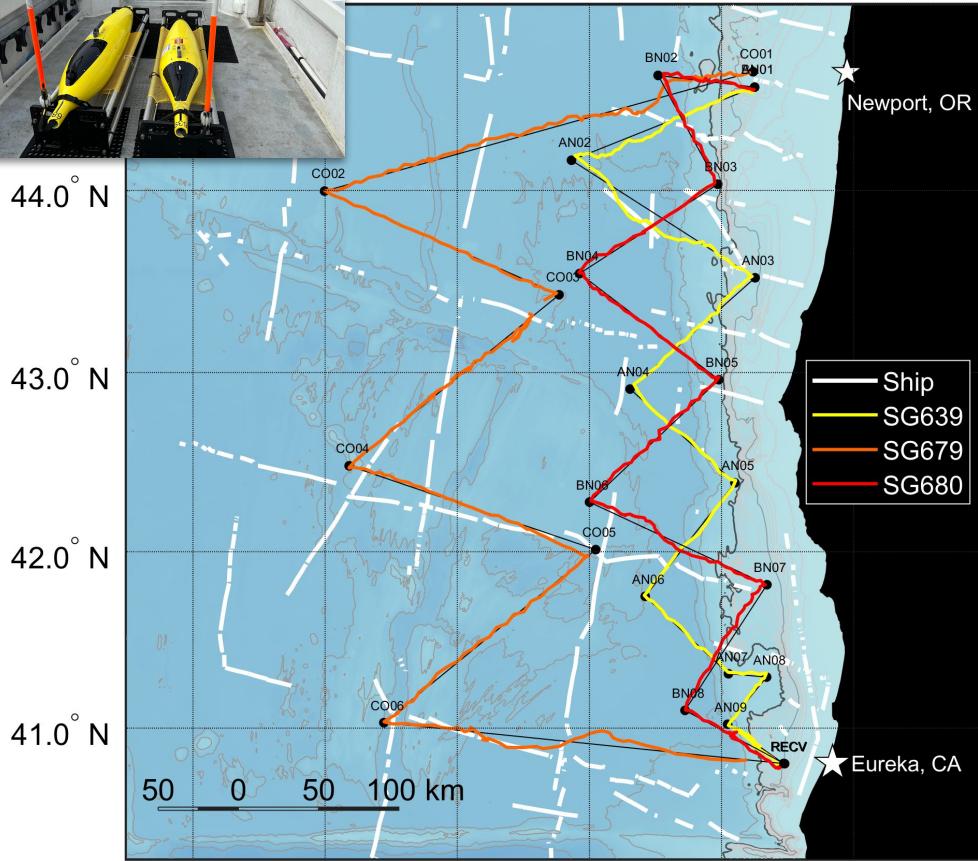


**Sperm whales as
initial case study
species**



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Concurrent surveys - U.S. West Coast, Fall 2024



129.0° W 128.0° W 127.0° W 126.0° W 125.0° W 124.0° W 123.0° W

California Current Cetacean and Ecosystem Assessment Survey (CalCurCEAS)

- Five month ship-based visual survey (Jul - Dec 2024)
 - Legs 2 and 3 overlapped gliders in space/time
- PAM glider survey (Aug - Oct)
 - One offshore - 63 days, 1460 km
 - Two nearshore/shelf - 41 days, 790-805 km
- Analysis ongoing for sperm whales, baleen whales, and beaked whales
 - ~5x sperm whale acoustic detections per unit effort than visual sightings

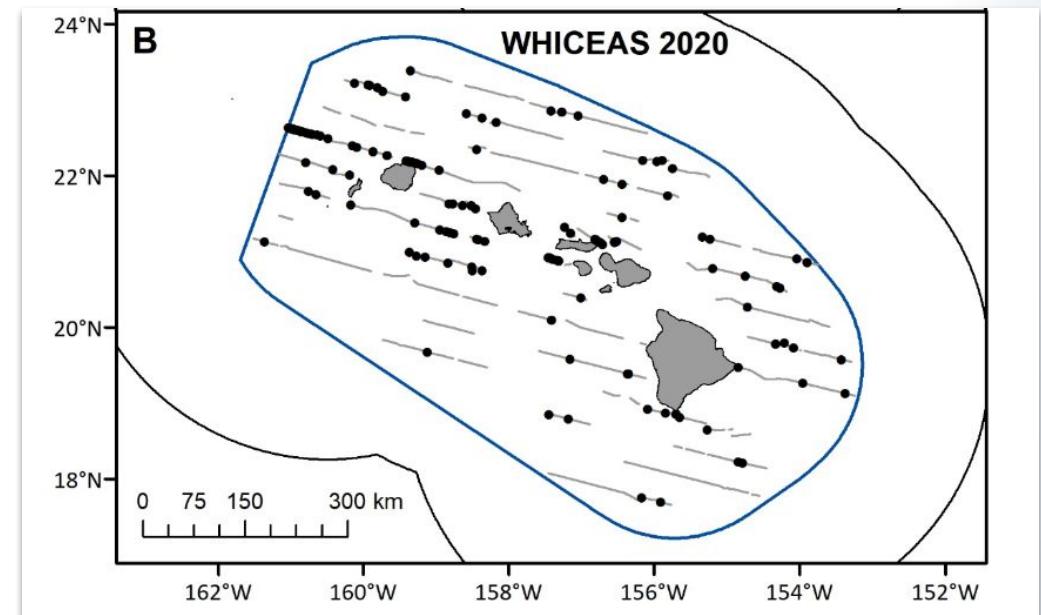


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Concurrent surveys - Hawai‘i, Winter 2026

Winter Hawaiian Islands Cetacean and Ecosystem Assessment Survey (WHICEAS)

- Two month ship-based visual *and acoustic* survey (planned for Jan - Mar 2026)
- PAM glider survey (Jan - Mar 2026)
 - Four PAM Seagliders
 - Maiden voyage for new PIFSC gliders
- Currently in track planning stages

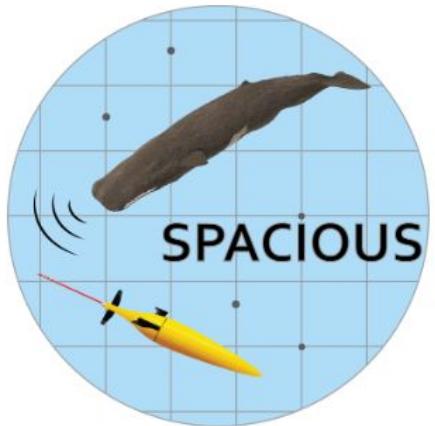


Bradford et al. 2022 NOAA TM NMFS-PIFSC-135



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Integrate glider data into species distribution models



SPACIOUS

(Spatial Population Assessment of Cetaceans Integrating acoustic Observations from Uncrewed Systems)

- PAM glider data cannot be used directly in existing statistical models
 - Gliders are slow, move in 3D, do not animal location or range
- Statistical methods are needed to fully utilize PAM glider for protected species management

Thursday, August 28, 2025 / 2-4 pm EST

Protected Species Abundance and Distribution Modelling and Data Integration

Co-Chars: Devin Johnson (PIFSC) and Jeff Moore (SWFSC)

2:35 - 2:50 pm

Integrating passive acoustic data from slow-moving uncrewed systems into cetacean distribution models

Janelle Badger, PIFSC



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U.S. DEPARTMENT OF COMMERCE

Research to Operations Plan

- Accelerate Pacific-wide PAM glider operations
- Match appropriate technology to research questions
- Provide framework to monitor technological developments
- Identify future investment needs



Follow our journey

<https://nmfs-ost.github.io/PAM-Glider/>



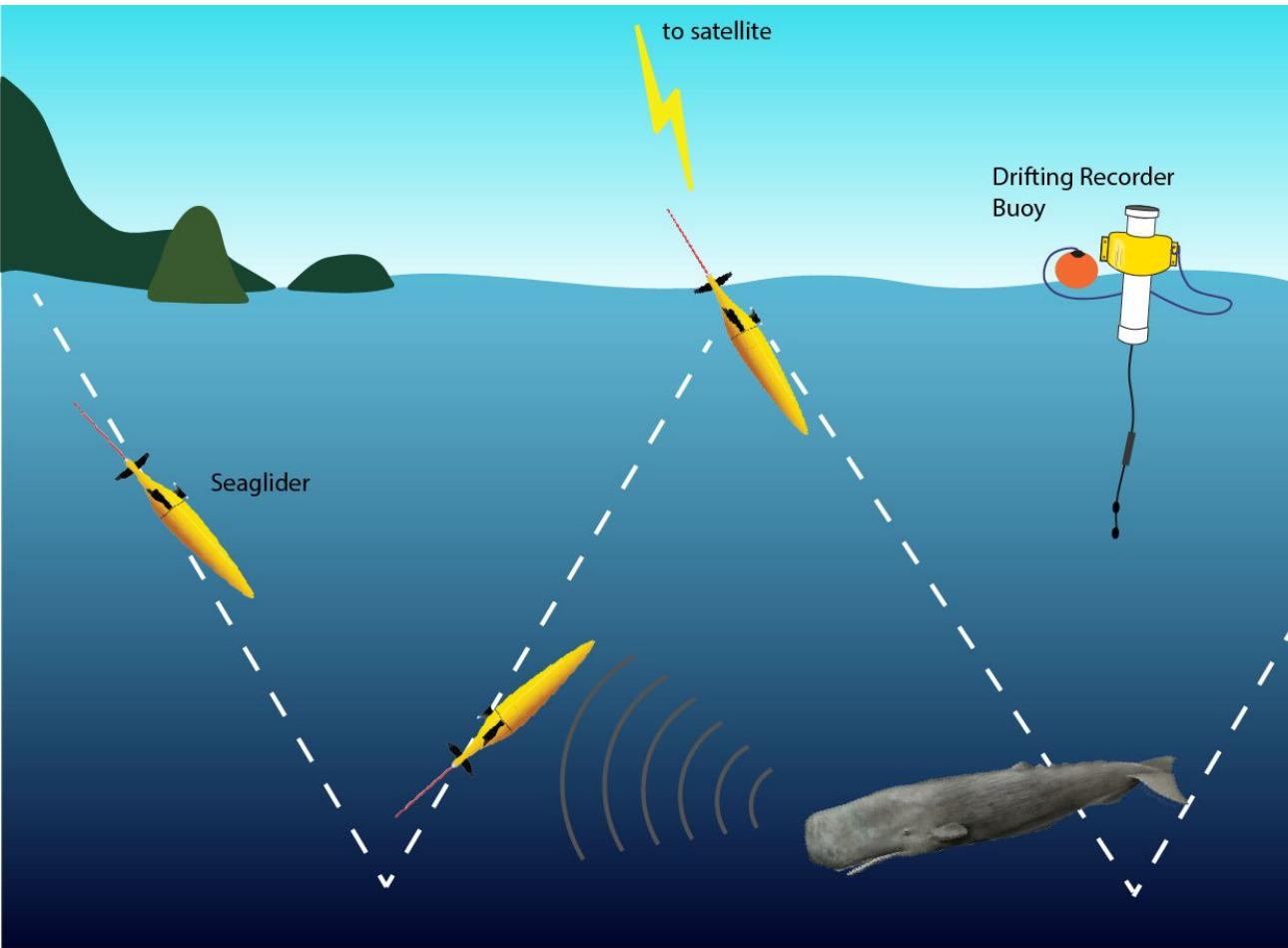
Credit: NOAA Fisheries/Jennifer McCullough



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ABSTRACT FOR REFERENCE.

Development of a Pacific-wide passive acoustic glider program to augment cetacean surveys

Selene Fregosi¹, Erin M. Oleson², Erik Norris², Shannon Rankin³, Kourtney Burger³, Anthony Cossio³, Jen Walsh³, David K. Mellinger⁴

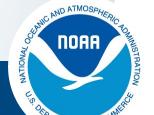
¹*Ocean Associates, Inc. contracted to NOAA Pacific Islands Fisheries Science Center*

²*NOAA Fisheries, Pacific Islands Fisheries Science Center*

³*NOAA Fisheries, Southwest Fisheries Science Center*

⁴*Cooperative Institute for Marine Ecosystem and Resources Studies, Oregon State University and NOAA Pacific Marine Environmental Laboratory*

A collaborative effort between PIFSC, SWFSC and OSU/PMEL aims to accelerate NMFS's use of passive acoustic monitoring (PAM) glider surveys to augment existing ship-based surveys for cetacean stock assessment. This effort builds on historically successful efforts by NMFS to use PAM-equipped gliders including studies of endangered right whales off the U.S. East Coast and odontocetes around the Main Hawaiian Islands. This previous work highlighted the feasibility of using PAM-equipped gliders to bolster data collection efforts for cetacean surveys. Use of gliders is of particular interest in the Pacific region, which is the largest area under NMFS jurisdiction and is subject to acute shortages of adequate ship time; therefore, this region must identify survey modalities that maintain assessment operations over as large an area as possible. While the initial effort is focused in the Pacific region, this project will result in a Research-to-Operations plan that can be adapted or applied in other regions. Primary goals of this work are to (1) build capacity to sustain glider operations within NMFS through purchasing equipment, developing infrastructure, and hiring piloting and technical staff; (2) conduct detailed in-water instrumentation testing and comparison of currently available glider and sensor types to provide guidance for various use cases; (3) conduct concurrent glider and shipboard surveys off both the U.S. West Coast and Main Hawaiian Islands which will provide a unique opportunity to compare these two data streams; and (4) advance animal distribution modeling methods to integrate the PAM-glider collected data into stock assessments.



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