Technical description of Fall 2025 field experiments in Monterey Bay

Overview of Experiment

The goal is to describe patterns of diel movement of organisms (from phytoplankton to zooplankton, fish, and marine mammals) from surface to deep, and from shelf to canyon, while occupying a hot spot of marine mammal activity. A goal is also to demonstrate how multiple modes of observing can work together to describe organism abundance and distribution. Here we are combining observations from the long-term deployment of moored instruments (through the Trophic Ecology Observatory project led by Kelly Benoit-Bird and John Ryan) with observations from multiple platforms including environmental DNA (LRAUV-ESP), image and video (LRAUV-Triton; LRAUV-Planktivore; LRAUV-Piscivore; IFCB), and acoustics (echosounder, hydrophone, acoustic Waveglider). The R/V *Packard* cruise will also contribute environmental DNA and acoustic surveys of organisms.

The experiment has three main goals and modes of operation:

1. Diel Vertical Migration
2. IFCB on Power Buoy Comparison with sensors on LRAUV
3. Monterey Bay Time series line (Stations C1, M1 and M2)

Diel Vertical Migration

Here the goal is to describe how the vertical distribution of organisms is changing on diel cycles. This is a repeat of an ESP sampling mission which was first completed earlier this year in July. This will allow us to compare seasonality of observed patterns.

Vehicles included: LRAUV Brizo/ESP; LRAUV Triton/Triton camera, LRAUV Makai/Piscivore, Waveglider Tiny

Duration: Sept 2nd - Sept 9th, ESP sampling begins night of Sept 4th and ends after Sept 9th daytime sampling.

IFCB Comparison

Here the goal is to compare observations of phytoplankton (with diel and tidal variability) across different platforms including IFCB (on powerbuoy), eDNA (LRAUV-Brizo/ESP), plankton-proxies (LRAUV-Pontus/Biolum), and images (LRAUV-Ahi/Planktivore).

Vehicles included: LRAUV-Brizo/ESP, LRAUV-Pontus/Biolum, LRAUV-Ahi/Planktivore

Duration: Sept 9th- Sept 14th, ESP sampling begins night of Sept 9th and ends night of Sept 13th

MBTS Line

Here the goal is to demonstrate how to conduct an autonomous Monterey Bay Time Series (MBTS) cruise using an LRAUV-ESP. It will also give context to the nearshore observations.

Vehicles included: LRAUV-Brizo/ESP, Waveglider Tiny

Duration: Sept 22nd – Sept 25th, ESP sampling begins Sept 22nd at M2 and finishes at C1.

List of Vehicles/Assets

1. LRAUV Brizo + ESP
2. LRAUV Triton + Triton camera
3. LRAUV Ahi + Planktivore
4. LRAUV Pontus + Biolum
5. LRAUV Makai + Piscivore
6. LRAUV Daphne + Sipper
7. Acoustic Waveglider Hanson
8. Tracking Waveglider Tiny

Deployed Moorings/Fixed Instruments

1. Upward facing echosounder
2. Hydrophone
3. Powerbuoy (wave energy) with Imaging Flow CytoBot (IFCB)
4. Docking buoy for LRAUVs (with solar power generation)
5. ADCP

Locations of fixed assets

Echosounder	36.7780	-121.8750
ADCP	36.7700	-121.8910
Hydrophone	36.7763	-121.8763
Powerbuoy/IFCB	36.7723	-121.8647
Wirewalker	36.7791	-121.8720
LRAUV-BRIZO/WG Tiny	36.7834	-121.8649
Docking Buoy	36.7786	-121.8603

Autonomous vehicle operations

LRAUV Brizo moved between 0-90m depth at 36.7834, -121.8649. It held position using **Tracking Waveglider Tiny** at the surface.

Acoustic Waveglider Hanson ran a circle of radius 3km (center = 36.7948, -121.8726). Ship to avoid Waveglider Hanson's path to avoid the ship when within 0.5km. **LRAUV-Makai/Piscivore** will run the same circular path, surfacing periodically and moving from 0-50m underwater.

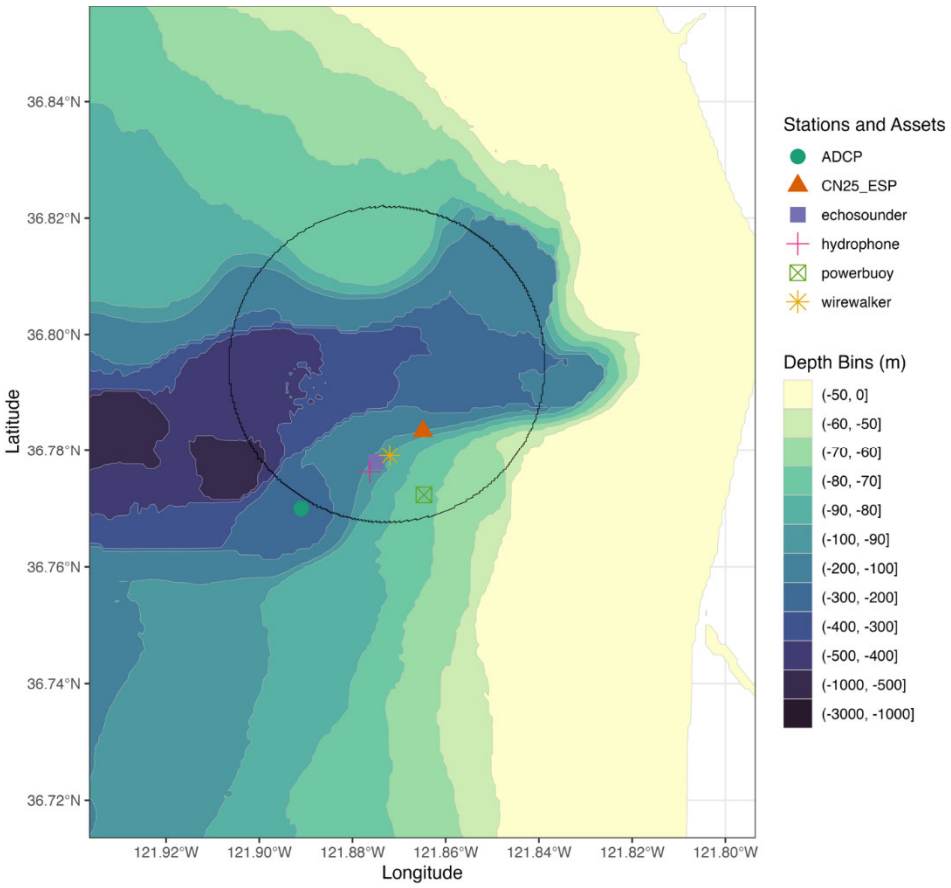

Figure: Overview of nearshore vehicle and mooring locations for Sept 6-10th. Black circle is path of Acoustic Waveglider Hanson and LRAUV-Makai/Piscivore. CN25_ESP marker is the location of Waveglider Tiny (surface) and LRAUV-Brizo/ESP (0-90m depth).

Vehicle Behavior

LRAUV-Brizo/ESP

Deploy Sept 2nd (late) or Sept 3rd (morning)
Recover Sept 18th
Will run three separate missions for the different activities. For DVM, will be centered at a single location using Waveglider Tiny to hold position. It will sample at 5m, 45m, and 90m starting at 12am and 12pm (a total of a 3-hour sampling period). When not sampling, it will collect contextual data yo-yoing from 4-90m. It will take a total of 30 samples from night of 9/4 to day of 9/9.
For the IFCB comparison, it will sample near surface (5m depth) at 1am, 1pm, and at lowest tide. It will sample from the night of 9/9 to night of 9/13. It will take a total of 12 samples.
For the MBTS line, on 9/15 it will begin to transect out to M2 and sample that station first, collecting samples at 5 depths: 5m, 10m, 20m, 60m, and 150m. It will then run the MBTS line sampling those same depths at M1 and finally C1, holding position at C1 under the Waveglider Tiny. This will take a total of 15 samples.

LRAUV Makai/Piscivore

Deploy Sept 3rd
Recover Sept 10th
LRAUV-Makai/Piscivore will have a camera system to detect fish and marine mammals during daylight surface waters. It will run the same 3km radius circle as the acoustic Waveglider Hanson, surveying from 0-50m depth. Camera will be turned on for the day and turned off at night.

LRAUV Triton/Triton camera

Deploy Sept 3rd
Recover Sept 9th
LRAUV-Triton/Triton will have a camera system to detect zooplankton. It will survey at the same location as LRAUV-Brizo/ESP sampling from 0-90m. It will duty cycle the camera to extend the duration of its deployment to ~4 days of sampling.
Camera ON: 23:30
Camera OFF: 3:30
Camera ON: 11:30
Camera OFF: 15:30
(8 hours per 24 hours)

Acoustic Waveglider Hanson

Recover Sept 9th (battery could fail by Sept 8th)
Acoustic Waveglider Hanson will run a 3km radius circle around the canyon midpoint (36.7948, -121.8726). It will actively avoid ship traffic and will divert from its path if the ship is within 0.5km.

Tracking Waveglider Tiny

Deployed for entirety of experiment, recovered post Sept 25th.
Waveglider Tiny will be used to keep position for the LRAUV-Brizo/ESP sampling during the DVM mission. It will also be used to keep position when LRAUV-Brizo/ESP samples at C1 during the MBTS line sampling. In between it can be used to survey to station M1 and back (TBD).

LRAUV-Ahi/Planktivore

Deploy Sept 9th
Recover Sept 15th
LRAUV-Ahi/Planktivore will be used for the IFCB comparison mission. It will sample around the IFCB powerbuoy location from 0-30m depth continuously from the night of Sept 9th to Sept 14th.

LRAUV-Pontus/Biolum

Deploy Sept 9th
Recover Sept 15th
LRAUV-Pontus/Biolum will be used for the IFCB comparison mission. It will sample around the IFCB powerbuoy location from 0-30m depth continuously from the night of Sept 9th to Sept 14th.

Research Vessel *David Packard*

The Research Vessel *David Packard* will operate in conjunction with the autonomous vehicles from September 6-10. It will support the science goals described above. Underway operations with multiple instruments will be carried out together with collections of data and samples using a CTD with a 24 bottle rosette.