

901902 - Unoccupied Aerial Vehicles for Science, Operations, and Outreach

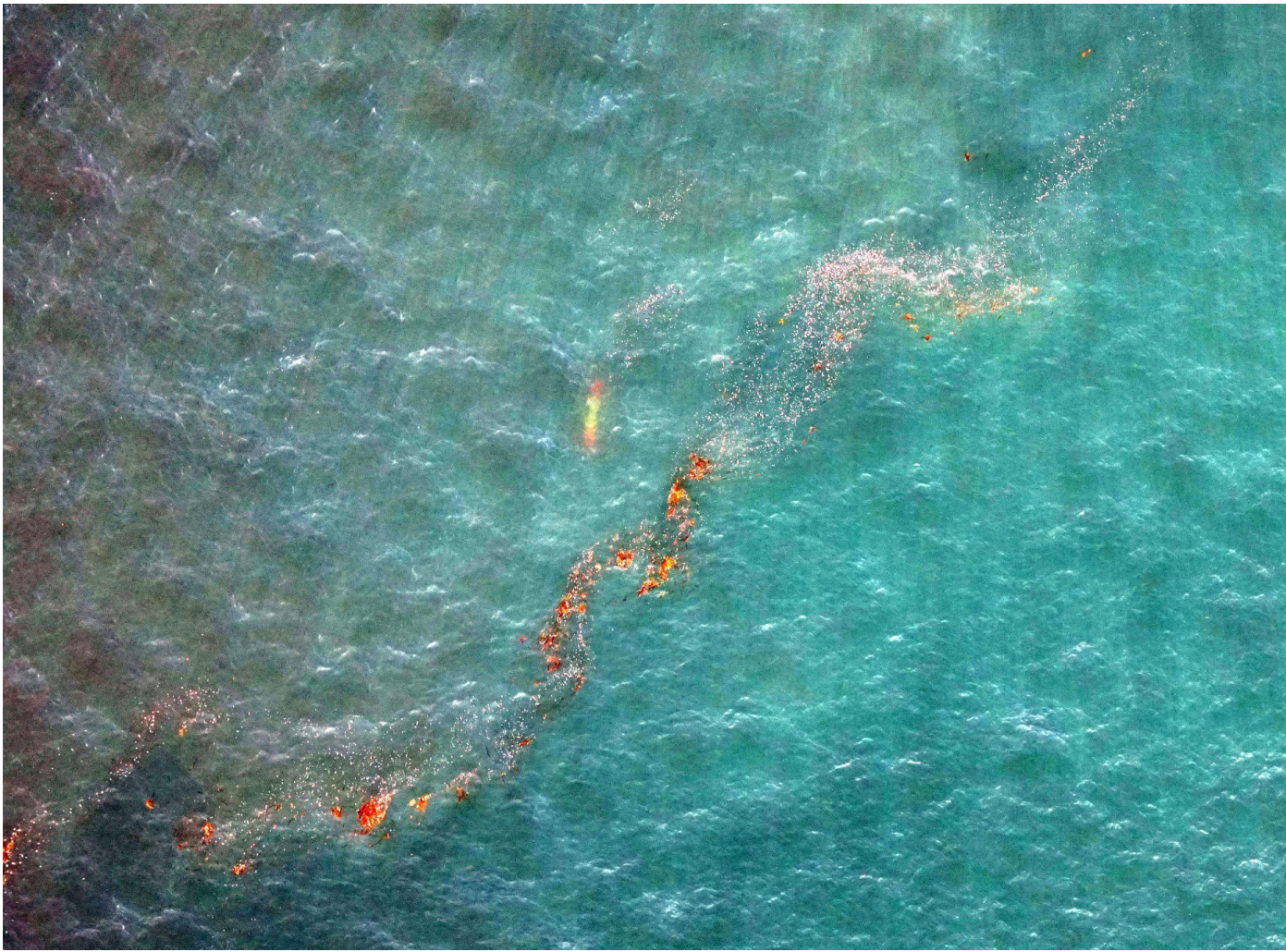
Week 51

1. Duane Edgington
 - a. Continued work on labeling
 - b. Refined augmentation module using Albumentations library for training image augmentation.
 - c. Preparing for SAHI image slicing for inference on the very large pixel count 7952x5304 UAVS images.
 - d. Participated in coordinated sampling missions Dec 14. (see Tom O'Reilly below)
2. Tom O'Reilly
 - a. The team demonstrated coordinated sampling between two UAVs and Piscivore-equipped LRAUV *Pontus* last week, just offshore of Moss Landing. Our goal was to assess whether the UAV could observe the surface expression of phenomena also observed by LRAUV. We used MBARI's Trinity UAV with Sony RGB camera payload, and our NOAA collaborator brought his Trinity with multispectral 'Red Edge' imager. We worked with the LRAUV team to design coordinated aerial and underwater surveys shown in the figure below. The LRAUV made repeated transits between yellow pins LRAUV-S and LRAUV-N at a depth of 1.5 meters, while the UAVs flew along the green tracks at 60 meters altitude.



b.

- c. The MBARI UAV detected a biofoam/alga front several hundred meters offshore, and in fact captured an image of the LRAUV swimming directly underneath the front, as seen in the contrast-stretched image below.

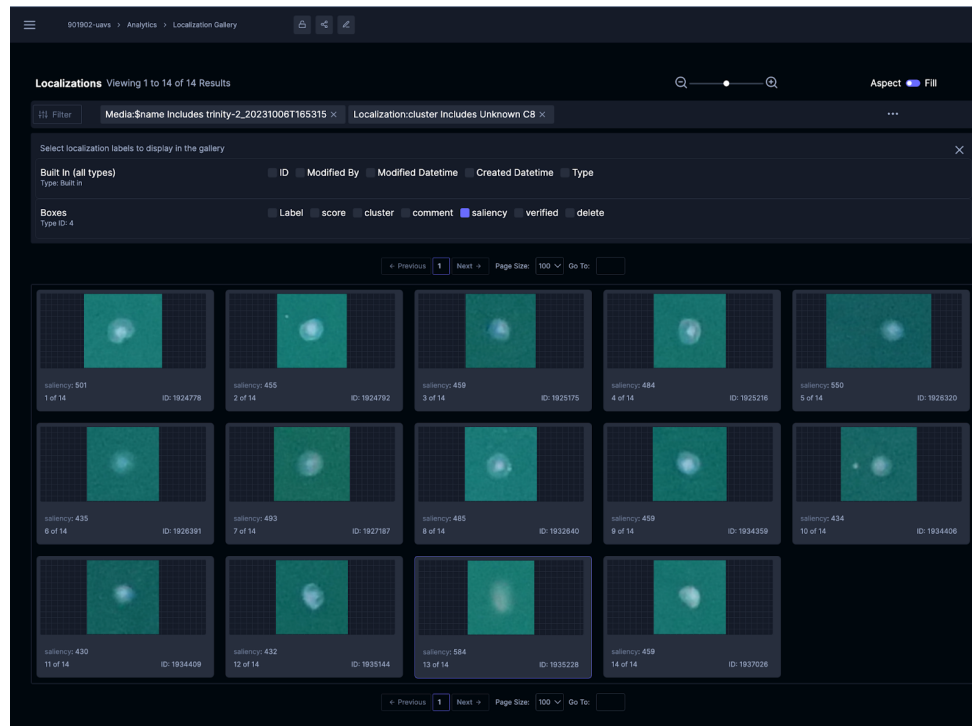


- d.
- e. Piscivore video shows generally clear water during its survey, but drifting fronds of surfgrass (*Phyllospadix* sp.) and eelgrass under the front. We are currently analyzing the aerial multispectral data as well as LRAUV sensor data (CTD, fluorometer, backscatter, etc).
- f.

Week 50

1. Danelle Cline

- a. The team is labeling after a few training sessions. Processing data as needed. We have been searching for jellies and have found our first cluster!



2. Duane Edgington
 - a. Continued work on sdcats and labeling localizations in preparation for training a model
 - b. Setting up amazon account for model training
 - c. Working on tasks preparing to train the first model and run inference on the very large images.
 - d. Abstract preparation for EGU 2024 (Due Jan 10 2024)
3. Paul McGill
 - a. Attended another training session for machine learning tools to process UAV images.

Week 49

1. Duane Edgington
 - a. Training session on 901102-uavs labeling Dec 5, 2023. Following up on action items. Planning follow-up team training session and labeling work.
2. Paul McGill
 - a. Finished calculations for Tom O to determine geographic coordinates of corners in aerial images
 - b. Attended a training session for our AI processing of aerial images

Week 46

1. Duane Edgington
 - a. Team meeting. Planning team training session on data management system for ML.
2. Paul McGill
 - a. Started some photogrammetry analysis for Tom O

Week 45

1. Danelle Cline
 - a. Brought processing up to date in preparation for hand-off to D.Edgington and team for labeling and model training
2. Duane Edgington
 - a. Team meeting. Planning training session to team on clustering/labeling toolset.

Week 44

1. Paul McGill
 - a. Still struggling with radio connection between antenna aiming system and ground control station

Week 43

1. Duane Edgington
 - a. Team meeting

Week 42

1. Danelle Cline
 - a. Meeting and request for more time
 - b. Finished hierarchical saliency detection algorithm
2. Paul McGill
 - a. Worked on antenna pointing system with Bryan but we're having problems with the radio link

Week 41

1. Paul McGill
 - a. Working on antenna-aiming servo platform to improve connectivity with UAV during flights
2. Tom O'Reilly
 - a. Conducted aerial surveys recently in north Monterey Bay over the "upwelling shadow", at Terrace Point (near UC Santa Cruz Seymour Center) and Davenport Landing beach. Imaged feeding sea birds, many moon jellies (*aurelia*), biofilm slicks and more from 60 meters altitude.







Week 40

1. Duane Edgington
 - a. Team meeting.

Week 37

1. Duane Edgington
 - a. Team is submitting an abstract to OSM 2024.
2. Paul McGill
 - a. Helped Duane E write abstract for OSM 2024

Week 35

1. Duane Edgington
 - a. Proposal response discussions

Week 33

1. Duane Edgington
 - a. Team meeting

Week 32

1. Danelle Cline
 - a. Deployed database to VM mantis and moved image data to nginx server

- b. Need to do a doodle poll to schedule discussion on labeling with the team
- 2. Paul McGill
 - a. Prepared for two deployments at Terrace Point but got fogged out both times.

Week 30

- 1. Danelle Cline
 - a. Weekly meeting
 - b. Tested loading label taxonomy into our database
 - c. Need to schedule label training and work on label taxonomy
 - d. Database being moved from a physical machine to the VM `manta.shore.mbari.org`
- 2. Paul McGill
 - a. Spent all day at Terrace Point in Santa Cruz on Fri waiting for fog to clear and winds to calm. Finally flew UAV in the evening and recorded 414 survey images.
- 3. Tom O'Reilly
 - a. Conducted our first survey over kelp beds offshore from Terrace Point near the Seymour Marine Discovery Center (UC Santa Cruz). Science team now assessing images.



Week 29

1. Danelle Cline
 - a. Weekly meetings and project proposal

- b. Loading the last 4 missions; need to schedule label training and work on label taxonomy
- 2. Duane Edgington
 - a. Team meeting
- 3. Paul McGill
 - a. Investigating how to test ground station antenna servos without using Pixhawk
 - b. Planning Friday's flight at Terrace Point with Tom O.

Week 28

- 1. Duane Edgington
 - a. Proposal work
 - b. Team meeting
- 2. Paul McGill
 - a. Searched the lab for parts for UAV ground station antenna pointer with Bryan, and discussed how to get system up and running.

Week 27

- 1. Duane Edgington
 - a. Proposal work.

Week 26

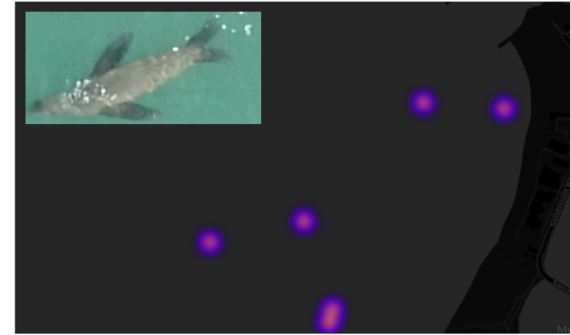
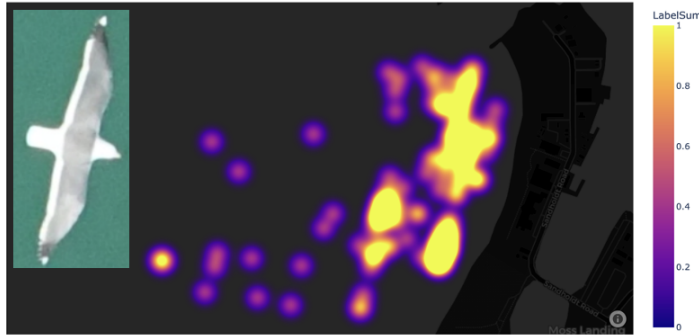
- 1. Duane Edgington
 - a. Team meeting, proposal process.
- 2. Tom O'Reilly
 - a. Helped finalize research permit allowing us to launch and land UAV from Santa Cruz County Parks property
 - b. Helping to plan over-ocean flights from Seymour Center UCSC
 - c. Conducted over-ocean aerial survey out of Davenport Landing, adjacent to upwelling center. Acquired imagery of jellies, cetaceans, fish schools and more.

Week 25

- 1. Paul McGill
 - a. Planning for Davenport flight this Friday.

Week 23

- 1. Danelle Cline
 - a. Weekly meeting
 - b. Sanity check: generated heat map display of distribution of detections in annotated drone missions so far.



c.

2. Tom O'Reilly

- a. Assessed operations sites in north bay, for access to upwelling shadow. Seymour Center and New Brighton State Beach especially promising
- b. Obtained Santa Cruz County Parks research permit, permission granted to fly from Bonny Doon Beach and Davenport landing

Week 22

1. Duane Edgington

- a. Team meeting May 31.

Week 20

1. Duane Edgington

- a. Continued work with Danelle on unsupervised clustering and active learning tools for UAV images and concepts
- b. Team meeting May 18

2. Tom O'Reilly

- a. Carried out flights to assess visibility of underwater targets, using Secchi disk
- b. Assessed UAV launch/land locations in Santa Cruz county near Soquel Point, which is near 'upwelling shadow' and associated thermal/biological features in Monterey Bay.

Week 19

1. Duane Edgington

- a. Continued work with Danelle on active learning tools for UAV images and concepts
- b. Collaborator meeting May 8
- c. Team Meeting May 10

Week 18

1. Duane Edgington

- a. Continued work with Danelle on active learning tools for UAV images and concepts
- b. Team meeting May 3
- c. Collaborator meeting planned May 8

Week 17

1. Duane Edgington

- a. Team meeting April 26

Week 16

1. Danelle Cline

- Setup database and web app to start editing the detections; expect to have data loaded by next week for the team to start revising.
- Developed anti-reflectance removal and improved object detection algorithm. Tested this on a recent mission deployment where we deployed a disc test to simulate a jelly target (Bill, Brian, deployed a Secchi disk in 0.5 meters water). Looks like we can detect the target with this method. This is very challenging as the target is very small. Boat was removed with the [Lama cleaner](#) (thanks to Duane E. for the tip).



c.

2. Duane Edgington

- Quick research on AI infill tools to mask (erase) overly salient objects

Week 15

1. Tom O'Reilly

- Trinity UAV flight with 'RedEdge' 10-band multispectral camera payload, flew over MLML aquaculture tanks at 60 meters altitude to test near-infrared response to chlorophyll. This false-color image consists of visible red and green bands plus near-IR band. Chlorophyll appears red. Most of the water-filled aquaculture tanks contain living alga.



- b. UAV flight with Sony RGB camera payload. We stationed a small boat with Secchi disk suspended over the rail at 0.5 meters depth while UAV flew overhead at 60 meters altitude to assess underwater target visibility in somewhat turbid conditions (measured Secchi depth = 1 meter). Target at 0.5 meter depth is easily visible from UAV at 60 meters altitude.



Week 14

1. Paul McGill
 - a. Helped with Trinity flight last Thu at ESB.
 - b. Trying to improve images taken by hyperspectral camera.

Week 13

1. Tom O'Reilly
 - a. Hosted NOAA collaborator JC Clark, discussed flight coordination strategies
 - b. Discussing UAV imagery access through CENCOOS website, with Axiom contractors

Week 12

1. Tom O'Reilly
 - a. Working with CENCOOS and Axiom to provide Internet access of processed UAV images through CENCOOS website

Week 11

1. Danelle Cline

- a. Workflow with sliced predictions and image clustering is revealing some interesting clusters. More on that next week.
2. Duane Edgington
 - a. Continued exploration of tools for detection.

Week 10

1. Duane Edgington
 - a. Working session with Danelle to bring up YOLOs and SAHI on AWS SageMaker Studio, and to pump aerial images to S3 bucket.
 - b. Team meeting.
2. Tom O'Reilly
 - a. Develop plans for next over-ocean flights, possibly next week, weather permitting. We plan to assess visibility "jelly-like" submerged objects, in this case a Secchi disk suspended at various depths from the Paragon, while the Trinity UAV with Sony science camera flies over at 60 meters altitude. We may also fly a RedEdge 10-channel multispectral camera payload (with includes near IR bands) to assess kelp and other chlorophyll spectral signatures; we plan to fly over the MLML kelp tanks just south of MBARI for this purpose.
 - b. Meeting on 3/13 with collaborators Elliot Hazen (UCSC) and JC Clark (NOAA UAV pilot) to discuss further collaboration activities, ranging from science applications to flight planning through post-processing and machine-learning.
 - c. Refining post-flight processing, including use of post-processing kinematics (PPK), which utilizes differential GPS groundstations within 100 km to greatly improve GPS accuracy.

Week 9

1. Tom O'Reilly
 - a. Refining post-flight processing procedures for rgb images acquired during flights on 2/16. Scheduled meeting with regional collaborators from NOAA, UCSC. Planning more over-ocean flights in next two weeks, weather permitting.

Week 8

1. Duane Edgington
 - a. Project meeting planned for next week

Week 7

1. Tom O'Reilly
 - a. Finished setting up, calibrating Trinity UAV in preparation for first flight
 - b. Coordinating first flight plan with project team and collaborators

Week 5

1. Paul McGill
 - a. Helping with assembly and checkout of new Trinity UAV
2. Tom O'Reilly
 - a. Working with team to configure new Trinity VTOL, becoming familiar with vehicle

Week 4

1. Tom O'Reilly
 - a. Took delivery of Trinity 90+ VTOL drone. Configured aircraft, learning operation, preparing for flight

Week 3

1. Danelle Cline

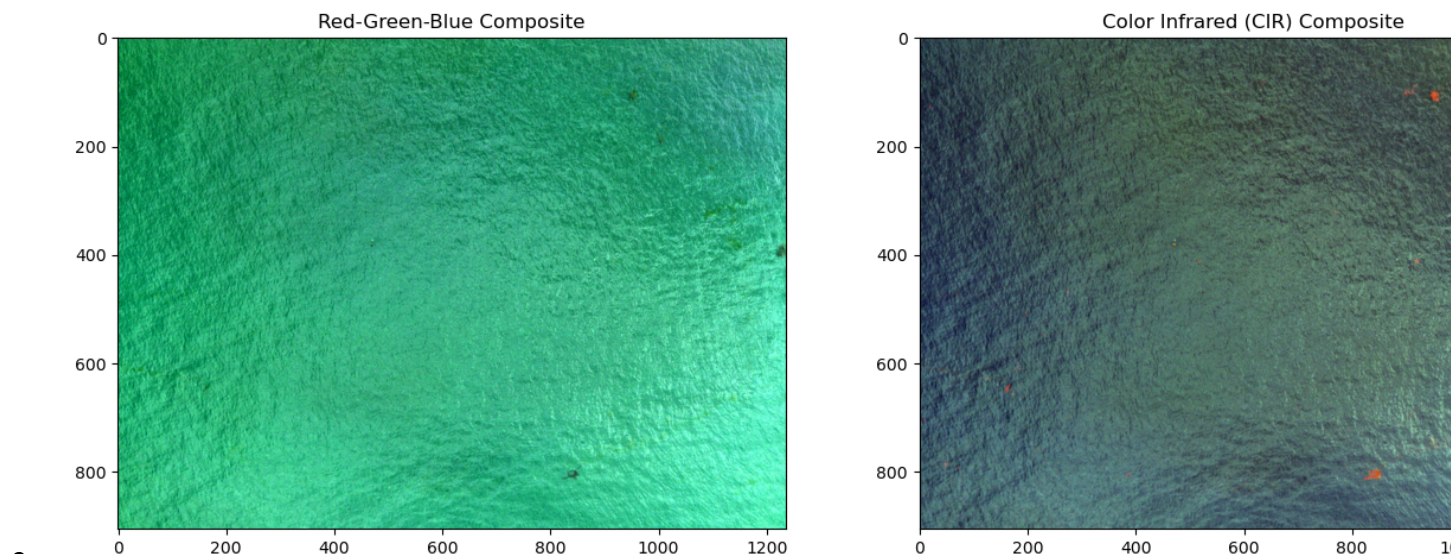
- a. Ran a few different models in the [HuggingFace](#) repository on aerial images using sliced predictions with the [sahi](#) library that Duane Edgington suggested (thanks Duane!). The intention was to see if these would work to flag class agnostic detections for later review. Some of the detections e.g. bird, boat were accurate, but others were not; this may work fine to flagging visually interesting objects for review which is the requirement.



Week 2

1. Tom O'Reilly

- a. I'm evaluating multispectral camera data from Trinity VTOL drone over-ocean surveys conducted just offshore of MBARI. The [Micasense RedEdge Dual-MX](#) camera simultaneously acquires data in 10 bands in the visible and near-infrared that closely match VIIRS, Landsat, and MODIS bands. These bands are very useful for detecting chlorophyll and other plant pigments. We believe the multispectral data can complement higher spatial resolution images from the Sony RX1R2 RGB camera in our biosurvey science application. I.e. we may be able to correlate the presence of jellies and other organisms seen in high-resolution RGB images with the presence of chlorophyll detected in lower-resolution multispectral images of the same area.
- b. For example the data below were acquired by the multispectral camera a few hundred meters offshore of MBARI at 60 meters altitude, have a ground-sampled distance (GSD) of 4 cm per pixel, and image width of 52 meters (1280 pixels). The image on the left is a composite of red, green and blue visible band reflectance, similar to what is seen with the naked eye; the right-hand image is a false-color infrared composite (CIR) image of red, green, and near-infrared bands. Several low-reflectance dark patches ~1 meter across are visible in the left image; the same patches are visible in the color infrared composite, showing high infrared reflectance (bright red). These patches are most likely floating kelp, with high near IR reflectance due to chlorophyll and other pigments.



- c.
- d. We will take delivery of a Trinity VTOL in the next few days, and will conduct more RedEdge multispectral surveys in the near future, along with higher spatial resolution RGB surveys of the same area with the Sony RX1R2 RGB payload.