# Shellfish and Estuarine Assessment of Coastal Oregon:
## An Aerial Perspective

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### Assessment Using Unmanned Aerial Systems (UAS)

UAS are remotely piloted aircraft capable of carrying light payloads such as cameras, LiDAR, and other small devices to distant and often difficult to reach areas. The relatively low cost, and ease of operation, and lower risk to pilots of UAS compared to manned plane or helicopter flights makes UAS a promising tool for resource management and scientific research.[1] [2]

The Oregon Department of Fish and Wildlife's Shellfish and Estuarine Assessment of Coastal Oregon (SEACOR) project is tasked with assessing bay clam populations and estuarine habitats in Oregon's estuaries. In 2016, SEACOR initiated a pilot study evaluating the utility of small UAS for assessing commercially and recreationally targeted bay clams and their habitats within several of Oregon's major estuaries. Species specifically targeted for this study include butter clams (*Saxidomus gigantea)*, cockles (*Clinocardium nuttallii)*, gaper clams (*Tresus capax)*, native littleneck clams (*Leukoma staminea)*, burrowing shrimp (*Neotrypaea californiensis, Upogebia pugettensis*), and native (*Zostera marina)* and non-native (*Z. japonica*) eelgrasses. These organisms are identified as species in need of management attention by the Oregon Nearshore Conservation Strategy (2015).[3]

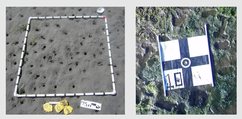
### Research Questions:

This study was designed to determine what habitat features can be identified and quantified using imagery from ODFW's UAS fleet. Specific research questions include:

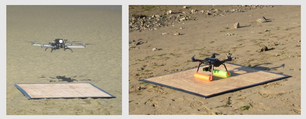
1. **Are bay clam species detectable from imagery and can they be distinguished from burrowing shrimp?**
2. **Are bay clam shows quantifiable or can presence only be established?**
3. **Can vegetation be identified and quantified?**

### Methodology

- **Choosing Test Sites**: UAS test sites were selected utilizing previously collected geospatial and biological data in Alsea and Netarts bays. Test sites were identified ton include known clam beds, shrimp beds, eelgrass, and other features exposed during low tide. Sites must be at least 5 nautical miles from airstrip per the FAA Certificate of Authorization (COA).
- **Ground-Truth**: Ground-truth measurements were conducted on-site the same day as UAS flights to ensure and verify the accuracy and integrity of the aerial imagery collected. Ground control point (GCP) locations were distributed evenly throughout each testing area and measured with high-precision GPS equipment (Trimble R7). Habitat information using SEACOR protocols, such as burrow counts, were conducted in 1 $m^2$ quadrats that were also used as additional GCPs.[4]



- **UAS Flights:** Flights were conducted using two platforms and sensors: a TurboAce Matrix-E quadcopter carrying a Sony RX100 M2 camera and a 3DR Solo carrying a GoPro Hero3 camera. Each flight varied in elevation, camera and settings, and total coverage initially to determine optimal equipment settings and flight parameters. Each platform was automatically tuned for current weather, wind speeds, lighting, and anticipated flight altitude.



- **Imagery Post-Processing**: The imagery collected required significant post-processing in order to create a geometrically corrected image mosaic (orthomosaic). Each image was geotagged to a relative GPS location, aligned, stitched, and corrected for distortion using GCPs in Agisoft's *Photoscan Pro* software, and then exported as a mosaic for further use in GIS software.

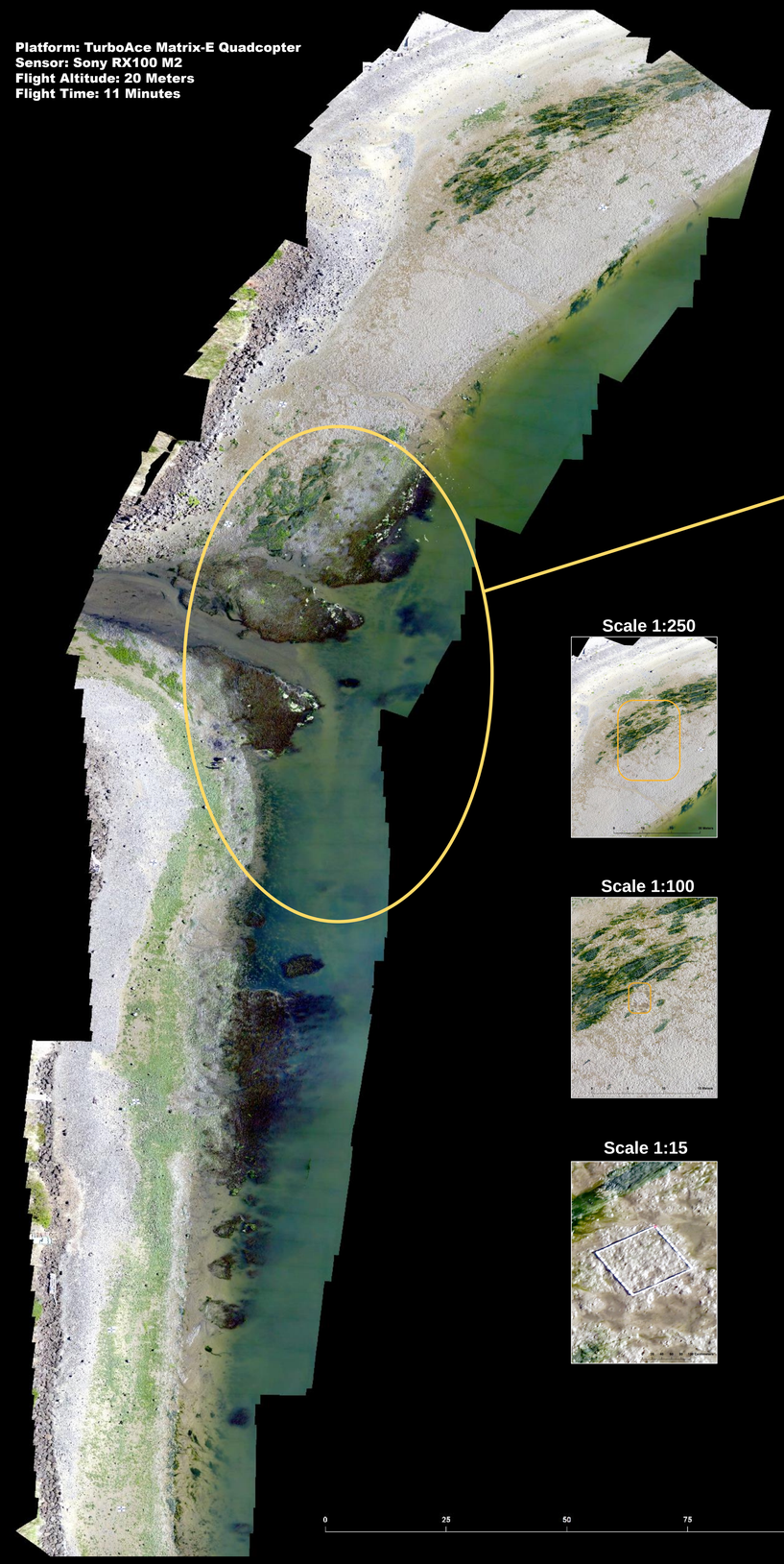
**References**.

[1] Linchant, et al. 2015. *Mammal Review. Impact Factor: 4.26*
[2] Watts, et al. *Remote Sens.* **2012**, *4*, 1671-1692
[3] Oregon Nearshore Conservation Strategy. 2015. http://www.dfw.state.or.us/conservationstrategy/read_the_strategy.asp
[4] Ainsworth et al. 2014. ODFW, Information Report Series, Fish. No. 2014-09. 119p

### Mosaic of Alsea Bay, Oregon Shoreline

Scale 1:1,100

**Platform: TurboAce Matrix-E Quadcopter**
**Sensor: Sony RX100 M2**
**Flight Altitude: 20 Meters**
**Flight Time: 11 Minutes**




Scale 1:250



Scale 1:100



Scale 1:15

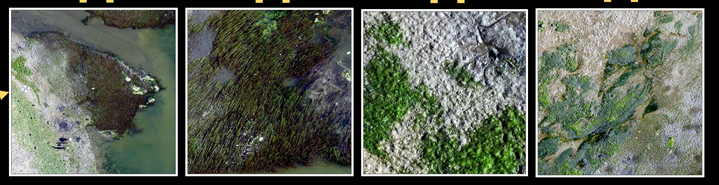


### Preliminary Results

**Identifiable Features**

- Gaper and Burrowing Shrimp Presence [A], [C], [D]
- Differentiated Vegetation [A], [B], [D]
- Areal Estimation of Vegetation and Other Habitats [All]
- Recreational Clamming Effort [A], [C], [D]
- Shallow Subtidal Vegetation [A]

[A] [B] [C] [D]



### Future Considerations

#### Limitations & Recommendations

**There is a tradeoff between resolution and aerial coverage that impacts the utility of this tool for SEACOR.**
SEACOR's unique mission means we have small features to visualize, necessitating *sub-centimeter* resolution. This resolution requires flights at low altitudes, which reduces aerial coverage. To expand SEACOR's efforts to entire tideflats or estuaries, we would need to:

1. Prioritize types of information gathered (e.g. presence of organisms, habitat proxies for shellfish, like eelgrass presence) **OR**
2. Invest in larger platforms with longer flight times and heavier, high-resolution sensor payloads.

**Current FAA regulations regarding UAS for agencies is restrictive and time-consuming.**
Upcoming changes to FAA UAS regulations may ease the burden of extraneous pilot certification requirements and allow agencies to fly in more areas at higher altitudes.

**Imagery post-processing significantly increases the time it takes to acquire usable data compared to field surveys.**
Upgrading computer systems can reduce the time it takes to process UAS imagery.

**Our UAS have short flight times.**
Financial investments into hexacopters/octocopters or fixed-wing aircraft would be required for aerial coverage of an entire estuary.

**Ground-truthing will always be required to some degree.**

**Use GCPs throughout the extent of the area to be surveyed.**
GCPs are important for reducing error in the final imagery products, especially when analyzing images for features less than 3 centimeters in size.

UAS compliments SEACOR field research by increasing temporal sampling of estuaries, and providing a tool to address immediate questions for management or regulations.

#### Next Steps

**Quantifying Features**: The final process will evaluate the capability of each UAS platform in comparison to manual data collection techniques. An automated process for analyzing the imagery to identify clam shows and other features will be considered after determining that the UAS and camera sensors used are capable of collecting sufficient data.

**SEACOR Website**

**Oregon Bay Clams**

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