**Overview**

Mapping and spatial analyses comprise a large bulk of the analytical deliverables associated with our ROV development project. This in part stems from the *in situ* field methods we are developing – current scientific SCUBA diver based benthic surveys (often) do not collect enough information to readily translate to the scale of maps. OR, even if those diver-collected data could be mapped, often the researchers do not have the precise geospatial positioning required. Our project is designed to resolve both potential shortcomings. Our ROV and benthic survey methods will cover large swaths of seafloor (numerous back-to-back, or 5m spaced, transects), collecting large amounts of information every step (every meter, every photo, every video still) of the way. And with our acoustic GPS system, we will have precise coordinates for the entirety of our benthic surveys. Uniting our various community structure and habitat data streams from the imagery with our GPS coordinates, and then overlaying / analyzing those ROV-derived variables in conjunction with existing habitat layers (e.g., bathymetry base layers, temperature, chlorophyll, canopy kelp cover imager, etc.) is our task. The challenge will be wrangling so many disparate data streams. The reward will be a rich landscape from which to ask MANY different types of research questions. Doing so has the potential to further both the *in situ* field methods and analytical approaches we use to evaluate and understand kelp-forest ecology and resilience.

**Data Streams**

*From the ROV*

Imagery

* CoralNet: percent coverage of sessile invertebrates, red and brown algae, and habitat type.
  + Most easily collected from photo stills. The GoPro takes 23MP photos which can be placed on a timer (e.g., I’ve taken many at 1s intervals).
  + Can also run analyses on stills from video. I’ve noticed the video \*typically\* has higher quality imagery relative to photos, but I’m uncertain of the quality of stills.
    - I know about Python code to extract stills from video, and I want to explore whether something similar exists for R.
  + Megan, given that you have experience with CoralNet, I think this is a good place to start in terms of our push in the AI realm.
* VIAME: abundances of conspicuous species such a sea stars, sea urchins, fishes, some algae
  + Works well with both photos or video. Likely will use video to start. VIAME automatically reduces a video down to a time series of stills at intervals that we can control.

.CSV Telemetry log

* Geospatial positioning data (lat / lon in decimal degrees).
  + Some (hopefully) minor processing will be required to clean up this data to correct erroneous readings. It should be reasonably straightforward to come up with a set of rules that identify step-lengths that are too long to be accurate.
  + I’m uncertain how to do this, but we’ll need some method of filtering coordinates, such that we can separate the instances (coordinates) where we’re on transect, vs coordinates where we’re descending the ROV, moving into position, etc. We can “hard code” this via knowing the timing of the transects and lining up that timing with the GPS data (in essence, manually specifying our survey times, and if this ends up being the easiest way, then fine). I’m guessing there’s also likely a more elegant solution, where we specify some set of rules / a function that repeatably / consistently identifies instances where the ROV in surveying vs diving, etc. I’ll think about this more as we continue to collect and visualize GPS transect tracks. It may also be worth familiarizing yourself with the MANY columns of the telemetry file (pre my filtered), as some of those accelerometer / thrust data could be useful when creating our “ROV behavior functions”
  + The following will likely be quite easy, I just haven’t done it yet: we want to extract the geometry from our GPS tracks, i.e., the net distance covered each step of the way, or for a set of steps, etc. I’ve done this in the past with point coordinates from NMDS, where we essentially use the Pythagorean theorem to calculate the distance between two points. Will need to go from decimal degrees to meters/feet.
* Heading and depth will also be useful (and heading will likely be useful to extracting the geometry from the above tracks).
* Ping1D Sonar Altimeter data (the distance between the ROV and the seafloor). Will need to extract possibly with Python (I’ll work on figuring this out). Having this information will be useful to calibrate / check our community inferences from the ROV imagery
  + I can also imagery some cool plots where we overlay the Ping1D data with the ROV’s depth data, such that we have a complete horizontal profile of the seafloor (via Ping1D) and the ROV’s relative position in relation to it (via Ping1D & depth data).

*Mapping layers*

For communication / PR / summary, synopsis documents

* Leaflet maps embedded within a, e.g., markdown file, or on a website, allowing a somewhat interactive experience.
* Other relatively simple base maps from which to make a pretty map?

Maps with additional complexity

* Bathymetry (depth contours) layers included (would also comprise a nice (likely static) summary map). NOAA should have a broad suite of these for our area. Bob Pacunski with WDFW is also a wealth of knowledge in this domain.
* Rough habitat type (sand, hard substrate, etc.) if these exist

Surface kelp canopy layers

* Use publicly available aerial imagery of canopy kelp from DNR. This would be a powerful visualization, as we could map (1) the location of SCUBA diver transects, (2) the location of ROV transects, all in relation to (3) canopy kelp.

MODIS terra / aqua satellite data

* I worked with MODIS data for one of my chapters, and it’s a bit of a learning curve to get the hang of it, but hopefully the work I did will help us jump in relatively quickly. MODIS imagery contains numerous physical variables, including sea temperature and chlorophyll. I envision these are less of “layers”, and more that we can extract this information into, e.g., a time series. For example, we can extract the chlorophyll data from around our ROV sites to create a time series of the past 20-ish years (since MODIS has been in orbit). These data would then be on-hand to be incorporated down the road into other analyses.