Science questions you can explore on the boat:

The sections of this document are meant to highlight different types of questions students could investigate while working on a boat like Admiral Jack. These are not exclusive, but could be helpful guidelines in helping students develop a question that could actually be explored with the equipment owned by Maritime High School on a boat like Admiral Jack, so we are setting them up for success as we help them design experiments.

Experiments that involve collecting water and bringing it back to the lab on campus can also be done from other floating/water-adjacent platforms (kayaks, small boats, the shore/beach/river, etc)

1. How does water change with depth?

Related questions (examples of questions that students might ask or that they could be prompted to come up with): Does the ocean (or river) change with depth? What factors produce these changes? Why is the ocean salty? Is the ocean the same temperature everywhere? How do we measure these things? How do the changes in water characteristics affect ecosystems? How might changes to these water characteristics (via climate change, human activity, etc) affect these ecosystems?

- What we can measure:
    - Temperature
    - Salinity
    - Dissolved oxygen
    - pH
    - Fluorescence/algae/plankton
- What materials we can use:
    - CTD (conductivity/temperature/depth sensor)
    - Niskin bottle (to gather water samples)
    - Vernier probes (if we bring the water on deck)
    - YSI Sonde (if we get one)
- Where we can measure it:
    - Select different locations (river, Elliott Bay, other Puget Sound locations)
    - Identify locations near particular landmarks (river inflow, waste water treatment plants, runoff pipes, etc)
    - Different depths
- When we can measure it:
    - Take the same measurements every week to create a “time series”
    - Take measurements in the same place at different times
    - Take measurements after major weather events (or simply record weather as part of data collection)
- Example student roles (these are just suggestions!)
    - Liaison with boat crew (i.e. talking to the captain before putting stuff in the water)
    - Data observer/recorder
    - Instrument deployment (i.e. putting stuff in the water)
- What data collection might look like:

Example of a 1-day data sheet:
Weather:
Water conditions:

Variable	Date	Location (+lat/lon)	Value at Depth 1 (0m)	Value at Depth 2 (1m)	Value at Depth 3 (5m)	etc
Temperature	5/20	Elliott Bay				

Salinity	5/20	Elliott Bay				
Dissolved Oxygen	5/20	Elliott bay				
Add rows as necessary						

Could repeat this type of data collection every week, and convert to a spreadsheet for analysis. You can also have students record multiple observations for the same sample at the same point.

- What data analysis might look like (tasks/discussion questions):
    - Make a line plot of temperature at a particular depth for every date (i.e. pick one depth and one variable and plot the values for every week).
        - How does this variable change over the course of your measurements? What factors might influence this variable? How do you know if any of these played a role in these measurements?
    - Make a depth plot of temperature for each week (plot all temperature values for each week on the same plot, maybe using a different color for each line). Could be done for any variable.
        - How does your variable change with depth? What factors might influence this variable? How do you know if any of these played a role in these measurements? (you can bring in prior knowledge about the context!)
    - Bar graph of data for a particular variable with error bars, to show variability across samples at the same place/time/depth and talk about accuracy/precision
        - What do your bars show you about the value of your variable at each measurement (time/place/depth)? What do your error bars tell you about the similarity or difference between individual measurements and measurements at different locations/times/depths?

Connection to NGSS:

- HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

Connections to other lessons:

- Oceanography (currently taught in 9th grade, Q3; includes general ocean structure, tides, density, and the effect of rivers, as well as Puget Sound)

Potential challenges:

- If you use a Niskin bottle to gather water at different depths, you need to make measurements of temperature/dissolved oxygen as quickly as possible once you bring it to the surface before it has time to equilibrate with the atmosphere.

- It can be hard to pull the Niskin bottle up from really deep and it is also hard to keep it straight up/down and know what depth it is at for sure (if there is current/the boat is drifting, it tends to deploy at an angle)
- Anything that gets deployed off the side needs to be kept clear of the rudder/propellers.

Possible discussion questions:

- General “science on a boat” questions”:
    - What was challenging about gathering these measurements?
    - How did you change your process for gathering measurements?
    - How did your roles in the group affect your experience of the process?
    - What did you notice in doing your role that your group members may not have?
    - How is doing science on a boat different from doing it in the lab?
- Data questions:
    - Does the data show you what you expected? Why or why not?
    - What possible sources of error might there be in gathering this data? How would this affect the values you measured?
- Science questions (these are process questions that are in addition to the questions that they are explicitly investigating):
    - If you had more time on the boat, what else would you want to know? What questions would you try to answer?
    - What other information might you want to gather and why?
    - Why is the information you gathered important for scientists to know? What about members of the larger community?
    - What other ways could we gather this information? What advantages or disadvantages are there to these different approaches?

2. How does water quality change with location/weather/depth?

Related questions: what do we mean by “water quality”? Why do we care about water quality? What factors influence water quality? How can we measure changes to water quality over time or by location? Who/what else is affected by water quality? How is water quality a reflection of our societal values and choices? (this is more of an environmental justice question, but still important!) How does human land use affect this? How do different water quality parameters relate to one another (i.e. if there are more nitrates do we see more bacteria? How does dissolved oxygen change if there are more bacteria and surfactants?) How is water quality different close to human habitation? How does water quality/characteristics change at different locations along a stream/river and what local features influence this (thinking about water treatment plants that drain into the river, other inputs to the river)?

- What we can measure:
    - Dissolved oxygen
    - pH
    - Nitrates
    - Ammonium
    - Turbidity
    - Microplastics
    - Bacteria
    - Surfactants
- What materials we can use:
    - Niskin bottle (to gather water samples)
    - Vernier probes (if we bring the water on deck)
    - YSI Sonde (if we get one)
    - LaMotte Colorimeter + reagents (if we get it)
    - Mesh filters (for microplastics - 0.33 or 0.35 mm)
    - Petri dishes with the correct medium for looking at different types of bacteria, ideally e. Coli vs other stuff for water quality
    - Incubator (for bacteria; this would be in the lab, not on the boat)
    - Water collection tubes (need screw on lids)
    - PPE!!! (gloves)
- Where we can measure it:
    - Select different locations (river, Elliott Bay, other Puget Sound locations)
    - Identify locations near particular landmarks (river inflow, waste water treatment plants, runoff pipes, etc)
    - Different depths
- When we can measure it:
    - Take the same measurements every week to create a “time series”
    - Take measurements in the same place at different times
    - Take measurements after major weather events (or simply record weather as part of data collection)
- Example student roles (these are just suggestions!)

    - Liaison with boat crew (i.e. talking to the captain before putting stuff in the water)
    - Data observer/recorder
    - Instrument deployment (i.e. putting stuff in the water)
- What data collection might look like:

Example of a 1-day data sheet:
Weather:
Water conditions:

Variable	Date	Location (+lat/lon)	Value at Depth 1 (0m)	Value at Depth 2 (1m)	Value at Depth 3 (5m)	etc
Nitrates	5/20	Elliott Bay				
Dissolved Oxygen	5/20	Elliott Bay				
Ammonium	5/20	Elliott bay				
Add rows as necessary						

Could also take water samples back to the lab to do more with microplastics (similar to the Q2 microplastics unit, where they process and count different types of microplastics) or to put water samples on petri dishes to develop bacteria cultures. This will require use of collection tubes and appropriate storage until analysis can happen (preferably in a cold, dark cooler)

Could repeat this type of data collection every week, and convert to a spreadsheet for analysis. You can also have students record multiple observations for the same sample at the same point.

- What data analysis might look like (tasks/discussion questions):
    - Make a line plot of temperature at a particular depth for every date (i.e. pick one depth and one variable and plot the values for every week).
        - How does this variable change over the course of your measurements? What factors might influence this variable? How do you know if any of these played a role in these measurements?
    - Make a depth plot of temperature for each week (plot all temperature values for each week on the same plot, maybe using a different color for each line). Could be done for any variable.
        - How does your variable change with depth? What factors might influence this variable? How do you know if any of these played a role in these measurements? (you can bring in prior knowledge about the context!)
    - Bar graph of data for a particular variable with error bars, to show variability across samples at the same place/time/depth and talk about accuracy/precision

        - What do your bars show you about the value of your variable at each measurement (time/place/depth)? What do your error bars tell you about the similarity or difference between individual measurements and measurements at different locations/times/depths?
    - Bar graph of counts of bacteria/types of microplastics for each location/time/depth (can average and add error bars if students make multiple independent measurements for the same time/place/depth)
        - Which time/place/depth had the most bacteria/microplastic? What factors might be contributing to this?

Connection to NGSS:

- HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
- HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Connections to other lessons:

- Oceanography (currently taught in 9th grade, Q3; includes general ocean structure, tides, density, and the effect of rivers, as well as Puget Sound)
- Microplastics unit

Potential challenges:

- If you use a Niskin bottle to gather water at different depths, you need to make measurements of temperature/dissolved oxygen as quickly as possible once you bring it to the surface before it has time to equilibrate with the atmosphere.
- It can be hard to pull the Niskin bottle up from really deep and it is also hard to keep it straight up/down and know what depth it is at for sure (if there is current/the boat is drifting, it tends to deploy at an angle)
- Anything that gets deployed off the side needs to be kept clear of the rudder/propellers.

Possible discussion questions:

- General “science on a boat” questions”:
    - What was challenging about gathering these measurements?
    - How did you change your process for gathering measurements?
    - How did your roles in the group affect your experience of the process?
    - What did you notice in doing your role that your group members may not have?
    - How is doing science on a boat different from doing it in the lab?
- Data questions:
    - Does the data show you what you expected? Why or why not?
    - What possible sources of error might there be in gathering this data? How would this affect the values you measured?

- Science questions (these are process questions that are in addition to the questions that they are explicitly investigating):
    - If you had more time on the boat, what else would you want to know? What questions would you try to answer?
    - What other information might you want to gather and why?
    - Why is the information you gathered important for scientists to know? What about members of the larger community?
    - What other ways could we gather this information? What advantages or disadvantages are there to these different approaches?
    - What are possible sources of the *E. coli* bacteria (nitrates/other nutrients/etc) identified in your sample?
    - Why is there such variability among the samples?

3. Who lives here?

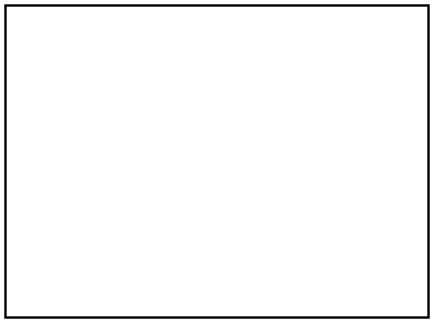
Related questions: What lives in the water? Is it the same everywhere? How do different organisms interact? How do we know who lives here? Where do the most phytoplankton/zooplankton/etc live? How do human communities interact with marine organisms? How do different water parameters relate to who lives here (i.e. how does salinity relate to the types of organisms we find in different places, such as the river and Elliott Bay? Where in the water column do plankton live and what changes at those different depths?)

- What we can measure:
    - Phytoplankton (counts/taxonomy)
    - Zooplankton (counts/taxonomy)
    - Water quality/variables such as dissolved oxygen, temperature, etc as described above.
- What materials we can use:
    - Niskin bottle (to gather water samples)
    - Plankton net (different size mesh for different size classes: zooplankton = 500 micrometer, phytoplankton = 25 micrometer)
    - Microscopes and slides (for phytoplankton)
    - Petri dishes (for zooplankton)
    - Pipettes
    - Equipment described above for measuring water characteristics.
- Where we can measure it:
    - Select different locations (river, Elliott Bay, other Puget Sound locations)
    - Identify locations near particular landmarks (river inflow, wastewater treatment plants, runoff pipes, etc)
    - Different depths
- When we can measure it:
    - Take the same measurements every week to create a “time series”
    - Take measurements in the same place at different times
    - Take measurements after major weather events (or simply record weather as part of data collection)
    - Take measurements in one place at different times of day (could be relevant for both zooplankton and phytoplankton)
- Example student roles (these are just suggestions!)
    - Liaison with boat crew (i.e. talking to the captain before putting stuff in the water)
    - Data observer/recorder
    - Instrument deployment (i.e. putting stuff in the water)
- What data collection might look like:

    Qualitative:

    - Weather:
    - Water conditions:
    - What color is the phytoplankton tow? Is it the color you expected?
    - Are there critters swimming around?

- What color is the zooplankton tow?
- Are the zooplankton very active?
    - Make a drawing of your organism:



Quantitative:

Depth:
Time:
Date:
Location:

Species	Measurement 1	Measurement 2	Measurement 3	Average
Diatom				
Dinoflagellate				
etc.				

→Can also gather quantitative data as described in the first two sections

- What data analysis might look like (tasks/discussion questions):
    - Bar graph of counts of different species of phytoplankton and zooplankton at each time/depth/location
    - Make a line plot of species count over time for a particular time/depth/location
        - How does the concentration/quantity change over the course of your measurements? What factors might influence this variable? How do you know if any of these played a role in these measurements?
    - Define and describe the set of characteristics used to identify and distinguish among the pennate and centric diatoms and the dinoflagellates. (i.e. how do we know which species is which?)
        - Based on your observations, how are diatoms and dinoflagellates similar? How are they different?
    - Depth plot of species (or bulk zooplankton/phytoplankton) counts
        - Where are phytoplankton most concentrated? Where are zooplankton most concentrated?
    - Combination plots showing profile/depth plot of different variables with sketches and/or bar graphs of plankton types/concentrations at different depths

Connection to NGSS:

- HS-LS2-6. Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Connections to other lessons:

- Water quality

Potential challenges:

- If you use a Niskin bottle to gather water at different depths, you need to make measurements of temperature/dissolved oxygen as quickly as possible once you bring it to the surface before it has time to equilibrate with the atmosphere.
- It can be hard to pull the Niskin bottle up from really deep and it is also hard to keep it straight up/down and know what depth it is at for sure (if there is current/the boat is drifting, it tends to deploy at an angle)
- Anything that gets deployed off the side needs to be kept clear of the rudder/propellers.

Possible discussion questions:

- General “science on a boat” questions”:
    - What was challenging about gathering these measurements?
    - How did you change your process for gathering measurements?
    - How did your roles in the group affect your experience of the process?
    - What did you notice in doing your role that your group members may not have?
    - How is doing science on a boat different from doing it in the lab?
- Data questions:
    - Does the data show you what you expected? Why or why not?
    - What possible sources of error might there be in gathering this data? How would this affect the values you measured?
- Science questions (these are process questions that are in addition to the questions that they are explicitly investigating):
    - If you had more time on the boat, what else would you want to know? What questions would you try to answer?
    - What other information might you want to gather and why?
    - Why is the information you gathered important for scientists to know? What about members of the larger community?
    - Why is there such variability among the samples?
    - Why might phytoplankton and zooplankton be concentrated at different depths? What factors might affect where they are concentrated

4. What happens to the light?

Related questions: can water penetrate into the ocean (river)? How do you know? Why does it matter where the light goes? What factors can change the depth to which light can penetrate? What species are affected by these changes? How does human land use affect this? How does weather affect this? Where do plankton live? How does the location of the plankton (phyto-/zoo-) vary with light/turbidity (i.e. do they all live right at the surface? Where do they live when the water is really cloudy? How deep can you find plankton (phyto-/zoo-)? Why do we care how deep the light can go? What can we see in the ocean that might tell us about light (i.e. kelp growing on the bottom of the bay/ocean/etc)? What human actions might disrupt underwater communities that rely on light?

- What we can measure:
    - Fluorescence/algae/plankton
    - Light penetration
    - Turbidity
    - Particulates
    - Plankton concentrations
- What materials we can use:
    - Secchi disk
    - Turbidity sensor
    - Fluorometer (if we get one)
    - Niskin bottle (to gather water samples)
    - Plankton net (different size mesh for different size classes: zooplankton = 500 micrometer, phytoplankton = 25 micrometer)
    - Microscopes and slides (for phytoplankton)
    - Petri dishes (for zooplankton)
    - Pipettes
    - LaMotte turbidity tubes
    - Test tubes/narrow graduated cylinders to observe settling of particulates
    - ROV/underwater camera
- Where we can measure it:
    - Select different locations (river, Elliott Bay, other Puget Sound locations)
    - Identify locations near particular landmarks (river inflow, waste water treatment plants, runoff pipes, etc)
    - Different depths
- When we can measure it:
    - Take the same measurements every week to create a “time series”
    - Take measurements in the same place at different times
    - Take measurements after major weather events (or simply record weather as part of data collection)
- Example student roles (these are just suggestions!)
    - Liaison with boat crew (i.e. talking to the captain before putting stuff in the water)

    - Data observer/recorder (if using a Secchi disk, it is important to have as many people looking as possible)
    - Instrument deployment (i.e. putting stuff in the water)
- What data collection might look like:

Weather (today AND also look up recent weather patterns/events that might influence results):
Water conditions:

Variable	Date	Depth	Location 1(+lat/lon)	Location 2(+lat/lon)	Location 3(+lat/lon)	etc
Turbidity	5/20	5m				
Secchi depth	5/20	N/A				
Particulates	5/20	5m				
Plankton counts	5/20					
Add rows as necessary						

- What data analysis might look like (tasks/discussion questions):
    - Bar graph of counts of different species of phytoplankton and zooplankton at each time/depth/location
    - Make a line plot of species count over time for a particular time/depth/location
        - How does the concentration/quantity change over the course of your measurements? What factors might influence this variable? How do you know if any of these played a role in these measurements?
    - Define and describe the set of characteristics used to identify and distinguish among the pennate and centric diatoms and the dinoflagellates. (i.e. how do we know which species is which?)
        - Based on your observations, how are diatoms and dinoflagellates similar? How are they different?
    - Depth plot of species (or bulk zooplankton/phytoplankton) counts
        - Where are phytoplankton most concentrated? Where are zooplankton most concentrated?
    - Combination plots showing profile/depth plot of different variables with sketches and/or bar graphs of plankton types/concentrations at different depths
    - Maps showing sampling sites and differences in measurements (this can be a good opportunity to connect to other studies of human development, on-shore land characteristics, etc)

Connection to NGSS:

- HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Connections to other lessons:

- Who lives here?

Potential challenges:

- Different measurement techniques have different degrees of accuracy and ease of use. Turbidity columns are easy can be very subjective unless students practice and confirm their readings. Secchi disks can be very accurate, but the boat needs to be very stationary and you should not rely on a single person reporting about whether they can see it.
- Anything that gets deployed off the side of a boat needs to be kept clear of the rudder/propellers.

Possible discussion questions:

- General “science on a boat” questions”:
    - What was challenging about gathering these measurements?
    - How did you change your process for gathering measurements?
    - How did your roles in the group affect your experience of the process?
    - What did you notice in doing your role that your group members may not have?
    - How is doing science on a boat different from doing it in the lab?
- Data questions:
    - What surprised you about the data?
    - Does the data show you what you expected? Why or why not?
    - What possible sources of error might there be in gathering this data? How would this affect the values you measured?
- Science questions (these are process questions that are in addition to the questions that they are explicitly investigating):
    - If you had more time on the boat, what else would you want to know? What questions would you try to answer?
    - What other information might you want to gather and why?
    - Why is the information you gathered important for scientists to know? What about members of the larger community?
    - Why is there such variability among the samples?
    - Why might phytoplankton and zooplankton be concentrated at different depths? What other factors that you measured might affect where they are concentrated?
    - How might activities like riparian restoration/native plant restoration/etc affect these results? How can you identify areas where this would have the most impact?

5. What's on the bottom of the ocean (river)?

Related questions: what is the bottom made of? How does the bottom of the ocean change in different places? Why does it matter what the bottom is made of? Who lives on the bottom of the ocean? Where does the stuff on the bottom of the ocean come from? Is the bottom of the ocean alive or dead? How much of the bottom material is different things (mud, living organisms, other stuff)

- What we can measure:
    - Color/smell/texture of the "mud" (this is qualitative but will definitely change from site to site)
    - Animal counts/taxonomy
- What materials we can use:
    - Sediment grab
    - Sieves and steel table
    - Dissecting microscope
    - Petri dishes
    - book for organism identification
    - 2oz jars for storing mud (need refrigeration/cooler with ice)
- Where we can measure it (bottom sample only for this):
    - Select different locations (river, Elliott Bay, other Puget Sound locations)
    - Identify locations near particular landmarks (river inflow, waste water treatment plants, runoff pipes, etc)
- When we can measure it:
    - Unless there is a major event like a landslide that ends in the water, these measurements are unlikely to show huge temporal differences while we are on the boat. This will be more of a place-difference.
- Example student roles (these are just suggestions!)
    - Liaison with boat crew (i.e. talking to the captain before putting stuff in the water)
    - Data observer/recorder (if using a Secchi disk, it is important to have as many people looking as possible)
    - Instrument deployment (i.e. putting stuff in the water)
- What data collection might look like:

Weather:
Water conditions:

Sediment characteristic	Date	Location 1 (+lat/lon)	Location 2 (+lat/lon)	Location 3 (+lat/lon)	etc
Color	5/20				
Smell	5/20				
Texture	5/20				
Mud composition					

Species observed					
Add rows as necessary					

- What data analysis might look like (tasks/discussion questions):
    - Qualitative descriptions
    - Maps showing sampling sites and differences in measurements (this can be a good opportunity to connect to other studies of human development, on-shore land characteristics, etc)
    - Bar graphs/pie charts showing composition of materials

Connection to NGSS:

- HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Connections to other lessons:

- Who lives here?

Potential challenges:

- Need to make sure we are not collecting sediment from hazardous sites
- Without more significant equipment to retrieve a sediment grab from the bottom of the ocean, this will only be possible in fairly shallow areas.
- Anything that gets deployed off the side of a boat needs to be kept clear of the rudder/propellers.

Possible discussion questions:

- General “science on a boat” questions”:
    - What was challenging about gathering these measurements?
    - How did you change your process for gathering measurements?
    - How did your roles in the group affect your experience of the process?
    - What did you notice in doing your role that your group members may not have?
    - How is doing science on a boat different from doing it in the lab?
- Data questions:
    - What surprised you about the data?
    - Does the data show you what you expected? Why or why not?
    - What possible sources of error might there be in gathering this data? How would this affect the values you measured?
- Science questions (these are process questions that are in addition to the questions that they are explicitly investigating):
    - If you had more time on the boat, what else would you want to know? What questions would you try to answer?

- What other information might you want to gather and why?
- Why is the information you gathered important for scientists to know? What about members of the larger community?
- Why is there such variability among the samples?
- What were the major differences in the sediment samples and the organisms that were found living in the sediment at the two stations? (What did Puget Sound look like ~20,000 years ago, and would you expect the seafloor sediments to change over the past 20,000 years?)
- How might activities like riparian restoration/native plant restoration/etc affect these results? How can you identify areas where this would have the most impact?

6. How do we explore the ocean?

How do we learn about places in the ocean that are too deep for humans? How do we explore places that are deep and inhospitable? How do we balance exploring/learning more/answering our questions and the financial burden? Who has access to technology to explore the ocean and how does this shape knowledge development? How does knowing more about what lives in the ocean change our relationship with the ocean, sense of curiosity, etc (i.e. when you know more, does it make the ocean more or less special to you?)

- What we can measure (these are likely to be more:
    - Observations of bottom composition
    - Animal counts/taxonomy
- What materials we can use:
    - Underwater camera
    - ROV
- Where we can measure it (bottom sample only for this):
    - Select different locations (river, Elliott Bay, other Puget Sound locations)
    - Identify locations near particular landmarks (river inflow, waste water treatment plants, runoff pipes, etc)
- When we can measure it:
    - Unless there is a major event like a landslide that ends in the water, these measurements are unlikely to show huge temporal differences while we are on the boat. This will be more of a place-difference.
- Example student roles (these are just suggestions!)
    - Liaison with boat crew (i.e. talking to the captain before putting stuff in the water)
    - Data observer/recorder (if using a Secchi disk, it is important to have as many people looking as possible)
    - Instrument deployment (i.e. putting stuff in the water)
- What data collection might look like:

Weather:
Water conditions:

Qualitative data collection: videos/pictures/descriptions

Quantitative data

Location characteristics	Date	Location 1 (+lat/lon)	Location 2 (+lat/lon)	Location 3 (+lat/lon)	etc
Bottom composition?	5/20				
Species observed	5/20				
Add rows as					

necessary					

- What data analysis might look like (tasks/discussion questions):
    - Videos/photos showing different species with habitat analysis
        - What lives here (plants, animals)?
        - What is the habitat?
        - How do these species interact?
    - Maps showing sampling sites and species observed (pictures, sketches, etc)
        - How are the different sites affected by human development?

Connection to NGSS:

-

Connections to other lessons:

- Who lives here?

Potential challenges:

- Anything that gets deployed off the side of a boat needs to be kept clear of the rudder/propellers.

Possible discussion questions:

- General “science on a boat” questions”:
    - What was challenging about gathering these measurements?
    - How did you change your process for gathering measurements?
    - How did your roles in the group affect your experience of the process?
    - What did you notice in doing your role that your group members may not have?
    - How is doing science on a boat different from doing it in the lab?
- Data questions:
    - What surprised you about the data?
    - Does the data show you what you expected? Why or why not?
    - What possible sources of error might there be in gathering this data? How would this affect the values you measured?
- Science questions (these are process questions that are in addition to the questions that they are explicitly investigating):
    - If you had more time on the boat, what else would you want to know? What questions would you try to answer?
    - What other information might you want to gather and why?
    - Why is the information you gathered important for scientists to know? What about members of the larger community?
    - Why is there such variability among the samples?
    - How might your observations be impacted by human development? What restoration/conservation activities might affect future observations?

7. How do we develop tools for science?

How do we know what we know? What are we actually measuring? How do we use the properties of materials to infer the properties of water and other materials? What role does engineering design play in science?

Some great resources for exploring sensor development for science research can be found at https://www.publicsensors.org. They work with students in the greater Seattle area and have kits available for educators to borrow.