



Teacher Notes

Muddy Waters

These notes are provided to assist educators preparing to implement the Muddy Waters ORSEA lesson.

Timing

This lesson could be implemented throughout an entire school year and take up to 20 class periods of instruction, or the lesson could be truncated and implemented over a five-day unit. The details of implementation will partially depend on whether students have regular access to a local urban estuary.

Implementation

Depending on the location of your classroom, you may directly replicate this lesson and its field components, or you can apply the urban estuary activities to an unprotected estuary (or even a freshwater system) that is closer to your school. Some data and information are also available online.

Preparation

Prior to beginning the unit, ensure you have access to the materials needed to test the following water quality parameters: Dissolved oxygen, temperature, pH, turbidity, salinity. To simplify the lesson, you may choose to focus on just two or three parameters.

In Oregon, teachers may be able to borrow water quality testing materials. Check with your local:

- STEM Hub: <https://stemoregon.org/regional-stem-hubs/>
- Watershed Council: <https://www.oregon.gov/oweb/resources/pages/watershed-councils.aspx>
- ODFW STEP Biologist: <https://www.dfw.state.or.us/fish/step/biologists.asp>

Video tutorials for using Vernier and other water quality testing materials are provided in the lesson.

Other equipment that will be needed include buckets, clipboards, and access to online spreadsheets to organize data back in the classroom.

ENGAGE

Options are provided for either an in-person or virtual visit to South Slough National Estuarine Research Reserve. The South Slough Reserve is the only NERR in Oregon, and it has several water quality

monitoring stations. Near-time data from South Slough can be accessed online through the [Centralized Data Management Office](#).

EXPLORE

EXPLORE and EXPLAIN are not linear. You will do a bit of looping.

Guiding Questions for Visual Assessment of the Urban Field Site

- Where does the estuary start? What is the water flow route (through the city)?
- What animals live in and around the estuary? How do we know?
- What can be measured in the estuary that can help tell its story?
- How can we test the water quality?

Resources for Students

Teach students to bookmark websites they will use frequently while working on this project. Make a bookmarks folder including links to:

- Local tides
- Local weather
- National Estuarine Research Reserve System's [Centralized Data Management Office](#)
- Sites that help students convert from standard to metric

Using Google to manage data

- [How to create spreadsheets](#)
- [How to add or edit a chart/graph](#)

EXPLAIN

In this section, student scientists will begin collecting water quality data from the urban estuary. Ideally, data collection can extend throughout the school year, so students can get started collecting data as soon as they know how to use the equipment. In between the field testing times, the teacher can review and dig deeper into the resources in the EXPLORE section that describe how water quality impacts ecosystems.

Tips for field activities

- Complete the top two areas of the data collection sheet in the classroom before taking it with you to the estuary.
- Attach to the field clipboard the Water Quality Parameters from NOAA and a macroinvertebrates key in case you want to collect some species.
- The data collection sheet can be printed on both sides and used for the next class.
- Use the time traveling to and from the urban estuary to identify potential human impacts.
- Collect and experiment with sediment to see how it behaves in water.

Students enter the data they collected then pull up the [Centralized Data Management Office](#) site and enter data from Winchester Arm. Hold class discussions on the parameters and findings.

Guided Questions for Data Analysis

- How does the turbidity in the urban estuary compare to South Slough?
 - o Why is it different?
 - o Discuss marshes and natural filtering that occurs in South Slough. What filters the water in the urban estuary?
 - o Identify areas that can be amended to improve water quality.
- Identify which parameters are within the acceptable/healthy range in both ecosystems.

Vocabulary

In lessons and student discussions, use the key vocabulary provided in the lessons. A Quizlet is provided to assess student vocabulary, or you can create your own assessment.

Guided Questions for Career Connections

Introduce students to wetland geologist Molly Keogh through the Researcher Bio. Ask students:

- What is Molly's career, what is her research about, and what questions are she trying to answer?
- How does Molly apply the data she collects from South Slough in her career?
- What has Molly learned from her data?

ELABORATE

Once the students have four or more data sets collected, teach them [how to make a chart](#).

- This takes some practice and fine tuning to get the results you want. I found it best to walk students through this step-by-step.
- Further exploration takes place with the datasets. Students start by comparing the same parameters of both estuaries but are encouraged to apply their new knowledge and explore.

Students interact with and interpret the data.

- Make predictions for future environmental conditions in the estuary.
- Plot data and explore relationships between parameters (for example: temperature vs. dissolved oxygen, water level vs. salinity).
- Describe trends they observed and discuss what may be driving these trends.

The Watershed Game

- Oregon Coast teachers can check out a copy of the game from an Oregon Coast STEM Hub [resource trailer](#)
- For help finding a copy *The Watershed Game* to borrow, contact Oregon Sea Grant marine educator cait.goodwin@oregonstate.edu

EVALUATE

Review standards while designing a summative assessment.