Muddy Waters: A Tale of Two Sloughs

What factors drive differences between an urban estuary and a protected estuary reserve?

Overview

Urban estuaries are often heavily impacted by human land use in the watershed. When comparing an urban estuary to a protected natural system, students may observe differences in water quality (temperature, pH, turbidity, salinity, dissolved oxygen) that affect the plants and animals that live there. In this unit, students compare and contrast an urban estuary in Coos County known as "Pony Slough" with characteristics of the nearby protected South Slough National Estuarine Research Reserve. They will learn how to measure water quality parameters and explore how they vary based on factors including tidal stage, season, and land use.

Essential Questions

- *How does the water quality of South Slough compare to that of the urban Pony Slough estuary?*
- *What phenomena (both natural and human-caused) affect water quality?*
- *How does water quality affect what organisms live in the two estuaries?*
- *What actions could be taken to improve the aquatic habitat of this urban estuary?*

Learning Goals

Students will learn the following:

- *Water quality is an indicator of estuary health.*
- *Water quality parameters (including temperature, pH, turbidity, salinity, and dissolved oxygen) can be measured using straightforward tools.*
- *Water quality is affected by both human land use in the watershed and by natural processes like tides and seasons.*
- *Water quality affects what species live in the estuary.*

Authors

Jackie Gooch
North Bend Middle School
Molly Keogh
University of Oregon

Grade Level

6-8

Time

5 or more days

Anchoring Phenomenon

Muddy Waters

Driving Question

What factors drive differences between an urban estuary and a protected estuary reserve?

Standards

Next Generation Science Standards

LS2.C – Ecosystem Dynamics, Functioning, and Resilience

Common Core Math Standards

8.F.B.4

Coos Estuary
Photo: NERRS Science Collaborative

Learning Objectives

Students will be able to:

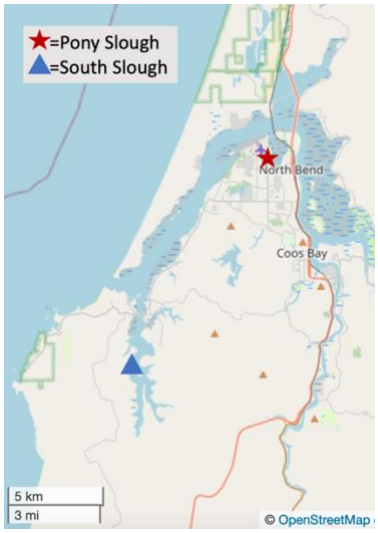
- *collect water samples and analyze them for a variety of water quality parameters (temperature, pH, turbidity, salinity, and dissolved oxygen).*
- *use a spreadsheet program to develop data tables, input and store data for comparison, and create charts.*
- *compare water quality data from a local estuary with data collected in South Slough, observe similarities and differences between the two sites, and formulate hypotheses about what makes them the same or different.*
- *discuss how people affect the water quality in an estuary, and propose ways that water quality can be improved.*

Introduction

The anchoring phenomenon for this unit involves comparing two estuarine habitats, observing and measuring differences in water quality, and exploring the underlying reasons for those differences. In this 'Tale of Two Sloughs', we compare Pony Slough, an urban estuary in Coos County, Oregon with the protected South Slough National Estuarine Research Reserve (SSNERR or South Slough Reserve) located approximately 13 miles away.

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

The unit begins with students visiting and making observations of both the protected and unprotected estuaries. Students learn about water quality parameters, their significance, and how to collect water quality data. After learning how to use water quality measurement tools, the students participate in four data collection days spaced over a school year. This schedule enables multiple classes to engage with the project during different class periods throughout the year, and data from all participating classes can be combined, giving students access to a larger dataset and allowing them to see variability across tidal cycles and seasons. Students will use the National Estuarine Research Reserve System's Centralized Data Management online database to access real-time or and/or historical water quality data from South Slough to make comparisons.



Location of Pony Slough and South Slough Reserve in Coos County, Oregon

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*

In Oregon, teachers may be able to borrow these materials. Check with:

- *Your local STEM Hub*
- *Your local Watershed Council*
- *Your local ODFW STEP Biologist*

Instructions for using water quality testing materials are provided in the lesson.

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

Lesson Procedure

ENGAGE

Students begin by observing differences between an urban and protected estuary.

Activity: Field trip to South Slough Reserve (1 day)
Kickoff the unit by taking students on a field trip to *South Slough Reserve* to learn about the flow of water from the mountains down into the bay and the filtration processes the water naturally goes through. To supplement the visit, or if an in-person field trip is not possible, students can watch the *Tide of the Heron* video which describes the unique ecology of the estuary and the characteristics of its upland, marsh, tideflat and open channel habitats. Students will learn that South Slough is protected and is relatively pristine, and that wetlands serve as natural filters that clean the water before it enters the bay. If possible, bring water samples from the protected estuary into the classroom for students to observe during the next activity.

Activity: Introduce the Urban Estuary (45 min)
If you have an urban estuary (bay, marsh, tidal creek or slough) in the area, ask students what they know about it, if they think it's healthy, and how they think its health could be determined. Guide students toward the idea that measuring biodiversity in the estuary and testing water quality parameters such as pH, salinity, temperature, turbidity, and dissolved oxygen could help assess the health of the estuary. Ask students what natural phenomena they think may affect water quality parameters to elicit their ideas about the effects of tidal exchange and seasonal changes.

Introduce two jars of water: One that is fairly clear (from South Slough) and the other is laden with sediment (from an urban estuary). Note: if water clarity is not noticeably different in the two water samples, consider enhancing the urban sample with additional sediment. The point is to stimulate thinking about where sediment goes when it washes off the land, and how sediment affects water clarity.

Allow students time to visually examine the samples, and then lead a class discussion about the differences they notice. Where do they think each sample came from and what evidence supports their claim? What more do they want to know about these samples and how could they find out?

Conclude the ENGAGE section by asking students to consider why the health of the urban estuary is important for the ecosystem and for humans.

LESSON RESOURCES

South Slough Reserve
- *South Slough field trip info*
- *Video: Tide of the Heron [12:31]*

Four parts of an estuary described in the Tide of the Heron video

Student examines water samples. Photo: C. Goodwin

EXPLORE

In this section, students learn how scientists collect data and they prepare to collect their own data at a local urban estuary. Note: Much of the information provided below can extend into the EXPLAIN section.

Activity: Field Site Pre-Visit

First, have the students complete a visual assessment of the urban estuary, noting what they can see (in person or through photos, *Google Earth*, etc.) before water quality tests begin. If students have previously visited the estuary, they may want to share stories of their finds. See the *Teacher Notes* for guiding questions. If needed, include a mini-lesson or refresher about tides using a NOAA *What Causes Tides?* video.

Activity: Measuring Water Quality

In the classroom, conduct lessons to help students understand the various *water quality parameters* they will be measuring. The *Monitoring Estuaries* tutorial from NOAA has background information about water quality in estuaries, and the MWEEs by the Sea *Water Quality* webpage contains teacher resources for measuring water quality with students. For a deeper dive, use the NOAA *Data in the Classroom* resource which guides students through using real online data to see relationships between water quality parameters and understand the effect that water quality has on estuarine organisms. This lesson also introduces the National Estuarine Research Reserve System's *Centralized Data Management Office* (CDMO) where students will later obtain data from South Slough.

Activity: How to Test Water Quality

Prior to testing water quality in the field, familiarize students with the tools they will be using to collect data. In a *Salmon Watch Water Quality* video from Oregon Department of Fish and Wildlife (ODFW) a hydrologist explains temperature, turbidity, dissolved oxygen and pH, and demonstrates how these parameters are measured in the field. Similarly, *Streamwebs Tutorial Videos* can be used to show students how to use Vernier equipment to measure water quality. Practice using the equipment in the classroom before heading out into the field.

Turbidity: In this "Muddy Water" lesson, students will pay particular attention to differences and impacts of sediment in estuarine environments. Have students watch a 6 minute *Turbidity* video from North Carolina, as well as read the Environmental Protection Agency (EPA) brochure *What is Sediment Pollution?* Additional information about *Turbidity and Water* is available from The U.S. Geological Survey (USGS).

Field Site Pre-Visit

- *Google Earth*
- *Teacher Notes (pdf)*
- *Video: What Causes Tides? [3:33]*

Measuring Water Quality

- *WQ Parameters (pdf)*
- *Monitoring Estuaries tutorial, NOAA*
- *Water Quality, MWEEs by the Sea*
- *Data in the Classroom, NOAA*
- *Centralized Data Management Office, NERRS*

Students explore Pony Slough. Photo: Jackie Gooch

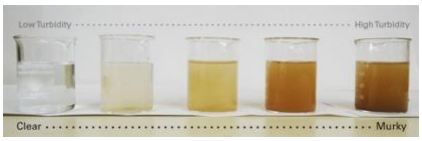
How to Test Water Quality

- *Video: Salmon Watch Water Quality from ODFW [15:30]*
- *Videos: Streamwebs Tutorials*

Turbidity

- *Video: Turbidity from ChapelHillGov [6:22]*
- *What is Sediment Pollution? EPA*
- *Turbidity and Water, USGS*

Turbidity is the measure of the amount of light that passes through water. Turbid water is murky or cloudy. Non-turbid water is clear.



Water samples with varying turbidity. Photo: Village of Chase, British Columbia

Have students review and practice using the data sheet they will use to collect their data. Use the *Student data collection sheet*, or the Water Quality *Streamwebs data sheet*, available in English or Spanish. Develop a *class spreadsheet* where students will input their data.

EXPLAIN

In this section, student scientists will begin collecting water quality data from the urban estuary so that they can compare their findings to online data from the protected 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. As students begin collecting data locally and comparing them to South Slough data, revisit and dig deeper into the water quality parameters and other resources in the EXPLORE section that describe how water quality impacts ecosystems.

Activity: Data Collection

Water sampling at the urban site should take place at least once per season (at least 4 collections per year) with different classes visiting during different times of day and tide levels. Alternatively, all data can be collected over the course of two weeks if necessary. The instructor should collect and keep all data obtained by students.

Have students enter the data they collected at their urban estuary on the class spreadsheet and then pull up the *Centralized Data Management Office* site to obtain data from South Slough Reserve. There are several monitoring stations at South Slough, but we chose the Winchester Arm station (SOSWIWQ) because data are available in real time and Winchester's salinity is close to that of the Pony Slough estuary.

Activities: Sediment Sleuths

As students travel to and explore the urban estuary on field collection days, have them make note of any disturbances of other factors they see in the environment which could affect turbidity or other water quality parameters.

Optional: Consider using soil corers to collect soil samples in the watershed. Explore how the soil from the estuary behaves in the water. Does it sink, remain suspended, or float?

Data Sheets

- *Student data collection sheet (pdf)(doc)(example)*
- *Streamwebs data sheets*
- *Class spreadsheet (xls)*

Students collect water quality data. Photo:Jackie Gooch

Screenshot of CDMO portal

SOSWIWQ station. Photo: NERRS

Sediment samples. Photo: C. Goodwin

Activity: Making Comparisons
As data are collected, hold class discussions on the parameters and findings. Have students identify which parameters are within the acceptable/healthy range in both the urban and protected ecosystems. Additional guided discussion questions are provided in the *Teacher Notes*.

During class discussions, review and model *Key Vocabulary* associated with this lesson, supplemented by the *NOAA Estuary Glossary* as needed. Use vocabulary definition flash cards or use the *Estuary and WQ Quizlet* to assess student learning.

Career Connections: Molly Keogh
Sediment is the foundation of every wetland, and there are scientists who focus on the study of sediment dynamics in their research. Introduce wetland geologist *Molly Keogh* from the University of Oregon. Learn about her career path and her research focused on the story of sediment in Oregon Coast estuaries.

ELABORATE

In this section, students analyze their data to make comparisons of the urban estuary and South Slough. They begin learning about how estuary managers address water quality issues.

Activity: Analyzing the Data
Once the students have four or more data sets collected, teach them how to use Google to *make a chart* that displays their data. Encourage students to apply their new knowledge as they interact with and interpret the data. For example, they can compare parameters across estuaries or compare different parameters within an estuary. See the *Teacher Notes* for guided questions and challenges for students as they explore.

Activity: Strategies for Improving WQ in Estuaries
What do scientists and watershed managers do with the types of data that students have collected? If possible, plan a virtual visit to South Slough to meet with a coastal scientist, and learn about work that has been done at South Slough or in other coastal ecosystems to determine what the experts have done to improve the water and habitat quality.

Have students watch the *Estuaries* video from Bellingham, Washintgon to learn how local scientists and ecosystem managers have addressed water quality problems.

Key Vocabulary

- *Vocabulary (pdf)(doc)*
- *NOAA Estuary Glossary*
- *Quizlet: Estuary and WQ*

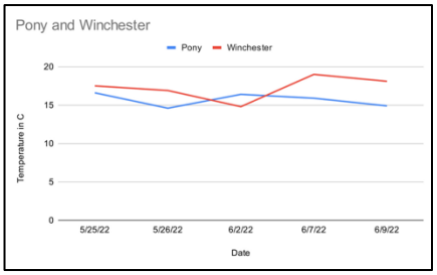
Career Connections

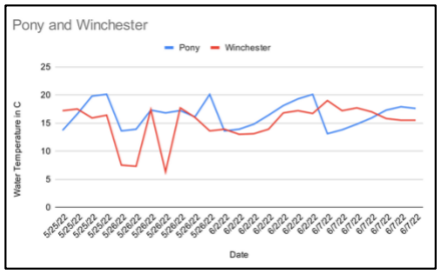
- *Researcher Bio: Molly Keogh (pdf)*

Researcher Molly Keogh, UO

Analyzing the Data

- *Teacher Notes (pdf)*
- *Google: Make a Chart*
- *Video: Estuaries [7:03]*





Water temperature comparisons: Pony Slough vs Winchester Arm

Activity: The Watershed Game

Play *The Watershed Game* with students to identify how land use may contribute excess sediment to a stream. Players work as a team to devise solutions to decrease this type of pollution in a fictional watershed.

EVALUATE

Opportunities for formative assessment are built-in throughout the project, and there are options for summative assessments as well. In the last two days of this unit, student scientists can share their interpretations of their data and propose improvements for the urban estuary. For this final assessment, each student chooses two charts that they have created and provide an interpretation of what is taking place and an explanation for the phenomena. The students compile formal reports that include a presentation with suggestions to amend the damage to the urban estuary. If time is limited, students could simply create a text box and type their explanations and restoration ideas in the spreadsheet.

Additionally, have the class as a whole share their results and improvement suggestions with interested community members. For example, in the development of this lesson, students shared their findings with school administrators since the urban estuary, Pony Slough, runs through school property. Students also shared their findings with their scientist advisort Molly Keogh, and new classes will continue to share with other scientists they collaborate with in the future.

The Watershed Game

- *Classroom version*

Game pieces from The Watershed Game

Researchers obtain sediment cores at Danger Marsh at South Slough Reserve. Photos: Jenni Schmitt

Next Generation Science Standards

Performance Expectations:

MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Science & Engineering Practices:

Engaging in Argument from Evidence

Disciplinary Core Ideas:

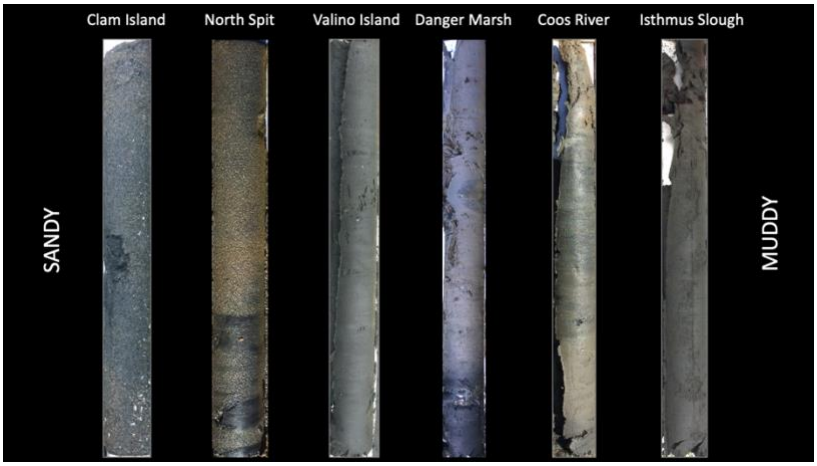
LS2.C – Ecosystem Dynamics, Functioning, and Resilience

Crosscutting Concepts:

Stability and Change

Common Core Math Standards

8.F.B.4 – Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (*x, y*) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values. (Possible linear function to explore: water temperature vs. depth)



Sediment cores from around Coos Bay. Photos: Molly Keogh

Acknowledgments

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See more lessons on the ORSEA webpage: oregoncoaststem.oregonstate.edu/orsea