CENTERS FOR OCEAN SCIENCES EDUCATION EXCELLENCE
BEST OF COSEE HANDS-ON ACTIVITIES

Activity Title: My Place in Puget Sound

Learning Objectives

Focus questions:

1. What is Puget Sound?

2. Where do I live in relation to Puget Sound? (or the ocean)

3. How do my activities at home add chemicals to Puget Sound? (or the ocean)

Ocean Literacy Principles

1g: The ocean is connected to major lakes, watersheds and waterways because all major watersheds on Earth drain to the ocean. Rivers and streams transport nutrients, salts, sediments and pollutants from watersheds to estuaries and to the ocean.

6e: Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (point source, non-point source, and noise pollution) and physical modifications (changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.

6g: Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Supplies and Materials

Day One

- Paper for pre-assessment drawing
- Identify the body of water most relevant to your location (for those in Seattle, this is Puget Sound)
- Identify the nearest wastewater treatment plant to your school, as well as where the wastewater effluent is released
- Map that includes the nearest body of water to you & include your school on the map (suggestion: use Google maps at maps.google.com)
- Self-doc worksheet for Water Use (completed by students before the lesson startsSpices (cinnamon, vanilla, thyme)
- SoundCitizen data packet of spices in treated wastewater

Day Two

- Google Map in satellite view
- EDCs Powerpoint presentation
- Endocrine disruptor student sorting sheet
- Personal Care Product worksheet
- Endocrine disruptor sorting key
- Dateline video: http://www.bing.com/videos/watch/video/not-easy-beinggreen/69v66r8

Background

This lesson was designed to be part of a larger curriculum entitled *My Place in Puget Sound (see http://depts.washington.edu/myplace/ for more information).* In this curriculum, students explore chemicals in the local estuary, Puget Sound, and the relationship between their everyday practices and chemicals in the Sound. We have generalized this lesson so that regardless of where you and your students live, you may still connect your actions to chemicals found in the water. Important driving ideas behind this lesson are:

1. Students need support in placing themselves in relation to important bodies of water (rivers, lakes, the ocean). Maps are a useful tool in providing this support.

2. Students engage in practices in their everyday lives that affect the chemicals in the water. The "Water Self-documentation" is a tool for you to bring those practices into the classroom and help students see the connections between chemicals in the water and their everyday practices.

3. It's ok if students don't initially feel a connection to the water. This lesson is not intended to tell them what to feel—it is intended to have students discover that there is a chemical connection between products that they use (and flush into the water) and chemicals in the water.

Big Ideas: Most of the time, we don't think about what happens to water once it goes down the kitchen sink or gets flushed down the toilet. We don't think about what happens to the soap that we use or the cleaners that we use when we rinse them down the drain. Wastewater treatment is very good at cleaning big things out of water, but not so good at cleaning chemicals out of the water. As a result, some of those chemicals remain in treated water after it leaves the wastewater treatment plant and gets released into a river estuary, or ocean near you. These chemicals might have an effect on the animals that live in or near the water, particularly the ones that live close by to where the treated wastewater (the "effluent") gets released into Puget Sound, rivers, or the ocean.

Duration

2 – 50 minute science periods

Audience

Grades 7-8

Procedure

BEFORE DAY 1

1. ***Pre-assessment*:** Explain to students that for the next couple of days, they will be studying how they are connected to what is in the water. But before we begin, we need to find out your ideas first. Hand out blank sheets of paper and ask students to draw a diagram or a picture of how they think their actions are related to what is in the water (name a body of water this is close to you that the students would know about). Allow 10-15 minutes for this.

2. Show a Google map of Puget Sound, zoomed out like the screen capture below. Ask students, where is the Pacific Ocean (or the nearest ocean near you)? Where is Puget Sound (or the nearest body of water near you)? Where is our school?

3. Zoom into the neighborhood of your school, keeping Puget Sound (or the nearest body of water) in view. Ask students to point to different features that may be important to them – the school, their neighborhoods, a local park or other community features that may be important.

4. Hand out the Water Use Self-documentation worksheet. Explain to students that over the next two days, they will be studying how chemicals can get from our homes into the water. To start this investigation, we will begin by thinking about how we use water in our own lives through a process called "self-documentation".

Go over the self-documentation sheet with students, emphasizing the importance of documenting what they do at each site that water leaves the house (washing dishes, taking showers, brushing teeth, cleaning the toilet) and what goes down the sink along with the water (food, shampoo, soaps, cleaners, etc).

DAY 1

Introduction--how do we use water and where does it go?

1. Go over the students' self-docs and discuss the following questions:

   a. How do you use water in and around your home?

   b. What goes down the drain from either the sinks or toilets in your home?

   c. Where does the water go once it leaves our house down the drain or toilet?

   d. What happens to food that you put down the garbage disposal?

The point of this discussion is for students to recognize that there are many ways in which they use water (not just for drinking or washing hands), and that there are many products that go down the

drain.

Showing SoundCitizen data

2. Explain to students that today we're going to be talking about how chemicals like cooking spices travel from our homes into the ocean. We'll be doing this by learning more about an organization called SoundCitizen and how it used to test for these chemicals in the water.

3. Explain to students that the SoundCitizen project was started when some students at the University of Washington in Seattle, Washington asked their professor to prove to them that we are all connected to Puget Sound. In order to do this, they started seeing what kinds of things they could measure in the water of Puget Sound. We will be looking at some of those things today by looking at some graphs.

Teacher note*: SoundCitizen was a research group in the University of Washington School of Oceanography that worked with the public (including K-12 participants) to understand how chemicals we use in our daily lives end up in Puget Sound. SoundCitizen started in a lab that studies the chemistry of the ocean - they study silly things like cooking spices (which can come from natural sources or people), and chemicals made by people that may have harmful effects on the environment (industrial solvents, perfumes, plasticizers and pharmaceuticals). Even if there were no people around Puget Sound, the natural plants and animals produce lots of natural chemicals that end up in Puget Sound, creating a "chemical fingerprint." Humans can alter that fingerprint by adding more natural chemicals or introducing human-made chemicals that don't occur in nature. More information about this research group is available at soundcitizen.org*

4. Explain to students that when water leaves your house, it goes to the wastewater treatment plant (if you are on a sewer system) to be cleaned, treated, and released out into rivers or oceans. Explain to students that they will now be looking at wastewater from Seattle that has been treated and about to be released into the Puget Sound. SoundCitizen collected this water and measured the levels of cooking spices in this water.

5. Hand out the packet of SoundCitizen data graphs. Explain to students that the spices that the scientists measured are both *natural* (coming from plants) and *artificial* (made from humans). For example, the cinnamon that we use comes from a plant. The vanilla that we use can either be natural or artificial, depending on the type that you use. On the graphs, natural vanilla levels are shown in the graph called "vanilla flux" and artificial vanilla is in the graph called "ethylvanillin flux". Also explain to the students the concept of "flux". This means amount of a substance per day. Finally, point out the *scale* of the Y-axis—for example, the maximum value on the Y-axis for cinnamon is 300 grams/day, but for vanilla it is 1400 grams/day. This will be an important feature of the graphs to notice as students draw conclusions about how much of each spice the scientists found.

Teacher note: To give students an idea of the amounts of spices that are going through the wastewater treatment plant, you can give them the following information: the West Point Wastewater treatment plant takes in about 112 million gallons of water a day. That's enough to fill almost 170 Olympic-sized swimming pools! Looking at the cinnamon flux data, then, it peaks at about 250 grams a day. You would need about four 67g bottles of cinnamon to equal that amount. Considering that you typically use about 1 teaspoon of cinnamon for an entire recipe of cookies, that is a lot of cinnamon! You can do the same with the thyme: in a 10g container of dried thyme, you would need 25 containers to equal the 250 grams a day that are moving through the wastewater treatment plant during the peak times. Considering that you usually use one or two pinches of thyme per recipe, that's a lot of thyme!

6. Go over each graph quickly, reminding students about the spices (that you've talked about already), referring them to the chart that shows the foods and the spices. Make sure you go over the axes and what they're showing.

7. Give students some time to work in small groups and to look at the graphs. In order to support the students looking at the graphs, you can start by asking them the following questions: What do you notice? What does it mean? Tell them to, as a group, come up with some conclusions based on the graph and be able to point to some places in the graphs that back up their conclusions.

8. Back as a whole group, ask students: what did you find in these graphs? *Students should come up with the fact that you can correlate the data with major holidays or events that correspond to the levels of spices*.

9. Ask the students: why do you think we're finding these patterns? *Students should start to talk about the spices coming from us, they leave our bodies, go into the wastewater and out to Puget Sound.*

Assessment**:** *This is a great time to check students' work for their understanding of the graphs, information in the graphs, and patterns they see in the graphs. Students should be able to draw conclusions about peaks in the graphs in relation to certain holidays. Students should also be able to explain where the spices came from (our bodies, our homes, our everyday practices), and where they would end up (in the ocean) after this water leaves the wastewater treatment plant*

10. Ask the students: why do you think this type of information might be important to understand?

a. If students are having a hard time answering this question, ask questions like: "How do you think spices might affect the water?"; "Do you think there might be other things besides spices out in the water?" "How do you think they might get out in water?" "How are you connected to the water (or name your local river, estuary, or body of water)?"

b. *Students should talk about how we all live in a watershed and are connected to the water, how there might be other things that are unhealthy that are going out into the water, that we are all connected, etc*. ***Students can walk away thinking spices are bad for the environment – there's no evidence we're aware of showing the spices are harming Puget Sound but it's a way to illustrate connectedness!***

c. If you teach in a community that primarily has septic tanks, help the students think through how chemicals from their homes may still get out into the water (e.g. septic tank leaks or things carried in stormwater runoff -- fragrance from dryer vents that deposit on the ground, fluids and metals from cars, pet waste, chemicals used in yard care, etc.)

DAY 2

Exploring endocrine disruptors in the water

Personal care products

1. Review with students what they found out about spices in the water and how those spices might have gotten in the water.

2. Explain to students that scientists don't think that there are any harmful effects of spices to ecosystems or to us, but today they will be studying a group of potentially harmful chemicals that have also been found in natural water systems, called endocrine disruptors.

3. *Depending on what grade your students are in, you can ask here about students' ideas of what the*

endocrine system is, why it's important to us, etc. If your students have not been exposed to the endocrine system yet, skip to step 4.

4. Begin the EDCs Powerpoint. Remind students that the endocrine system is made up of internal signals that direct biological function, including the development of special tissues and cells that are specific to males or females, but it affects a broad range of things like survival, development, growth, etc. and not just reproduction. External signals from the environment that can affect this system of internal signals are call endocrine disrupting compounds. Explain to students that what they will be looking at ingredients in personal care products for chemicals called *endocrine disrupting compounds*.

Endocrine disrupting compounds

In the laboratory, some chemicals known as "***endocrine disrupting compounds***" or "***EDCs***" have been shown to mimic the hormones that animals naturally produce within their bodies and affect reproductive development and function. The endocrine system is a system by which tissues "talk" to each other. For example, the brain will send a hormone through the blood stream to the gonads, inducing a change in what the cells in the gonads are doing (e.g. causing the production of more sperm or inducing ovulation of eggs). Endocrine disrupting chemicals can mimic or block natural hormones. Although EDCs do not appear to cause immediate death, data suggest they impact survival, development, immune system function and reproductive success of animal (sub-lethal effects).

5. Use the endocrine disruptor sorting sheet to give each group of students the names of the endocrine disrupting compounds they will be looking for on the personal care products. Explain to students that each of these chemicals are present in personal care products and have been shown to disrupt internal signals (***endocrine disrupting compounds***). Although the names of ingredients are long, how they're named has particular meaning to chemists. Ask students to sort the names of the ingredients – prompt them to look for clues in the names about how the compounds may be related.

Option: If your students are familiar with chemical drawings, you can use the second page with the structures for students to sort

Note: links to more information about each ingredient including references of scientific studies & summaries of biological impacts are also present on the second page

6. Once students have sorted the compounds, ask groups to explain what they grouped together and why. Go over the answer key as a class.

7. Now tell students they are going to look for these ingredients in travel size personal care products and fill out the "What is in personal care products?" worksheet. Products can include makeup, shampoo, conditioner, lotion, toothpaste, shaving cream, lip balm, soaps, nail polish, mouthwash, deodorant, sunscreen, face wash, etc. If you have travel-sized samples, pass them out to the students or you can have students look in their backpacks for their own products (chap stick, deodorant, etc).

8. Ask students: how many of you found any of those compounds in any of the products you looked at? (many students should raise their hands) How many people had more than one of these compounds in the products you found?

Teacher note: Uses of self-doc chemicals in personal care products

1. placental extracts	*Unclear*
2. benzophenone-1	*Sunscreen*
3. benzophenone-2	*Sunscreen, masking, fragrance ingredient*
4. benzophenone-3, oxybenzone	*Sunscreen*
5. benzophenone-4, sulisobenzone	*Sunscreen*
6. homosalate	*Sunscreen*
7. octyl methoxycinnamate	*Sunscreen*
8. 4-methylbenzylidene camphor	*Sunscreen*
9. butylparaben	*Preservative, fragrance ingredient, masking*
10. isobutylparaben	*Preservative*
11. ethylparaben	*Preservative, fragrance ingredient*
12. methylparaben	*Preservative, fragrance ingredient*
13. propylparaben	*Preservative, fragrance ingredient, perfuming*
14. Fragrance	*Deodorant, masking, perfuming*
15. Dibutyl phthalate	*Plasticizer, fragrance ingredient*

Teacher note: Currently, the United States does not require screening for effects of endocrine disrupting chemicals (EDCs) before they are put into consumer products. If you want to have a more in-depth discussion with your students about regulation of EDCs, you might find it helpful to refer to a comparison between U.S., Canadian, and EU strategies for chemical regulation (available at www.gao.gov/new.items/d06217r.pdf).

Especially interesting might be the charts on pp. 8-9 and 13-14. What is not transparent in these tables is the fact that "endocrine disrupting effects" have historically not been assessed in "health and ecological effects" under US regulation until the 1996 Food Quality Protection Act, which amended the Federal Food, Drug, and Cosmetic Act.

9. Explain to students that compounds like parabens are present in many of the products we use everyday. Parabens preserve products so they last longer. But, they act as endocrine disrupting compounds. Show students an example of a product with no parabens (ie, Burt's Bees shampoo). Explain to students that a 12-oz bottle of Burt's Bees shampoo is $8.00. Explain to students that these types of products are usually sold at stores like PCC and Whole Foods. Ask students: do you think these products are more expensive, less expensive, or the same as products that do contain parabens? *In general, more expensive*.

10. Go back to the **EDCs Powerpoint**. Show students the different types of chemicals that SoundCitizen measured. Ask students: do you think all of these chemical groups have endocrine disruptors in them? Once you've had a class discussion, forward the animation on this slide & a pink box will appear around the groups of chemicals that contain EDCs. Remind students that while SoundCitizen didn't measure ALL possible endocrine disruptors, you're going to look at data about the chemicals they *did* measure that have been linked to endocrine disruption.

11. Show students slide in EDCs PowerPoint of endocrine disruptors in natural water systems. Explain to students that SoundCitizen wanted to know about the average concentrations of chemicals around water that has hardly any people (Barkley Sound) and water that has lots of people and cities around it (Puget Sound). Ask students to discuss how these chemicals may be getting into the watershed and what these data might mean for the health of Puget Sound. (If needed, remind students about how they use water in their homes and what is cleaned out of wastewater.) Ask students: do you think that these chemicals are being found in your local watersheds? Why or why not? What does this have

to do with your own personal health?

Note: the point of this discussion is for students to understand that there are many factors that go in to consumer decisions, including media influences (advertisements), prices, family and cultural values, and product availability. The issue of what it means to be "green" is very complex despite claims by many products that they are "green".

12. Show the video (6 minutes) from Dateline that compares two families' health/environmental choices and the levels of various chemicals in their bodies: http://www.bing.com/videos/watch/video/not-easy-being-green/69v66r8

- Discuss with students: what factors weighed into each family's choices of products? What other factors would you consider important in deciding which products (cleaning, cosmetic, cooking, food) to buy?

12. ***Post-assessment***: Conclude the lesson with another opportunity for students to draw how human actions are connected to the chemistry of the water. Using their original drawings, have students add to or revise their original drawing *in a different color pen* or *on a sticky note* so that their original drawing is still intact. You can then have them write a reflection on what they learned about the connection between their own practices/actions and the chemistry of the water.

Assessment

See procedure for assessment

This lesson plan was provided by COSEE OLC. For more information, please contact Carrie Tzou at tzouct@u.washington.edu