ENVIRONMENTAL SYSTEMS LESSONS
High School level
DRAFT

Project:
Data Sets and Inquiry in Geoscience Environmental Restoration Studies (NSF GEO-0808076)

Authors:
Daniel Zalles, Center for Technology in Learning, SRI International
David Montgomery, Dep't of Earth and Space Sciences, University of Washington

Lesson One
The Natural System

Activity 1: What are systems?
(The purpose of this activity is to have you understand what a "system" is, in the broadest sense)

1. The natural environment of the reservation is a system -- an "ecosystem". Systems consist of different parts that depend on –one another, so that when one part breaks down, or goes away, it affects all the other parts of the system, either directly or indirectly. Examples of systems are the human body, a business, a machine, a school, the Tulalip Tribes community, the Pacific Ocean, and the whole Planet Earth.

   Pick one of these examples from above and explain how it is a system. For example, if you pick the human body, explain how the parts of the body depend on each other one another, and how if one part of the body fails, the failure affects the other body parts.

2. Think of another system and explain why it is a system. Explain how its parts are related to each other one another and what would happen if certain of those parts failed or disappeared. How would those failures or disappearances affect the rest of the system?

Activity 2: How is the natural environment of the Tulalip community a system?
(The purpose of this activity is to for you to tie what you've learned this year about the Tulalip community and its natural environment to the concept of what a "system" is)

3. Here are some elements of the Tulalip ecosystem. Explain how each of the elements are related and dependent on each other one another. Study the information in the handouts first, however, because the handouts provide basic information that will help you answer the questions. But don't look at for simple answers to handouts that you can copy. To answer the questions properly you have to **reason** about the information.

a. Meandering, slowly migrating river channels
    *   What function does this element perform for the ecosystem?
    *   How did our ancestors depend on this element?
    *   What happens if you take this element away?

b. Log jams in rivers
    *   How is this feature good for the environment?
    *   How did our ancestors depend on this feature?
    *   What happens if you take this feature away?

c. Salmon
    *   How is this feature good for the environment?
    *   How did our ancestors depend on this feature?
    *   What happens if you take this feature away?

d. Salmon-eating animals (bears, eagles, etc)
    *   How is this feature good for the environment?
    *   How did our ancestors depend on this feature?
    *   What happens if you take this feature away?

e. Excrement of salmon-eating animals
    *   How is this feature good for the environment?
    *   How did our ancestors depend on this feature?
    *   What happens if you take this feature away?

f. Cedar trees
    *   How is this feature good for the environment?
    *   How did our ancestors depend on this feature?
    *   What happens if you take this feature away?

g. Herb and food-bearing plants
    *   How is this feature good for the environment?
    *   How did our ancestors depend on this feature?
    *   What happens if you take this feature away?

Activity 3: How did settlers of European descent change the tribe's ecosystem?
(The purpose of this activity is to for you to explore the connections between what European settlers did to the tribe's ecosystem and what the effects have been on the ecosystem

Imagine that you are one of the leaders of an Indian tribe on a reservation that is similar to the Tulalip reservation. Imagine that this reservation is in the Western Washington area. It has rivers which flow into an estuary. The estuary flows into the Puget Sound, which flows into the Pacific Ocean. The reservation's ecosystem has thick cedar forests that are difficult to pass through. Before Europeans came to settle there, the tribal people

had a lifestyle that depended on the health of the natural environment. The the people benefited from the ecosystem to survive and contributed to it to keep it healthy. For example,

- They ate salmon but made sure that they only caught the salmon when they were big adults returning from the ocean to spawn and didn't eat the young ones.
- They cut down cedar trees to make canoes would didn't cut so many down that the cedar forests would disappear
- They ate fruits and vegetables and herbs from plants that existed in the wild but made sure that they didn't harvest so many of the trees and bushes that the trees and bushes would disappear

Today, the tribe's economy relies mainly on its casino and the people no longer live off the land but depend on non-native food from grocery stores for their diets. Also they primarily depend on cars and motorboats rather than canoes for transportation.

Before Europeans arrived, there was a big village near the river banks. There were lots of logs in the river and lots of side channels that frequently changed their course. Adult salmon swam up from the ocean to spots along these channels where they laid eggs. The spots where they laid these eggs were perfect for the health of the eggs and the juvenile salmon that hatched there because they were shaded by big cedars and other trees along the river, so that the water would not get too warm, the pools and side channels created by the meandering river provided safe peaceful waters and clean gravel in which they lay in the pools and side channels provided just the right kinds of protection that the salmon needed. The channels along the river sometimes created small floods after a rainstorm so the people were careful to not build their village too close to the river bank. When the Europeans arrived, they did several things to the river and the estuary that the river flowed into. Now, the tribe has charged you with coming up with a plan for restoring the river that runs into the estuary.

Directions:
Below are two vertical lists of causes and effects. Connect the entries in each list the way you think they should be connected. Use arrows to connect them. Multiple arrows can go from one or more entries in the first vertical list to one or more entries in the second vertical list.

Number each arrow then below the lists explain the reasoning behind each of your connections. Use the numbers you put on the arrows for your explanations. As much as it is appropriate, use information you've learned from other lessons this year and from today's handouts to explain your reasoning.

What European settlers did:	**What happened as a result:**
They removed the logs in the river and straightened the channel so that they could travel through the	There are bigger and more severe floods than ever before

river more easily in big boats	
	The wild salmon have mostly disappeared
They put a dam upstream from the river and the levees along the river to keep the river from flooding	
	The river's channel is much more shallow than it used to be because much more sediment falls into the river during rain storms than before
They cut down many trees in the forest for lumber	
They put dikes in the estuary in order to make the land around the estuary free of salt water and capable of supporting farm crops	Many of the plants along the river and estuary, which the tribe ate and used for medicine, have disappeared
They polluted the water with chemicals from crop fertilizers and industrial wastes	

(the students will need a good deal of help at first but I think once they understand the concept they will be able to carry out the functions)

Lesson Two
Looking Ahead

Activity 1: What can be done? What should be done?
*(The purpose of this activity is to get you to appreciate what types of decisions tribal leaders have to sometimes make on tough issues that have **no easy answers**. By doing this activity, you have to apply what you know so far about the current state of the tribe's ecosystem to the task of figuring out what policies would be best for the tribe's future. To figure this out, you have to think about **what policies stand the greatest chance of being successful** but also think about **what policies are worth doing in the first place**, especially if the money could also be spent on other things for the community. What we care about in this activity is that **you apply your most insightful reasoning skills**.)*

The tribe that you studied about in Lesson 1 wants to spend $1 million to do something to improve their ecosystem. The tribe has given you this list of possible actions:
- Remove the dikes and levees
- Remove the dam

- Try planting new trees in areas that have been logged
- Try to stop the water pollution
- Try planting new native food plants along the banks of the estuary

Here are your choices about these actions:
A. Try to carry out ALL of these policies with the money
B. Try to carry out SOME of these policies with the money (Identify which policies)
C. Try to carry out NONE of these policies and instead spend the money in other ways that might benefit the tribe (List the ways)

1. Make a list of questions that you would want answers to before you made a final decision on which choice is best.

2. Even though you don't have your questions answered, go ahead and make a "tentative" decision and explain why. In your explanation include: (we will have to explain what tentative means)
   - How would your choice *serve the tribe the best*?
   - Why would your choice likely be *the one that is most successful*?

For the sake of helping you answer these questions, here is an unrelated example of an application of this activity to a completely different topic: The mayor of the city has to decide whether to spend $1 million on a campaign to convince people to stop smoking. He is not sure if this campaign is going to be successful because there have been studies showing that similar stop smoking efforts in other cities have cut the public smoking rate anywhere from only 10% all the way up to 60%. So, not only is he not sure how successful this effort will be but there are other ways he could spend the $1 million, such as on tax cuts, school sports programs, or repairing roads. Here's what four different groups of people in the city think about the effort:

Group 1 thinks it will be successful but not the best way to spend the money
Group 2 thinks it will be unsuccessful but still a good way to spend the money
Group 3 thinks it would be successful and also the best way to spend the money
Group 4 thinks it would be unsuccessful and not the best way to spend the money