WATERSHED ON WHEELS 2013 SEASON
EDUCATING GUIDELINES AND LESSON SUMMARIES

Note:

The purpose of this document is to provide an informal review of the lessons taught over the course of the Spring, Summer, and Fall 2013 season of the Watershed on Wheels, aka WOW, as part of the mobile environmental education program through the Silvio O Conte National Fish and Wildlife Refuge. This review will be useful in allowing the reader to understand, from the educator perspective, a practical approach to implementing the lessons that were used for this 2013 season as well as provide a useful tool to help to guide future environmental education initiatives.

-Gordon Clark

River Table Lesson:

Objectives:

- Teach students about the basic principles of river geomorphology.
- Introduce River Vocabulary
- Review/ Introduce how water cycles through the environment
- Understand and explore how the Connecticut River has formed since the last Ice Age
- Explore the concept of a watershed
- Explore the properties of erosion.

Brief Lesson Overview:

Prep the table by smoothing out all of the sand across the table while leaving a pool of water at the bottom of the table by the drain. Also, it is important to have some "groundwater" accumulated before doing any of the following demonstrations. This can be accomplished by turning the water on for a moderate about of time (10-15 min), or until the water starts to flow laterally across the surface, aka a river forms.

I would begin the lesson with having the students gather "anywhere you would like" along the outside of the river table, my only request being that "we are all going to have our hands at our sides for now." The importance of the latter was to deter students from getting their hands too messy, too soon. *The river table is a curiosity to students and adults alike because it is rather a novelty. It is hard to resist the urge to touch the plastic sand. I like to set the intention in the beginning.* Additionally, it is also important to mention that it is difficult to teach around the table with greater than 8 students. The smaller the group, the better.

First, it was necessary to explain what the river table was composed of. In the simplest breakdown, I would refer to the two materials present in the table: water and recycled plastic. Next, I would explain how the table worked to "demystify" what the students were looking at. "The water will flow from here [pointing to the top] to here [pointing to the pool of water by the drain] , which we will pretend is the ocean. Which ocean does the Connecticut River flow into?" *I always test the student's knowledge, even on the seemingly most basic concepts, to keep their attention and to include them as much as possible.* "The water is then going to drain down into this BIG bucket, where it is then picked up by this little pump down here (offer for them to get down in there and check it out), where it is then carried up this LONG hose… etc. *I found they were almost always curious to figure out to the smallest detail how this table worked and I was more than happy to explain in as much detail as they wanted. I found it led to a good transition to the next topic.*

After explaining how the table works, I would mention to them that this is like an artificial water cycle that I can control with a knob. My next question is to have them teach me what they know about their water cycle in nature. *I would work through with them to piece it together if they don't know or need a refresher.* The terms <u>evaporation</u>, <u>condensation</u>, and <u>precipitation</u>, are identified and briefly explored.

After my water cycle review, I asked the students how they thought the Connecticut River was formed. *Often, this is where I have the best opportunity to gain some perspective on the student's knowledge and to adapt the rest of my lesson to suit their level of understanding. The*

students rarely can identify that the river was formed from glaciers interacting with the landscape. I ask them [to get them excited for the next brief history lesson] "don't you think that it is important to know how this massive river, the BIGGEST RIVER in New England, was formed, especially since you guys live IN the WATERSHED?" Typically, this will at the very least stoke their curiosity. I begin to explain that the river formed from glaciers that existed here over 10 million years ago from the most recent Ice Age. *I often refer to the movie,* The Ice Age," *which everyone can relate to.*

I will pretend that I am a glacier and will squish down on the sand to form a valley, the weight of my hands pressing down being similar to the weight of the massive glaciers pressing down on the land. *I suppose I could have also allowed the students to participate in this activity*. *Usually, I would do it myself because of time constraints. "*After the glaciers left, they filled this giant valley with a bunch of water. This water formed a massive lake that geologists call, Lake Hitchcock. We would have all been either underwater 10,000 years ago when these glaciers melted, or we would have had some great lakefront property." *Often I will let the students have a moment to imagine this scenario.*

After forming the valley with my hands acting as very heavy glaciers, I will turn on the water and allow this giant valley that I made in the middle of the pool to become "our Lake Hitchcock." *This is our first experiment, I explain*. [~10-13 minutes into lesson] I tell the students that their task (while the water is beginning to fill the valley) is to raise their hands and explain to me what they are seeing and how they think that a river is going to form from this lake. I prompt them to try and understand how the landscape might be soon severely altered by the force of water. I allow them to explore this with their classmates with myself facilitating the discussion. Soon the water breaks free at the bottom end of the lake and I explain that now our lake has turned into a river, and that is how the Connecticut River has formed. *Obviously, a rather simplified version – nonetheless, it is particularly dramatic.*

Next, we explore the topic of erosion. If the term is new to the students, I explain the term as a type of weather whereby the force of water picks up sand and sediment and carries it downstream. I further point to examples of erosion that are occurring in front of them. Then, I ask them to point out examples for me. During this discussion, I will implore them to use some river vocabulary words so we can talk about this river. Using erosion as a means to identify the parts of a river, I introduce the terms (if they don't already know) river bed, river bank, sometimes cut bank, the river's mouth or delta, and the rivers headwaters. "Where is the erosion happening? Why is it happening? What force provides the energy to make water have this erosional capacity? (Gravity) Where is all the sediment travelling?" *Eventually, I try to bring them back to the real Connecticut by suggesting, "do you think these things are happening in the real Connecticut River right now?"*

If time allows, I will do any combination of the following interactive activities:

(a) Use the fake plants to put anywhere they want in the river. Use an inquiry based learning approach to make them discuss how they think the plants are affecting the river, specifically erosion
(b) Use small rocks to place anywhere in the river the students want. Use a similar inquiry based learning approach and help facilitate a discussion on how the rocks might affect the flow of the river and their affect on erosion.
(c) Each student uses one finger to dig a small "well" on the dry parts of the river's edge, i.e. away from the flowing water. The students dig down until they hit the

ground or find some water. Each student should find water. Then, facilitate a discussion on where that water came from, where is it flowing, how is it flowing, and the importance of how that groundwater is flowing underground (sub-surface flow), especially if there might be some pollution added to the well.

(d) Ask the students where they think the most dangerous place to build a house is, outside of literally in the river. We place the fake house by some cut bank or bank otherwise and discuss why they chose this spot. What do they think the outcome will be?

I will wrap up the lesson by going over the topics covered and asking them if they have any final questions about the Connecticut River. *If there is time, the students often will enjoy "helping out" by flattening the river table sediment for the next group.*

River table

Objectives:

- Define erosion and find an example of it
- Describe how the Connecticut River was formed (and is still forming)
- Explain how natural things (i.e. trees/plants, rocks) change the river, and people don't need to adjust its shape
- Describe how people might affect the river (i.e. it's shape, the water quality, how people interact with the water, etc.)
- Explain how changing seasons affect the flow of water in the river

Notes: The students are pretty excited to touch the sand at this station. I typically invite the students to gather around the table, but to keep their hands at their sides to start with. I let them know that we will have a chance to touch the sand, but that I'll invite them to do so in a few minutes. Setting this rule out in the beginning should alleviate any anxiety they might have, but I've also found it easier to remind them of the rule later on if I've set it out initially. The key to this station, I think, is flexibility. The river tends to do similar things each time you run it, but it's much better to teach what's in front of you then trying to force the river in a certain direction. If the river erodes toward an edge of the table, I ask if the water is strong enough to wash away the metal, and how the side might be changing the river. We can also relate what we see to real life. If we talk about housing placement or storm drains or hurricanes, the students may be able to make more connections to the simulation.

We are going to build a river. Does this look like a river to you? What does it look like? What are we going to have to do to make this look more like a river? Does anyone know how the Connecticut River formed? Did people build it? Do you know what a glacier is? Thousands of years ago, there was a giant block of ice, a glacier, sitting on top of Massachusetts. It was miles thick, and really heavy. It pushed down the land because it was so heavy. (Pound down the land in the middle)

Is there a glacier in Massachusetts today? We would probably notice a giant block of ice on our heads, I think. Where did it go? The air started to warm up, and the glacier began to melt. What do you get when ice melts? All of the water melting off of the glacier had to go somewhere. The easiest place for it to go was down the valley that the glacier had pressed down. As the glacier kept melting, the water kept moving down towards the ocean. Now, there is no glacier feeding the Connecticut River. Where does it get its water from now? Snow and rain coming off of the land feed the river today, meaning that it is fresh water. And it flows from the north towards the ocean in the south. (Turn water on)

The water should follow the path that the glacier created. What do you notice about it? Is there erosion happening along the banks? What does erosion mean? Is there sand coming out of the source? All of the sand moving in the water is being picked up by the moving water and carried downstream. A lot of it is getting dropped off, or deposited, near the end of the river, and it's forming what's called a delta. Is this what the Connecticut River looks like? What do we still need to do? How do we get a curvy river? (Hand out rocks to add)

What's happening to our river now? It's beginning to get curvy. Why? Water is really lazy. It takes the easiest path to get from the highest point to the lowest point. If something is in its way, it either picks it up or goes around it. We can see where this is happening along our river. Is the water strong enough to move the sand? Is it strong enough to move the rocks? Instead, it's going around the rocks, and some have created islands below them. Are we done building a river now? What do we still need? What do you know about plants? They have branches, leaves, and roots. What do those structures help the plant to do? Leaves help the tree do photosynthesis. What about roots? Under the ground, the roots grab onto water and nutrients in the soil. They also help the tree to stand upright, like thousands of tiny hands. Without roots, the tree would fall over. (Hand out trees to add)

Are the trees changing our river at all? How is the water moving around the obstacles? Are the rooted trees catching any of the sand moving down the river? Do they slow down the speed of the water at all? Do they slow down erosion at all? Let's do an experiment, which involves putting your hand into the sand. Find a spot covered in water and hold your hand out over it, but not in it. Now, squeeze your fingers like you have claws on the end of them. Your hands are now tree roots. Let's see what happens when we add large trees into our river. (Place hands into soil, palms all the way down)

What's happened to our river? Are all of our plants still in the water? Is the water moving differently? Is there more erosion or less erosion? What will happen if we take our hands out one at a time? Do we notice more or less erosion? Do trees and plants help the river change at all? (Take hands out, one at a time, or add both hands in first to see a larger effect)

Let's do another experiment. This time, find a spot not covered in water and take one finger and push it all the way to the bottom and swirl it around a little bit. What do you find? Where is that water coming from? To test if it really is coming from the river, let's drain our river. (Turn water off and let river drain)

Do that experiment again. If the water in our holes was coming from the river, they should be dry now, since our river is dry. What do you find? So where is the water coming from? Underneath the ground, even under our feet, if we dug far enough, is water, just called groundwater. It doesn't come from the river or the ocean or rain; it's just water in the ground. Many people get water for their houses from groundwater, digging holes just like those we just dug, called wells. (Flatten out land)

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Lesson Plans for the WoW Express, 2012
By staff at the Silvio O. Conte National Fish & Wildlife Refuge and the Vermont Institute of Natural Science

Introduction (10 minutes):
Gather all of the children into one group in front of the trailer with the map of the Connecticut River Watershed. Introduce yourself and the rest of the staff. Explain a little about the purpose of the United States Fish and Wildlife Service and the Silvio O. Conte National Fish and Wildlife Refuge. Use the map to show the boundaries of the Watershed and ask the students to find the approximate location of their school on the map. Emphasize the fact that they live within the Conte Refuge and all of the concepts they will learn today relate directly to organisms and processes that occur near to their homes and schools. Give a brief overview of what a watershed is and explain that what we do on land can influence what happens in the rivers and oceans. Finally, briefly describe the four stations that they will be rotating between. Break the students into four groups and begin the rotation.

Station #1: The River Table

Purpose: The purpose of this lesson is to introduce students to river and watershed terminology, the ways in which rivers shape the earth's surface, and management decisions that can be made to manage rivers more effectively. This lesson will focus on additional concepts based on related state science standards specified for each grade level. Additional topics may include the water cycle, natural resource management, and pollution.

Objectives: As a result of this lesson, students will be able to:

1. Define various terms related to watersheds and river geomorphology.
2. Describe how water can shape the earth's surface.
3. Make decisions to effectively manage rivers.
4. Explain how pollution on land within the watershed can be carried into rivers, and ultimately the ocean.

Duration: 20 Minutes

Materials:

- Emriver Em2 geomodel river table, with a meandering river channel formed through the center
- Colored water in a squirt container
- Objects for students to place in the river table, such as plastic houses, vegetation, farm animals, tractors, plastic parking lot, etc.

Instructional Procedures:

1) Begin with the water turned off. Introduce the river table and how it works, pointing out the recirculating water system. If the water cycle is part of the state standards of the group you are talking to, ask the students to explain how water is brought back to the top of the river in nature. Briefly explain the concepts of condensation, precipitation and evaporation and how these terms apply to watersheds.
2) Point out some main river features, such as the headwaters and the mouth of the river. Explain a little about the river meanders and how they form, including the outside bends (cut banks) and inside bends (point bars). Describe how erosion and deposition of sediments occurs in river bends.

3) Turn on the water to demonstrate these concepts to the students.

4) Hand each student a laminated vocabulary word. One word at a time, explain what the word means and allow the student to place it in the appropriate location on the river table.

5) Once all the words have been placed, ask the students to observe the river and tell you how it has changed since the water was turned on.

6) Hand each student a plastic item, such as vegetation, farms, farm animals or houses. Ask students to make a management decision about where they think the best location is for their item. One at a time, allow students to place their items on the table and explain why they chose the location that they did.

7) If pollution or natural resource management is part of the state standards of the group you are talking to, discuss how pollution on land can flow into rivers, and ultimately the ocean. Squirt food coloring, representing fertilizer, on the farm fields to show the students that groundwater can carry the fertilizer to rivers.

8) Place a flat piece of plastic next to the river to represent an impermeable parking lot. Squirt food coloring, representing oil and gas released from cars, on the plastic and ask students to observe what happens. Did more color go into the river from the ground water or the impermeable parking lot? Why do they think this happened? (Discuss the role of groundwater in filtering pollutants out of water)

9) Ask the students to come up with ways in which these pollution sources can be limited (for example, paving parking lots with permeable pavement). Also, discuss ways in which the students can help limit their contribution to pollution in their everyday lives.

10) As a conclusion to the activity, ask the students to raise their hands and answer some questions regarding watersheds and rivers. You should include questions about river behavior, vocabulary, pollution, ways that they can help limit pollution and their location within the CT River Watershed.

Assessment:

In the Post-Visit School Packet, teachers will be given a quick multiple-choice quiz to implement during class time. The results of this quiz will be submitted to WoW Express personnel in order to evaluate student understanding.

Connection to State Standards:

The Watershed Table by State		
Activity	State Standard	
	3rd Grade	**5th Grade**
Vermont	S3-4:47: Waves, wind, water and ice shape and reshape the earth's land surface by eroding rock and soil in some areas and depositing them in other areas.	S5-6:47: Some changes on the earth can be very slow, such as weathering and mountain-building, and some can be very fast—such as volcanoes and earthquakes.
	S3-4:49: The varied earth materials have different physical and chemical properties, which make them useful in different ways, for example, as building materials, as sources of fuel, for growing the plants we use as food, or supporting animal life. Earth materials provide many of the resources that humans use.	S5-6:49: Responsible management of the earth's resources (air, soil, water, trees) is beneficial for the environment and for human use.
	S3-4:48: Liquid water is changed by heat from the sun to gas (vapor) and returns to a liquid or solid state when cooled to the freezing point.	S5-6:48: The cycling of water in and out of the atmosphere plays an important role in determining climatic patterns. Water evaporates from the surface of the earth, rises and cools, and falls again to the surface as rain. The water falling on land collects in rivers and lakes, soil and porous layers of rock and much of it flows back into the ocean.
Connecticut	3.4,a1: Earth materials that occur in nature include rocks, minerals, soils, water and the gases of the atmosphere. Earth materials are natural resources that provide us with things we need to live, including food, clothing, water, air, shelter, land and energy.	4.3: Water has a major role in shaping the earth's surface. Water circulates through the earth's crust, oceans and atmosphere.
	3.4,a3: The supply of many natural resources such as fossil fuels, meals, fresh water and fertile soil is limited; once they are used up or contaminated they are difficult or impossible to replace.	
	3.4,a4: Human actions can affect the survival of plants and animals. The products of the fuels people burn affect the quality of the air. Waste and chemicals from factories, farms, lawns and streets affect the quality of the water and soil.	
	3rd-5th Grade	
Massachusetts	Earth and Space 12 (Grades 3-5): Give examples of how the surface of the earth changes due to slow processes such as erosion and weathering, and rapid processes such as landslides, volcanic eruptions, and earthquakes.	
	Earth and Space 10 (Grades 3-5): Describe how water on earth cycles in different forms and in different locations, including underground and in the atmosphere.	
	3rd-4th Grade	5th-6th Grade
New Hampshire	S:ESS1:4:5.1: Identify and describe processes that affect the features of the Earth's surface, including weathering, erosion, deposition of sediment.	S:ESS1:6:2.2: Describe and define the different landforms on the Earth's surface, such as coastlines, rivers, mountains, deltas, canyons, etc.
	S:ESS1:4:5.2:Explain how wind, water, or ice shape and reshape the Earth's surface.	S:ESS1:6:5.2: Explain how some changes to the Earth's surface happen abruptly, as a result of landslides, earthquakes and volcanic eruptions; while other changes happen very slowly as a result of weathering, erosion and deposition of sediment caused by waves, wind, water, and ice.
	S:ESS1:4:7.1: Recognize and describe the Earth's surface as mostly covered by water.	S:ESS1:6:7.2: Explain that water quality has a direct effect on Earth's life forms.
	S:ESS1:4:7.2: Explain that most of Earth's water is salt water which is found in the oceans, and that fresh water is found in rivers, lakes, underground sources, and glaciers.	S:LS3:6:1.1: Provide examples of how all organisms, including humans, impact their environment; and explain how some changes can be detrimental to other organisms.

Watershed and River Vocabulary:

- **Bank-** The land alongside or sloping down to a river
- **Channel**- An area that contains flowing water confined by banks
- **Condensation** – physical change from the gas state to the liquid state
- **Cut bank**- an eroded, concave, often very steep bank formed at a bend of a river or stream by the flow of water around the bend
- **Delta**- sediment deposit where mouth of river meets ocean
- **Evaporation** – physical change from liquid state to gas state
- **Flood plain** – a strip of flat land bordering a stream or river that receives the overflow of flood waters
- **Groundwater**- water that collects in an aquifer or cracks in underground rocks below the Earth's surface
- **Headwaters**- The place from which the water in a river or stream originates
- **Meanders**- A winding curve or bend of a river
- **Mouth**- The place where a river empties into another body of water
- **Non-point Source Pollution** – comes from many different sources throughout the watershed area
- **Point Bar**- A low, curved ridge of sand and gravel along the inside bend of a meandering stream. Point bars form through the slow accumulation of sediment deposited by the stream when its velocity drops along the inner bank.
- **Point Source Pollution** – comes from known location and one person or group can be held responsible for its entry into the watershed
- **Precipitation** – water in the atmosphere falling to Earth, including rain, snow, sleet or hail
- **Riparian Area**- The vegetated areas at the interface between land and a river or stream
- **Riverbed**- A channel occupied, or formerly occupied, by a river
- **River Erosion**- The gradual removal of rock material from river banks and river beds.
- **Runoff**- water coming off the land into the rivers, streams and ponds. Often carries pollution and nutrients into the surface water
- **Surface Water**- water visible on the Earth's surface (lakes, streams, oceans, etc.)
- **Tributary**- A river or stream that flows into another stream, river or lake
- **Water Cycle**- continual path of water through time

Facts About the Connecticut River Watershed

- The CT River Watershed is 7.2 million acres, or about 11,000 square miles
- It was designated as one of just 14 American Heritage Rivers by President Clinton in 1998, due to its historic and cultural significance to the nation.
- The CT River provides 70% of the freshwater entering Long Island Sound annually
- It is New England's longest river, 410 miles long, and runs through Vermont, New Hampshire, Massachusetts and Connecticut
- Its source is Fourth Connectucut Lake, a tiny beaver pond 300 yards from the Canadian border, at an elevation of 2,670 feet.
- The river empties into Long Island Sound at Old Lyme, CT.
- The river's depth varies from a few inches to 130 feet deep just below the French King Bridge in Gill, MA. The depth of the river is constantly changing as the river transports and rearranges its load of sediment.
- Several federally threatened and endangered species inhabit the Connecticut river, including the shortnose sturgeon, the piping plover, the puritan tiger beetle, and the dwarf wedgemussel.
- There are several waterfalls on the river, including Moose Falls, Beecher Falls, Fifteen Mile Falls (buried beneath Moore Reservoir), McIndoe Falls, Bellows Falls, Turner Falls, South Hadley Falls, and the Enfield Rapids.
- The first dam on the CT River is at Moose Falls in Pittsburg, NH, four miles from its source at the Canadian border.
- There are over a dozen dams on the river's main stem and over a thousand dams on its tributaries. The first full main stem barrier was built at Turners Falls in 1798.
- The CT River forms the eastern border of Vermont and the western border of New Hampshire, but technically only flows in New Hampshire, which has legal claim to the riverbed all the way to the bank on the Vermont side.
- It is one of the few large, developed rivers in the US without a port city at its mouth. This is because the silt deposits at the mouth of the river create shallow, shifting shoals in Long Island Sound that are difficult to navigate in larger ships.
- The CT River is tidal and navigable as far inland as Hartford, sixty miles from Long Island Sound.
- The river was spanned by its first bridge at Walpole, NH to Bellows Falls, VT in1785.
- Thomas Cole's 1836 painting "View from Mount Holyoke, Northampton, Massachusetts, after a Thunderstorm" depicts a river loop, or oxbow, that still exists as a cut-off meander at Northampton, MA. This painting hangs in the Metropolitan Museum of Art in New York. In February 1840, the river flooded, cutting Cole's famous oxbow out of the river's main downstream course.
- The longest covered bridge in the United States is the Cornish-Windsor Bridge which connects Cornish, NH and Windsor, VT. It was built in 1866.
- The watershed includes the highest (Mount Washington at 6,288 feet) and lowest (sea level) elevations in New England.
- There are 356 towns in the Watershed.
- The Watershed is home to more than 2 million people
- The river's name is the French corruption of the Algonquian word "quinetucket" and means *long tidal river*.
- The Water Quality Act of 1965 has had a major impact on controlling water pollution in the Connecticut River and its tributaries. Since then, the river has been restored from Class D to Class B (fishable and swimmable).