Wiyot Tribe
Environmental Department

Clean Water Act §319 Non-Point Source Pollution Control Program

NON-POINT SOURCE POLLUTION EDUCATION CURRICULUM

Wiyot Tribe – Table Bluff Reservation

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List of Acronyms

BGCA	**Boys & Girls Club of America**
BMP	**Best Management Practices**
HBNWR	**Humboldt Bay National Wildlife Refuge**
LID	**Low Impact Development**
NPS	**Non-Point Source**
TBR	**Table Bluff Reservation**
USEPA	**United States Environmental Protection Agency**
USFWS	**United States Fish & Wildlife Service**
WTED	**Wiyot Tribe Environmental Department**
YSI	**Yellow Springs Instruments**

I. Introduction

The Wiyot people have a strong dependence on the Eel River, Humboldt Bay and its tributaries, and the Mad River for the valuable resources that serve tribal sustenance and cultural purposes. Fishing, hunting, and gathering food and culturally significant materials are particularly important to tribal members who have long depended on fish and wildlife for subsistence. Before the damming of wetlands and salt marshes by European settlers, there were over 100 miles of travelable waterways up into sloughs and creeks that empty into Humboldt Bay. Using redwood canoes, these routes were means of reaching important locations, such as ceremonial grounds and fishing sites. Food resources such as shellfish, crabs, seals, otter, fish, and lamprey (commonly referred to as "eels") were often harvested from the rivers, bay, and mudflats in canoes and continue to be, in the present era, a main staple of the Wiyot diet. Basket and textile materials such as tule and willow root were, and still are, collected from wetland and riparian habitats. Clean, clear, and appropriately cool waters are vitally important to the continuing viability of the fisheries utilized by the Wiyot people. Water is essential in use of medicinal medicines, soaking basket materials, leaching foods, such as acorns, and bathing the sick when in ceremonies, or when used while fasting during ceremonies. Non-point source (NPS) pollution threatens the quality of these water-bodies and their respective watersheds, and by extension threatens the ability for those water-bodies to provide the resources upon which the Wiyot people depend. Educating tribal youth about the causes, impacts, and prevention of NPS water pollution is an important means of instilling environmental stewardship in future generations and protecting tribal waters and their resources.

The purpose of this curriculum, developed by the Wiyot Tribe Environmental Department, is to strengthen the tribal youth's knowledge on issues relating to NPS pollution and ensure that the tribal youth continue to be strong environmental stewards for their Tribe. The Environmental Department of the Wiyot Tribe has been working with the Social Services Department to improve environmental education for tribal youth. Currently, the Tribe's youth program has 15-20 tribal youth members participating in both cultural and environmental activities. With the help of the Boys & Girls Club of America (BGCA), the lead educator(s) of the NPS pollution environmental education program will be assisted by a college level trainee. With the help of BGCA in previous years, the environmental education program has witnessed greater success in regards to attendance due in part to the combined efforts of the BGCA's concurrent educational program. It is the hope of the Environmental Department that this educational program will reaffirm students' familiarity of NPS pollution and water quality while providing further knowledge on material related to these topics.

II. Program Summary

The following curriculum was established to refresh the tribal youth on their knowledge of NPS pollution on entire watersheds and introduce new concepts that were not covered in the previous years. The first lesson will serve as an overview of what the students learned last year in order to guide them towards further understanding the overall effects of NPS pollution to the health of humans, plants, and wildlife as well as to the overall health of our environment. We will begin with an introduction to the water cycle, watersheds, and NPS pollution. The students will participate in an activity consisting of a mock watershed that allows students to place NPS pollution within various environments (i.e. forest lands, gold course, residential streets, etc.) and watch as rain carries this pollution downstream. Students will also have the opportunity to install Best Management Practices (BMPs), using sponges, modeling clay, etc., in order to contain the pollution on site before it pollutes a nearby water source. Another activity will test the students' knowledge of commonly seen/harvested fish species. Using preserved specimens, flash cards, or photos projected on a screen, students will use field guides/keys to identify fish species. Later, students will dive deeper into their understanding of residential NPS pollutants and learn about how NPS pollution affects water sources near Table Bluff Reservation (TBR). An activity will be held that will take concepts from the first lesson and apply them to real life situations. Using BMPs commonly installed on construction sites, students will try their hardest to contain pollution from flowing off of the reservation's main road, Wiyot Dr., into a nearby storm drain. Later, a field trip will be taken to the TBR wetlands where students will assist the Environmental Department in the cutting and preparation of willows for future planting. In the next lesson, students will take a tour of their watershed in order to view different ecosystems from the headwaters down to the confluence of Elk River to Humboldt Bay. A field trip will be taken to the Headwaters Forest Reserve - Elk River and Lower Elk River where students will calculate the stream flow and monitor water quality using proper scientific methods and equipment. Next, the students will travel to the nearby wildlife refuge to learn about the effects of lead on the health of both humans and wildlife. Students will also learn the different genera and species of their local flora and fauna. In the next lesson, students will visit nearby South Spit Beach where they will learn about ocean dynamics (i.e. waves, tides, currents) and assist the Environmental Department in cleaning up marine debris. Lastly, the curriculum will conclude with a lesson in the Tribe's Community Center aimed at stressing the importance of reducing or eliminating NPS pollution generated from motor vehicles (i.e. roadside pollutants) by planting willow cuttings harvested during an earlier lesson in the program's curriculum.

III. Environmental Education Curriculum

Lesson 1: "Revisiting NPS Pollution"

During this lesson, students will review watersheds, the water cycle, non-point source (NPS) pollution, and how to distinguish non-point from point source pollution. The lesson will begin by introducing the water cycle and how water moves through a watershed. Students will review the difference between point and NPS pollution and learn how pollution can affect all environments of a watershed. The lesson will also cover how pollution affects soil and air as it moves from one environmental medium to the next.

K-12 CA Standards

- ✓ **Water on Earth moves between the oceans and land through the processes of evaporation and condensation. As a basis for understanding this concept:**
    a. *Students know* most of Earth's water is present as salt water in the oceans, which cover most of Earth's surface.
    b. *Students know* when liquid water evaporates, it turns into water vapor in the air and can reappear as a liquid when cooled or as a solid if cooled below the freezing point of water.
    c. *Students know* water vapor in the air moves from one place to another and can form fog or clouds, which are tiny droplets of water or ice, and can fall to Earth as rain, hail, sleet, or snow.
    d. *Students know* that the amount of fresh water located in rivers, lakes, underground sources, and glaciers is limited and that its availability can be extended by recycling and decreasing the use of water.
    e. *Students know* the origin of the water used by their local communities.
- ✓ **Topography is reshaped by the weathering of rock and soil and by the transportation and deposition of sediment. As a basis for understanding this concept:**
    a. *Students know* water running downhill is the dominant process in shaping the landscape, including California's landscape.
    b. *Students know* rivers and streams are dynamic systems that erode, transport sediment, change course, and flood their banks in natural and recurring patterns.
    c. *Students know* beaches are dynamic systems in which the sand is supplied by rivers and moved along the coast by the action of waves.
- ✓ **Waves, wind, water, and ice shape and reshape Earth's land surface. As a basis for understanding this concept:**
    a. *Students know* some changes in the earth are due to slow processes, such as erosion, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.

b. *Students know* natural processes, including freezing and thawing and the growth of roots, cause rocks to break down into smaller pieces.
c. *Students know* moving water erodes landforms, reshaping the land by taking it away from some places and depositing it as pebbles, sand, silt, and mud in other places (weathering, transport, and deposition).

✓ **Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:**

a. Observe common objects by using the five senses.
b. Describe the properties of common objects.
c. Describe the relative position of objects using one reference (e.g., above or below).
d. Compare and sort common objects by one physical attribute (e.g., color, shape, texture, size, weight).
e. Communicate observations orally and through drawings.

Educator's Lesson Plan

1. Discuss the water cycle
    a. Engage students by explaining, diagramming, or acting out the different stages and associated environments of the water cycle
2. Discuss watersheds
    a. Use a topographic map, illustration, and/or a Google Earth image to visually distinguish the boundaries of our watersheds (i.e. Eel River and Mad-Redwood watershed)
3. Discuss pollution (both point and NPS pollution)
    a. Engage students by describing the two types of pollution and then using photos, flash cards, etc. of specific pollution examples (i.e. storm drain = point source pollution; hydrocarbon sheen in creek = NPS pollution) in order to quiz students on their retention and understanding
    b. Explain to students how NPS pollution encompasses the large majority of pollution occurring in our environment
4. Discuss the effects of pollution to the health of humans and other organisms as well as the environment as a whole
    a. Use specific examples to describe how pollution can personally affect the student (i.e. air pollution and asthma)
    b. Use specific examples to describe how pollution can affect other organisms or a specific environmental media (i.e. turbidity on the oxygen uptake for a salmonid)
5. Students will participate in the following activities *"NPS in the Watershed"* and *"Fish Identification Workshop"*

Activities

"*NPS in the Watershed*" – Using an Enviroscape® Watershed/Non-Point Source Pollution model, this activity will show the students how non-point and point source pollution can affect the different environments in a watershed. The different environments from which pollution is generated in the model include, but may not be limited to, the following:

- Non-Point Sources
  - Residential
  - Stormwater runoff
  - Forestry Areas
  - Transportation
  - Recreational
  - Agricultural and Construction

- Point Sources
  - Factory
  - Sewage Treatment Plant
  - Storm Drains

The model shows how NPS pollution such as stormwater runoff, represented by soil (cocoa), hazardous chemicals (colored drink mix), and hydrocarbons (cocoa plus water), can enter waterways located either in the upper reaches of a watershed (i.e. creeks, rivers, lakes) that eventually affect downstream waters or in waters located in the lower reaches of a watershed (i.e. estuaries, bays, ocean). The model also comes equipped with supplies to demonstrate Best Management Practices (BMP), in which NPS pollution is stopped from entering a waterway. The model demonstrates BMP's with vegetated buffer strips (felt) and wetlands (sponges) capable of capturing and biologically breaking down NPS pollution. BMP's are also demonstrated using berms (clay) capable of channelizing and holding water on a construction site, thus preventing NPS pollution from flowing offsite into a waterway. Students will have a great understanding of how all of the environments are connected through the flow of water and the runoff that is generated (see Appendix 2: Environmental Curriculum Activities – Figure 1).

Supplies Required

- Enviroscape® Watershed/Non-Point Source Pollution Model and accessories (1)

"Fish Identification Workshop" – Using laminated keys, students will identify locally found fish species either by a photograph or by preserved samples provided by Humboldt State University's fish collection. A discussion will take place about how NPS pollution can affect the distribution of certain culturally important species. For example, the erosion of the Eel River Valley can lead to increase turbidity levels which deposit sediment into deep pools. This deposition, in combination with lowered water levels from both legal and illegal water diversions, eliminates pockets of cold, oxygen rich water that salmon require in order for survival. Salmon are a culturally important species which require a temperature range of 55-60° F (for adults) and 35-65° F (for eggs). If suitable habitat is not available or water quality is impaired (i.e. higher temps, blue-green algae, etc.), due to the presence or continued input of NPS pollution (sediment from logging and gravel extraction), then the result will be the increased mortality of eggs, jacks, and returning adult spawners. Large fish kills can then lead to decreased fecundity rates and lowered genetic diversity within the population for a specific river system such as the Eel River.

Supplies Required

- Mac's Field Guide to Northwest Coastal Fishes
- Mac's Field Guide to Freshwater Fish of North America
- Projector
- Laptop
- Index cards
- Preserved fish specimens

Lesson 2: "Pollution Close to Home"

During this lesson, students will discuss the different types of pollution associated with activities occurring on Table Bluff Reservation (TBR). Since this pollution is occurring so close to home, students will understand how this pollution can affect not only their own health, but the health of their family or pets. Some of these pollution types can include, but are not limited to, the following:

- Runoff from reservation roads
- Solid waste (i.e. trash)
- Agricultural practices (i.e. bacteria, pesticides, fertilizer)
- Construction activities
- Household hazardous waste

K-12 CA Standards

- ✓ **Each of the more than 100 elements of matter has distinct properties and a distinct atomic structure. All forms of matter are composed of one or more of the elements. As a basis for understanding this concept:**
    a. *Students know* the structure of the atom and know it is composed of protons, neutrons, and electrons.
    b. *Students know* that compounds are formed by combining two or more different elements and that compounds have properties that are different from their constituent elements.
    c. *Students know* the states of matter (solid, liquid, gas) depend on molecular motion.
    d. *Students know* that in solids the atoms are closely locked in position and can only vibrate; in liquids the atoms and molecules are more loosely connected and can collide with and move past one another; and in gases the atoms and molecules are free to move independently, colliding frequently.
    e. *Students know* how to use the periodic table to identify elements in simple compounds.
- ✓ **Chemical reactions are processes in which atoms are rearranged into different combinations of molecules. As a basis for understanding this concept:**
    a. *Students know* reactant atoms and molecules interact to form products with different chemical properties.
    b. *Students know* how to determine whether a solution is acidic, basic, or neutral.
- ✓ **Principles of chemistry underlie the functioning of biological systems. As a basis for understanding this concept:**
    a. *Students know* that carbon, because of its ability to combine in many ways with itself and other elements, has a central role in the chemistry of living organisms.

b. *Students know* that living organisms are made of molecules consisting largely of carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur.

Educator's Lesson Plan

1. Walk with the kids to TBR's parking lot area
2. While walking and upon arrival, discuss NPS pollution associated with TBR's roads
    a. Engage students by asking them to think about what pollutants can be found on roads
    b. Discuss what the chemical makeup and properties of these pollutants asking students if they know the individual elements involved
    c. Discuss with students the different ways these pollutants, though found on the ground, can have a harmful effect on both humans and wildlife
3. Discuss how we can prevent these pollutants from originating and/or reaching waterways
    a. For automobiles, talk about proper vehicle maintenance, ways to reduce gas usage (i.e. carpools) and carbon deposition, etc.
    b. For construction activities, talk about proper installation and maintenance of BMPs for control of erosion and sediment, hazardous material safety, etc.
    c. For agricultural and residential issues, talk about application of fertilizers and pesticides, disposal of pet waste, household hazardous waste, etc.
4. Walk with the students to storm drain south of Community Center
5. Students will participate in the following activity *"Road Warriors: Stop Pollution in Its Tracks!"*
6. Walk with the students to the willows above TBR's retention basin
7. Discuss the effectiveness of willows in the filtration of pollutants (in this case pollutants associated with roads)
8. Discuss the benefits of TBR's retention basin
9. Students will participate in the following field trip, *TBR's Wetland*

Activity

"Road Warriors: Stop Pollution in Its Tracks!" – Students will learn the type of NPS pollution affiliated with reservation roads, the harmful health and environmental effects associated with these pollutants, and ways we can prevent the generation of NPS pollution in order to prevent the possible contamination of importance resources (i.e. reservation groundwater). First, students will assess the Tribe's main access road (Wiyot Dr.) to discuss what pollutants they believe are present and how they originated. Next, students will simulate NPS pollution by using similar application techniques for the EnviroScape® Watershed/Non-Point Source Pollution Model in Lesson 1: "Revisiting NPS Pollution." The following pollution sources (and how they will be demonstrated) will be empathized to show the students the varying sources of pollution on TBR:

- Hydrocarbons (cocoa and water mixture)
- Pesticides and fertilizers (red drink powder mixture)
- Sediment from construction sites (sand)
- Bacteria (green drink powder mixture)

After NPS pollution is applied, water will be administered (to simulate rain) and students will observe NPS pollution being washed into the storm drain. Next, students will assist with the installation and application of BMPs in order to prevent NPS pollution from entering the storm drain. Some examples of available BMPs will include, but are not limited to, the following:

- Straw wattles
- Sand bags
- Storm drain catch basin inserts
- Cat litter

Supplies Required

- Hose w/ spray nozzle
- Cocoa mix
- Colored drink powder
- Sand
- BMP demonstration tools

Field Trip

TBR Wetlands – Students will assist the Wiyot Tribe's Environmental Department (WTED) with retrieving willow cuttings from the reservation wetland. These willows will be soaked for the duration of the summer education period in order to allow for the establishment of an adequate root ball. During the activity period in Lesson 6: "Looking to the Future," these willows will then be planted in swales at the entrance to TBR's Community Center parking lot. This will add to the aesthetic beauty of the reservation as well as aid in filtration of parking lot runoff.

Supplies Required

- Gloves
- Saws
- Buckets
- Plant pots

Lesson 3: "Understanding Our Watershed from Top to Bottom"

Students will travel from the headwaters of the Elk River watershed down to Humboldt Bay where the creek eventually terminates. Along the way, students will learn the diverse ecology associated with different sections of the watershed (i.e. headwaters to estuary) and learn how human impacts (i.e. channelization) and NPS pollution can affect these environments.

K-12 CA Standards

- ✓ **Living organisms depend on one another and on their environment for survival. As a basis for understanding this concept:**
    a. *Students know* ecosystems can be characterized by their living and nonliving components.
    b. *Students know* that in any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.
- ✓ **Adaptations in physical structure or behavior may improve an organism's chance for survival. As a basis for understanding this concept:**
    a. *Students know* plants and animals have structures that serve different functions in growth, survival, and reproduction.
    b. *Students know* examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.
    c. *Students know* living things cause changes in the environment in which they live: some of these changes are detrimental to the organism or other organisms, and some are beneficial.
    d. *Students know* when the environment changes, some plants and animals survive and reproduce; others die or move to new locations.
- ✓ **Newton's laws predict the motion of most objects. As a basis for understanding this concept:**
    a. *Students know* how to solve problems that involve constant speed and average speed.
- ✓ **The velocity of an object is the rate of change of its position. As a basis for understanding this concept:**
    a. *Students know* position is defined in relation to some choice of a standard reference point and a set of reference directions.
    b. *Students know* that average speed is the total distance traveled divided by the total time elapsed and that the speed of an object along the path traveled can vary.
    c. *Students know* how to solve problems involving distance, time, and average speed.

d. *Students know* the velocity of an object must be described by specifying both the direction and the speed of the object.
e. *Students know* changes in velocity may be due to changes in speed, direction, or both.

- ✓ **Students solve problems involving addition, subtraction, multiplication, and division of whole numbers and understand the relationships among the operations**
- ✓ **Students choose and use appropriate units and measurement tools to quantify the properties of objects:**
    a. Choose the appropriate tools and units (metric and U.S.) and estimate and measure the length, liquid volume, and weight/mass of given objects.
- ✓ **Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:**
    a. Differentiate observation from inference (interpretation) and know scientists' explanations come partly from what they observe and partly from how they interpret their observations.
    b. Measure and estimate the weight, length, or volume of objects.
    c. Formulate and justify predictions based on cause-and-effect relationships.
    d. Conduct multiple trials to test a prediction and draw conclusions about the relationships between predictions and results.
    e. Construct and interpret graphs from measurements.
    f. Follow a set of written instructions for a scientific investigation.

Educator's Lesson Plan

1. Students will participate in the following field trips to the *Elk River Headwaters Trail* and *Lower Elk River*
2. While walking at the Elk River Headwaters Trail, discuss the varying ecosystems associated within a watershed
    a. Examples can include flora and fauna commonly found, water quality parameters, etc. in the headwaters as compared to lower reaches of the watershed (i.e. estuary)
3. After the Elk River Headwaters Trail, travel "downstream" to an area of Elk River near a local dairy, Triple Creek Jersey
    a. While traveling, discuss with the students the visual changes in ecosystems as we travel down from the headwaters
4. Students will participate in the following activity *"How to Know the Flow"*
5. Students will get hands-on experience with scientific equipment
    a. Deploy Global Water Flow Probe to retrieve a stream flow calculation and compare to students' stream flow calculations
    b. Deploy Yellow Springs Instruments (YSI) 6600 series water quality monitoring sonde to determine the physical parameters of water quality at the site

6. Discuss both flow rates in conjunction with water quality parameters
    a. Determine if any hypotheses and/or conclusions can be made about the overall health of Elk River based on results

Activity

"How to Know the Flow" – Using proper protocols/methodology, students will learn how to set up a scientific experiment in order to accurately calculate stream flow using the following formula:

$$\text{Flow} = \frac{A\,L\,C}{T}$$

Where:
A = Average cross-sectional area of stream
L = Length of the stream reach measured
C = Coefficient or correction factor (use 0.8 for rocky-bottom stream and 0.9 for muddy-bottom streams)
T = Time, in seconds, for the float to travel the length of *L*

The following are detailed instructions in order to accurately determine stream flow:

- ✓ Measure the distance of the stream (*L*) that you wish to evaluate (this is usually 20 feet).
- ✓ Using the attached datasheet (see Appendix 2: Environmental Curriculum Activities – Figure 2), record the value for *L* on the datasheet
- ✓ Using stakes, a hammer, and heavy-duty string, run two transects (line should be taut and near the water surface) across the stream at the start (upstream = transect #1) and bottom (downstream = transect #2) of this distance.
- ✓ Measure the distance of the transect line and divide by 4 to determine the equal segments in order to calculate *A* (For example, if the length of the transect is 8', points A to B, B to C, C to D, and D to E would all equal 2') **NOTE**: Points A and E are delineated by the transect stakes
- ✓ Using field tape and a measuring tape, mark points B, C, and D on the transect line and record on the datasheet
- ✓ Using a waterproof yardstick, measure water depth at points B, C, D and E (E = 0') and record on the datasheet
- ✓ Perform necessary calculation on datasheet to determine the value of *A* for the stream reach surveyed
- ✓ Explore the stream's substrate to determine *C*; If it is a rocky-bottom (gravel, cobble, boulder, etc) we will use the value of 0.8 but if it is a muddy-bottom (silt, clay, mud) we will use the value of 0.9
- ✓ Record the value for *C* on the datasheet
- ✓ To calculate *T*, place an orange in the fastest moving section of the stream
- ✓ Using a stopwatch, track the time it takes for the orange to travel from transect #1 to transect #2

- ✓ Record the time on the datasheet
- ✓ Repeat this procedure for a total of 3 times, recording each trial on the datasheet in order to calculate the average time. **NOTE**: If the orange is impeded by rocks, sticks, cobble, etc., discard the time and perform time trial again
- ✓ Determine stream flow (in ft^3/sec) by plugging in all variables into the formula Flow = ALC/T

Supplies Required

- Heavy-duty string
- Stakes (4)
- Hammer
- Tape measure
- Waterproof yardstick
- Field tape
- Oranges
- Fishing net
- Stopwatch
- Calculator
- Clipboards
- Pencils
- Flow meter
- YSI 6660 series sonde

Field Trips

Headwaters Forest Reserve – Elk River Trail & Lower Elk River – Students will discover their watershed by travelling up to the headwaters of the Elk River. Once there, students will learn about the diverse ecosystems in higher reaches of the watershed as compared to other ecosystems located in the lower reaches (i.e. estuary). There will be a discussion on how NPS pollution in these ecosystems can also have an effect on habitats downstream. Next, students will travel downstream to Elk River near a local dairy, Triple Creek Jersey, where they will assess stream flow and deploy a YSI 6600 series sonde to monitor water quality. The field trip will conclude with a discussion about possible sources of NPS pollution and how we can use the data collected to assess the overall health of Elk River.

Lesson 4: "Effects of Lead Poisoning"

During this lesson, students will travel to the local wildlife refuge to learn about the toxic effects of lead to both humans and wildlife. With the assistance of the WTED staff, students will learn their local flora and fauna using binoculars, a spotting scope, handheld lenses, and field guides to key out species.

K-12 CA Standards

- ✓ **Different types of plants and animals inhabit the earth. As a basis for understanding this concept:**
    a. *Students know* how to observe and describe similarities and differences in the appearance and behavior of plants and animals (e.g., seed-bearing plants, birds, fish, insects).
    b. *Students know* how to identify major structures of common plants and animals (e.g., stems, leaves, roots, arms, wings, legs).
- ✓ **Plants and animals meet their needs in different ways. As a basis for understanding this concept:**
    a. *Students know* different plants and animals inhabit different kinds of environments and have external features that help them thrive in different kinds of places.
    b. *Students know* both plants and animals need water, animals need food, and plants need light.
    c. *Students know* animals eat plants or other animals for food and may also use plants or even other animals for shelter and nesting.
    d. *Students know* how to infer what animals eat from the shape of their teeth (e.g., sharp teeth: eats meat; flat teeth: eats plants).
    e. *Students know* roots are associated with the intake of water and soil nutrients and green leaves are associated with making food from sunlight.
- ✓ **All organisms need energy and matter to live and grow. As a basis for understanding this concept:**
    a. *Students know* plants are the primary source of matter and energy entering most food chains.
    b. *Students know* producers and consumers (herbivores, carnivores, omnivores, and decomposers) are related in food chains and food webs and may compete with each other for resources in an ecosystem.
    c. *Students know* decomposers, including many fungi, insects, and microorganisms, recycle matter from dead plants and animals.
- ✓ **Living organisms depend on one another and on their environment for survival. As a basis for understanding this concept:**
    a. *Students know* ecosystems can be characterized by their living and nonliving components.

Educator's Lesson Plan

1. Students will participate in the following field trip to the *United States Fish and Wildlife Service's (USFWS) Humboldt Bay National Wildlife Refuge (HBNWR)*
2. Discuss the harmful effects of lead
    a. Human health effects
    b. Wildlife health effects
    c. Effects to the environment
3. Discuss ways in which humans and wildlife can be exposed to lead as well as how lead can enter our environment
4. Discuss ways to prevent lead from occurring in the environment
5. Students will participate in the following activity *"Bird and Plant Exploration"*

Activity

"*Bird and Plant Exploration*" – Students will explore the HBNWR with staff members of the WTED. A discussion will be aimed at how NPS pollution (specifically lead) can affect wildlife populations (i.e. waterfowl) and humans that consume these species.

Supplies Required

- Leica spotting scope
- Binoculars
- Hand lenses
- The Sibley Guide to Birds
- The Sibley Field Guide to Birds of Western North America
- Mac Field Guide to Northern California Wildflowers

Field Trip

USFWS HBNWR – The USFWS national wildlife refuge is a perfect location to discuss NPS pollution, in regards to lead, because it is a prime waterfowl hunting location. The use of lead bullets ("shot") has been prohibited due to extensive research into the continued ingestion of "residual" lead by waterfowl. Due to its low level of toxicity, lead can be very harmful or even deadly to both humans and wildlife. Lead bioaccumulates up the food chain as other species like scavengers (i.e. turkey vultures) and predators eat poisoned individuals. Therefore, lead's deadly effects can persist in the environment long after its initial use.

Lesson 5: "The Last Stop for Pollution"

During this lesson, students will learn how NPS pollution can affect the water quality of large water bodies (i.e. rivers, lakes, and oceans) and affiliated tributaries. Using what they have learned up until this point, students will trace some pathways that NPS pollution may take to eventually reach its final destination. Students will learn some of the common NPS contaminants, where they may have originated from, and some preventative methods that can be taken at the source to safeguard water quality for the entire watershed.

K-12 CA Standards

- ✓ **Topography is reshaped by the weathering of rock and soil and by the transportation and deposition of sediment. As a basis for understanding this concept:**
    a. *Students know* beaches are dynamic systems in which the sand is supplied by rivers and moved along the coast by the action of waves.
- ✓ **Energy from the Sun heats Earth unevenly, causing air movements that result in changing weather patterns. As a basis for understanding this concept:**
    a. *Students know* the influence that the ocean has on the weather and the role that the water cycle plays in weather patterns.
- ✓ **Many phenomena on Earth's surface are affected by the transfer of energy through radiation and convection currents. As a basis for understanding this concept:**
    a. *Students know* the sun is the major source of energy for phenomena on Earth's surface; it powers winds, ocean currents, and the water cycle.
- ✓ **Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. As a basis for understanding this concept:**
    a. *Students know* how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.
    b. *Students know* the relationship between the rotation of Earth and the circular motions of ocean currents and air in pressure centers.

Educator's Lesson Plan

1. Students will participate in the following field trip to *South Spit Beach*
2. Upon arrival, engage the students in a discussion of ocean dynamics (i.e. tides, waves, currents)
    a. Ask students, about Earth's tidal cycles, how waves are generated, and how currents occur
3. Engage the students in a discussion on marine debris
    a. Ask students about how they think this trash originated on the beach (review watersheds)

b. Ask students to guess what common marine debris they will encounter
c. Explain the Great Pacific Garbage Patch (i.e. size, what it is mainly comprised of, and how it originated)
d. Explain ocean currents
e. Discuss the harmful effects of marine debris
    i. Human health effects
    ii. Wildlife health effects
    iii. Environmental health effects (i.e. chemical breakdown, invasive species)

4. Review safety procedures
    a. Wear gloves at all times and use trash pickup tools
    b. DO NOT HANDLE ANY SHARP OBJECTS (i.e. needles, razors, metal, etc.); ALERT ADULT SUPERVISOR TO ANY SHARP OBJECTS
    c. Adult supervisors will carry hazardous materials containers for sharps
    d. Do not lift any heavy objects
    e. Additional safety requirements as needed for specific sites (i.e. fall hazards)
5. Students will participate in the following activity *"Clean Your Beach"*

Activity

"*Clean Your Beach*" – Marine debris continues to be a persistent problem as oceans are the last stop for pollution in the watershed. The ingestion of debris by marine species (i.e. gulls, albatross, mammals, etc.) can lead to severe illness or death. In the Pacific Ocean, debris is carried by the currents where it eventually ends up in the Great Pacific Garbage Patch (roughly twice the size of the continental United States). By cleaning up the South Spit, students will ensure that both humans and wildlife are safe from the harmful effects of marine debris.

Supplies Required

- Gloves
- Trash pickup tools
- Heavy duty bags
- Hazardous materials containers

Field Trip

South Spit Beach – Students will travel to the South Spit Beach, located near TBR, to clean marine debris from the shoreline. South Spit is a prime location for a beach cleanup since it is located approximately 2 miles from TBR by road. Many tribal members utilize this beach, or areas very near, for personal, ceremonial, and gathering purposes.

Lesson 6: "Looking to the Future"

During this lesson, students will learn how they can make a difference today to better tomorrow. Students will learn how nature treats and remediates NPS pollution and how we can utilize nature to help us treat pollution on site. Students will leave the program with a good understanding of the harmful effects of NPS pollution and ways they can reduce or prevent it from occurring. Lastly, and hopefully, the "take home message" will be focused on strengthening the connection that the Wiyot youth have with their environment in order to ensure that they will not only grow to be strong environmental stewards, but they may pursue environmental careers as well.

K-12 CA Standards

- ✓ **Plants and animals meet their needs in different ways. As a basis for understanding this concept:**
    a. *Students know* different plants and animals inhabit different kinds of environments and have external features that help them thrive in different kinds of places.
    b. *Students know* both plants and animals need water, animals need food, and plants need light.
    c. *Students know* roots are associated with the intake of water and soil nutrients and green leaves are associated with making food from sunlight.
- ✓ **Different types of plants and animals inhabit the earth. As a basis for understanding this concept:**
    a. *Students know* how to observe and describe similarities and differences in the appearance and behavior of plants and animals (e.g., seed-bearing plants, birds, fish, insects).
    b. *Students know* how to identify major structures of common plants and animals (e.g., stems, leaves, roots, arms, wings, legs).
- ✓ **Earth is composed of land, air, and water. As a basis for understanding this concept:**
    a. *Students know* characteristics of mountains, rivers, oceans, valleys, deserts, and local landforms.
    b. *Students know* changes in weather occur from day to day and across seasons, affecting Earth and its inhabitants.
    c. *Students know* how to identify resources from Earth that are used in everyday life and understand that many resources can be conserved.
- ✓ **Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:**
    a. Observe common objects by using the five senses.
    b. Describe the properties of common objects.

c. Describe the relative position of objects using one reference (e.g., above or below).
d. Compare and sort common objects by one physical attribute (e.g., color, shape, texture, size, weight).
e. Communicate observations orally and through drawings.

Educator's Lesson Plan

1. Reiterate to students the importance of willows in the natural remediation of pollutants from the environment
2. Reiterate the importance of preventing NPS pollution from entering the environment and the discuss the importance of immediate remediation when pollution is detected
3. Discuss ways that we can utilize nature to store, soak, and treat NPS pollution on site before reaching a nearby water source (i.e. Low Impact Development (LID))
4. Discuss ways students can strive to be environmental stewards for a brighter, greener future
    a. Examples can include picking up trash, conserving water and energy, picking up pet waste, etc.
5. Discuss different environmental careers that students may find interesting and ways that students can achieve a future in their desired field of study
6. Students will participate in the following activity *"Planting a Greener Future"*

Activity

"*Planting a Greener Future*" – Students will take the willow cuttings retrieved during the field trip in Lesson Two: "Pollution Close to Home" and plant them in the drainage ditches off of the TBR parking lot. By doing so, the students will forever have a connection to making TBR, their home, a cleaner place to live and enjoy.

Supplies Required

- Gloves
- Shovels/trowels
- Soil
- Soil amendment

4.0 Program Evaluation

The execution of a precise environmental education program does not end with development but rather, in order to get the most from an education program, it is important to evaluate the program while it is being implemented. Did the lessons draw and maintain the students' interest? Did the demonstration materials adequately explain the lesson concepts? Can the activities be improved or better-presented to better suit the audience? Are the students absorbing the concepts and information presented? These are among the many questions that should be asked when implementing an education program.

While the Wiyot Tribe's NPS pollution education program is underway, WTED staff will evaluate its efficacy. This will be done informally, by making observations of student behavior and responses, with the intent of answering the above questions (and others). Since flexibility in lesson structure allows the educator(s) to make adjustments that accommodate the audience, this curriculum will be subject to minor alteration as the program is administered. The educator(s) can learn a lot from the students and this experience can be applied to the aforementioned lessons or future curricula. The educator(s) will evaluate the program while it is in progress and make decisions about any program adjustments, if needed.

5.0 Conclusion

This education program is another example of the WTED's continuing commitment to addressing pollution threats and reinforcing the attitudes of land stewardship for future generations. The Wiyot Tribe is dedicated to educating tribal youth on topics relating to cultural and environmental practices. This curriculum is intended to outline an effective method of educating Wiyot youth on the causes and effects of NPS pollution and ways we can prevent the generation of NPS pollution and/or possible contamination of nearby water sources. As mentioned previously, water is a valuable resource to the Wiyot Tribe for personal, ceremonial, and gathering purposes. Overall, it is in the best interest of the Tribe to protect the water sources not only affecting tribal property but nearby as well. In combination with NPS pollution prevention, the Wiyot youth will gain knowledge in how the WTED scientifically monitors these water sources in order to determine if water quality has declined, been sustained, or has improved from previous years. By providing lessons and activities demonstrating environmental elements and concepts such as watersheds, the water cycle, wetlands, runoff, and human influence on the environment, the Wiyot youth will learn about NPS pollution and what they can do to safeguard their precious natural resources.

IV. Appendices

Appendix 1. Map of Activity and Field Trip Sites

Appendix 2: Environmental Curriculum Activities

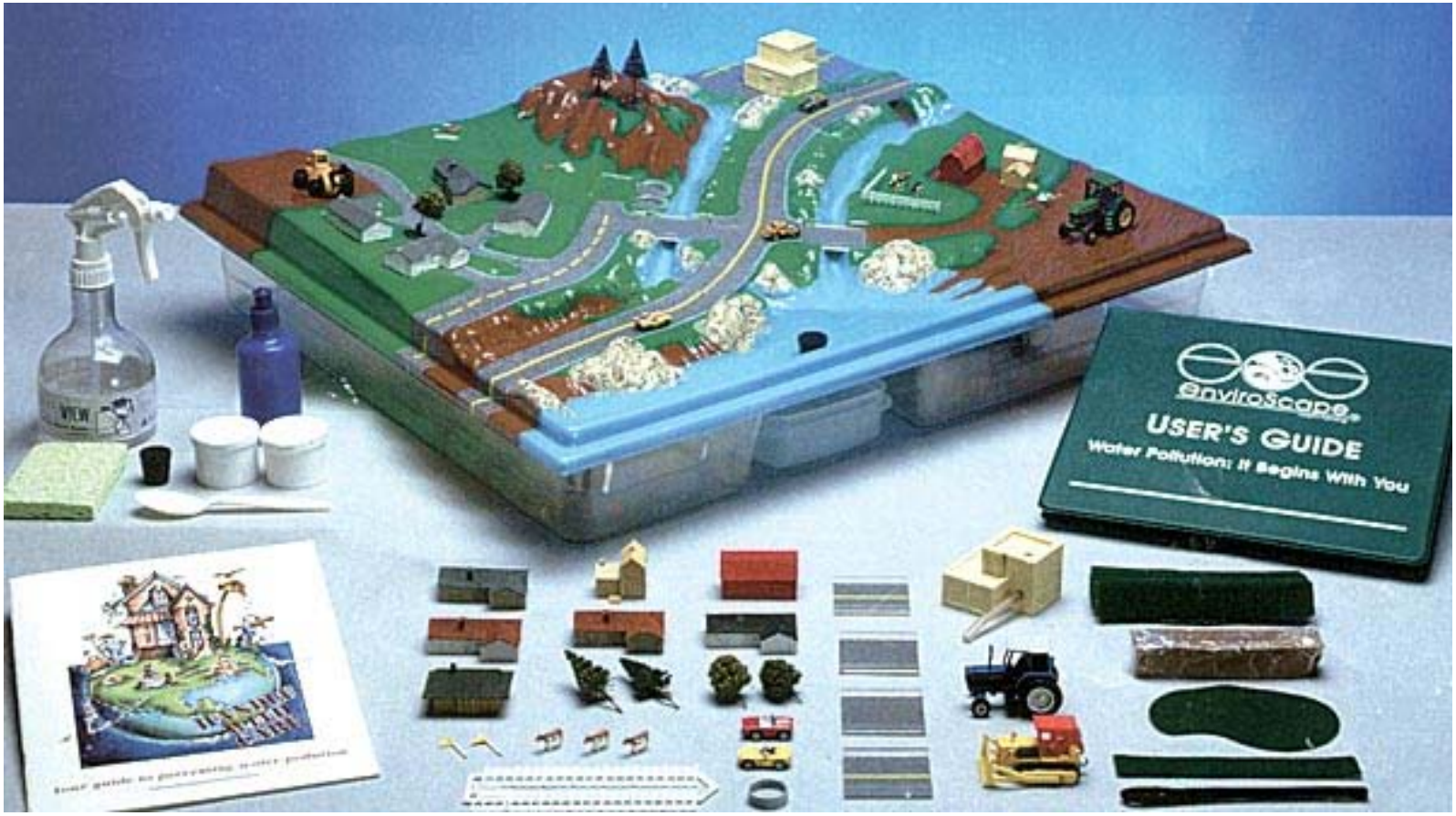
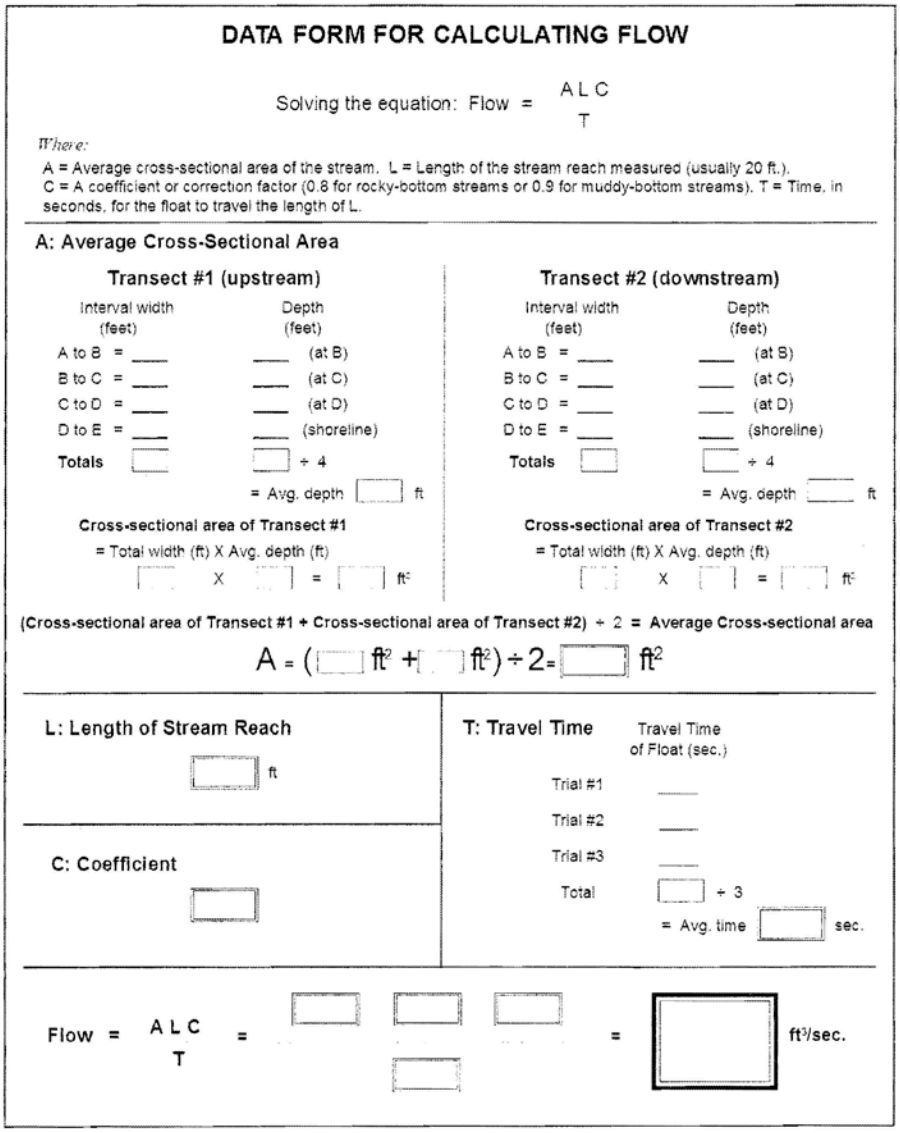


Figure 1. Watershed NPS Pollution Model.* A model designed to demonstrate how NPS pollution travels within a watershed. NPS pollution demonstrated in this model are: soil (cocoa powder), hazardous chemicals (colored drink powder), and hydrocarbons (cocoa powder w/ water). Students will also have the opportunity to learn about BMP's and how we can manage the landscape to naturally capture and/or eliminate NPS pollution thus, preventing the contamination of our waterways.

*Photo taken from Enviroscape® website at: http://www.enviroscapes.com/nonpoint-source.html



DATA FORM FOR CALCULATING FLOW

Solving the equation: Flow = $\frac{A L C}{T}$

Where:

A = Average cross-sectional area of the stream. L = Length of the stream reach measured (usually 20 ft.).
C = A coefficient or correction factor (0.8 for rocky-bottom streams or 0.9 for muddy-bottom streams). T = Time, in seconds, for the float to travel the length of L.

A: Average Cross-Sectional Area

Transect #1 (upstream)

	Interval width (feet)	Depth (feet)
A to B =	____	____ (at B)
B to C =	____	____ (at C)
C to D =	____	____ (at D)
D to E =	____	____ (shoreline)
Totals	[ ]	[ ] ÷ 4

= Avg. depth [ ] ft

Cross-sectional area of Transect #1

= Total width (ft) X Avg. depth (ft)

[ ] X [ ] = [ ] ft²

Transect #2 (downstream)

	Interval width (feet)	Depth (feet)
A to B =	____	____ (at B)
B to C =	____	____ (at C)
C to D =	____	____ (at D)
D to E =	____	____ (shoreline)
Totals	[ ]	[ ] ÷ 4

= Avg. depth ____ ft

Cross-sectional area of Transect #2

= Total width (ft) X Avg. depth (ft)

[ ] X [ ] = [ ] ft²

(Cross-sectional area of Transect #1 + Cross-sectional area of Transect #2) ÷ 2 = Average Cross-sectional area

$A = ([\ ]\ ft^2 + [\ ]\ ft^2) \div 2 = [\ ]\ ft^2$

L: Length of Stream Reach

[ ] ft

T: Travel Time

	Travel Time of Float (sec.)
Trial #1	____
Trial #2	____
Trial #3	____
Total	[ ] ÷ 3

= Avg. time [ ] sec.

C: Coefficient

[ ]

Flow = $\frac{A L C}{T}$ = [ ] [ ] [ ] / [ ] = [ ] ft³/sec.

*Datasheet taken from United States Environmental Protection Agency's (USEPA) website: http://water.epa.gov/type/rsl/monitoring/upload/2003_07_24_monitoring_volunteer_stream_ds5a.pdf

Figure 2. Datasheet for Calculating Stream Flow.* An activity designed for students to follow proper scientific protocols/methodology in order to collect precise scientific data. Students will set up their own experiments and use the following datasheet to collect the required data in order to calculate the following stream flow formula (Flow = ALC/T)

References

California Department of Education. 2004. *Science Framework for California Public Schools: Kindergarten Through Grade Twelve.* Sacramento: California Department of Education.

California Department of Education. 2006. *Mathematics Framework for California Public Schools: Kindergarten Through Grade Twelve.* Sacramento: California Department of Education.