Final Project Report

"It's All Connected": A Casco Bay Watershed Stormwater School-Based Education Initiative

Project Sponsors: Cumberland County Soil & Water Conservation District &
Casco Bay Interlocal Stormwater Working Group (ISWG)
Sponsor Contact Person: Sarah Plummer, Education Coordinator
Project Start Date: October 2004
Project End Date: June 2006

I. Project Overview

Project Purpose

The overarching purpose of the "It's All Connected" program was to promote the long-term reduction of stormwater pollution within the Casco Bay Watershed by laying the foundation for an informed and active public. More specifically, the program accomplished this through the use of place-based, experiential learning activities in kindergarten through high school classrooms. Students increased their understanding of their local watershed, the sources and impacts of stormwater pollution, and personal and community behaviors that could reduce this pollution. The program was delivered and coordinated by a stormwater educator housed at the Cumberland County Soil & Water Conservation District (CCSWCD). This educator worked collaboratively with school systems and teachers to customize onsite and field-based program delivery. All program materials were to be web-based to increase access and cost-effectiveness.

This program met the priority needs identified by EPA NPDES Stormwater Phase II regulated municipalities within the Casco Bay Watershed for the delivery of stormwater education in schools. Students received nonpoint source pollution and other related stormwater lessons through the use of a variety of existing environmental curricula. In addition, two new, stormwater-specific, place-based education modules were to be developed on this subject matter as part of the Friends of Casco Bay's (FOCB) Casco Bay Curriculum.

In the first module, students would be able to identify Casco Bay's pollution sources, review local beach data to identify when it is unhealthy to swim, trace water flow to Casco Bay, and learn how runoff can be reduced by green roofs and other innovative practices. The second module would provide activities for students to do at home and in the community to protect Casco Bay from stormwater pollution.

The goals of the program included providing educational programming to 11 schools within the Casco Bay Watershed, including a minimum of one school per participating Phase II regulated municipality (MS4s), with a minimum of 220 students educated.

Project Outcomes

A total of 3,199 students were served through this program, primarily in upper elementary and middle schools in 10 MS4 municipalities throughout the Casco Bay Watershed, including Cape Elizabeth, Cumberland, Falmouth, Freeport, Gorham, Portland, Scarborough, South Portland, Windham, and Yarmouth. In total, 20 schools received educational programming within these communities.

Below is a summary of school activities in each community. For a more detailed listing of these activities, see Appendix A.

Cape Elizabeth
Total Students: 150
Lesson topics: Watershed model & discussion of nonpoint source pollutants.
School: Cape Elizabeth Middle School

Cumberland
Total Students: 54
Lesson topics: Water quality parameters – define and discuss how affected by NPS pollution; water quality testing from local water bodies; NPS pollution issues.
School: Greely High & Chebeague Island Schools

Falmouth
Total student: 1
Lesson topic: Casco Bay Curriculum Workshop (a senior attended).
School: Falmouth High School

Freeport
Total Students: 68
Lesson topics: Water quality parameters and testing of local water bodies; nonpoint source pollution issues.
School: Mast Landing & Freeport High Schools

Gorham
Total Students: 98
Lesson topics: Watershed model & discussion of nonpoint source pollutants.
School: Gorham Middle School

Portland
Total Students: 453
Lesson topics: Amount of water in the world & the water cycle; historical and present perspective of pollutants in Portland Harbor; watershed model and discuss nonpoint source pollutants and how they relate to aquatic animals.
Schools: Levey Day, St. Patrick's, Longfellow Elementary, King Middle, & Portland High Schools

Scarborough
Total Students: 600
Lesson topics: nonpoint source pollution issues, including an emphasis on soil.
Schools: Scarborough Middle School

South Portland
Total Students: 1033
Lesson topics: Amount of water in the world & the water cycle; where rivers begin, how they flow & building watershed models; historical and present perspective of pollutants in Portland Harbor; construction of landscape models to learn about different types of buffers & impervious vs. pervious surfaces; cumulative impact of NPS pollution on a river system.
Schools: Dyer, Kaler, Small Elementary & South Portland High Schools

Windham
Total Students: 682
Lesson topics: Bioaccumulation from pesticide runoff in an aquatic food web; water-related adaptations in aquatic animals; construction of landscape models to learn about different types of buffers & impervious vs. pervious surfaces; hydropower; historical land use of the Presumpscot River; watershed / vernal pool / NPS pollution hike; water quality testing.
School: Windham Middle & Manchester Elementary Schools

Yarmouth
Total Students: 60
Lesson topics: Watershed model & using local maps to identify watersheds; learning about water quality testing and completing testing from local water bodies; where rivers begin, how they flow & building watershed models.
School: Yarmouth Elementary School

Key Project Personnel
Melissa Sternlieb was the stormwater educator who began work on this program, and she was assisted by Serve ME AmeriCorps Volunteer Abigail Morgan. Melissa left her position in June 2005, when the program was undertaken by CCSWCD educator Sarah Plummer.

Friends of Casco Bay's Stormwater Module
As part of this program, one new, stormwater-specific, place-based education module was developed by Mary Cerullo, entitled "Environmental Issues." The module combines both the stormwater ecosystem and student activities topics (described in "Program Purpose") into one comprehensive unit. See Appendix B to review this module.

Teacher Workshop: The Casco Bay Curriculum
Although not specified in the program requirements, a teacher workshop was prepared and implemented. A total of 17 formal and informal educators from six MS4 communities and 14 schools or other organizations attended this Casco Bay Curriculum workshop, which featured place-based, hands-on nonpoint source pollution and stormwater education lessons from the three Casco Bay Curriculum modules, with emphasis on the stormwater module (Appendix B).

The workshop, co-hosted by CCSWCD and FOCB, was held on May 5, 2006. Attendees participated in several hands-on activities provided in the Curriculum, and also received education about local nonpoint source pollutants, the Casco Bay Watershed, stormwater, and the NPDES requirements. The workshop was very well received by attendees, who aim to use the Curriculum in the current or following school years. See Appendix C for the Workshop Agenda and Appendix D for a sample of participant evaluations.

II. Results

Program Outputs
School tracking and offsite educational program delivery, teacher contacts, and topics covered were tracked as outputs and may be viewed in Appendix A.

Program Outcomes
Program outcomes were documented through assessment of student awareness of stormwater issues before and after participating in the program. Documentation of their awareness includes student artwork, literature, poetry, letters, quizzes, and class notes. See Appendix E for a sample of these student assessments.

Other evidence of student learning and behavior change is more anecdotal, and provided to the stormwater educator through the experience of being with the students. Overall, the students' reaction to the lessons and materials used in this program was overwhelmingly positive. Students responded enthusiastically to hands-on lessons that were engaging and fun. Likewise, they were truly interested in the subject matter of nonpoint source pollution, stormwater, local water bodies and watersheds, and actions they could take to reduce pollution. Students of any age could relate well to and become invested in these types of messages.

In many situations, the same classes were visited on a consistent basis. This schedule allowed for assessment of the students' retention of earlier lessons. Students' recollections were impressive; they stated facts included in prior lessons, as well as actions they had taken, or encouraged family members and neighbors to take, to reduce pollution. Students were excited when their classrooms were visited and eager to share their ideas about pollution and ways they and their families could become part of the pollution reduction solution.

III. Discussion of Lessons Learned: Successes & Challenges of the Program

Documenting Program Outcomes
It can be difficult to capture students' comprehension of any type of lesson. Teachers are constantly searching for meaningful ways to capture an assessment of what their students have learned as a result of the lesson taught. The same challenges presented themselves with this program. It is difficult to quantify or capture the students'

comprehension and their reactions to a particular lesson or subject matter. However, a handful of teachers provided some concrete outcomes as ways to observe what messages the students learned. See Appendix E for a sample of artwork, literature, tests, and other student submissions.

Unfortunately, not all teachers obliged when asked to provide student self-reporting. Teachers are very busy and their time is regulated by curriculum standards. The educator was very appreciative of teachers that used valuable class time to have their students complete a follow-up activity to the lessons. It proved that the teacher was invested in the lesson topic, and that the students were provided an additional opportunity to explore the subject matter. In order for these submissions to happen, it helped to tell both teachers and students why the submissions were useful and who would be using them in the future. It was also useful to visit the classroom on a consistent basis, so the submissions could be received for review.

Multiple versus Singular Class Visits

It can be even more difficult to quantify or measure students' learning if a class is visited just once or a couple of times versus multiple times in the course of a school year. Most teachers were interested in scheduling multiple lessons over a series of months. This is a successful way to carry out an education program, although a single visit is still a meaningful way to reach students as well. During a series of visits students become more familiar with the educator and the types of materials that are presented. The educator has the opportunity to assess students' prior retention, and to build upon lessons taught at a prior meeting. Students build a rapport with the educator and an understanding of the series of pollution messages. Singular visits are still effective, as the materials are presented in the same way and students are exposed to similar content. A series of visits, however, ensures these messages are repeated and assessed.

Involvement of Participating Communities

Ten of the 11 Maine MS4 communities were serviced through this program. Three direct mailings were made to each community, and two postings were made on the Maine Mathematics and Science Alliance listserv, which services Maine math and science teachers. Many teachers did respond to these outlets; however, not all did. The Interlocal Stormwater Working Group (ISWG) Facilitator, Jeff Edelstein, was contacted in a final effort to reach the 2 MS4 communities which had not yet participated in the school based program (Westbrook and Falmouth) (later, a Falmouth High School senior attended the workshop). He contacted the NPDES representatives of these two communities, who were unable to provide any teacher contacts. At this point, the effort was considered futile by the project staff and administrator, since many other teachers in the other participating communities were interested in the program's offerings. It made more sense to expend effort where the program was requested and working well than to continue to expend efforts trying to involve other teachers.

In order to reach specific schools in the future, directly contact the school and ask for the name and contact information of environmental or earth science teachers, those that are involved with environmental clubs or service learning projects, or those with a special interest in environmental issues.

Web-Based Materials
As stated in the "Program Purpose" section of this report, all program materials were to be web-based to increase access and cost-effectiveness. Specifically, this refers to FOCB's Casco Bay Curriculum module developed for this program. The module has not yet been posted on the web, because it continues to be reviewed and modified. FOCB has plans to place the finalized materials on the web once the revisions are complete. The materials were made available, in their current state, to workshop participants at no charge.

IV. Future Applications

Future Use of Casco Bay Curriculum Stormwater Module
The stormwater module, which was developed for this program, was reviewed by the stormwater educator, Sarah Plummer. Her review was and continues to be used by FOCB to revise the Curriculum. The lessons presented in this module are specific to Casco Bay and its watershed, and provide interactive, place-based lessons for upper elementary / middle school students. CCSWCD's educator will use the module materials in future classroom activities, and will continue to serve as a reviewer and resource for FOCB as they continue to finalize the Curriculum.

V. Summary

The "It's All Connected" program aimed to enhance students' understanding of their local watershed, the sources and impacts of stormwater pollution, and personal and community behaviors that could reduce pollution. Through the use of existing environmental science curricula and materials developed by FOCB, the CCSWCD educator brought place-based, experiential learning activities to 20 schools around the Casco Bay watershed, reaching nearly 3,200 students.

The program successfully promoted the long-term reduction of stormwater pollution within the Casco Bay Watershed by laying the foundation for an informed and active public. Students were presented with engaging lessons that demonstrated the causes of nonpoint source pollution and actions they could take in order to remediate it. In addition to students, 17 educators participated in a workshop that featured stormwater education lessons and pertinent information that teachers are planning to integrate into their curricula. The stormwater educator will continue offering stormwater education and acting as a resource for teachers in the Casco Bay Watershed. Both students and teachers were overwhelmingly receptive to and interested in the program offerings and materials.

VI. Appendices

Appendix A. Program Outputs: School Activity Details
Appendix B. Casco Bay Curriculum's Stormwater Module: Environmental Issues
Appendix C. Casco Bay Curriculum Workshop Agenda
Appendix D. Evaluations from Workshop Participants
Appendix E. Program Outcomes: Sample of Student Projects

APPENDIX A
Program Outputs: School Activity Details

Towns, Students, and Schools Serviced through the "It's All Connected" Stormwater Grant

Date	Town	School	Teacher	Grade	# Students	Topic(s) covered
11/9/2005	South Portland	Dyer School	Maureen Regan	4	21	Amount of water in the world/water cycle
11/9/2005	South Portland	Dyer School	Patsy Roberts	4	21	Amount wtr./wtr. cycle
11/10/2005	Windham	Windham Middle School	Leah Campbell	6	25	"Marsh Mystery" - bioaccumulation from pesticide runoff
11/10/2005	Windham	Windham Middle School	Leah Campbell	6	26	"Marsh Myst."
11/10/2005	Windham	Windham Middle School	Wendy Day-Maynard	6	25	"Marsh Myst."
11/10/2005	Windham	Windham Middle School	Wendy Day-Maynard	6	25	"Marsh Myst."
11/14/2005	Yarmouth	Yarmouth Elementary School	Mary Jo Moore	4	20	Watershed model & "Watershed Address" postcards w/ local maps
11/15/2005	Windham	Windham Middle School	Kristin Arbour	6	21	"Marsh Myst."
11/15/2005	Windham	Windham Middle School	Kristin Arbour	6	27	"Marsh Myst."
11/15/2005	Windham	Windham Middle School	Nancy Fish	6	25	"Marsh Myst."
11/15/2005	Windham	Windham Middle School	Nancy Fish	6	26	"Marsh Myst."
11/16/2005	South Portland	Brown School	Sue Small	4	24	Amount wtr./wtr. cycle
11/16/2005	South Portland	Brown School	Tiffany Drake	4	25	Amount wtr./wtr. cycle
11/18/2005	South Portland	Kaler School	Sally Beatty	4	16	Amount wtr./wtr. cycle
11/18/2005	South Portland	Kaler School	Shelby Kavanaugh	4	20	Amount wtr./wtr. cycle
11/21/2005	Yarmouth	Yarmouth Elementary School	Mary Jo Moore	4	20	Water quality testing from local waterbodies
12/6/2005	Windham	Windham Middle School	Leah Campbell	6	25	"Water Address"- water-related adaptations
12/6/2005	Windham	Windham Middle School	Leah Campbell	6	26	"W. Address"
12/6/2005	Windham	Windham Middle School	Wendy Day-Maynard	6	25	"W. Address"
12/7/2005	South Portland	Dyer School	Maureen Regan	4	21	Where rivers begin & how they flow; build watershed models
12/7/2005	South Portland	Dyer School	Patsy Roberts	4	21	Rivers & models
12/12/05	Windham	Windham Middle School	Kristin Arbour	6	21	"W. Address"

12/12/05	Windham	Windham Middle School	Kristin Arbour	6	27	"W. Address"
12/12/05	Windham	Windham Middle School	Nancy Fish	6	25	"W. Address"
12/14/05	South Portland	Brown School	Sue Small	4	24	Rivers & models
12/14/05	South Portland	Brown School	Tiffany Drake	4	25	Rivers & models
12/15/05	Windham	Windham Middle School	Wendy Day-Maynard	6	25	"W. Address"
12/15/05	Windham	Windham Middle School	Nancy Fish	6	26	"W. Address"
12/20/05	South Portland	Kaler School	Sally Beatty	4	16	Rivers & models
12/20/05	South Portland	Kaler School	Shelby Kavanaugh	4	20	Rivers & models
1/4/06	Yarmouth	Yarmouth Elementary School	Mary Jo Moore	4	20	Rivers & models
1/9/06	Cumberland/N. Yarmouth	Greely High School	Jan Treadwell	11-12	20	Water quality parameters; define & how affected by NPS pollution
1/11/06	South Portland	Dyer School	Maureen Regan	4	21	"The Dirty History of Portland Harbor"
1/11/06	South Portland	Dyer School	Patsy Roberts	4	21	"Dirty Hist."
1/13/06	Windham	Windham Middle School	Tricia Pattenaude	8	10	"Marsh Myst."
1/18/06	South Portland	Brown School	Sue Small	4	24	"Dirty Hist."
1/18/06	South Portland	Brown School	Tiffany Drake	4	25	"Dirty Hist."
1/20/06	South Portland	Kaler School	Sally Beatty	4	16	"Dirty Hist."
1/20/06	South Portland	Kaler School	Shelby Kavanaugh	4	20	"Dirty Hist."
1/27/06	Cumberland	Greely High School	Jan Treadwell	11-12	20	Water quality testing from local waterbodies
2/6/06	Windham	Windham Middle School	Leah Campbell	6	26	Build landscape models to learn about different types of buffers and impervious vs. pervious surfaces
2/6/06	Windham	Windham Middle School	Leah Campbell	6	25	Landscape models
2/6/06	Windham	Windham Middle School	Kristin Arbour	6	21	Landscape models
2/15/06	South Portland	Brown School	Sue Small	4	24	Landscape models
2/15/06	South Portland	Brown School	Tiffany Drake	4	25	Landscape models
2/15/06	South Portland	Dyer School	Maureen Regan	4	21	Landscape models
2/16/06	South Portland	Dyer School	Patsy Roberts	4	21	Landscape models
2/17/06	South Portland	Kaler School	Sally Beatty	4	16	Landscape models
2/17/06	South Portland	Kaler School	Shelby Kavanaugh	4	20	Landscape models
2/27/06	Windham	Windham Middle School	Tricia Pattenaude	8	10	Landscape models
3/2/06	Portland	Levey Day School	Kristin Fox	3-5	20	Amount wtr./ wtr. cycle
3/6/06	Windham	Windham Middle School	Wendy Day-	6	25	Landscape models

			Maynard			
3/6/06	Windham	Windham Middle School	Wendy Day-Maynard	6	25	Landscape models
3/6/06	Windham	Windham Middle School	Helen Hurgin	6	12	Landscape models
3/8/06	South Portland	Brown School	Sue Small	4	24	Cumulative impact of NPS pollution on a river system
3/8/06	South Portland	Brown School	Tiffany Drake	4	21	Cumltv. impact on river sys.
3/9/06	Windham	Windham Middle School	Nancy Fish	6	25	Landscape models
3/9/06	Windham	Windham Middle School	Nancy Fish	6	26	Landscape models
3/9/06	Windham	Windham Middle School	Kristen Arbour	6	27	Landscape models
3/24/06	South Portland	Kaler School	Sally Beatty	4	16	Cumltv. impact on river sys.
3/24/06	South Portland	Kaler School	Shelby Kavanaugh	4	20	Cumltv. impact on river sys.
4/12/06	South Portland	Dyer School	Maureen Regan	4	21	Cumltv. impact on river sys.
4/12/06	South Portland	Dyer School	Patsy Roberts	4	21	Cumltv. impact on river sys.
5/12/06	Portland	Levey Day School	Kristen Fox	2-5	25	"Dirty Hist."
5/25/06	Gorham	Gorham Middle School	Irene Friedrichs	6	25	Watershed model; discussion of nonpoint source pollution
5/25/06	Gorham	Gorham Middle School	Irene Friedrichs	6	25	Watershd. model & disc. NPS
6/1/06	Portland	St. Patrick's	Deborah Flaherty	1	15	Watershd. model & disc. NPS; relate to aquatic animals
6/6/06	Cape Elizabeth	CE Middle School	Evan Solander	6	25	Watershd. model & disc. NPS
6/6/06	Cape Elizabeth	CE Middle School	Evan Solander	6	25	Watershd. model & disc. NPS

APPENDIX B
Casco Bay Curriculum's Stormwater Module: Environmental Issues

Friends of Casco Bay's Casco Bay Curriculum

Draft May 2005

Module 3: Environmental Issues

This module addresses pollution, in particular, stormwater runoff and oil spills, that impacts the Casco Bay ecosystem. (*Activities were prepared by FOCB for Cumberland County Soil & Water Conservation District for "It's All Connected" stormwater program for area schools under a grant from Casco Bay Estuary Project.)

1. ***The Dirty History of Casco Bay**** (Who Dirtied the Water?)
As the teacher reads a story about pollutants from the past and the present that impact the Bay, students add each "pollutant" as it is mentioned into a clear container of water.

2. ***Casco Bay Watershed****
Students learn how pollutants flow down a watershed into water bodies like Casco Bay.

3. ***Sleuth Out Pollution!**** -- Rainy day activity
Students investigate their neighborhoods looking for pollution sources.

4. ***Soil Pollution**** -- Rainy day activity
Students experiment with splash cards to find out where soil runoff is most likely to occur in the schoolyard during a rain storm.

5. ***Storm Drain Stenciling**** -- Sunny day activity
Students see the connection between streets and the Bay by stenciling local storm drains.

6. ***Keeping Water from Running Away****
Students see that natural areas vs. manicured lawns absorb stormwater runoff differently.

7. *Design Your Perfect Yard**
Students consider about how they actually use (or would like to use) their outdoor living space, to design their ideal yards, keeping in mind ecological principles.

8. ***Keep Your Butts Out of the Bay!****
Students learn about the impact of the item most commonly found in beach cleanups.

9. ***Sewage: Testing the Beaches for Bacteria****
Students review data from beach testing at Willard Beach, South Portland, to learn about the occurrence of bacterial pollution and when they should not go swimming.

10**. *Oil Spill Cleanup: The* Julie N**

Students attempt to clean up an “oil” spill and learn about the *Julie N* tanker spill.

11. ***Oil Spills and Birds***
Students try to clean oiled feathers and take a quiz on cleaning oiled birds.

12. ***Removing Dams: Opening up the Presumpscot River***
Students consider how habitat alterations by humans effect aquatic life using the example of Smelt Hill Dam from the Presumpscot River.

Friends of Casco Bay's Casco Bay Curriculum

Module Three: Environmental Issues
Activity # 1: The Dirty History of Casco Bay DRAFT

Activity: The Dirty History of Portland Harbor

Background:
Beginning in the mid-1800s, tanneries, foundries, slaughterhouses, and shipyards lined the waterfront of Casco Bay, particularly in Portland and South Portland. Over the years, power plants, gas stations, tank farms, and sewage outfalls were added to the shoreline. Though many of these pollution sources have been removed, polluted runoff from homes, boat sewage, oil spills, and combined sewer overflows, still threaten the health of the Bay. During a heavy rainstorm, combined sewer overflows carry both raw sewage from houses and businesses and stormwater runoff from streets and parking lots directly to the Bay.

Even though Casco Bay is cleaner than most other estuaries, many different pollutants have been dumped into it over the years. In the 1800s, many of the pollutants came from large industries along the shoreline and from sewage disposal from individual homes and businesses. The causes of this pollution were easy to trace. In recent times, most of the pollution has come from polluted runoff from streets, homes, and businesses that are often many miles away. These kinds of this pollution are more difficult to trace back to their sources.

Learning Objective: Students learn about some of the sources of pollution to Casco Bay and that individuals, not just factories and cities, contribute a great deal of the pollution to Casco Bay.

Challenge: Find out who polluted Casco Bay.

Materials
"The Dirty History of Portland Harbor" pamphlet by Edward Hawes (We can provide copies.)
A large, clear bowl
Long-handled spoon
Toy sailboat
Small film canisters with the name of each polluter on the outside and household ingredients for "pollutants" (listed next to each polluter) inside. One for each student, not including the one student who gets to have the sailboat.

Procedure
1. Before class, fill a large, clear container with water and place a long-handled spoon next to it. Display at front of the classroom.

2. Ask students if they can figure out what an "environmental historian" does. Explain that Edward Hawes is an environmental historian who traced Portland's pollution history from the factories and businesses that used to line the Bay. Much of their by-products

ended up in the sediments of Casco Bay. His detective work, as well as recent studies of pollution in Casco Bay, are the basis for this story.

3. Give every student a film canister. Explain that when his/her subject's name is read in the story, he/she will empty its contents into the bowl of water and stir.

4. Teacher reads the attached story, as students add the pollutants.

5. At the end of the story, ask students how they could prevent Casco Bay from becoming polluted. Point out that many of the old sources of pollution were industries and municipalities; more recent sources of pollution are primarily from residents and individuals.

6. Challenge students to read "The Dirty History of Portland Harbor" or historical information about other Casco Bay communities to identify more pollution sources.

7. Scoop out large materials and dispose of "polluted" water by pouring down the toilet. It's important to inform students that none of the ingredients that were actually used will harm the sewage treatment system.

Relevant Learning Results
SCIENCE & TECHNOLOGY
K. SCIENTIFIC REASONING
Students will learn to formulate and justify ideas and to make informed decisions.
Elementary Grades 3-4

- Draw conclusions about observations.
- Practice and apply simple logic, intuitive thinking, and brainstorming.

Middle Grades 5-8

- Construct logical arguments.

L. COMMUNICATION
Students will communicate effectively in the applications of science and technology.
Middle Grades 5-8

- Make and use scale drawings, maps, and three-dimensional models to represent real objects, find locations, and describe relationships.

M. IMPLICATIONS OF SCIENCE AND TECHNOLOGY
Students will understand the historical, social, economic, environmental, and ethical implications of science and technology.
Elementary Grades 3-4

- Explain practices for conservation in daily life, based on a recognition that renewable and non-renewable resources have limits.

Middle Grades 5-8

- Explain the connections between industry, natural resources, population, and economic development.

The Dirty History of Portland Harbor

INTRO.: The **Native Americans** who lived here called the region Aucosisco, believed to mean "place of the herons."

1. The **first European settlers** of Casco Bay built a dam across the falls at Stroudwater Crossing to harness water power. The mill ground grain to make flour and some got in the water. (Add flour) "FLOUR MILL"

2. In the 1800s a **tannery** in Back Cove used strong chemicals to tan horsehides to make leather. These chemicals, called arsenic and chromium, were dumped into Back Cove, part of the Harbor. (Yellow drink mix, coffee) "TANNERY"

3. A **paint factory** on Munjoy Hill used lead and mercury to manufacture paints. These too were dumped into the Harbor. (Orange drink mix) "PAINT FACTORY"

4. In the 1850s, a **foundry** on the Portland waterfront (now the site of the Narrow Gauge Railroad) poured cyanide, arsenic, metal particles, and powerful acids into the Harbor. Foundries are buildings where metals are cast. (Green drink mix) "FOUNDRY"

5. **Shipbuilders** in South Portland built and repaired boats starting in the 1850s. Paints used to cover the bottom of boats contained copper and lead. The waste from the paints washed into the Harbor. Later, especially during the 1940s when many ships were being built for World War II, many other toxics from shipbuilding were discarded into the Harbor. (yellow & red drink mix) "SHIPBUILDERS"

6. In the 1890s a new **sewer system** in Portland and South Portland carried sewage, or human waste, away from homes and factories and into the Harbor. (Brown sugar and toilet paper) "SEWER SYSTEM"

7. At first, **bacteria** in the mud could absorb and clean up the sewage. But after a while, there was too much sewage for the bacteria to handle all the waste. (Raisins or jimmies) "TOO MUCH WASTE!"

8. Soon the **fish** around the area started to die because they could not get enough oxygen from the water. (Goldfish crackers) "FISH"

9. In the 1900s, many **canneries** were built in both Portland and South Portland. There were several canneries at Spring Point in South Portland. These businesses canned fish, vegetables, and meat. Lead was used to solder, or fuse, the cans. This lead ended up in the Harbor. (Coffee) "CANNERIES"

10. Many **gas filling stations** also cropped up in both Portland and South Portland in the 1900s. Gasoline, containing many toxic chemicals, leaked from tanks into the groundwater, which flowed into the Harbor. These slow leaks may continue today. (Syrup) "GAS STATIONS"

11. (NOW PRESENT DAY) A **builder** began to clear land for new homes, and disturbed a lot of soil. When it rained, the soil washed into the Harbor, carrying with it nitrogen that made algae bloom. (Soil) "SOIL"

12. A **new homeowner** was cleaning out his garage. He wanted to get rid of some paint thinner. When no one was looking, he poured it down a storm drain! This storm drain led directly into the Harbor without getting cleaned first. (Vinegar) "PAINT THINNER"

13. One of his **neighbors** was very proud of her large lawn stretching down to the water's edge. She used fertilizers to make her lawn green. These chemicals washed into the Harbor. (Baking powder) "FERTIZLIER"

14. Next door, a **driver** was washing his new car, and the soap flowed down the street and into the Harbor. (Dish soap) "CAR SOAP"

15. Down the street, a **homeowner** did not pump her septic system for over 5 years. A septic system holds and distributes waste and wastewater from homes. If they are pumped regularly, they work properly. This septic system was not, and it got backed up and overflowed. The waste flowed into the Harbor. (Brown sugar and toilet paper) "SEPTIC SYSTEM"

16. A **driver** down the street changed the oil in her car and didn't know that she should dispose of it properly at a garage or the dump. Instead, she poured it down the storm drain, which flowed directly into the Harbor without getting cleaned first. (Syrup) "CAR OIL"

17. Another neighbor was a **gardener**, and was tired of bugs and other pests eating her vegetables and flowers. She used pesticides, or bug poison, to keep these critters from eating her plants. These chemicals also washed into the Harbor. (Red drink mix) "PESTICIDES"

18. A **tanker truck** tried to go around a corner too fast and flipped over, spilling its load of jet fuel into the Fore River in South Portland. (Coffee mixed with cooking oil) "JET FUEL"

19. A **tourist** was enjoying a meal on a hill by the Bay, when a gust of wind picked up his trash and carried it into the Harbor. (Bits of paper napkin) "TRASH"

20. A **smoker** flicked the remains of his cigarette into the street, where a rainstorm swept it down the storm drain. The storm drain led directly into the Harbor, and that's where the cigarette butt ended up. (Cut-up white straw, color one end red) "CIGARETTE"

21. A **dog owner** was walking his dog on the paths at Back Cove and didn't pick up his dog waste, which contains bacteria, parasites, and nutrients. When it rained, the dog poop washed into a storm drain, too. Do you remember where storm drains lead? (Raisins or jimmies) "DOG WASTE"

22. During a winter storm, a **plow truck** spread salt and sand on the roads to melt ice and prevent accidents. Some salt and sand washed down storm drains, and some off the road – most of it ended up in the Harbor. (Salt & sand) "SALT & SAND"

23. A **car** that needed repairs and had broken parts drove over a bridge. It leaked antifreeze onto the bridge and when it rained, this washed into the Harbor. (Purple drink mix) "ANTIFREEZE"

24. A **fisherman** was fishing on the Maine State Pier, next to the building with the whale paintings. Instead of throwing his fishing line away, he threw it into the harbor. (Fishing line) "FISHING LINE"

25. A **vacationer** was riding with his family in a powerboat, which has a holding tank for human waste. The tank should be emptied at a marina so the human waste can be disposed of properly. The vacationer didn't know this and dumped the waste right into Portland Harbor. One boat won't matter, right? (brown sugar and toilet paper) "HOLDING TANK"

END: A **sailor** was out on the Harbor and discovered that Portland Harbor didn't look clear and clean any more. "Who polluted the Harbor?" he cried. (Plastic sailboat)
The answer is, "We all did!"

Friends of Casco Bay's Casco Bay Curriculum

Environmental Issues
Activity #2 Casco Bay Watershed DRAFT

Background

We all live in a watershed. Most of the water pollution entering Casco Bay comes from activities in the watershed, from driving our cars to clearing land to fertilizing our lawns. Definition of watershed: A watershed is like a large funnel that carries the water that falls onto the land, buildings, and roads into a water body like Casco Bay. The water may flow along the surface in streams or rivulets or move underground, percolating through the soil or squeezing between cracks in rocks as *groundwater,* until it reaches the sea.

The Casco Bay watershed collects water from 53 towns all the way up to Bethel, Maine. A quarter of Maine's population lives in the Casco Bay watershed on only 3% of the State's land. Anything done on the land may eventually affect the Bay.

Learning objective

A watershed model illustrates that what people in students' communities do has an effect on Casco Bay (and on their own water supply).

Challenge: Make/Examine a model of your community to see where water pollution comes from and goes.

Materials

Maps of Casco Bay watershed and communities (www.mywatershed.com/cb.htm)
Funnel
Gravel
Water
Bowl
Clear acetate sheet
Erasable markers
Computer with Internet access
Illustration of a watershed (to be done)
Optional: CCS&WD watershed model
Optional: Topographic map

Procedure

1. Divide students into working groups for all activities.
2. Illustrate the definition of a watershed using a watershed model funnel partially filled with gravel, water, catch basin/bowl) (illustration).
3. Ask students to find out if their town and school is in the Casco Bay watershed by looking up Casco Bay Watershed in an Internet Search engine or go directly to www.mywatershed.com/cb.htm.
4. Challenge students to map the most direct route to Casco Bay from their town or school neighborhood. (Older students may follow lines of a contour map)
5. Discussion: Over two-thirds of the water pollution in Casco Bay has been attributed to non-point source pollution (also called polluted runoff), rather than point sources such as

sewage treatment plant discharges, factories, paper mills, oil spills, etc. Equate that statement to the famous Pogo comic strip declaration, “We have met the enemy and they is us.”

Extension: Consider the Source

Ask students to determine where their community's water supply comes from (i.e., reservoirs, wells, etc.). Repeat step # 3, only this time, have students trace a route from their neighborhood to their water supply. (Note: Water pollution also travels underground through groundwater to a water supply and to the sea.)

Relevant Learning Results

SCIENCE & TECHNOLOGY

B. ECOLOGY

Students will understand how living things depend on one another and on non-living aspects of the environment.

Middle Grades 5-8

- Describe various mechanisms found in the natural world for transporting living and non-living matter and the results of such movements.

L. COMMUNICATION

Students will communicate effectively in the applications of science and technology.

Elementary Grades 3-4

- Ask clarifying and extending questions.
- Reflect on work in science and technology using such activities as discussions, journals, and self-assessment.
- Function effectively in groups within various assigned roles (e.g., reader, recorder).

Middle Grades 5-8

- Make and use scale drawings, maps, and three-dimensional models to represent real objects, find locations, and describe relationships.
- Access information at remote sites using telecommunications.
- Identify and perform roles necessary to accomplish group tasks.

M. IMPLICATIONS OF SCIENCE AND TECHNOLOGY

Students will understand the historical, social, economic, environmental, and ethical implications of science and technology.

Elementary Grades 3-4

- Explain practices for conservation in daily life, based on a recognition that renewable and non-renewable resources have limits.

Middle Grades 5-8

- Describe an individual's biological and other impacts on an environmental system.
- Explain the connections between industry, natural resources, population, and economic development.

Friends of Casco Bay's Casco Bay Curriculum

Environmental Issues
Activity #3 Sleuth Out Pollution! DRAFT

Background
Issues to be addressed
What is polluted runoff?
What are sources of pollution in stormwater runoff? (pesticides & fertilizers, pet wastes, litter, oil & road salt, soil & sand, leaky septic systems, hazardous wastes, motor oil)

Learning objective
Students brainstorm a list of pollution sources from home and neighborhood. Then students investigate their own neighborhoods looking for pollution sources listed on their worksheet.

Challenge: Be a pollution detective.

Materials
Worksheet
Pencil
Clipboard, one for each pair
Optional: Photos of rainy day with stormwater runoff
Optional: Mason jar filled with cloudy water collected during a rainstorm.

Procedure
1. Ask students what the biggest cause of water pollution in Casco Bay is. Record guesses on the board.
2. Inform them that the biggest source, accounting for over two-thirds of all the water pollution in Casco Bay. It's *stormwater runoff*, the excess water that flows off lawns, roofs, parking lots, and streets during and after a storm. (If possible, show students a Mason jar filled with the stormwater runoff collected during an earlier storm.) Explain that stormwater picks up all sorts of materials, some visible, and some dissolved in the water, and carries it downhill until it ultimately reaches the Bay.
3. Ask students to consider the impact of stormwater runoff from one household vs. from a whole community. (cumulative impact of individual contributions to pollution can add up to a big impact)
4. Inform students that on the next rainy day they will become "pollution detectives," looking for evidence of stormwater pollution. Remind them to bring appropriate rain gear and boots or a change of shoes for walking in the rain.
5. Divide students into pairs, one observer, one recorder. Provide worksheet (below) and a clipboard to each pair to record their observations. Have them review the worksheet indoors and discuss where in the schoolyard might be the best place to observe stormwater runoff.
6. On a rainy day to go outside and look for pollution sources in the neighborhood around the school (or assign as homework if rain is forecasted).
7. Upon return to classroom, ask students what they found. Where did the pollution originate?

8. Ask students for ideas to stop the polluted runoff (i.e., plant grass, trees or shrubs, don't rake up pine needles, put down mulch, replace a straight path with a curved one, pick up after your dog)

Search for the evidence!

On a rainy day sleuth out actual or suspected sources of water pollution:

____ Dirty water flowing downhill toward a stream, gully, or other water body

____ A worn, straight path that leads toward a gully, road, or stream

____ A storm drain that is blocked by leaves and other debris

____ Bare ground where soil can wash away in the rain

____ Oil stain on a driveway or road that indicates oil or gas dripping

____ Pet droppings

____ Other evidence of stormwater pollution (_____)

Relevant Learning Results

SCIENCE & TECHNOLOGY

B. ECOLOGY

Students will understand how living things depend on one another and on non-living aspects of the environment.

Elementary Grades 3-4

- Investigate the connection between major living and nonliving components of a local ecosystem.

Middle Grades 5-8

- Describe various mechanisms found in the natural world for transporting living and non-living matter and the results of such movements.

J. INQUIRY AND PROBLEM SOLVING

Students will apply inquiry and problem-solving approaches in science and technology.

Elementary Grades 3-4

- Conduct scientific investigations: make observations, collect and analyze data, and do experiments.

K. SCIENTIFIC REASONING

Students will learn to formulate and justify ideas and to make informed decisions.

Elementary Grades 3-4

- Draw conclusions about observations.
- Practice and apply simple logic, intuitive thinking, and brainstorming.

L. COMMUNICATION

Students will communicate effectively in the applications of science and technology.

Elementary Grades 3-4

- Record results of experiments or activities (e.g., interviews, discussions, field work) and summarize and communicate what they have learned.
- Ask clarifying and extending questions.
- Reflect on work in science and technology using such activities as discussions, journals, and self-assessment.
- Function effectively in groups within various assigned roles (e.g., reader, recorder).

Middle Grades 5-8

- Identify and perform roles necessary to accomplish group tasks.

Friends of Casco Bay's Casco Bay Curriculum

Environmental Issues
Activity # 4 Soil Pollution DRAFT

Background
Most people don't think of soil as a source of water pollution, but it is. Phosphorus and nitrogen are found naturally in soil; they are also ingredients in lawn fertilizers. When soil is eroded from lawns and dirt roads these nutrients (the same as those found in commercial fertilizers) can flow into water bodies. There, they do just what they do on land—promote the growth of green plants.

When phosphorus enters a pond or other freshwater body, it may trigger an algae bloom, a population explosion of tiny aquatic plants. In salt water, nitrogen is the essential ingredient that promotes an algae bloom. Algal blooms can kill fish, turn the water murky, make rocks slippery, and give drinking water an unpleasant taste and odor. When it rains hard, the water droplets explode as they hit the ground, propelling soil particles and the phosphorus and nitrogen attached to them great distances.

Learning objective
Students construct splash cards to identify areas around the schoolyard (or their own backyards) where soil runoff is happening.

Challenge: Find out where soil pollution is happening.

Materials
5-6 Popsicle sticks or wooden skewers (used for grilling) per team of 2-3 students each
White 3"x5" index cards
Permanent marker
Ruler
Stapler
Clipboards
Paper and pencils
Computers with Internet access

Procedure

1. This activity is best done in a soaking rain. Check the weather report for a storm forecast, as the splash card "sampling materials" for this activity must be in place before it starts to rain.

2. Staple white index cards to the top half of Popsicle sticks or poke wooden skewers through the top and bottom of the index cards so that there are 3-4 inches of stick protruding below the bottom of the cards. Place the index cards so that the bases of the cards are in the same position on all sticks.

3. Use a permanent marker to make a line two inches from the bottom of the stick.

4. Distribute 5 or 6 cards to each team.

5. Explain the potential impact of soil washing into our waterways (See Background.)

6. Instruct students that they will insert the sticks into the ground down to the two-inch line at several locations around the yard—bare soil, under trees, at the edge of driveway, etc.

7. Return after a rainstorm and survey the state of the index cards around the yard.

8. Have students note on clipboards the location of the index cards that were most coated with mud. When it rains hard, the water droplets explode as they hit the ground, propelling soil particles and the phosphorus and nitrogen attached to them great distances. The areas of concern are where the splash cards are most muddied.

9. Back in the classroom, discuss why those areas with the muddiest index cards are ones that need attention to prevent soil runoff. Why was soil exposed in those areas? Was the soil disturbed by construction? Worn away by foot or car traffic?

10. Using information gathered in the "Watershed" and "Sleuth Out Pollution" activities, identify the closest water body(ies) where the eroded soil could end up. Freshwater or salt water or both?

11. Discuss how to prevent soil erosion. Assign various websites for students to research to find ideas, such as, plant grass or shrubs, add berms, replace straight paths with winding paths, fence off worn areas and create new pathways using gravel or lattice, place bales of hay around construction sites, create rain gardens, etc.

Resources include:

EPA's website on Polluted Runoff http://www.epa.gov/owow/nps/

Maine Department of Environmental Protection Non-point source pollution webpage; http://www.maine.gov/dep/blwq/doceducation/nps/index.htm

Casco Bay Estuary Project: Stormwater
http://www.cascobay.usm.maine.edu/storm.html

If students do not have computer access, use brochures on stormwater and protecting watersheds from the Maine Department of Environmental Protection, CCS&WD, etc.

Relevant Learning Results

SCIENCE & TECHNOLOGY

J. INQUIRY AND PROBLEM SOLVING

Students will apply inquiry and problem-solving approaches in science and technology.

Elementary Grades 3-4

- Make accurate observations using appropriate tools and units of measure.
- Conduct scientific investigations: make observations, collect and analyze data, and do experiments.
- Use results in a purposeful way: design fair tests, make predictions based on observed patterns, and interpret data to make further predictions.

Middle Grades 5-8

- Design and conduct scientific investigations that include controlled experiments and systematic observations. Collect and analyze data, and draw conclusions fairly.

K. SCIENTIFIC REASONING

Students will learn to formulate and justify ideas and to make informed decisions.

Elementary Grades 3-4

- Draw conclusions about observations.
- Practice and apply simple logic, intuitive thinking, and brainstorming.

Middle Grades 5-8

- Construct logical arguments.

L. COMMUNICATION

Students will communicate effectively in the applications of science and technology.

Elementary Grades 3-4

- Record results of experiments or activities (e.g., interviews, discussions, field work) and summarize and communicate what they have learned.
- Ask clarifying and extending questions.

Middle Grades 5-8

- Access information at remote sites using telecommunications.

MATHEMATICS

F. MEASUREMENT

Students will understand and demonstrate measurement skills.

Elementary Grades 3-4

- Select measuring tools and units of measurement that are appropriate for what is being measured.

J. MATHEMATICAL REASONING

Students will understand and apply concepts of mathematical reasoning.

Elementary Grades 3-4

- Demonstrate an understanding that support for a claim should be based on evidence of various types (e.g., from logical processes, from measurement, or from observation and experimentation).

Activity # 5 Storm Drain Stenciling **DRAFT**

Background
Many communities have sanitary sewer systems with underground pipes that carry sewage from bathrooms, sinks, and kitchens to a wastewater treatment plant. The water that flows off the streets may flow down into storm drains and empty directly into Casco Bay. When it rains, however, stormwater runoff from the street and sewage from homes and businesses may mix when the combined volume of water may be too great for the sewage treatment plant to handle. The water may be diverted to overflow pipes, called Combined Sewer Overflows (CSOs), and is discharged untreated directly into the Bay.

When people pour hazardous wastes, such as household cleaners, unused paint, paint thinner, used oil, and lawn care chemicals, down a storm drain, they don't realize that they are dumping pollutants directly into the Bay. Even if they reached the sewage treatment facility, the treatment process may not be able to remove the hazardous components. These chemicals can harm marine life, encourage the growth of algae blooms, and make the water unsafe for swimming or harvesting shellfish.

One way to address this problem is to reduce runoff during a storm by diverting water from roofs or parking lots and by slowing the flow of water over lawns by planting bushes or building retention ponds or "rain gardens."

Learning objective
Students are able to answer questions:
What are storm drains?
What does storm water carry besides rainwater or snowmelt?
Where does the water go?

Challenge: Teach your community not to dump into storm drains.

Materials
"Drains to Casco Bay" stencils (available from one's community or contact FOCB)
Safety vests or bright T-shirts
Cans of bright colored spray paint
Safety cones
Whisk brooms
Wire brushes
Rubber gloves
Safety goggles
Cameras
Plastic trash bags
Rags/paper towels
Map of storm drain locations
Local watershed map with streams, rivers, wetlands, and coast

Signed permission slips
Computer with access to Internet

Procedure

1. Before starting this activity, contact the town's public works department or local highway department to request permission to stencil storm drains and to request maps of storm drain locations. Ask what kind of paint should be used. If possible, borrow traffic cones and safety vests from them.
   The City of South Portland, for example, stencils the community's storm drains every time a city worker cleans out a storm drain of leaves and other accumulated debris that may block water flow. The stencil sends a conservation message to residents and also lets the city staff know that the drain was recently serviced.
2. Download the public service announcement (PSA) that has appeared on local television: "If stormwater pollution were rubber duckies" from the Internet. (Transcript is below.) Go to http://www.ocwatersheds.com and click on Public Education/Other materials.

   Transcript: *If stormwater pollution was a rubber duckie it wouldn't matter what went down the drain. But it does. Because stormwater pollution is not rubber duckies. It is trash, oil, cigarette butts and pet waste going untreated to the sea. That's not good for any of us because we all live downstream. Clean water. It means quality of life.*
3. As students watch the video, have them record what kinds of pollution are carried in stormwater runoff. (Examples of stormwater runoff may include litter, oil, antifreeze, paint, leaves, grass clippings, pesticides, sediments from construction sites, cigarette butts, pet waste, etc.) If they have a hard time deciding if something is harmful, explain that nothing should go down a storm drain that you wouldn't swim in or drink!
4. Explain that these harmful kinds of pollution are washed into storm drains, and in turn, into local bodies of water. Explain how combined sewer overflows work (See Background above. See Illustration at http://www.nyc.gov/html/dep/html/watersewer.html). Often, people don't understand the connection between what they may dump into storm drains and the resulting water pollution that could affect their drinking water supply, fishing hole, and swimming beaches.
5. Ask students how they could educate neighbors about how to prevent stormwater pollution. (Possible responses: write a brochure, stencil storm drains in town, create a public service announcement like "rubber duckies.")
6. Examine the watershed map and the storm drain map to find suitable locations to stencil (if available).
7. Choose a day when the weather has been dry. Pavement needs to be dry and the temperature should be at least 50^{o}F so paint will dry. Do the project on a day with no wind so paint doesn't drift or splatter on parked cars.
8. Divide students into teams and have them decide who will do various tasks such as, clean site, hold the stencil, spray paint, watch for traffic, take photos, and answer questions from passers-by.
9. Arrange traffic cones around drains.
10. Clean area with a broom and wire brush to remove loose dirt.
11. Lay the stencil on the sidewalk, street, or manhole cover. Orient so it can be easily read by pedestrians.

12. One or two people can hold the stencil flat while one person holds the spray can of paint 6 to 8 inches from the stencil. Use a back and forth motion to spray until stencil is uniformly covered. Don't use too much paint or it will run under the stencil and smear.
13. When painting is done, carefully peel the stencil off the surface.
14. Mark the storm drain on your map as you complete each stencil.
15. When completely done, lay the stencil flat inside a large plastic garbage bag and allow it to dry overnight.
16. Bring a copy of your map to town officials so they know which drains have been stenciled.

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Relevant Learning Results

SCIENCE & TECHNOLOGY

B. ECOLOGY

Students will understand how living things depend on one another and on non-living aspects of the environment.

Middle Grades 5-8

- Analyze how the finite resources in an ecosystem limit the types and populations of organisms within it.
- Describe various mechanisms found in the natural world for transporting living and non-living matter and the results of such movements.

L. COMMUNICATION

Students will communicate effectively in the applications of science and technology.

Elementary Grades 3-4

- Gather and effectively present information, using a variety of media including computers (e.g., spreadsheets, word processing, programming, graphics, modeling).
- Function effectively in groups within various assigned roles (e.g., reader, recorder).

Middle Grades 5-8

- Make and use scale drawings, maps, and three-dimensional models to represent real objects, find locations, and describe relationships.
- Access information at remote sites using telecommunications.
- Identify and perform roles necessary to accomplish group tasks.

M. IMPLICATIONS OF SCIENCE AND TECHNOLOGY

Students will understand the historical, social, economic, environmental, and ethical implications of science and technology.

Elementary Grades 3-4

- Explore how technology (e.g., transportation, irrigation) has altered human settlement.
- Explain practices for conservation in daily life, based on a recognition that renewable and non-renewable resources have limits.

Middle Grades 5-8

- Describe an individual's biological and other impacts on an environmental system.
- Give examples of actions that may have expected or unexpected consequences that may be positive, negative, or both.
- Explain the connections between industry, natural resources, population, and economic development.

Activity #6 Keeping Water from Running Away DRAFT

Background
Vegetated areas can act like a sponge, trapping surface water runoff and giving it time to soak into the ground where it is needed. Where there is little vegetation water escapes, eroding away exposed soil and transporting pollutants. See what surfaces hold water best.

Polluted runoff (also called non-point source pollution) accounts for two-thirds of all water pollution in the Casco Bay region. Polluted runoff includes oil and gas from streets and driveways, dirt, fertilizers, and pesticides from yards, pet waste. It is one source of water pollution that most people can prevent. Sprawl creates more large lawns and more paved surfaces, which do not absorb water runoff as well as natural areas do.

Canopies of various heights from trees to shrubs to ground cover soften the impact of heavy rains. Under these plants, leaves, needles, and other natural debris (all of which is termed *duff*) help prevent erosion, keep roots moist, and decompose into nutrient-rich soil.

Learning objective
Grass is not as effective as trees, shrubs, ivy, and natural ground cover in reducing stormwater runoff. Students see that natural areas vs. manicured lawns absorb stormwater runoff and the pollutants it contains.

Challenge: Find the best natural sponge in your yard.

Materials
Five gallon or half-gallon milk cartons (Make sure each group has same size container.)
Water
Watches with second hands (one for each group)
(Graph paper and pencils)

Procedure
1. Ask students to help you locate examples of these surfaces around the schoolyard or neighborhood. They should be within sight of each other:

Grassy area
Pavement
Duff: the leaves, pine needles, and other plant materials found beneath a stand of trees
Compacted dirt, as next to a driveway or playground
Bare soil

2. Divide the students into five groups and assign one surface to each group.

3. Have each group fill its milk carton to the brim with water from an outside spigot.

4. Send them to the different substrates and, at your signal, have them pour out all the water at once and time how long it takes the water to disappear.

5. Return to the classroom to graph and discuss the results. On a graph, one axis is for substrates, the other is for time it took water to disappear into the substrate.

6. Have students present their graphs to the class.
Were they surprised at their findings?
Did they see any evidence of erosion or disturbing the habitat as their water disappeared?
What surface absorbed water best?

7. From the students' findings, deduce ways to minimize stormwater runoff from one's yard.

Relevant Learning Results

SCIENCE & TECHNOLOGY

B. ECOLOGY

Students will understand how living things depend on one another and on non-living aspects of the environment.

Elementary Grades 3-4

- Investigate the connection between major living and nonliving components of a local ecosystem.

Middle Grades 5-8

- Describe various mechanisms found in the natural world for transporting living and non-living matter and the results of such movements.

J. INQUIRY AND PROBLEM SOLVING

Students will apply inquiry and problem-solving approaches in science and technology.

Elementary Grades 3-4

- Conduct scientific investigations: make observations, collect and analyze data, and do experiments.
- Use results in a purposeful way: design fair tests, make predictions based on observed patterns, and interpret data to make further predictions.

K. SCIENTIFIC REASONING

Students will learn to formulate and justify ideas and to make informed decisions.

Elementary Grades 3-4

- Draw conclusions about observations.
- Use various types of evidence (e.g., logical, quantitative) to support a claim.
- Practice and apply simple logic, intuitive thinking, and brainstorming.

Middle Grades 5-8

- Construct logical arguments.

L. COMMUNICATION

Students will communicate effectively in the applications of science and technology.

Elementary Grades 3-4

- Record results of experiments or activities (e.g., interviews, discussions, field work) and summarize and communicate what they have learned.
- Ask clarifying and extending questions.
- Reflect on work in science and technology using such activities as discussions, journals, and self-assessment.
- Make and/or use sketches, tables, graphs, physical representations, and manipulatives to explain procedures and ideas.

M. IMPLICATIONS OF SCIENCE AND TECHNOLOGY

Students will understand the historical, social, economic, environmental, and ethical implications of science and technology.

Elementary Grades 3-4

- Explain practices for conservation in daily life, based on a recognition that renewable and non-renewable resources have limits.

MATHEMATICS

C. DATA ANALYSIS AND STATISTICS

Students will understand and apply concepts of data analysis.

Elementary Grades 3-4

- Make generalizations and draw conclusions using various types of graphs, charts, and tables.
- Read and interpret displays of data.

Middle Grades 5-8

- Construct inferences and convincing arguments based on data.

F. MEASUREMENT

Students will understand and demonstrate measurement skills.

Elementary Grades 3-4

- Solve and justify solutions to real-life problems involving the measurement of time, length, area, perimeter, weight, temperature, mass, capacity, and volume.
- Select measuring tools and units of measurement that are appropriate for what is being measured.

Middle Grades 5-8

- Demonstrate the structure and use of systems of measurement.

G. PATTERNS, RELATIONS, FUNCTIONS

Students will understand that mathematics is the science of patterns, relationships, and functions.

Middle Grades 5-8

- Describe and represent relationships with tables, graphs, and equations.

J. MATHEMATICAL REASONING

Students will understand and apply concepts of mathematical reasoning.

Elementary Grades 3-4

- Demonstrate an understanding that support for a claim should be based on evidence of various types (e.g., from logical processes, from measurement, or from observation and experimentation).

Middle Grades 5-8

- Support reasoning by using models, known facts, properties, and relationships.

K. MATHEMATICAL COMMUNICATION

Students will reflect upon and clarify their understanding of mathematical ideas and relationships.

Elementary Grades 3-4

- Use simple tables and graphs to communicate ideas and information in presentations in a concise and clear manner.

Middle Grades 5-8

- Use statistics, tables, and graphs to communicate ideas and information in convincing presentations and analyze presentations of others for bias or deceptive presentation.

Activity # 7 Design Your Perfect Yard DRAFT

Background

Our idea of the "perfect yard" grew from our ancestors' appreciation of the manicured lawns of English estates. Large expanses of grass require large investments of fertilizers, pesticides, and maintenance.

Edwin Beard Budding invented the lawnmower in 1830. Soon Americans became obsessed with lawns. By 1870, thanks to promotion by landscape architects, the detached home with a manicured lawn was the standard to which homeowners aspired. (Source: *New York Times*, "A Thousand Years of House & Home," December 30, 1999) Today, Americans spend about $7 billion a year on lawn care equipment and supplies.

Learning objective

By thinking about how we actually use our outdoor living space, students might design their yards to reflect how we really use them, and create a yard that requires less lawn, less maintenance, and is more environmental to boot.

Challenge

Design your own ideal yard.

Materials

Unlined paper or large-scale graph paper
Colored pencils
Photos of different kinds of yards, especially from different cultures, which can be found on the Internet or in Home & Garden magazines. Try to locate examples of English estates (our heritage), Japanese gardens, desert or xerotrophic yards, forested area, wildflower fields, rock gardens, paved playground, water garden, etc.

Procedure

1. Ask students to guess what invention helped to shape the character of the American suburbs. Then ask, "How has the lawnmower changed our lives? What would our yards look like without it?' Share background information.

2. Show the photos of different kinds of yards to the students and ask for their comments on
   - Which they like best
   - Which they think uses least amount of chemicals to maintain
   - Which uses least amount of water
   - Which takes the least amount of work to maintain
   - Which prevents runoff /holds water
   - Which has the least amount of grass

3. Ask them to consider

How would you like to use your yard?

Who else would you like to use it? (Wild animals, birds, insects. friends, pets, etc.)
In what ways could you make your yard better for the environment? (prevent stormwater runoff, buffer plantings to hold soil, no bare ground, less grass, etc.)

4. If students will be using graph paper to make their yard maps, the teacher may want to explain how to make a scale drawing:
    - Architects, landscape designers, home decorators, and others make renderings or scale drawings of areas they are creating or redesigning.
    - Demonstrate how to use a pace (one step) to measure distance approximately. According to the dictionary, a pace, or one step, represents 30 inches, or for estimation purposes, 3 feet. (The students can measure and see if this is accurate for their steps.) Have a few students (perhaps one boy, one girl) pace off the dimensions of the classroom (length and width).
    - Have all students, working in pairs, count off grids on their graph paper to represent the dimensions of the classroom. Show scale, symbols on maps and have students create their own symbols to represent classroom features such as, desks, chairs, walls, windows, and doors.

5. Send students home to make a rough map of their yards (or map the schoolyard). They may want to pace off the length and width of the property. Direct them to sketch in the approximate location of buildings, large trees or shrubs, patios, driveways, paths, fences, and property lines.

6. Ask students what features they would add/delete to make their yard more environmentally-friendly and more kid-friendly. Are they the same features?

7. Have them trace the permanent features from their map such as, lot lines and buildings, onto another piece of paper. Have them draw their ideal landscapes on this map.

8. Discuss one highlight from each landscape. Highlight yards that minimize grass, as they require fewer chemicals to maintain them (fertilizers and pesticides); yards that have many trees or bushes, as these help to prevent stormwater runoff.

Extension: Literature
Read excerpts from *The Secret Garden* by Frances Hodgson Burnett to the class, or have students read scenes from the play aloud. Discuss how a special piece of land can be a refuge and an outlet for creativity.

Design Your Perfect Yard
Relevant Learning Results
SCIENCE & TECHNOLOGY
B. ECOLOGY
Students will understand how living things depend on one another and on non-living aspects of the environment.
Elementary Grades 3-4

- Investigate the connection between major living and nonliving components of a local ecosystem.

Middle Grades 5-8

- Analyze how the finite resources in an ecosystem limit the types and populations of organisms within it.
- Describe various mechanisms found in the natural world for transporting living and non-living matter and the results of such movements.

L. COMMUNICATION
Students will communicate effectively in the applications of science and technology.
Elementary Grades 3-4

- Ask clarifying and extending questions.
- Reflect on work in science and technology using such activities as discussions, journals, and self-assessment.
- Make and/or use sketches, tables, graphs, physical representations, and manipulatives to explain procedures and ideas.
- Function effectively in groups within various assigned roles (e.g., reader, recorder).

Middle Grades 5-8

- Make and use scale drawings, maps, and three-dimensional models to represent real objects, find locations, and describe relationships.
- Access information at remote sites using telecommunications.
- Identify and perform roles necessary to accomplish group tasks.

M. IMPLICATIONS OF SCIENCE AND TECHNOLOGY
Students will understand the historical, social, economic, environmental, and ethical implications of science and technology.
Elementary Grades 3-4

- Explain practices for conservation in daily life, based on a recognition that renewable and non-renewable resources have limits.

Middle Grades 5-8

- Describe the historical and cultural conditions at the time of an invention or discovery, and analyze the societal impacts of that invention.
- Describe an individual's biological and other impacts on an environmental system.
- Give examples of actions that may have expected or unexpected consequences that may be positive, negative, or both.
- Explain the connections between industry, natural resources, population, and economic development.

MATHEMATICS
K. MATHEMATICAL COMMUNICATION
Students will reflect upon and clarify their understanding of mathematical ideas and relationships.
Elementary Grades 3-4

- Use simple tables and graphs to communicate ideas and information in presentations in a concise and clear manner.

Middle Grades 5-8

- Use statistics, tables, and graphs to communicate ideas and information in convincing presentations and analyze presentations of others for bias or deceptive presentation.

SOCIAL STUDIES
GEOGRAPHY
A. Skills and Tools
Students will know how to construct and interpret maps and use globes and other geographic tools to locate and derive information about people, places, regions, and environments.

Activity # 8 Keep Your Butts Out of the Bay! DRAFT

Background
The website, http://www.cigarettelitter.org**,** poses the question, "What happens after that butt gets casually flicked onto the street, nature trail, or beach? Typically, wind and rain carry the cigarette into the water supply, where the toxic chemicals the cigarette filter was designed to trap leak out into aquatic ecosystems, threatening the quality of the water and many aquatic life forms. Cigarette butts may seem small, but with several trillion butts littered every year, the toxic chemicals add up!" "[Cigarette butts] also present a threat to wildlife. Cigarette filters have been found in the stomachs of fish, birds, whales and other marine creatures that mistake them for food ... Composed of cellulose acetate, a form of plastic, cigarette butts can persist in the environment as long as other forms of plastic." (Clean Virginia Waterways)

Each fall, Coastweek celebrates Maine's links to the sea, featuring public events, nature walks, boat tours, and community service opportunities such as the Coastal Cleanup. Volunteers of all ages meet at a specified coastal site, pick up trash, and record the type and amount of debris found. Not only does the coast get tidied up, but the data reported helps coastal managers pinpoint the sources of marine debris and begin to devise solutions.

Learning objective: Students will learn how cigarette debris comprises the most common form of coastal pollution, and how it impacts our health and the environment's.

Challenge: Find a way to eliminate the most common form of coastal pollution.

Materials
Drawing paper
Colored pencils, markers
Computer with Internet access
Maine Coastal Cleanup data (provided, also find on the Web through
www.coastalcleanup.org The Ocean Conservancy International Coastal Cleanup/Past Cleanups/Maine
www.maine.gov/spo/mcp ME Coastal Program, Click on Quick Links: Coastweek, Maine

Procedure
1. Ask students what they think is the most common pollutant collected during Coastal Cleanup.
2. Have students examine the results of the Maine Coastal Cleanup to find/confirm the answer. (cigarette butts and other smoking materials accounted for o*ne-third* of all the debris items collected—more than 100,000 of them)
3. Discuss what some possible impacts of discarded cigarette butts and other smoking products (such as, cigarette lighters, tobacco wrappers, cigar tips) could be on the ocean. (Responses may include: looks ugly, toxics released into water, mistakenly eaten by marine animals, etc.)
4. Invite the students to design a public service project:
    a. Design a product that provides an alternative to disposing of cigarette butts instead of by simply flicking them on the ground. Before students begin designing their inventions, brainstorm what properties it ought to have, such as, fireproof, convenient, eye-level, eye-catching, etc. For inspiration, go to http://www.cigarettelitter.org, "Products."

b. Design a bumper sticker that helps to address the problem of disposing of cigarette butts. Discuss the message that you want to convey and then discuss how to do it with few words, pictures, and/or statistics.
c. Design a message that could be inserted on the packaging of a cigarette pack, using a combination of words, pictures, and/or statistics.

5. Discuss what kinds of motivations or incentives might persuade smokers to change their behavior of tossing cigarette butts on the ground (reward, such as money for each recycled butt like bottle deposits to promote recycling, punishment, such as embarrassment, tax to pay for clean up, legislation, etc.)

Extension: Take the Cigarette Litter Quiz!

Go to www.cigarettelitter.org and click on Quiz in the lefthand column.

Relevant Learning Results

SCIENCE & TECHNOLOGY

J. INQUIRY AND PROBLEM SOLVING Students will apply inquiry and problem-solving approaches.

Elementary Grades 3-4

- Conduct scientific investigations: make observations, collect and analyze data, and do experiments.
- Use results in a purposeful way: design fair tests, make predictions based on observed patterns, and interpret data to make further predictions.

Middle Grades 5-8

- Design and conduct scientific investigations that include controlled experiments and systematic observations. Collect and analyze data, and draw conclusions fairly.
- Verify and evaluate scientific investigations and use the results in a purposeful way

K. SCIENTIFIC REASONING Students learn to formulate and justify ideas and make informed decisions.

Elementary Grades 3-4

- Draw conclusions about observations.
- Practice and apply simple logic, intuitive thinking, and brainstorming.

Middle Grades 5-8

- Construct logical arguments.

L. COMMUNICATION Students will communicate effectively in applications of science & technology.

Elementary Grades 3-4

- Ask clarifying and extending questions.
- Reflect on work in science and technology using such activities as discussions, journals, and self-assessment.
- Make and/or use sketches, tables, graphs, physical representations, and manipulatives to explain procedures and ideas.

Middle Grades 5-8

- Discuss scientific and technological ideas and make conjectures and convincing arguments.
- Defend problem-solving strategies and solutions.
- Access information at remote sites using telecommunications.

M. IMPLICATIONS OF SCIENCE AND TECHNOLOGY

Students will understand the historical, social, economic, environmental, and ethical implications

Middle Grades 5-8

- Give examples of actions that may have expected or unexpected consequences.

MATHEMATICS

C. DATA ANALYSIS AND STATISTICS Students will understand and apply concepts of data analysis.

Elementary Grades 3-4

- Make generalizations and draw conclusions using various types of graphs, charts, and tables.
- Read and interpret displays of data.

Middle Grades 5-8

- Construct inferences and convincing arguments based on data.

K. MATHEMATICAL COMMUNICATION Students clarify understanding of mathematical ideas & relationships.
Elementary Grades 3-4

- Use simple tables and graphs to communicate ideas and information in presentations in a concise and clear manner.

Middle Grades 5-8

- Use statistics, tables, and graphs to communicate ideas and information in convincing presentations and analyze presentations of others for bias or deceptive presentation.

Activity # 9 Sewage: Testing the Beaches for Bacteria DRAFT

Background

Wastewater from almost every sink, tub, and toilet flows from smaller pipes to larger sewer mains, typically three to five feet in diameter. Here it combines with runoff from rainstorms, as well as all the debris and chemicals that wash off the street or are poured into storm drains. In dry weather the wastewater is transported to a treatment plant, where it is treated before being discharged to a water body. The wastewater flows to the plant mostly by gravity, but it is assisted in spots by pumps.

During periods of heavy rainfall, the combined sewage volume quickly exceeds the carrying capacity of the sewage system and overwhelms the treatment plants. In order to keep sewage from backing up in the system – where it could spurt through manhole covers or backflood into homes and businesses, a combined sewer overflow (CSO) diverts and discharges excess wastewater—untreated—directly into Portland Harbor. CSO pipes carry both stormwater runoff and untreated sewage from homes and businesses directly into the Bay. (adapted from Riverkeeper.org)

Some communities in Casco Bay test their swimming beaches for sewage pollution, for example, Willard Beach in South Portland and East End Beach in Portland. Twice a week (or more) throughout the summer, lifeguards sample for waterborne bacteria found in human sewage and sometimes found in stormwater runoff. They test for *Enterococcus* bacteria, itself harmless, which occurs with other bacteria that can cause illnesses. If the bacterial count is found to be high Most of this bacteria comes from Combined Sewer Overflows (CSOs). Friends of Casco Bay has been working with these and other municipalities to encourage them to remove or upgrade their CSOs.

At Willard Beach, a yellow warning flag is posted on the beach after a heavy rain, even before testing results are known. A red flag indicates that water quality testing has found unacceptable levels of bacteria. A useful rule of thumb is to avoid swimming in areas near stormwater pipes the day after a rain storm.

More and more communities are testing their beaches for bacterial pollution. In 2003, the Natural Resources Defense Council reported that the US experienced 18,000 days of beach closings and advisories because of poor water quality. Almost nine-tenths were because of high bacteria levels. That represents a 50% increase over 2002. More beach closings may be a good thing, in that we are identifying the problem rather than assuming "C'mon in, the water's fine." Better yet would be if more frequent monitoring found that our beaches really are getting cleaner!

For more information on the science of testing beaches for bacterial pollution, go to http://mainehealthybeaches.org/science.html.

Learning objective
Students interpret data from beach testing at Willard Beach, South Portland, and the National Weather Service records to learn about the link between stormwater runoff and the health of their beaches.

Challenge: Determine when it's too dangerous to go into the water (and it's not because of sharks!).

Materials

Data sheets from Willard Beach for 2000, 2001, 2002, 2003 (provided)

Yellow highlighters

Computer with Internet access

Weather Service monthly weather records for Portland, Maine (Access from NWS website for 2000, 2001, 2002. http://www.erh.noaa.gov/er/gyx/index.php.

Also simplified, printed copies are provided for 2002, 2003, 2004)

Procedure

1. Ask students how many go swimming in the ocean. What do they worry about it before entering the water, if anything? How many people worry about sewage pollution?
2. Explain the water testing programs carried out by the lifeguards/rangers at two area beaches. Note that they only test between Memorial Day and Labor Day, the duration of the "beach season" in Maine.
3. High levels of bacteria often occur soon after a rainstorm because of stormwater runoff from combined sewer overflows. Have students review the data and highlight days when the count is above 100 colonies in 100 milliters (ML) of water.
4. Try to determine if these high readings occurred around the times of rainstorms by matching the dates of high bacteria readings with National Weather Service records. (Use data sheets provided or go to http://www.erh.noaa.gov/er/gyx/index.php, The Gray, Maine, National Weather Service forecast Office; click on links on the left side of the page for "Climate-ME and NH," then "Daily high/low temperature and precipitation statistics for major and cooperative ME & NH," "Monthly Climate Statistics," "Pwm" (Portland). Select relevant months, as August 2002 for Portland.
5. Look for dates with high bacteria readings in the test results from Portland and South Portland. Did high bacterial readings correspond to days with precipitation?
   If not, brainstorm other possible causes (such as, sewage treatment plant broken down, a ship in the harbor dumping sewage, etc.).
6. Discuss why it is wise to avoid swimming after a heavy rainstorm.
7. Have students make up signs that inform the public about when they should not swim at local beaches.
8. Go to the City of South Portland's website to learn what the community is doing to reduce stormwater pollution and what residents can do to help: www.southportland.org, link to City Departments, Water Resource Protection, Stormwater Runoff.

Extension: Check it out

A website dedicated to Maine's healthy beaches: http://mainehealthybeaches.org/ provides information about statewide beach testing programs. Does your community have such a program? If not, this website explains how to get one started.

Relevant Learning Results

SCIENCE & TECHNOLOGY

B. ECOLOGY

Students will understand how living things depend on one another and on non-living aspects of the environment.

Elementary Grades 3-4

- Investigate the connection between major living and nonliving components of a local ecosystem.

Middle Grades 5-8

- Describe various mechanisms found in the natural world for transporting living and non-living matter and the results of such movements.

L. COMMUNICATION

Students will communicate effectively in the applications of science and technology.

Elementary Grades 3-4

- Ask clarifying and extending questions.
- Make and/or use sketches, tables, graphs, physical representations, and manipulatives to explain procedures and ideas.
- Function effectively in groups within various assigned roles (e.g., reader, recorder).

Middle Grades 5-8

- Access information at remote sites using telecommunications.
- Identify and perform roles necessary to accomplish group tasks.

M. IMPLICATIONS OF SCIENCE AND TECHNOLOGY

Students will understand the historical, social, economic, environmental, and ethical implications of science and technology.

Elementary Grades 3-4

- Explain practices for conservation in daily life, based on a recognition that renewable and non-renewable resources have limits.

Middle Grades 5-8

- Describe an individual's biological and other impacts on an environmental system.
- Give examples of actions that may have expected or unexpected consequences that may be positive, negative, or both.
- Explain the connections between industry, natural resources, population, and economic development.

MATHEMATICS

C. DATA ANALYSIS AND STATISTICS

Students will understand and apply concepts of data analysis.

Elementary Grades 3-4

- Make generalizations and draw conclusions using various types of graphs, charts, and tables.
- Read and interpret displays of data.

Middle Grades 5-8

- Construct inferences and convincing arguments based on data.

F. MEASUREMENT

Students will understand and demonstrate measurement skills.

Elementary Grades 3-4

- Solve and justify solutions to real-life problems involving the measurement of time, length, area, perimeter, weight, temperature, mass, capacity, and volume.
- Select measuring tools and units of measurement that are appropriate for what is being measured.

MIDDLE GRADES 5-8

- Construct inferences and convincing arguments based on data.
- Organize and analyze data using mean, median, mode, and range.

Activity # 10 Oil Spill Cleanup: The *Julie N* DRAFT

Background: The *Julie N* Oil Spill

About 700 commercial ships a year, most of them oil tankers, visit Portland Harbor. In 2002, 28,263,167 tons of oil came into Portland Harbor, making it the second largest oil port on the East Coast. Oil spills can have a devastating impact on animals, humans, and the environment, which is why Casco Bay communities, businesses, government agencies, and environmental groups have instituted strong oil spill prevention and clean-up procedures.

Despite careful planning, disasters still happen. On the morning of September 27, 1996, the *Julie N*, carrying 8.8 million gallons of oil, tried to pass through the old Casco Bay Bridge, with less than 10 feet of clearance between the two sides of the drawbridge. A fateful command by the ship's pilot to turn to port, quickly corrected to starboard, caused the vessel to strike the bridge. The collision ripped a hole 15 feet high and 30 feet long in the ship's hull below the waterline. Eventually, the ship lost nearly 180,00 gallons of oil: the largest spill in Portland's history.

This accident set into motion an oil spill response that engaged more than 700 persons in recovering 140,994 gallons of the 179,634 gallons that leaked from the damaged ship. The vessel was quickly surrounded with booms. Skimmers vacuumed up the boomed oil, which was several inches thick, into collection barges. Absorbent pads, like high-tech diapers, soaked up some of the spill. (In some spills, not the *Julie N*, dispersants are poured on top of the oil to act like detergents to break it down into tiny droplets that can be gobbled up by oil-eating bacteria.)

Designated boat washing areas, where all the oil washed from the blackened hulls could be collected, were set up to clean the contaminated boats. In the end, 114 boats were hauled out and scrubbed clean, fishing was banned for a time in the Fore River and out to Great Diamond Island, and 13.7 miles of shoreline were affected--half of them, the Coast Guard said, "heavily oiled." Eight miles of marshes, especially those in Portland's Stroudwater area and Thompson Point, were oiled; the best thing action there, scientists concluded, was to do nothing, "to let them recover naturally." 1,679 birds were seen with oil on their feathers, and 27 birds, mostly cormorants and gulls, were killed.

Typically, only 10 to15% of the spilled oil is recovered; the recovery rate for the *Julie N* spill was 78%, attributable to the rapid response and training of nearly 60 volunteer organizations, spill response contractors, and state, federal, and local agencies. Despite the excellent recovery rate, approximately 38,618 gallons of oil were lost to the environment. The collision released both #2 home heating oil, a light, highly refined petroleum product, and #4 oil, a heavy fuel oil used to power the tanker. Each posed unique threats to the environment. The #2 diesel fuel evaporates quickly but also disperses rapidly throughout the water column. The heavier oil, though less toxic, persists for a long time, creating a "bath-tub ring" of black oil around everything it touches, including boats, birds, mud flats, and salt marshes. Number 2 fuel oil poisons marine life, and the heavy oil coats shorebirds, smothers bottom dwellers, and contaminates the sediment.

Friends of Casco Bay (FOCB) surveyed the Bay for environmental damage and harm to wildlife and provided vessel support to response agencies. Working with state and private entities, FOCB staff coordinated volunteers to assist with rehabbing oiled birds. Staff assisted the state in gathering clam and mussel samples at threatened clam flats. FOCB collected sediment samples for testing and ensured that damaged sites received adequate post-spill biological monitoring.

Learning Objective
Students will discover what methods are used to clean up an oil spill for the *Julie N* and for other spills, appreciate how difficult it is, and discuss its impacts on marine and bird life.

Challenge How can you clean up an oil spill?

Materials
News stories, websites about *Julie N* spill, such as,
http://www.csc.noaa.gov/products/maine/html/oilcase.htm
Reference materials on cleaning up oil spills
Aluminum or glass pans (one for every team) or ½ gallon plastic milk jugs cut in half lengthwise
Refrigerated salt water (1 teaspoon salt per gallon of water)
Container for waste water
Cotton balls
Wood chips/straw
Plastic cups
Absorbent pads
Sponges
Paper towels
Spoons
Cooking oil or motor oil (if there are disposal facilities for used motor oil)
String
Detergent
Eyedropper
Paper, pencils

Procedure
1. Discuss the *Julie N* spill that occurred in 1996 when the oil tanker ran into the old Casco Bay bridge ("The Million Dollar Bridge"), with less than 10 feet of clearance through the drawbridge. (A tanker is typically 80-90 feet wide.) Provide resources through newspaper archives or web search.

2. Demonstrate how oil floats on water. Add oil to a clear jar ¾ filled with water and blue food coloring. Shake and watch how the oil and water separate. Explain that over time the water and oil tend to mix somewhat so that some of the oil (which is heavier than this cooking oil) will sink to the bottom of the ocean. Discuss what would happen to flounders, clams, lobsters, and other bottom dwellers.

3. For each team, fill a large pan/half of milk jug with cold salt water. Add a mound of sand to simulate a sandy shoreline to one end, then add 1 (or more) tablespoon of cooking oil to simulate a spill.

4. Let each team of three to four students choose two or three different clean-up materials to test and decide how they will use each material. Have students record effectiveness of materials tested.

5. Discuss how their efforts corresponded to techniques used to clean up the *Julie N* and other actual oil spills. Discuss what kinds of equipment actual oil spill clean-up personnel use (such as oil containment booms, skimmers, dispersants, oil absorbing materials, etc.) and how similar they are to items the students used. Use reference materials on cleaning up oil spills.

6. What can we as consumers do to reduce the risk of oil spills? (Use less energy, use fewer oil-based products, require oil tankers to have double-hulls)

7. Discuss what ports can do to prevent and/or quickly clean up spills. Portland has an oil spill readiness plan in place, Coast Guard conducts practice drills, oil spill booms are stationed in trailers at strategic locations around the Bay so they can be pulled around sensitive habitats like salt marshes quickly, volunteers have been trained to clean oiled birds, oil companies have strict safety and environmental requirements for any visiting tankers.)

Extension: Oil from other sources

Oil tanker accidents spill about 37 million gallons of oil into the ocean every year. Much more oil enters the ocean (363 million gallons) from industrial waste and automobiles. When people pour used motor oil into the ground or into a septic system, it eventually becomes run-off that empties into the ocean. Discuss how we could prevent these "everyday spill."

Friends of Casco Bay's Casco Bay Curriculum
Environmental Issues

Activity # 11 Oil Spills and Birds DRAFT

Background

The intertidal zones and coastal areas that are the habitat for fish, birds, and other wildlife are often the most vulnerable to oil spills. Birds may perish when oil coats and clumps their downy feathers, decreasing the surface area so they are no longer insulated from the cold water. They ingest the oil when they attempt to preen their feathers, then become sick or die.

How hard is it to save an oiled bird? Many factors affect the success of any rescue effort, such as the time birds spend in the wild before being captured and how many are brought in at once. Depending on the severity of the oil spill, rescuers have returned 13% to 100% to the wild.

Rescuers must first stabilize an oiled bird before they try to clean it. Even if a bird has only a small amount of oil on its body, it will preen incessantly to try to realign its feathers. It will stop eating, become dehydrated, and become susceptible to hypothermia, in which its body temperature drops dangerously low. A bird can quickly become emaciated and anemic, so rescuers first try to make the bird comfortable, treat or protect it from sores, and give it water and food. Until the bird is relatively healthy, they do not stress it further by repeatedly washing and rinsing, and, finally, drying it.

During the *Julie N* spill in Portland in 1996, FOCB volunteers staffed a hotline for people reporting oiled wildlife. 1,679 birds were seen with oil on their feathers, and 27 birds, mostly cormorants and gulls, were killed. Within the first few days after the spill, a temporary Wildlife Rehabilitation Center set up near the spill treated 18 birds. Biologist Deborah Anderson said, "The good news it the timing of the spill, the location of the spill, and weather conditions generally worked to minimize damage to wildlife. Late September is a relatively quiet time for birds in Casco Bay, because the first pulse of migration for wading birds and shorebirds is ending, and the second pulse of migration for waterfowl has not hit its peak, and large rafts of wintering birds such as black ducks, have not yet arrived." John Kenney of the Maine Dept. of Inland Fisheries and Wildlife trains volunteers to clean oiled birds and staffs a 24-hour hotline for reporting oiled wildlife.

Learning Objective

Students will discover how to clean an oiled bird by trying to clean a feather and by taking a quiz about how rehabilitation centers treat oiled birds.

Challenge How can you clean an oiled bird?

Materials

Vegetable oil
Containers of water
Paper
Pencils
Dawn dishwashing liquid
Feathers, two for each group

Blow dryer
Hand lenses, one for each group
Activated charcoal
Ensure
Pedialyte

Procedure
1. Before class, fill several pans with water and add vegetable oil to their surfaces.
2. Ask students to discuss the impact of an oil spill on wildlife. (Examples include oil seeps into eggs and kills them, suffocation of fish by oil coating gills, damage to feathers or fur, animals die from swallowing toxic oil)
3. Give each team two feathers and ask them to submerge one in the water for a few minutes.
4. Have the students use a hand lens in order to draw the structure of each feather.
5. Give the students a clean bowl of water and few drops of Dawn dishwashing liquid. They may change the water as often as needed until they the feather is clean and rinsed thoroughly.
6. After they have succeeded in removing the oil from the feather as best they could, have them blow-dry the feather.
7. Have the students use a hand lens in order to draw the structure of the cleaned and dried feather. Compare it to the unoiled feather and their previous illustrations.
8. Ask the students to take the quiz about oiled wildlife. They are encouraged to discuss the answers in their teams. (All the answers are True, except for # 3 & #8.)

Oiled Wildlife Quiz: Are these statements *True* or *False*?

1. A bird's feathers provide buoyancy, insulation, and waterproofing.

2. The interlocking structure of a bird's feather, not the oil it applies to its feathers, is primarily what makes it waterproof.

3. Humans have a higher body temperature than birds.

4. Birds do not have sweat glands. Instead they pant like dogs do to release excess heat.

5. After an oil spill, 95-99% of the oiled animals brought in for treatment are birds.

6. A spot of oil the size of a dime can kill a bird.

7. Gulls most often become oiled by feeding or scavenging on other oiled birds.

8. You should wash an oiled bird as soon as it arrives at a rehabilitation facility.

9. Activated charcoal, Pedialyte, and Ensure are fed to oiled birds to help them regain their strength.

10. Dawn dishwashing liquid is most often used to wash oiled wildlife.

11. There is 24-hour hotline in Maine for reporting oiled wildlife: 1-877-OIL-BIRD.

Friends of Casco Bay's Casco Bay Curriculum
Environmental Issues

Activity # 12 Removing Dams: Opening up the Presumpscot River

DRAFT

Background

The Presumpscot River drops 270 vertical feet over its 25-mile length between Sebago Lake and its outlet into Casco Bay in Falmouth. At one time, it had at least 12 natural falls, and its name means "many falls." Today, 8 dams still restrict its flow.

The Smelt Hill Dam was the first hydroelectric plant built in Maine, in 1889. Before then, the first paper mill and saw mill were built on the site in 1735. Removal of this dam in the fall of 2002 re-opened a seven-mile stretch of river, restoring habitat for fish species that had once populated the river in great numbers, such as striped bass, Atlantic salmon, alewife, blueback herring, American eel, smelt, and shad.

Dams and other tidal restrictions, such as dikes, culverts, and causeways, reduce the estuary habitat, impede the flow of freshwater into the estuary, turn salt marshes into freshwater marshes, and block the movement of migratory fish. Anadromous fish, like salmon and alewives, are born in freshwater streams and then migrate to the open sea. When they mature and are ready to spawn, they return to freshwater streams of their birth. Catadromous fish, such as the American eel, go in the opposite direction: they are born in the ocean and spend their time as juveniles in fresh water. Dams, even those with fish ladders (small "steps" that fish can leap over), inhibit the movement of these fish.

Procedure

1. Locate the Presumpscot River on a map of the Casco Bay region.
2. Ask students why dams are built.
3. Go to the Internet to learn why the Smelt Hill Dam and several other dams on the Presumpscot River were constructed.
4. Discuss with students how a dam in a river may harm marine life. (Restricts migratory fish passage, holds back nutrients and fresh water from the Bay, changes salt water habitat to freshwater habitat)
5. The Smelt Hill Dam was removed in October 2002. Challenge the students to find out how the section of the Presumpscot River from the dam site to the mouth of the river has changed since then. See the Friends of the Presumpscot River website: http://www.presumpscotriver.org. Students can view a map of the river that shows the location of the other dams. A classroom poster with extensive information about the history and biology of the river, *Presumpscot River: A River in Time, a Gift to the Future*, is available for a small donation from Friends of the Presumpscot River, P.O. Box 223, South Windham, Maine 04082. See also the website of the Presumpscot River Watch: http://www.prw-maine.org.

Extension: Adopt-A-Salmon Family
Have the class engage in the National Fish & Wildlife Service program of incubating and hatching salmon eggs and then releasing baby salmon.
FMI:http://www.megalink.net/~lakes/salmon.html.

APPENDIX C
Casco Bay Curriculum Workshop Agenda

AGENDA

Casco Bay Curriculum Workshop ~ May 5, 2006

The workshop will run from 8:30 a.m. – 2:30 p.m., with two 15 minutes breaks at approximately 10:00 a.m. and 1:00 p.m. and a 30 minute break at 11:30 a.m. (lunch).

1. Introductions & background of attendees and facilitators

2. Activity: Lobster Trivial Pursuit
   Activity description: Students learn about different adaptations and features of lobsters through an interactive game.

3. Overview of Casco Bay Curriculum. Review new stormwater education regulations as mandated by the Clean Water Act, and how these relate to teachers.

4. Review of Casco Bay USGS Maps & US Maps for estuary locations

5. Activity: Attitudes Then & Now
   Activity description: Students read and discuss a children's book written in 1957 and compare attitudes about "swamps" and estuaries to today's point of view.

6. Activity: What is an Estuary Good For?
   Activity description: Students use props such as a coffee filter, strainer, cereal box, etc. to discover the many uses of estuaries.

7. Review the leading environmental threats to Casco Bay and its watershed, including stormwater and nonpoint source pollution.

8. Activity: The Dirty History of Casco Bay
   Activity description: As the teacher reads a story about pollutants from the past and present that impact the Bay, students add each "pollutant" as it is mentioned into a clear container of water.

9. Discussion: Using other subject matters to reinforce environmental education

11. Outdoor Activity: Keeping Water from Running Away
    Activity description: Students see that natural areas versus manicured lawns absorb stormwater runoff differently.

12. Discussion: Service Learning Opportunities & how they fit in with Casco Bay Curriculum

13. Activity: Oil Spill Cleanup: The *Julie N*

Activity description: Students attempt to clean up an "oil" spill and learn about the Julie N *tanker spill in South Portland.*

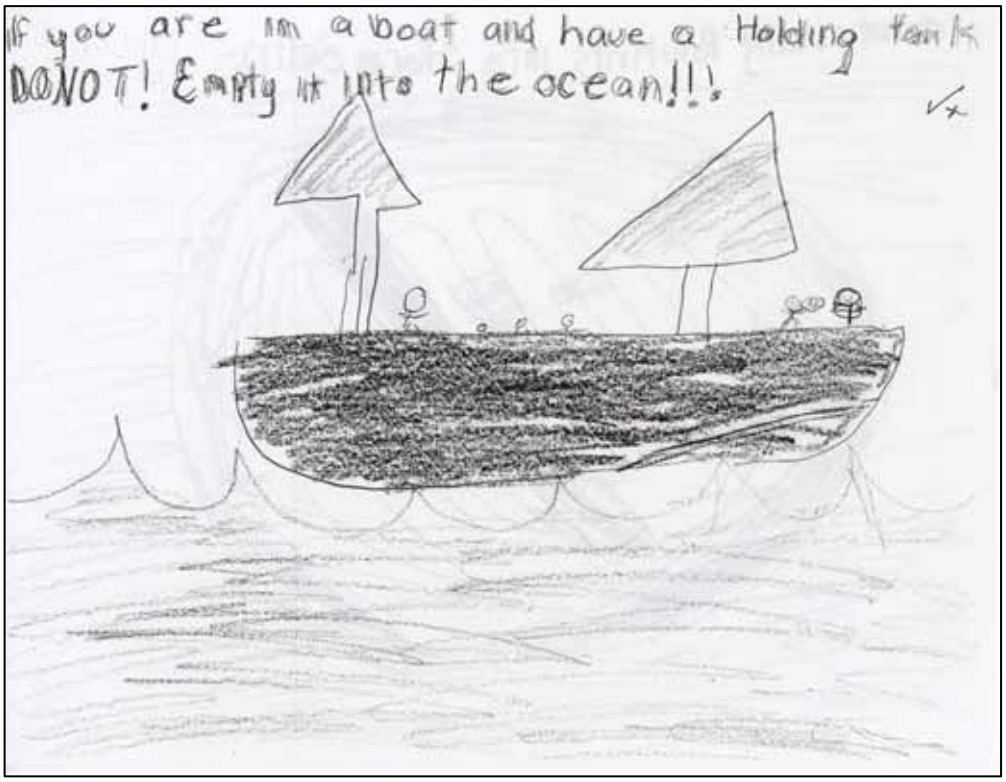
14. Activity: Keep Your Butts out of the Bay!
    Activity description: Students learn about the impact of the item most commonly found in beach cleanups.

15. Wrap up: Questions, Comments, Complete evaluations & CEU forms

APPENDIX D
Evaluations from Workshop Participants

(Hard copies mailed to grant administrator)

APPENDIX E
Program Outcomes: Sample of Student Projects




do not putany Polutints inte storm drains
Olivia
Indorf

Care for Casco Bay!
Keep it clean!

Believe it or not you can prevent water pollution. In the 1700's - to early 1900's a pollution called Point Source Pollution is what was polluting the harbor. Point Source Pollution is when you know what company is polluting a source of water and you point at them until they stop. But today we are polluting Casco Bay. Together we can stop water pollution in Casco Bay.

By: Emma K. Jane Brown School So. Portland

and a fence so the poop doesn't go into the water.

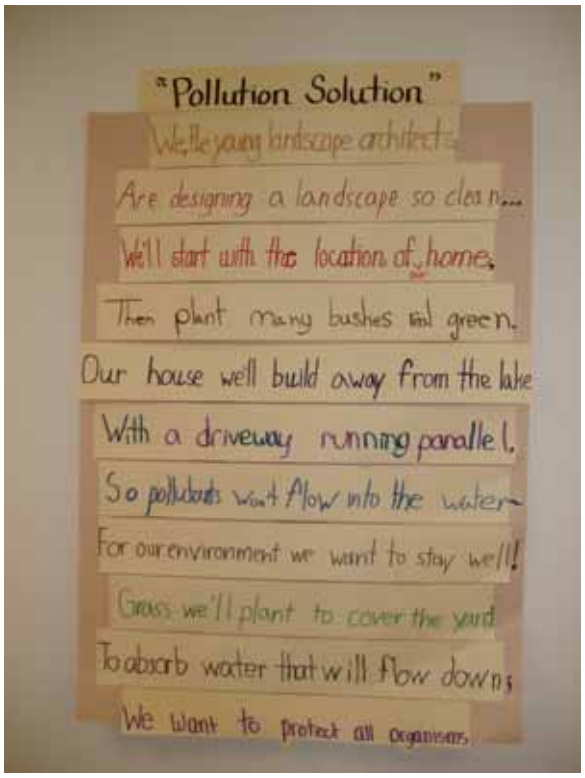
Ms. Plummer 2/15/06
Visit #5.

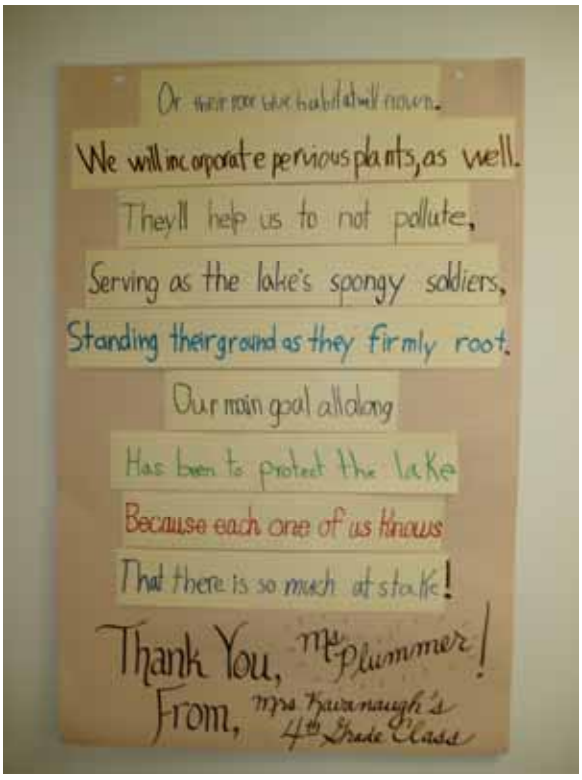
Impervious Surfaces
- car - telephone pole?
- trailer - door
- window - parking lot
- building - driveways
- telephone wire

Buffer: A vegetational wall that keeps soil from getting into the lake/river/ocean and polluting it.

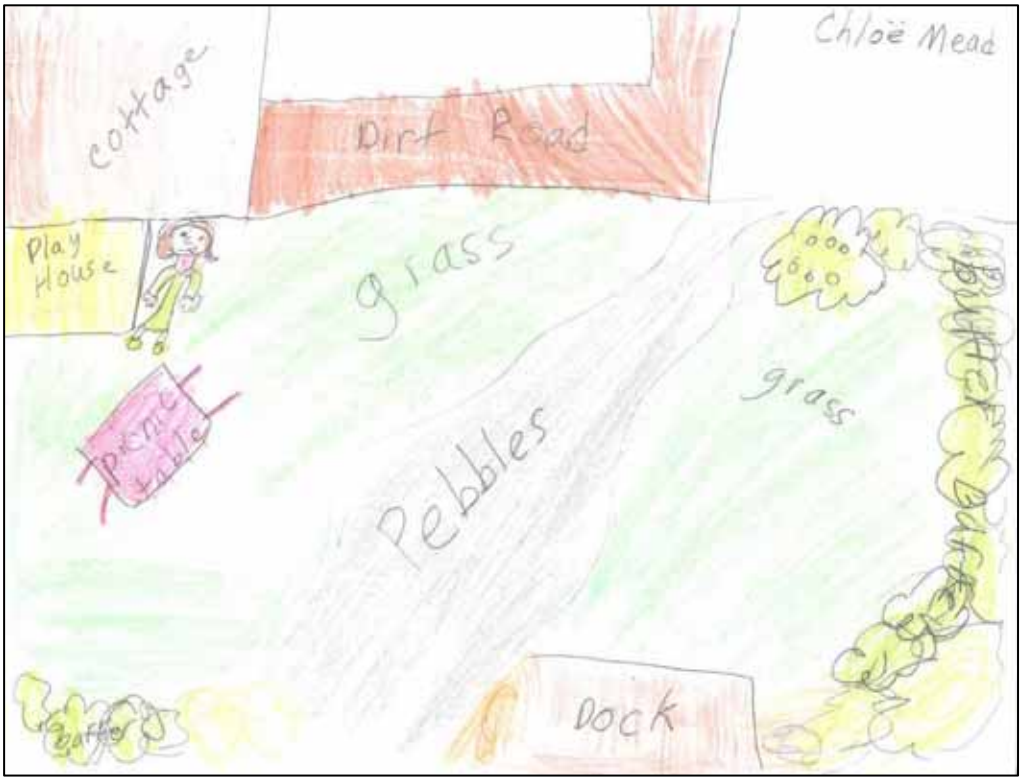
If you have a cat, dog or any outdoor animal and you live by a lake/river/ocean you should have a buffer

BY: CLARA K. ELLIS


"Pollution Solution"
We're young landscape architects
Are designing a landscape so clean...
We'll start with the location of homes,
Then plant many bushes and green.
Our house we'll build away from the lake
With a driveway running parallel.
So pollutants won't flow into the water
For our environment we want to stay well!
Grass we'll plant to cover the yard
To absorb water that will flow down,
We want to protect all organisms


We will incorporate pervious plants, as well.
They'll help us to not pollute,
Serving as the lake's spongy soldiers,
Standing their ground as they firmly root.
Our main goal all along
Has been to protect the lake
Because each one of us knows
That there is so much at stake!
Thank You, Mrs. Plummer!
From, Mrs. Kavanaugh's 4th Grade Class

(These two drawings were created after a lesson about designing a landscape with vegetated buffers)




driveway
car
garage
tree
basket ball court
grass
plants
well
grass
cottage
stone wall
tree
grass
grass
walkway
tree
plants
tree
table
plants

Levey Day School
400 Deering AVE
Portland ME 04103

Dear Sarah,

It was so fun when you came and we did the thing when we polluted the mini-boulevard.

I learned many different things. I never knew how much people polluted all the water resources. I also didn't know that a long time ago people just put their poop in the ocean and I didn't know that throwing dirt into the water was bad for the fish and the plants.

I hope you come back next year.

Thank you for coming.

Sincerely,
Sam Steinbock

Lily B.

Levey Day School
400 Deering Ave.
Portland, ME 04103

Dear Sarah Plummer, May 15, 2006

Dear Sarah Plummer,

Thank you for coming and spending your time with us. I really enjoy how you make learning fun, and visual. I learned a lot.

I learned that lots of things pollute water like flour and fishing line; That our actions every day help and destroy the enviroment-well, some of them anyway.

I hope you can teach us again in the future. I would love that but too bad I'll be gone next year. I wish you could come back this year but oh well. I had lots of fun with you anyway.

Sincerely,

Lily Bruenjes

Lily Bruenjes

Levey Day School
400 Deering Ave
Portland, ME 04103

May 5, 2006

Dear Sarah Plummer,

I enjoyed your visit alot, Thank you so much for coming. I learned alot, and had tons of fun along with the 2nd, 3rd, and 4th grades.

Some of the stuff that I learned includes;
1. How much pollution people make.
2. How far back pollution goes.
3. How much pollution is in the Portland Harbor, and more.

Thank you again.

Sincerely,
Kobi Davidson

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Follow-Up Activity to "The Dirty History of Portland Harbor"
The Study of Land & Water

1-26-06

Last week you all had the opportunity to discover who polluted our neighboring Casco Bay. You became actively involved with the story of "The Dirty History of Portland Harbor" that was written by the Environmental Historian, Edward Hawes, by actually "dumping" a particular "pollutant" into our precious "bay" (your film canister).

Now it's time for you to reflect back on this activity and think about what you learned from it. Please respond carefully and thoughtfully to the following questions and activities. Take a look at the expectations for answering these questions.

Expectations:

- Quality handwriting, drawing & coloring
- Complete sentence answers (no phrases or just words)
- Appropriate punctuation, capitalization, grammar & spelling
- Responses that demonstrate understanding and critical thinking skills

1) Name **at least three** pollutants that have historically been dumped into Portland's Harbor, causing it and the living things within it harm and damage.

Trash, Pesticides, and human waste.

2) Did the first European settlers of Casco Bay know the effects of the flour that their mill released into the Stroudwater River many years ago? **Explain your answer.**

NO, Because I would think if they knew they would at least try to prevent it.

3) True or False:

a) Fish have died as a result of not being able to get enough carbon dioxide from the water due to the pollution in their natural habitat. True

b) Chemicals like arsenic, chromium and lead have been dumped into the Harbor in the past. True

c) Algae blooms when nitrogen-rich soil is washed into the Harbor. (False)

d) Car oil can safely be poured into storm drains. False

e) People should wash their vehicles in their driveways instead of on their lawns, to help prevent pollution of our water. False

4) If one group of vacationers decides to empty their powerboat's holding tank for human waste into Portland Harbor, will it really matter since it's just one boat? **Explain your answer.**

Yes, because it does not matter if it is only 1 power boat because each person may have gone more than once, and that's a lot of waste that can Pollute our Casco Bay!

5) At the end of the story a sailor out on the Harbor discovered that it didn't look so clear and clean to him anymore. In fact, it looked pretty dirty and polluted. **Who** ~~polluted the Harbor?~~

WE DID! Yes!

6) What is the **number one cause** of pollution to our planet's water supply?

The #1 cause of Pollution is ... SOIL!

7) **True or False**: Individuals, not just factories and cities, contribute to a great deal of the pollution to Casco Bay. True

8) ***Fill in the blanks***: During a heavy rain storm, combined sewer overflows carry both raw waste from houses and businesses and stormwater drains from streets and parking lots directly to Casco Bay!

9) **Describe 3 specific ways** that you and your family can avoid contributing to the pollution of Casco Bay…

1. If I drop trash I will pick it up.
2. I will ask my mom to wash her car on the lawn instead of the drive way.
3. I will never put Pesticides on any of my fruits or vegetables.

(10) **Create** a **drawing with color** and **detail** in the space below that illustrates ***one of the specific ways*** you described in question #9 that will prevent pollution of our water.