

A Scientific Cleanup

VIRGINIA SOL

Science BIO.9

Social studies WG.7, GOVT.1

Language arts 10.1, 10.2, 10.11

Technology C/T12.2, C/T12.3, C/T12.4

OBJECTIVES

- Discuss problems associated with aquatic debris
- Identify testable questions relating to litter distribution at a local water site
- Design an experiment to investigate litter distribution at the site
- Make predictions of litter distribution at site
- Participate in a cleanup at the site
- Compile data on litter collected
- Analyze data and make conclusions relating to litter at the cleanup site
- Make conclusions relating litter to the local ecosystem as well as human health and safety
- Communicate findings from investigation
- Recommend actions for remediation and pollution prevention

MATERIALS

- Large-scale map of cleanup area
- Large garbage bags for collecting litter
- Gloves
- Bucket for sharp items
- Scissors to cut fishing line
- Digital camera to record cleanup
- First aid kit
- Copies of Cleanup Checklist for Students and Cleanup Data Card
- Clipboards and pencils

SAFETY & REGULATIONS

See Cleanup Checklist for Students, and also the guidelines under Planning a Safe Trip in the Introduction section of this packet.

TIME NEEDED

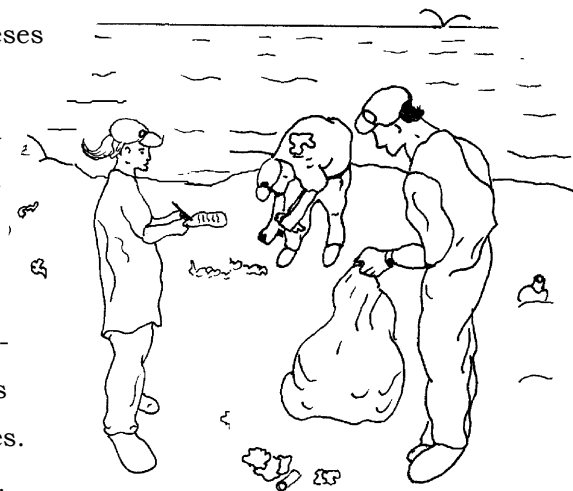
This lesson will involve a field trip to participate in a cleanup. In addition, up to two class periods could be used before the trip. Another period will be needed after the trip.

What can we learn by analyzing litter collected from our local site?

This lesson is intended for tenth-grade Biology students. The target Virginia Science SOL is BIO.9, which deals with dynamic equilibria within populations, communities, and ecosystems. Specifically, this lesson is directed primarily at BIO.9d, the effects of natural events and human influences on ecosystems, and BIO.9e, the complexity of the Chesapeake Bay and its watershed. While the lesson focuses on a beach cleanup along the Chesapeake Bay or Atlantic Ocean, it can be easily modified for cleanups along rivers, streams and lakes.

In addition to science content, this lesson focuses on teaching students the science process skills listed in the SOL for tenth-grade Biology. General goals listed in the Biology SOL include forming questions and answering questions by experiments, carrying out research to validate or challenge ideas, and designing experimental tests. More specific objectives for students include the following:

- Forming hypotheses based on direct observations and information from the literature.
- Defining variables and designing investigations to test hypotheses.
- Forming conclusions based on data.
- Constructing and defending a scientific viewpoint.



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Ideas for this lesson were taken from the different resources listed at the end of the lesson. The activity “A Scientific Beach Clean-up” by Save Our Seas was one major source of ideas.

Human influences on ecosystems...

Different forms of water pollution include litter and debris, sediment, sewage, oil, toxic chemicals, and fertilizer or pesticide runoff. Litter and debris is one pollution form that students can directly affect through participating in a cleanup campaign. Cleaning up aquatic debris gives students a direct and positive role in protecting our aquatic habitats and land-use areas. Participating in cleaning an area can help the students realize that solving water pollution problems requires everyone's involvement. Participating in a cleanup activity can also lead to a student's development of an environmental ethic and heightened commitment to preserve water quality, beauty, and wildlife.

The complexity of the Chesapeake Bay and its watershed...

The Chesapeake Bay receives tons of litter every year, accidentally or deliberately dropped from boats and ships, and originating from the land. This creates many problems for humans and animals. Small terrestrial animals living by the Bay are affected by entanglement in and ingestion of litter, as are fish, birds, and sea turtles. Wildlife is also affected when aquatic habitats are damaged or smothered by debris. Some litter, such as paper or wooden material, gradually degrades by biological,

chemical and physical processes. However, other litter is non-degradable. Plastics are a particular problem because they can take more than 400 years to degrade, and they are also light enough to stay floating in the water instead of sinking and becoming buried.

LESSON INTRODUCTION

Discussing problems associated with aquatic debris...

Discuss with the students some problems associated with litter and aquatic debris. Ask students about different water sites they are familiar with, including ocean beaches, lakeside beaches, and banks of rivers and streams. Ask students what they like to do at these sites and what they have seen other people doing. Activities will include playing and relaxing, swimming, fishing, canoeing, and using larger boats. Also ask students to think about animals that live in or around the water. Both humans and other animals depend on the water being litter-free and unpolluted. Ask students to name examples of what they consider to be litter, and what kinds of litter they have seen around water sites. Ask the students how they think these kinds of litter can create problems.

Identifying testable questions relating to litter distribution at a water site...

Before students begin planning any details of their experimental cleanup, the cleanup site should be determined. You might ask about local opportunities for your students to volunteer in a conservation cleanup project. Several

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groups organize volunteer cleanups in Virginia, and are happy to include school groups. The Ocean Conservancy coordinates the International Coastal Cleanup throughout the world. In Virginia, the International Coastal Cleanup is coordinated each September and October by Clean Virginia Waterways (www.longwood.edu/cleanva). Spring cleanups include the James River Regional Cleanup organized by the James River Advisory Council and the Clean the Bay Day organized by the Chesapeake Bay Foundation. Contact information for these cleanups is provided at the end of this lesson. Details of other cleanup groups, along with contact information, are also provided in the Litter and Debris in Our Waterways chapter earlier in this curriculum packet. You may also choose to carry out your own cleanup at any public beach that is sand or gravel and known to collect litter. State and local parks often have streams and rivers in need of a cleanup. Be sure to ask permission to conduct the cleanup if the area is maintained by any management organization. A park or beach manager may also be able to provide you with cleanup supplies and arrange for collection of trash after the cleanup.

Have students work in small groups to identify possible testable questions for the class to study. The four-question strategy can be used to help groups identify questions, as described in the Designing an Experiment chapter earlier in this section. After each group of students has identified a possible question, the class will need to decide which they will study. They

could vote on this, but you must make sure they choose a “doable” question. Students are likely to choose a question relating different locations on the beach to the amount of debris collected. Different areas on the beach could include open water areas, areas influenced by a river, and areas influenced by a dock or harbor. Students also can look at high tide, mid tide and low tide parts of the beach. A large-scale map of the beach can be used to assign different areas for different groups of students. Groups of students can walk “transects” on different areas of the beach, and different groups of students covering similar areas of the beach will represent replications in the experiment or “repeated trials.” The amount of debris collected by each group of students will be recorded on the Cleanup Data Card. Most likely, the amount of debris will be recorded as number of items. It also could be recorded as estimated weight. Students can be assigned to carry out background research on their chosen question. This could be done using computers in class time at school, or students could be asked to do their research as an out-of-class assignment.

ACTIVITY PROCEDURES

Designing an experiment to investigate litter distribution...

Have students create an experimental design diagram to summarize the plans for their experiment. (See the Designing an Experiment chapter earlier in this section for information on experimental design diagrams.) Students

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should begin by defining the independent and dependent variables for their experiment. The best way to generate repeated trials will be for several groups of students to work on the same kind of beach area. Each group will represent one trial. Each group of students should make their own prediction about the litter distribution at the site. The prediction should be in the form of a hypothesis, based on past experiences as well as information they have found in their background research.

INLAND SOURCES OF MARINE DEBRIS

According to the U.S. Environmental Protection Agency, land-based sources cause 80% of the marine debris found on our beaches and in our oceans. In addition to litter on our streets, other land-based sources include landfills, ill-maintained garbage bins and trash that is illegally dumped in or near water bodies. Data collected by The Ocean Conservancy indicate that the debris items most frequently found on our nation's beaches and waterways are related to fast-food consumption (i.e., bottles, cans, cups, plates, food containers, straws, etc.) and smoking activities (i.e., cigarette filters and other litter such as disposable lighters). Some people illegally dump tires, car parts, old refrigerators, construction waste, and other trash into our rivers and bays.

MARINE DEBRIS FROM BOATS

While in the past it was common practice for boaters to dispose of shipboard garbage by simply throwing it overboard, this is illegal now due to federal laws and international agreements. Fishing vessels may be responsible for plastic netting, rope, and a variety of kitchen garbage such as cottage cheese containers, ice cream cartons, etc. Large freighters may be responsible for such items as strapping bands, plastic pellets, and kitchen garbage.

Participating in a cleanup...

Follow all your normal school procedures for taking students on a field trip. It is a good idea to plan time for the students to enjoy the beach area while they are there for the cleanup. You might have them bring lunches and have a picnic. In advance of the cleanup, brief the students on materials to bring and safety precautions. You may use the Cleanup Checklist for Students sheet at the end of this lesson in addition to general information in the Introduction section on Planning a Safe Trip.

Help the students translate their experimental design into a working plan at the site. Depending on the exact nature of the experiment, students may need help measuring off distances along the beach or stream. At the cleanup site, make sure each group of students has large garbage bags and copies of the Cleanup Data Card from the end of this

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lesson. The students should have one bag for recyclables (clean aluminum cans and glass bottles, and plastic bottles marked “1” or “2” on the bottom) and another bag for non-recyclable litter items. Sharp items, such as broken glass, should be put into a bucket or box, and not in the trash bags.

Compiling data on litter collected...

Back in the classroom, students should be encouraged to use spreadsheet and database software to organize their data. They should produce data tables and graphs using computers. The students should be able to compare the number of pieces or estimated weight of debris collected by different categories of debris. Either bar graphs or pie charts will be effective. Some information on preparing data tables and graphs is provided in the Analyzing Experimental Data chapter of this packet section.

Analyzing cleanup findings...

Students can analyze their data to make conclusions about the litter collected at the water site. They should write a conclusion including the six steps described in the Analyzing Experimental Data chapter. Following these six steps, the students should summarize the purpose of the experiment, the major findings, whether the original hypothesis was supported, a comparison with other people’s findings, a possible explanation for the findings, and suggestions for extending the experiment. Students should try to include conclusions relating the litter collected at the

water site to the local ecosystem. Encourage students to link their conclusions to important local water quality issues.

Communicating cleanup findings...

Each small group of students can make a short oral presentation of their work to the class. These oral reports can include summaries of the question tested, background information collected, the experimental design diagram, data tables and graphs, and final conclusions. Students should be asked to critique their own performance and the group process for preparing and delivering the oral report. This supports the Virginia English SOL 10.1 and 10.2.

The class might work together to make a poster display of their findings. They could also display some of the litter and debris that was collected. They could also produce a web page summarizing their work, to be posted on the school web site. If the students contributed to a larger cleanup effort, they may be able to prepare part of a summary report by the organization leading the cleanup. Finally, it would be a good idea for students to write letters to organizations that support cleanup activities or to local appointed and elected officials. Students can write describing their cleanup and stating their positions on litter-related legislation.

Recommending actions for site remediation and pollution prevention...

Students should reflect on how they feel about the problem of litter and aquatic debris, and

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they should be able to suggest some strategies to reduce litter pollution at the water site. Have the students work in their groups to brainstorm possible strategies. The amounts of different debris collected should indicate likely sources and behaviors causing the litter pollution. Emphasize with students how the litter problem is due to human behaviors, and discuss with them how they might be able to have some impact on the problem by changing those behaviors. Students can do some research on the “trash-free” approach adopted by many National and State Parks. Following this approach, visitors are required to take their trash home after a visit instead of leaving it in trashcans. Parks provide bags and post signs explaining the policy, but do not provide the usual number of trashcans. Some parks have found that this has decreased litter in the park, while others have seen an increase.

Commercial fishing vessels produce rather a lot of garbage while they are at sea, but have little available storage space. Ask students to research ways that trash might be stored until the boat returns to dock.

ILLEGAL DUMPING

In the U.S., it is illegal to dump any trash in any lake, stream, river, bay, or within three nautical miles of shore. Even beyond three nautical miles, it is always illegal to dump anything made of plastic.

Proper disposal of trash is important, but people must also be educated to work at reducing the amount of waste they produce. This is important, as the growing demand for manufactured and packaged goods has led to an increase in non-biodegradable solid wastes in our waterways. Everyone can reduce their waste significantly by using the three “Rs,” Reduce, Reuse, and Recycle. The three “Rs” were described in the Litter and Debris in our Waterways chapter earlier in the curriculum packet.

Help students think about how litter pollution is related to different public policy decisions. Government agencies are working to solve litter problems, and many organizations and individuals are engaged in gathering data and making recommendations. All citizens, including students, can choose to become actively involved, helping work towards creation and implementation of anti-litter laws and public information campaigns. Students can be challenged to investigate the status of different legislations at local, state, and federal levels. They can research which groups favor and oppose different bills, and the reasons the groups have taken their positions.

QUESTIONS

- What were your main findings of the cleanup?
- What was your most interesting finding during the cleanup?
- How might litter have got into the water or onto the shore?

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- If the litter is not picked up, what do you think will happen to it in the next five years?
- What effects do you think the litter might have on humans or animals?
- What could we ask lawmakers to do about the problem of pollution?
- What can each of us do to minimize the problem of litter pollution?

ASSESSMENTS

- Written reports of the cleanup investigation.
- Small-group oral presentations. All students should participate in their group presentation. Students should critique their own performance in the oral presentation and the effectiveness of the group process. Virginia English SOL 10.1 and 10.2 can give help for instructions and grading rubric for the presentations.

EXTENSIONS

- Students could extend this activity by returning to the water site at weekly or other intervals for an ongoing quantitative study of litter.
- Students could extend the activity by carrying out comparisons of their data with data collected by other cleanups. See the previous lesson in this section, Comparing Water Quality Data, for specific suggestions.
- Since the lesson describes an investigative experiment for students to carry out, the

lesson could easily be extended as a longer-term science project for individuals or small groups of students.

- Students may wish to carry out a storm drain stenciling project. Since a great deal of litter enters our rivers and bay from urban runoff, storm drain stenciling can help educate people about the connection between our streets and the water quality in nearby water bodies. Virginia's Department of Conservation and Recreation (DCR) offers free storm drain stenciling kits, as does The Ocean Conservancy. DCR also encourages schools to "Adopt-A-Stream," and conduct two or more cleanups every year. For details, see www.dcr.state.va.us/sw/adopt.htm

RESOURCES

For the teacher...

- A Scientific Beach Cleanup. *Save Our Seas*.
- Beach Cleanup Results. *Save Our Seas*.
- Chesapeake Bay Foundation "Clean the Bay Day" every spring. www.cbf.org/calendar/ctbd.htm
- *Chesapeake Bay Program*. Chesapeake Bay Program Office, 410 Severn Avenue, Suite 109, Annapolis, MD 21403. 800-YOURBAY or www.chesapeakebay.net

The Chesapeake Bay Program represents one of the nation's largest conservation efforts, created in 1983 through an agreement between the US Environmental Protection Agency, Maryland, Virginia, Pennsylvania, the District of Columbia, and the Chesapeake Bay Commission.

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- James River Advisory Council “James River Regional Cleanup” every spring in Charles City, Chesterfield, Cumberland, Goochland, Henrico, and Powhatan Counties, and Lynchburg and Richmond. 804-717-6688 or www.jamesriveradvisorycouncil.com
- Marine Debris. *Virginia Institute of Marine Science*. www.vims.edu/cbnerr/teach/debris/index.html
- Marine Debris on the Chesapeake Bay. *Bay Link Lesson Plans*.
- Marine Debris Survey. *Save Our Seas*.
- *Students and research: Practical strategies for science classrooms and competitions*. Cothron, J. H., Giese, R. N., & Rezba, R. J. (3rd Ed.). (2000). Dubuque, IA: Kendall/Hunt Publishing Company.
- The Beach Sweep. *Plastic Debris Teaching Activities*.
- *The Ocean Conservancy*. Pollution Prevention and Monitoring Office, 1432 N. Great Neck Road, Suite 103, Virginia Beach, VA 23454. 757-496-0920 or www.oceanconservancy.org

The Ocean Conservancy coordinates the International Coastal Cleanup throughout the world. In Virginia, the International Coastal Cleanup is coordinated by Clean Virginia Waterways (www.longwood.edu/cleanva). Data collected during the International Coastal Cleanup is used to educate people and create solutions to the problems of solid waste and litter. The aim is to help change behaviors and practices that create debris.

- *U.S. Environmental Protection Agency*. Marine Debris Abatement - Trash in our Oceans. www.epa.gov/OWOW/oceans/debris
- U.S. Environmental Protection Agency. Marine Debris Curriculum: Turning the Tide on Trash. www.epa.gov/OWOW/OCPD/Marine/contents.html
- Virginia Department of Environmental Quality Office of Litter Prevention and Recycling. www.deq.state.va.us/recycle
Available publications include the following. “The New Three Rs: Reduce, Reuse, & Recycle!” “An Idea Notebook for Elementary Teachers on Litter Control;” and “Operation Waste Watch Kit.”
- Whose Flotsom is This? *Bay Links Lesson Plans*.

STUDENT HANDOUTS

Cleanup Checklist for Students

Cleanup Data Card

Cleanup Checklist for Students

(IDEAS FROM “APPENDIX E: STUDENTS’ CHECKLIST” FROM
SAVE OUR SEAS.)

A FEW THINGS TO REMEMBER

- Make sure you wear proper clothes for the cleanup. It is always colder along the water so bring additional warm clothes with you.
- Even summer can be cool at the beach, so be prepared.
- Dressing in layers can keep you warm even in cool weather, for example, long pants, turtleneck, sweater, jacket, windbreaker, and hat.
- In case of rain, wear wool or waterproof clothes. They will keep you warm even when wet.
- Wear gloves and sturdy shoes for the cleanup. Glass or other debris can be sharp and dangerous.
- On hot or sunny days, you should have at least a quart of water, juice, or soft drinks. Drinking fluids throughout the day can keep you from getting overtired or having a headache.
- Be sure to use sunscreen.

CLOTHES TO WEAR

- Windbreaker or jacket
- Sweater
- Long pants
- Sturdy shoes
- Gloves, for example gardening gloves, dish gloves, or disposable gloves

- Hat, either sun hat or wool hat depending on the weather

OTHER ITEMS TO BRING

- Drinks (1 quart)
- Bag lunch
- Sunscreen
- Sunglasses
- Change of clothes in case of getting wet

SAFETY DURING THE CLEANUP

- Stay with your group members at all times.
- Do not go near or into the water.
- Keep your shoes on at all times to protect your feet from harm.
- Keep out of dunes and do not step on any plants.
- Do not touch any wildlife that you find or taste any water or plants.
- Learn what poison ivy and poison oak look like, and avoid these plants.
- Call an adult immediately if you find any stranded animal.
- Call an adult immediately if you find any dangerous item, such as a syringe, large drum, chemical container, or medical waste.
- Do not eat any food without first carefully washing your hands.

Cleanup Data Card

(Ideas from "International Coastal Cleanup Data Card"
from The Ocean Conservancy.)

Cleanup Site Name: _____

Cleanup Site Location: _____

Today's Date: _____

Name of Cleanup Leader (Teacher): _____

Names of People Working on This Card: _____

Distance Cleaned: _____

Number of Trash Bags Filled: _____

Estimated Weight of Debris Collected: _____

Stranded or Entangled Animals: _____

List all stranded or entangled animals that you found during the cleanup. Were they dead or alive?
What were they entangled in (fishing line, rope, net, etc.)?

Most Peculiar Item Collected : _____

Items Collected

Please pick up all debris you find on the beach or shoreline. Keep a tally of the items listed below. Tally the items as you collect them, and write the final total for each item at the end.

SHORELINE AND RECREATIONAL ACTIVITIES

(Debris from beachgoers and picnickers, or litter from streets/storm drains, etc.)

- Bags _____
- Clothing or Shoes _____
- Balloons _____
- Cups, Plates, Forks, Knives, Spoons _____
- Beverage Bottles (Plastic, 2-Liter or Less) _____
- Food Wrappers or Containers _____
- Beverage Bottles (Glass) _____
- Pull Tabs _____
- Beverage Cans _____
- Six-Pack Holders _____
- Caps or Lids _____
- Straws or Stirrers _____
- Toys _____

OCEAN/WATERWAY ACTIVITIES

(Debris from recreational/commercial fishing and boating.)

- Bait Containers or Packaging _____
- Fishing Nets _____
- Bleach or Cleaner Bottles _____
- Light Bulbs or Tubes _____
- Buoys or Floats _____
- Oil or Lube Bottles _____
- Crab/Lobster/Fish Traps _____
- Plastic Sheeting or Tarps _____
- Crates _____
- Rope _____
- Fishing Line _____
- Strapping Bands _____
- Fishing Lures or Light Sticks _____
- Wooden Pallets _____

SMOKING-RELATED ACTIVITIES

- Cigarettes/Cigarette Filters _____
- Cigar Tips _____
- Cigarette Lighters _____
- Tobacco Packaging _____

DUMPING ACTIVITIES

- Appliances (Refrigerators, Washers, etc.) _____
- Cars or Car Parts _____
- Batteries _____
- 55-Gallon Drums _____
- Building Materials _____
- Tires _____

OTHER DEBRIS ITEMS OF CONCERN

Identify and count other items found that are of concern.

- _____
- _____

NOTES