Virginia's State Parks
Your Backyard Classrooms

Chesapeake Edition
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Virginia's State Parks

... Your Backyard Classrooms

Field Activities
Grades K-12

Developed to meet Virginia Standards of Learning

for use at

Caledon Natural Area
Chippokes Plantation State Park
Leesylvania State Park
Mason Neck State Park
Seashore State Park and Natural Area
Westmoreland State Park
York River State Park

Developed for
The Virginia Department of Conservation and Recreation
Division of State Parks

by
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Virginia Institute of Marine Science
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# Table of Contents

**Introduction** .................................................. 1  
**Chesapeake Area Map** ........................................... 2  
**To the Teacher** .................................................. 3  
**Grade Level, Subject and Park Directory** .................. 7  

**Parks**  
- Caledon .......................................................... 8  
- Chippokes ........................................................ 10  
- Leesylvania ......................................................... 12  
- Mason Neck ........................................................ 14  
- Seashore ............................................................ 16  
- Westmoreland ....................................................... 18  
- York River .......................................................... 20  

**Activities**  
- Treasured Maps .................................................. 22  
- Telling Tides ....................................................... 24  
- Water Motion & Commotion .................................... 28  
- Sand Shakes & Mud Pies ......................................... 33  
- Going . . . Going .................................................. 37  
- Where Has All the Topsoil Gone? ......................... 39  
- Where the Water Falls ........................................... 41  
- Mainstream ........................................................ 45  
- Pollution Solutions .............................................. 50  
- Habitat Hunt ....................................................... 53  
- Little Limnologists .............................................. 57  
- Wanted: Dead or Alive .......................................... 61  
- Whose Clues? ...................................................... 64  
- What's My Line? .................................................. 68  
- Changing of the Green ......................................... 72  
- A Forest Grows ................................................... 75  
- Kneedeep ............................................................ 79  

**Hotfoot** ........................................................... 83  
**Marsh March** ...................................................... 87  
**Wetland in a Pan** ............................................... 93  
**Hide and Seek** .................................................. 95  
**Small Fry Spies** .................................................. 97  
**Feathered Feeders** ............................................. 101  
**Beaver Tales** ...................................................... 105  
**Picking up the Past** ............................................ 109  
**Now You See Them,** **Now You Don't** ................... 113  
**Catch a Class Act** ............................................. 116  
*Callinectes sapidus*: Beautiful Tasty Swimmer .......... 122  
**Ups and Downs** .................................................. 126  
**How "Eagle Eyed" Are You?** ............................... 130  
**You, Too, Can Canoe!** ........................................ 133  
**Water-Way To Get Around** .................................. 135  
**Great Bay Land Grab** ......................................... 139  
**Whose Flotsam is This?** .................................... 143  
**Clues to the Past** .............................................. 146  
**Plantations and Plenty** ...................................... 151  
**Yesteryear** ........................................................ 153  
**Fragments of the Past in Lee's Woods** ................ 156  
**Down By the Old Mill Stream** ............................ 159  
**Researching the Bay** ......................................... 162  

**Information**  
- Standards of Learning ......................................... 168  
- Key Words .......................................................... 169  
- Helpful Phone Numbers ........................................ 172  
- Species List ....................................................... 173  
- Chesapeake Bay Primer ....................................... 185
Dear User:

Since 1936, Virginia State Parks have served to preserve the Commonwealth's natural and historic resources and to provide opportunities for people to enjoy and learn about those resources. Several of Virginia's State Parks and Natural Areas—Caledon, Chippokes, Leesylvania, Mason Neck, Seashore, Westmoreland and York River—are intimately linked with one of the region's most precious and most threatened resources, the Chesapeake Bay. Increasingly, these parks have a vital role in the future of the Bay.

Because only a tiny fraction of the Chesapeake Bay region falls within the bounds of these parks and natural areas, they can provide only minimal direct protection to the Bay. However, through education—especially the education of Virginia's young people—they parks and natural areas can play a major part in protecting and restoring the Bay.

Your Backyard Classrooms makes it easy, fun and rewarding for classes, grades K-12, to use these seven parks for learning about the Chesapeake Bay and the region's natural and cultural heritage. Included are 40 activities that address an array of subjects and important Bay issues and concepts while satisfying State Standards of Learning objectives. The activities are designed to involve students before, during and after field trips, and encourage them to make hypotheses, observations and inferences. Although each activity includes a concise step-by-step procedure, group leaders are encouraged to mix, match and adapt activities to customize field trips to meet their own instructional goals.

Please use Your Backyard Classrooms often and join in the fight to save the Chesapeake Bay.

Sincerely yours,

Ronald D. Sutton
Virginia’s State Parks . . . Your Backyard Classrooms

To the Teacher

What Research Says to the Field Tripper

The thought of a class field trip, especially in an outdoor setting, can cause jitters in even the most experienced teacher. The purpose of this guide is to provide lots of ideas for activities to keep students organized, on task, and excited about learning in Virginia’s estuarine parks. The tips in this section will help to make the trip an outstanding learning experience.

Some great advice comes from John Falk (formerly Associate Director of Education at the Smithsonian Institution’s Chesapeake Bay Center for Environmental Studies), who taught thousands of students who came to the Center for school field trips. He and his staff conducted a systematic study of the children’s behavior, and the following are some excerpts from an article written about those observations:

"Take Only Memories, Leave Only Footprints"

. . . is a good motto for park visitors. State Park regulations prohibit the collection or destruction of any park resource. It is recognized, however, that sometimes minor sacrifices of renewable resources are necessary for effective education. For example, a menhaden that is passed among 50 inquisitive hands is unlikely to survive, but its loss may benefit the rest of the species; and no harm can come from dissecting a dandelion that is destined to be mowed tomorrow.

Nonetheless, groups may damage fragile resources by inadvertently disturbing an ecologically sensitive area. Therefore, if any collecting or off-trail work is planned, please check with the park staff. The staff can assist with minimum-impact planning and will advise on locations.

Discuss environmentally responsible planning and behavior with students, both before the trip and at the park. Many students seldom interact with natural environments and are simply unaware of the consequences of their actions. A visit to the park offers a rare opportunity to teach “hands-on” environmental ethics.

The activities provided in this guide are designed to ensure the necessary structure and framework for productive field trips. Both pre- and post-field trip lesson suggestions are included to give students a sense of mission and to reinforce learning that takes place at the Park. Science process skills are emphasized, with ample opportunities for students to conduct activities in which they are challenged to think and explore and investigate some of Virginia’s most interesting Bay country.


3
Field Trip Tips

Before the Trip

☐ Visit the Park ahead of time to become familiar with the site. Use the park map in this guide to find the essentials—parking area for the buses, restrooms, picnic tables, shelter area, visitor center or office, and emergency telephone. Check in with the staff about:
  • date and time of trip
  • activity plans
  • site selections
  • facilities for students with special needs
  • equipment availability
  • safety considerations

☐ Write out a detailed list of materials and equipment needed. Double check for everything you might possibly need or want.

☐ Have a set of alternate lesson plans in case of uncooperative weather or environmental conditions (such as high tide vs. low tide, strong winds, rain, very hot or very cold temperatures, sun vs. clouds, etc.).

☐ Check on procedures required by your school and school system. Schedule the bus and make plans for substitutes and for any students who are not going on the trip. Decide on departure and return times.

☐ Send home permission slips for the students along with a description of the field trip plans for the parents and give a copy to the principal. Include the departure and return times if they are not within the regular school day.

☐ Consider public relations. The local newspaper might be interested.

☐ Give the students a list of items they will need:

  • bag lunch and drink with the student’s name on the bag
  • change of shoes and clothes to leave on the bus
  • soft-soled shoes that can get wet and muddy (NO bare feet)
  • jacket, gloves and hat (it is often cooler near water than at school or home), handkerchief, rain gear, brimmed hat, sunglasses, chapstick, sunscreen, insect repellent (as necessary)
  • notepad or clipboard, with pencil attached with string (NO loose papers)

☐ Select your chaperones. For most outdoor field trips, assign one adult to five students in grades K-4, and one adult to eight students in grades 5-7. Older students need at least two chaperones per class. All students should follow the "buddy" system of watching out for each other. Name tags for primary age children with their name, school, and teacher's name can be very helpful in case someone gets loose!

☐ Assign jobs to students and/or chaperones. Various people can be in charge of lunches, field equipment, maps, first aid kit, etc. If small group work is involved, assign roles within the groups.

☐ Establish emergency procedures and discuss with chaperones and students.

☐ Provide students with advance orientation to the site (maps, slides, videos). Practice any new skills, techniques and procedures which students will need. Introduce any unfamiliar vocabulary or concepts. Share the objectives of the trip and the planned itinerary with students.

☐ Plan activities for students to do on the bus. A visual scavenger hunt relevant to the field trip is easy and effective. For example, finding possible sources of non-point pollution would work well with watershed studies.

☐ Take first aid kit. Be sure to find out if any students have special needs, such as bee sting or allergy medications and asthma or diabetic information.

☐ Take life jackets (or find out if the Park has some to loan) if any activity will be in or near water that is higher than the students' waists.

☐ Take a camera. Pictures of specimens and activities will be useful for follow-up; pictures of the group will be enjoyed by all.

At the Park

☐ On arrival, check in with the park staff.

☐ Explain to students all safety and logistical considerations, such as boundaries they are to respect for individual activities or the trip as a whole. Review chaperone or "buddy" system assignments and the procedure for emergencies. Remind them about respectful care of the environment.

☐ Take a bathroom break before beginning your activities (and before getting too far away from the rest areas).

☐ Acclimate the students to the setting with an activity such as a scavenger hunt or exploratory game. Use the site map to preview the park.

☐ Describe the day's itinerary for the students so they will know what to expect.

Dive in and enjoy the day!
A Little Help from Our Friends: 
Small Group Dynamics

Scientists usually conduct field research by working together in 
organized teams. This approach can also be used successfully 
with student groups, each group sharing a task as well as the 
equipment necessary to complete it.

However, it is not uncommon during group field activities for one 
or two diligent students to do all the work while the rest of the group 
stands by without becoming involved. To avoid this scenario, the 
teacher should organize the group assignments so that each student 
has a specific job. The active involvement of each student then becomes 
esential to the successful completion of the activity.

The role assignments described below are for groups of four students each, and can be adapted for many types of field or classroom activities.

☐ Materials Manager. This person is responsible for obtaining all equipment and supplies needed by the group. The materials manager should learn to use all equipment correctly and demonstrate its use to the other group members. This person supervises the use of equipment during the activity, collects it when the work is complete, and inventories items before they are returned. If any equipment is lost or needs repair, the materials manager notifies the teacher before the items are put away.

☐ Reader. The reader is responsible for making sure all group members understand the assignment and complete it in the time allotted. This student reads aloud all written instructions and is the only group member who should go to the teacher with questions while the field work is being done. The reader also keeps the group on task so that they are able to finish their work on time.

☐ Starter. The starter is the first person to conduct the specific activity necessary for data collection. For example, this student fills the water sample bottles, tests pH, reads the thermometer, etc. If the activity includes repeated sample collections, the other group members should take turns performing these tasks after the starter has begun the work.

☐ Recorder. The recorder keeps notes on all important data and group observations. This student is responsible for recording the group’s hypotheses and predictions for later comparison with the data actually collected. If the teacher does not provide data charts, the recorder should design them. The recorder also summarizes the group’s findings and reports them to the rest of the class after the field work is complete.

Role assignments may be made by the group members themselves or by the teacher. To randomly make role assignments, students in each group can be numbered 1 through 4. The teacher can begin each activity by announcing that, for example, all “ones” will be readers, all “twos” will be recorders, etc. If several different activities are scheduled, roles should be changed so students can have different responsibilities. It may be helpful in the beginning to write out each role description on a card so that the students can refer to them while conducting the field activity.

Role descriptions adapted from “Collaborative Groups,” Full Option Science System, Lawrence Hall of Science, University of California, Berkeley, CA, 1989; provided by Vicki Clark, Richmond Mathematics and Science Center.

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Biological Considerations: Some Simple Precautions

Snakes - The copperhead is the only poisonous snake found in all seven Bay area State Parks. Seashore and possibly Chippokes have the venomous cottonmouth. Both are reclusive. To be safe, however, all snakes are best left alone, and everyone should pay close attention to where they place their feet and hands, especially in dense vegetation.

Mammals - A class may catch a glimpse of secretive mammals such as a raccoon, skunk or fox. Park mammals are never intentionally fed or kept as “pets,” so if a mammal does not flee when approached, or is otherwise acting strange, it may be sick, possibly with rabies. Steer the class away and report it to a ranger.

“Bugs” - All parks have their share of gnats, mosquitoes, deerflies, chiggers and ticks. Thick undergrowth often harbors both ticks and chiggers. Commercial insect repellents are usually adequate to keep park “bugs” at bay. Ticks occasionally transmit serious disease. Since ticks can be active during any mild weather, students should get a careful tick check from a parent after returning home. Ticks often attach in the scalp and on tender skin such as around the groin.

Poison Ivy is abundant in all seven Bay area Parks. It may appear as a low shrub or as a woody vine. The main stem on mature plants may be covered with brown “hair.” The leaves are smooth and shiny above, and are divided into three distinct leaflets. The fruits are clusters of small berries, which turn white when ripe. Anyone coming into contact with poison ivy should wash the area with soap immediately.
Special Situations: Handicapped Students

Working with handicapped students in the out-of-doors can be a rewarding experience for both the student and the teacher. Too often, handicapped students are excluded from these types of learning experiences, when, with proper preparation, these students can be included with ease.

For Physically Handicapped Students

☐ Visit the park to determine the suitability of the field study site.

☐ Are suitable facilities available for the handicapped (e.g., restroom, ramps, tapes, visual materials, boardwalk trails)?

☐ Is access to the specific field study site(s) in the park possible? Are there any especially hazardous areas (e.g., steep grades on trails inappropriate for wheelchairs, sandy or marshy areas)?

☐ Are any programs or exhibits specifically designed for handicapped individuals available (e.g., braille labels, tactile exhibits, taped tour guides, special trails)?

☐ How many adult chaperones will be needed by the group?

☐ Adapt the activity. Most field activities are designed for visually able, ambulatory students. Activities can be enhanced for handicapped students in several ways, such as stressing multisensory observations or changing the pace at which the activity is conducted. For example, visually handicapped students can study birds by listening to their songs or learn to identify trees by feeling the shape of the leaves. It may be necessary to “relocate” natural finds to sites where they can be observed safely and studied by handicapped students. You may also need to modify the directions by tape recording, reproducing in large print or braille, or making a signer available. Make every effort to allow handicapped students to work independently on and fully participate in the activities.

☐ Adapt the equipment for the field study as needed. Simple modifications of existing equipment can help in involving the handicapped in the field experience. Measuring devices, like meter sticks or graduated cylinders, can be adapted by notching or taping to allow visually impaired students to make tactile measurements. Wheelchair-bound students can collect water samples if long handles are placed on cups or scoops. These modifications take only a little creativity and time on the part of the teacher and can allow for full participation.

☐ Assign appropriate roles within the group. Examine the various group roles for those appropriate for handicapped students. For example, in “Habitat Hunt,” a student in a wheelchair would not be able to go into a river or stream to collect water samples but could collect and study soil samples or record the data as it is collected.

☐ Avoid the temptation to water-down the content rather than modifying the method of presenting the content. A teacher’s expectations should not be any lower for physically handicapped students.

For Mentally or Emotionally Handicapped Students

☐ Be attuned to the abilities of the students, presenting the information and expecting the students to conduct the activity at an appropriate level. Pacing of the activity is important for these groups, and the instructor should be flexible enough to adapt the activity if one aspect is of particular interest to the students.

☐ Avoid stressful situations in the field by practicing skills and necessary decision-making before the trip.

Special situations call for special perspectives, offering the entire group new ways to perceive and learn about the environment. By adapting methods and materials for the handicapped, new and effective teaching approaches appropriate for all students are discovered.
<table>
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<th>PAGE NO</th>
<th>GRADE LEVEL</th>
<th>PARKS</th>
</tr>
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<tr>
<td>Treasured Maps § ♦</td>
<td>22</td>
<td>K 1 2 3 4 5 6 7 8 9 10 11 12</td>
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<td>24</td>
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<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Water Motion &amp; Commotion § ♦</td>
<td>28</td>
<td>4 5 6 7 8 9 10 11 12</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Sand Shakes &amp; Mud Flies § ♦</td>
<td>33</td>
<td>2 3 4 5 6 7 8 9</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Going...Going § *</td>
<td>37</td>
<td>6 7 8 9</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Where Has Topsoil Gone? § ♦</td>
<td>39</td>
<td>6 7 8 9</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Where the Water Falls § ✱</td>
<td>41</td>
<td>4 5 6 7 8 9</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Mainstream §</td>
<td>45</td>
<td>6 7 8 9</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Pollution Solutions §</td>
<td>50</td>
<td>7 8 9 10 11 12</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Habitat Hunt §</td>
<td>53</td>
<td>3 4 5 6</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Little Limnologists §</td>
<td>57</td>
<td>4 5 6 7</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Wanted: Dead or Alive §</td>
<td>61</td>
<td>K 1 2 3 4 5 6 7 8 9 10</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Whose Clues? §</td>
<td>64</td>
<td>6 7 8 9 10 11 12</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>What's My Line? §</td>
<td>68</td>
<td>6 7 8 9 10 11 12</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Changing the Green §</td>
<td>72</td>
<td>3 4 5 6</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>A Forest Census §</td>
<td>75</td>
<td>4 5 6 7</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Kneeldeep § ♦</td>
<td>79</td>
<td>3 4 5 6 7</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Hotfoot § ♦</td>
<td>83</td>
<td>4 5 6 7 8 9 10 11 12</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Marsh March §</td>
<td>87</td>
<td>4 5 6 7 8 9 10 11 12</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Wetland in a Park §</td>
<td>93</td>
<td>K 1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Hide and Seek §</td>
<td>95</td>
<td>K 1 2 3 4 5 6 7</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Small Fry Spies §</td>
<td>97</td>
<td>K 1 2 3 4 5 6 7 8 9</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Feathered Feeders §</td>
<td>101</td>
<td>1 2 3 4 5 6 7 8 9</td>
<td>CA CA CP LE MN SS WE YR</td>
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<tr>
<td>Beaver Tales § ♦</td>
<td>105</td>
<td>4 5 6 7 8 9</td>
<td>CA CA CP LE MN SS WE YR</td>
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<tr>
<td>Picking up the Past §</td>
<td>109</td>
<td>4 5 6 7 8 9 10 11 12</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Now You See Them §</td>
<td>113</td>
<td>7 8 9 10 11 12</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Catch a Class Act §</td>
<td>116</td>
<td>K 1 2 3 4 5 6 7 8 9 10 11 12</td>
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</tr>
<tr>
<td>Callinectes sapidus ♦</td>
<td>122</td>
<td>K 1 2 3 4 5 6 7 8 9 10 11 12</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>Ups and Downs §</td>
<td>126</td>
<td>3 4 5 6 7</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
<td>How &quot;Lagie-Eyed&quot; Are You? §</td>
<td>130</td>
<td>3 4 5 6 7 8 9 10 11 12</td>
<td>CA CA CP LE MN SS WE YR</td>
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<tr>
<td>You, Too, Can Canoe! §</td>
<td>133</td>
<td>3 4 5 6 7 8 9 10 11 12</td>
<td>CA CA CP LE MN SS WE YR</td>
</tr>
<tr>
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<td>136</td>
<td>4 5 6 7 8 9</td>
<td>CA CA CP LE MN SS WE YR</td>
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<tr>
<td>Great Bay Land Crab §</td>
<td>139</td>
<td>9 10 11 12</td>
<td>CA CA CP LE MN SS WE YR</td>
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<td>Whose Flotsam is This? § ♦</td>
<td>143</td>
<td>K 1 2 3 4 5 6 7 8 9 10 11 12</td>
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<td>151</td>
<td>4 5 6 7 8 9 10 11</td>
<td>CA CA CP LE MN SS WE YR</td>
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<td>Plantations and Plenty §</td>
<td>151</td>
<td>4 5 6 7 8 9 10 11</td>
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<td>Yesteryear § *</td>
<td>153</td>
<td>4 5 6 7 8 9</td>
<td>CA CA CP LE MN SS WE YR</td>
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<td>156</td>
<td>7 8 9 10 11</td>
<td>CA CA CP LE MN SS WE YR</td>
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<tr>
<td>Down By the Old Mill Stream § ✱</td>
<td>159</td>
<td>5 6 7 8 9 10 11</td>
<td>CA CA CP LE MN SS WE YR</td>
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<tr>
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<td>162</td>
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**KEY:**

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**PARKS**

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<thead>
<tr>
<th>CA</th>
<th>Caledon</th>
</tr>
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<tbody>
<tr>
<td>CP</td>
<td>Chippokes</td>
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<td>LE</td>
<td>Leesylvania</td>
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<td>MN</td>
<td>Mason Neck</td>
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<tr>
<td>SS</td>
<td>Seashore</td>
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<td>WE</td>
<td>Westmoreland</td>
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<tr>
<td>YR</td>
<td>York River</td>
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How does human eyesight compare to that of a bald eagle? What is an eyrie? What does the bald eagle's scientific name mean? Why are natural areas important and necessary? What is lycopodium? What role do forest streams play in shaping the land?

At Caledon Natural Area, students have the opportunity to learn about the national symbol of the United States. They can discover the effects of habitat destruction, human impact, and human responsibility to protect and preserve habitats of unique biological significance. Students can also study the field-to-forest transition, forest streams, a brackish marsh, a freshwater pond, and the Potomac River.

Caledon Natural Area encompasses 2579 acres, including four miles of undisturbed shoreline on the Potomac River. Studies leading to its 1984 designation as a Natural Area revealed that 21 species of mammals, 31 species of reptiles and amphibians, 122 species of birds, and 500 species of plants inhabit this site. Almost 1/3 of the Natural Area is climax forest of trees averaging 80-100 years of age, with some as old as 150 years. This forest was designated a Registered National Landmark in 1974, deemed one of the best examples of old, undisturbed oak-tulip poplar forests in the country.

Caledon's primary mandate is to protect the American bald eagle. It's one of the most significant summering areas for bald eagles on the East Coast. As a result, four zones of protection have been delineated: 1) the Educational/Recreational Zone, which is comprised of the visitor center, hiking trails, and picnic area; 2) the Eagle Wildlife Area, a buffer zone with restricted access; 3) the Eagle Impact Zone, the restricted access area where eagles roost and nest; and 4) the No Boating Zone, where all boats are prohibited within 1000 feet of the Caledon shoreline between April 15th and October 15th, with the exception of commercial fishermen and crabbers.

Park personnel conduct eagle tours into the restricted areas during the summer and fall. These tours begin with some instruction on the life history of this bird of prey and methods for visually discriminating between silhouettes of osprey, eagles, and turkey vultures in flight. A closeup look at a model of an eyrie and "eagle eye" activities round out the preliminary activities. On the river, spotting telescopes and binoculars are used to look at nests and search for birds.

Teachers interested in conducting their educational activities at the brackish tidal marsh, the freshwater Jones Pond, or the shoreline of the Potomac, are advised that these areas is seasonally restricted because these habitats fall within the Eagle Impact Zone.

In the Educational/Recreational Zone, the visitor center has exhibits and a film on the bald eagle, a film on the history of Caledon, and the Environmental Education Lab. From the picnic area, four miles of trails extend through the forest. The first trail, Fern Hollow Trail (0.9 miles), is self-guided using a brochure that provides information about each of the numbered stops.

Poplar Grove Trail (0.8 miles) loops off Fern Hollow Trail. The remains of huge American chestnut tree logs are visible reminders of the terrible blight that decimated this species in the 1950s. Laurel Glen Trail (0.7 miles) loops off Poplar Grove Trail, winding through climax growth paralleling a creek bed rich with plant and animal life. Benchmark Trail (1.1 miles) diverges from and rejoins Laurel Glen Trail. It is named for the stone surveyor's marker engraved "John Short-1754" that is found in the middle of the trail.

All four trails traverse low hills and ravines, crossing small streams which eventually join the Caledon marsh and the Potomac River.
Osprey flies with crook in wings.

Turkey vulture soars with wings in a dihedral.

Bald eagle soars with flat wings.

Northern harrier flies low with vulturelike dihedral.
Chippokes Plantation State Park

What was it like to build and run a plantation in the 1600s? Is a “goober pea” a nut or a legume? What is a “rooter” used for? What crop dominated the economic, social, legislative, and religious life of Virginia during the Colonial Period? Find the answers at Chippokes Plantation State Park!

The plantation grounds and buildings at the park provide glimpses of history dating from the early 1600s. As one of the nation’s oldest continuously farmed plantations, Chippokes provides a visible historical record of technological change tools, equipment, and farming techniques.

The roadways leading into the park are lined with a managed loblolly pine forest, an example of good forestry practices. The visitor center, overlooking the James River, has displays on the history of the plantation and an overview of life on the James River.

From the visitor center, several hiking/biking trails can be accessed. College Run Trail (1.3 miles) follows the James River and ends near the plantation mansion grounds. College Run Trail has a fairly steep incline on the first section from the visitor center to the River House; wheelchair-bound students can be taken to the River House by bus and join the tour at that point. From this trail, both the James River and Chippokes Creek Trails diverge. The former (0.5 miles) ends beachside on the James. Fossil shells and bones of animals alive and vital 25 million years ago mix with shells of more recent inhabitants, littering the shallow shoreline of the river’s south side. The Chippokes Creek Trail (1 mile) runs to its namesake.

The park trails wind through diverse habitats of maritime and hardwood forests, swamps, tidal creeks, and salt marshes. Bald cypress trees and red maples sink their roots into the dark tannic swamp waters, providing perches for herons, egrets, and other birds. Fringing the shoreline, the marshes form a transitional zone between shallow water habitats and upland vegetation. Bring binoculars to see great blue herons picking their way along the tidal creeks, seagulls, ducks, comorants and bald eagles.

The plantation grounds can be reached by road or by trail. The first cluster of buildings encountered comprise the newly constructed Antique Farm Equipment Complex, Tools, and Wares Complex, which houses interpretive displays. Across the road from the complex is the River House, the oldest standing structure on the property.

Set in the middle of wide fields, looking down over the river, are the mansion grounds. The front of the mansion, which faces the James, was painted white to serve as a navigational aid, both day and night. Next to the mansion is the brick kitchen where meals were prepared and brought over to the main house. A carriage house displays buggies and carts used by the planters to tour the plantation. Elaborate formal gardens and a corn crib with displays of antique farm and home hand tools may be viewed during a plantation tour.

Fields of peanuts, soybeans, corn, and wheat are cultivated throughout the plantation grounds. Small demonstration plots of tobacco and cotton provide visitors with an up-close look at two very important Virginia crops, both historically and presently.

Today, soil conservation is a primary focus of the Farm Management Plan developed by the Virginia Agricultural Foundation to protect the James River, Chesapeake Bay, Chippokes Creek, College Run, and wetlands that surround the plantation. A number of soil erosion and sediment control structures have been constructed on the grounds and conservation tillage practices are used in all crops except peanuts.

Park: open daily

Facilities: visitor center (open seasonally), plantation tours (some buildings open daily, others by tour only), trails, Antique Farm Equipment Complex, picnic areas, restrooms, gift shop and concession.

Fees: may apply for parking, plantation tours, picnic shelter reservations.

Topographic Maps:
Quadrangles: Hogs Island (37076), Bacon's Castle (37076), Surry (37076)

Tidal Information:
Use Reference Station listings for Scotland, VA; or convert from Sewell's Point, Hampton Roads by:
- adding 2 hrs 44 mins for high water
- adding 3 hrs 15 mins for low water

Directions: Chippokes Plantation can be reached from Williamsburg by taking a 20 minute ferry ride across the James River from Jamestown. Proceed on Rt. 31 to Surry. Turn left onto Rt. 10 and go about 2 miles to Rt. 634. Turn left and continue 3 miles to the park.

Chippokes Plantation State Park
Route 1, Box 213
Surry, Virginia 23883
(804) 294-3625
Canvasback

Redhead

Lesser scaup

Mallard

Wood duck

American wigeon

Duck ducks run and patter when taking wing.

and deep underwater to feed.

Marsh ducks spume from water on takeoff.

...and zip up to feed at surface.
Leesylvania State Park

What does “Niebsco” mean? What is “SAV”? Who were the Doogs? Where is it possible to touch on the 1600s, the Revolutionary War, the Civil War, railroad building in the late 1800s, and the present in two short miles?

Leesylvania, meaning “Lee’s Woods,” is a 508 acre tract of land with about three miles of water frontage on the Potomac River between Neabsco and Powell’s Creeks. It’s a site with a long, unique, and colorful background that invites exploration, both from a historical and a natural history point of view.

The park itself is still under development and will be for several years. Currently there is no visitor center from which to launch a visit. Instead, teachers are directed to one of three areas, depending on their planned agenda of activities. Presently, there are two trails and several different coastal habitats that can be investigated. Future plans include an environmental study area, a marina, modern restroom facilities and a visitor center.

Lee’s Woods Trail (2.0 miles) leaves from the base of Freestone-Point and climbs up to a bluff overlooking the Potomac River and Occoquan Bay. A self-guided brochure points out a number of historical interests along the trail. The trail passes by Confederate Civil War battery emplacements, the chimney and foundation remains of the Fairfax house, the probable site of the Henry Lee II (father of Robert E. Lee) homestead, and the Lee family graveyard. The park has assorted historical artifacts including cannonball fragments, bottles, bricks, arrowheads, pipe stems, and fossils of petrified wood. More detailed information about Leesylvania is found in “A History of Leesylvania,” a brochure available for a nominal fee at the park.

Powell’s Creek Trail (2.0 miles) can be the basis for a natural history lesson focusing on the role of upland forests in a watershed. The trail passes by an overlook of Powell’s Creek. Bring binoculars or a spotting scope to get a good view of a bald eagle nest in a tree across the creek and possibly a bald eagle. Assorted birds feed on fish and plants along the intertidal flats below. Osprey may also be seen in the vicinity of the water. Go on a hydriella walk...This submerged aquatic vegetation, or SAV, is prolific in the late spring and early summer. Small mammals such as raccoons, opossum, muskrats, river otters, and beavers inhabit this forest/marsh/creek ecosystem.

From the overlook, the trail descends to the edge of Powell’s Creek, turns back into the woods, crosses the feeder creek, and ascends to the uplands on the other side of the ravine. This area is a classic example of a virgin watershed.

Along the south shore of Powell’s Creek, the beach is flat and clean, providing good seining opportunities at low tide for fish and other organisms that inhabit these very low salinity waters. There is a good “hands-on” swampy marsh of cat-tails which can be explored with dip nets. Spotted and painted turtles, and frogs are among its inhabitants.

Investigate a bog hole. The park has some field sampling equipment available for use, including seine, dip nets, buckets, boots, hand lenses, binoculars, spotting scopes, and reference materials.

Over at Freestone Point, the combined effects of currents, tides, and winds on the shoreline are illustrated. A beach has built up on one side of the point, while the shoreline further south is being undercut and is eroding away. During the 1950s, a pier extended out from this beach to a controversial gambling and drinking “boat-el,” part of the former resort built here.

Park: open weekends and holidays while under construction; school group visitation encouraged during week (teachers must make special arrangements).

Facilities: trails, picnic areas, restrooms, amphitheatre, canoe trips.

Fees: may apply for parking, canoe trips.

Topographic Maps:  
Quadrangles: Quantico (38077), Indian Head (38077)

Tidal Information:  
Use Reference Station listings for Quantico Creek, VA; or convert from Washington, DC by:  
- subtracting 1 hr 4 mins for high water  
- subtracting 1 hr 59 mins for low water

Directions: Leesylvania State Park is located three miles north of Dumfries in Woodbridge, VA. From the south, take I-95 north to Dumfries; follow U.S. Rt. 1 north to Neabsco Road (turn right just before crossing over Neabsco Creek). The park is located 1.5 miles down Neabsco Road on the right.

From the north, take I-95 south to the Dale City, Rippon Landing exit and follow the signs to Northern Virginia Community College (Smoketown Road). Turn right onto Rt. 1 and take the first left onto Neabsco Road. Continue 1.5 miles to the park entrance.

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Leesylvania State Park  
16236 Neabsco Road  
Woodbridge, VA 22191  
(703) 670-0372

Terrenea®
White-tailed deer
Virginia’s State Parks . . . Your Backyard Classrooms

Mason Neck State Park

What is the historical significance of Mason Neck? Who were the Doegs? What tree sheds its bark every year? What animal lives in a lodge and acts like a lumberjack? How do deer affect the forest understory?

American and natural history come together on the 1800 acres comprising Mason Neck State Park. The park is party to a cooperative management agreement along with Gunston Hall (homestead of George Mason IV, author of Virginia Bill of Rights), Pohick Bay Regional Park, and Mason Neck National Wildlife Refuge (through which access to the park is achieved). Mason Neck State Park borders on Belmont Bay of the Potomac River, a shallow bay (<6 ft) with an average salinity of 3ppt. The shallowness of the embayment provides easy foraging for the American bald eagle which roosts and nests in the area.

The Visitor Center/Elizabeth Hartwell Environmental Education Center overlooks Belmont Bay. There are visual, A-V, and “hands-on” exhibits on the habitats, animals, and plant life which can be observed in the park as well as information on the cooperative management agreement and the history of Mason Neck.

The wetlab area is well-stocked with field sampling equipment such as scapes, nets, waders, tree and soil core samplers, water test kits, specimen jars, as well as microscopes, glassware, dissecting kits, weather station, reference books, files of activities and reference materials, animal pelts, herbarium collections, arrowheads, and other items or activities. The motto for environmental activities at the park is “collect, observe, put back."

Next to the visitor center is a beach where seineing can be done. There is also a tidal freshwater pond and a nontidal holding pond nearby. Dip nets can be used to find tadpoles, frogs, crayfish, minnows, and dragonfly larvae. Painted turtles may be seen sunning themselves on logs. Sunfish, rock bass, channel, yellow, and brown catfish, and pumpkinseeds inhabit the ponds. Guided canoe trips along the shoreline and to Kane’s Creek depart from the beach.

Bay View Trail (1 mile) winds along the shore of Belmont Bay and through mixed hardwood forest. Raised boardwalks traverse a swamp where several wood duck boxes have been placed. A beaver lodge holds a prominent position at the edge of the swamp and beaver “logging” activities are evident. Note that the park staff have had to skirt the bases of some of the trees with wire to protect them against the beavers’ teeth. Observation areas overlook a marsh where binoculars may assist in spotting great blue herons, black ducks, wood ducks, sparrow hawks, red-tailed hawks, and possibly even bald eagles. Along the trail, the obvious absence of a forest understory is the combined result of the park’s large white-tailed deer population and the dense crown of the trees.

Wilson Spring Trail (.75 miles) connects Bay View and Kane’s Creek Trails, winding through the hardwood forest. Kane’s Creek Trail (1 mile) ends at Kane’s Creek, a tidal freshwater marsh and creek. Beavers have built an enormous dam/loge in part of the creek and river otters and muskrats also inhabit this area. An observation blind near the creek helps to screen viewers from the wildlife.

Both Mason Neck State Park and National Wildlife Refuge are wintering grounds for bald eagles. Some nests are also present. Kane’s Creek is a sensitive area in this respect, and as a result, access to the creek and marsh area is limited to between April 1st and November 30th.

Park: open daily
Facilities: visitor center (open seasonally), trails, picnic areas, restrooms, Hartwell Environmental Education Center (call for program information), canoe trips, wet lab, grist mill tours.
Fees: may apply for parking, canoe trips, special education programs, grist mill tours.

Topographic Maps:
Quadrangle: Fort Belvoir (38077)

Tidal Information:
Use Reference Station listings for High Point, Occoquan Bay, VA; or convert from Washington, DC by:
- subtracting 1 hr 2 mins for high water
- subtracting 1 hr 25 mins for low water

Directions: To reach the park, take I-95 south to exit 55 or I-95 north to exit 56 and follow the signs to U.S. Rt. 1. Proceed on U.S. 1 to Gunston Road (Rt. 242). Follow Gunston Road to High Point Road (about 4.5 miles), turn right on High Point Road into the Mason Neck Management Area, and continue 2.5 miles to the park.

To reach the George Washington Grist Mill Historical State Park, continue on Rt. 1 north about 5 miles. Turn right towards Mt. Vernon. Go about 1/4 mile to the grist mill on the left.

Mason Neck State Park
7301 High Point Road
Lorton, VA 22079
(703) 339-7265

Tamarisk
Seashore State Park and Natural Area

Do trees have knees? Does the pineapple have a relative in Virginia? Can dunes migrate? How can Christmas trees help beaches? The answers to these questions and many more can be found at Seashore State Park in Virginia.

Developed by the Civilian Conservation Corps, the park encompasses 2,770 acres. The biodiversity of this area (approximately 600 plant species, including several endangered or threatened species) was integral to its designation as a National Natural Landmark in 1965. Seashore State Park and Natural Area provides a marvelous setting for discovery.

Most groups begin their visit at the visitor center, which contains exhibits about the bald cypress trees, a videotape about the park, and several animal mounts including a leatherback turtle. Trail maps are obtained here.

From the visitor center, seventeen miles of trails extend throughout the Natural Area. The Bald Cypress Trail (1.5 miles) is a popular self-guided trail, using a brochure available at the visitor center. The trail passes by lagoons of bald cypress trees, with their “knees” extending up from the dark tannic swamp waters. Hanging in ghostlike strands from the limbs of the cypress trees is Spanish moss, a relative of the pineapple. Seashore State Park marks the northernmost range of this plant. The boardwalks and observation decks are good areas from which to watch and listen for woodpeckers, frogs, and turtles.

High Dune Trail (0.25 miles) climbs to the top of a maritime forest dune ridge. Separating Bald Cypress Trail from Long Creek Trail, this upland dune area forms a transitional zone between freshwater and saltwater habitats. Long Creek Trail (5.0 miles) follows this habitat transition, beginning at the main park road and ending at Broad Bay. White Hill Lake, accessed by Osprey (1.2 miles), White Hill Lake (1.4 miles) or Long Creek Trails, is a nesting site of ospreys, which return to the Natural Area every year around March. Cape Henry Trail (6.0 miles hike/bike) passes through the bald cypress swamps, and continues through an old dune area. Another osprey nest can be seen from the wooden bridge that spans the salt marsh near 64th Street. The trail ends at The Narrows on Broad Bay where there is a small beach.

The park is situated with access to beaches on both Broad Bay (via 64th Street) and the Chesapeake Bay. Salt marshes border parts of Long Creek Trail, White Hill Lake, and 64th Street. The Chesapeake Bay beaches are accessed through the park campground entrance. Boardwalks protect the fragile dunes and beach grass, and Christmas trees are used to help reduce beach erosion. The branches of the trees trap sand and help stabilize the dunes. The vegetation of the beach and dunes are well-adapted to survive in the inhospitable climate of the beach and shoreline. An extensive underground system of roots and rhizomes enables the beach grasses to send new shoots to the surface and helps stabilize the sand.

Wreck lines reveal signs of numerous inhabitants, including humans. Shells, crab molts, and egg cases of whelks and skates may be found among the debris. Ghost crabs and mole crabs are among the beach inhabitants. Pond nets, tankers, and the Chesapeake Bay Bridge Tunnel compose an interesting backdrop to the shoreline.

**Park:** open daily

**Facilities:** visitor center (open seasonally), trails, picnic areas, amphitheater, restrooms, environmental education center, campground, cabins.

**Chesapeake Bay beach:** special arrangements may be necessary for beach access.

**Fees:** may apply for parking.

**Topographic Maps:**

**Quadrangle:** Cape Henry (36076)

**Tidal Information:**

Use Reference Stations listings for Lynnhaven Inlet for Broad Bay; or convert from Sewell’s Pt., Hampton Roads by:

- subtracting 9 mins for high water
- adding 6 mins for low water

**Directions:** From I-64, take the North Hampton Blvd. (Rt. 13) exit. Proceed about 2 miles to Shore Drive (U.S. Rte. 60). Turn right. Follow Shore Drive over Lynnhaven Inlet Bridge. After the traffic light at North Great Neck Road, continue to the next traffic light. Turn left for park office, campground, beach parking and access to the Chesapeake Bay. Turn right at the light for the picnic area, visitor center and trails.

To reach Broad Bay via 64th Street, continue along Shore Drive past the blinking light. Shore Drive becomes Atlantic Avenue. Follow Atlantic Avenue to 64th Street. Turn right on 64th Street and follow to the end for marshes, boat ramp, parking, and access to Broad Bay.

Seashore State Park and Natural Area
2500 Shore Drive
Virginia Beach, VA 23451
(804) 481-2131 office
(804) 481-4836 visitor center
Westmoreland State Park

Camels and rhinoceroses in the Potomac? Whales and sharks on land? What is a prehistoric sea? Who were the Powhatans? What is a Yahaken? Who invented the game of lacrosse?

Westmoreland State Park, 1,300 acres adjoining the Potomac River, was built by the Civilian Conservation Corps during the Great Depression. The park presents a window to the prehistoric past. Finds of shark teeth and fossilized bones of whales, camels, rhinoceroses, and crocodiles represent times long ago and vastly different from the present: The warmer climate is reflected in the fossil remains of the plants and animals that thrived.

The visitor center has displays on the fossil history of the area including fossilized bones of the aforementioned animals and representative shark teeth of some 20 species that once inhabited the ocean covering what is now land. There are other displays and exhibits on the Potomac River and the Chesapeake Bay, as well as animal mounts.

Several trails wind throughout the park. Big Meadow Interpretive Trail (0.6 miles) is self-guided using a brochure available either at the trailhead or the visitor center for a nominal fee. The brochure draws the reader back to the time of the Powhatan tribe of the Algonquian Indians who lived in this region. At each numbered stop, different trees and plants used by these Native Americans for food, clothing, shelter, or weapons are pointed out, and various species of wildlife are described.

The trail winds through the woods and descends to the beach. Large stands of big cordgrass line the path to the beach. Here, Indians fished and gathered oysters for food. An observation tower at nearby Yellow Swamp is accessed by raised boardwalks. From the tower, careful observers might see great blue herons, ducks, turtles, and frogs. There is a beaver dam nearby, and beaver and muskrats may be seen, or at least signs of their presence may be visible.

The beach itself yields chunks of gray clay, used by Indians to make pots. From here, binoculars would be useful in looking for ospreys, bald eagles, and other birds along the water and in the sky. The beach area and the base of the cliffs are good locations for fossil hunting. Be forewarned that digging in or climbing on the fragile cliffs is prohibited. From the end of Big Meadow Trail, hikers can either retrace their steps or pick up Turkey Neck Trail (2.5 miles). Wild turkeys are common in the park. Look for large areas of overturned leaves and scratch marks on the ground. An explosion of heavy, frantic wingbeats signals the flushing out of a turkey. Ben Franklin's choice for the national symbol, Turkey Neck Trail is crossed by Beaver Dam Trail (0.6 miles).

Rock Spring Pond Trail (0.5 miles) ends at Rock Spring Pond, a freshwater pond that was once a reservoir. Beavers have built dams and lodges here and there are obvious signs of their "logging" activities. Try using dip nets to see what inhabits the pond itself. Look for frogs, turtles, and minnows.

Laurel Point Trail (1.3 miles) travels through the hardwood forest, passing by the mountain laurel that supplies the basis for the trail name. Box turtles, deer, and eastern king snakes (which kill and eat copperheads) are part of the wildlife residing in the park. A shorter trail, Beach Trail (4 miles), parallels the beach. On the beach, sea ca can be used to capture a variety of fish species. Wander along the wreck lines and see the shells, animal parts, and plant parts that wash up with the tides. A lucky observer may find a shark's tooth. The base of the cliffs can be reached from the end of this main beach area.

Park: open daily

Facilities: visitor center (open seasonally), trails, picnic areas, restrooms, campgrounds, cabins, boat ramp, amphitheater.

Fees: may apply for parking.

Topographic Maps:
Quadrangles: Stratford Hall (38076), Colonial Beach South (38076)

Tidal Information:
Use Reference Station listings for Colonial Beach, VA; or convert from Washington, DC by:
- subtracting 5 hrs 27 mins for high water
- subtracting 6 hrs 12 mins for low water

Directions: Westmoreland State Park is located five miles northwest of Montross. Follow State Rt. 3 from either Rt. 301 or Rt. 360. The park is located just off Rt. 3, on Rt. 347, between the birthplace of George Washington, and Stratford Hall, the birthplace of Robert E. Lee.

Westmoreland State Park
Route 1, Box 600
Montross, VA 22520
(804) 493-8821
York River State Park

What happens when a river meets the sea? Are marshes governed by “zoning laws”? What is a corduroy road? How can ever-changing estuarine conditions support such diverse and productive marine life?

York River State Park provides the opportunity to discover the answers to these and many more questions on coastal and estuarine habitats. Encompassing 2,505 acres, the park fronts on 3.5 miles of the York River while stretching back through a succession of marshes, tidal creeks, and hardwood forests.

The visitor center has “hands-on” exhibits and slide shows which provide information about the park and its history. A wet lab with room for small groups is available for use as well as field sampling equipment, microscopes, wildlife specimens, and guidebooks. The wet lab also houses a freshwater and a saltwater aquarium.

Beach seineing and dip net activities along the shoreline and around the patches of saltmarsh grass will expose some of the marine life that inhabit these estuarine waters. Bring binoculars to search the water and sky for ducks, seagulls, and osprey.

Fourteen miles of trails lead to interesting coastal habitats beckoning exploration. Taskinas Creek Trail is self-guiding using a brochure available at the visitor center. The trail meanders through a succession of pine forests to hardwoods, spanning the marshes and creek with boardwalks. Taskinas Creek is fed by freshwater tributaries and receives daily inflow of saltwater from the tides. This area provides classic examples of wetland zonation patterns.

Taskinas Creek is special—it is one of four sites along the York River that has been designated a Chesapeake Bay Estuarine Research Reserve (CBERRS) by the Commonwealth. These reserves, recognized by the NOAA National Estuarine Research Reserve System, provide representative natural areas for long-term research, monitoring, and education. The primary aim of these designations is to improve scientific understanding of estuarine systems while providing information about the condition of estuarine resources. Part of the Taskinas Creek reserve will be used for educational and recreational purposes while the remainder will be kept pristine for research purposes.

Mallotopi Trail (1.4 miles) winds through woodlands and marsh areas. Woodstock Pond Bike/Fitness Trail (1.3 miles) has 20 fitness stations to use in enjoyable surroundings. Woodstock Pond is a freshwater pond. Four fishing docks provide good stations for dip netting. Eight miles of additional trails through the back country woodlands of the park showcase numerous species of trees, flowers, birds, and other wildlife.

Natural history is not the only subject of interest at York River State Park. There are opportunities to learn about the history of settlement and commerce in the region. Remnants of what appear to have been 17th century logging or corduroy roads are found in at least two places in the Taskinas Creek marsh. A pre-historic Indian site was found at Croaker Landing (boat launch facility). There is also a mid-19th century farm site on Taskinas Creek. Furrows in the woods and old house foundations are evidence of past inhabitants. Student attention can be directed to the York River itself. The channel is routinely used to transport pulpwood and pulpwod products from the paper mills upriver. Watermen can be seen working their boats or nets, harvesting crabs or fish. Recreational fishermen and boaters also make frequent use of the river.

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Park: open daily
Facilities: visitor center (open seasonally), trails, picnic areas, restrooms, canoe trips, wetlab, amphitheater, boat ramp.

Fees: may apply for parking, canoe trips.

Topographic Maps: Quadrangle: Gressitt (37076)

Tidal Information:
Use Reference Station listings for Allmondsville or convert from Sewell’s Pt., Hampton Roads by:
- adding 55 mins for high water
- adding 57 mins for low water

Directions: From I-64, take exit 54B 8 miles northwest of Williamsburg. Go north on State Rt. 607 (Croaker Road) for 1.1 miles, then turn right onto State Rt. 606 (Riverview Road) and follow for 1.7 miles to the park entrance.

York River State Park
5526 Riverview Road
Williamsburg, VA 23185
(804) 564-9057

Lippman
Treasured Maps

At about the same time Captain John Smith was exploring and mapping the Chesapeake Bay, Cervantes wrote, "Journey all over the universe in a map, without the expense and fatigue of traveling." This activity enables students to travel through a park area, placing and then locating "treasures," using mapping and map reading skills.

Background

Maps are essential tools for virtually everyone, whether they are used to document the landscape of a foreign land, to trace the migrations of rockfish, to locate a store in a large shopping mall, to find the way to an unfamiliar place, or to explore a state park trail.

The first comprehensive map of the Chesapeake Bay and its tributaries was made by Virginia's first principal explorer, Captain John Smith. From the time he arrived in the Chesapeake Bay in April 1607, until he was forced to return to England in September 1609 because of severe gunpowder burns, Smith dedicated much of his exploration of the Bay and its tributaries to gathering map data.

Lacking the technological advantages of today, such as aerial and satellite photography, and plagued by hostile Indians and insect infestations, Smith's view of Virginia was limited primarily to what he could see from the waterways. From his boat deck, Smith recorded compass bearings for each change in the shoreline. For areas he couldn't explore, he relied on interviews with friendly Indians. Back in England, he constructed his map of Virginia with these data, carefully differentiating the features he actually saw from those based on hearsay. For 65 years, this map, copied and revised by many, was the basis for nearly all other maps of Virginia used by explorers, settlers and the European press.

Like explorers and settlers long ago who relied on the accuracy of Smith's map to find their way in a strange land, people today rely on and use maps for many reasons. The detail and accuracy of the information contained on a map determines how useful it will be for a particular purpose, and it is important to be able to compare and choose maps properly. Equally important is fostering the ability to interpret a map quickly and accurately, following its symbols, and developing an understanding of relative geography, whether it is of a park, a city, a state, a country, or the world.

Procedure

Before the Trip:
1. Split the class in half and designate the halves as groups "A" and "B." Divide each group into teams of about four students each, making sure both groups have the same number of teams.
2. Study the park map (included in the park description section) to locate two general treasury hiding areas that are out of sight of each other, but still within easy walking distance of a central gathering point.
3. Make a copy of the map and draw lines around the two treasury hiding areas on the copy, marking them "A" and "B."
4. Make enough copies of the marked map for each team to have one and distribute them.
5. Review the map with the students. Explain basic map reading principles, such as orientation and interpreting scales and symbols from the legend.
6. Choose a "treasure" for each team to hide, such as small bags of candy coins or any small items that

Grade Levels: 2 - 12

Objectives

Students will investigate topographic variation by:
- interpreting and using maps.

Materials

Per team:
- map of the site with hiding areas "A" and "B" marked
- clipboard and pencil
- treasure with tag attached

Advanced teams:
- compass
- measuring tape
- protractor
- ruler or drafting compass
- topographic map of park

Where

This activity is suitable for all seven estuarine state parks or any site for which there is an available map.

When

At the Park: 1 hour, daylight hours.

Time of Year: Any time of year.

Resources


Treasured Maps

might stimulate student enthusiasm...even lunch!

7. Explain that each of the "A" teams will be hiding their treasures somewhere in the "A" hiding area, and the "B" teams somewhere in the "B" area. Each team will mark on its map the exact location where they hid their treasure and note any helpful landmarks. The "A" teams and the "B" teams will be working out of sight of each other. When all the treasures are hidden, each "A" team will switch its map with one of the "B" teams. Then each team will search for the treasure marked on the map they receive.

At the Park:
1. Gather at a designated central area and review the procedure.
2. Distribute a treasure, a map, and a pencil to each team (Bring extras.)
3. Each team chooses an identification name or number and writes it on both their map and the tag attached to their treasure.
4. Send the "A" and "B" teams to their respective treasure hiding areas, allowing them about 20 minutes to hide their treasures and mark the exact locations on their maps. One or more chaperones should accompany each group of teams to coach the students.
5. When all the treasures are hidden, gather the teams and have the "A" teams trade maps with the "B" teams. Be sure each "A" team gets a map with a treasure marked in the "B" hiding area and vice versa.
6. After the maps are exchanged, each team searches for the treasure by reading the map and determining its location as marked. Teams can determine whether they've found the correct treasure by comparing the identification tag on the treasure with the name or number written on their map.
7. Special awards might be given to the team that finds its treasure the fastest, and the team that selects the most clever hiding place and most accurately marks its location on the map.

USGS Topographic Maps

<table>
<thead>
<tr>
<th>Park</th>
<th>Quadrangle(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caledon</td>
<td>King George (38077)</td>
</tr>
<tr>
<td>Chippokes</td>
<td>Hog Island (37076)</td>
</tr>
<tr>
<td></td>
<td>Bacon's Castle (37076)</td>
</tr>
<tr>
<td></td>
<td>Surry (37076)</td>
</tr>
<tr>
<td>Leesylvania</td>
<td>Quantico (38077)</td>
</tr>
<tr>
<td></td>
<td>Indian Head (38077)</td>
</tr>
<tr>
<td>Mason Neck</td>
<td>Fort Belvoir (38077)</td>
</tr>
<tr>
<td>Seashore</td>
<td>Cape Henry (36076)</td>
</tr>
<tr>
<td>Westmoreland</td>
<td>Stratford Hall (38076)</td>
</tr>
<tr>
<td></td>
<td>Colonial Beach South (38076)</td>
</tr>
<tr>
<td>York River</td>
<td>Cressit (37076)</td>
</tr>
</tbody>
</table>

Copies available for loan use at parks. For personal copies or more information, write:
VA Division of Mineral Resources, P.O. Box 3667, Charlottesville, VA 22903. (804) 293-5121. $2.50 each plus tax and shipping.

Extensions

1. Students construct maps of the school grounds or their classroom and practice the treasure hunt game at school before going to the park.
2. Students make a map of an imaginary place (marking where a treasure is buried by "X"). Designing their own symbols, including a legend explaining each symbol, a compass rose, and a scale to show relative distance. They exchange maps, interpret, and write out directions to the location of the treasure marked on the map they are reading.
3. Students bring in maps from home to study different legends and symbols.

Variations

Prepare a map worksheet of the park that asks questions that require map (and/or compass) reading and interpretation, such as: "You are at the front door of the visitor center. Which direction is the river?"

Younger students:
Prepare in advance a special map of a small area of the park, such as a playground or picnic area. Hide treasures yourself, then send students on a treasure hunt, helping them read the map and understand its layout.

Gifted/Advanced:
1. The activity can be varied according to time available and level of understanding. Groups with more time and skills may use USGS topographic maps and hide the treasures over a large area. (See park information section for list of the USGS topographic maps.) For treasures hidden close to landmarks, only their relative locations need to be marked on the maps. For those hidden far from landmarks, their locations must be marked accurately on the maps, and the students must use compasses, protractors, measuring tapes and scaled rulers to find them.
2. John Smith used triangulation in mapping the Bay. Research the background and methods of triangulation and try it out in the park.
Telling Tides

Students will learn to read a tide chart, determine the times of the high and low tides for a particular day for a standard reference point, as well as the tidal height relative to mean low water. Using this information, they will learn how to correct for differences in tidal times and heights for any other location on the same day.

Background

A tide is a special type of wave which is perceived as the vertical movement of ocean waters. Tides are caused by the gravitational pull of the moon and sun. Although the moon is very small compared to the sun, it is much closer to the earth. As a result, its tidal influence is more than twice that of the sun. These gravitational forces "pile up" water into bulges which move as long waves around the earth, creating in the Chesapeake Bay, and in many other locations, two high and two low tides every 24 hours and 40 minutes. Such tides are called semi-diurnal tides. Other parts of the earth, such as the Gulf of Mexico, experience diurnal tides—one high and one low every day.

The height of the tides in a given location is not the same every day of the year. As the moon revolves around the earth, the relative positions of the sun, moon, and earth change. Twice a month—when the moon is full and when it is new—the moon, sun, and earth are in alignment and their combined gravitational forces create "spring tides," with water levels higher at high tide and lower at low tide than average. When the moon is in 1/4 and 3/4 phases, the sun and moon are at right angles, and their gravitational forces counteract one another. The result are "neap tides," where the change in water level between high and low tides is the least.

Position during new moon, spring tide:

- Earth
- Moon
- Sun

Position during full moon, spring tide:

- Moon
- Earth
- Sun

Position during a neap tide:

- Moon
- Earth
- Sun

As water level rises, approaching high tide, the tide is flooding. As the water drops towards low tide, the tide is ebbing. Slack water is the period just before the tide changes when the tidal current movement is minimal. Mean low water is the average height of all low tides measured at a given place over a 19-year period and mean high water is the average heights of all high tides at a given location over the same period of time. Sea level is the mean level halfway between high and low tide, used as a standard in reckoning land elevation or sea depths.

The ability to predict tides is useful to many people—fishermen, boaters, oceanographers, marine biologists, meteorologists—to name a few. For example, meteorologists tracking hurricanes are able to determine the potential impact of the hurricane on a shoreline in terms of water level by knowing the phase of the moon and the time of high or low tide.

Grade Levels: 6 - 12

Objectives

Students will investigate tidal patterns by:
- determining the times and water heights of low and high tides at a designated reference station for a particular day using a tide chart;
- calculating the tidal differences between the reference station and any other location;
- comparing the effects of the moon phases on tidal height.

Materials

Per student:
- copy of Tide Graphs (or copies of the excerpts provided)
- pencil, ruler
- Worksheet

Where

In the classroom.

When

At school: allow about 1 to 1 1/2 hours for the activity.

Time of Year: whenever it is appropriate prior to making a field trip.

Procedure

Tide charts are widely published for most locations throughout the Bay and its tributaries. Most tide charts list the time for each high and low tide during a span of dates and list the heights of the tides relative to mean low water for the location. Such charts can usually be obtained from tackle shops and marinas near tidal areas. Some agencies (see "Resources") also publish tide
Telling Tides

Charts. These are based on the tides at a given location and have conversion figures to calculate the times and heights of tides at other places in the vicinity. In the Bay region, tides are most often listed relative to Sewell’s Point in Hampton Roads, Washington, DC, or Baltimore. Daily tide information can be obtained from many newspapers, from recorded telephone services and from some radio station announcements.

1. Review the background information on tides with the class. Discuss:
   - Why is it important (useful) to be able to predict the times and heights of tides?
   - Who do you think uses tide charts?

2. Give each student a copy of the accompanying excerpts of the “Tidal Difference Table” and “Tide Graph Calendar” from Tide Graphs. Explain that these are taken from tables used by scientists to predict tides in the Chesapeake Bay.

3. Explain how to interpret the calendar with a similar diagram on the blackboard. Point out:
   - The curved line represents the change in the level of the tide with time. The high points, or crests, represent high tides. The low points, or troughs, represent low tides.
   - The Y-axis represents the tide height above or below mean low water (the zero mark). It is marked off in half foot increments.
   - The X-axis represents the change in time. It is marked off in 1 hour increments up to 24 hours. To convert times after 12:00 noon to conventional time, subtract 12. Thus 18 would be 6:00 pm. Each day is marked with a tall vertical line.
   - The second row of numbers below the X-axis gives the tide height for each high tide. A short, vertical line extends from each of these numbers through the X-axis, directly below each crest. This makes it easy to pinpoint the time of the tide.
   - The third row of numbers below the X-axis gives the height for each low tide. A positive number means the tide is above mean low water. A negative number means the tide is below mean low water. Again, a short vertical line extends from the number through the X-axis to facilitate reading the time.

4. Next explain that the tide times and heights differ throughout the Bay and review the Tidal Difference Table. Point out:
   - The “place” column represents the exact locations for which the tides can be predicted.
   - The “tide differences/time” columns list the average difference in time for each location from the tidal time for Sewell’s Point in Hampton Roads. Since the average difference is not usually the same for high and low tides, these are listed under the columns marked “HW” and “LW,” respectively.
   - Time differences are listed in hours and minutes. A “plus” (+) indicates the tide occurs later than the tide at Hampton Roads and must be added. A “minus” (-) means the tide occurs before the tide at Hampton Roads and must be subtracted.
   - The “tide differences/height” columns list the average differences in height from the tidal heights for Hampton Roads. Again, the average differences are not usually the same for high and low water, thus these are listed in the “HW” and “LW” columns.
   - To calculate the tide height for a location, subtract the “minus” figures (listed for that location) from, or add the “plus” figures to, the height for Hampton Roads, as determined from the calendar.

5. Give each student several copies of the accompanying Worksheet. Complete one with the class using a specific date and location as an example. Use the following steps to complete the Worksheet.
   - Enter the date and location at the top with the selected example.
   - Under the “Hampton Roads” column, enter the times and heights for the tides as taken from the calendar for the selected date.
   - Under the “Tidal Differences” column, enter the corresponding figures from the Tidal Differences Table. Be sure to indicate (+) or (-).
   - Sum the figures (watching the + and - signs) in the “Hampton

Resources


Roads” and “Tidal Differences” columns to complete the “Corrected Tides” column.

6. Students can then calculate tides for other dates and locations on their own.

Follow-up:

1. Students can use their tide chart reading abilities in conjunction with any of the other park activities by predicting the tides for the specific day and park of their field trip. “Water Motion and Motion” is an especially appropriate tide activity. Use the correct tide charts for the park visited. The specific locations of each park are indicated in the table entitled State Park Tidal Conversion Figures.

2. Compare the phases of the moon and the resulting tides for a specific month. Chart the differences in the tidal heights over the month and indicate the occurrence of the spring and neap tides.
Telling Tides

Tidal Difference Table

<table>
<thead>
<tr>
<th>Place</th>
<th>Time (Hrs, Mins</th>
<th>Tidal Differences</th>
<th>Height (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HW</td>
<td>LW</td>
<td>HW</td>
</tr>
<tr>
<td>York River</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tides Marshes Light</td>
<td>-0.09</td>
<td>-0.07</td>
<td>-0.3</td>
</tr>
<tr>
<td>Gloucester Point</td>
<td>+0.16</td>
<td>+0.07</td>
<td>-0.1</td>
</tr>
<tr>
<td>Yorktown</td>
<td>+0.07</td>
<td>+0.01</td>
<td>-0.1</td>
</tr>
<tr>
<td>West Point</td>
<td>+2.03</td>
<td>+2.28</td>
<td>+0.3</td>
</tr>
<tr>
<td>James River</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mulberry Point</td>
<td>+1.56</td>
<td>+2.16</td>
<td>-0.1</td>
</tr>
<tr>
<td>Hog Point</td>
<td>+2.11</td>
<td>+2.28</td>
<td>-0.4</td>
</tr>
<tr>
<td>Jamestown Island</td>
<td>+2.54</td>
<td>+3.26</td>
<td>-0.5</td>
</tr>
<tr>
<td>Outer Coast of Virginia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virginia Beach</td>
<td>-1.30</td>
<td>-1.35</td>
<td>+0.9</td>
</tr>
<tr>
<td>Chesapeake Bay Eastern Shore</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onancock</td>
<td>+2.52</td>
<td>+3.09</td>
<td>-0.7</td>
</tr>
<tr>
<td>Fisherman's Island</td>
<td>-0.47</td>
<td>-1.00</td>
<td>+0.5</td>
</tr>
</tbody>
</table>

Tide Graph Calendar

HAMPTON ROADS, VIRGINIA

Jun 1990

Daylight Saving Time

VIMS Computer Center Tide Calendar
**Worksheet**

<table>
<thead>
<tr>
<th>Name:</th>
<th>Date:</th>
<th>Location:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#1 Hampton Roads</th>
<th>#2 Tidal Differences (enter + or –)</th>
<th>#3 Corrected Tides (Add #1 to or subtract #2 from)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of 1st high tide:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (ft) of 1st high tide above mean low water:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of 1st low tide:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (ft) of 1st low tide below mean low water:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of 2nd high tide:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (ft) of 2nd high tide above mean low water:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of 2nd low tide:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (ft) of 2nd low tide below mean low water:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**State Park Tidal Conversion Figures**

<table>
<thead>
<tr>
<th>Park</th>
<th>Designated Reference Station*</th>
<th>Average Time Difference (Hrs, Mins) from Sewell’s Pt., Hampton Roads**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>High Water</td>
</tr>
<tr>
<td>Chippokes</td>
<td>Scotland (James River)</td>
<td>+ 2.44</td>
</tr>
<tr>
<td>Seashore</td>
<td></td>
<td>– 0.52</td>
</tr>
<tr>
<td>Ches. Bay beach</td>
<td>Cape Henry</td>
<td>– 0.13</td>
</tr>
<tr>
<td>Broad Bay</td>
<td>Lynnhaven Inlet</td>
<td>+ 0.55</td>
</tr>
<tr>
<td>York River</td>
<td>Allmondsville (York River)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Park</th>
<th>Designated Reference Station*</th>
<th>Average Time Difference (Hrs, Mins) from Washington, DC**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>High Water</td>
</tr>
<tr>
<td>Caledon</td>
<td>Riverside, MD (Potomac River)</td>
<td>– 3.35</td>
</tr>
<tr>
<td>Leesylvania</td>
<td>Quantico Creek, VA (Potomac)</td>
<td>– 1.04</td>
</tr>
<tr>
<td>Mason Neck</td>
<td>High Point, Occoquan Bay, VA (Potomac)</td>
<td>– 1.02</td>
</tr>
<tr>
<td>Westmoreland</td>
<td>Colonial Beach, VA (Potomac)</td>
<td>– 5.27</td>
</tr>
</tbody>
</table>

*Nearest landmark with published tides on which conversion figures are based; actual times of tides at parks may be slightly different.

**Hampton Roads times from *Tide Graphs*; Washington, DC times from *TideLogs*. Slight discrepancies may exist between the references.
Water Motion and Commotion

In teams, students measure current speed, wave height, wave frequency, calculate the tide, and make predictions regarding the effects of these factors on the movement of a simulated oil spill. Once a "spill" occurs, teams of "environmental experts" measure its movements toward shore, and assess its impact on the landscape, biota, and human resources.

Background

The Chesapeake Bay is a great mixing bowl, receiving runoff from a land area 1 1/2 times the size of Virginia. For every gallon of water entering the Bay from its watershed, 30 to 40 gallons of ocean water moves in and out of the Bay mouth. Both the fresh and salt water are in constant motion, mixing together and moving nutrients, fish eggs, shellfish larvae, plankton, minerals, sediments and pollutants.

As in all estuaries, the salinity of the Chesapeake Bay varies greatly with location. At the Bay mouth, the salinity approaches that of ocean water (30-35 parts per thousand or ppt). Midway up the Bay, the salinity is about half that of the ocean water, and it continues to decrease further up the Bay and its tributaries. Salinity also tends to increase with depth, since salt water is denser than fresh water. As a result, salt water tends to move up the Bay along the bottom, forming a salt wedge, with fresher water flowing out of the Bay near the surface. Where the salt water and fresh water meet, there is often considerable mixing, which stirs up the sediments and resuspends nutrients.

Water movements are grouped into three major categories: waves, tides and currents. A current is the horizontal flow of water. Currents in the Bay and the tidal stretches of its tributaries are complex, influenced by water depth, shoreline and bottom contours, tides, rainfall, wind, barometric pressure and many other factors. In a tidal river, speed and direction of currents differ with time and place. Water may flow fast near the shore and slowly near the middle of the channel. Surface waters may flow downstream while water near the bottom may flow upstream. Currents also change with the tide.

Waves are surface disturbances that appear as moving ridges of water. Actually, as a wave passes, the water on the surface moves vertically and the water below the surface moves mostly in a circular fashion. Wind causes waves, and wave size is primarily determined by wind speed and fetch, the distance wind blows over the water. The greater the wind speed and the longer the fetch, the larger the wave.

Grade Levels: 6 - 12

Objectives

Students will investigate possible interrelationships between water motion and dispersion of a hypothetical pollutant by:
- estimating, measuring and calculating basic characteristics of waves and currents;
- predicting the movement of a simulated oil spill;
- observing and predicting the impact of the spill on the biota, landscape, and human activities.

Materials

Per class OR per team:
- two 1.5 m wooden stakes
- 10 m long measuring tape OR
- 10 m long piece of string with finger loops in the ends
- meter stick
- grapefruits (1 per team)
- watch with second hand

For popcorn slinger:
- one 5-gallon plastic bucket with cutout bottom covered with screening
- 25 m of heavy twine or light rope
- 20 liters of plain popped popcorn
- permanent marker

Per team:
- tide chart
- clip board, pencils, paper
- Water Motion Worksheet
- "wettable" footwear, hip boots or waders
- map of Chesapeake Bay region or Virginia
- calculator (optional)
Waves are also affected by tides, currents, weather systems, water depth, and shape of the shoreline.

Waves have three aspects that can be easily measured. These are: wavelength, the distance between identical points on two successive waves; wave height, the distance between the lowest point of a wave (trough) and the highest point (crest); and wave frequency, the number of waves to pass a point in a unit of time.

A tide is a special type of wave which is perceived as the vertical movement of ocean waters. Tides are caused by the gravitational pull of the moon with the sun's gravity playing a minor role. These forces "pile up" water into bulges which move as long waves around the planet, creating in the Chesapeake Bay and in many other locations, two high tides and two low tides every 24 hours and 40 minutes.

Often in the news are reports of oil spills, chemical spills, and other pollutants entering our waterways. Determining where and how a spill will spread is a complex problem, requiring a thorough understanding of tides, currents, and waves, among other factors.

Before the Trip:
1. Review the basic concepts of tides, currents, and waves with the class.
2. Using a large map of the Chesapeake Bay, show the class the location of the park to be visited. Discuss:

- Standing on the park shore, which direction (left or right) is down river (toward the ocean)? Why is this direction called down river?
- Are there likely to be tides at the park?
- Predict the height of the waves that will be seen at the park—10 cm, 100 cm, 2 m?
- How can the information from a map help with predicting wave height?
- What are some other things that affect wave height that can't be predicted with the map?
3. Divide the class into teams of four students.
4. For each team, copy an up-to-date tide chart and the Water Motion Worksheet. (Sources of tide charts are listed on page 25.)
5. Practice reading the tide chart, calculating the high and low tides for the particular park where the field trip will occur. (The activity "Telling Tides" teaches how to read a tide chart and to calculate the tidal time differences for each park. The tidal conversions are based on the time difference of the park's tides from those at a designated reference point. Sewell's Point in Hampton Roads is the standard for most southern Chesapeake Bay tide charts, and much of the Potomac River is referenced to tides at Washington, DC.)
6. For the park, each team calculates the high and low tides which will occur closest to the time of the field trip, and enters these on a copy of the Water Motion Worksheet.
7. Explain that when they go to the park, each team will be taking measurements of currents and waves, and determining the tide. Based on the prevailing conditions at the park's shoreline, they will predict the movement of a simulated oil spill, (i.e. which way it will move, how long it will take to reach shore, if at all, and whether it will stay together or break up)
8. Provide some hypothetical measurements so students can practice the calculations.
9. Make a popcorn slinger, following the accompanying directions. Prepare or acquire plain popcorn (no butter or salt).
10. Depending upon resources and equipment availability, either fully equip each team for the field exercises, or plan to set up stations between which the teams can rotate.

At the Park:
1. Select a location along the beach where there is ample room for the students to spread out. Break into teams. If there is room on the beach and there is enough equipment, each team can set up its own station for taking measurements. If space or equipment are limited, the teams can rotate stations for measuring current speed and wave action.
2. Each team completes steps 1-4 on the Worksheet.
3. After all measurements are completed, each team should discuss their results among themselves and make predictions about the

Credits
Adapted with permission from Water Water Everywhere... "Oil is Lighter than Water: Evaluating the Impact of an Oil Spill." Oregon State University Sea Grant College Program, Corvallis, and Oregon Dept. of Education, Salem.

Where
Suitable at all seven estuarine parks or any public beach on the Bay or a tributary.

When
At the Park: Allow at least 2 hours for entire activity at the park, avoid picking time that coincides with slack tide.

Time of Year: Any time is suitable, water is warmer in the fall.

Resources


OBIS, "Oil Spill." Lawrence Hall of Science, Univ. of CA at Berkeley. Write: Delta Education, Box M, Nashua, NH 03061.

Water Motion and Commotion

direction the simulated spill will move and how quickly it may reach shore if it occurs 25 m from shore, following the questions under No. 5 on the worksheet.

4. Regroup and discuss each team's predictions.

5. After a few practice attempts at throwing the empty popcorn slinger into the water, fill it with popcorn and create the spill. Mark the toss location with a stake.

6. Allow up to 15 minutes to observe the spill and follow its movements. If the popcorn comes ashore, record the time and mark the location with a stake. Measure or pace off the distance between the stakes.

7. Depending upon the local conditions, the spill will either break up rapidly, move downstream with the current, or come ashore. Assuming that the oil spill came directly ashore at this location, discuss:

- How many different types of animals would be covered or affected on land? In the water?
- Could some animals escape the spill? How?
- What animals might not be able to escape?
- How many different types of plants might be affected on land? In the water?
- Would animals that eat these plants be affected?
- What would happen to the shoreline? Beach activities? Swimming? Boating? Fishing?
- Do you think any of the spill would sink? If so, how would it affect the river bottom? The biota living near or on the bottom?
- How would you start to clean the "spill" up?
- How long do you think the spill's impact would last in this area?
- After the allotted time is up or the spill has dispersed widely, regroup and gather up all equipment.

Follow-up:

Hold a group discussion about the movement of the spill, with each team presenting its predictions and findings. (Differences in calculations may occur, depending on how the measurements were taken in the field.) Discuss the simulated spill's potential impact on different aspects of the environment. What were the limitations of the activity? What other factors should be considered when environmental experts assess the possible movement and impact of a real chemical or oil spill? (Consider effects of variations in waves, currents, wind, sun, air temperature, precipitation, boat traffic, etc.) Emphasize the complexity of the problem.

Extensions

1. Try different methods of containing a spill. Students can devise containment equipment.

2. Make a wave jar. Fill a jar with equal parts of vegetable oil and colored water. Replace the lid, and turn it slowly to end. Study wave motion.

Variations

Younger students:
Students make the wave and current measurements. Help them make predictions about the movement of the spill. As students watch the movement of the spill, ask leading questions about the spill and its impact on the environment to develop their observational skills.

Gifted/Advanced:
1. Customize the worksheet by removing formulas and instructions as appropriate for the group. A highly advanced class might be instructed to design their own methods for predicting the location, movement, and impact of the spill, and make their own measurements, calculations, and observations in the field.

2. Research salt water intrusion or salt wedge formations, how they relate to the circulation of water in the Bay and its tributaries, and how this is relevant to various pollution problems.

How to Make a Popcorn Slinger

1. Assemble all materials required for the popcorn slinger as indicated.

2. Mark off 5 m intervals on the 25 m line with a permanent marker. Firmly tie the 25 m line to the bucket handle.

3. Contact a popcorn concessionaire (listed under "Popcorn" in YellowPages) for stale plain popcorn or pop a 2 pound bag of corn to make the necessary 20-24 liters.

4. At the park, first practice throwing the bucket empty. Grab the rope near the bucket and start twirling the popcorn slinger over your head. When the bucket has gathered momentum, let it fly out over the water. After landing, the weight of the bucket will pull it under the water and the buoyant popcorn will be forced out. Before hauling the bucket in, let it sink beneath the surface so as not to disturb the spill.

5. Once you feel comfortable tossing the bucket, fill it with about 20 liters of popcorn and take a strategic position (dock, breakwater, large rock, etc.) from which to toss the corn. Make sure the line is secured on shore to prevent loss of the slinger. Keep the line tangle-free to avoid hindering the bucket's flight. If you have trouble making the slinger work, someone can wade out into the water and pour the popcorn out to create the spill.

6. Count the marked intervals as the bucket is hauled in to determine the spill's distance from shore.
1. Using the tide chart, determine the following:

Expected time of low tide: ________________

Expected time of high tide: ________________

Present time: ____________________________

The tide should be rising _________ falling _________ (check one).

The tide appears to be rising* _________ falling _________ (check one).

2. Determine current speed (V):

- Throw a grapefruit straight out from shore, about 20 meters. (A good heave will do.)
- Watch the grapefruit to determine the direction of the current.
- Several meters downstream of the grapefruit, push two stakes into the sand on the beach, exactly 10 meters apart and both equidistant from the water's edge.
- Two people act as spotters. Each sits about a meter inshore from a stake and sights over it, across the water, in a line perpendicular to the shore. The spotters wait for the grapefruit to cross their lines of sight.
- A third person, with a watch or stopwatch, begins timing when the first spotter indicates when the grapefruit reaches his/her line of sight and stops timing when the grapefruit reaches the second spotter's line of sight.

Record the time (t) in seconds it took the grapefruit to travel the distance (d) of 10 meters:

\[
t = \text{______________ seconds} \quad \text{current } (V) = 10 \text{ m (distance)} / \text{______________ t (sec)}
\]

\[
\text{current } (V) = \text{______________ meters/second}
\]

3. Determine the wave frequency (f):

- The measurer wades out knee deep and holds a meter stick vertically in the water with one end on the bottom.
- On a signal from a timer on shore, the measurer counts the number of waves that pass the meter stick for 2 minutes.
- Record this number below.

Number of waves in 2 minutes: ________

Frequency (f) = number / 120 seconds = ________ waves per second
4. Determine wave height (h):

- One person, the measurer, wades out to where individual waves can be identified (no farther than knee deep) and holds a meter stick vertically in the water with one end on the bottom.
- The measurer bends over and calls out the high (wave crest) and low (wave trough) water line measurements in centimeters as a wave passes.
- Another person on shore records these measurements below. Repeat five times. Subtract trough height from crest height to get the wave height for each pair of measurements and record. Add the wave heights together. Divide this sum by 5 to determine the average wave height.

![Diagram of crest and trough with height measurements](image)

<table>
<thead>
<tr>
<th>Measurement (cm)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest</td>
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<td>Trough</td>
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<tr>
<td>Wave Height</td>
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</tr>
</tbody>
</table>

Sum of wave heights =
Divide above sum by 5 =
Average Wave Height:

5. Before the spill occurs, predict the following:

- How fast (minutes) will the spill (first piece of popcorn) reach the shore?
- Which direction will the spill move?
- Where will the spill come ashore? (Distance in meters down beach from where popcorn is thrown.)
- Will the spill stay together or break up?

6. After the spill, record the following:

Time of spill: ________________ Spill was ________________ meters from shore.

Time first popcorn reached shore: ________________

First popcorn reached shore ________________ meters from toss location.
Sand-Shakes and Mud-Pies

Students collect sediment samples from different wet habitats, measure and compare sediment composition from these sites in order to find relationships between sediment size and various environmental factors. Elementary students separate and observe layers; older students make calculations based on their data.

Background

The composition of the sediments that make up the shorelines of the Chesapeake Bay and its tributaries is dependent on a number of factors such as exposure to wind, waves and currents, established vegetation, source, and shoreline slope.

Sediments are often classified by size as follows: clay (less than 0.004 mm), silt (0.004-0.062 mm), sand (0.062-2 mm) and granules or pebbles (larger than 2 mm). Sand is usually classified further as fine, medium or coarse.

There are several different kinds of minerals in typical beach sand, including quartz, magnetite, garnet, mica, feldspar and limestone, as well as particles of shell, plastic, and sometimes coral. The difference in size, shape and density of these materials determines how they are moved by water and wind along the shoreline.

Shorelines are molded by the energy from moving water (waves and currents) and wind. The amount of energy affecting a site determines, to a large extent, the sizes of particles present. Denser and larger particles require more energy to be moved than less dense and smaller particles. Smaller particles stay suspended in water until the water movement slows enough to let them settle out. Thus, larger sand particles are moved and deposited by large waves on an open beach but are rarely carried up into tidal creeks by the gentle currents and tides. Silts and clays collect among the roots and stems of plants forming marsh mud.

Storms sometimes move dense sediments onto a beach. Such deposits may be revealed as dark bands if one digs a trench in the sand. The strength of a storm may be inferred by the width of the dark band.

Longshore currents typically move sediments along shorelines. Current direction may change during the year. The movement of coastal sediments is affected by man-made objects such as docks and jetty lines, which disrupt the flow of sediments along the shore, thereby altering the natural coastline. This can cause accretion (build up) in some places and erosion in others.

Procedure

Before the Trip:
1. Collect enough wide-mouth, straight-sided, plastic jars (such as those used for peanut butter) to have two per sample site.
2. Visit the park to locate at least four areas where the shoreline sand or soil is under the direct influence of wind and/or water. These areas might include:
   - Bay or river beach in the area the waves wash over (swash zone)
   - Bay or river beach above the line of debris left by high tide (wrack line)
   - Bay side of sand dune
   - Top of sand dune (collect from boardwalk)
   - Back side of a sand dune
   - Tidal marsh
   - Edge of a tidal creek
   - Bottom of a woodland stream
   - Edge of a pond
3. List the sites and give each an identifying name. Collect a few small samples of different sediments. Mark the jars with the site names.

When

At the Park: allow about 1 hour in the field, but duration depends on number of sites visited and time required to reach each site; any daylight hours, low to mid tides best at some locations.

Time of Year: Any time.

3. Discuss with the class the basic types of sediments. Describe the sites to be visited and have the students describe the types of sediments they would expect to find at each.

4. Students name factors that might affect particle size at a site. List those on the board and then
come to a consensus on which factors (two to six) will be investigated on the field trip. Some factors might be: wave action, fetch, current speed or plant density.

5. Explain that each of the factors they have listed can be considered an independent variable that might have some effect on the dependent variable, sediment particle size.

6. Share the samples you collected with the class. Make observations on the texture, smell, and appearance. Which samples might be silt? Clay? Sand?

7. Make small group sampling team assignments. Give each group a copy of the park map with the sampling site locations identified. The groups then predict what type(s) of sediment will be found at each site.

8. Assign each group the task of designing an original rating scale for one of the independent variables. Criteria for the scale must be readily observable or quantifiable. For example, for a wave action scale of 1 to 5, 1 could be glassy calm, and 5 could denote white caps.

9. Discuss proposed scales. Correct and improve as necessary. Develop data sheets (see example provided), fill in rating criteria designed by groups, and make one copy for each group.

At the Park:

1. Break the class into small groups for on-site collecting.
2. At each collection site, students half fill the appropriately labeled jars (2 per site) with sediment samples.
3. Students rate the independent variables for each site on their data sheets.

Follow-up:

1. Prepare a large master reference sediment jar by half filling one jar with equal amounts of sediment collected at each site. (Groups collected two jars at each site. Use one of those jars from each group for this step.)
2. Fill the master reference and all of the remaining sample jars with water to within 1 cm of the top and screw on the tops. Shake them vigorously until all of the particles are well-separated and suspended. Set them side-by-side in a well-lit place in the classroom where they can be studied by the class without being moved again.
3. The next day, study the sediment layers in the master reference jar with the class. The top layer has the lightest and finest particles and the bottom layer the coarsest and heaviest particles. Create a particle size category scale by numbering

Where

Caledon: woodland streams readily accessible; access to other aquatic habitats is seasonally restricted.
Chippokes: open sandy river beach, section of beach with erosion control measures, marshes, and tidal creek all in close proximity.
Leesylvania: long stretch of river beach with varying degrees of exposure accessible from picnic area, small pond and stream reached from entrance road, large tidal creek and marsh reached via Powell's Creek Tr. Mason Neck: near visitor center are pond and river beach, various streams and wetlands accessible via Bay View and Kane's Creek (seasonally restricted) Trs.
Seashore: ocean-like beach facing Bay mouth provides high energy environment site; sand dunes, cypress swamps, tidal marshes, tidal mud flats can also be investigated.
Westmoreland: river beach accessed from Big Meadows Tr., or pool area; tidal wetlands reached from Big Meadows Tr.; woodland streams accessed via Turkey Neck Tr.; pond reached by Rock Spring Tr.
York River: near visitor center are tidal creek, salt marsh, river beach, pond; woodland stream flowing into pond reached via short, off-trail trek through woods.

Resources

The Beach: A River of Sand. (Film, 25 mins). Available from: Sea Grant Communications, VA Institute of Marine Science, Gloucester Point, VA 23062. (804) 642-7169.
the layers, starting the numbering with the top layer. (#1 represents the finest sediments and the highest number—the total number of layers—represents the heaviest sediments.)

4. Each team carefully compares the layers in their sample jar with the layers in the master reference jar and assigns the corresponding particle size category scale value (layer number) to each layer in the sample jar. They should write these values on their sample jar.

5. The teams next measure and record the depth of each sediment layer and the total sediment depth in their sample jars.

6. From these measurements, they determine the percentage of each sediment component by dividing each layer depth by the total sediment depth in the jar, then converting that fraction to a percentage.

Using the sample given:

<table>
<thead>
<tr>
<th>#</th>
<th>2 cm/8 cm</th>
<th>1 cm/8 cm</th>
<th>1 cm/8 cm</th>
<th>4 cm/8 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>.25</td>
<td>.125</td>
<td>.125</td>
<td>.50</td>
</tr>
</tbody>
</table>

7. Teams next prepare bar graphs for their samples showing the percentage of each sediment component. (In the example shown, the numbers of the X-axis correspond to the particle size scale determined for the master reference jar.

8. Discuss the results to determine which site(s) had the smallest particles (silt and clay), which had the largest particles, and which had the greatest range of sizes. Consider the independent variables. What inferences might be drawn?

9. Determine which factors affected particle size at the sites using the following procedure:

- Determine the average particle size category for each sample by multiplying the numerical rating of each particle size layer by its percentage within the sample.
- Add these values for all particle size categories in the sample.

Using the sample given:

| 3 x .25 = .75 |
| 4 x .125 = .50 |
| 5 x .125 = .625 |
| 6 x .50 = 3.00 |

(rounded off = 4.9)

4.9 = average particle size category at the site.

- Complete the data sheets by recording the average particle size category for each site.
- Make a graph for each variable by plotting the numerical rating for that variable for each site on the X-axis against the average particle size category for the same site on the Y-axis. (See example.)

10. Discuss the students' results:

- Is there a clear relationship between particle size category and one or more of the independent variables? (Graphs with points that can be connected with a fairly straight line show the most direct correlation between the two variables.) If so, what seems to be the relationship?

- Do some independent variables show little or no relationship to particle size category? If so, why might that be? (Some chosen variables may actually have no influence on particle size categories. In other cases, an independent variable may have an overriding influence on particle size category. For instance, the plot in the example shows the stream as a waveless site with medium-sized particles. Here, a strong stream current might have more effect than no waves.

---

**Extensions**

Students write letters to schools, tourist bureaus, or marine labs in different locations, asking them to send a small sample of sand or sediment. Send return envelopes and small sturdy plastic bags.

- Compare the sand samples from around the U.S. and/or world for particle size, shape, color, and composition.
- Look for tiny pieces of plastic with the samples. Plastic sand (called beach confetti) is a growing environmental problem worldwide.
- Use maps to plot the locations of samples received and discuss the possible origin of the sands in each of these places.

**Variations**

Younger students:

Omit the calculations, but concentrate on having students make detailed observations of the sediments collected and suggesting possible causes for variations in particle size at different locations.
Data Sheet

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Wave Action</th>
<th>Fetch</th>
<th>Current Speed</th>
<th>Plant Density</th>
<th>Other Factor</th>
<th>Average Particle Size Category* at Each Site</th>
</tr>
</thead>
<tbody>
<tr>
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Explanation:

Site Name: Use name assigned by instructor. Be sure it corresponds with name on sample jar.
Wave Action:
- 1 = smooth as glass
- 5 = whitecaps

Fetch (Means distance across open water wind can blow):
- 1 = can toss pebble to opposite bank
- 5 = cannot see opposite shore

Current Speed:
- 1 = no perceptible current (floating object does not move)
- 5 = strong current (floating object moves quickly)

Plant Density:
- 1 = no plants growing on site
- 5 = plants so thick you can hardly dig up a soil sample

*Average Particle Size Category: To be determined with sample back at school and calculated separately for each site sample.

Example. Wave action rating for each site versus average particle size category.

![Graph showing the relationship between wave action and average particle size category.](Image URL)
In this activity, students demonstrate the forces of weathering and erosion and play a game that introduces them to the filtering action of shoreline or wetland plants.

**Background**

The health of waterways and the quality of drinking water are affected by the connection between land and the water. Rain and wave action erode upland areas along shorelines, sending particles of soil into the water, clouding creeks, rivers, and the Chesapeake Bay. This sediment or silt also chokes fish, blocks sunlight needed for growth by underwater plants, and buries and smothers aquatic plants and bottom-dwelling animals.

Although erosion is a naturally occurring process, it is often accelerated by human activities on the land. Some practices that expose or loosen soil include construction and other development for housing and roads, conventional tillage for crops, allowing livestock to trample streambanks, and improper lawn care. Any loosened or exposed soil is prone to being washed away.

To slow erosion, these activities must be controlled. Plants help to hold soil in place and to trap soil eroding from other places. Wetland plants are especially valuable in filtering soil before it reaches the waterways. On shoreline properties, people often build structures for erosion control. A bulkhead is a wall built to keep waves from carrying away the shoreline. Another method is the placement of rocks (called "rip rap") along the shore, which dissipate wave energy while holding the existing shoreline. Planting or maintaining trees and other plants on shoreline as well as upland areas is always a good way to slow the erosion process.

**Procedure**

**Before the Trip:**
- Read the directions, assemble materials, and do a trial run. The amount of water needed to get results will vary depending on tray size, amount and type of soil or sand.
- Set up stations for students to demonstrate weathering and erosion. Divide the class into groups of four. Each group will do both demonstrations, then will discuss the results as a class.
- **Demonstration: Tilt It and Spill It.** Start with several shallow pans with soil or sand covering the bottom and a sprinkling can of water (or large paper cup with holes in the bottom). Predict what will happen when the water is sprinkled onto the soil. Restate predictions as a testable hypothesis. Test the hypothesis and record observations.
  - What do you think will happen if you try this again in another pan, this time tilting one end of the pan up 10° or so?
  - Sprinkle the water on again and record the results.
  - How were the results different?
  - What landforms can you name that resemble the flat pan and the sloped pan? (flat = lawn, playing field, etc.; sloped = bank of a stream or river, hillside, etc.)
  - What is this process called when it happens in nature? (Erosion).
  - Why are farmers concerned about erosion?
  - Spread the soil evenly again in the pans. Ask the class to develop hypotheses about erosion control mechanisms. Provide the class with materials that might be useful in preventing erosion. Give them 5 minutes to devise and construct a way to slow erosion. After 5 minutes, make it rain again and observe how the erosion control devices work.

**Grade Levels:** 2 - 9

**Objectives**

Students investigate equilibrium in erosion and deposition by:
- predicting effects of moving water on soil;
- modeling an erosion simulation;
- observing results of a test;
- inferring causes and effects;
- planning for personal action to save soil;
- hypothesizing about erosion variables.

**Materials**

- 5 clear jars of similar size
  - two shallow, nonbreakable baking-type pans
  - sand or soil
  - one watering can with sprinkling spout or cup with holes in the bottom
  - three clear containers or jars
  - assorted sticks, stones, small pieces of sod, popsicle sticks, spoons, pieces of plastic, etc.
  - hand lenses

**Credits**


**When**

At the Park: Allow 20-30 min. for the game, and up to an hour to take the walk.

**Time of Year:** Any time of year.
• Which method worked the best? Why?

4. Demonstration: Soil and Pebble Shakers. Fill a jar with soil, sand, pebbles, and water; shake well. While shaking the jar, predict which particles will settle to the bottom fastest and which will settle last. Why? Set the jar on a flat surface and allow the particles to settle overnight. Observe the order of the deposition of layers. Draw and label the layers. Use a hand lens to compare the sizes of the particles in the different layers.

• Is the water completely clear?
• If not, why not?
• If these particles were eroding from a stream or river bank, which would cloud the water the most?
• Which would travel farthest? Why?
• Which size particle would naturally erode faster? Why?

At the Park:

1. Lead the class to a lawn or field area to play the following game simulating how plants function as sediment traps. Divide the class into two teams: Team 1 will be “plants growing along a shoreline,” and Team 2 will be “soil particles.”

• The plants form an irregular line at one end of the field, spaced so their outstretched arms do not touch.

• The area behind the plants is designated the waterway.

• The soil particles line up facing the plants and, on a signal, must make their way to the waterway without being touched by a plant. Slow the soil particles by requiring them to drag one foot.

• The plants may bend, stretch, and stoop, but may not move their feet (“roots”) in order to tag the soil particles. Soil particles may not go around the end of the plant line.

• When a soil particle is tagged, he or she becomes a plant at that exact spot.

• The game continues until all the particles at the start of the game are caught or escape to the waterway.

2. Repeat the game several times, using student suggestions for modifying the plant spacing to change the results. Keep count of the number of rounds required to complete each game with the modified spacing. Give each student a chance to play both roles.

3. After the game, discuss the roles played and relate the results of the rounds to what actually happens when it rains.

• Were the plants able to trap more particles in areas where they grew close together?
• What happened when there were gaps or bare spots in the line of plants? Relate this to the formation of gullies.

• Why are shoreline or wetland plants important to the water that they border?

Ask students to suggest some solutions to problems of erosion, based upon the game.

4. Ask students to name some signs of erosion. Take them on a walk to look for these signs. Look for: muddy water in puddles, creeks, streams, or rivers; water running or dripping onto bare ground; bare slopes with paths that seem to have been cut by water; gullies; soil washing away from construction sites or other areas where the ground and plants have been disturbed.

5. At each sign located, ask:
• Can you tell where the soil went?
• Can you find any structures built by man to control erosion?
• Do these devices appear to work?
• Find natural materials or situations that help to control erosion.
• How do these help to slow erosion?

Follow-up:

1. Students identify at least five sites on the school grounds where they might collect runoff after a rain shower.

2. Students predict the relative amounts of sediment that will be suspended in the runoff from each site by ranking the sites.

3. Label jars of similar dimensions with the site names and keep them ready for a rainy day.

4. When it rains, fill the jars with runoff from each site.

5. Students observe and rank the jars according to the clarity of the water, after shaking them.

6. Students compare the results with their predictions and discuss:
• Does any sediment settle out?
• Are all the samples the same?

Where

Caledon: several fields near visitor center are ideal for game; look for signs of erosion near visitor center, along park driveways and trails.

Chippokes: field between visitor center and pool ideal for game; observe signs of erosion and erosion control methods along beach and agricultural areas.

Leesylvania: open places near picnic area or Freestone Point beach ideal for game; signs of erosion seen along beach and Lee’s Woods Trail.

Mason Neck: lawn near picnic area suitable for game; erosion evident along most of park shoreline.

Seashore: lawn between office and amphitheater or beach are best locations for game; signs of erosion along trails and along Broad Bay shore near 64th St. boat ramp.

Westmoreland: field in front of visitor center ideal for game; signs of erosion visible along trails and shoreline bluffs.

York River: field near visitor center ideal for game; signs of erosion and protective value of wetlands evident along shoreline.

Resources


• Is it possible to determine the source of this sediment?
• What are some ways to control the erosion or keep the sediment out of the nearest waterway?

7. Students do an erosion inspection around their homes. Discuss options for improving problem areas.
Where Has All The Top Soil Gone?

Students study sediment load of local water sources, devise and conduct experiments to test the effect of Best Management Practices on erosion control.

Background

Erosion is the natural process by which soil and rocks are moved by wind or water along the earth’s surface. As fertile topsoil is eroded, land productivity decreases. The eroded particles, which eventually settle out of the air or water during sedimentation, alter the environment on which they land. In the Chesapeake Bay or its tributaries, the suspended particles block light energy, thereby reducing photosynthesis in Bay vegetation. As particles settle, bottom organisms are covered, and channels are filled with sediment. In addition, the particles can adsorb chemicals including fertilizers, pesticides, heavy metals and other toxins and carry them to the Bay. Most sediments come from nonpoint sources, such as bare fields, housing projects, construction sites and cities.

Commercial fertilizers and animal manure supply nutrients to improve crop productivity and urban landscapes, but not all of the fertilizer stays on the land. Nitrogen, important for leaf and stem growth, is water soluble and easily leaches into groundwater supplies or is carried in surface runoff. Phosphorus, used on crops to develop strong root systems, bonds to soil particles and, thus, may be transported into waterways along with sediments.

Nitrogen and phosphorus, when transported into the Bay in unnaturally large quantities, contribute to nutrient overenrichment. Phytoplankton, which thrive on increased nutrient levels, multiply rapidly, clouding the water, and reducing sunlight penetration. Without sufficient sunlight, much of the phytoplankton eventually dies, settling to the bottom, where bacteria (decomposers) consume it. The bacteria do not need sunshine, but they do need oxygen. During the summer, much of the Bay’s deep waters are oxygen-stressed because oxygen demand is high and the warmer water cannot hold as much oxygen as colder water can. This situation sometimes results in fish kills, and occasionally in the spectacle of crabs leaving the water.

A variety of agricultural practices, called Best Management Practices (BMP’s), are being used extensively in the Bay region and elsewhere to reduce soil erosion. Some BMP’s divert and control runoff, while others slow the water flow so that more water is absorbed into the soil. BMP’s include strip cropping (planting different crops in alternating rows across the slope), terracing (stair-stepping the land’s slope with terraces), contour plowing (plowing with the land’s contour), no-till or minimum-till systems (leaving most crop residue on the field and preparing the soil and planting in one operation), crop rotation (following one crop with another to eliminate bare fields and provide natural soil enrichment), establishing permanent seed cover on highly erodible areas, and leaving natural plant growth, or “buffer” zones, along river and stream banks. An additional practice is the use of manmade soil erosion and sediment control structures to contain sediments.

Procedure

Before the Trip:

1. To determine if the school grounds are suitable farmland, students take several soil samples from four to five locations by digging small holes about four inches deep in several places and removing about a 1/2 cup of clean soil from the bottom of each hole.

2. Combine the samples and mix thoroughly. Place the mixed sample in a sealed plastic bag and take it to the local Virginia Extension Office (look under the County Government section in the phone book) for analysis. Allow one week for processing of the sample, longer in the spring when demand is high. The Extension Office will provide in-

Grade Levels: 6 - 9

Objectives

Students will investigate changes caused by water flowing over soil by:

- observing sediment in water samples;
- controlling variables necessary to compare observations;
- modeling BMP’s;
- observing BMP’s in use.

Materials

Per team:

- 3 clear plastic or glass jars (same size)
- 2 aluminum foil roasting pans
- 1 hand spade or shovel
- sprinkler-head watering cans or large cups with holes punched in the bottom

To wear:

- “wettable” footwear

When

At the Park: 1/2 to 1 hour, any time of day.

Time of Year: Any time of year is suitable. Turn-around time for soil sample analysis is considerably longer during the spring.
formation on the suitability of the soil sample for farming, and can answer any questions.

3. To investigate the sediment load in local water sources, students first must decide how to get consistent results from their sampling methods. Together, discuss the variables that must be controlled in order to have results that can be compared fairly (e.g., same size and shape of containers, same volume). Determine the volume of water to be collected, and collect similarly sized and shaped clear containers.

4. Students collect the water samples in the containers from a variety of local water sources such as streams, lakes, rivers, and ditches. The best time to collect samples is following a rainy period. Be sure that students identify the location sampled and collect water from the water body itself, not from bottom material.

5. After students bring samples to school, they gently shake each jar and compare the color and clarity of the samples, predicting how much sediment will settle out of each. After the particles settle overnight, students compare the amount of sedimentation to their predictions.

6. After receiving the soil sample analysis, discuss the report, the importance of soil nutrients to plant growth, and the effect of sediment load and nutrient enrichment on the Chesapeake Bay.

7. Divide the class into groups of four or five students. Distribute two aluminum foil roasting pans to each group. The groups cut a V-notch, about two to four cm deep, in the middle of one short side for a water spout. Prepare one extra set of pans for teacher demonstrations.

8. Discuss the Best Management Practices that are being used throughout the Bay region to reduce agricultural runoff.

9. After discussing the practice of establishing permanent crop cover to reduce erosion, solicit suggestions of ways to model the procedure using the set of teacher demonstration pans. One way to carry out the procedure is to fill both pans with soil, cover one with sod cut from grass, elevate one end, pour water simultaneously over both pans and collect the runoff in a cup at the notched spout.

10. Discuss variables in the experiment and how to control them. Students may suggest that the pans must be tilted equally, equal amounts of water must be poured from the same height and at the same rate of flow.

11. Several students should conduct the experiment and discuss the results by comparing the amount and clarity of the water that flows off each pan.

12. Once everyone understands how to control for variables, each group chooses one BMP to model using their pans. Groups should discuss their plans with the teacher before actually conducting their tests. BMP’s that are easiest to model include terracing, mulching, planting across the slope, and establishing a buffer zone. Soil will be needed to model crops and plantings. Each team could bring in their own materials or the teacher may furnish them.

13. Each group explains its model and discusses the results of its experiment. Discuss:
   - Which pans showed the most erosion? the least?
   - Why do farmers need to understand this problem?
   - If you were a farmer, what factors would you consider when deciding which BMP’s to use?

At the Park:

1. Collect samples from creeks and rivers to check for sediment load as students did at school. (Note: The accessible river and creeks at Chippokes will not reflect the effects of BMP’s at Chippokes since these are tidal waters and are carrying sediments and runoff from other farms and the river bottom.)

2. Lead the students on a tour of the farm and look for no-tillage fields, the buffer zone between farm land and the river and the man-made sediment control structures. Look for evidence that these methods are having some impact.

Where

Chippokes Plantation State Park.
Check with park staff about the best access to river and creeks. Chippokes is the only park with farmland for observing BMP’s.

Resources


U.S. Government, Department of Agriculture, Soil Conservation Service. (The local office is listed in phone book under County or U.S. Government).

Virginia Division of Soil and Water. (804) 786-2064 for information; (804) 786-3334 for audio-visual materials.


Extensions

1. Students select a site with erosion problems on the school grounds and devise and implement a strategy for correcting the problem.

2. Students look for BMP’s and WMP’s (worst management practices) as they ride back to school.
Students use a model to demonstrate the movement of water and pollutants in a watershed, then visit a park to observe firsthand the effects of vegetation on soil erosion and how rain finds its way to the sea.

**Background**

A watershed is an area of land which drains into a particular body of water. A watershed can be small, such as a ravine drained by a single stream, or large, such as the entire 64,000 square miles that drains into the Chesapeake Bay. The Bay’s watershed begins in central New York, and includes parts of Pennsylvania and Delaware, a bit of West Virginia, most of Virginia and Maryland, and Washington, DC. It is drained primarily by the smaller watersheds of the Bay’s six major rivers: the Susquehanna, Patuxent, Potomac, Rappahannock, York and James.

This vast Bay watershed encompasses many different land features: mountains, forests, fields, wetlands,
Where the Water Falls

farms and cities. As rainwater falls on the watershed, it nourishes plants, quenches the thirst of man and other living creatures, soaks into the ground, or runs off the land to join streams and rivers. Along the way, it picks up an assortment of substances: soil particles eroded from bare ground; decaying organic matter from pastures and forests; oil from city streets; and fertilizers and pesticides from lawns and fields. Some of these substances benefit Bay life, some are detrimental even in small quantities, and most are harmful in large doses. Unfortunately, many human activities on land do result in excessive loads of substances being washed into the Bay.

People can reduce their impact on the Bay and its tributaries through careful planning and conservative living. Understanding the watershed concept and how pollution enters the waterways are the first steps to solving the problem.

**Procedure**

**Before the Trip:**
1. Introduce the idea of a watershed. Explain that each river, creek, and stream have their own watersheds and that smaller watersheds join to make larger watersheds. Review the principles of the water cycle. How are rain, streams, rivers, the Bay, and the watershed connected or related to one another?
2. Using a map of Virginia or the central Atlantic states, students locate the rivers flowing into the Chesapeake Bay and determine the limits of the Bay’s watershed. Locate the park to be visited on the map.
3. Divide the class into teams of about four students each.
4. Each team makes a model of a watershed: Use a piece of foil in an aluminum baking pan to make a topographic representation of a watershed. Crinkle the foil to make mountains, hills, and valleys, and form a basin or bay at the end opposite the mountains.
5. Explain that there are two types of pollution, point source and nonpoint source. Point source pollution has an identifiable source, such as waste discharging from a pipe. Nonpoint source pollution cannot be strictly identified as to its source because it originates over a large area. Nonpoint source pollution includes stormwater runoff, atmospheric deposition (airborne pollutants such as sulfur, lead, and nitrogen emitted from cars and smokestacks), failing septic systems, and contaminated groundwater.
6. Sprinkle some powdered drink mix over an area of the watershed to represent a nonpoint source pollutant. Make it “rain” on the watershed using a paper cup with holes punched in the bottom and observe the way the rain moves the pollutant.
7. Repeat using food coloring (point source pollution) placed in a small spot. Make it “rain” again, and observe the movement of the pollutant.
8. Discuss more specific examples of runoff and how these affect the water. How is this model similar to a real watershed? How is it different?

**At the Park:**
1. Find two small areas (approximately 10 square feet or so) close together, one vegetated and one bare, with similar slopes. Students describe the features of these portions of the watershed—slope, plants, etc.
2. With a bucket or sprinkling can, make it “rain” at the highest points in the two areas. Continue pouring until it becomes evident that different things are happening

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**Where**

*Caledon:* basin-like hill near visitor center and above Fern Hollow Tr. forms perfect watershed, leading into wooded ravine and stream; water obtained at visitor center and its effects on bare and vegetated slopes observable at start of Fern Hollow Tr.

*Chippokes:* most sloped areas heavily wooded; raindrop activity best conducted on College Run Tr., on either side of College Run; adventure some could try ravine to west of visitor center and picnic area; river water can be poured on vegetated and unvegetated sections of shoreline bluffs.

*Leesylvania:* Powell’s Creek Tr. traverse rim and mouth of watershed; several places along trail suitable for groups to “flow” to the stream below.

*Mason Neck:* small pond near visitor center sets in basin surrounded by open and partially wooded slopes, ideal for “raindrops”; pond water can be used on vegetated and unvegetated areas on hillside.

*Seashore:* best location for raindrop activity is from top of old dredge spoil pile near 64th St. boat ramp; Broad Bay water, at base of hill, can be used on vegetated and unvegetated sections of mound.

*Westmoreland:* several areas along Big Meadows Tr. suitable for “raindrops” to follow watershed leading into Big Meadows Run; river water may be poured on vegetated and unvegetated portions of shoreline bluffs.

*York River:* ravines of various sizes lead into Woodstock Pond; most accessible is grassy slope between picnic shelter #3 and pond; pond water can be poured on trail leading down this hill and grassy area to the side.

**When**

These activities can be done at any time, but after a recent rain it may be easier to observe the effect of water poured on the land.
on the two plots. Students should describe what they observe.
- What happens to the water?
- What happens to the soil?
- Where there is little grass in the plot, the water may carve its own "river"—is this how some rivers could be formed?

3. With clear cups, collect a little runoff from both areas. Where was water easier to collect? Why? Does the water in the two cups look different?

4. Lead the class to a point of relatively high elevation. Position the students a few feet from each other and have the students pretend they are raindrops that just hit the ground.

5. The students then walk the path that they think the rain would take if it were running over the surface of the land without soaking in or being taken up by plants. While walking, they record or discuss features that might affect the rain or that the rain might pick up as it makes its way downhill—soil particles, leaves, rocks, chemicals, litter, etc., and note any signs of erosion. If possible, walk all the way to a body of water, such as a stream or river. Advanced students can try tracing their paths on topographic maps.

6. Once the water is reached, use a map or maps to trace the rest of the path to the Bay and to the Atlantic Ocean. Discuss:
- Are there other land features, including man-made, that the water flows past that would affect its quality (cities, farms, factories, etc.)?
- Would the rain or river water change any of the land? List the things that the water might pick up as it flows to the ocean.
- How could people in the watershed help keep pollutants out of the water?

Follow-up:
Together, choose one activity that students could do to help keep their watershed clean, such as revegetating bare ground on the school grounds or at home, encouraging their parents to recycle motor oil, or conserving water with short showers, "frugal flushes," etc. To help educate other students in the school, the class can make posters and plan a public relations campaign to encourage participation in a clean-up activity. Set an attainable goal and have students keep track of their progress.

Resources


Silver Burdett Science Series (5th grade science text).


Variations

1. In small groups, students adjust the topography of their aluminum foil watersheds so that several tributary watersheds are produced. Prepare original topographic maps, noting each watershed on the map.

2. Make posters illustrating the effects of pollutants entering a watershed and the waterways.

Gifted/Advanced:
Before the field trip, students could read "Odyssey" by Aldo Leopold, which describes the adventures of atom "X" as it makes its way from the mountains to the sea. During the trip, as they walk the path of a raindrop to the water, students make notes on the possible adventures which might befall a molecule of water here, as it cycles its way to the Bay. After returning to school, students use these notes to write essays. Require that a minimum of six adventures be described. (Leopold, A. Reprinted 1966. "Odyssey." A Sand County Almanac. Oxford University Press.)
Where the Water Falls

Odyssey

Aldo Leopold

X had marked time in the limestone ledge since the Paleozoic seas covered the land. Time, to an atom locked in a rock, does not pass.

The break came when a bur-oak root nosed down a crack and began prying and sucking. In the flash of a century the rock decayed, and X was pulled out and up into the world of living things. He helped build a flower, which became an acorn, which fattened a deer, which fed an Indian, all in a single year.

From his birth in the Indian's bones, X joined again in chase and flight, feast and famine, hope and fear. He felt these things as changes in the little chemical pushes and pulls that tug timeless at every atom. When the Indian took his leave of the prairie, X moldered briefly underground, only to embark on a second trip through the bloodstream of the land.

This time it was a rootlet of bluestem that sucked him up and lodged him in a leaf that rode the green billows of the prairie June, sharing the common task of hoarding sunlight. To this leaf also fell an uncommon task: flicking shadows across a plover's eggs. The ecstatic plover, hovering overhead, poured praises on something perfect: perhaps the eggs, perhaps the shadows, or perhaps the haze of pink phlox that lay on the prairie.

When the departing plovers set wing for the Argentine, all the bluestems waved farewell with tall new tassels. When the first geese came out of the north and all the bluestems gloved wine-red, a forehanded deer-mouse cut the leaf in which X lay, and buried it in an underground nest, as if to hide a bit of Indian summer from the thieving frosts. But a fox detained the mouse, molds and fungi took the nest apart, and X lay in the soil again, foot-loose and fancy-free.

Next he entered a tuft of side-oats grama, a buffalo chip, and again the soil. Next a spiderwort, a rabbit, and an owl. Thence a tuft of sporobolus.

All routines come to an end. This one ended with a prairie fire, which reduced the prairie plants to smoke, gas, and ashes. Phosphorus and potash atoms stayed in the ash, but the nitrogen atoms were gone with the wind. A spectator might, at this point, have predicted an early end of the biotic drama, for with fires exhausting the nitrogen, the soil might well have lost its plants and blown away.

But the prairie had two strings to its bow: Fires thinned its grasses, but they thickened its stand of leguminous herbs: Phalaris, clover, bush clover, wild bean, vetch, lespedezas, and Baptisia, each carrying its own bacteria housed in nodules on its rootlets. Each nodule pumped nitrogen out of the air into the plant, and then ultimately into the soil. Thus the prairie savings bank took in more nitrogen from its legumes than it paid out to its fires. That the prairie is rich is known to the humblest deer-mouse; why the prairie is rich is a question seldom asked in all the still lapse of ages.

Between each of its excursions through the biota, X lay in the soil and was carried by the rains, inch by inch, downhill. Living plants retarded the wash by impounding atoms; dead plants by locking them to their decayed tissues. Animals ate the plants and carried them briefly uphill or downhill, depending on whether they died or defecated higher or lower than they fed. No animal was aware that the altitude of his death was more important than his manner of dying. Thus a fox caught a gopher in a meadow, carrying X uphill to his bed on the brow of a ledge, where an eagle laid him low. The dying fox sensed the end of his chapter in foxdom, but not the new beginning in the odyssey of an atom.

An Indian eventually inherited the eagle's plumes, and with them propitiated the Fates, whom he assumed had a special interest in Indians. It did not occur to him that they might be busy casting dice against gravity; that mice and men, soils and songs, might be merely ways to retard the march of atoms to the sea.

One year, while X lay in a cottonwood by the river, he was eaten by a beaver, an animal that always feeds higher than he dies. The beaver starved when his pond dried up during a bitter frost. X rode the carcass down the spring freshet, losing more altitude each hour than heretofore in a century. He ended up in the silt of a backwater bayou, where he fed a crayfish, a coon, and then an Indian, who laid him down to his last sleep in a mound on the riverbank. One spring an oxbow caved the bank, and after one short week of freshet X lay again in his ancient prison, the sea.

An atom at large in the biota is too free to know freedom; an atom back in the sea has forgotten it. For every atom lost to the sea, the prairie pulls another out of the decaying rocks. The only certain truth is that its creatures must suck hard, live fast, and die often, lest its losses exceed its gains.

Reprinted with permission from Nina Bradley.
Mainstream

In a stream, the animals that reveal the most about the neighborhood are the macroinvertebrates—insects and other visible "spineless wonders." This activity surveys for diversity (number of different kinds) and abundance (number of each kind), to determine the health of park streams.

Background

Most water en route to the Chesapeake Bay starts the journey in small streams. The cleanliness of these streams has a direct impact on the health of the Bay. Thus it is especially important to keep them clean. If streams are carefully monitored, pollution sources such as failing septic systems, leaking gasoline tanks and poorly managed construction sites can be identified and the problems corrected.

One common method of determining stream health is to study the macroinvertebrates that live there. Macroinvertebrates are simply spineless animals that are large enough to see without magnification. In streams, they include assorted snails, worms, crayfish and many immature forms of insects, such as caddisfly larvae, dragonfly nymphs, various beetle larvae and crane fly larvae.

Some forms of invertebrates may be especially sensitive to or tolerant of pollution. The presence of sensitive species, such as stonefly nymphs, indicates a healthy stream. An abundance of tolerant forms, such as pouch snails or midge fly larvae, may indicate a pollution problem. Such animals are therefore called indicator species. (Other types of organisms, such as some algae, can be indicator species, too.)

In addition to indicator species, the diversity of macroinvertebrates can tell a lot about the health of a stream. Typically, if there are many different species in fairly equal numbers, the stream is healthy. If there are only a few species, or one or two species that outnumber the others, the stream may be polluted.

Procedure

Before the Trip:
1. Visit the park to discuss plans with the staff and to explore park streams for at least one good study site for each team of six students in the class. (If possible, pick sites in at least two different streams.) Mark the study sites on a copy of the park map. Look for the following features in selecting sites:
   - easy access for the class;
   - fairly flat clear space along the bank for equipment and examination of specimens;
   - stretches of flowing water with depths of 3’ to 12’;
   - firm, sandy or pebbly bottom; even better, if found, are bottoms with 2” to 10” diameter stones.
2. If chosen sites are widely dispersed, secure adult helpers to assist the student teams during the field trip.
3. Explain and discuss with the class the concepts of indicator species and macroinvertebrates, and indicate that much can be determined about the health of a stream by studying its macroinvertebrates.
4. Make a copy of the accompanying macroinvertebrate illustrations for each student. Discuss ways to distinguish key features about each type. Explain that the identification sheet only shows some of the most common forms and that the major objective in the field is to sort the catch by similarity of forms. (Note: The illustrations are not to scale.)
5. Divide the class into teams of about six to work together at the park.
6. Make enough copies of the Stream Survey sheet for each team to

Grade Levels: 6 - 10

Objectives

Students will investigate variation in stream macroinvertebrate populations and visible indicators of stream quality by:
- observing actual appearance and smell;
- sampling macroinvertebrates;
- classifying macroinvertebrates;
- graphing data;
- interpreting data.

Materials

Per team:
- 3’ x 4’ framed window screen
- rubber gloves
- white or light solid colored sheet or drop cloth
- 12 clear plastic cups
- tweezers
- macroinvertebrate illustrations and data sheet (at least one per sampling site)
- Stream Survey sheet (at least one per sampling site)
- hand lenses
- metric rulers
- thermometer (°C)

To wear:
- "wettable" footwear

Credits

Portions of this lesson were provided by the Save Our Streams Program, sponsored by the Izaak Walton League of America (see "Resources").
Mainstream

have at least one copy for each study site.
7. Explain all field trip plans. Students can practice using the equipment in an imaginary stream on the school grounds.

At the Park:
1. Be sure each team is fully equipped and lead the class to the study sites. Assign adult helpers as needed.
2. At their respective sites, each team follows these directions:
   • Take measurements and make observations to complete the Stream Survey Sheet.
   • Spread the white sheet or drop cloth on a fairly flat patch of ground close to the stream. Weight down the corners with rocks or logs. Place tweezers and 12 clear plastic sorting cups, half filled with stream water, on the sheet.
   • Hold the window screen in the stream, wide edge down, with the bottom securely pressed against the stream bed and the top tilted back until it almost touches the water.
   • Starting 2 m upstream from the screen, work towards it, stirring up the bottom with hands and feet. Turn over all logs, sticks and rocks along the way and brush gloved hands over all surfaces. Dislodged macroinvertebrates will be caught on the screen.
   • Carefully remove the screen with a forward scooping motion.
   • Place the screen on the sheet.
   • With tweezers, carefully sort all specimens into the cups. Look closely and carefully. Many animals may be very small—less than 0.5 cm. Be alert! Some insects, such as water boatmen, give painful bites.
   • While some team members sort, others can identify or describe the different groups for the data sheet at the bottom of the macroinvertebrate identification sheet. Hand lenses may help in distinguishing features. If a match can be found on the identification sheet, note the type of stream quality indicator it represents.
   • If the catch is scantly, repeat the process a few meters upstream from the first sample site. Be sure to record the number of times samples are taken at the site.
   • When all of the catch has been sorted, count and record the number of each type on the data sheet and return all specimens to the water.
   • Tidy up the area and make sure that any overturned rocks or logs in the stream are returned to their original positions.
3. Regroup the class. If there are other convenient sampling sites, and if time permits, each team can sample at a different location.
4. Before leaving the park, compare data sheets. If any apparent pollution problems were found, bring them to the attention of the park staff.

Follow-up:
1. Students make bar graphs showing the numbers of each type of organism they collected at each site. The groups may be labeled with symbols rather than names. If some groups took more than one sample at a site, they should divide their macroinvertebrate numbers by the number of samples taken.
2. Compare the bar graphs for the sites. Discuss:
   • Are they similar?
   • Do some show a much greater abundance of one kind of macroinvertebrate? If so, was it identified as an indicator of poor water quality?
   • Do some show many kinds of animals in fairly equal numbers? If so, were some of them identified as indicators of good water quality?
3. Use all of the class data to make another bar graph showing the macroinvertebrate diversity for each site. Sites with greater diversity may be healthier streams.

Where

Caledon: several woodland streams can be reached from Fern Hollow Tr., originating at the picnic area.
Chippokes: streams within park boundaries but none accessible from trails; easiest is reached by walking west from James River Tr., just after the trail bends north behind mansion.
Leesylvania: woodland stream can be reached from Powell’s Creek Tr.
Mason Neck: numerous streams empty into Kane’s Cr., but all require getting off the trails and pass through seasonally restricted areas; check with park staff.
Westmoreland: several woodland streams reached from Turkey Neck Tr.; require getting off the trail.
York River: woodland streams drain the park like fingers joining the York; no direct trails to them; all reached by getting off trails parallel to them on ridges above; closest stream enters Woodstock Pond and can be reached by short trek through woods from picnic area.

When

At the Park: Allow up to 30 minutes per site for sampling and sorting; allow time for several sites as well as time to hike to and from sites.

Time of Year: Late spring to early fall.

Resources


Variations

Gifted/Advanced:
1. Contact the Save Our Streams Program (Izaak Walton League) for stream monitoring information and kit.
2. Try to identify some of the invertebrates collected to at least their genus name.
# Stream Survey

<table>
<thead>
<tr>
<th>Park:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of stream:</td>
<td>Survey team:</td>
</tr>
<tr>
<td>Sample #:</td>
<td>Time:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water Depth (in cm):</th>
<th>Water Temperature (°C):</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ brown</td>
<td>□ foam</td>
</tr>
<tr>
<td>□ green</td>
<td>□ mud</td>
</tr>
<tr>
<td>□ clear</td>
<td>□ scum</td>
</tr>
<tr>
<td>□ oily sheen</td>
<td>□ other</td>
</tr>
<tr>
<td>□ black</td>
<td>□ rotten egg</td>
</tr>
<tr>
<td>□ musky</td>
<td>□ brown</td>
</tr>
<tr>
<td>□ none</td>
<td>□ orange/red</td>
</tr>
<tr>
<td>□ other</td>
<td>□ yellow</td>
</tr>
<tr>
<td>□ cottony white</td>
<td>□ other</td>
</tr>
</tbody>
</table>

## Unusual Colors and Odors in Water

<table>
<thead>
<tr>
<th>Condition</th>
<th>Possible Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muddy water</td>
<td><strong>Erosion</strong> of soil in upstream areas; in tidal waters it could also be caused by high winds.</td>
</tr>
<tr>
<td>Greenish color</td>
<td>Microscopic plants called algae. Algae may grow to exceed normal limits due to excessive amounts of nutrients entering the water. Nutrient sources include fertilizers, pet waste, grass clippings, leaves, etc.</td>
</tr>
<tr>
<td>Yellow-brown to dark brown water</td>
<td>Acids released from decaying plants. Naturally occurs each fall when dead leaves collect in the stream. Also common in streams draining marsh or swampland.</td>
</tr>
<tr>
<td>Orange to red coating on stream bed</td>
<td>Results from bacterial action upon iron. May indicate a high erosion rate or industrial pollution.</td>
</tr>
<tr>
<td>Colored sheen on water surface</td>
<td>May indicate oil has entered the stream, particularly if there is also an oily odor. Decaying plant matter can release some oils naturally.</td>
</tr>
<tr>
<td>Foam</td>
<td>When foaming occurs in only a few, scattered patches and is less than 3 inches high and cream colored it is probably natural. If the foaming is extensive, white in color or greater than 3 inches, it may be due to detergents entering the stream.</td>
</tr>
<tr>
<td>Rotten egg odor</td>
<td>Indicates sewage pollution. Odor may also be naturally present in swamp or marshland.</td>
</tr>
<tr>
<td>Yellowish coating on stream bed</td>
<td>May indicate polluted water draining from a coal mine.</td>
</tr>
<tr>
<td>Musky odor</td>
<td>May indicate presence of untreated sewage, livestock waste, algae or other conditions.</td>
</tr>
<tr>
<td>White cottony masses on stream bed</td>
<td>Could be &quot;sewage fungus.&quot; The presence of this growth indicates sewage or other organic pollution.</td>
</tr>
<tr>
<td>Blue-green algae</td>
<td>Could indicate sewage or other pollution if growth is excessive.</td>
</tr>
</tbody>
</table>

(Source: Save our Streams Program.)
## Some Common Stream Macroinvertebrates

### Group 1 Indicators of Good Water Quality
(Illustrations not to scale)

<table>
<thead>
<tr>
<th>Invertebrate</th>
<th>Description</th>
<th>Illustration</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stonefly Nymph</td>
<td>6 legs with hooked tips, long antennae, 2 hair-like tails, 1.5 to 4 cm</td>
<td><img src="image1" alt="Stonefly Nymph" /></td>
<td><img src="image2" alt="Stonefly Nymph" /></td>
</tr>
<tr>
<td>Dobsonfly Nymph</td>
<td>dark-colored, 6 legs, many long feelers on lower 1/2 of body, short antennae, 4 hooks at back end, 2-10 cm</td>
<td><img src="image3" alt="Dobsonfly Nymph" /></td>
<td><img src="image4" alt="Dobsonfly Nymph" /></td>
</tr>
<tr>
<td>Mayfly Nymph</td>
<td>brown, plate-like gills on sides of body, 6 large hooked legs, many long feelers on lower 1/2 of body, antennae, 2 or 3 long hair-like tails, 0.6 cm to 2.5 cm</td>
<td><img src="image5" alt="Mayfly Nymph" /></td>
<td><img src="image6" alt="Mayfly Nymph" /></td>
</tr>
<tr>
<td>Water Penny</td>
<td>saucer-shaped body with raised bump on 1 side and 6 legs on other side, to .6 cm</td>
<td><img src="image7" alt="Water Penny" /></td>
<td><img src="image8" alt="Water Penny" /></td>
</tr>
<tr>
<td>Riffle Beetle</td>
<td>oval body covered with tiny hairs, 6 legs, antennae, to 1.5 cm</td>
<td><img src="image9" alt="Riffle Beetle" /></td>
<td><img src="image10" alt="Riffle Beetle" /></td>
</tr>
<tr>
<td>Caddisfly Larva</td>
<td>6 hooked legs on upper 1/3 of body, 2 hooks at back end, up to 1.5 cm</td>
<td><img src="image11" alt="Caddisfly Larva" /></td>
<td><img src="image12" alt="Caddisfly Larva" /></td>
</tr>
<tr>
<td>Snails</td>
<td>shell opens on right or in center</td>
<td><img src="image13" alt="Snails" /></td>
<td><img src="image14" alt="Snails" /></td>
</tr>
</tbody>
</table>

### Group 2 Indicators of Fair Water Quality
(Illustrations not to scale)

<table>
<thead>
<tr>
<th>Invertebrate</th>
<th>Description</th>
<th>Illustration</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damselfly Nymph</td>
<td>large eyes, 6 hooked legs, 3 broad oar-like tails, 1.5 cm to 2.5 cm</td>
<td><img src="image15" alt="Damselfly Nymph" /></td>
<td><img src="image16" alt="Damselfly Nymph" /></td>
</tr>
<tr>
<td>Sowbug</td>
<td>gray, oblong body wider than it is high, more than 6 legs, antennae, .6 cm to 2 cm</td>
<td><img src="image17" alt="Sowbug" /></td>
<td><img src="image18" alt="Sowbug" /></td>
</tr>
<tr>
<td>Scud</td>
<td>fat body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp, .6 cm</td>
<td><img src="image19" alt="Scud" /></td>
<td><img src="image20" alt="Scud" /></td>
</tr>
<tr>
<td>Beetle Larva</td>
<td>light colored, 6 legs on upper 1/2 of body, feelers, antennae, .6 to 2.5 cm</td>
<td><img src="image21" alt="Beetle Larva" /></td>
<td><img src="image22" alt="Beetle Larva" /></td>
</tr>
<tr>
<td>Crayfish</td>
<td>2 large claws, 8 legs, resembles small lobster, 1.5 cm to 21 cm</td>
<td><img src="image23" alt="Crayfish" /></td>
<td><img src="image24" alt="Crayfish" /></td>
</tr>
<tr>
<td>Clam</td>
<td></td>
<td><img src="image25" alt="Clam" /></td>
<td><img src="image26" alt="Clam" /></td>
</tr>
<tr>
<td>Watersnipe Larva</td>
<td>green, many caterpillar like legs, conical head, feathery “horn” at back end, .6 to 2 cm</td>
<td><img src="image27" alt="Watersnipe Larva" /></td>
<td><img src="image28" alt="Watersnipe Larva" /></td>
</tr>
<tr>
<td>Dragonfly Nymph</td>
<td>large eyes, 6 hooked legs, 2 cm to 5 cm</td>
<td><img src="image29" alt="Dragonfly Nymph" /></td>
<td><img src="image30" alt="Dragonfly Nymph" /></td>
</tr>
<tr>
<td>Crane Fly Larva</td>
<td>green or brown, plump caterpillar-like segmented body, finger-like lobes at back end, .8 - 5 cm</td>
<td><img src="image31" alt="Crane Fly Larva" /></td>
<td><img src="image32" alt="Crane Fly Larva" /></td>
</tr>
</tbody>
</table>
### Some Common Stream Macroinvertebrates (cont’d)

<table>
<thead>
<tr>
<th>Group 3 Indicators of Poor Water Quality (Illustrations not to scale)</th>
<th>Midge Fly Larva</th>
<th>Aquatic Worm</th>
<th>Pouch Snail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leech</td>
<td>worm-like</td>
<td>can be very tiny, thin worm-like body, up to .6 cm</td>
<td>shell opens on left</td>
</tr>
<tr>
<td>brown, slimy body, ends with suction pads, .6 to 5 cm</td>
<td>segmented body, 2 legs on each side, up to .6 cm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blackfly Larva</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>one end of body wider, suction pad, up to .6 cm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of samples taken ________  Macroinvertebrates caught ________

Name or description (use metric ruler to note approx. size)  Sketch  Number

| 1. |  |  |
| 2. |  |  |
| 3. |  |  |
| 4. |  |  |
| 5. |  |  |
| 6. |  |  |
| 7. |  |  |
| 8. |  |  |
| 9. |  |  |
| 10. |  |  |
| 11. |  |  |
| 12. |  |  |

Check if appropriate—Looks like an indicator of water quality that is:

<table>
<thead>
<tr>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
</table>

(Use back of sheet if necessary.)
Pollution Solutions – Questions of Quality

Background

Determining what actually constitutes water of good quality is quite difficult. Many factors, including dissolved oxygen, bacterial content, turbidity or clarity, sedimentation rates, salinity, pH, and temperature are measured in water quality research. In order to be valuable, data from a location must be compared with many other measurements over previous seasons in order to observe trends which indicate a change in quality. In addition to being measured over time, these factors must be measured at various depths and locations. Indicator species—plants and animals associated with water of various quality—are also useful in evaluating water. Dissolved oxygen is an important indicator, since most species require oxygen. Sometimes oxygen levels can drop dramatically because of sudden algae population explosions or “blooms,” caused by excess nutrients. In daylight, the algae produce more oxygen than they consume. However, such blooms usually result in a net loss of oxygen, since it is consumed by the algae in darkness and by decay organisms when the algae die. Estuaries are particularly vulnerable to low dissolved oxygen in summer, when warmer water promotes algae growth, yet holds relatively less oxygen than cooler water.

Turbidity (or lack of water clarity) may be measured with a Secchi disk. The Secchi disk is a black and white weighted disk attached to a line. The depth at which one can no longer distinguish between the light and dark areas is the Secchi reading. Low water clarity indicates a large number of particles suspended in the water. The particles may be inorganic, such as silt, or organic, from plankton or decaying matter. Low water clarity decreases the amount of sunlight available for photosynthesis. Suspended particles can interfere with filter feeding and respiration through gills.

pH is a measure of how acid or basic the water is. pH is usually measured with papers or meters. A
Pollution Solutions – Questions of Quality

neutral pH is 7, with 1 being most acid and 14 being most basic. The pH scale is logarithmic, so the difference between two pH units represents a ten-fold difference in pH. The pH of normal rain water is around 5.6.

Pollution sources are frequently referred to as “point” or “nonpoint” sources. Point sources have an identifiable origin, such as a waste pipeline from an industry or sewage treatment plant. Nonpoint pollution is carried into waterways primarily by rain water runoff from urban areas and the countryside.

The question of what constitutes clean water is somewhat subjective—different standards apply to different uses: clean enough for sailing is not necessarily clean enough for swimming. Perception of pollution is generally associated with levels known or suspected to impact on the natural biota and biological processes. Distortions of reproductive processes, changes in species reproduction rates, abundance, distribution and diversity, and abnormal physiological responses all suggest water quality problems. These changes may, however, also be caused by natural factors or combinations of natural processes and manmade effects. This complicates the definition and setting of standards for water quality.

Lessons in water quality testing need to be presented within the context of the setting. While readings do furnish hard data, their evaluation is usually subject to various interpretations.

**Procedure**

**Before the Trip:**
1. Prepare a water quality testing plan. Many of the tests described in “Habitat Hunt” can be used to determine certain types of water quality. Water quality testing usually involves the use of chemicals and chemical testing procedures. Before attempting these activities with students, teachers need to become competent with the specific kits they will be using, learn how to read and interpret results, and be prepared to implement appropriate safety procedures. Many types of test kits are available at different price ranges, sensitivities, and levels of user friendliness. Some school systems (check with the science supervisor) already own water testing equipment. Kits by LaMotte and HACH are used by many teachers.

2. The organization Save Our Streams (see “Resources”) offers a one-day training program for water quality analysis. Workshops are held periodically throughout Virginia. At an SOS workshop, participants learn how to conduct chemical tests and biological stream surveys, becoming qualified to adopt a stream and become part of SOS’s citizen monitoring program, but are not obligated to do so.

3. The Field Manual for Water Quality Monitoring offers practical advice on water quality tests. Sources of kits are included, as is a detailed plan which enables stu-

**Where**

_Caledon:_ woodland streams, hardwood swamps, fresh and brackish marshes, a pond, tidal creeks, and Potomac River. Access to all but woodland streams near visitor center is seasonally restricted and requires park-provided transportation.

_Chippokes:_ cypress swamps, marshes, tidal creek and James River reached via College Run Tr.; a woodland stream originates behind antique farm complex (no direct trail).

_Leesylvania:_ woodland streams, hardwood swamps, fresh marshes and tidal creek all accessible from Powell’s Creek Tr.; Potomac River flows past picnic area.

_Mason Neck:_ woodland streams, hardwood swamps, fresh marshes, a pond, tidal creeks and Belmont Bay all accessible by Bay View Tr.

_Seahorse:_ Chesapeake Bay accessed from office parking lot; cypress swamp pools behind visitor center; salt marshes, tidal creek and Broad Bay reached from 64th St. boat ramp area; White Hill Lake reached via trails.

_Westmoreland:_ Potomac River, tidal creek and brackish marshes reached by Big Meadows Tr.; hardwood swamps and fresh marshes reached by Turkey Neck Tr. from end of Big Meadows Tr.; pond reached by Rock Spring Pond Tr.

_York River:_ woodland streams, hardwood swamps, fresh and brackish marshes, a pond, tidal creeks and York River all reached on foot from visitor center.
Pollution Solutions – Questions of Quality

dents to organize environmental data into an index figure which provides a convenient summary rating. Each park has a reference copy of this publication.

4. Select and pre-test kits and equipment to be sure everything performs as it should. Check the uses for which tests and equipment are intended. Not all work equally well in salt and fresh water.

5. Develop a data sheet for field work. The sample data sheets included with the activities "Habitat Hunt" and "Mainstream" cover some easily assessed pollution indicators.

6. Visit the park to become familiar with the aquatic environments suitable for testing. Select several test sites.

7. With the class, develop a concept map for "pollution" with at least 35 terms (see the activity "Researching the Bay" for concept development directions). Break the class into small groups and charge each with developing a definition of pollution, based on the concept developed. Share definitions and discuss what pollution is (and is not). Put the best consensus definition on the board.

8. Ask students to give their ideas about how they can tell if pollution is present, or if it is not. List their responses on the board. Lead this exercise towards recognizing the need to identify and quantify presence of individual pollutants.

9. Tell the class about the planned field trip. Familiarize them with the equipment and test kits and point out how they can be used to test for various types of water quality.

10. In class, practice doing all of the tests with appropriate safety procedures and equipment care. Use plain tap water, which you may enhance with a pinch of something (nontoxic) for which you will be testing (e.g., salt, vinegar, fertilizer).

11. Review the park map and plan logistical details. Organize items for taking measurements at each site.

12. If topographic or land use maps of the area are available, examine them for uses and features which could favorably or unfavorably affect water quality.

At the Park:

1. With the class, examine site maps to locate test sites. Proceed according to the plan.

2. Take time to enjoy the natural features of the park. Water quality exists within the context of the environment. Hopefully, serious pollution will be hard to find in the park, but there will be opportunities to observe proper land use management and some nearly pristine areas. These values and benefits are among the reasons for pollution control and are important to environmental education, so enjoy.

Follow-up:

1. On the return trip, have everybody on the left side of the bus look out the left windows, and record as many sightings of sources of pollution problems as possible. Students on the right side of the bus look out the right window and list examples of pollution control.

2. Back at school, compile the two lists, compare and discuss.

   - What negatively impacts the local environment?
   - What cancels out or compensates?
   - What improves?
   - What goes into the water? The air? The earth?
   - Which are point source problems? Nonpoint sources?

3. Compile data from the trip. Look for patterns and trends.

4. Based on the data, ask each student to draw his or her own tentative conclusions about the water quality of the test sites, in a written statement which includes justification for the conclusions and suggestions for how to verify them.

5. Students take into consideration all that they have seen, thought about and done for this activity and rate their local environment A, B, C, D or F. They then compose individual (or small group) letters to the mayor, city manager, commissioner of parks, or other official informing him or her of the grade and the reasons why it was awarded. (Whether or not to actually send some of these letters is discretion.)

Resources


Citizen's Program for the Chesapeake Bay, Inc. Baybook – A Guide to Reducing Water Pollution at Home. 6600 York Road, Baltimore, MD 21212. (301) 377-6270.

HACH Chemical, P.O. Box 907, Ames, IA 50010. 1-800-247-3990.


Save Our Streams (SOS), Izaak Walton League of America. Offers workshops, information, references and a video for teachers. Call (703) 528-1818 for information, or write SOS, IWL, 1401 Wilson Blvd., Arlington, VA 22209.

Virginia Water Control Board. (804) 367-0056.

Extensions

Obtain a copy of Baybook. Plan and conduct water pollution prevention projects.

Variations

Younger students:

Use only a few tests and discuss very thoroughly.
Habitat Hunt

One of the fascinating things about coastal environments is the variety of habitats which can exist relatively close together. Extreme environmental changes such as periodic inundation, temperature fluctuation and varying salinity all make demands on flora and fauna which require some unique and highly specialized adaptations. In this activity, students explore three or more habitats.

Background

Each of the seven Chesapeake Bay estuarine Virginia state parks offers at least three different aquatic habitats for exploration. These habitats include streams, ponds, tidal creeks, swamps, marshes, tidal rivers and the Bay itself. Each type of habitat is unique physically, chemically and biologically, and each plays an important role in the ecology of the Bay and the surrounding region.

Streams are the first corridors for surface water en route to the Bay. Typically, within the Bay region, streams are cool, clear, well-oxygenated, have pH ranges reflecting nearby soil and vegetative conditions, and move at a slow but perceptible pace.

Stream waters in the Bay area often pause in ponds, which are nearly always man or beaver-made. There the water takes on new characteristics. Oxygen levels and clarity often drop, temperatures typically rise in the summer but drop in the winter, and the pH may be altered by the pond's biological activity.

Eventually, the stream waters reach sea level where they meet the tides of the Chesapeake Bay. Depending on proximity to the mouth of the Bay, the tidal waters'...

Grade levels: 6 - 12

Objectives

Students will investigate variation among aquatic habitats by:
- predicting patterns in relationships;
- devising a plan for the investigation;
- observing biotic and abiotic factors;
- measuring environmental parameters;
- collecting data;
- drawing conclusions;
- communicating results.

Materials

Students will make their own lists but the following could be used:
- salinity test kit, hydrometer or salinometer
- pH paper
- LaMotte or HACH Company test kits (dissolved oxygen, pH, salinity)
- non-glass thermometers
- clear plastic bottles or jars
- safety goggles
- buckets
- watch with second hand
- Secchi disk or white meter stick
- assorted sieves
- "floatables" and measuring tape for velocity observation
- dip net
- enamel pan
- notebook, pencils
- cameras
- soap and water (for washing after using chemicals)
- assorted field guides

Resources

See "Species Zonation List" in the "Information" section of this guide.
Habitat Hunt

characteristics vary. Salinity may be imperceptible or approach that of sea water at 35 parts per thousand. In the main tributaries and tidal creeks, the waters are often turbid (murky) from suspended silt and an abundance of plankton. Temperatures reflect prevailing weather patterns. pH typically rises with proximity to the mouth of the Bay, due to the buffering effect of the high calcium levels of sea water. Water movements result primarily from the tides and wind.

Procedure

Before the Trip:
1. Study the park information section of this guide to become familiar with the park to be visited. Identify at least three aquatic habitats that can be investigated during a field trip there. Visit the park; the staff will be glad to assist. In some parks, the various habitats are far apart and require transportation between sites; thus careful planning and timing are essential.

2. Review the activity procedure with the class. Describe to the students the basic types of aquatic habitats that will be visited (such as stream, pond and tidal river) and orient them to the basic park features using the maps in this guide, a topographic map of the park, and other visuals if available. (See park information section for USGS topographic map numbers.)

3. Lead the class in a brainstorming session to make a list of basic aquatic habitat characteristics that can be measured or observed in the field, such as water movements, available light, substrate, turbidity, biota, salinity and pH.

4. Divide the class into teams of about four students each. Assign each team the responsibility of collecting data on one aquatic habitat characteristic. More than one team can collect information on the same characteristic, if the list is small or the class large. Each team makes predictions about what they think their data will show.

5. Help each team devise a plan for collecting data. Include:
   - a data collection method
   - data entry chart (include date & time of measurements)

6. Before departing for the park, the teams should practice their data collection techniques such as measuring salinity, pH and turbidity with water samples prepared at school or collected from nearby bodies of water.

At the Park:
1. Each team carries out their data collection plans. Assist them when necessary.

2. After all the sites have been visited, but before leaving the park, each team presents their observations to the whole class, explaining how closely their observations were to their predictions and describing the differences and similarities in their observations between the sites. Speculate about what factors, man-made and natural, influence the observed characteristics and how.

Follow-up:
1. The teams organize their data with graphs, bar charts and tables, and formally present their findings to the rest of the class. They should suggest reasons for the differences and similarities between the aquatic habitats and suggest how these ideas might be tested.

2. Lead the class in a discussion to synthesize the team observations into generalized profiles for each habitat and to find apparent correlations in their data.

3. Using the data, examine the list of apparent correlations. Develop these into hypotheses and experimentally test them.

Where

Caledon: woodland streams, hardwood swamps, fresh and brackish marshes, a pond, tidal creeks and Potomac River. Access to all but woodland streams near visitor center is seasonally restricted and requires park-provided transportation.

Chippokes: cypress swamps, marshes, tidal creek and James River reached via College Run Trail; a woodland stream originates behind antique farm complex (no direct trail).

Leesylvania: woodland streams, hardwood swamps, fresh marshes and tidal creek accessible from Powell's Creek Tr.; Potomac River flows past picnic area.

Mason Neck: woodland streams, hardwood swamps, fresh marshes, a pond, tidal creeks and Belmont Bay all accessible by Bay View Tr.

Seashore: Chesapeake Bay accessed from office parking lot; cypress swamp pools behind visitor center; salt marshes, tidal creek and Broad Bay reached from 64th Street boat ramp area; White Hill Lake reached via trails.

Westmoreland: Potomac River, tidal creek and brackish marshes reached by Big Meadows Tr.; hardwood swamps and fresh marshes reached by Turkey Neck Tr. from end of Big Meadows Tr.; pond reached by Rock Spring Pond Tr.

York River: woodland streams, hardwood swamps, fresh and brackish marshes, a pond, tidal creeks and York River; all reached on foot from visitor center.

When

At the Park: 2 to 4 hours, access to tidal areas might be limited by the tide. Ask park staff in advance which phase is best.

Time of Year: Any but observations will vary with the seasons.
Some suggested aquatic habitat characteristics to explore, equipment to use, features to note and questions to ask:

A. **Water and air temperature** - Use non-glass thermometers, since glass could be a hazard at slippery field sites. *How do the air and water temperatures compare and why are they the same or different? Is the water influencing the air temperature or vice versa? How can you tell?*

B. **pH** - Use pHdrion paper, Merk pH paper, pH meter or LaMotte or HACH colorimeter. *What factors influence pH: precipitation, biota, soil conditions, other water chemistry features or other factors?*

C. **Salinity** - Hydrometers and silver nitrate test kits are acceptable for this activity. *How might recent weather patterns have affected the salinity readings? (At some parks and after rainy spells at others, salinity is too low to detect, even in tidal areas.)*

D. **Dissolved oxygen** - Use an oxygen meter or a test kit (such as HACH or LaMotte). *Do the oxygen levels at each site seem to be influenced by water movement or stillness, biota, water temperature or other factors? How do you think the readings compare at other times of day or year?*

E. **Turbidity (water clarity)** - Use a Secchi disk, a white meter stick or collect a bottle of the water at each site. Note the clarity and color of the water and the abundance and size of suspended particles. *Do you think the observed turbidity is the result of waves, runoff, algae or other factors?*

F. **Water movements** - Observations and measurements can be made about the direction and speed of flowing water and the size and frequency of waves using the techniques described in the activity, “Water Motion and Commotion.” *What are the probable forces behind the water movement... wind, tide, gravity? Or why does the water appear still? Are man-made factors, such as dams or jetties involved?*

G. **Bottom characteristics** - Sort substrate particles by size using a series of progressively smaller mesh sieves. If sieves are not available, examine bottom samples in shallow pans with a little water to separate the components. *Is the bottom primarily clay, sand, silt, gravel or mixed? Is the bottom hard or soft? Is recognizable organic matter present? If so, how much?*

H. **Vegetation** - Note the presence, abundance and variety of plants growing in the water. *What are their shapes and textures? Which parts are above or below water? What is the water depth where they are growing? Are the plants herbaceous, trees or shrubs? Make sketches.*

I. **Animals** - A dip net and bucket may be useful. Note all forms of animal life seen in or on the water such as wading birds, insects and fish. Note signs of aquatic and amphibious animals such as tracks, scat, fish breaking the surface of the water and eggs. *Extreme care should be taken to avoid hurting or being hurt by any animals caught and all must be released where they were caught. Do the animals’ features and habits reflect anything about the habitat in which they are found?*
Sample Data Sheet

Team Name

Date __________________________ Location __________________________

Brief Description of Aquatic Areas __________________________________________

<table>
<thead>
<tr>
<th>Habitat</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Air temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waves</td>
<td></td>
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<td></td>
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<tr>
<td>Soil Type</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Vegetation in aquatic habitat (sketch)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animals/Insects in or near aquatic habitat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salinity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Observations</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
Little Limnologists

The Greek word “limne” means pool or fresh water marshy lake; thus, a “little limnologist” is a small person who studies bodies of fresh water. With the easy-to-follow directions provided, your students will investigate pond life and like professional “large limnologists,” will publish their findings.

Background

Ponds are bodies of fresh water, distinguished from lakes by their smaller size and shallower depth. Ponds may be fed by springs, streams, groundwater, and of course rain and its accompanying runoff.

A variety of plants such as pickerelweed, cattails, water lilies, duckweed, pondweed and coontail live in ponds. These plants, along with phytoplankton (microscopic plants) are the basis of the pond’s food chain.

Microscopic animals, or zooplankton, are typically abundant and diverse in ponds. Among these are daphnia, hydra, and cyclops which can be found in the smallest water sample.

Although frogs, tadpoles, snakes, turtles and an assortment of fishes are the pond animals that seem to get most of the attention, the often missed and more unusual of the pond’s inhabitants are its many “spineless wonders,” the invertebrate animals. The larvae or nymphs of many insects, such as mosquitoes, damselflies, and dragonflies abound in virtually every pond. Other fascinating pond insects include water striders, whirligig beetles, water boatmen, and predacious diving beetles. Tiny clams and mussels, snails, worms, amphipods, and isopods all live in and around the murky mud bottom. Ponds also attract an array of birds—wood ducks, green herons, prothonotary warblers and yellowthroats—and mammals, such as muskrats, beavers and otters. Close inspection of a pond reveals a whole different world!

Procedure

Before the Trip:
1. Visit the park and pond to become familiar with its resources and select appropriate study sites. Meet with park staff.
2. With the class, make a list of familiar plants and animals that live in and around ponds.
3. Describe the activity to the class.
4. Divide the class into teams of three to five students.
5. Discuss how to handle pond animals: hold them gently; put them promptly into containers with fresh pond water for observation;

Grade Levels: 3 - 6

Objectives:

- collecting specimens from several areas of a pond;
- observing and making field notes about two specimens in detail;
- classifying and identifying the specimens;
- organizing and producing a class “field guide.”

Materials:

Per team:
- long handled, fine meshed dip net
- 5 gallon bucket
- enamel or plastic dissecting tray
- quart jar or small clear plastic bottles (like medicine bottles)
- magnifying glass
- field guides
- ruler
- pond viewer - one large can, rubber band, masking tape, plastic wrap

Per student:
- boots or old sneakers
- change of clothing (just in case)
- 3 copies of Field Notes page
- clipboard
- pencil

When

At the Park: allow at least an hour for pond investigation, daylight hours are suitable. A quiet visit in early morning or evening may provide glimpses of pond visitors and inhabitants such as herons, beavers, and otters.

Time of Year: Late spring through early fall.

57
and keep only one of each species for study. All animals, insects, and larvae should be quickly and carefully transferred to the study pans. Observe but do not touch insects and animals such as predacious diving beetles, water boatmen, large snapping turtles and snakes, since all can give painful bites.

6. Discuss the use of field guides and how to take good notes for identifying plants and animals seen in the wild. With younger students, discuss characteristics of insects, mammals, reptiles, and amphibians. Use pictures and illustrations to help build their observational skills, encouraging them to pick out similarities and differences among several insects, birds, plants, or reptiles.

7. Make three copies of the accompanying Field Notes page for each student. Younger students may use plain paper instead for drawing pictures of the animals, plants, insects, etc.

8. Distribute one copy to each student to practice sketching and taking descriptive notes about a plant or animal in the classroom or on the school grounds. Discuss the concepts of habitat and animal behavior so that students understand these sections on the Field Notes page.

9. Make pond viewers for each team. Remove the top and bottom of large cans. Tape the cut edges and use a rubber band to hold a piece of clear plastic over one end. To use, put the covered end into the water and look down through the open end.

At the Park:

1. Near the pond area, find a place to sit. Review procedures, safety tips and respectful handling of animals. Demonstrate the use of the equipment. Three different netting techniques can be used:
   - To catch the quicker animals that are likely to flee (frogs, turtles, or minnows), approach the edge of the pond slowly with the dip net ready to scoop them up.
   - To catch slower animals and water plants, reach out into the pond as far as possible with the dip net and drag it along the bottom to scoop up some of the bottom muck, leaves and vegetation. Carefully search through the contents of the net to find an assortment of organisms.
   - In a few locations, the pond may be shallow enough and the bottom firm enough to permit wading. By moving slowly and quietly through the shallows, a variety of animals may be caught that would otherwise be missed. Be sure to inquire about wading conditions with the park staff.

2. After the demonstration, break into teams and spread out around the pond. Proceed with collecting. Each team should:
   - Put active animals in buckets half filled with pond water. Put slower animals in pans with about an inch of pond water in the bottom.
   - Pay attention to where in the pond the animals were found (on surface, in mud, etc).
   - Return everything, except the specimens, to the pond immediately, including globs of mud and leaves. Check the ground for

Where

Caledon: Jones' Pond is ideal site; special park transportation required; access seasonally restricted to small groups.

Chippokes: No ponds but fresh water marsh and cypress swamp on College Run provide similar habitats; access by foot is difficult and wet.

Leesylvania: two ponds (one is an old swimming pool) near picnic area are suitable for small groups; fresh water marsh of Powell's Creek.

Mason Neck: pond near visitor center is ideal site; wading not recommended since bottom is soft.

Seashore: cypress swamp pools and White Hill Lake provide a few suitable locations; discuss access to sites with park staff.

Westmoreland: Rock Spring Pond (0.5 mile walk on Rock Spring Pond Tr.) is a good study site; wading not recommended since bottom is soft.

York River: Woodstock Pond is ideal site; short piers provide access.

Resources

Court, J. Ponds and Streams. Franklin Watts, NY.


things that might have fallen or wriggled out of the net and return them to the pond, too.

- Use a jar or a small clear plastic bottle to collect pond water and examine it with a magnifying lens to find minute organisms.
- Try peering into the pond with the pond viewer.

3. Move among the teams, encouraging them to collect a variety of plant and animal specimens. Informally ask students to point out interesting and important identifying characteristics of their specimens and features that seem to be special adaptations for life in and around the pond.

4. After each team has collected six to ten specimens, move to a dry (and preferably shady) spot with the specimens. Working alone, each team member prepares Field Notes pages for three or four different specimens, including important identifying features such as:
- special markings and colors
- position and numbers of legs, fins, eyes, leaves, etc.
- conditions in which the specimen was found, e.g. in mud, attached to leaves, swimming near surface, floating on water, rooted along pond edge, etc.

5. If enough field guides are available, have students identify their specimens after taking the field notes, or save identification for back at school. Various field guides can be found in local libraries.

6. When all teams have completed their notes, put all the specimens together for group observations.

7. At the end of the session, collect all Field Notes pages for safe keeping after students put their names on them.

8. Together, return all specimens to the pond, clean up and account for all materials and equipment, and leave the site in its original state or better.

Follow-up:
1. Return the Field Notes pages to their owners for completion. If identification of the specimens was not done at the park, students may use field guides and other references to identify the specimens from their notes at this time.
2. When all pages are completed, collect them to make a class field guide. Students decide how the guide should be arranged, i.e. how the specimens should be classified—by animal categories, by habits, by physical characteristics, etc.—as authors do when making real field guides. The class may even wish to make a table of contents, title and authors’ page, and index.
3. If possible, make a photocopy for each student, who can then color the drawings similar to the natural coloring of the animals.
4. Hold a class discussion, considering the following questions:
   - How are the organisms similar/different?
   - What adaptations do they appear to have to suit them for pond life?
   - What do you think each might eat? What might each one be eaten by?
   - What happens to them in winter?
   - What might make life difficult for them? (Muddy water, pesticides, marsh draining project, etc.)
   - Do humans have any impact on the organisms?
   - Could the organisms live in a stream, mountain lake, ocean?
   - Is the pond community relatively stable or changing rapidly?

Extensions
1. Older students write a full report about one specimen, including a description of its life cycle, uses of the species by man (if appropriate), how it interacts with other pond inhabitants, where it fits into the pond food chain, etc.

2. Younger students make pond animal or plant puppets or masks out of socks or paper bags and paper and textile scraps. Choose their favorite animal seen on the trip. Each team makes up a short puppet show about the animals and how they live together in the pond, and presents it to the class. Build on environmental awareness by encouraging students to be air, water, etc., as well as plants and animals.

3. Collect a few jars of pond water to take back to school to study under a microscope.

Variations
Younger students:
1. Place small pond specimens one at a time in a petri dish of water and project the image of their shape and movement on the wall or a screen using an overhead projector.

2. Read the book Have You Seen My Duckling? (see "Resources") as a follow-up to the pond field trip. Students can make up their own versions of the story in writing or do a skit as a class.

Gifted/Advanced:
Students prepare a dichotomous key or a flowchart style key for the class field guide, or use such a key to identify the plants and animals.

Handicapped:
Teachers pre-collect pond specimens and set up stations for viewing or work one-on-one with students to collect specimens.
# Field Notes

Name:

<table>
<thead>
<tr>
<th>Plant’s or animal’s name:</th>
<th>Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat:</td>
<td></td>
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<tr>
<td>Size (measured or compared):</td>
<td></td>
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<tr>
<td>Behavior:</td>
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<td>Special Features:</td>
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Students collect specimens along a shoreline and use them to construct a food web. To understand the concept of a food pyramid, students participate in a simulation, taking the roles of hungry fish.

**Background**

The Chesapeake Bay estuary has long been acclaimed for its high productivity. To most, this productivity is viewed from the top of the food chain, and is measured in terms of tons of crab meat, flounder, bluefish, and oysters taken annually from its waters. However, the abundance of fish and shellfish in the Bay is the direct result of far more outstanding productivity, at the base of the food chain.

Production in any ecosystem begins at the plant level, where the sun's energy is harvested during photosynthesis. Plants are thus classified as primary producers. In the Bay, most primary production occurs in three areas: throughout the Bay in the top several meters of the water column by phytoplankton (microscopic, free drifting plants such as diatoms, dinoflagellates, and some algae); in the shallows, just below the surface by submerged aquatic vegetation (SAV) (rooted plants growing mostly below the low tide mark); and in the intertidal zone by wetland plants. Some primary production also occurs with algae attached to various surfaces—from mud flats to pilings—and some plant material enters the Bay from non-tidal wetlands and terrestrial areas bordering its waterways.

This abundance of plant material is consumed by a myriad of Bay organisms. Most of the larger plants, such as SAV and wetland plants, only enter the food chain after they die and become detritus (decaying organic matter). Essential to the decay process are decomposers, such as bacteria and fungi. The detritus and the decay organisms are consumed by various animals.

**Grade Levels: 4 - 7**

**Objectives**

Students will investigate trophic interrelationships in an estuarine food web by:
- observing evidence of organisms in the field;
- predicting position in food web;
- inferring feeding relationships;
- simulating feeding behavior of fish.

**Materials**

To wear:
- boots or old sneakers

To take:
- note cards (10 per team)
- pens or pencils (1 per team)

Available at the parks:
- buckets

For use at school:
- 11" x 1" strips of green cloth and red cloth (or any 2 colors)

**Where**

**Caledon:** beach at mouth of creek at Caledon Marsh; seasonally restricted access and park transportation required.

**Chippokes:** beach at mouth of College Run near College Run Trail.

**Leesylvania:** beach at Freestone Point near picnic area.

**Mason Neck:** beach near visitor center.

**Seashore:** beach near campground or shoreline near 64th St. boat ramp.

**Westmoreland:** beach at mouth of Big Meadows Creek near end of Big Meadows Trail.

**York River:** beach by picnic shelter #3 and adjoining salt marshes.

**When**

**At the Park:** 1 hour, daylight hours.

**Time of Year:** Any.
from tiny copepods and other zooplankton to menhaden. Menhaden and other filter feeders, including clams, oysters, barnacles and anchovies, also feed directly on the phytoplankton.

All of the organisms that feed on the plants can be classified as primary consumers. Most of these are eaten by larger animals, such as blue crabs, croaker, and weakfish, the secondary consumers. These in turn may be eaten by tertiary consumers such as bluefish, sandbar sharks, and ospreys.

Most consumers, however, do not fit neatly into these classifications. A menhaden, in the same mouthful, may eat detritus, bacteria consuming the detritus, and even copepods eating the bacteria. All at once, this makes the menhaden a primary, secondary, and tertiary consumer. Since consumption usually occurs in a complex network instead of along a simple food chain, the more descriptive term for these interactions is food web.

Another term, food pyramid, addresses the fact that at each level of consumption, the total amount of biomass (living matter) supported decreases. For instance, it may take four tons of diatoms at the base of the pyramid to produce one pound of bluefish near the top. This is largely because each consumer requires vast amounts of energy to build and maintain its own living tissues. The consumers get this energy (which originally entered the system from the sun via photosynthesis) by “burning” organic molecules, such as carbohydrates and fats, from the plants and animals they consume.

The food pyramid of the Chesapeake Bay is especially large because of the Bay’s incredible capacity for primary production. This production capacity is largely the result of the Bay’s geological features. Its immense watershed, over 64,000 square miles, funnels in a constant supply of nutrients and organic matter. The Bay’s gently sloping shores and many protected coves permit SAV beds and wetlands to thrive with little disturbance from pounding waves. With an average depth of only seven meters, phytoplankton are able to photosynthesize throughout much of the water column. The wide mouth of the Bay permits the unrestricted flow of salt water in from the ocean. As this mixes with the fresh water flowing in from the watershed, nutrients from the bottom and oxygen and carbon dioxide are drawn in, further enhancing production.

Despite all its capacity, the Chesapeake Bay’s productivity can be grossly disrupted. The destruction of wetlands reduces the energy input from detritus. Si, washing off agricultural and construction sites, blocks the penetration of sunlight essential to phytoplankton and SAV. Excessive nutrients from farms and faulty septage systems can cause algal blooms that also block sunlight and deplete dissolved oxygen supplies, critical for nearly all life forms. Boat traffic near SAV beds and marshes can create wave action that destroys the plants.

Procedure

Before the Trip:

1. Discuss with the class the concept of a food chain, web and pyramid. Talk about familiar food chains and webs.
2. Introduce the terms primary producer, primary consumer, secondary consumer and decomposers.
3. Generate with the class a list of animals and plants that might live near the shore. If available, share pictures of as many of these plants and animals as possible. Tentatively categorize them as to where each fits into the food chain and discuss observable clues which would help to verify or disprove the assigned position in the food chain.
4. Review all field trip plans.
5. Divide the class into teams of about 3 students each to work together at the park.

At the Park:

1. Lead the class to a shoreline — ideally a place with both a beach and marsh nearby. Set boundaries and give each team a collecting bucket, ten note cards and a pen or pencil.
2. Allow the class 10 to 20 minutes to explore the shore and to collect as much evidence of organisms as possible. Evidence that
Wanted: Dead or Alive

hints based on the following list of common beach finds:

- feather: nearly all birds eat other animals. Many small birds also eat fruits and seeds. Large birds often eat other birds, fish, or mammals.
- clam or oyster shells: most of these are filter feeders, consuming lots of tiny plants and animals.
- blue crab shell: these eat nearly any small animal they can catch or large animal they find dead.
- hoof print: the only native hoofed animals in the parks are deer, which feed exclusively on plants.
- fiddler crab: these eat detritus, algae, and decay organisms found in the mud.
- plant stems: easy, they’re primary producers.

4. Each team gives the rest of the class an explanation of their food web, explaining which organisms they think represent primary producers and primary and secondary consumers and suggesting what organisms might occupy broken links in their web. Encourage all students to discuss each team’s food web. Discuss:

- Which organisms were most abundant and where do these seem to fit in the food web?
- Which organisms were least abundant and where might they fit?
- Which organisms are most closely associated with living in the water, which with land, and which with both places?
- How does each team’s food web differ from the others’ and how are they alike?

5. Return all specimens near to where they were found.

Follow-up:

1. Play the following game to help students understand the food pyramid concept:

- Divide the class into three groups of equal size.
- Make one group “diatoms,” representing the primary producers. Give each diatom an 11” x 1” strip of green cloth to hang from a pocket or belt loop. (If plenty of material is available, use yard-long strips as waist bands.)
- Make another group “anchovies,” to represent the primary con-
sumers. Give each a red strip of cloth.
- Make the remaining students “bluefish,” representing a secondary consumer at the top of the food pyramid.
- Record the number of each type of organism.
- On the school grounds, mark off an area (100 sq. m or less) to be the habitat.
- Have the diatoms and fish mingle with each other within the habitat. When an anchovy encounters a diatom, it eats it by taking its green strip and the diatom leaves the habitat. When an anchovy has received two green strips, it continues to mingle but stops eating. When a bluefish encounters an anchovy that has two green strips, it eats the anchovy by taking its red and green strips and the anchovy leaves the habitat. The bluefish stops eating after consuming three anchovies. (Hint: If the students get too rowdy trying to catch each other, slow them down by making them each drag one foot.)
- When all the fish are full or have nothing left to eat, the fish stop where they are. Any fish which hasn’t eaten a full meal must drop dead from starvation and sit down in the habitat.
- Record the number of each type of organism remaining. (There should only be bluefish left at the end of this round.)
- Ask the students to suggest ways to adjust the numbers of organisms at the beginning of the game to create a more balanced feeding relationship. Try more rounds of the game, based on their suggestions, until the game ends with some of all three organisms remaining. Record the numbers of each type of organism at the beginning and end of each round.

2. In class, record on the board the number of each organism at the beginning and end of each round and make bar charts as shown.

3. Discuss:

- Why must there be more primary producers than primary consumers and more primary consumers than secondary consumers in order for a system to be balanced?
- What might be some real situations where the producer-to-consumer ratios would change in the Chesapeake Bay and what would be the results?
- If you are concerned about world hunger, would you be helping more by eating higher or lower on the food pyramid? Explain.

First Round: Start

[Bluefish]
[Anchovies]
[Diatoms]

First Round: Stop

[Bluefish]

Last Round: Start

[Bluefish]
[Anchovies]
[Diatoms]

Lippen*
Whose Clues?

Mystery stories are sometimes called "who-done-its." Putting together evidence (clues) to identify the perpetrator is fun. It can also be part of a scientific approach to problem solving. This activity focuses on actual clues left behind by various animal suspects. From this evidence, students make inferences about both the perpetrators and the circumstances under which the clues were left.

Background

The prospect of a class trip to a state park or other natural setting may inspire students to envision scenes from National Geographic specials or Disney nature films: A cotton-tailed rabbit dashing into a thicket just beyond the grasp of a swooping red-tailed hawk, a beaver gnawing down a birch sapling, an otter in hot pursuit of a bluegill, or a gang of wild turkeys scratching about on the forest floor for beech nuts and beetle grubs. All are very real scenes, happening daily in state parks but seldom witnessed, and especially not by crowds of enthusiastic youngsters. However, all animals leave behind clues of their activities—what they've been eating, where they've been walking, running, resting and rearing their young. When 15 to 30 pairs of eyes start searching an area for these signs, fascinating—and wonderfully gross!—discoveries are sure to follow.

Tracks, among the most obvious clues of an animal's presence, are most easily found in mud or sand near puddles, ponds or waterways. Each type of animal leaves a distinct footprint, distinguished by the number of toes, claw marks, size, and arrangement of the tracks.

Marks left by feet are not always very distinctive but they may still be important clues. For example, claw marks on smooth bark indicate where squirrels, opossums or raccoons have been climbing. Narrow trails or pathways indicate the regular routes of deer, rabbits or raccoons. A worn place on the bank of a creek or pond might be where beavers or otters regularly come ashore. Miniature tunnels through thick grasses are used by shrews, mice and voles. Small, soft ridges in the soil mark the tunnels of moles.

Animals leave an abundance of evidence of what and where they have been eating. Deer and other browsers snap off tips of twigs and branches. Squirrels drop stripped pine cones and nut shell fragments. Small, freshly overturned patches of leaves and soil might indicate where a squirrel has stashed or recovered nuts. Large patches of overturned leaves might be where a gang of turkeys have been foraging. Scattered feathers or tufts of fur show where a predator captured a bird or mammal.

The form and contents of droppings, or scat, can reveal a lot about the types of animals living in an area and what they've been eating. The scat of Virginia's native plant-eating animals tends to be small and uniform in size and composition. Scat of carnivores and omnivores tend to be larger and may contain hair, bones, and undigested seeds.

Not everything that looks like a dropping is necessarily scat, however. Among birds of prey, such as owls, not all of the indigestible parts of a meal pass through the digestive tract. Instead, these birds regurgitate pellets of fur and bones, about the size of the end of a thumb, which often accumulate under a favorite roost.

Roosts of other birds might be recognized by white splatters from their droppings on the ground under trees. Other signs of animal resting places may be compressed

Grade Levels: K - 10

Objectives

Students will investigate interrelationships between animals and their environment by:

- observing clues to wildlife activities;
- inferring about the types of wildlife present in an area and their activities.

Materials

- orange or red ribbon or flagging tape (two 1-foot pieces per student)
- ice cream sticks or short dowel rods (2 or more per student)
- copy of questions (1 per team)
- clip boards, paper and pencils (optional)
- plaster of Paris (optional)

Credits


When

At the Park: 1 hour, daylight hours.

Time of Year: All seasons.

Resources


Whose Clues?

vegetation in a thicket where deer have been resting, or a few hairs clinging to the bark just outside a hole in a tree where a squirrel or raccoon has been entering and exiting with regularity.

Many animals, especially birds, build nests when they’re ready to raise young. Although most nests in an area will be well hidden, a few can usually be spotted. Song birds’ nests are typically tucked away in thicket or in the leafy cover of trees, and may be constructed of an infinite variety of materials including grasses, spider webs, straw, hair and strips of bark. Large birds of prey, such as red-tailed hawks and bald eagles, build nests of sticks high in the tree tops. Woodpeckers excavate holes in dead trees or limbs and nest within the hollow.

Some animal homes may be used year-round, such as squirrels’ large leafy nests near the tops of trees. Beaver lodges constructed of mud, branches and vegetation may be conspicuous. A smaller wetland resident, the muskrat, constructs a similar, but smaller lodge from mud and grasses.

Procedure

Before the Trip:
1. Visit the park and select the best site or sites for this activity. Areas with plenty of diversity and with a little mud or sand are best, but the activity should work just about anywhere.
2. Describe to the class what the area of the park to be visited looks like.
3. With the class, brainstorm about the types of animals that might live in that part of the park and clues that those animals might leave behind. Write ideas on the board.
4. Divide the class into teams of three. Each team makes a set of six flags out of foot-long pieces of bright orange or red ribbon, taped to ice cream sticks. (Any thin, but not sharp or splinterly, stick will do, as long as it can be pushed into the earth.)
5. Explain to the class that they will look for animal clues at the park and mark the clues with the flags.

Where

Caledon: most accessible areas are edges of fields and woods near visitor center.
Chippokes: areas along beach near College Run Tr. and near mouth of College Run offer opportunities to find tracks and signs of animals associated with water.
Leesylvania: beach near picnic area is easily accessed and should have a variety of animal signs.
Mason Neck: beach and pond near visitor center should be ideal.
Seashore: marshes near 64th Street boat ramp should have many animal signs; cypress swamp near visitor center should be full of animal clues, finding them may require leaving trails.
Westmoreland: edge of woods and field near visitor center; woods along Big Meadows Tr. or beach and woodland area at end of Big Meadows Tr. should provide variety of animal clues.
York River: salt marsh near mouth of Taskinas Creek; beach by picnic shelter #3; edge of Woodstock Pond.

Extensions

1. Students use track field guides to identify the signs they found and verify their answers.
2. Make plaster-of-Paris casts of pet and people tracks found on the school grounds or at home.

Variations

Younger students:
One chaperone per group will be necessary. Chaperones should participate in the clue hunting with hints directing students to clues they might otherwise miss. Small groups of children could look for animal tracks. Pictures of different animal tracks could be shown and discussed before the trip.

Gifted/Advanced:
Students formulate a testable question and make a hypothesis about an animal behavior study that can be conducted at home or in the school yard (using birds, invertebrates, pets, etc.), design, and conduct the study.
1. What kind of a sign is it? (Track, scat, evidence of feeding (such as a gnawed branch), actual remains (such as a bone, feather or shed skin), a nest, pathway, tunnel or other sign.)

2. What type of animal do you think left the sign?

3. What was the animal doing when it left the sign? How can you tell?

4. With scat or owl pellets, what had the animal been eating? (Neat stuff can be found by examining pellets or poking around in scat with a stick. Most wild animal scat is relatively odorless.)

5. For each of the above questions, if you could do anything you wanted, how would you find out if your answers are correct?
Whose Clues?

black walnuts opened by gray squirrel

whitetail deer running track

greater yellowlegs and tracks

whitetail deer scat

mole runway

lizard droppings

antler gnawed by rodents

turkey and track

flicker and track

beaver signs

front

hind

67
What's My Line?

Along the shoreline, elevation is "where it's at," literally and figuratively. Communities thrive and persist within boundaries dictated by topography. Knowing where a study site is, in terms of vertical space, provides insight into both physical and biological conditions. Using the easy to make and use surveying equipment described in this activity, students can accurately measure elevation.

Background

The abiotic (non-living) and biotic (living) characteristics of a natural ecosystem are often introduced to students using a cross-sectional drawing that shows "typical" plants and animals positioned within their "typical" habitat. This perspective is valuable in studying how differences in elevation, sunlight, temperature, moisture, soil, etc. affect the distribution of plants and animals in their habitat.

When students collect field data, they sometimes get preoccupied with the methods of collection and measurement, and fail to synthesize the data collected. One way to put field data into perspective is to make a cross-sectional map of the habitat and include the biotic community. As students use their field data to complete the map they should begin to discern the interrelationships that exist within an ecosystem.

Beaches and dunes or old fields are ideal habitats for profile studies, because the changes observed while mapping illustrate the processes of primary succession and secondary succession, respectively. The profile activity can be applied to any ecotone (a zone where two community edges blend) to illustrate changes in distribution, such as high to low marsh, field to forest, or wetlands to pond or stream. The variety of organisms is typically greater in ecotones, with plants and animals from both communities living in the overlap area.

Procedure

Before the Trip:
1. Make enough measuring and guide pole sets from 2" x 2" lumber for each team of 3 to 4 students.

Grade Levels: 6 - 12

Objectives

Students will investigate topographic variation in a landscape and look for interrelationships between living and non-living components by:
- measuring and mapping elevation changes;
- recording corresponding biotic and abiotic features along a transect.

Materials

Per team:
- 2" x 2" x 2 m wooden pole
- 2" x 2" x 1.5 m wooden pole
- two 2" x 2" x 1.5 m wooden stakes (or something comparable)
- meter stick
- hammer
- roofing nail (short nail with wide head)
- nylon or cotton string: one piece 4.6 m long; another piece 20.5 m long
- permanent marker
- line level (available in hardware stores)
- data sheet, clipboard, pencil for recording field data
- other field equipment for measuring abiotic features (e.g. thermometer, soil core sampler, etc.)
- 8.5" x 11" graph paper for maps
Make the measuring pole 2 m long and the guide pole 1.5 m long. Label both poles. Stand the poles upright, side by side, on the floor. Mark a line on the measuring pole where the top of the guide pole touches it and number the line "0." Next mark each centimeter above and below the zero mark for 100 cm. Number the marks every 5 cm and put a plus (+) sign on those above the zero mark and a minus (-) sign on those below the zero mark as illustrated. Drive a roofing nail into the top center of the guide pole.

2. Cut a length of strong nylon or cotton string 4.6 m long. Using 20 cm on one end, tie a loop just big enough to fit over the head of the nail on the guide pole. Using 40 cm on the other end, tie a loop large enough to get a hand through. Make sure that exactly 4 m of line remains between the knots. Mark the string between the knots every 50 cm.

3. Make a transect line by tying the 20.5 m length of string to two stakes 1.5 m long (made from 2" x 2" lumber, dowels, or any stake material). Sharpen the stakes on one end. Be sure to leave exactly 20 m of string between the stakes; wrap the string around the stakes to avoid tangling.

4. Divide the class into teams of 3 to 4 students. The teams should decide upon a role for each member, such as guide pole holder, measuring pole holder, level reader and data recorder.

5. Demonstrate the complete profiling process on the school grounds with four students. First stretch out the transect line and drive the stakes into the ground with a hammer. Be sure not to drive the stakes into underground cables or pipes. One student stands the measuring pole at the beginning of the transect line, holding the looped end of the string against the pole. Another student stands the guide pole 4 m along the transect, with the other end of the string looped over the nail. (The string should be taut, but not stretched between the poles.) A third student attaches a line level to the middle of the string and instructs the measuring pole holder to move the string up or down the pole until the line level bubble is centered. The change in elevation where the string meets the pole is measured using the centimeter scale and read aloud for the data recorder. The students then move the measuring pole to the guide pole position and move the guide pole 4 m down the transect line to make another measurement. The process continues until the entire 20 m transect is completed and five changes in elevation have been recorded.

Discuss with the class what should be done if, for example, a slope is so steep that the elevation changes by more than 100 cm over

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**Where**

Caledon: field/woods edge; across stream near junction of Laurel Glen and Poplar Grove Trs.; across ravine and up slope between Fern Hollow Tr. and picnic area.

Chippokes: edge of river, across beach, to edge of College Run Tr. near mouth of College Run; across College Run and up banks at trail bridge; across 2 sides of fenced pasture to north of mansion, near trail gate (do not climb fence, beware of barbed wire).

Leseguivania: beach to upland transition near picnic area; across old swimming pool; across any old home site; across ravine along Powell's Cr. Tr. Mason Neck: beach to edge of pond; field/woods edge near picnic area; parallel to 1 of 3 bridges crossing wetlands on Bay View Tr.

Seashore: beach to dunes near campground; parallel to Bald Cypress Tr. bridge across cypress pool; salt marsh near 64th St. boat ramp.

Westmoreland: field/woods edges; beach to uplands near end of Big Meadow Tr.; across sections of wetland near end of Big Meadow Tr.

York River: salt marsh onto upland near Taskinas Cr. canoe launch; from Woodstock Pond dam, across marsh to edge of river; across ravines at upper end of pond.

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**When**

At the Park: 2 to 3 hours, depending upon complexity of profile.

Time of Year: Any time is suitable but a greater diversity of plant and animal life may be observed during the warmer months.

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**Resources**


What’s My Line?

the standard 4 m distance. (Suggest measuring the elevation change over a shorter distance and record the distance between the poles, using the 0.5 m marks on the string.)

6. Guide the class through discussion to develop a list of environmental profile data that might be useful for studying habitats, communities and ecotones. Use this list to make a profile data sheet for the field trip (see sample Profile Data Sheet). Discuss:

- What habitats might be found at the park?
- What abiotic features (such as light, moisture, slope, elevation and soil type) might distinguish each habitat and how?
- What communities of organisms might be found that will distinguish these habitats as ecosystems?
- How can these biotic and abiotic features be quantified or measured?

7. The students should develop several hypotheses about the inter-relationship of abiotic and biotic features. The data gathering and subsequent analyses will be to test their hypotheses.

8. Be sure the features to be noted and the methods of quantifying them are at a level suitable for the class. For instance, plant identification can be limited to simply distinguishing between grasses, other herbaceous plants, shrubs, and trees. Soil type might be just sand, gravel, mud, etc. Point out that the abiotic features are natural independent variables, and the changes that result are dependent variables.

9. If necessary, review the various techniques for making the measurements and identifications required to complete the profile data sheet.

10. Look over a map of the park with the class to decide where profiles will be conducted. Decide whether teams will make their transects: a) in separate areas, resulting in diverse sets of data; b) parallel to each other, giving similar results that can be compared for slight variations; or c) end-to-end, allowing the construction of long profiles.

At the Park:

1. Help the teams identify exactly where they will be conducting their transects and set up the transect lines.
2. Each team measures and records the changes in elevation across their transect, filling in all pertinent data on the data sheet.
3. Watch for and help the students solve measurement problems, if necessary. Point out the need to use intermediate spacing if the standard 4 m distance causes a small depression or rise to be missed.

Follow-up:

1. As a class, make a profile map from the field data as follows:
- Based on the data collected, tape pieces of graph paper together (end-to-end and side-to-side) and set an appropriate scale (e.g. 1 block on graph paper equals 10 cm). Draw X and Y axes along the bottom and left edges of the graph paper. Mark and number the blocks according to the scale chosen.
- Graph the points for all changes in elevation recorded from the field data. Connect the points to make an elevation profile of the transect site.
- Use symbols or drawings to indicate the locations of plants, animal signs or other characteristics noted in the field to complete the profile.
2. Lead the class in a discussion to help the students analyze their data:
- What were the abiotic features noted along the transect? Which changed and which did not?
- When there was a change in abiotic features, were there corresponding changes in the plant or animal life?
- Are there any evident relationships between slope and abiotic or biotic features?
- Were any specific features common across the entire profile?
- What might have caused observed changes in elevation? Erosion? Deposition? Man?
3. Students should now be able to confirm or reject their hypotheses.

Extensions

1. Make a wall mural of the cross section map from the profile, drawing in animals and plants.

2. Try a profile along a boardwalk nature trail so students can profile wetland habitats without getting wet.

3. Profile wetland habitats on either side of a pond or stream. Use a line and sinker from a boat to get depth variations across the water (try to work in a line between two landmarks to minimize lateral movement). Combine these to make a complete profile across the entire aquatic habitat.

4. Lay out several parallel profiles to create a topographic map by connecting points of similar elevation. Compare results to a USGS topographic map (see park information section).

5. Do profiles in the same area at different times of year to record seasonal differences.

Variations

Younger students:
Simplify the profile by eliminating the transect line. Pick two points in the field to work between. Use a shorter string without marks and keep the distance from the guide pole to the measuring pole constant, regardless of any intermediate changes in features. Back in class plot the points along the axes and let students “connect-the-dots.” Complete the profile by having them glue on drawings of some of the common plants and animals observed.
## Profile Data Sheet

**Team Name:** Mud Stampers  
**Date:** May 1  
**Location:** Jack River State Park  
**Brief Transect Description:** From edge of river across marsh and into woods just below visitor center.

<table>
<thead>
<tr>
<th>Station No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance b/w Guide &amp; Meas. Poles</td>
<td>4m</td>
<td>4m</td>
<td>2.5m</td>
<td>1.5m</td>
<td>4m</td>
<td>4m</td>
</tr>
<tr>
<td>Elevation change on Meas. Pole</td>
<td>+10cm</td>
<td>+12cm</td>
<td>-28cm</td>
<td>+20cm</td>
<td>+24cm</td>
<td>+39cm</td>
</tr>
<tr>
<td>Common Plants &amp; Position*</td>
<td>small willow, 3.5-5.0m</td>
<td>short grass 5-9cm</td>
<td>musk grass 5-9cm</td>
<td>musk grass 5-9cm</td>
<td>short grass 5-9cm</td>
<td>tall grasses 8-15cm</td>
</tr>
<tr>
<td></td>
<td>bare 2-4m</td>
<td>-2-4m</td>
<td>-2-4m</td>
<td>-2-4m</td>
<td>-2-4m</td>
<td>-2-4m</td>
</tr>
<tr>
<td>Animals, animal signs &amp; Position*</td>
<td>periwinkles 3.5-5.0m</td>
<td>herring gull 2-4m</td>
<td>raccoon tracks 2m</td>
<td>2-4m</td>
<td>2-4m</td>
<td>2-4m</td>
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<tr>
<td></td>
<td>-2-4m</td>
<td>-2-4m</td>
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<td>-2-4m</td>
<td>-2-4m</td>
<td>-2-4m</td>
</tr>
<tr>
<td>Soil Type</td>
<td>grey mud</td>
<td>grey mud</td>
<td>grey mud</td>
<td>grey mud</td>
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<td>grey mud</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>to sand</td>
<td>sandy</td>
</tr>
<tr>
<td>Soil Moisture</td>
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<td>moist</td>
<td>moist</td>
<td>moist</td>
<td>moist</td>
<td>firm</td>
</tr>
<tr>
<td>Soil Compaction</td>
<td>very soft</td>
<td>soft</td>
<td>soft</td>
<td>soft</td>
<td>soft</td>
<td>firm</td>
</tr>
<tr>
<td>Other Key Features &amp; Position</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>

*Position refers to where (in meters) within a transect station the plants, animal signs, etc. were located.

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*Note: The diagram shows a line graph with distance (m) on the x-axis and depth (m) on the y-axis, indicating changes in elevation along the transect route.*
Changing of the Green

Sassafras

Students investigate differences in the abundance of woody and herbaceous plants growing in areas with different mowing regimes to explore the tendency for forests to succeed field habitats that are left undisturbed.

Background

When Captain John Smith explored the Chesapeake Bay in the early 1600's he noted, "Virginia doth afford many excellent vegetables and living creatures, yet grass there is little or none, but what growth in low marshes; for all the country is overgrown with trees." Such would still be the case today, were it not for the steady influence of saws, plows, mowers and livestock since there is a natural tendency for land to revert to forest after being disturbed.

Signs of this succession can be easily found on almost any patch of open ground left undisturbed for a few years. The evidence is young, woody plants—vines, shrubs and trees—sprouting among the grasses and other herbaceous species that preceded them. By far, the most obvious and most abundant pioneer tree species in the Bay region are scrub and loblolly pines. However, several other woody plants might be among the first to grow in an area, including Japanese honeysuckle, trumpet vine, poison ivy, smooth and winged sumac, blackberries, green briar, wild rose, red cedar, sassafras, sweet gum, tulip poplar and red maple.

Most woody species cannot tolerate being cropped off by mowers or grazing animals and are thus absent or scarce on lawns and pastures. However, if undisturbed, woody plants rapidly appear. At first they are scattered and somewhat hidden among the grasses, goldenrod, Queen Anne’s lace and other annuals and perennials. With each successive year, more woody plants appear. Many sprout from seeds, and others—particularly the vines and brambles—grow as vegetative shoots from the original pioneer plants.

Grade Levels: 6 - 12

Objectives

Students will investigate change in plant composition of quadrats of earlier and later succession stages by:

- predicting relative abundance of plants;
- distinguishing between herbaceous and woody plants;
- quantifying plants within a given space;
- comparing actual ratios of plants.

Materials

- insect repellent (ticks and chiggers can be a nuisance in tall grass)

Per team:

- quadrat markers (1 hula hoop OR four meter sticks, bolts and wing-nuts)
- bean bags or other tools for random point selection
- clipboard, paper, pencil

Credits


When

At the Park: Allow 30 minutes per study site. Regular park hours.

Time of Year: Late spring through fall best, can be done in winter.
Changing of the Green

Red Cedar

Woody plants can take over entire fields or very small patches of ground, such as the corner of a lawn, along the edge of a fence or in an untended flower bed.

During the early stages of succession, the combined woody and herbaceous plant growth can be very dense and lush, providing valuable cover and food for many animal species such as bobwhite, cotton-tail rabbits, box turtles, snakes, grasshoppers, praying mantises and garden spiders. Some state parks keep sections of old fields in the early stages of succession by mowing them on a two to four year cycle. This maintains habitat diversity, valuable to wildlife.

Procedure

Before the Trip:
1. Visit the park to locate at least two study sites. One should be an area mowed at least twice a year. The other should be a place that has been unmowed for at least two years. If possible, locate several areas at various stages of succession. The park staff should be able to help locate these sites and give some indication of the last mowing date.

2. Review with the class the concept of species abundance, in which abundance (A) is calculated by dividing the number of individuals of one species (or group of species) (N) by the total number of individuals of all species found in an area (T). Thus:

   \[ A = \frac{N}{T} \]

   For example, there may be 400 pine seedlings growing on a plot with 1600 other plants. Thus:

   \[ A = \frac{400}{1600 + 400} = \frac{400}{2000} = 0.20 \]

3. Divide the class into teams of three.
4. Each team lists two or three ways to estimate the abundance of plants in a large area without counting each plant. Write their ideas on the board and discuss the pros and cons of each. Lead the class to the concept of using quadrats (samples of small sections of the area) to make population estimates about the whole area.
5. Each team makes a quadrat marker by one of the following methods:
   - Square marker: Join the ends of four meter sticks with wing-nuts and bolts to make a square. (Any other 1 m long pieces of thin, sturdy material will do.) The wing-nuts can be loosened or removed to fold down the marker for storage or transport.
   - Hoop-style marker: Hula-Hoops work well, but be prepared to cut them in one piece to fit around large plants.
6. Ask the class to think of ways that sampling with quadrats could be biased. (E.g. The sampler is afraid of spiders so doesn't take any quadrat samples near "spider plants.") Lead them to the concept of taking random samples and have each team think of two or three ways to choose random quadrat samples. Write their ideas on the board and settle on a simple method that can be used during the field trip. (A bean bag tossed randomly into the study site is sufficient for this activity.)
7. On the school grounds, practice selecting random samples, using the quadrat markers, and calculating the abundance of some type of plant, such as grasses or broad-leaved plants.

8. Explain to the class that they will be investigating the abundance of woody plants in various sites at the park. Provide the recent history of each site: Has it been mowed, plowed, burned? If so, when? Each team ranks the sites on paper, predicting which ones will have the greatest abundance of woody plants.

9. Review ways to distinguish woody from herbaceous plants:
   - Woody plants usually have solid, tough, flexible stems. The main stems on herbaceous plants are often hollow and usually easy to break.
   - Woody plants stay alive through the winter. Even though they may lose their leaves, the stems

Where

Caledon: visitor center lawn; old field behind visitor center; old orchard near Newton House.
Chippokes: vista along College Run Cr.; driveway to last tenant house on Cedar Lane; park roadsides between mown areas and forest; powerline easements.
Leesylvania: road spoil site; marina spoil site.
Mason Neck: Phase II abandoned farm fields; field next to Belmont Bay has woody species about 5 yrs. old.
Westmoreland: most fields mowed at least once a month; powerline easements mowed about once a year.
York River: fields near visitor center; old fields near maintenance area; horse trails.

Resources

remain flexible and the bark, when scraped a little, has a greenish tint and is moist and supple. Many herbaceous plants stay green through the winter, but these are usually low to the ground and lack a live, central stem.

10. Make sure everyone can recognize poison ivy, which can cause a terrible rash. It may appear as a woody vine or look more like a low shrub. The leaves are usually smooth and shiny above, and are divided into three distinct leaflets. The main stem of mature vines is often covered with brown “hair.”

At the Park:
1. At each study site, set the boundaries for the area being investigated and have each team do the following:
   - Randomly select three points within the study area.
   - At each point, lay the quadrat marker on the ground with the point at its center. (Disconnect at one point, if necessary, to get around trees too large to reach over.)
   - In each quadrat, count all the woody plants and all herbaceous plants and record the numbers. Plants that are partially within the quadrat should be counted. Consider as one plant anything that grows in a clump, such as some grasses, or plants that are joined above the ground by runners, such as strawberries.
   - Repeat the above steps two more times and use the total counts to calculate the abundance of the woody plants for the site.

Follow-up:
1. Each team compares their predicted rankings for the sites with the results of their field study. Take a show of hands to determine which teams ranked the sites accurately. Discuss their results:
   - How did the mowing regime seem to affect the abundance of woody plants growing in a site?
   - Why might woody plants be less able to survive in frequently mowed areas than herbaceous plants?
   - What factors, other than mowing, might affect the abundance of woody plants? (e.g. A salt marsh might never be mowed but may not have woody plants in lower areas due to the influence of frequent flooding by salt water. The floor of densely shaded forests may have few or no woody plants, if the mature trees are not counted.) Consider also the effects of natural and man-made fires.
2. Take class totals for the woody and herbaceous plants counted at each study site and calculate abundance using these numbers. Make a bar chart on the board showing the results for each team. (See example.)

Extensions
1. Students search for successional changes by finding old photographs of familiar places and comparing them with the sites today.

2. Fence off a 1 m² plot on the school grounds and keep a monthly record of the species growing there for a period of several years. This could be an interesting way to plant a tree on the school grounds.

Variations
1. Do a quadrat study with areas along a different gradient such as salinity in a tidal marsh, moisture in a ravine or frequency of inundation from low to high marsh.

2. Consider doing this activity along different power line easements. Power companies generally keep records of mowing regimes for easements. Be sure to get permission from the power company and property owner.

Younger students:
1. Encourage the students to categorize the woody stems in their own different ways.

2. Map the park area and label each site prior to the trip. Students draw or color types of vegetation, shading drawings to represent the predicted abundance of woody plants.

3. Estimate species abundance in the quadrats together as a group.

Discuss the results shown on the graph with questions such as:
   - Which is likely to give more accurate results—large samples or small samples? Many samples or fewer samples?
   - If each team had taken 20 samples at each site, and the class results were again graphed, would the difference between individual team results be greater, smaller or about the same? (Team results should approach the class average with increased sample size.)
A Forest Grows

Blowing in the wind, stuck to fur, or pre-packaged with fertilizer, today’s seeds are tomorrow’s forests. Through this activity, students discover some of the forest’s reproductive strategies.

Background

From the cypress swamps of Cape Henry to the wooded slopes and ridges of the Allegheny Mountains, all of the forests within the Chesapeake Bay’s watershed are essential to its health. The most important reason: forests hold the soil and slow the rush of rainwater off of the land, minimizing the flow of sediments into streams, rivers and the Bay.

The Bay aside, forest values are many. Forests add to the diversity of plant and animal species. They shade streams, keeping shallow waters cool and free of certain types of prolific algae. They allow rain water to percolate into the soil, recharging aquifers and keeping streams and rivers flowing at relatively consistent rates. Forests provide inviting places for people to hike, camp, picnic and hunt, and they provide the raw materials for a vast array of products from lumber and turpentine to paper and flower-bed mulch.

Forests go through a process of succession, where certain species become established in an area only after other species have grown there first. Pines grow best in open sunlight and are often the first trees to grow in an area. Eventually, pines are replaced by other species such as sweet gums, maples and tulip poplars. These in turn are replaced by oaks, hickories and beeches. When a forest reaches the stage where the tree species change very little over time (100 - 200 years in the Bay region), it is called a climax forest.

Because a seedling often has a better chance of surviving if it can grow away from its parent tree, many tree species have evolved ways to disperse their seeds. Pine, tulip poplar, ash and maple seeds have “wings” that permit them to be carried by the wind as they flutter to the ground. Sycamore seeds have “parachutes” and can ride the wind for miles. Beeches, oaks, hickories and walnuts produce nuts that are relished by squirrels. The squirrels eat many of these nuts but they also plant some by burying them for winter storage. Tupelo, dogwood, persimmon, cherry and holly produce fruits which are consumed by raccoons, opossums and song birds. The seeds, adapted to endure the rigors of digestive systems, are eventually dropped, complete with a little dose of fertilizer.

Procedure

Before the Trip:

1. Discuss with the class the basic concepts of forest succession and how it is to the advantage of many tree species to disperse their seeds.
2. Ask students to give their ideas about how tree seeds might travel and write these ideas on the board.
3. After the students classify these methods into groups and subgroups similar to the listings on the illustrated seed dispersal chart, write the classified list on the board.
4. Students name or describe trees (or other plants) that they know using the methods listed on the board. Write these beside the methods.
5. From this list, make a chart similar to the one illustrated. Give each type of seed dispersed described by the class a block on the chart. Group similar methods together. Do not include the names of trees listed by the class.

At the Park:

1. Lead the class to a forested area of the park.
2. Make sure everyone can recognize poison ivy, which can cause a terrible rash. It may appear as a woody vine or look more like a low shrub. The leaves are usually smooth and shiny above, and are divided into three distinct leaflets. The fruits, which usually grow in clusters, are round, slightly fuzzy, about 5 mm wide and white when ripe. For an illustration, see the previous activity, “Changing of the Green.”
3. Give each team 2 copies of the seed dispersal chart and a roll of clear tape.

Grade Levels: 4 - 10

Objectives

Students will investigate variation in seed structure and methods of dispersal by:

- observing seeds’ physical appearances, evidence of trees’ reproductive strategies;
- inferring possible relationships among types of seeds, seed dispersal methods, and location of seedlings.

Materials

- large envelope, bag or box for holding collections
- notebook or plain paper
- clipboard
- pencils or pens
- clear adhesive tape
- flagging tape or bright ribbons
- 5-10 plain sheets of paper

6. Divide the class into teams of 2 to 4 students each.
7. Make at least two copies of the seed dispersal chart for each team.
A Forest Grows

4. Instruct the teams to collect one sample of each type of seed or fruit they can find and to tape each onto the chart in the block for the dispersal method that they think applies to the seed.
5. Set boundaries for the search for seeds and fruits.
6. The teams spread out and collect seeds and fruits for about 15 minutes.
7. Reassemble the students and place their charts together on the ground where everyone can see them.
8. Discuss:
   - Which seed(s) seems to be most common?
   - Which dispersal method seems to be most common?
   - Were any of the seeds or fruits taken directly off the parent tree?
   - Could anyone tell if a fruit or seed was laying on the ground directly under the parent tree or if any seeds were obviously not under the parent tree?
9. Explain that the next part of the activity will help them better discover how far seeds might have traveled from the parent tree.
10. Give each group some flagging tape or bright ribbon, plain sheets of paper, and tape. Instruct them to:
    - Find a tree seedling (or sapling) two to four feet tall.
    - Mark the seedling with a flag.
    - Pick one (and only one) leaf from the seedling and tape it to a piece of paper.
    - Search the forest for a big tree with leaves that look like one from the seedling. Consider this to be the parent tree, though it in reality it may not be. (Since it may be hard to see the leaves on very tall trees, suggest that they look for fallen leaves under tall trees as well.)
    - If a leaf can be reached on the parent tree, pick one leaf and tape it next to the seedling leaf.
    - As one team member stands by the parent tree, another returns to the seedling and stands by it. A third team member walks directly from the parent to the seedling, counting the number of steps between them, and records this number on the paper under the leaves.
11. Allow 15 to 20 minutes to conduct the activity. Reassemble the class and place the collections on the ground where everyone can see them. Discuss:
   - Which seedling was closest to the parent tree?
   - Which seedling was farthest from the parent tree?
   - Were there any seedlings for which a parent tree could not be found?
   - How do you think each seedling was planted?
   - Was there any evidence that any of the seedlings came from seeds like those found in the first part of the activity?
   - What seems to be the most common seedling?
   - What seems to be the most common tree in this forest?
   - Are the most common tree and seedling the same species?
   - Based on the above question, will the forest look very different when the seedlings are full grown?
12. Collect all of the seed and leaf collections and place them in a large envelope, bag or box for the trip back to school. Collect all of the pieces of flagging tape placed on seedlings.

Follow-up:
1. Tape or tack the papers with the leaf samples on a wall in rows. Group those with similarly-shaped leaves together in columns.
2. Give each leaf type an identifying letter or number.
3. Each student should study the leaf display and make a bar chart showing the distance, in footsteps, of each type of seedling from its parent tree. (Students should calculate and use averages for those species represented by more than one seedling.)
4. Students can use field guides to identify the seeds and leaves they collected and, where appropriate, to match the seeds to the leaves.

Where

Caledon: forest near visitor center is suitable, particularly interesting is climax forest accessed by Fern Hollow and Poplar Grove Trails (2 mile walk, round-trip, from visitor center). Chippokes: succession from pine forest to hardwoods is evident in plantation pine tree stand near visitor center.
Leesylvania: any woods along various trails are suitable, Powell's Creek Trail passes through fairly mature hardwood forest.
Mason Neck: Kane's Creek Trail passes through mature hardwood forest quite open in some places, permitting students to spread out but still be in sight of each other.
Seashore: certain sections of trails near visitor center pass through areas providing great views of succession in a maritime forest.
Westmoreland: Turkey Neck Trail, originating near park office, passes through a mature hardwood forest.
York River: small stand of pines near start of Mattaponi Trail is a good location to observe succession in a pine forest, other trails pass through forests in various successional stages.

When

At the Park: 45 minutes to 1 hour, plus walking time to and from study site; any daylight hours.

Time of Year: Late summer to early fall is best, since seeds and fruits are most abundant then.

Resources

Harlow, W. M. 1941. Fruit Key & Twig Key. Dover Publications, Inc.
A Forest Grows

Common Tree Seeds and Fruits

- Hickory
- Persimmon
- Beech
- Black Willow
- Hop Hornbeam
- Sweetgum
- Sycamore
- Dogwood
- Pine
- Water Tupelo
- Live Oak
- Red Maple
- Pawpaw
- Ironwood
- Tulip Poplar
# Seed Dispersal Chart

## Seeds Carried by Animals

<table>
<thead>
<tr>
<th>Eaten and Left in Droppings</th>
<th>Buried for &quot;Storage&quot;</th>
<th>Other</th>
</tr>
</thead>
</table>

## Seeds Carried by Wind

<table>
<thead>
<tr>
<th>&quot;Parachutes&quot;</th>
<th>&quot;Wings&quot;</th>
<th>Other</th>
</tr>
</thead>
</table>
Knee Deep

Students find out what a cypress swamp is like by closely observing the unique sights, smells, sounds and textures of this special environment.

Background

Seashore State Park's cypress swamp is an area of timeless beauty. On a leisurely walk along the 1.5 mile Bald Cypress Trail, the modern explorer can make some of the same discoveries made by English explorers nearly 400 years ago: Spanish moss hanging from cypress tree limbs; American bitterns lurking in the shadows of button bushes rimming tea-colored pools; painted turtles basking on mossy cypress knee islets; and warblers, vireos, wrens, and bullfrogs joining in a chorus accompanied by the rattling drum of pileated woodpeckers.

Procedure

Before the Trip:
1. Contact the park to schedule a field trip and to discuss plans.
2. Visit the park and obtain a copy of the Bald Cypress Nature Trail interpretive brochure. The brochure provides detailed background information about the cypress swamp. It may be borrowed from the Seashore Environmental Education Center library or purchased for a nominal charge.
3. With brochure in hand, walk the Bald Cypress Trail, noting items of interest at each marker post and selecting five places where the class will make careful sensory observations. These places may be at some of the posts or places in between. Try to choose sites with qualities clearly unique to the cypress swamp and maritime forest. Some places to choose as sensory stops might include:
   - on a boardwalk across a cypress pool
   - under a large pine tree
   - on the edge of a briar thicket
   - close to some cypress knees projecting from the water
   - next to an old, overgrown dune
   - at a fallen log
4. For each student, make a copy of the accompanying Sensory Chart.
5. At school, tell the class they will be visiting a cypress swamp,
one of the first places explored by some of the very first Englishmen to come to America, and that in many ways, the swamp is just like it was then. Explain that before these men arrived, they must have had their own ideas about what the New World would look, sound, smell, and feel like. Upon exploring a swamp, their senses must have been surprised by all the new things to see, hear, smell, and touch.

6. Divide the class into groups of about four students each. Each group makes four lists—special sights, sounds, textures, and smells—that they expect to encounter in the swamp. Groups should list as many things they can think of, but not anything that would be found in other places.

At the Park:
1. Give each student a Sensory Chart, clipboard, and pencil.
2. Lead the class along the Bald Cypress Trail to the sensory stops selected during the pre-trip visit. Point out interesting features described in the trail brochure along the way.

3. At each sensory stop, allow students to spread out a little and to then stand or sit quietly for five minutes. Students should note one special sensory experience for each of the four senses listed on the Sensory Chart, and answer the corresponding questions.

Follow-up:
1. Write on the board all (or a representative sample) of the sensory things the students predicted they might experience in the cypress swamp.
2. Take a show of hands to determine which things were actually experienced.
3. Make another list on the board of all (or some) of the things not already listed, that the students experienced.
4. Compare the lists and discuss:
   - What was the most surprising thing that wasn’t experienced that was expected?
   - What was the most surprising thing that was experienced?
   - Using everyone’s descriptions, can a cypress tree be defined?
5. Each student composes a poem, haiku, or short story incorporating his or her noted perceptions of the cypress swamp.

Resources
Seashore Natural Area. “Swamp Subzone.” Passport to Paradise. Virginia Beach, VA.

Extensions
Draw or cut out pictures of plants and animals observed in the swamp and make a collage. Color the picture, blending the animals in with their surroundings. This may be done as small individual projects, or as a class project using a large poster or bulletin board format.

Handicapped:
Since this activity emphasizes sensory activities, defining the cypress community in these terms, it is suitable for the visually and hearing impaired. Photos and tape recordings could be made in place of written records. Sensory perspectives should also be of interest to fully sighted students, and be used with mixed groups.
Sensory Chart

Instructions: At each designated stop along the trail, describe one special thing that you sense for each of the four senses listed below and answer the questions. Pick something different each time and only list things you have never experienced anywhere else.

<table>
<thead>
<tr>
<th>Sounds - Describe a sound (squeaky, rumbling, etc.)</th>
<th>Rate loudness from 1 (whisper) to 5 (shout)</th>
<th>Where does the sound seem to be coming from?</th>
<th>What do you think made the sound?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
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<tr>
<td>2.</td>
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<td>3.</td>
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<tr>
<td>4.</td>
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<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Smells - Describe a smell (sweet, spicy, etc.)</th>
<th>Where does the smell seem to be coming from?</th>
<th>Does it smell like anything familiar? What?</th>
<th>What do you think makes the smell?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
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<tr>
<td>2.</td>
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<td>3.</td>
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<td>4.</td>
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<tr>
<td>5.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sights - Describe something you see</td>
<td>Is it an animal?</td>
<td>Is it a plant?</td>
<td>Name it, if you can</td>
</tr>
<tr>
<td>-----------------------------------</td>
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<td>-------------------</td>
</tr>
<tr>
<td>1.</td>
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<tr>
<td>2.</td>
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<td>3.</td>
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<td>4.</td>
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<tr>
<td>5.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Textures - Describe something you touch (cool, wet, etc.)</td>
<td>Is it an animal?</td>
<td>Is it a plant?</td>
<td>Name it, if you can</td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td></td>
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<tr>
<td>2.</td>
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<td>3.</td>
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<td>4.</td>
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<td>5.</td>
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</tbody>
</table>
Hot Foot

If you have ever walked barefoot across a beach on a brilliant summer day, you already appreciate sand’s ability to absorb heat. In this activity, students measure temperatures in the beach habitat to examine the effect of this abiotic factor on dune organisms.

**Background**

When students visit a beach, one of the last habitats they would think of is a desert because of all the “water, water everywhere”. However, in many ways, the dune and upper beach habitats are very similar to a desert. The stresses of high temperatures on the sand, intense sunlight, wind, salt spray, and dry soils demand special adaptations.

Plants on the dunes share some of the typical desert plant adaptations. Many of the plants have reduced leaves, waxy coatings over the leaves, succulent stems and leaves, or tiny hairs or spines covering the leaf surfaces. The plants also have specialized root systems, often running deep and wide to collect water from the porous sand. These adaptations are most noticeable among the primary dune plants, such as sea rocket, Russian thistle, and sand bur. Even the shrubs of the dunes, bayberry and wax myrtle, have waxy leaves. Occasionally, prickly pear cactus and yucca plants growing in the dunes are obvious reminders of the desert habitat.

Animals living among the dunes must also cope with the desert-like environment. One of the best ways to get away from the intense sun and heat is to dig into the sand. The ant lion digs in the sand without reinforcing the sides of its hole, which becomes a funnel. Prey then slide down the sides of the funnel into the waiting jaws of the ant lion. Other digging animals do reinforce their holes: the ghost crab with special secretions and the wolf spider with a modified web. Blow gently across the surface of one of these holes to see the web.

Some dune animals, like ghost crabs, have light body color which serves as camouflage and reduces absorption of heat from sun. Some have hairs, which, in addition to acting as sensory adaptations, help reflect the sun’s rays. Many dune animals are crepuscular (active at dawn and dusk) or nocturnal (active at night), and thereby avoid the heat of the day.

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**PROFILE OF A TYPICAL COASTAL ZONE ECOSYSTEM**

(Barrier Island or Barrier Beach)

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**Grade Levels: 4 - 12**

**Objectives**

Student will investigate variation in temperature and its possible effect on location of living things by:

- predicting, measuring, recording and comparing air, moist sand and dry sand temperatures in different locations in the beach habitat;
- examining adaptations of plants and animals living in the same habitat.

**Materials**

Per team:
- thermometer
- meter stick
- hand shovel, trowel or garden spade
- data sheet
- clipboard, pencils

**Credits**


Illustration of beach profile was adapted with permission from Common Plants of the Mid-Atlantic Coast. 1982°. G. Silberhorn. Johns Hopkins University Press, Baltimore.
Anyone who has walked across the hot sand barefoot during the summer realizes the great effect the temperature might have on beach and dune inhabitants. By measuring differences in temperature along the beach and dunes and by observing plants and animals living there, students can gain a better appreciation for the environmental stresses and the special adaptations which allow these organisms to survive in their habitat.

Beach investigation and exploration activities should NEVER be conducted on the primary dunes (first row back from the water). These dunes are both extremely fragile and vitally important to the physical (and hence biological) stability of the beach. Disturbance by humans leaves them susceptible to severe erosion. This activity may quite satisfactorily be conducted across the open beach and over the back or secondary dunes. Use only designated crossings over the primary dunes.

**Procedure**

**Before the Trip:**
1. Set up experiments in the classroom to measure and compare the temperature differences which occur between air and water; between large and small bodies of water; and between dark and light surfaces exposed to sunlight. Let students become familiar with reading the thermometers. Settle on one temperature unit for recording results. In addition to temperature, other abiotic factors can be measured during this field activity if equipment such as a wind meter (anemometer) and or a soil moisture meter are available. See *Living in Water* (under "Resources") for several activity ideas.
2. Brainstorm a list of the abiotic factors affecting dune organisms in addition to temperature. Then compile a list of various adaptations which would help organisms live in a habitat with these environmental stresses. Categorize these adaptation ideas into groups such as: color, body shape and structures, senses, appendages for digging and moving, and behavior. (For younger students, the teacher might have to list some categories on the board first in order to facilitate brainstorming ideas.) Assign or have students select one category and create an imaginary dune animal which illustrates its adaptations.
3. Through class discussion, develop a list of 5-10 predictions about temperatures at various locations and depths (e.g. on an open beach with dry sand, temperature will decrease 1°C with depth).
4. Devise data tables for recording measurements to compare with the class predictions. (See sample.) Students rank the beach sites from highest temperature to lowest temperature based on what they predict will be the temperature differences at those sites.
5. Divide the class into workgroups for the field trip.

**At the Park:**
1. Begin temperature measurements at each site (such as lower beach, upper beach, top of secondary dune, behind dune in swale) with air temperature. Record air temperatures at different heights, such as 1 m and 1 cm above the sand, making note of any wind differences. One field group should measure water temperature as well.
2. Begin measuring sand temperature at several depths, such as just under surface, 1 cm deep and 10 cm deep, or as needed to test predictions. Results will be more accurate if the thermometer is shaded during measurements. Make these measurements in areas of wet sand and dry sand on the lower beach, upper beach, and different locations in front of, on, and behind the secondary dunes. Carefully describe the location of each temperature measurement either quantitatively (e.g. every meter along a transect) or qualitatively (e.g. back face of a secondary dune, in shade, no wind). Caution students to limit digging on the dunes to avoid damaging plant roots.
3. Walk along the beach and among the secondary dunes, looking for animal holes, such as those of ghost crabs, wolf spiders, digger wasps and ant lions. Measure the temperature at the opening of the holes and down inside the holes.

**Resources**


Observe any live animals found among the dunes and look for adaptations which help them survive in the dunes.
4. Take a close look at the different types of plants growing among the dunes. Select some different kinds of dune plants to measure temperature above the
plant, near the middle of the plant, or at the base of the plant, recording any temperature differences, especially if the plant's seeds are found under the plant. Make observations of adaptations which may help them survive in this dune habitat.

Follow-up:
1. Combine data from different student groups, taking average temperatures where measurements were replicated. Use bar graphs (or other appropriate quantitative graphic tools) to display results of temperatures associated with the different locations and with the different species of plants and animals.
2. Look at results and discuss any trends:
   - How close were the class predictions to the final results?
   - What would be some reasons for the differences in temperature the class measured?
   - How would you predict these temperatures might change during the day and throughout the year?
3. Conduct library research on the life history of any of the plants and animals observed on the dunes. Make drawings of the organisms and identify various adaptations for dune life. Present findings orally.
<table>
<thead>
<tr>
<th>Location</th>
<th>1 m above</th>
<th>1 cm above</th>
<th>1 mm above</th>
<th>On surface</th>
<th>1 cm below surface</th>
<th>10 cm below surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beach Intertidal Zone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beach at Base of Primary Dunes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beach Side of Secondary Dunes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top of Secondary Dunes</td>
<td></td>
<td></td>
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<tr>
<td>Inland Side of Secondary Dunes</td>
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<td></td>
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<tr>
<td>Swale Between Dunes</td>
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<td></td>
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<tr>
<td>At Dune Plant #1 (name or describe)</td>
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<tr>
<td>At Dune Plant #2 (name or describe)</td>
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<td></td>
</tr>
<tr>
<td>At Dune Plant #3 (name or describe)</td>
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</tbody>
</table>
Marsh March

Squish...squish...squish... in a marsh. Your students walk on water and on land at the same time. Marsh habitats reflect this in-betweenness. In this activity, students look for the indicators of transition from the aquatic to the terrestrial.

Background

Along the fringes of the Chesapeake Bay, its tributaries and up to the farthest reaches of its headwaters, are habitats essential to the Bay’s survival—habitats that are part land and part water—wetlands.

By definition, wetlands are areas that have soil saturated or covered with water for a period of time, and have plants that are adapted to living, at least part of the time, in water. The most familiar wetlands are fresh- or saltwater marshes, wooded swamps, and bogs.

Wetlands have many values. The stems and leaves of wetland plants trap eroded soil washing from the land and absorb the energy of storm waters. Nutrients that might over-enrich the waterways are trapped and used by wetland plants for growth. When these plants die, they enrich the waterways with decaying matter called detritus, a vital food source for microscopic organisms near the base of the food chain. Countless aquatic animals find food and shelter in wetlands including juveniles of many commercially valuable fishes, such as striped bass, and crustaceans, such as blue crabs. An array of wading birds, song birds, waterfowl and birds of prey are attracted to wetlands for food and nest sites.

Historically, wetlands have been maligned by man. Blamed as sources of insect pests, they were ditched and drained. Often close to dredging operations, they were covered with dredge spoil. Considered inconvenient barriers between humans and waterways, they were dredged in some places and filled in

Grade Levels: 4 - 12

Objectives

Students will investigate natural organization of a wetland and the interrelationships between the wetland and the surrounding environment by:

- planning a study;
- observing wetlands;
- inferring cause and effect relationships.

Materials

- “wettable” footwear
- Wetlands Observation Sheets (1 per team)
- Wetlands Investigation Guides (1 per team)
- Wetlands Investigation Guide - Teacher's Version (1 per teacher)
- clipboards
- pencils
- insect repellent
- trowel

87
others for the construction of marinas and waterfront homes. Steadily over the past few decades, scientific evidence of the benefits of wetlands has mounted and recently laws have been enacted for their protection. However, the future of wetlands rests in the hands of today’s youth.

Procedure

Before the Trip:

1. Study the park information in this guide and visit the park to identify the best location for exploration.
2. Divide the class into teams of three to five students.
3. Give each team a copy of the accompanying Wetlands Investigation Guide. Ask if anyone happens to already know the answers to any of the questions. After obtaining an answer to one of the questions, ask the student how he/she knows that answer is true. Do not tell the student whether he or she is correct, but thank the student for the information and point out that part of a scientist’s concept of “true facts” is that they may be verified by anyone who takes the time and trouble to make careful observations. Explain that the class will be visiting a wetland to make careful observations which will enable them to infer answers to the questions posed in the Investigation Guide.
4. Give each team a copy of the Wetlands Observation Sheet. Point out that the 12 observation suggestions already listed should be helpful in developing inferences about wetlands, but that the students will need to make other observations also. Allow time for the teams to consider what kinds of additional observations may be needed to address all of the investigation questions, and to add these to the back of the observation sheet. Collect all of the Investigation Guides and completed Observation Sheets. Check the students’ observation lists to make sure that everything they have added may actually be seen, felt, smelled, or heard.
5. Review the field trip plans.

At the Park:

1. Return to each team its copy of the Wetlands Observation Sheet, but not the Investigation Guides.
2. Explain the importance of approaching the wetland area quietly in order to improve chances of seeing wildlife. Lead the class to the edge of the wetland. Pause for a few minutes of silent observation.
3. Remind students that they might not observe wetland features in the order listed on the Observation Sheet and that they may record any observations of interest, whether or not they are suggested on the sheet. Lead them into the wetland. In some areas, this will be along a boardwalk. In others, where the footing is sound, it will be directly onto the wetland. The teams make as many observations possible in 30 minutes. Lead the class to key areas of the wetland (particularly where the elevation, and hence, the flora, changes dramatically) and encourage them to use all of their senses. Dig (and replace after observation) small plugs of soil so teams may observe below surface conditions. If possible, make a photographic record of the areas/items observed.
4. When students have completed their observations, lead them out of the wetland to an assembly area suitable for a group discussion about their observations. Compare the teams’ observations.
   • Did everyone see everything the same way?
   • Which observations does the group think will be most useful for suggesting possible answers to the investigation questions?
5. If you have the knowledge (or access to a knowledgeable guide), tour the wetland with commentary on the value of wetlands.

Follow-up:

1. Return to each team its Investigation Guide. The teams consult their list of observations and identify those which should be helpful in responding to each of the questions on the Investigation Guide. On the guide sheet after each of the investigation questions, students note the numbers of their observations which may lead to an answer, and, within the right hand column, state what

Where

Caledon: swamps and marshes, seasonally restricted, requiring park transportation and scheduling. Access is across fairly rugged terrain. Chippokes: freshwater marshes and cypress swamps, visible from roads and trails but investigation requires crossing fairly rugged terrain. Leesylvania: large freshwater tidal marsh 1 mile along Powell’s Creek Tr.; small freshwater marsh just off main road; fringe marshes along Potomac River; guided canoe trips into Powell’s Cr. wetlands. Mason Neck: swamps and freshwater tidal marshes accessed by Bay View Tr. with boardwalks across wetlands; guided canoe trips into Kane’s Creek wetlands. Seashore: 90% wetland, mostly cypress swamps, observable from boardwalks along Bald Cypress Tr.; tidal salt marshes near 64th Street boat ramp on Broad Bay. Westmoreland: freshwater marsh at end of Big Meadow Tr.; Turkey Neck Tr. skirts large marsh and swamp. York River: salt marshes near visitor center; marsh at mouth of Taskinas Cr.; boardwalks cross marshes along Taskinas Cr. Tr. and Mattaponi Tr.; tupelo swamps in ravines; guided canoe trips into Taskinas Cr. wetlands.

When

At the Park: Allow up to 1 hour for observations and discussion, plus time to walk to and from wetland area. Any daylight hours are suitable. Most tidal wetland areas may be best observed during low tide.

Time of Year: Any time of year is suitable. In spring and summer, new green plants are emerging or at peak growth. In fall, some will be in flower. By winter, most plants will be brown and dying back.

Resources

**Example:**

<table>
<thead>
<tr>
<th>Investigation Question</th>
<th>Relevant Observations</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Where does the wetland and the upland begin?</td>
<td>#3, #4, #8, #11</td>
<td>The borderline between upland and wetland separates drier soil where bushes and trees grow from wetter mud where mostly grass-like plants grow.</td>
</tr>
</tbody>
</table>

they believe to be a likely answer to the question, based on those observations. Copy the example provided in the box on the blackboard.

Work through the first two questions as a class, then allow the teams time to do the remaining seven questions. Some observations will have bearing on several questions, some may have nothing to do with any of the questions.

2. The teams share and explain their inferences. As you moderate the discussion, recognize inferences which lead students towards the ideas suggested in the teachers’ version of the *Investigation Guide*, but also pursue discussion of other logical and interesting inferences that your students have made.

3. Discuss the following: *Thinking of the conditions in which wetlands can exist; what are some human activities that might destroy them?*
   - Damming the waterway downstream might flood wetlands.
   - Damming the waterway upstream may dry them up.
   - Water drawn from the waterway for irrigation or a draw-down in the water table by nearby wells could dry up a wetland.
   - Cutting a ditch across a wetland may drain it.
   - Pushing dirt onto the wetland, as for preparing a construction site, would obviously destroy it.
   - Dramatically disturbing the soil on the nearby uplands might result in enough sediment to be washed onto the wetland to fill it in.
   - Repeated wakes from excess boat traffic could destroy a marsh by erosion.
   - Potentially, global warming could raise sea level enough to destroy coastal wetlands by flooding.

*How does the wetland help life forms in the adjacent waterway by trapping sediments?*
   - Suspended particles intercept light essential to aquatic plant life.
   - Suspended particles clog gills of fishes and other estuarine organisms.
   - Sediments cover and smother oysters and other stationary bottom dwellers.

*How do wetlands help life in the estuary by removing excess nutrients?*
   - Excess nutrients, such as nitrogen and phosphorous, cause sudden population explosions of algae. The algae block light necessary for beneficial plant life and deplete oxygen in the water, especially when they die and are being decomposed.

*Where might the excess nutrients come from?*
   - Agricultural runoff from fertilizers and live stock wastes.
   - Human wastes from inadequate or failing sewage treatment systems.
   - Lawn fertilizers.
   - Possibly acid rain.

**Extensions**

1. Investigate ways to verify the inferences made.
   - Discuss the scientific method. The teams develop one inference into a testable statement, design and conduct the research.
   - Investigate scientists’ views on certain topics and the basis of those views.

2. Students map the distribution of plants and animals observed.

3. Visit the same area at another time of year. Compare both sets of observations and develop inferences about seasonal changes.

4. Students design an advertising campaign to inform others about wetland values and issues.

5. Students find and share media reports about wetlands.

6. Students research current wetland legislation and express their written opinions to appropriate politicians. Call 1-800-662.CRIS (Chesapeake Bay Hotline) for information on current issues.

**Variations**

**Younger students:**
Eliminate use of teams and *Observation Sheets*. Discuss key wetland features before the field trip and guide class observation of these features, using the *Teacher’s Version of the Investigation Guide*. Consider questions individually, seeking out pertinent observations. Take pictures of these features and your observers, collect representative leaves, and make an informative classroom display.

**Gifted/Advanced:**
1. Students design quantitative techniques to investigate a wetland (e.g. determine elevation of wetland’s upper limit and water depth of lower limit; identify and list specific plants; catch and identify animals; compare soil particle size and organic content with samples from different areas of the wetland and the upland).

2. Design and conduct an “EQ” survey (environmental quotient) to assess public knowledge of wetlands and their values.
Wetlands Observation Sheet

Scientific observations are descriptions of what we actually see, hear, feel, taste, or smell. We make inferences when we use logic, or even guesses, to interpret or explain our observations. One set of observations may lead you to many inferences or none. How do you know if your inferences are on the right track? Use the scientific method to test your ideas. This observation guide suggests where to direct your observations in order to make some logical inferences about a wetland.

<table>
<thead>
<tr>
<th>1. Are all the plants in the marsh the same kind?</th>
<th>7. Are some specific types of plants usually found close to the water?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>2. How many kinds are there?</td>
<td>8. Are some types of plants never found close to the water?</td>
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<tr>
<td></td>
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<tr>
<td>3. Are they distributed evenly, randomly, in clumps, or in some pattern?</td>
<td>9. Is the soil everywhere equally damp and of the same feel (texture) and smell?</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Are some kinds always found close together?</td>
<td>10. Are there any kinds of plants you find only in areas of a particular smell, texture, or dampness?</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Are some kinds never found close together?</td>
<td>11. What does it look (smell, feel) like under the surface?</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>6. Is the same amount of water visible everywhere?</td>
<td>12. Are there any plants that are not green? Where did you see them?</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

List other observations on the back of this sheet which your team will need to make in order to suggest answers to the inference questions.
## Wetlands Investigation Guide

<table>
<thead>
<tr>
<th>Investigation Question</th>
<th>Relevant Observations</th>
<th>Inference (Possible Answer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Where does the upland end and the wetland begin?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Does the wetland have a lower limit? If so, what is it?</td>
<td></td>
<td></td>
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<tr>
<td>3. What seem to be the conditions necessary for a wetland to thrive?</td>
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</tr>
<tr>
<td>4. Where might the wetland be changing or being destroyed?</td>
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<tr>
<td>5. What characteristics of the wetland indicate that it can catch and hold sediment such as eroded soil?</td>
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</tr>
<tr>
<td>6. What features of the wetland might help remove excess nutrients and toxins from the water?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. What indicates that the wetland might be part of the aquatic or estuarine food chain?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. What indicates that the wetland is important to land and water animals?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. How might the marsh protect adjacent higher ground from some effects of storms and flooding?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Where does the upland end and the wetland begin?
- The upper limits of wetlands are usually marked by changes in vegetation and ground moisture. In most state park marshes, there is a clear transition from trees and shrubs to tall grass-like plants, such as cattails, sedges, rushes or cord grasses. The vegetation changes are less clearly defined on the upper edge of swamps, which are forested. There, soil moisture changes might be the best clue. Unless it has rained very recently or there has been a prolonged dry spell, wetland soil will be noticeably wetter, often squishy or even inundated.

2. Does the wetland have a lower limit? If so, what is it?
- The lower limit will be the adjacent waterway. Not every wetland, such as Seashore's cypress swamps, will have a visible lower limit but may seem bound on all sides by uplands or stretch on indefinitely.

3. What seem to be the conditions necessary for a wetland to thrive?
- By finding the upper and lower limits to wetlands, students can infer the conditions required for wetlands (i.e. an abundance of water but not deep water or swiftly moving water as by current or waves).

4. Where might the wetland be changing or being destroyed?
- Over geologic time, wetlands are very dynamic places, undergoing rapid change. Trapped sediments can fill in wetlands. Rising sea level can flood them and erosion can wash them away. Only erosion may be readily apparent. This is best observed along the lower limits of wetlands bordering swift tidal creeks or open bays or rivers.

5. What characteristics of the wetland indicate that it can catch and hold sediment such as eroded soil?
- Encourage students to observe the abundance of plant stems and leaves and to think of them as filters of water washing off the uplands or being brought in with the tides.

6. What features of the wetland might help remove excess nutrients and toxins from the water?
- (This question might best be reserved for advanced students.). Basically nutrient and toxin removal occurs in two ways. Many nutrients and toxins will be bound to the sediments trapped in the wetland. Others will be assimilated directly into plant tissues. Remind students that nutrients in the water can be taken up as fertilizer by the lush wetland plants.

7. What indicates that the wetland might be part of the aquatic or estuarine food chain?
- Encourage students to observe the abundance of dead plant matter (detritus) in the wetland. If necessary, point out that most of the detritus along the waterway edge is likely to be washed into the estuary. From this, students might deduce the importance of wetland plants as a major component of estuarine food chains.

8. What indicates that the wetland is important to land and water animals?
- Wildlife benefits can be inferred by observing animals present, such as fiddler crabs, turtles, snakes, insects and birds, and by finding their signs, such as droppings, tracks and nests. Other wildlife values can be identified by noting seeds and fruits that might be food items.

9. How might the marsh protect adjacent higher ground from some effects of storms and flooding?
- Shoreline erosion protection can be inferred by observing eroded areas along the shoreline where marshes are absent. Examination of the peatlike soil may lead to inferences about its role in absorbing water and buffering flooding effects.
A wetland model demonstrates some of the critical functions of wetlands, and illustrates how wetlands effectively buffer the impact of flooding and filter runoff from land.

Background

It's hard to tell just by looking at wetlands that they help filter silt and pollutants from runoff (water coming from land) as well as tidal waters, and often reduce flood damage. By building a simplified wetland model, some of these important wetland functions can be demonstrated.

For more background information on wetland values, see "Marsh March" in this guide.

Procedure

Make the Model:

1. Along the bottom of one side of an aluminum roasting pan, spread a layer of modeling clay to represent land. Leave the other half of the pan empty to represent a Bay tributary or other body of water.
2. Form the clay into a gradual slope toward the center of the pan.
3. Smooth the clay along the sides of the pan to seal the edges. If desired, form meandering streams in the clay.
4. Cut a carpet scrap or sponge two to three inches wide, and long enough to stretch across the bottom of the pan along the entire edge of the clay (see diagram). The carpet or sponge will represent the wetland buffer between dry land and open water.

Prepare the Class:

1. Show the class pictures of different types of wetlands, including swamps, fresh- and saltwater marshes, and discuss the different types of plants and animals found in these wetlands.
2. Lead a class discussion by asking the students what they consider to be the characteristics of wetlands. List these characteristics on the board.

Grade Levels: K - 9

Objectives

Students investigate interrelationships among precipitation, runoff and wetlands by:
- modeling and observing flood buffering and filtering effects of wetlands in class.

Materials

- modeling clay
- aluminum roasting pan
- carpet scraps
- 4 jars of clean water
- 2 jars of soil

For in-class extension:
- small aluminum pans
- modeling clay
- florist foam
- an assortment of paints, papers, toothpicks, twist ties, cotton swabs
- an assortment of natural materials such as twigs, pine needles, soil, pebbles, feathers, etc.

Credits


Where

In the classroom.

When

At School: Allow 1 to 2 hours for demonstrations and discussion.

Time of Year: Any time. Try to tie in with field trip for "Marsh March," the next activity in this guide.
3. Explain that the wetland model will be used to demonstrate, in a simplified way, two important functions of wetlands.

First Demonstration:
1. Explain that water will be poured slowly on the upland portion of the model twice to represent rain. The first time, the wetland strip will be in place. The second time, the strip will be removed.
2. Ask the students which time they think the water will accumulate fastest in the open part of the pan, or if they think there will be no difference. Take a count of hands for each option.
3. With the marsh in place, pour water slowly on the upland as shown. The students observe and describe what happens. (The water should move across the pan and accumulate slowly.)
4. Remove the carpet strip, pour water on the dry model and repeat the demonstration. Again the students observe and describe what happens. (The water should reach the other side of the pan and accumulate more quickly without the barrier.)
5. Explain that wetlands function like the carpet or sponge, by slowing and retaining rainwater running off the land and thus help prevent flooding.
6. Discuss:
   - If a wetland is destroyed and houses are built there, what might happen to the houses during a severe rain storm? Why? (They might be flooded because the wetlands will not be there to absorb and slow the rush of water off of the higher ground.)
   - If many wetlands are destroyed along a river and many houses are built near the river, which houses will probably experience the worst flooding—the ones upstream or downstream? Why? (The ones downstream because the water will be accumulating in the river from a larger area. The more wetlands that are destroyed in a watershed, the greater the flooding problems.)

Second Demonstration:
1. Explain that the second demonstration will be just like the first, except that soil will cover the clay. The rain should pick up and carry some of the sediment as it travels over the land.
2. Ask the students if they think the water accumulating in the open part of the pan will be cleaner with the marsh in place or with it removed, or if they expect no difference. Take a tally of hands.
3. Pour the water from the previous demonstration out of the pan and replace the carpet or sponge. Spread soil over the clay and slowly pour water on the upland as before. The students observe and describe the water that accumulates in the pan. (The water in the pan should be fairly clear since the carpet or sponge should trap most of the sediment.)
4. Repeat the demonstration with the carpet or sponge removed. The students describe the results.
5. Explain that the thick mat of roots and plant stems in a real wetland helps trap sediments that wash off of the land, much as the carpet or sponge did, and thus helps keep waterways free of silt and some other pollutants.
6. Conclude with a discussion:
   - What might a river look like after a heavy rain if much of its wetlands have been destroyed? (Muddy)
   - How might muddy water affect fish in a river? (It makes it hard for them to see and clogs their gills.)
   - How might muddy water affect oysters in an estuary? (The mud settles out and smothers the oysters.)

Resources


Educational Images, Inc. *Ecology of a Swamp; Freshwater and Salt Marshes* (slide sets). P.O. Box 3456, West Side, Elmira, NY 14905.


Extensions

1. Students, individually or as small groups, make their own, more detailed, wetland models, using small aluminum pans and, instead of carpet, use florist foam. Provide reference books with pictures of different types of wetlands. Students can use their imaginations to make plants and animals from an assortment of materials and stick them in the foam and clay. Some ideas:
   - For cattails, use cotton swabs painted brown or toothpicks painted green with bits of brown clay stuck to the tops.
   - Use pine needles for reeds.
   - Shape wetland creatures from clay or cut them from paper and glue them onto toothpicks.
   - Make trees by gluing pieces of green sponge onto twigs.

2. Follow-up by doing "Marsh March," a wetlands field observation activity in this guide.
Hide and Seek

In this activity, an age old game takes on an educational twist, helping students recognize the importance of a few adaptations that help keep animals from being seen.

Background

Many animals, whether living in the Chesapeake Bay, a stream or pond, in the woods or thicket, or in a garden or lawn, have evolved behaviors, shapes and colorations to avoid being seen by other species of animals. For prey species, avoiding detection means a better chance of not being eaten. For predators, it means a better chance of catching a meal. For many, it means both.

One common strategy is camouflage. Often, a few stripes or spots to break up the animal's outline is all that's needed for it to blend with its surroundings. Most species of fish have some form of camouflage—the most basic being a dark colored back, to blend in with the bottom and avoid being seen from above, and a light colored belly, to blend in with the sky and avoid being seen from below. Some species, like the flounders, change their coloration to match their surroundings. The white-tailed deer fawn is camouflaged with light spots, resembling the dappled light that reaches the forest floor.

Another form of camouflage is to be shaped like some part of the surrounding habitat. An insect called the walking stick is shaped (and colored) like a small twig, and is difficult to detect in the shrubs and trees where it lives. Within the Bay, there are some other spindly creatures that rely on their shape for camouflage. Skeleton shrimp and sea spiders (not closely related to terrestrial spiders) resemble the branched hydroids in which they live, and in the eelgrass beds hide pipefish which often align themselves with the strap-like leaves, swaying with them in the currents.

Perhaps the most common strategy to avoid detection is to remain motionless. A fawn will instinctively lay curled on the ground when danger is near, even when its mother bounds away to safety. A killifish will freeze when it detects a predator, only to scoot into the safety of vegetation or other shelter when the predator comes within the critical distance of a few feet. Many snakes typically wait motionless to ambush any prey that wanders into striking distance.

Procedure

Before the Trip:
1. Contact the park to discuss plans and to identify the best location for this activity, preferably free

Grade Levels: K - 7

Objectives

Students will investigate variations in color patterns, body form and movement which allow for camouflage by:
- observing people in relation to environmental settings;
- simulating predator-prey dynamics;
- inferring explanations for camouflage success.

Materials

- blindfolds (1 per student)
To wear:
- take or ask 1 student to wear camouflage outfit

Credits


A skeleton shrimp moves like an inchworm. When still it resembles a branch of coral or twig.
of poison ivy, thorny plants, ticks and chiggers. (Park personnel can advise.)

2. Brainstorm with the class, and list on the board, examples of animals that can avoid being seen without completely hiding. For each example, list the strategy or strategies the animal uses and whether the strategy helps the animal avoid being eaten, helps it catch food, or both. For younger students, list strategies on board and use pictures to illustrate them.

3. Explain the field trip plans and the game described below.

At the Park:
1. Lead the class to the previously chosen location, and set perimeters for the game.
2. Blindfold one student who will be the predator.
3. The predator counts to 15 slowly while the others hide. The students hiding must be able to see the predator at all times.
4. After counting, the predator removes the blindfold and looks for prey. The predator can turn around, squat and stand on tip-toes, but cannot walk or change location.
5. The predator spots as many classmates as possible within 30 seconds to one minute, identifying them out loud and describing where they are found. When identified, the prey come to the predator because they have been eaten.
6. After the time is up, all the eaten prey become predators and put on blindfolds.
7. The original predator counts aloud to ten while all the remaining prey come closer but still try to stay undetected.
8. All the predators remove their blindfolds and take turns naming the prey they can see (30 seconds to one minute time limit).
9. Repeat the process if several prey are still hidden.
10. When only one or two are left hidden, have them stand up and identify themselves. It may be surprising how close the prey get to the predators.
11. Play the game again one or two times.
12. After the game, discuss why some prey were able to get close to the predators without being caught.

Follow-up:
Each student invents an animal that lives and hides in a particular habitat, real or imaginary, and draws a picture of it in its environment, showing how it hides. Examples might be “walligators” with brick patterned backs for life on a brick wall, or “sneaker snakes” that disguise themselves as shoelaces.

Where
- Caledon: old field near the front of visitor center; in woods just off Fern Hollow Trail near picnic area.
- Chippokes: woods near the picnic area and pine woods between visitor center and swimming pool.
- Leesylvania: Powell’s Creek Nature Trail.
- Mason Neck: woods near picnic area and Bay View Trail.
- Seashore: woods near picnic area.
- Westmoreland: woods along Big Meadows Trail.
- York River: pine thicket near start of Mattaponi Trail; along Beaver Trail; 1st big hill on Taskinas Creek Trail.

When
- At the Park: 45-60 minutes for game and discussion; daylight hours.
- Time of Year: when leaves are on the trees is best but can be done in the winter.

Resources

Extensions
1. Take along some camouflage material, jackets, pants or shirts. Play a round of the game with a few students wearing these and see if they can get closer than anyone without camouflage. Play another round but this time the camouflaged prey must keep moving slowly, even after the predator stops counting. How do the results change?

2. Students suggest ways other than the use of camouflage materials that they might disguise themselves to avoid detection in various surroundings. Allow them to alter their appearance in some way, then play another round of the game to see if the results change.

Variations
- Younger students:
  Practice the game at school before the trip. To foster a better understanding of the objectives, observe colors and patterns against different backgrounds and pictures of animals camouflaged in their surroundings. See “Resources.”
Small Fry Spies

Natural environments display endless combinations of shapes, colors, textures, and sounds to be explored by the curious young learner. In this activity, small groups visit different park sites for a structured version of "I Spy," and organize their observations into an exhibit after the field trip.

Procedure

Before the Trip:
1. Visit the park, decide which trails to use, and identify good places for observation stops.
2. Arrange for one adult or youth leader to work with every group of five on the activity. Meet with the leaders (ideally at the park), provide each with a complete copy of the activity directions, and review the activity procedure. Discuss equipment. A camera and a small portable tape recorder are needed. Only the adult leaders will be using the cameras and tape recorders. Perhaps the leaders will be willing to use their personal equipment.
3. Explain to the class where they will be going for the field trip and that they will play a game while walking along trails in the park. When they find special things that their group leaders see, smell, hear, or touch, they will get "medals" to wear.
4. As a several-session class project, work from the directions and patterns on the accompanying I Spy sheet to prepare the medals. Prepare one of each kind for each student. Divide each kind into batches of five, placing them in separate bags or clipping them together with a label.
5. Students will be wearing lots of these medals during the activity at the park. One way to attach the medals is to clip a big metal shower curtain hook or a large paper clip into a belt loop or button hole. The medals can be hung on this clip.
6. Put each leader's set of medals into a basket or bucket along with five clips. (There will be 16 different medals, so each leader should have 16 batches of five medals.)
7. Divide the class into groups of five students.
8. Prepare the class for the trip by telling them such things as what to wear, and details about the bus ride, lunch, and bathrooms.

At the Park:
1. Assemble the students into their groups and introduce each to its leader. Give the batches of medals to the leaders and help students attach the hooks to their clothing.
2. Review the activity plan and schedule.
3. Before leaving the assembly area, each group leader should try one of the "I Spy" items. For example: "I spy something round under the school bus." As students locate the item (a tire obviously qualifies, but if somebody happens to see something else that is round and under the bus, like a bottle cap, that would be acceptable, too), the leaders get the round medals out of their baskets and put them on the students. The leaders then take photographs of the round items observed. After everyone is clear on the general procedure, the groups set out on the trails.
4. Allow about 40 minutes for the trail walks and observations. Leaders should try to have the group see (smell, touch, hear) all of the items, and if possible, get photographs of all items observed and a tape recording of all sounds heard for the game.
5. Reassemble the group and admire all the medals. Discuss some of the observations made during the game. Supplement, if you like, by

Grade Levels: K - 2

Objectives

Students will investigate variations in colors, shapes, smells and textures of specimens in the park by:
- making directed observations;
- classifying items encountered on the field trip based on one variable.

Materials

For every 5 students:
- camera and film
- small portable tape recorder (optional)
- 16 small plastic bags and marker
- basket or bucket
Per student:
- copies of "medals" patterns cut from heavy paper
For class:
- about 10 yds of string (metallic elastic preferred)
- glue, tape, scissors
- items for decorating medals (glitter pens, crayons, markers, bits of cotton, fabric, tissue, cellophane, feathers, bits of yarn, etc.)

When

At the Park: Lesson takes about 1 hour.

Time of Year: Any time.
Small Fry Spies

they write their names on their
medals, the medals can be attached
to the poster as well. Time permit-
ting, each group could do several
posters so that all of the
photographs and medals get clas-
sified and displayed. For the
sounds which were observed, as-
semble any tapes made and display
photos of the sound sources.

4. Discuss the items pictured and
speculate about the possibilities of
change. Will all of the spotted items
be spotted forever? Are the sounds
always there?

5. Plan an open house session. In-
vite the principal, other office or
building staff, the group leaders
from the field trip, and parents. The
groups who made the posters can ex-
plain their research to the guests.

Follow-up:

1. Get the photographs developed
as quickly as possible.

2. Divide the class into work
groups. Give each work group a
poster which you have labeled
prominently with one of the "observ-
able characteristics" from the field
trip (shiny things, rough things, etc.).

3. Working with one group at a
time, help them select the
photographs of their observations.
They then glue the appropriate
photographs to the poster. After

Where

Caledon: Fern Hollow Tr. makes for
an easy walk through the woods.
Chippokes: College Run Tr. passes
variety of sites, natural and man-
made, offering many opportunities
for sensory discoveries.
Leesylvania: Lee's Woods Tr. has
several loops, permitting groups to
go different ways.
Mason Neck: Bay View and Wilson
Springs Trs. are suitable or groups can
make their own trails around the
visitor center or picnic areas.
Seashore: trails originating at and
near visitor center permit groups to
fan out to use their senses in dif-
erent areas of park.
Westmoreland: some easy walks in-
clude Big Meadows Tr. and along sec-
tions of Turkey Neck Tr.
York River: several trails provide
nice walks through a variety of
places, including Taskinas Creek Tr.
and Woodstock Pond Tr. Groups can
spread out to explore open places
near visitor center, picnic areas, and
beach.

Variations

Gifted/Advanced:
Use the same general format, but in-
corporate measuring and comparing
sizes and weights of observed items
or two or three criteria. For example;
"I spy with my eye a round long
thing that is bigger than a pencil but
smaller than a trash can" (log); and "I
spy with my eye something that is
green, smooth, and triangular" (leaf
or blade of grass). Posters created for
follow-up should arrange
photographs in some order, i.e., small-
est to largest.

Second grade:
Conduct game more like a scavenger
hunt where students do all the
"spying" and get medals after point-
ing things out to the leader.
I Spy Medals

For each student, redraw these patterns onto heavy paper, making each at least twice as large as shown. Write the key word on the back of each shape. Punch a hole on the top of each and tie on a 6" to 8" loop of string or yarn.

If desired, replace some of the selections with others more appropriate for the class, making sure to note any changes on the Group Leader Instructions.

Students decorate the front of each medal with magazine pictures or other materials to represent the selections.

Work on two or three medal types at a time. As they are completed, place five of each type in a small labeled bag.
Group Leader Instructions

With this lesson, students find and identify shapes, patterns, smells, textures and sounds in nature with a game of "I Spy."

Your role is to find along the trail the characteristics listed below and get students to find them. When you see one of the visual characteristics, say:

"I spy something _______" (name of one of the characteristics) "______" (give a hint about where it is with words like under, over, on top of, behind, etc.). For example, if you see a mushroom, say, "I spy something round beside the big tree."

- If it is a sound, say, "I hear something that sounds _______" (soft, high pitched, low pitched, etc.).
- If it is a smell, say, "I smell something that smells _______" (musty, pleasant, etc.).
- If it is something to be touched, say, "I feel something _______" (rough, smooth, fuzzy, etc.).

You and your group will be "spying" only the 16 things listed: If the students have trouble finding the things you have spied, give more hints, especially those that describe where to look. If they are finding things too quickly, give harder hints.

You will be given a basket with "medals" that the students made in school. The medals are in bags that are labeled for each of the characteristics. Be sure to put a medal on each student for each successful observation. Try to make sure everybody observes all 16 things and gets a medal for each. Check the characteristics off as they are found.

- [ ] rectangle
- [ ] triangle
- [ ] round
- [ ] square
- [ ] striped
- [ ] spotted
- [ ] shiny
- [ ] pleasant smell
- [ ] earthy or musty smell
- [ ] fuzzy
- [ ] rough
- [ ] smooth
- [ ] soft sound
- [ ] high pitch
- [ ] low pitch
- [ ] crackle sound
Feathered Feeders

A truly “bird brained” lesson, this activity requires students to think like hungry birds, who must find food at the park.

**Background**

The various Chesapeake Bay habitats provide an abundance and variety of food for many species of birds. The shape and size of each bird’s beak give clues to what it eats and which habitat it prefers.

Herons and egrets use long, pointed spear-like beaks to catch fish, crabs, frogs, and snakes. The bill of the oystercatcher is used to snap muscles in shellfish to open them, and to probe into the mud for small crabs and worms. Ibises probe into the mud for fiddler crabs and other burrowing animals with their long down-curved bills. Rails use long, slightly curved bills to feed on clams, crabs, worms and insects. The sandpipers, with their straight pincer-like beaks, probe into the sand or mud for small burrowing animals.

While flying, brown pelicans spot fish and dive into the water, using their pouch-like bills as dip nets to scoop up fish. Ospreys and eagles also dive, but catch fish with their talons. Their strong hooked beaks tear meat into bite-sized pieces. Kingfishers dive into the water, catching food with spear-like beaks.

Other birds find food while swimming or floating on the water. Ducks and geese have broad flat beaks for feeding on aquatic plants. Saw-toothed edges on the beaks of mergansers (ducks) help them to grasp fish.

**Procedure**

**Before the Trip:**

1. Identify the types of birds common to the beach and/or marsh habitat.
2. Describe bird adaptations and their advantages (e.g. feathers, hollow bones, eyes, talons, webbing, etc.).
3. Make enough copies of the accompanying bird head illustrations to allow one bird drawing per student. Cut out the bird heads, with their names, from the copies. Do not permit the students to see how the ill-

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**Grade Levels:** K - 9

**Objectives**

Students will investigate variation in bird beaks and the interrelationships of form and function by:

- **Classifying** birds with similar beak shapes;
- **Inferring** about possible bird foods based on beak shapes;
- **Locating** and identifying possible bird foods in the field.

**Materials**

- colored construction paper
- string or yarn
- glue
- stapler
- clear plastic bags
- index cards, 5 per student
- pencils

**Credits**


**Where**

Caledon: edge of woods and old Newton House site; old field behind visitor center. (Note: not a beach/wetland habitat.)

Chippokes: area between College Run Tr. and river, east of Coll. Run.

Leesylvania: beach and upland near picnic areas.

Mason Neck: beach and upland near visitor center and pond.

Seashore: marsh area along Osprey Tr.; campground beach; 66th St. beach along Broad Bay at marsh edge.

Westmoreland: Big Meadows Tr. along marsh or any stretch of beach.

York River: salt marsh and beach near visitor center.
Feathered Feeders

Illustrations are grouped or the group labels.

4. Distribute the illustrations. Ask the students to:
   - cut out the drawings and mount them on colored construction paper;
   - measure and cut a piece of yarn long enough to go over their own heads comfortably;
   - attach the yarn to the top corners of the construction paper.

5. Talk about adaptation, focusing on bird beak shapes. Encourage the class to make some inferences about what a beak shape can tell about a bird (i.e., type of food it feeds on), and what ways birds can be classified into groups (i.e., beak shapes).

6. After each student studies the shape of the beak on his or her bird picture, direct the students to form groups of similar beaks. Discuss with each group their logic in forming the group.

7. Each group makes inferences as to which food items their beaks might be adapted to eat. Pictures of habitats, reference materials, or samples of possible food types would be helpful to assist students in determining the range of food sources available to birds.

8. Lead a class discussion with each group sharing their beak adaptation speculations. Conclude by explaining how the bird beaks are grouped and labeled on the original illustrations.

At the Park:

1. The students put on their bird heads and re-form into the groups established in class.

2. Provide each group with a strong clear plastic bag, and five index cards and a pencil per person.

3. Explain that they will have 15 minutes to look for food items, food item remains or signs of feeding which match the feeding habits of the birds in their group. Food items or remains that can be collected, such as crab shells and fish bones, are to be placed in the bag. Students should briefly note on one index card each item put in the bag and where it was found. Items that cannot be collected, such as feeding signs (e.g., beak holes in the sand), or living organisms (e.g. swimming fish or insects) should be described on an index card, with locations indicated, and the numbers of each noted.

4. Lead the students to a beach, marsh or other area suitable for the students to conduct their hunt. Survey the area with the class, set the boundaries for the activity, and point out any hazards.

5. The students patrol the areas they predict will have the food for which their beak types are specialized.

6. After 15 minutes, call the groups back together to share their discoveries in a "show and tell" style discussion.
   - Which group found the most food? Which group found the least?
   - Based on the food types found, predict which types of birds might be the most common in this habitat? Which might be the least common and why?
   - Were any real birds observed that had beak types like theirs? If so, where were they seen and what were they doing?

7. After discussion, the food items should be returned to approximately where they were found.

8. If a bird skull collection is available at the park, study the skulls. Students can guess what species the skulls are and what they might eat, or match the skulls to pictures. Students could also group the skulls according to some pattern of logic they choose.

Follow-up:

1. As a class, construct a large chart listing (or showing with additional cut out illustrations) the birds for each group, the beak shape, the types of food found, and the locations where the food was found.

2. Discuss and analyze the importance of bird beak adaptations. Encourage the students to make inferences about habitat selection based on the groups of birds found there.

3. Encourage students to research bird feet adaptations.
   - In what ways are some feet used by birds in feeding?
   - In what ways are bird feet adapted for the bird's habitat?

When

At the Park: 45 minutes, daylight hours, preferably low tide.

Time of Year: All seasons.

Resources


Extensions

Assemble materials with which the class can make beaks. Determine the types of food they could possibly eat using that type of beak. Examples of materials: chopsticks, popsicle sticks, strainer, tongs, pliers, spoons, sponges, nutcrackers, etc.

Variations

Younger students:

1. Use cutouts from colored construction paper to represent foods found on the beach or marsh. Scatter the "foods" in an area of the park and let the children go on a food hunt.

2. Assign a chaperone to each group to assist the students in developing their observation skills.
Feathered Feeders

Pincer-like bill for grasping caterpillars, beetles, bugs, and other insects found among the foliage of trees and thickets.

Mockingbird  Cuckoo  Vireo

Crushing bill for cracking seeds of many different types of land plants.

Cardinal  Evening Grosbeak  Purple Finch

Probing bill for poking into mud and soil for worms and crustaceans.

Ibis  Rail  Woodcock

Mockingbird, cuckoo, vireo, evening grosbeak, purple finch, ibis, and rail by Hamberger*, cardinal and woodcock by Kotschig*.

103
Feathered Feeders

Ripping bill for eating meat of birds, mammals, reptiles and fish.

![Great Horned Owl](image)

![Hawk](image)

![Vulture](image)

Long grasping bill for catching fish, crustaceans and other aquatic prey.

![Heron](image)

![Belted Kingfisher](image)

![American Bittern](image)

Wide bill for straining seeds, crustaceans and aquatic plants from water and muddy bottoms of waterways.

![Common Tern](image)

![Mallard](image)

![Mute Swan](image)

Hawk, vulture, and heron by Hammerger®, great horned owl, belted kingfisher, American bittern, common tern, mallard, and mute swan by Kotschig®.
Beaver Tales

There is something intriguing about beavers. It is easy for us to see them in terms of human activity: engineers, architects, and homemakers. Beavers, like humans, don’t just live in their environment, they change it, thereby affecting all of their neighbors. Beaver activity has shaped some park environments. This activity explores their effect.

Background

If any one animal, native to the Chesapeake Bay region, were chosen as the ideal species for environmental education studies, it would probably be the beaver. Its many physical and behavioral adaptations for its lifestyle; its abilities as an engineer; its habits of altering the environment to meet its own needs; the dependence of other species on the beaver; its unmistakable signs when present in an area; the prominent role it holds in the settlement of this nation; and the story of its eradication and reintroduction in many parts of this country could all combine to give the beaver the status of “most favored study animal.”

The beaver could easily have been the product of a “create-a-wetlands-animal” activity in which students build an imaginary animal with every part being adapted for some aspect of its environment. For protection against the chilling effect of life in water, the beaver has a dense pelt, a layer of subcutaneous (under the skin) fat, and specialized heat exchanging circulation to its extremities. Organs in its groin, called castor glands, secrete an oil which the beaver uses to mark its territory. Sebaceous glands produce oil which waterproofs the beaver’s fur. On each hind foot, the second claw is split and used like a comb to keep the fur groomed for maximum water repellency. The hind feet are webbed to provide propulsion through the water. The outermost digits on the forepaws are modified for grasping, much like a human thumb, and the front claws are long and adapted for digging.

This animal’s characteristic large front teeth grow continuously, keeping pace with the constant wear from gnawing on wood. To seal out water during dives, the beaver’s ears and nose have special flaps and the back of its mouth closes. Its front teeth project through the lips to permit gnawing, chewing and swallowing underwater without forcing excessive amounts of water into the digestive tract and lungs. A beaver’s eyes have nictitating membranes which serve as underwater goggles.

Grade Levels: K - 10

Objectives

Students will investigate changes in beaver habitat areas caused by beavers and interrelationships between beavers and their environment by:

- suggesting adaptive functions;
- observing clues to beavers’ life history;
- modeling beaver-predator behavior;
- inferring protective importance of hearing and smelling.

Materials

- dark bandana or similar material for a good blindfold
- odor source such as bottle of cologne
- guided imagery reading selection (optional)
- paper, pencil and clipboards for poems or drawings (optional, one set per student)

To wear:
- “wettable” footwear

Where

Caledon: beaver sites are within seasonally restricted areas.
Chippokes: beaver signs visible from south side of College Run Tr. at bottom of hill, below visitor center.
Leesylvania: beaver signs near Powell’s Cr. overlook on Powell’s Cr. Tr.
Mason Neck: boardwalks on Bay View Tr. cross over marsh area where lodge and beaver activity are visible.
Westmoreland: Big Meadow Run is superb beaver habitat, reached by Big Meadows Tr. or Turkey Neck and Beaver Dam Trs.
York River: beavers inhabit Woodstock Pond; colonies in upper reaches of Taskinas Cr. accessed by overland trek.
The beaver’s astounding array of specialized behaviors have led many to credit the animal with high intelligence, but most of these behaviors are probably instinctive. This animal has a powerful compulsion to stop running water, hence it builds dams. Small trees, branches and twigs are stored on the bottom of the pond to consume when the water freezes. Tail-slapping may be a warning signal of danger. Beavers build elaborate lodges complete with underwater entrances and emergency exits, overhead ventilation, and separate grooming and sleeping areas. Their tendency to girdle (gnaw the bark off completely around the trunk) trees too large to actually cut down kills the trees and opens the forest canopy, permitting new sapling growth and thus ensuring a food source for future generations.

Since beavers significantly alter lowland habitats, a wide variety of plant and animal species rely on beavers for their own habitat requirements. Beaver ponds become home for many slow-water fishes such as bluegill and pickerel. Aquatic and wetland plants take root in and around beaver ponds, benefiting from the continuous water supply and open canopy. Wading birds and waterfowl are attracted to the abundant fishes and plant foods. Other parts of the ecosystem also benefit from beavers: their ponds serve as firebreaks, thus protecting nearby forests, and as sediment traps, keeping waterways cleaner downstream.

Throughout North America’s past, beavers have been cherished and pursued by man. Its meat has been eaten by many and the tail is considered a delicacy. Beavers’ castor glands have been used to manufacture perfumes and medicines (but not castor oil, which comes from plants). The beaver has been most sought for its fine fur. Beaver pelts were among the earliest trade items between the first settlers and Native Americans, and for a time, were very fashionable as coats and top hats. Trappers, in pursuit of the beaver, led the way for the settlers’ westward advance.

As a result of relentless trapping pressure, beaver populations were virtually eliminated from Virginia. However, beavers today represent a great success story in wildlife management. In the 1930s, about 12 pairs of beavers from other states were released in a few Virginia Piedmont and mountain counties. For many years thereafter, beavers enjoyed unofficial endangered species status protection (the Endangered Species Act was initiated in the 1960s). Today, scarcely any headwater in Virginia or the Chesapeake watershed is without resident populations of beavers and they once again contribute to the fur trade through a carefully managed trapping program.

Unfortunately for would-be observers, beavers tend to be most active at twilight and night, thus they cannot predictably be seen by groups visiting the parks. However, beavers leave many signs which can be examined, including gnaw marks on trees and stumps, dams, lodges, canals radiating from pond edges, footprints and tail drag marks in

When

At the Park: 1 to 2 hours, daylight hours. Small quiet groups may glimpse a beaver in evening or early morning (special arrangements may be necessary).

Time of Year: Any time is suitable, but in fall there will be more fresh signs, since beavers are most active then.

Resources

the mud, and small piles of slightly
odiferous mud and leaves which
mark the beaver's territory. These
signs, plus an abundance of beaver
literature ranging from fables to
scientific papers, make the beaver an
ideal subject for interdisciplinary
studies.

Procedure

Before the Trip:
1. Visit the park to locate the
areas with the most beaver activity.
Consult with park staff.
2. Review the entire activity pro-
cedure with the class, but do not
provide information about beavers yet.
Assign several students to find pic-
tures or drawings of beavers to
bring to class (or find some yourself).
3. Divide the class into teams of
three or four students.
4. Assign each team one or more
of the following questions.
Brainstorm at least three plausible
answers to each:
• Since the beaver spends much of its
life in the water, even in winter, how
might the beaver be adapted to stay
warm?
• Beavers have special organs, called
castor glands, that secrete an odorous
oil. How might the beaver use this
oil?
• Some of the claws on a beaver's hind
paws are split. What could be the
function of these split claws? (Hint:
It has to do with staying dry.)

• The beaver's "little fingers" are offset
slightly to oppose the other digits for
grasping, somewhat like the human
thumb. How can this be important
for the beaver's lifestyle?
• Why are a beaver's hind feet webbed?
• How might the beaver use its flat
tail?
• Beavers have clear, eyelid-like struc-
tures (called nictitating membranes)
over their eyes. What function(s)
might these serve?
• The beaver's front claws are long and
strong. What might they be used for?
• Why do a beaver's front teeth grow
continuously?
• What could be the purpose of special
flaps inside the beaver's ears, nose
and mouth?
• Why might beavers store small trees,
branches and twigs on the bottom of
their pond?
• How can it be to the beaver's ad-
vantage to gnaw the bark off in a
complete circle around the trunk of
trees which are too large for the
beaver to completely cut down?
(Hint: Think about how the forest might change.)
• What are some plants and animals
that might be attracted to an area
after beavers have moved in?
• How might a forest benefit from
having beaver ponds in its waters-
sheds?
• How might the aquatic animals and
plants living downstream benefit
from beaver ponds upstream?

Variations

While at the park and still seated in
the beaver habitat, read a selection
describing the activities of a beaver
from one of the resources listed.
Back in the classroom, ask students
to express their feelings about the
reading and the beaver's habitat by
writing poetry or drawing pictures.

Younger students:
Omit the library research, but
present limited background informa-
tion in class. Play memory (using
only 2 memories) and tag games, or
children can take turns acting out dif-
ferent beaver behaviors while the
rest of the class guesses.

Extensions

1. Assign some additional beaver-rel-
related research topics, if appropriate
references are available. Some might
include:
• Investigate the influence of
wildlife, such as the beaver, on
human history as reflected in the
names of places.
• Read some Native American and
folk tales in which the beaver has a
role. Compare the characteristics
given to the beaver in these stories
with what is known about beavers
today.
• Investigate the history of beaver
trapping and beaver reintroduction
and management. Find some num-
bers (e.g. of trapped animals,
lowest and current population es-
timates) and use them to graph and
explain changes in beaver popula-
tions over the last 200 years.
2. Take a field trip or encourage stu-
dents to visit a zoo which has live
beavers on display. E.g. Virginia
Living Museum, 524 J. Clyde Morris
Blvd., Newport News, VA 23601,
(804) 595-1900.
3. Use the filmstrip listed under
"Resources" to further examine
wildlife conservation, including the
beaver.
5. At the end of the brainstorming session, a representative from each team presents their answers to the rest of the class.

6. If available resources permit, the teams can then research their questions in the library and make quick follow-up presentations. If not, provide students with the accompanying background information.

7. Show the accompanying pictures of beaver signs so students will recognize these in the field.

At the Park:
1. Lead the students into an active beaver area.

2. Give each team a different beaver sign to look for. After a few minutes, re-assemble the group and ask each team to point out their sign if they found it. Discuss any other signs that are found as well as the effects of the beavers on the environment.

3. Find a comfortable spot within the beaver area for the class to sit quietly. Explain that the beaver has relatively poor vision but has good senses of smell and hearing. Ask students to close their eyes and to sense the beavers’ world for two to five minutes using only their senses of smell and hearing. What does it smell like and sound like?

4. When time is up, ask students to share things they sensed by using a “memory circle.” The first student begins by saying, “In the beaver habitat, I heard...” or “I smelled...” and add an observation. The next student repeats the first student’s observation and adds a new one. To avoid reciting a chain of 25 observations, the fourth student can start repeating only the three most recent observations (i.e., adds one to the end and drops one from the front.)

5. Next play a beaver simulation game. This can be played in the beaver area or another part of the park, preferably covered with leaf litter to make the hearing part of the game easier. Try a sample run with the “beaver” not blindfolded. The procedure is as follows:
   • Students form a large circle.
   • One student designated the beaver stands in the middle of the circle.

   • Another student, designated the predator, is given an odor source such as a bottle of cologne. (In places where they coexist, beaver predators include bobcats, bears and coyotes. In most of Virginia now, the main predators are man and stray dogs.)
   • All the other students are non-predators.
   • The leader points to one of the students, either the predator or a non-predator.
   • The selected student walks slowly toward the beaver, pausing between steps. If the selected student is the predator, he (she) must wave the odor source in front of him (her) with each step.
   • If the beaver detects an approaching predator, it claps its hands (simulating the tail slap), and points to the predator. If the beaver has correctly located the predator, the predator must return to the circle edge.
   • If the predator gets close enough to tag the beaver before it claps, it becomes the next beaver.
   • If a non-predator is selected, it also slowly walks toward the beaver, but passes by without tagging it. If the beaver claps its hands as a false alarm, the non-predator becomes the next beaver. (In nature, it would be to the beaver’s disadvantage to frequently signal danger and flee if there is no danger, since it might not get enough to eat or be able to perform other important tasks on land.)

6. After playing the game for several rounds (teacher’s discretion), ask the students to discuss the game. Some questions to ask include:
   • What were the best strategies for the beavers and the predators?
   • In nature, why would the beaver lose if it frequently made the danger noise and fled from non-predators?
   • Why would it be important for a beaver to use its senses of smell and hearing rather than just sight?
   • Would a beaver be more cautious to sounds and smells on land or in the water and why?
Picking up the Past

Hold a fossil and feel the texture of time... some object that possibly no person has ever touched before... something that has not seen the sunshine for millions of years.

Background

What are fossils?
A fossil is any evidence of life from the past. Some plants and animals are easily fossilized—many, however, are not. Most fossils are formed from the hard parts like teeth, bones, shells or wood. Animals and plants that die and are quickly buried have the best chance of becoming fossils.

What are the types of fossils?
A mold is an impression of an organism left in some other material. An example would be footprints left in mud that over time turned to rock. If dirt and other materials fill and harden in a mold, the result is a cast. Casts of ancient clams can be found along the Chesapeake Bay and its tributaries. Permineralization adds certain inorganic substances to shells or skeletal structures of a permeable nature. Ground water accomplishes this alteration by invading the pores and depositing minerals there. Petrification occurs when ground water completely dissolves original shells or skeletal material and deposits some other

Grade Levels: 4 - 9

Objectives

Students will investigate variation in fossil forms by:
- collecting, classifying and identifying a variety of fossils;
- making models of fossils.

Materials

- old sneakers or boots
- buckets (1 per team of 4 to 8)
- Fossil Identification Sheets (1 per team)
- fossil identification guides
- USGS topographic maps
- plaster of Paris (optional)
- vaseline (optional)
- styrofoam cups (1 per student, optional)

Credits

Illustrations by Mary Parrish® used with permission from the Department of Paleobiology, Museum of Natural History, Smithsonian Institution, Washington, D.C.

When

At the Park: Allow 1 to 2 hours, should be scheduled to coincide with low tide.

Time of Year: Any time of year, weather permitting.

material in its place. A final category is unaltered remains in which the original material of the organism, such as shells, bones, or sharks' teeth, is preserved. Most of the common fossils found in the Bay region, such as scallop shells, sharks' teeth and whale bones, are usually unaltered remains. Though usually not
the same color as modern shells, teeth or bones due to bleaching or staining, they are nonetheless comprised of the organisms' original matter.

Geologic History of the Chesapeake Bay

The Atlantic Coastal Plain of North America has been shaped by a series of rises and falls in the level of the ocean over the past 95 million years. When the ocean rose over the land (a process called transgression), the coastal plain was flooded and the shore could be as far inland as the eastern edge of the Piedmont (e.g. Alexandria, Fredericksburg, Richmond and Petersburg). When the ocean subsided, or regressed, the coast could be as far east as the middle of the continental shelf. With each transgression and regression, river valleys would be flooded, filled with sediment, then drained, recarved and shifted.

About 2 million years ago the latest of a series of Ice Ages began. At that time, part of the original Chesapeake Bay basin was carved by a great river flowing from north to south. As the ocean waters rose and fell with the waxing and waning of the polar ice, the Bay basin was shaped. Toward the end of the last Ice Age, about 18,000 years ago, the last bit of glacial sculpting carved the upper reaches of what is now called the Susquehanna River. Ocean waters began to fill the lower reaches of this modern basin about 10,000 years ago. This portion became the Chesapeake Bay, which soon thereafter was filled to its present level.

How old are the fossils?

Because the Bay region has such a dynamic geologic history, it is difficult for the amateur to determine the age of fossils collected along the tidal river beaches. The tooth of a mammoth that died in a bog 20,000 years ago might be found lying beside a shark's tooth that fell to the ocean floor 25 million years ago. For the novice, the best age estimates will be made by identifying the fossil with a good reference book and using the age given in the book.

What are you likely to find?

Fossilized bones and bone fragments, sharks' teeth and mollusk shells are common finds along tidal river beaches. Bone fragments could have come from marine animals such as fish or whales, or from large land mammals, such as mastodons, horses or wolves. At Leesylvania State Park, perhaps 100-million-year-old petrified wood fragments are found.

Procedure

Before the Trip:

1. Review with the students the basic geologic history of the Chesapeake Bay, how fossils are formed and the various types of fossils. If possible, show them actual specimens similar to those likely to be found at the field trip site.
2. Review all plans for the field trip.

At the Park:

1. Assemble the students at the visitor center and study the park fossil collection. (There is no center at Leesylvania, but arrangements can be made with staff to see park specimens.)
2. Divide the class into collecting teams of 4 to 8 students each. Provide each team with a bucket and a copy of the accompanying fossil identification sheet.
3. Proceed to the collecting area. Define boundaries for the class. If students are allowed to wade to look for fossils, define clearly how far out they may go and be sure they wear sneakers or boots.
4. Assign each team to a section of beach to search for fossils and instruct them to keep anything that resembles a fossil. Fossils found on the beach may be kept. However, people are encouraged to take only a few specimens, to increase the chances for the next fossil hunter. Unusual finds should be reported to the park staff. Digging is not permitted and fossils found in the eroded bluffs may not be taken. Climbing on the bluffs is hazardous, accelerates erosion and is therefore prohibited.
5. After a specified time, reassemble the group. Each team devises its own method of class-

Resources

Thomas, M. C. Fossil Vertebrates - Beach and Bank Collecting for Amateurs. Write: Smithsonian Institution, Museum Bookshops, Washington, DC 20560.
Thomas, M. C. Let's Find Fossils on the Beach. Write: Smithsonian Institution, Museum Bookshops, Washington, DC 20560.
Picking up the Past

ifying the fossils. A representative from each team explains their classification system and shares their finds with the rest of the class. (The teams should record the numbers and types of fossils found, so that a bar chart can be developed in class.) The following questions may be helpful in guiding the discussion:

- How many different fossils were found?
- Are there any fragments or portions of whole organisms?
- What kind of fossil was found most often?
- Where were the best places along the beach to locate fossils? Why might these be the best?
- Were any items collected that look like but may not be fossils and vice versa?

6. In case no fossils are found, be prepared to conduct another activity, such as Number 1 in “Follow-up.” Also, more time could be spent examining and discussing the park fossil collection.

Follow-up:

1. Students make their own plaster of Paris cast and mold “fossils” from various objects (e.g. shells, leaves) found at school or around home. For example, coat a leaf with vaseline and place it on a styrofoam plate. Cover with mixture of plaster of Paris. After the plaster hardens, invert the plate and remove the leaf from the plaster. The impression of the “fossil” remains.

2. Students prepare a bar chart showing the relative numbers of the various fossils found.

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Extensions

Review with the class topographic maps of the park and surrounding area. Careful analysis reveals steep contours (or scarps) left by the tidal rivers when they flowed over the land prior to the last Ice Age. (See park information section for appropriate USGS map numbers and titles.) A set of maps is also available for loan to groups upon arrival at each park.

Variations

Gifted/Advanced:
Photograph samples of all types of fossils found. Upon returning to school, each student thoroughly researches one fossil to verify its identification and possible age range, and to determine what the original organism might have looked like.

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Coral (*Astraea palma*)
Snail (*Turritella plebia*)
Barnacle (*Balanus concavus*)

Scallop

All illustrations life size

111
Snaggletooth shark (*Hemipristis serra*)

Sand shark (*Eugomphotus sp.*)

Porpoise ear bones

Periotic

Tympanic bulla

Porpoise teeth

(*Eurinodelphis bossi*) (*Squalodon calvertensis*)

Sevengill shark (*Notorynchus sp.*)

Extinct mako shark (*Isurus hastalis*)

Ray dental plate fragments (*Aetobatis sp.*)

Crocodile tooth and scute

(*Thecachamps antiqua*)

Extinct great white shark

(*Carcharodon megalodon*)
Students capture, mark, release, and within a week recapture fiddler crabs and periwinkle snails in a salt marsh to estimate population sizes.

Background

As a part of understanding a species, scientists may estimate population size. Plant populations can often be estimated with only one visit to a site, but the mobility of animals necessitates more complex techniques.

One ecological method used to estimate animal population sizes involves capturing and counting animals, then marking and releasing them. This first count is not complete, since some might be missed. A second capture in the same area a few days later will produce a mixture of marked and unmarked animals. Calculations based on these numbers give an estimate of the actual population.

Chesapeake Bay salt marshes harbor two animals whose populations can be estimated using this method, the fiddler crab (Uca species) and the marsh periwinkle snail (Littorina irrorata). When present at a site, both are usually quite abundant and their differing behaviors provide for contrasting results in a comparative study.

Both of these animals have an internal biological clock which coordinates their activities to high and low tides. The crabs go into their burrows before high tide and stay there until low tide. At low tide, they can be observed feeding on algae and detritus on the marsh mud. Males have one larger claw which is used to display to females, and to compete with other males. Periwinkle snails move up the blades of Spartina marsh grass before high tide and return to feed on algae on the marsh surface at low tide. By looking at the direction the snails are moving, you will know whether the tide is moving in or out. Periwinkle snails are able to breathe air with a primitive "lung" but must stay moist and they return to water to reproduce.

When these animals are collected in the field and kept in captivity for a few days, they will continue to move into and out of burrows or up and down the side of the container in rhythm with the time of the tides. Fiddler crabs also exhibit color changes with the tides and time of day.

Procedure

Before the Trip:
1. Visit the park to meet with staff and identify the best site(s) to conduct the activity. Avoid sites where this activity has been conducted recently. Find an area in the marsh with a population of fiddler crabs and periwinkles. (You may need two different sites.) Plan a rectangular study plot with a circumference in meters about equal to the number of students in the class. It should not exceed 6 m on the narrow side.

Grade Levels: 7 - 12

Objectives

Students will investigate equilibrium in populations by:
- using a capture-mark-release-recapture technique;
- inferring and predicting changes in populations;
- collecting data;
- mathematically analyzing the data.

Materials:
- 25 m tape measure
- four corner stakes, 1.5 m long
- small nets
- hammer

To wear:
- clothes and shoes that can get wet and muddy
- a change for the ride home

For each three students:
- brightly colored fingernail polish
- clipboard, paper and pencil
- one bucket
2. Check tide charts to choose field trip dates and times that coincide with low tide.

3. Review the entire activity with the class.
   - Explain that this population estimation technique is similar to but simpler than methods actually used by ecologists.
   - Emphasize the importance of treating the study animals and the field site with care.
   - Prepare students to get muddy while in the marsh.

4. On a sheet of paper, each student writes his or her predictions to the following:
   - On the first trip, how many fiddler crabs and periwinkles will be found in a square meter of the salt marsh?
   - On the second trip, how many of each will be found and how many will be ones marked on the first trip?
   - Which species, if either, will have the higher recapture rate?
   - What are some factors that might affect the results of the study? (e.g., mobility, territoriality, hiding ability, human intrusion, weather, tides and natural mortality of each species.)

At the Park:

1. Lead the students to a section of marsh where they can devise and practice methods for catching and handling fiddler crabs. Reassure students that despite the ferocious look of the large claw on the males, they do not pinch very hard. This step is best done in teams. Allow sufficient time to develop good techniques. (Hints: stealth, nets, persistence, and ingenuity.) Advise them to avoid holding crabs by just the claw or one leg, since these break off easily (autotomize) as a means of escape. They should be held by the carapace or by all the legs and claw on one side as illustrated.

2. At the preselected study plot in the marsh, mark off the rectangular study site with a stake at each corner.

3. Without anyone stepping inside the plot, surround it on all sides, standing about one meter apart, with every third student holding a bucket.

4. Students on the narrow sides stay in their position to catch crabs that try to escape the perimeter. Students on the long sides move at the same pace in a straight line toward the center of the plot. Catching all fiddler crabs and periwinkles possible and placing them carefully in the nearest bucket. Be sure students do not collect animals outside the study plot.

5. When the students meet in the center, they turn around and walk halfway back to their starting points. At this location, teams of three students work together to count, record and mark their crabs and snails. Mark the animals with a small dot of fingernail polish on the shell, being careful not to mark near the opening on the periwinkle shells or near the mouth and eyes on the crabs. After marking, each animal should be kept in a bucket long enough for the dot to dry.

6. When the counting and marking process is complete, all students

Where

Seashore: marshes near 64th Street boat ramp on Broad Bay.
York River: marsh at mouth of Toms River near visitor center (fiddler crabs and especially the periwinkles tend to be concentrated near marsh edges along the creek and river, perhaps requiring non-rectangular study plots).

This activity can also be conducted at other suitable sites. Periwinkles and fiddler crabs are typically found in salt marshes dominated by Spartina alterniflora. If present, periwinkles will easily be spotted on the grass stems and nickel-sized holes in the mud indicate the presence of fiddler crabs.

When

At the Park: Allow at least 1 hour for catching, counting and marking; during low tide for both trips (remember low tide typically changes by about an hour each day).

Time of Year: Late spring through early fall. Fiddler crabs disappear into their burrows once the temperature drops below 60°F.

Resources


except the bucket holders walk out of the study site. The bucket holders then carefully release the animals and leave the study site. As a result, animals will be released within 1.5 m of where they were caught and there will be less chance that they will be stepped on.

7. Two students measure and record the outside dimensions of the study site for calculating its area.

8. Return to the study plot two days to a week later. The students repeat the capture process in the same area.

9. Once all the animals have been collected, count and record the numbers of marked and unmarked crabs and snails.

10. Release the animals, as before. Remove the plot corner stakes.

Follow-up:

1. Tally up each category of numbers from the two field trips.

2. Students calculate the estimated population size for each species in the study plot with the following equation:

\[ P = N_1 \times \frac{N_2}{N_m} \]

where:
- \( P \) = estimated population of study plot
- \( N_1 \) = number of animals marked and released on first trip
- \( N_2 \) = total number of animals captured on second trip
- \( N_m \) = number of marked animals recaptured on the second trip

3. This equation assumes that the same proportion of the population is captured during each visit.

Demonstrate with hypothetical numbers how the equation works if 1/10th, 1/2 or all of the residents are caught during each visit. Show with hypothetical numbers how this population estimate does not give accurate results if there is a large turnover in the population due to emigration, immigration, mortality or reproduction within the study plot.

4. Calculate the population density of each species using the following formula:

\[ D = \frac{P}{A} \]

where:
- \( D \) = population density
- \( P \) = total population of plot
- \( A \) = area of plot (calculated from outside dimensions)

5. Make a bar chart on the blackboard showing the population densities and recapture ratios for each species.

6. Make bar charts comparing the calculated density figures and the recapture ratios (\( N_2/N_m \)) with their pre-field trip predictions.

7. Lead a discussion to speculate about the differences in the results for the two species.
- Is one species more mobile than the other?
- Does one hide better than the other?
- Is one more territorial?
- Could predation or mortality have affected the results?
- Could the activity itself have affected the populations in the study plot, such as by trampling the marsh or making marked individuals more noticeable to predators?

Extensions

1. Before the first field trip, demonstrate the underlying principles of one population estimation technique using the OBIS activity, “Bean Bugs.” It describes a method of random sampling which is used to estimate an entire population of beans tossed in a pre-measured area on the floor.

2. With copies of the park map, calculate the total area of likely fiddler crab and periwinkle habitat and then calculate an estimate of the total number of fiddler crabs and periwinkle snails in the park.

3. Try the same procedure with ghost crabs on a beach at night. Warning: Ghost crabs are fast and can pinch hard.

Variations

1. Instead of using one class with two field trips, have two different classes do the collecting on the first and second visit to the plot.

2. Conduct a similar activity using different species in a different habitat, such as grasshoppers or crickets in a field.
Catch a Class Act

Students will seine along a beach to collect and investigate estuarine fishes and invertebrates. After seining, students observe the unique characteristics of each organism and make inferences about the function of these adaptations.

Background

Shallow areas along the shores of the Chesapeake Bay and its tributaries teem with life awaiting discovery. One very effective means to find out what's there is by seining. The ideal beach seine is a nylon net, 20 feet long by 4 feet tall. In the water, the top of the net is held up by floats and the bottom is held down by lead weights. The net is held open and pulled through the water (with the bottom of the net dragging bottom) with two poles attached vertically to the ends. With just a little practice, a group of two or more can catch a vast array of estuarine organisms along nearly any state park tidal beach with a seine.

The opportunities to observe and infer about estuarine organisms' adaptations are virtually unlimited with a single successful haul of a beach seine. For example, a blue crab's pincers are useful for defense and grasping prey. The sleek, streamlined shape of the silverside enables it to evade predators. The bluefish, also streamlined, swims swiftly to overtake its prey. A flounder's unusual form, with both eyes on one side of its head, lets it view the world with two eyes while lying camouflaged on the bottom. The flexible, almost plastic form of sea lettuce allows it to sway with the tides and waves without being torn apart.

Grade Levels: K - 12

Objectives

Students will investigate variation in estuarine organisms and the interrelationships between form and function by:

- collecting organisms with a seine;
- observing them in containers;
- inferring about their adaptations.

Materials

- 20' x 4' seine
- clear plastic 1.5-gallon "aquarium"
- 5-gallon bucket
- field guides
- old towel to clean up with
- hand lenses (optional)
- notebook and pencils (optional)
- "wettable" footwear
- "wettable" old clothes
- change of clothes and shoes per student

Procedure

Before the Trip:

1. Study the park information in this guide and contact the park staff to determine the best location and time for seining. Usually it is best to seine at low tide.
2. Explain the entire activity to the class. Divide the class into teams of three to five students each.
3. Provide or have each team locate drawings or photographs of two aquatic organisms native to the Chesapeake Bay from resources at school or home.
4. Each team works together to observe and note characteristics, such as body shape, coloration, means of locomotion, and mouth shape. They then make inferences about the functions of those ob-
served characteristics. (Refer to the accompanying chart and illustrations for ideas.) To conclude this portion of the activity, each team presents its observations and inferences to the rest of the class.

5. Review the field trip plans, safety rules and use of equipment with the students. Some important safety and comfort tips:
   • Wear boots or old shoes at all times.
   • Wear warm enough clothing.
   • Avoid walking on shoreline rocks and logs. They can be very slippery (like walking on wet noodles).
   • Be alert. Don't pick up anything bare-handed from the net or beach that looks like it might sting, pinch, or bite.
   • Stinging jellyfish might be present at Seashore or York River State Parks. Anyone going into the water there between late May and mid-September will need hip boots, waders, long trousers and socks, or tights.

6. Emphasize the importance of respecting the environment and its organisms. A few fish and invertebrate mortalities can be expected (these are not wasted as they cycle into the food chain). Plan to keep just a few specimens of each organism in containers for observation. Return the others to the water immediately.

7. If a seine is available at school (most parks will have one for you to use when you get there), have the students practice seining on the school grounds using the instructions below.

At the Park:
1. Lead the students to the seining area. Be sure each team has a bucket and a plastic aquarium or clear container for holding and observing the catch.
2. Discuss and demonstrate the use of the seine on the beach, if this was not done at school.
3. Two students use the following procedure to seine:
   • Begin with the net rolled up on its poles (half of it on each pole). One student remains in ankle-deep water and the other wades straight out (no further than waist deep water), both unrolling the net as they go.
   • Position the net perpendicular to the shore with one person on each end and both facing in the direction in which they will be seining.
   • Place the poles vertically in the water so the weighted or lead line rests on the bottom and the float line is on the surface.
   • Each person grasps his or her pole with one hand about half way down the net and with the other hand just above the top of the net.
   • Tilt the poles slightly backwards so the bottom of the net is a little ahead of the top. This helps to keep the lead line against the bottom.
   • Both people walk at the same slow pace with the net in this position for 20 to 50 meters, making certain the lead line stays against the bottom. If the lead line rises off the bottom or if the poles are allowed to drag behind, organisms will escape under the net. (However, if rocks or logs are encountered, lift the net quickly over the object and return it to the bottom.) The net will be heavy; it is sometimes easier to pull the net rather than push it. The rest of the students should not walk in the water with the net as this frightens the fish away.
   • To bring the net in, the person farthest from shore moves at a faster pace and swings toward shore in a large curve until he or she is even with the other person who has slowed. When the net is parallel to the shore, they both resume the same pace and move the net toward shore until it is on the beach, with the netted animals just above the water's edge.
4. While the two students pull the seine, the others partially fill their "aquaria" with river water collected by bucket, in preparation for holding some samples of the catch.
5. Just before the net comes ashore, all students wet their hands. This helps minimize damage to a fish's slime coat (which protects it from infections) during handling.
6. As soon as the seine is beached, the students from each

Where

Caledon: four miles of Potomac River shoreline, access to river is seasonally restricted and requires park-provided transportation. Chippokes: two miles of James River shoreline, most accessible site is 0.25 mile down College Run Trail. Leesylvania: Potomac River beaches; freshwater marshes along Powell's Creek. Mason Neck: sandy beach along Belmont Bay is most popular; nearby freshwater marshes. A well-equipped wet lab is available. Seashore: sandy beach at Chesapeake Bay mouth with nearly ocean-like conditions; salt marshes and mudflats on Broad Bay at 64th Street boat ramp.

Westmoreland: most accessible is Potomac River beach near boat ramp and swimming pool; less disturbed beach is 0.6 mile down Big Meadows Trail.

York River: short but productive stretch of beach on York River by picnic shelter #3. A well-equipped wet lab is available.

When

At the Park: 1-3 hours, low tide is preferred.

Time of Year: May to October.

Resources


See "Species Zonation List" in the "Information" section of this guide.
team carefully fold back the net and quickly select one representative of each different organism caught and place it in their aquarium.

7. Within two or three minutes, the two seiners return to the water with the net and flip it over to release the remaining organisms. Other students pick up any organisms that fell on the beach and return them gently to the water.

8. Repeat the process, giving other students the opportunity to use the seine and to ensure a good assortment of organisms.

9. Change the water in the aquaria periodically during the seineing process to prevent a rise in temperature and to keep it oxygenated. Carefully pour out some of the water into an empty bucket. Empty the bucket, collect new river water and slowly pour it into the aquaria containing the organisms. If possible, keep the aquaria shaded.

10. Once a variety of specimens are collected, the teams observe and note the characteristics of the organisms in their aquaria for five to ten minutes and discuss among themselves likely adaptations the characteristics represent.

11. Bring the teams together and lead a discussion about the organisms' adaptations.

- Which are probably the fastest swimmers? Why?
- Which ones were caught in large numbers? What are some possible explanations?
- Which ones could inflict some pain? How is this an advantage?
- Which ones might have the best vision? Why?
- Which ones might be the hardest to see in the water? What adaptations make them this way?

12. When the discussion is completed, the students return all of the organisms to the water and clean up the equipment, rinsing the net in fresh water and placing it to dry as directed by park staff.

Extensions

1. Students develop biographies for some of the organisms collected with the seine, with each biography focusing on the organism's adaptations for where it lives, how it feeds and how it protects itself.

2. Students create models of make-believe aquatic organisms and explain how their organism lives based on its physical features. Collect and hang them from the ceiling to turn the classroom into a make-believe aquatic habitat.

3. Students create a mural which represents the community from which they collected, including drawings of the plants and animals identified with each organism showing clearly at least one of its adaptations.

4. Obtain several species of fresh, whole fish or invertebrates from a local seafood market to investigate form and function.

Variations

Younger students:
Adults pull the seine and help students in observing each organism's texture, shape, means of movement and color, and in determining how these characteristics might help it survive. Students should organize their observations by sense used (touch, smell, etc.), and compare organisms in terms of length, width, size or weight.

Gifted/Advanced:
Seine in two or more aquatic habitats (e.g. tidal creek, river). Students describe features that are specific adaptations for each particular habitat. If they find similar animals and/or adaptations in both habitats, solicit explanations.
### Some Seinable Species and Their Adaptations

<table>
<thead>
<tr>
<th>Species</th>
<th>One Notable Feature</th>
<th>Probable Function</th>
<th>Parks Where Might Be Found</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Eel</td>
<td>Snake-like shape</td>
<td>To get into tight areas for hiding and searching for food</td>
<td>All</td>
</tr>
<tr>
<td>Atlantic Croaker</td>
<td>Croaking or drumming noise</td>
<td>Communicates with others about food, danger, attracts mate</td>
<td>All</td>
</tr>
<tr>
<td>Blue Crab</td>
<td>Powerful pincers</td>
<td>For protection and grasping prey</td>
<td>All</td>
</tr>
<tr>
<td>Catfish</td>
<td>Barbels (whiskers) around mouth</td>
<td>To detect food by touch and taste in muddy waters where it lives</td>
<td>All</td>
</tr>
<tr>
<td>Chain Pickerel</td>
<td>'Large toothy mouth</td>
<td>To seize and hold prey</td>
<td>CA, CP, LE, MN</td>
</tr>
<tr>
<td>Comb Jellies</td>
<td>Steady pumping movement</td>
<td>To stay suspended in water and to filter plankton from water for food</td>
<td>SS, WE, YR</td>
</tr>
<tr>
<td>Grass Shrimp</td>
<td>Semi-transparent</td>
<td>Difficult to be seen by predators</td>
<td>All</td>
</tr>
<tr>
<td>Hogchoker</td>
<td>Flat with both eyes on one side of head</td>
<td>For lying camouflaged on bottom, and to see prey and predators above</td>
<td>All</td>
</tr>
<tr>
<td>Killifish</td>
<td>Vertical or horizontal stripes</td>
<td>Camouflage</td>
<td>All</td>
</tr>
<tr>
<td>Menhaden</td>
<td>Flat, streamlined shape</td>
<td>For speed and agility to escape predators</td>
<td>All</td>
</tr>
<tr>
<td>Oyster Toadfish</td>
<td>Sharp spines on back and gill covers</td>
<td>Protection</td>
<td>SS, WE, YR</td>
</tr>
<tr>
<td>Pipefish</td>
<td>Long, very slender shape</td>
<td>To hide among eel grass, looking like plant stem</td>
<td>CA, CP, WE, SS, YR</td>
</tr>
<tr>
<td>Silversides</td>
<td>Silvery coloration</td>
<td>Confuses predators especially when in normal school formation</td>
<td>All</td>
</tr>
<tr>
<td>White Perch</td>
<td>Upward projecting mouth</td>
<td>To feed on animals near surface</td>
<td>All</td>
</tr>
</tbody>
</table>

CA - Caledon  
CP - Chippokes  
LE - Leesylvania  
MN - Mason Neck  
SS - Seashore  
WE - Westmoreland  
YR - York River
Some Seinable Species

Sizes indicated are for adults. Those caught in seine are often much smaller.

American Eel
100 cm

Atlantic Croaker
50 cm

Chain Pickerel
60 cm

Killifish
18 cm

Pink Comb Jelly
11 cm

Sea Walnut (Comb Jelly)
11 cm

Menhaden
35 cm

Oyster Toadfish
38 cm

Illustrations: comb jelly by Lipson*, American eel, Atlantic croaker, chain pickerel, killifish, menhaden, oyster toadfish by Tanuma*
Some Seinable Species

Blue Crab
22.5 cm

Channel Catfish
120 cm

Hogchoker
15 cm

Silverside
14 cm

Pipefish
25 cm

White Perch
48 cm

Illustrations: Blue crab courtesy of EPA; grass shrimp by Lizmorn; catfish, hogchoker, silverside, pipefish and white perch by Teramura.
Callinectes sapidus: Beautiful, Tasty Swimmer

“Some days I think the crab’s the dumbest creature on earth . . . other days I know he’s outsmarting me” (waterman, quoted in Watermen of the Chesapeake).

Students who participate in this activity match wits with blue crabs and are rewarded by a traditional Virginia crabfest.

This activity requires careful planning and abundant adult supervision: students will be working along the water’s edge, handling crabs that can pinch hard, will be near boiling water and may use sharp knives. As with any type of fishing, crabbing requires the grace of good luck.

Background

The blue crab is one of the most abundant and best known inhabitants of the Chesapeake Bay. Its fascinating form and life history make for wonderful lessons in biology and the crab’s delectable flesh is the basis of a multimillion dollar industry.

Its scientific name reveals a lot about the blue crab. The genus, Callinectes (Greek), means “beautiful swimmer.” Blue crabs (and a few close relatives) are unique among crabs in that they are well-designed for swimming: streamlined with a back pair of paddle-shaped legs.

The species, sapidus (Latin), means “tasty” or “savory” alluding to its popularity as food. Since the mid 1800s, blue crabs have been harvested commercially from the Chesapeake Bay, the world’s most productive crabbing waters. In recent years, the annual catch from the Bay has ranged from 50 to 80 million pounds, equating to 150 to 240 million crabs.

As anyone who has ever caught or handled a live blue crab knows, they are remarkably quick and pugnacious. If unable to escape, a blue crab’s primary defense is its powerful claws. Crabs also use their claws for catching and grasping food, which includes a smorgasbord of small fish, other crabs, clams, oysters, vegetation and nearly any dead, but not putrefied, estuarine animal.

Adult males’ claws are bright blue and white; females’ claws look like they have been dipped in red nail polish. The back, or carapace, of the male and female is drab olive, almost army green. On the white underside is an apron (actually a modified abdomen) which shields the sex organs and fertilized eggs.

Grade Levels: K - 12

Objectives

Students investigate crabbing by:
- catching, cooking, “picking,” and eating blue crabs;
- sharing responsibilities;
- using materials and equipment in a safe manner.

Materials

To wear:
- “wettable” footwear
- clothes that can get fishy
- life jackets

For crabbing:
- medium-sized (~4-6 gallon) cooler box with ice for bait
- bait: chicken necks, fish heads, bait-fish, etc. (1 per student plus a few extras)
- prepared crabbing lines
- 5-gallon buckets
- crabbing nets

For crab cooking and picking:
- portable water
- vinegar
- salt
- seafood seasoning
- large steamer pot with rack
- barbecue tongs
- camp stove
- newspapers to cover tables
- paper plates
- (1 per person)
- small knives
- (1 per person, optional)
- live, keeper size crabs
- (at least 1 per person)
- nut crackers
- (1 set per 3 people, optional)

The male’s apron is narrow, with a missile-shaped tip. The immature female’s apron is triangular and the
Callinectes sapidus: Beautiful, Tasty Swimmer

Mature female's is half-moon shaped with a small triangular tip. Mating generally occurs in the late summer to early fall. The female stores sperm as she hibernates in the lower Bay through the winter. When she emerges in the spring, fertilization occurs. She carries eggs, called sponge, under her apron. The sponge starts out bright orange or yellow and turns black as the eggs mature. About May or June, when the female is near the mouth of the Bay, 750,000 to 3,000,000 semi-transparent larvae are released to drift with the tidal currents.

The seaward flow of surface waters carries the blue crab larvae (zoa) out of the Bay and into the rich coastal waters, where they grow rapidly, feeding on plankton and typically molting every 7-10 days. After seven molts a larva becomes a megalops. Resembling a miniature lobster, the megalops can crawl and swim. It moves along the bottom of the Atlantic toward the mouth of the Bay and is swept in by saline waters moving into the Bay along the bottom via the salt wedge.

After several more molts, the juvenile blue crab is tiny but recognizable. Molting frequency decreases with growth and at 16 months, the blue crab is about five inches wide and is considered marketable. Males or "jimmies" continue to grow throughout their three year lifespan. Females or "sooks" live about two and a half years and stop growing at their 21st or 22nd molt, when they mate.

As with all crustaceans, molting is a critical stage in the life of the blue crab. After wriggling out of its old shell, a crab is soft, helpless and vulnerable. It must immediately begin to inflate itself with water to stretch out its new shell and hide for its life, usually in the underwater grasses or mud of the shallows. After about two days, the shell becomes completely hard and the crab emerges from hiding.

Procedure

Before the Trip:
1. Contact the park to determine the best crabbing area for your group. It is recommended that a picnic shelter be reserved for the crab picking because tables are necessary. A shelter reservation fee may apply.
2. Since an abundance of crabs cannot be guaranteed, identify a place to purchase crabs near the park. Note: Even seafood dealers may not have a regular and constant supply of blue crabs. Plan an alternative for the crab picking portion of this activity.
3. Using the crab illustrations:
   • Describe the crab's back legs. What purpose do you think they serve? (They are flattened into "paddles" to propel them through the water.)
   • Describe the crab's profile. What does this shape suggest? (It's streamlined to reduce drag, enabling it to swim swiftly.)
   • What are the functions of the claws? (Defense and catching and clinging to food items.)
   • What is the function of the female's apron? (It protects her eggs.)
4. Point out other key crab features such as:
   • Differences between a male, an immature female and a mature female.
   • Location and mobility of the eyes.
   • Antennae.
   • Mouth parts.
   • Explain the blue crab's life history.
5. Review all field trip plans.
6. Each student makes a crabbing line as follows:

Where

Seashore: best crabbing areas are along main Chesapeake Bay beach and in Broad Bay near 64th Street boat landing.
Westmoreland: any of the beaches along the Potomac.
York River: any of the shoreline along the York and the lower stretches of Taskinas Creek, especially at the mouth.

When

At the Park: Allow at least 1 1/2 hours for crabbing and 2 1/2 hours for cooking, picking, and clean-up. A moving tide is generally better for crabbing than a slack tide. Crabbing at night is illegal in Virginia.

Time of Year: May-October, or when the air temperature consistently stays above 50°F (10°C).

Resources


Cut an approximately 1/2 inch diameter dowel or stick, eight to ten inches long.
Measure and mark 5 inches on the dowel with a permanent marker or notches. (This will be used to measure crabs for identifying "keepers.")
Cut about 20 feet of twine.
Tie one end of the twine to the dowel and wind it on, leaving about 3 feet free.
Tie a 1/2 or 1 oz. lead sinker about 18 inches from the end of the twine. (The remaining 18 inches will be used to tie on the bait at crabbing time.)
8. Organize all equipment.
9. Practice the crabbing procedure (See "At the Park," Step 4) in the classroom. If you have students who already have mastered this skill, ask them to teach this session.

At the Park:
1. Distribute equipment and proceed to the crabbing area.
2. Securely tie a piece of bait near the sinker on each crabbing line.
3. Spread out along the shore, with groups of students close enough together to share buckets and nets.
4. Proceed with crabbing:
   - At the water’s edge, unwrap most of the crabbing line in the water from the dowel and coil it loosely in the left hand (if right-handed).
   - With the right hand, gently sling the baited line into the water.
   - Pull in any slack line.
   - Hold the line taut and wait.
   - When there’s a tug on the other end, have a second person place the crab net near the line in the water and hold it still as the line is gently pulled, bringing the crab into position over the net. Don’t lift the crab out of the water with the line, since it might drop off and escape.
   - Swiftly scoop the crab up with the net.
   - While the crab is still in the net, measure it with the marks on the crabbing line dowel. If the crab is less than five inches wide, from point to point on its back, release it into the water. If the crab is five inches or wider, it’s a legal “keeper.”
   - Deposit the crab in a bucket right-side-up. Crabs tend to die if left on their backs.
   - Keep the bucket shaded, or lay a piece of wet newspaper over the crabs. Do not keep water in the bucket, since the crabs will rapidly deplete the oxygen and suffocate. They can use oxygen from the air as long as their gills are kept moist with a periodic dousing.
   - Tip: If you have to pick up a blue crab, gently pin down its claws with one foot (not a bare foot!), leaving its swimming legs exposed. Grasp it tightly where the swimming legs join the body.

5. When finished with crabbing, wind up lines, remove the bait, and dispose of it properly.
6. Rinse off the lines and dip nets with fresh water.
7. Proceed to the picnic area for the rest of the activity.
8. Prepare the crabs as follows:
   - Put 1 tablespoon of salt and about an inch of water and vinegar in equal parts in a large steamer.
   - Put the steamer rack in place and bring the liquid to a boil.
   - Pick up each crab with a pair of tongs and make sure it’s still alive. Discard any dead ones since they spoil quickly.
   - Rinse off each crab in a bucket of clean water and drop it into the steamer.
   - When the steamer is half full, sprinkle the crabs with a seafood seasoning.
   - Finish filling the steamer with crabs and top with more seasoning.
   - Cover the steamer tightly and let it steam for 20 to 25 minutes, or until all of the crabs are bright red.
   - Serve the crabs onto plates with tongs. Allow to cool before handling.
9. Give a lesson on how to pick a crab or have experienced “tutors” positioned strategically at the tables. There are many ways to pick a crab, some involving sharp instruments (see “Picking Like a Pro”).

The five steps described below require a nutcracker, a small dull knife (such as a butter knife) and determination. Most of the “picking” can be accomplished with fingers only. If you decide to use knives, make sure students place the crabs on the table when they cut.

Step 1. Remove the claws by breaking them off at the body. Crack with a nutcracker to remove the meat.
Step 2. Hold the crab in the palm of one hand, holding the crab’s legs on one side with the thumb. With the other hand, peel off the carapace (top shell). Remove the apron.
Step 3. Scrape off the grey, spongy gills. Pull off the “face” of the crab where it joins the lower shell. Remove the internal organs and the yellow “ck” by scraping them out. Rinse the crab if you like. Break the two sections of the body apart. Both

Extensions
1. Assign selected readings from Beautiful Swimmers by William Warner.
2. Study blue crab larvae mounted on microscope slides (obtain from a scientific supply house such as Carolina Biological).
3. Save an uncooked crab on ice for each two or three students. The next day dissect and study the crab’s anatomy. Compare the anatomy of the crab to other animals which the class has studied.
4. Before the field trip, develop a bulletin board or interest center on the “Life History and Commercial Importance of the Blue Crab” as a class project.

Variations
Younger students:
(or groups short on time)
Catch crabs but release all that are caught. The next day at school, bring several cooked crabs (purchased) to school and pick them for the students to eat or for the process of removing the meat and get a taste.
Callinectes sapidus: Beautiful, Tasty Swimmer

Picking Like a Pro

Note

The method described under “Picking Like a Pro” requires use of sharp knives, and is recommended for secondary students and adults only.

Directions courtesy of the Virginia Marine Products Board. "How to Crack into a Crab" (full color poster illustrating steps). 91 Main St., Suite 103, Newport News, VA 23601. ($1.05)

Step 1. Remove the two large pincer claws by breaking them off at the body. Tap the claw just below the pincer to make a straight, clean cut in the shell. Gently break the claw open and remove the meat with your knife. Repeat procedure for other claw.

Step 2. Hold the crab in one hand and lift up on one point to remove the carapace (shell).

Step 3. Cut off the “face” of the crab where it joins the lower shell and remove the internal organs by scraping them out with the knife. It is not necessary to wash the crab at this point.

Step 4. Make a straight cut from the back to the front of the crab, just above the leg joints. This cut is important; be sure to make it deep enough. Repeat the procedure for the other side of the crab. Set the two pieces removed aside.

Step 5. Cut off (do not pull off) the remaining legs where they join the body. It is advisable to keep the thumb pressed securely over the backfin meat when making these cuts. Note where the flat, paddle-shaped swim fin or backfin is attached to the body.

Step 6. Locate the large chunk of white muscle on either side of the crab body (the “backfin” or “lump” meat), and remove it with the knife. (This muscle is located where the backfin was attached.) The rest of the white meat in the crab body is located in the chambers separated by thin walls of cartilage. Remove the meat by sliding the knife under and lifting it out. This meat is called the “flake” or regular meat.

Step 7. Remove the meat from the two pieces cut off from the top of the crab in Step 4. There will be one chunk of white muscle (top of backfin muscle) that comes off easily, revealing a piece of cartilage. Make a diagonal cut just under this piece of cartilage, and remove the rest of the meat from the chambers.
S

tudents play a game to introduce them to the pressures that bring about the decline of populations of plants and animals.

Background

A visit to a state park, zoo, aquarium, or natural history museum can be a reminder of the great diversity of life on Earth. It is this diversity that provides a countless variety of foods, life-saving medicines, and materials for daily life. The species around today have evolved and changed through time, and thousands of types of plants and animals once in existence have been lost to extinction. Some species have gone the way of the dinosaurs—wiped out by some natural change in ecological conditions—or by other natural causes such as disease or predation. In recent times, plants and animals have been rendered endangered or extinct by human activities—exploitation, habitat alteration or destruction, pollution, and the introduction of new species.

Why save endangered species? Congress answered this question with the Endangered Species Act of 1973. The act’s preamble states that endangered species of fish, wildlife, and plants “are of esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people.” This law works to preserve imperiled species and calls for the conservation of critical habitat—the areas of land, water, and air space that these species need for survival.

Species in trouble are identified and placed on a state or federal list of endangered and threatened wildlife and plants. An endangered species is defined as one that is in danger of extinction. A threatened species is one that is likely to become endangered within the foreseeable future.

Some of Virginia’s endangered species include the shortnose sturgeon, bald eagle, peregrine falcon, red-cockaded woodpecker, gray bat, Delmarva fox squirrel, northern flying squirrel, Kemp’s ridley and leatherback sea turtles, several species of whales, and a wetland plant called swamp pink. Some of the state’s threatened species are the yellowfin mudtom (a fish similar to a catfish), piping plover (a shorebird), Dismal Swamp shrew, and loggerhead and Atlantic green sea turtles.

Grade Levels: 3 - 7

Objectives

Students will investigate changes in population levels by:

- modeling the behavior of a migrating species confronted with impediments to its survival.

Materials

- bases (2 for every 3 students, see “At the Park” step 3)
- flip chart and marking pen

Credits

The migration game was adapted with permission from: Aquatic Project WILD. 1987©. “Migration Headache.” Western Regional Environmental Education Council. Write: VA Dept. Game and Inland Fisheries, 4010 W. Broad St., Richmond, VA 23230. (804) 367-1000. Illustrations of shortnose sturgeon and sea turtles used with courtesy of the artist, Richard Barnard©. Illustration of piping plover used with permission of artist©. Swamp pink art by Megan Rollins©.

When

At the Park: 30 to 45 minutes for game and discussion, 30 to 60 minutes for walk, daylight hours.

Time of Year: Year round.
Ups and Downs

Procedure

Before the Trip:
1. Review the park section of this guide or contact the park staff to locate an open area suitable for this activity.
2. Review with the class the concept of a habitat—the area in which a plant or animal finds the things it needs for survival, such as light or food, water, shelter, space and the opportunity to reproduce.
3. Students draw or describe their own habitats, depicting where they get their food, water, shelter, and space.

At the Park:
1. Find an open space for active work.
2. Explain to the class that:
   • they will play a game in which they will act as a population of piping plovers.
   • the piping plover's habits and needs are described (in box).
   • in this simulation game, the piping plovers will be migrating back and forth from season to season between their nesting and wintering habitats.
3. At each end of a 70-90 foot playing field, place one base for every three students. (A base can be any small portable object that's not likely to blow away, is large enough for three students to get a foot on and is not likely to hurt feet or ankles moving in a frenzy. Plastic coffee can tops or rags should do fine.)
4. The plovers line up along the nesting habitat at one end, with one foot on any base.
5. On signal, the plovers must migrate to their wintering habitat by racing to the other end of the field and placing one foot on a base. Only three students may have a foot on one base at a time. If they cannot find a spot on a base, then they have not found suitable habitat, and they die and must sit out. For the first round, however, there should be enough habitat for all.
6. One student or an adult assistant jots down the numbers of plovers that survive each round of winter and spring migrations for graphing later.
7. Once the plovers have flown safely to their wintering habitat,

Where

Since endangered and threatened plants and animals are very uncommon, they can only be found in a few areas of the state. Before visiting one of the state parks for this activity, check with park staff to find out if any of these species can be seen there. Parks and National Wildlife Refuges manage lands to provide suitable habitat for many of these species.

Caledon: several fields near visitor center are ideal for game; visitor center has information about endangered bald eagle; Caledon has large concentrations of eagles during summer, and a nest used for many years; sometimes eagles can be spotted near visitor center; eagle tours offered seasonally.

Chippokes: best location for game is field between visitor center and pool; bald eagles can sometimes be seen flying overhead or perched in trees along river; best viewing area is in front of visitor center and along College Run Tr.

Ilesyta: game can be played in open places near picnic area or on beach at Freestone Point; bald eagles frequent park and have nested nearby; chances of spotting an eagle are best in places with river view or Powell's or Neabsco Creeks.

Mason Neck: lawn near picnic area is suitable for game; visitor center has exhibits on bald eagle; eagles roost in park in large numbers during winter and are seen regularly flying near visitor center throughout year; special observation blind is available to small groups seasonally.

Seashore: lawn between office and amphitheater and beach are best locations for game; mounted leatherback sea turtle is in visitor center; park is a refuge for many species of locally endangered or threatened species of plants, insects and reptiles, including eastern chicken turtle; example of chicken turtle's critical habitat—cypress pools—can be seen near visitor center; bald eagles are sometimes spotted around Broad Bay near 64th Street boat ramp.
The piping plover is a threatened shorebird in Virginia. They spend the winters along the Gulf coast and along the Atlantic from Virginia southward and spend the summers around the Great Lakes and along the Atlantic coast from Virginia northward into Canada. They feed on small animals found on beaches and tidal flats such as marine worms, mollusks, fly larvae and beetles. They usually nest on beaches by making a simple depression in the sand, well above the high water line. If disturbed, as by people walking along the beach, the plowers take flight, leaving the eggs exposed to the sun. If exposed for long, the eggs can overheat, killing the developing embryos. Hence, piping plowers, as well as other shore nesting birds, need quiet beaches, free of people for successful nesting.

they should turn around and prepare for the spring migration.

8. Before giving the signal for the return migration, however, explain that this year there has been a bridge built to their favorite nesting island, bringing lots of tourists to the beach, so some of their habitat is no longer safe.

9. Remove one base from the nesting end, and send them on their migration. When they reach this end, three students will be left out. (Have them sit on the sideline to watch the next rounds.)

10. Just before it’s time for the fall migration, explain that there has been an oil spill near their favorite wintering beach.

11. Remove two or three bases from that end of the field, and make the signal to start the migration. This time, many more plowers will die, and the population will be much smaller.

12: Explain that a hurricane blew down the bridge to their nesting grounds and there are fewer tourists to frighten them away.

13. Add one plate there and signal the migration. With lots of healthy habitat, the plowers will have a good nesting year. Some of the students may return to play as young plowers, but only as many as can fit on the plates in the nesting habitat.

14. Continue the game for at least six migration trips, with both good and bad cycles. Get students to help make up the course of events, introducing a variety of changes in food supply, disease, weather, human dis- turbance, efforts at protection, etc.

15. At the end of the game, discuss the events with the class.

- Which factors caused the plover population to decrease? Increase?
- Which events were caused by humans? Which were natural?

16. If available at the park, have students tour the visitor center to learn more about extinct, endangered or threatened species that live (or have lived) i or the park.

17. Lead the class on a walk to try to spot an endangered or threatened species (see “Where”) and to experience their habitat.

Follow-up:

1. Using the data recorded in the field, make a bar chart showing the changes in numbers of plowers for each migration.

2. Organize a library trip and help students find out more about a species chosen from the accompanying partial lists of threatened, endangered, extirpated and extinct species or from a more complete one provided by a state or federal agency (see “Resources”). Have them write short reports (with original

Where (cont’d)

Westmoreland: field in front of visitor center is perfect for game; visitor center exhibits cover ancient extinct species, represented by fossil specimens, and imperilled modern species, represented by mounted specimens of striped bass, osprey and bald eagle; fossils can be found on park beaches and eagles can sometimes be spotted flying near river.

York River: field near visitor center is ideal for game; bald eagles are sometimes spotted in and over park.

Resources


Natural Heritage Program. Dept. of Conservation and Recreation. 203 Governor St., Suite 402, Richmond, VA 23219. (804) 786-7951.


VA Dept. of Game and Inland Fisheries. 4010 W. Broad St., Richmond, VA 23230. (804) 367-1000.

## Ups and Downs

### Shortnose Sturgeon

- **Amphibians**
  - *Endangered*
    - Shenandoah salamander (*Plethodon shenandoah*)
    - Tiger salamander (*Ambystoma tigrinum*)

- **Birds**
  - *Endangered*
    - Bald eagle (*Haliaeetus leucocephalus*)
    - Bewick’s wren (*Thryomanes bewickii altus*)
    - Loggerhead shrike (*Lanius ludovicianus*)
    - Migrant loggerhead shrike
    - Peregrine falcon (*Falco peregrinus*)
    - Red-cockaded woodpecker (*Dendrocopos rufus*)
    - Roseate tern (*Sterna dougalli*)
    - Wilson’s plover (*Charadrius wilsonia*)

- **Crustaceans**
  - *Threatened*
    - Madison cave isopod (*Antrolana lina*)

- **Fish**
  - *Endangered*
    - Blackbanded sunfish (*Enneacanthus chaetodon*)
    - Blueside darter (*Etheostoma jessiae*)
    - Carolina darter (*Etheostoma collis*)
    - Sharphead darter (*Etheostoma acuticeps*)
    - Shortnose sturgeon (*Acipenser brevirostrum*)
    - Tippecanoe darter (*Etheostoma tippecanoe*)

- **Mammals**
  - *Endangered*
    - Delmarva Peninsula fox squirrel (*Sciurus niger cinereus*)
    - Eastern big-eared bat (*Plecotus roxinessisi*)
    - Eastern cougar (*Felis concolor couguar*)
    - Fisher (*Martes pennanti*)
    - Gray bat (*Myotis griseascens*)
    - Indiana or social myotis (*Myotis sodalis*)
    - Northern flying squirrel (*Glaucomys sabrinus coloratus*)
    - Northern flying squirrel (*Glaucomys sabrinus fuscus*)
    - Virginia big-eared bat (*Plecotus townsendii*)

- **Mollusks**
  - *Endangered*
    - Appalachian monkeyface (*Quadrula spasa*)
    - Birdwing pearly mussel (*Lemnox rimosus*)
    - Cumberland bean mussel (*Villosa tradalis*)
    - Cumberland combshell (*Epioblasma brevidens*)
    - Cumberland monkeyface (*Quadrula intermedia*)
    - Dromedary pearly mussel (*Dromus dromus*)
    - Fine-rayed pigtoe (*Fusconaia cuneolus*)
    - Green-blossom pearly mussel (*Epioblasma torulosa gilvumaculum*)
    - James spiny mussel (*Pleurobema collina*)
    - Litt.e-winged pearly mussel (*Pegasius fabula*)
    - Oystér mussel (*Epioblasma capeiformis*)
    - Shiny pigtoe (*Fusconaia cor*)
    - Snuffbox (*Epioblasma triquetera*)
    - Tan rippleshell (*Epioblasma florentina walker*)
    - Virginia coi (*Polygyrus virginicus*)

- **Plants**
  - *Endangered*
    - Harper’s fimbriystis (*Fimbriystis perpusilla*)
    - Long-stalked holly (*Ilex collina*)
    - Mat-forming water-hyssop (*Racopra stragula*)
    - Nes:onia (*Nes:onia umbellula*)
    - Northeastern bulrush (*Scirpus ancistrochaetus*)
    - Peter’s Mountain Mallow (*Malvina corei*)
    - Piratebush (*Buckleya distichophylla*)
    - Shale-baron rockcrop (*Arabis serotina*)
    - Small whorled pogonia (*Isotria medeoloides*)
    - Swamp-pink (*Helianthus bullata*)
    - Variable sedge (*Carex polymorpha*)
    - Virginia round-leaf birch (*Betula alba*)
    - Virginia sneezeweed (*Helenium virginicum*)
    - Virginia spiraea (*Spiraea virginiana*)

- **Reptiles**
  - *Endangered*
    - Bog turtle (*Clemmys muhlenbergii*)
    - Eastern chicken turtle (*Deirochelys reticularia*)
    - Hawksbill sea turtle (*Eretmochelys imbricata*)
    - Kemp’s ridley sea turtle (*Lepidochelys kempi*)

- **Crustaceans**
  - *Threatened*
    - Chittenango ovate amber snail (*Succinea chittenangoensis*)

### Virginia Endangered and Threatened Species, 1990

- **Fish**
  - *Endangered*
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    - Blueside darter (*Etheostoma jessiae*)
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    - Kemp’s ridley sea turtle (*Lepidochelys kempi*)

- **Crustaceans**
  - *Threatened*
    - Chittenango ovate amber snail (*Succinea chittenangoensis*)
Background information about the bald eagle, an overview of the Caledon eagle tour and suggestions for preparations and follow-up activities for the tour are provided.

Background

Bald Eagles and Man

The bald eagle is special to Americans. Bald eagles represent noble ideals such as courage and strength and are associated with wild, unspoiled places. Its image can be found on the Presidential Seal, currency, state flags, postage stamps, corporate letterheads and a vast array of commercial packaging from potato chip bags to peanut cans.

Unfortunately, despite its prominence in American life, the bald eagle has faced trouble from man even before its declaration as the national symbol in 1792. Considered a threat to livestock and game, eagles have been shot and poisoned. Dependent on mature, secluded, shoreline trees for nest sites and perches, they have steadily lost critical habitat to the development of waterfront homes, businesses and farms. Due to its position at the top of the food chain, pollutants such as heavy metals and pesticides have caused reproductive problems.

An especially infamous and devastating pollutant was DDT, a very popular insecticide, with widespread use from the end of World War II until it was banned in this country in 1973. DDT is a "persistent pesticide," meaning it doesn't break down chemically into a less harmful substance for a long time. It accumulates in animal tissues and becomes increasingly concentrated as it moves up the food chain. For eagles and other fish-eating birds, the accumulation of DDT in their systems caused severe egg shell thinning. As a result, the birds could not incubate their eggs without breaking them and were thus rendered, for all practical purposes, reproductively sterile.

Fortunately, bald eagle populations are beginning to recover from the ravages of the past 200 years. Laws have been passed to protect them from being shot and poisoned; the release of toxic chemicals into the land and into the waterways has been greatly regulated; and some shoreline areas have been set aside to provide nest and roost sites. Eagle relocation programs transplant young eagles from areas with healthy populations to areas with few or no eagles. Eventually, many of these eagles return to their release sites to nest and rejuvenate the area's eagle population.

Today the Chesapeake Bay region has one of the healthiest eagle populations in the eastern United States. (The recovery region in-
How "Eagle Eyed" Are You?

Number of Young Bald Eagles Produced in Chesapeake Bay (Virginia and Maryland)

Year
Number
0 20 40 60 80 100 120 140 160 180 200 220 240 260

Includes not only Virginia and Maryland, but also parts of West Virginia, Delaware, New Jersey, and Pennsylvania. In 1989, 198 nesting pairs fledged 217 eaglets, an increase from 136 successful nests in 1986 and from an all time low of 37 nests (7 fledglings) in 1962.

Unfortunately, this population trend is likely to reverse. Since bald eagles require large expanses of undisturbed, forested shoreline for nesting, roosting and hunting perches, they face a serious threat from the evergrowing human population and particularly from the development of shorelines. The majority of critical eagle habitat is on private land, much of which has tremendous real estate value. Without substantial incentives for landowners to keep coastareas undisturbed, eagles may lose most of their choice habitat.

Bald Eagle Life History

Bald eagles typically mate for life. Their nests, called eyries, are usually built near the tops of tall trees (80-100 feet above ground). They are made of sticks and lined with moss, feathers or other soft material. A pair may return to the same nest each year, adding on new material each season. Some nests have been used for more than 35 years and have become as large as 8 feet across and 12 feet deep. (One nest was 20 feet deep, 10 feet wide, and weighed 2 tons!)

In the Bay region, nesting can begin as early as December and run until mid-June. Usually 1 to 3 eggs are incubated for about 35 days. The eaglets emerge helpless and blind but grow rapidly on a diet of fish and other meat foraged by both parents. After about 75 days they take their first flights. The parent birds continue to care for the fledglings for several more weeks before they finally disperse.

During the fledgling period, young eagles learn to find and catch their own food, which despite the eagle’s image as a fierce predator, is most often carrion or animals very near death. By far, their main food is fish, but they also eat waterfowl, small mammals and occasionally reptiles. Sometimes eagles will rob other raptors (especially ospreys) of their catches, a practice which encouraged Ben Franklin to lobby for the wild turkey as the national symbol in preference to the eagle.

Bald Eagle Identification

Bald eagles are the largest raptors in Virginia, with a wingspan of 70 to 90 inches. Adult bald eagles are unmistakable with a white head and tail, dark brown body, and a large yellow beak and yellow eyes. Birds less than four years old are mostly dark with irregular white mottling and lack the white head and tail. Often, bald eagles are confused with turkey vultures and ospreys, which are other large raptors common to the region.

Where

Caledon is the only park with formally arranged eagle tours. However, the other six Chesapeake Bay estuarine state parks are used by bald eagles. For more information, see "Ups and Downs."

Resources


How "Eagle Eyed" Are You?

the Bay area. However, when soaring, these birds can be easily differentiated, even at great distances, by their wing profiles. Turkey vultures hold their wings in a dihedral, or V-shape. Ospreys often have a crook in their wings and eagles hold their wings out almost flat.

Bald Eagles and Caledon Natural Area

Although bald eagles can be seen at all seven Virginia state parks in the Chesapeake Bay region, Caledon Natural Area is unique as a special eagle haven. (See park information section.) For years eagles have nested in the park and each summer, large numbers of eagles congregate there from all over the southeastern United States. More than 50 eagles have been spotted at or near Caledon in a single day!

Because of this abundance of eagles, visitor access to much of Caledon is carefully regulated. The park is divided into four zones, only one of which is accessible to visitors daily. The remaining three zones are preserved as eagle habitat, closed to the public completely from early fall through late spring to protect nesting areas. At other times, access is limited to small groups making brief visits to the shoreline for opportunities to view eagles. This access is provided in the form of eagle tours, conducted by the park staff.

Procedure

Before the Trip:
1. Begin planning early, preferably in the spring of the preceding school year, since tours are only offered in the summer and early fall. Fall trips usually get booked up fast!
2. Identify specific learning objectives for investigating topics of interest such as focusing on bald eagle life history, the effects of toxic substances in the food chain, or eagle management strategies. With advance notice, the park staff will tailor its presentation to help meet these objectives.
3. Contact the park to make reservations, and to discuss fees and specific field trip objectives.
4. Familiarize the class with key characteristics of the bald eagle.
5. If binoculars are available at school, have students use them on the school grounds, where they can learn to adjust the focus and practice bringing objects quickly into view. Spotting scopes will also be used at the park!
6. Explain that eagles are very alert and do not tolerate loud noises. Therefore, in order to have a good chance of seeing eagles and to avoid disturbing them, it is very important to be quiet and still while in the eagle viewing area.

At the Park:
1. Lead the class to the visitor center to tour the exhibits. Study the large aerial photograph of the park to see how the park is divided into special zones for protecting the eagle population.
2. A ranger will give an introduction to the tour and lead the group out to the park tus.
3. After a short ride to Triangle Field, a staging area, students will examine a life-size replica of an eyrie, be given eagle identification tips, and have an opportunity to practice using binoculars by taking a special field test. Discuss:
   - How can these birds shape such a nest structure?
   - Why do they pick treetops?
   - How much territory does a nesting pair need and why?
   - Why does the fact that eagles tend to choose mature trees for nests cause problems for them? (Often dead trees which humans tend to cut down.)
   - How could the eagles' habit of returning to the same nest area each year help or hurt the population?
4. The group will be driven closer to the Potomac shoreline, to then walk about a 1/4 mile to the area where eagles are often observed.
5. At the conclusion of the tour, the park bus will return the group to the visitor center.

Follow-up:
1. Discuss the following:
   - If no eagles are seen, why weren't they there? Where could they be? What might they be doing?
   - How much space does an eagle need and how do we know (or how could one find out)?

Extensions

If adequate reading materials are available, research and present reports on important bald eagle issues such as its status on the endangered species list; the accumulation of toxic chemicals in the food chain; eagle migration routes; the importance of eagles to Native American cultures, and eagle relocation programs.

Variations

Younger students: Talk about eagles before the trip—identification, food sources, where they can be found. Show pictures. After the field trip, do "Follow-up" activities Nos. 1 and 3.

Gifted/Advanced: Distinguish between mature and immature birds and count the numbers of each. Record locations.

Why does the Natural Area have to be "zoned" with restricted access?
Given that eagles take 4-5 years to mature—what impact does this have on repopulation? How can people help eagles?
How do you suppose eagles catch fish? Waterfowl?
Why do fish, as a primary food source, cause problems for eagles? (Pesticides wash into streams and rivers, easily entering the aquatic food chain.)
How does coastal development negatively affect eagles?
Do eagles migrate? What is the benefit to migratory behavior? The detriments?
What are human perceptions of raptors in general?

2. Give students a special assignment related to bald eagles.
Make a giant collage with eagle images collected from magazines, postage stamps, product packaging, etc.
Build an eagle nest on the school grounds with materials gathered, with permission, from a local woodlot.
You, Too, Can Canoe!

Details are provided for what to expect with, and how to prepare for, park-conducted canoe trips into tidal wetlands. Tips and a model activity are given for maximizing student awareness and involvement.

Background

For some, the prospect of taking a class on a canoe trip brings visions of kids floundering in the tide as they try to control unwieldy craft and returning with saturated clothes. Fortunately, canoes are remarkably stable and easy to control. With a little organization and by following a few basic precautions, a canoe trip into a Chesapeake Bay wetland can be a fun, easy, safe, and memorable experience.

Three state parks offer guided estuarine canoe trips: Leesylvania, Mason Neck, and York River. These trips are led by a park staff member and include a brief overview of canoeing safety and techniques, and detailed, on-the-water interpretations of estuarine and marsh features. Dip nets and buckets are provided for catching and holding some of the smaller estuarine inhabitants and there are usually opportunities to observe, from a distance, the larger, more agile residents.

Conducted canoe trips can be long or short, lasting from 1 1/2 to 4 hours. All students, grades 3 and up, are welcome. Groups with students under 14 years old should bring one adult chaperone for every two students. The number of people that can be accommodated on a trip ranges from 11 to 18, varying with the size of the participants and the size of the park canoes. Thus a class of 30 may need to schedule two or three canoe trips on the date that they visit. Fees apply and vary according to the canoe trip duration.

Check with the park well in advance for details and reservations.

The learning value of a canoe trip, like any field trip, increases significantly when students are prepared in advance, have well-defined objectives during the trip and have closely related follow-up activities. The following seven procedural steps describe ways to arrange a successful park-conducted canoe trip. The last step suggests a model for observing diversity of life forms found in a wetland. Other objectives, such as learning about tides and currents, variations in water chemistry, wetland plant adaptations or carrying out student-planned experiments are alternatives. For activity ideas to adapt or incorporate into a canoe trip, consider other units in this guide such as “Habitat Hunt,” “Marsh March,” “Water Motion and Commmotion” and “Catch a Class Act.” With advance notice, the park ranger should be able to tailor the trip according to your specific objectives.

Procedure

Before the Trip:
1. Identify the learning objectives for the field trip.
2. Contact the park to make reservations, to discuss the learning objectives, and to determine the ideal group size and student-to-chaperone ratio. Visit the park for orientation.
3. Explain to the class all field trip plans, including when and how long they can expect to be in the canoes.
4. If the class is too large for one canoe trip, divide the class into smaller groups, including chaperones. (See “Where” for group sizes.) If the class must be divided, plan alternative activities for the students who are not canoeing.

Grade Levels: 3 - 12

Objectives

Students will investigate variation in estuarine life forms by:
• observing flora and fauna visible from a canoe.

Materials

To wear:
• old clothes and shoes that can get wet; cap

To take:
• change of clothes (just in case)
• insect repellent
• sun screen

For model activity:
• park map copies (one per student)
• 8 1/2 x 11” (or larger) poster board
• drawing pens, crayons, colored pencils, or markers
• note pad and pen or pencil

When

At the Park: 1.5 to 4 hours, daylight hours.

Time of Year: spring through fall.

5. Divide each group into teams of two or three canoeing partners. Team experienced canoeists with the inexperienced.

6. Review with the class some basic canoeing safety rules:
• move into and out of the canoe in a crouched manner
• remain seated at all times
• keep your weight low and in the center of canoe
• wear life jackets throughout the trip
• alert the park ranger to any problems
• no horseplay
You, Too, Can Canoe!

7. Review with the class basic wetland and estuary information such as that described in "Marsh March" and in field guides. (See Lippson's Life in the Chesapeake Bay and White’s Chesapeake, Nature of the Estuary.)

8. To encourage student investment and attentiveness during the canoe trip, organize a single project for the students. One example is:

• Students brainstorm a list of plants and animals they might expect to find on the canoe trip. The list is recorded on the board and on paper.

• Each student chooses one plant or animal to research and to exhibit with a poster. After learning the plant’s or animal’s life history and habitat requirements, they present their findings and poster to the class.

• During the canoe trip, students pay close attention to the types of plants and animals present in the wetland.

• Immediately after the canoe trip, students make a list of the species they saw.

• Upon returning to school, they compare this list to the predicted list made before the trip. The results are discussed with questions such as: What similarities or differences are there between lists? Why were some plants or animals not found that they expected to see?

At the Park:

Before the canoe trip departs, encourage students to be especially observant for marsh inhabitants and their signs, to ask the ranger questions, and to participate in discussions during the trip.

Where

Leesylvania: six canoes can accommodate 11 to 17 people; trips usually conducted on Powell's Creek which passes through extensive freshwater tidal marsh.

Mason Neck: six canoes can accommodate 11 to 17 people; trips originate at visitor center on Belmont Bay and go up Kane’s Creek through extensive freshwater tidal marshes.

York River: six canoes can accommodate up to 18 people; trips originate near visitor center and are conducted on Taskinas Creek. Regular canoe trips are conducted in lower portion of creek in salt marsh; extended trips go to upper reaches of creek, providing opportunity to observe transition from salt marsh to fresh marsh to swamp.
Boats of all kinds have been key players in the Chesapeake Bay's history. In this activity, students use a dichotomous key to learn about some types of boats used on the Bay, then build models of these boats and float them at the park.

Background

Native Americans of the Chesapeake region traveled and traded over a wide area. They used log canoes to travel by water. The larger loads of the early European settlers were most easily shipped by water. As a result, their farms and villages grew along the shores of the Chesapeake and on the banks of its rivers. For the first two hundred years of European settlement, ships and boats were the most important transportation in the Chesapeake region.

Towns for trading and shipping usually sprang up on rivers at the fall line, where the rivers tumble through rapids and waterfalls on the edge of the Piedmont, before meeting the placid tidal waters of the coastal plain. Richmond, Alexandria, Fredericksburg, and Petersburg were all built on the fall line.

Until the 1800s when canals were dug alongside the rivers, the fall line was the point at which goods and crops had to be moved over land. The remains of canals can be seen today along the James, Potomac and Susquehanna Rivers above the fall line. Boats were towed up and down the canal by mules or other animals. The C and D Canal which connects the upper Chesapeake Bay with Delaware Bay is still in use, not only by ships but also by migrating striped bass.

Hundreds of kinds of boats and ships have sailed the Chesapeake Bay, serving every possible use: transportation of people and cargo from across a creek or around the world, fishing, piracy, fighting wars and racing. Some boats and ships are unique to the Bay. Nine of these, the log canoe, sailing log canoe, skipjack, deadrise, yawl boat, Baltimore clipper, pungy, bugeye, and ram, are illustrated and described in this activity. Many of these traditional boats can be seen in Baltimore Harbor.

Procedure

Before the Trip:
1. Introduce the topic of boats by compiling, as a class, a list of “boats we have been aboard.” For each, note its purpose, approximate size, and any special interesting features.
2. Obtain some historical material about the use of boats in the Chesapeake region. The Chesapeake Bay Teaching Resources Lending Library at VIMS has a number of books which are available for loan. Try Chesapeake Notes and Sketches: This Was Chesapeake Bay, and The Lord's Oysters.
3. Select and assign student readings (factual or fictional) about pirates, shipping, travel, or other use of boats on the Bay. For secondary students, many sections of James Michener's novel, Chesapeake, or William Warner's Beautiful Swimmers would be appropriate.
4. Divide the class into workgroups of two or three students.
5. Distribute copies of the accompanying Bay Boats Dichotomous Key and Bay Boats to each group.
6. Review the dichotomous key instructions and “Special Boat Words” with the class. Explain that the key is similar to the kind of key scientists use to identify plants and animals.
7. Compare the groups' results. Did all groups arrive at the same identifications? Discuss.

Grade Levels: 4 - 8

Objectives

Students will investigate variation in boat design by:
- using a key to classify types;
- constructing models of various types;
- observing behavior of models on moving water.

Materials

- copies of information sheet and dichotomous key provided
- pencils and clipboards for each student or group
- a supply of clean trash, paper and cardboard, and/or natural materials for building models
- tape, glue, staples, string, rubber bands, and scissors
- fishing line
- stakes or other markers
- stopwatch
- tape measure
- "wettable" footwear

Credits

Adapted with permission from The Changing Chesapeake, 1989. "Travel and Trade in Early Times; "Working Boats and Ships of the Chesapeake Bay." V. Chase, National Aquarium in Baltimore, Baltimore, MD.

Resources

Chesapeake Bay Teaching Resources Lending Library Catalog. 1989.
Sea Grant Communications, VA Institute of Marine Science, Gloucester Pt., VA 23062.
8. With the class, plan a boat-building session (or two). Students, working in small groups or individually, design and construct a facsimile of one of the nine boats pictured on the Bay Boats sheet. Discuss options for construction materials and assign responsibility for procurement. Materials could include cleaned pieces of trash (which would fit in with a lesson on litter pollution) or natural materials. Hulls could be made from plastic tubs, or plastic or cardboard milk cartons. Be sure to tie a long piece (several meters) of fishing line to each completed model, so that they will not sail away to become litter.

9. Do a "test float" in the sink or bathtub before field trip day. Students should tinker with their designs until they float with some stability.

At the Park:

1. Take the models to a stream or other body of water at the park. Find a location where the current seems to be moving gently. Float a leaf to check speed and direction. Be prepared for wet feet.

2. Mark a starting point and finish line along the bank (perhaps 2 or 3 m, depending on current speed).

3. Maneuver the vessels along a starting line so that their handlers are holding them and standing behind them (up current). Release the boats, but hold on to the fishing line. Select a few students to clock the amount of time it takes for the vessels to reach the finish line. Time no more than four or five boats together to minimize collisions.

4. Repeat this once or twice (time permitting) for a more accurate experiment and average the times for each vessel. Be sure to collect all boats from the water when the activity is over.

Follow-up:

1. Discuss:
   - If you had to make your boat go faster or slower, what are the options?
   - Are some designs better than others for certain purposes?
   - Which is more important, current, wind, or auxiliary power?
   - If you could own one of these boats, which would you want? Why?
   - How have boats changed/stayed the same over the last 200-300 years?
   - Are any non-power boats still used? Why?
   - What kinds of boats are most common today? Why?

2. Examine a map of the whole Bay or a tributary and identify places where these Bay boats may have actually worked. Select some points between which some of the boats may have traveled in a day. Consult the map legend for scale, and note how many miles this typical day's run might have been.

Where

Caledon: very small boats could be sailed in woodland streams reached by trails that start at visitor center; boats could also be sailed in tidal creek flowing through Caledon Marsh. Access to marsh is seasonally restricted to small groups and park transportation must be arranged.

Chippokes: boats could be sailed in College Run from bridge on College Run Tr.

Leesylvania: boats could be sailed by wading in some areas along Potomac shoreline; shoes or boots would be essential.

Mason Neck: boats could be sailed in pond near visitor center.

Seashore: older students could sail boats in Narrows at 64th St.; younger students in small groups could sail them in tidal mosquito ditch close to boat ramp.

Westmoreland: students could wade, with shoes or boots, and sail their boats at beach near swimming pool.

York River: with life jackets on, two or three students at a time could sail boats from canoe launching dock on Taskinas Creek; other areas include beach below picnic shelter #3, and Woodstock Pond.

When

At the Park: Sailing trials could take from 20 minutes to an hour, depending on conditions, number of boats and number of trials.

Time of Year: Late spring through early fall is the safest time to work around the water.

Extensions

Gifted/Advanced:
Locate pictures and descriptions of several other Bay boats or ships. Expand the dichotomous key to classify them, or design original keys to classify the boats in other ways.
Bay Boats Dichotomous Key

Directions:
- Look at the pictures and read the descriptions on the Bay Boats page.
- Write the number listed for each boat under the word "Boats" below.
- Follow the arrows to the right and write the number under each heading for each boat that fits the description.
- When each arrow stops, and there is only one answer, write the name of the boat under the description.

Boats

- Powered by motor
  - Window cabin
    - No window cabin
  - One or more fixed masts
    - Has sails
      - No fixed masts
    - Has no sails
      - Double ended (both ends the same)
        - One mast
          - Not double ended (bow and stern different shapes)
            - Not painted pink and green
              - More than one mast
                - Three or more masts
                - Fewer than three masts
            - Painted pink and green
              - Not painted pink and green

Special Boat Words
- bow - front (forward) of boat
- stern - back (aft) of boat
- masts - poles that hold the sails upright
- sloop - boat with one mast
- double ended - identically shaped bow and stern
- schooner - boat with 2 or more masts close together
- topmasts - additions on top of masts
- raked masts - tilted backwards toward the stern
# Bay Boats

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>1. DEADRISE:</strong> Common watermen's workboats which may be used for crabbing, oystering, clam dredging and fishing. Often up to 45' long with a small cabin in front. Motor powered.</td>
<td><strong>2. SKIPJACK:</strong> Used for oyster dredging in Maryland, they are the last commercial sailing fleet in the U.S. Graceful boat with sharp bow, squared stern and a single mast with sloop rigged sails.</td>
<td><strong>3. SAILING LOG CANOE:</strong> These fast boats were adaptations of the Native American log canoes. Bow and stern pointed, made from five logs, two removable masts.</td>
</tr>
<tr>
<td><img src="image1" alt="Deadrise Boat" /></td>
<td><img src="image2" alt="Skipjack Boat" /></td>
<td><img src="image3" alt="Sailing Log Canoe" /></td>
</tr>
<tr>
<td><strong>4. BALTIMORE CLIPPER:</strong> Common in the early 1800s these very fast ships carried cargo all over the world. Two raked masts, schooner-rigged.</td>
<td><strong>5. LOG CANOE:</strong> Native Americans made these open boats by repeatedly burning and scraping a single log. Both ends pointed, paddle powered, up to 50' long.</td>
<td><strong>6. YAWL BOATS (&quot;PUSH BOATS&quot;):</strong> These little motor boats evolved from the small boats carried by large sailing ships. They are used today as mini tugs which provide power for skipjacks.</td>
</tr>
<tr>
<td><img src="image4" alt="Baltimore Clipper" /></td>
<td><img src="image5" alt="Log Canoe" /></td>
<td><img src="image6" alt="Yawl Boat" /></td>
</tr>
<tr>
<td><strong>7. RAM:</strong> Three or four masts, long, narrow and slow, these narrow schooners were sailing barges used in the C &amp; D Canal at the top of the Bay.</td>
<td><strong>8. BU GYEYE:</strong> Double ended with one fixed mast, these ships dredged oysters, hauled vegetables, lumber, coal and illegal whiskey.</td>
<td><strong>9. PUNGY:</strong> Similar to the Baltimore Clipper, but designed for use on the Bay. Schooner-rigged, two curved masts, some were painted pink and green.</td>
</tr>
<tr>
<td><img src="image7" alt="Ram Schooner" /></td>
<td><img src="image8" alt="Bugye Boat" /></td>
<td><img src="image9" alt="Pungy Boat" /></td>
</tr>
</tbody>
</table>
Great Bay Land Grab

Confronted with the responsibility of planning for the sale and subsequent use of park lands, students analyze the resource and evaluate plans in terms of future impact.

Background

The Chesapeake Bay and its tributaries are very busy places. Waterfront property has become a premium commodity. The Bay supports important commercial fisheries, and is ranked third in the nation in overall fishery catch. It is the largest producer of blue crabs, and among the leaders in clams and oysters. The value of the Bay's fishing catch exceeds $100 million per year. It is also a key commercial waterway boasting two of the five major North Atlantic ports (Baltimore and Norfolk). Nearly $30 billion worth of cargo was shipped via the Bay in 1989. A variety of industries and power plants line the Chesapeake Bay shores to use the water for cooling and processing. The gentle climate, natural beauty and recreational opportunities are attracting more people who visit or make their homes here. The Bay also has value as a natural resource providing breeding and feeding grounds for marine life, serving as a major stopover for migratory waterfowl, and supporting the largest nesting population of bald eagles in the lower 48 states.

Development of waterfront property can fall into one of five categories: industrial, residential, recreational, commercial, or agricultural. Each type of development results in benefits and hazards. The benefits are generally economic and people-oriented and the hazards are often environmental.

Industrial development can include power generating plants, chemical manufacturers, chicken processing plants and others. Industries are attracted to the Bay because they generally require large quantities of water for cooling and processing. They provide jobs and economic stability but can introduce

Grade Levels: 7 - 12

Objectives

Students will investigate changes associated with land use decisions by:
- observing existing features;
- considering social impact;
- analyzing features of a site;
- planning use options;
- communicating persuasively;
- evaluating options;
- predicting effects of decisions;
- visualizing alternate uses.

Materials

- copy of Roles for each student
- copies of site map, several per group
- cameras, film
- presentation supplies as needed (flip chart, posters, projector, etc.)
Great Bay Land Grab

various pollutants into the Bay including toxic chemicals, excess nutrients, and heated water.

Residential development and commercial development are currently booming around the Bay. As waterfront housing developments go up they are accompanied by new shopping centers, stores, gas stations and other businesses. This type of development tends to increase waste water flow and surface runoff.

Recreational development includes marinas and boat landings providing access for fishermen and boaters, and land purchased for city parks, state parks and wildlife preserves. Increased use of the Bay by boaters can result in increases of floatable pollutants like plastics, and increases in oil pollution. Parks and refuges help maintain the environmental integrity of the land surrounding the Bay, but recent increases in property values of land adjacent to the Bay make it expensive for governments to purchase land for these purposes.

Agricultural development increases runoff and can introduce pesticides and excess nutrients into the Bay. Fewer farms and the increase in environmentally sound farming practices have reduced the environmental impact of agriculture over the past few years.

Any type of development along the Bay that requires the clearing of land destroys wildlife habitat and increases sediment runoff in the Bay. In a 1975 study the Smithsonian Institution identified 113 sites around the Chesapeake Bay vital to wildlife. By 1980 over half of these sites were developed or being developed.

Each square mile of land that is developed sends 25 to 50 thousand tons of soil into the water. An abundance of nutrients emptied in the Bay from sewage, runoff from farm fields, or other sources, triggers a chain of events beginning with increased algal growth which depletes oxygen supplies in the water and can result in major fish kills.

Over the years, the Bay and its tributaries have remained highly productive while absorbing considerable pressure from both natural and human sources. If human demands on the Bay continue to increase, the Bay may lose its ability to cleanse itself. Population projections through the year 2000 indicate a 24% increase in the number of people living in the Chesapeake Bay drainage area since 1980. This means 237 people per day will buy or build homes in this area, the need for water will rise 166%, exceeding current supplies, and these newcomers will generate 260 million gallons of sewage per day. In the words of William Ruckleshaus, past director of the E.P.A., "The Chesapeake, more than most bodies of water, is a people's Bay. Its survival is up to all of us" (1983).

Procedure

Before the Trip:
1. Prepare role assignments for students, filling in names for each role. Be careful to make some assignments which will allow students to play roles different from their present personas, e.g. assign some mediocre students Ph.D. roles, or let the class brain play one of the school dropout roles. Modify role descriptions with local details if desired.

Copy the map of the park. Divide it into three approximately equal segments. Give each section some waterfront, and make dividing lines along present features (streams, roads) when possible. Label the sections A, B and C Assemble references for classroom use.

2. Check a local newspaper for an article dealing with a local land use dispute. Assign it as a class reading and conduct a brief discussion, soliciting class opinions on what the central characters ought to do.

3. Explain that the class will be making some similar kinds of decisions. Read this aloud:
   It is now the year 2000.
   __________________ (name: a student government officer), Governor of the Commonwealth of Virginia, has announced that due to a severe budget deficit __________________ State Park (name field trip site) will be closed and sold to raise at least $4,000,000. The Commonwealth has issued a Request for Proposals for prospective buyers to bid on the land and explain their ideas for use. Proposals will be heard by the

Where
Caledon: access to most of park seasonally restricted and requires park-provided transportation; interior roads to to sections of park along Potomac.
Chippokes: park roads and trails provide access to a variety of areas.
Lee'sylvania: understanding of park's resources obtained by traveling slowly along park road and by walking trails and beach at Freestone Point.
Mason Neck: trails leading out from visitor center go to sections of park; some areas inaccessible; some characteristics can be inferred with topo map.
Seashore: park roads lead to representative areas including beach on Chesapeake Bay; cypress swamps, tidal marshes and beach on Broad Bay.
Westmoreland: most shoreline can be explored from road stretching from boat ramp to cabins; Big Meadows Tr. leads to extensive wetland area; Turkey Neck Tr. leads to hardwood forest.
York River: representative shoreline and wetland areas seen near visitor center and at Croaker Landing; all trails offer views of hardwood forests.

When
At the Park: 1 hour for on-site group work, plus time to tour the park any time of day.

Time of Year: Any season, in-class activities require 3-5 class periods.

Secretary of Natural Resources, the Attorney General, and a State Senator (the selection committee), who will select three worthy projects.
4. Distribute copies of the park maps showing A, B, and C plots, the role assignments and background information to everyone.
5. Announce the proposal guidelines:
   • one page written summary
   • 5-10 minute oral presentation to selection committee; may include visuals (maps, graphs, photos, artist's conceptions, etc.).
Great Bay Land Grab

- must specify which park segment (A, B, or C);
- must offer the exact amount indicated in role description.
6. Provide the class with an overview of the project plan. Groups will work up preliminary plans for both site development and class presentations (using maps and available resources). They then will visit the park for in-depth exploration of the sites, and prepare and present their proposals after the field trip.
7. Review with the class any maps and references obtained. Point out documents which provide guidelines for waterfront development.
8. Groups begin their planning. While the selection committee considers how to evaluate the proposals, development groups consider and prepare worksheets for:
- size and locations for buildings, roads, etc.
- compatibility with existing uses
- erosion control
- long-term impacts
- pollution implications
- impact on natural environment
- community benefits
- adherence to development guidelines
- effective ways to "pitch" their sales presentation
- what they need to do on site to prepare effective presentations
9. Check each team’s plans for the site visit to the park. Make sure plans are organized and contain sufficient detail to be helpful with planning.

At the Park:
1. Together, the class should become familiar with as much of the park as possible. This could include a canoe trip, a trail hike, a visit to the visitor center, and/or a chat with park staff about natural resources and land uses in the area. During this tour, locate the boundaries of plots A, B, and C.
2. The class then separates into the role groups to work on their plans on site. If everybody wants to develop site A, you will have to assign a few to the other sites. (Be fair, flip a coin.) Groups should take pictures, make sketches, locate facilities, and record information on their worksheets.

Follow-up:
1. Get film developed as quickly as possible.
2. Allow several class periods for groups to prepare their presentations.
3. Schedule and conduct students’ presentations: up to 10 minutes each, with 3 minutes for questions.
4. The selection committee conducts a public hearing after the presentations. Do this in an organized manner: the chair must present an agenda, recognize each speaker and keep the discussion on track.
5. The selection committee meets and selects one project for each plot, making sure that they collect at least $4,000,000.
6. After the decision is announced, assign as homework a one-two page essay which discusses the probable effects on the community 20 years later. Consider pollution, environmental benefits, value to the community and economic implications.

Resources

*Baybook. 1987. Alliance for the Chesapeake Bay.
Chesapeake Bay Foundation Fact Sheets. *Chesapeake Bay Preservation Act.* “Wetlands and Section 403.” (301) 488-8816.
Chesapeake Executive Council. Contact: EPA Chesapeake Bay Liaison Office. (301) 266-6873.

*Telephone the Chesapeake Regional Information Service (1-800-662-CRIS) to obtain these and similar publications. The staff can assist with specific informational needs. Many up to date informational resources are available at no cost.

Extensions

1. Use the video tape Coastal Growth, A Delicate Balance and some of the activities described in its study guide. The general instruction for dilemma discussions will be helpful in conducting "The Great Bay Land Grab" activities.

2. Conduct the activity "Researching the Bay" concurrently, using the specific informational needs for this project as the research topics. "The Great Bay Land Grab" can be conducted without extra references, but is enhanced by use of researched material.
Selection Committee: __________, __________, and __________ all went to the University of Virginia together and studied environmental law. They have worked for state agencies and have risen to positions of power and prestige. __________ is Virginia's Secretary of Natural Resources, __________ is the Attorney General of Virginia, and __________ is a long-time State Senator. These three individuals must decide to whom the park will be sold. They must examine the site, devise a system for rating proposals (based on environmental impact, community interests, economic implications), hear proposals, and sell enough of the park to raise at least $4,000,000.

Realtors: __________ won the lottery in 2007. At the time, she was living in an abandoned school bus with her good friends __________ and __________. Having developed an appreciation for fine living, they founded the international real estate firm "Tri Giggle, Inc." which specializes in exclusive luxury homes. Tri Giggle proposes to buy a plot for $2,000,000 to subdivide into large lots for elegant homesites.

Power Company: As everybody suspected she would, __________ went to MIT, earned her Ph.D., at the age of 22, and became a famous authority on nuclear power. When she went to work for Virginia Power, she was delighted to find that __________, an environmental engineer, and __________, a public relations specialist, would be on her staff. All three are sincerely committed to nuclear power as environmentally sound, safe, and cost effective, and they would like to buy a park plot for $2,500,000 for a small nuclear power plant.

Restaurant Owners: __________ and __________ have traveled a bit. After dropping out of school they worked as deck hands on a freighter. Eventually, in Casablanca, they were astonished to run into __________, who had just completed a book about international foods. Together they decided to return home and open a fine restaurant featuring foods from all over the world. With royalties from the book as financial backing, they are able to offer $1,000,000 for one of the park plots for their restaurant.

Environmentalists: __________ and __________ were the kind of people who escorted flies outdoors rather than swatting them. Their love of nature led them to become environmentalists, and they founded "Naturecare" in 1999. Astute as ever, they hired __________, a successful used car salesman, as general manager. Although "Naturecare" operates on a small budget, they are hopeful that they will be able to buy one of the park plots for $500,000 in order to set it aside as a wildlife refuge.

Local Politicians: If you want to hear the latest news and gossip, everyone knows to ask __________ and __________. Naturally, they are local politicians. They love their work, but have to deal with some really difficult decisions. Local sewage treatment has become a crisis they can't ignore. The old plant, just upriver of the park, overflows with every rain, pouring raw sewage into the river. Voters are demanding action. The community Board of Supervisors has authorized $1,750,000 for the purchase of land for a state-of-the-art sewage treatment facility.

Retirement Home: Nobody could believe it when they heard that __________ had eloped with __________ and that they had gone to Nags Head to sell timeshare condos. After the hurricane last year, they had nothing left but their savings, which they decided to come home with. They would like to start a condo-style retirement community on the park site, and have hired __________ (who earned an MBA at VCU and has been business manager for three nursing homes) as general manager. They have $2,000,000 to purchase land.

Teen Center: __________ went to JMU and __________ to Longwood. Both earned scholarships for graduate study at Johns Hopkins, became psychologists, and went into business together ten years ago, specializing in teen counseling. They have come to believe that many teens with drug and alcohol problems need to get away from the situation at home during counseling and, with encouragement and financial backing from __________, a local philanthropist, hope to open a substance abuse residential center for teens. They have $900,000 to spend on land.

Estuarine Lab: __________, who always loved to go fishing, worked as a waterman briefly after graduation, became interested in fisheries management, took a few biology courses, and the next thing he knew he was a graduate student at VIMS. Of course, __________ and __________ were already there. After completing their Ph.D.s, none of them could find a job. So, they wrote a proposal to EPA to start their own laboratory for estuarine research. It was funded. They have $1,250,000 available to purchase waterfront land. With the lab, they plan to research aquaculture and population dynamics, with the objective of stabilizing Virginia's fisheries.
Whose Flotsam is This?

Until fairly recently, trash was just a noun. Your students know trash as a transitive verb also. To trash: to ruin a person, place or thing. This activity untrashes a park site, and contributes data to a national program which is a leader in the fight to stop global trashing.

Background

Whether discarded intentionally, blown or washed overboard accidentally, or originating from land, the Chesapeake Bay receives tons of litter each year. Not only is the litter unsightly, it is hazardous. Sea turtles swallow plastic bags mistaking them for a favorite food, jellyfish, then slowly starve as their digestive systems are inactivated. Seagulls and other birds become entangled in discarded fishing line and scores of fish die in old nets drifting free with the tides. Swimmers cut their feet on broken bottles and boat engines and propellers are damaged by plastic bags, ropes, and fishing line. Small marsh animals perish in drink bottles that outwardly are inviting shelters or nooks to find food, but in reality may be inescapable death traps.

The ultimate fate of litter in the Bay is varied. Paper products and untreated wood decay. Glass and metals sink and are eventually covered by sediment. But plastics are, for the most part, non-degradable (will not disintegrate) and are light enough to float or remain suspended in the water. Thus a single piece of plastic litter might be a problem for hundreds of years.

Many organizations, government agencies and individuals are working to solve litter problems. Among the attempted solutions are anti-litter laws, public information campaigns and photodegradable (disintegrate in presence of sunlight) and biodegradable (eventually disintegrate biologically) plastics. While these may reduce some of the negative effects of plastic litter in the environment, they do pose other problems. They do not degrade if buried, as in a landfill, and they cannot be recycled with other non-degradable plastics.

In 1988, the Coast Guard issued regulations that prohibit the dumping of plastic in our oceans and waterways, implementing Annex V of MARPOL, an international treaty. The regulations apply to all U.S. vessels wherever they operate, and to foreign vessels operating within 200 miles of the U.S. coast. While these regulations will not eliminate waterborne litter, they should help mitigate the problem.

Grade Levels: K - 12

Objectives

Students will investigate inter-relationships between the environment and litter by:
- observing types and conditions of shoreline litter;
- inferring about possible sources and effects of litter;
- collecting, organizing, and reporting data.

Materials

To wear:
- "wettable" sturdy footwear (no sandals or flip-flops)
- leather and rubber gloves

Per team:
- Beach Cleanup Data Card
- Guide to Marine Debris
- A Guide to Good Data Collection
- clipboard
- pens or pencils
- five gallon bucket
- plastic trash bags (at least 1 per person)

Credits

Activity and background information adapted with permission from Aquatic Project WILD. 1987. "Plastic Jellyfish." Western Regional Environmental Education Council. Write: VA Dept. of Game and Inland Fisheries, 4010 W. Broad St., Richmond, 23230. (804) 367-1000.

Solutions to a complex problem like waterborne litter require a thorough understanding of the problem. One non-profit marine conservation group, the Center for Marine Conservation (CMC), is building a database on marine debris for the entire United States. The CMC receives much of its information by encouraging groups to collect shoreline litter, keep count of the types of litter collected and send in the statistics. With a little ingenuity, a coastal-field trip can contribute to this valuable research and be a great learning experience.

Procedure

Before the Trip:

1. Write to the Center for Marine Conservation (use form provided) to request copies of their beach cleanup handouts—Beach Cleanup Data Card, A Guide to Good Data Collection, and Guide to Marine Debris. Ask for at least one copy of each handout for every team of two to four students.

2. Make an extra copy of the list side of the Beach Cleanup Data Card. On the copy, cross out the word “COLLECTED” and write “PREDICTED.” Use this modified copy to make enough for each team.

3. Divide the class into teams of two to four students each.

4. Lead a class discussion on the problems of waterborne litter.
   - What, to you, is litter... a gum wrapper, cigarette filter, 20 feet or 1/2 inch of fishing line?
   - What types of litter did you see last time you were on a public beach?
   - Have any of you ever been injured by beach litter or do you know anyone who has?
   - Have you ever seen animals trapped or killed by litter?
   - Have you ever seen animals making use of litter in lieu of natural materials?

5. Distribute the handouts. On the “Items Predicted” sheet, each team marks the number of each item they predict they will find during the field trip. Review the other handouts, the activity, and field trip plans with the class.

6. Emphasize important safety procedures:
   - Wear gloves.
   - Do not go near large drums. Report these to park rangers.
   - Be careful with sharp objects.
   - Be careful with potential hazards such as tampon applicators, condoms, and syringes. (Note: Discussion of these materials is at the discretion of each teacher, depending on the age and maturity of the students. Decide whether to just list them or avoid them altogether, and see that chaperones understand the policy.)

At the Park:

1. Be sure each team has a Beach Cleanup Data Card, a clipboard and pen or pencil. (Bring some extras.)

2. Each team chooses a data recorder to tabulate on the data card the litter they find.

3. Equip each team with receptacles for carrying litter. Use garbage bags for most items and a five gallon bucket for sharp items that might cut through garbage bags.

4. At the shoreline, set boundaries, such as “from the water’s edge to the high tide mark” and “from the tidal creek to the big log.” Do not add marshes, if the footing is sound, since waterborne debris readily collects there.

5. The teams spread out and collect litter within the boundaries for a designated period of time.

6. Regroup the class. The teams sort their litter on the beach or lawn in groups, as classified on the data card.

7. A member from each team selects a piece of their litter to discuss the following points:
   - How might the litter have gotten into the water or onto the shore and how could it have been avoided?
   - If not picked up, what might happen to the litter in 1 year, 5, 20, 400 years?
   - How could the litter affect wildlife and man, both negatively and positively, if left in the water or along the shore?
   - Identify at least one way that the litter can be recycled.
   - What appears to be the source of the majority of litter collected by each team (i.e. picnickers, fishermen, boats, etc.)?

Resources


Whose Flotsam is This?

- What was each team's most interesting, surprising, or unusual litter-related observation of the day?
- When the discussion is completed, together gather the litter and dispose of it appropriately (preferably by recycling).

Follow-up:
1. Each team compares their "Items Collected" lists with their "Items Predicted" lists and makes bar graphs showing the relative amounts of the types of litter predicted and collected.
2. On the blackboard or with overhead transparencies, compile all the lists and graphs into one.
   1. Each team completes its Beach Cleanup Data Card.
   4. Collect the cards and send them to the CMC.

The most abundant types of trash collected during "Clean the Bay" Day in 1989. (Source: Center for Marine Conservation).

<table>
<thead>
<tr>
<th>THE DIRTY DOZEN</th>
<th>Number of Pieces</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pieces of paper</td>
<td>8894</td>
<td>9.05</td>
</tr>
<tr>
<td>2. Cigarette filters</td>
<td>7144</td>
<td>7.27</td>
</tr>
<tr>
<td>3. Pieces of glass</td>
<td>6972</td>
<td>7.09</td>
</tr>
<tr>
<td>4. Metal beverage cans</td>
<td>5642</td>
<td>5.74</td>
</tr>
<tr>
<td>5. Pieces of plastic</td>
<td>5529</td>
<td>5.69</td>
</tr>
<tr>
<td>6. Plastic cups, spoons, forks, straws</td>
<td>5399</td>
<td>5.49</td>
</tr>
<tr>
<td>7. Small pieces of foamed plastic</td>
<td>5042</td>
<td>5.13</td>
</tr>
<tr>
<td>8. Glass beverage bottles</td>
<td>4508</td>
<td>4.59</td>
</tr>
<tr>
<td>9. Plastic caps and lids</td>
<td>3902</td>
<td>3.97</td>
</tr>
<tr>
<td>10. Pieces of wood</td>
<td>3694</td>
<td>3.76</td>
</tr>
<tr>
<td>11. Miscellaneous types of plastic bags</td>
<td>3297</td>
<td>3.35</td>
</tr>
<tr>
<td>12. Foamed plastic cups</td>
<td>3110</td>
<td>3.16</td>
</tr>
<tr>
<td>Total</td>
<td>63,195</td>
<td>64.29</td>
</tr>
</tbody>
</table>

To: Center for Marine Conservation
1725 DeSales St. NW
Washington, DC 20036

Please send the indicated number of copies of the following:

____ Beach Cleanup Data Cards
____ Guides to Marine Debris
____ Guides to Good Data Collection

Teacher's Name:__________________________________________

School Name:__________________________________________

Address:__________________________________________

_____________________________ Cleanup Date:

Grade:__________________________ Cleanup Location:__________________________

Extensions

1. Encourage independent exploration of topics such as:
   - Status of local, state and federal litter-related legislation. (E.g. investigate the progress of a bottle bill in the VA General Assembly over the last decade.) What groups favor and oppose which bills and why?
   - Recent innovations with plastics such as recycling, biodegradables and photodegradables. Debate the pros and cons of using these materials.

2. Students write letters to their lawmakers, stating their own positions on litter-related legislation.

3. Students create litter art in the form of posters showing the effects of litter on the bay, or sculptures or mobiles from litter collected during the field trip.

4. Students are challenged to invent useable products from recyclable plastics.

5. Start a class recycling project.

Variations

Social studies classes write a description of the culture of people from the area by analyzing the types of litter collected.

Younger students:
Each team of students must have an adult monitor to pick up and carry all potentially hazardous litter, as well as record data, as the students collect and sort the litter.

Gifted/Advanced:
1. Students keep a file on the consequences of pollution disasters like oil spills, etc. using newspapers, magazines, and TV as sources of information.

2. Obtain further data from the CMC so students can perform statistical comparisons between their findings and the baseline data.
Students take a 1.3 mile walking-tour of Chippokes Plantation, inspect significant historic buildings and artifacts, and make inferences about plantation life from their observations while answering a series of questions.

Background

Historians use a variety of methods to learn about everyday life in previous time periods. By studying the types and designs of buildings and the construction materials used, they are able to infer many details about a farm's prosperity and social structure. Chippokes Plantation is typical of Virginia plantations. The number and variety of outbuildings as well as the presence of two "main houses" enable students to visualize plantation life and see how it changed through the years.

The River House, built in the early 1800s, is believed to be sitting in the same spot as an earlier house, built in 1642. The foundation has a definite seam in the brick, indicating that the house was later expanded. The dimensions of the older section of the current house match the dimensions specified in a 1642 lease. The house was to be 40 feet long by 20 feet wide with two chimneys, glass windows and a cellar. Though historians have no proof that the house was actually built, the fact that the River House's original dimensions fit those specifications leads them to believe that the house did indeed exist. However, because the brick bond is typical of nineteenth century America, the current house is believed to be a reconstruction. One chimney has a different brick bond pattern from the rest of the foundation, suggesting that it has been repaired.

Outbuildings along College Run Trail were previously used as the kitchen, tenant and slave quarters, barns and farm buildings. Though most have been converted for private residences or other functions, visitors can still visualize their former uses. By comparing slave/tenant farm quarters to the owners' homes, one gets a feel for the difference in social roles and the attitudes towards slaves. The owners' spacious homes offered a view of the river, while slave/tenant farmers' quarters were cramped.

Grade Levels: 4 - 11

Objectives

Students investigate changes over time by:
- observing clues;
- making inferences about the history of human use of the area.

Materials

Per team:
- Clues to the Past Student Worksheet
- clipboard
- pencils

Credits

Plantation layout sketch from River Times used with permission from the Mathematics and Science Center, Richmond, VA.

Where

Chippokes: College Run Trail is paved bike/hike trail, running 1.3 miles from visitor center to mansion; there are two inclines on trail where wheelchair and walking-handicapped students may need assistance. As an alternative, students may be transported by road from visitor center to River House after introduction at beginning of trail ("At the Park" Step 2).

When

At the Park: 1.5 to 2 hours, daylight hours.

Time of Year: Any time is suitable for the walk, visitor center and mansion open seasonally.
often with more than one family occupying them. Chippokes, like many Virginia plantations, relied on sharecroppers to farm the land after the Civil War. Sharecroppers typically received one-half of the crop for themselves if they used the owner's draft teams, or three-fourths if they farmed with their own animals.

The mansion, built in 1854 by Albert Jones, is typical of plantation homes of the day. The stucco front, painted white to serve as a landmark for river travelers, is inscribed to resemble large stone blocks. Such blocks were considered more prestigious than red brick, but because a painted surface required additional upkeep, often only the front was finished this way. The formal gardens, replanted during the 1920s, contain ornamental species typical of the period: azaleas, boxwood, and crepe myrtle. Ornamental fruit trees and a wild flower garden are also present.

Unlike many plantations, Chippokes never relied solely on a tobacco crop, which may partly explain why it prospered long after many others failed. Chippokes is still a working farm with a variety of crops and cattle.

Procedure

Before the Trip:
1. Contact the park staff to arrange the date and time and to ensure facilities will be open. Make reservations to tour the mansion.
2. Discuss plantation life with the class. Encourage them to think about the many activities on a plantation as well as the workers needed to run it.
3. Discuss how historians learn about the past, by reading old documents, studying pictures, and examining artifacts for clues. Explain that the students will act as historians as they study the buildings at Chippokes to learn about plantation life.
4. Divide the class into teams of three to four students each. Provide each team with a copy of the accompanying Clues to the Past Student Worksheet. Students will work as teams to answer the questions about the historical buildings along the 1.3 mile College Run Trail.

At the Park:
1. Tour the visitor center before beginning the walk.
2. Lead the class to the beginning of the College Run Trail. Point out that Virginia’s first successful settlers landed here before crossing the James River to settle on Jamestown Island. While on this side of the river they met and were befriended by Chief Chippokes.
3. Keep the group together until the first stop at the River House, about 0.5 mile down the trail. (As an option, students may be transported closer to River House by road.)
4. Allow student groups to proceed at their own pace from here but set a time (about 1 hour) for everyone to gather at the end of the trail. Assign adult leaders to assist the groups as needed. Encourage students to use their observational skills to answer the questions.
5. One adult should proceed to the mansion to meet the first group to finish. Conduct informal discussions about what it would be like to live and work on a plantation until everyone finishes.
6. When the entire group is reassembled, lead a discussion of the findings. Accept all inferences as long as students can support their opinions. (A suggested format for student reporting is: “We think _______ because _______.”) Some questions to guide further thought might be:
    • How is a plantation similar to a farm today? How is it different?
    • How is a plantation similar to a town today? How is it different?
    • What kind of activities do you think the owner’s children participated in each day? Slave children?

Resources


History of Chippokes (brochure).
Chippokes Plantation State Park, Surry, Virginia.

Extensions

1. Students write a sample journal entry for a day in the life of the owner’s child or a slave child living on the farm, including details about typical activities as well as their feelings about their lives.
2. Students make a model of a typical plantation showing outbuildings and crop lands.

Variations

Younger students:
Students answer only the starred (*) questions on the Clues to the Past Worksheet.

Follow-up:
Ask students the following:
• If you wanted to make a peanut butter and jelly sandwich in the kitchen in 1800, what would you have to do?
  a. Raise wheat. Visit grist mill to grind flour for bread.
  b. Raise the peanuts. Shell, roast, and grind them with a hand grinder.
  c. Go to the orchard and pick fruit. Cook over fire for several hours. Pour into jar, seal with wax.
  d. Milk the cow, churn the butter.
  e. Bake the bread on the hearth (mixing, kneading, rising takes several hours).
  f. Haul water and heat it to clean up.
  g. Assemble your sandwich.
Clues to the Past Student Worksheet

Note: Younger students should answer questions marked with (*) and may answer others if they like. Older students should answer all questions.

RIVER HOUSE (Built in early 1800s)

1. Stand on the trail and look at the end of the house facing the trail.
   a) What evidence do you see that the house was expanded sometime after it was built?

   b) What events might have prompted the owner to expand the house?

2. Examine the chimney brick pattern. Brick layers call the long side of a brick the “stretcher” and the short end a “header.” A typical brick pattern in the 1800s was one row of headers followed by three rows of stretchers. The brick pattern changes mid-way up the left chimney.
   a) What does the pattern become? (draw)

   b) What might have happened to result in a change in the brick pattern?

3. Notice the stars on all four chimneys. They are fairly recent additions. A clue to their purpose is hidden inside the house. Stars on opposite chimneys are connected by a large bar that runs through the attic. What purpose might the stars and bars serve?

4. Walk up close to the house and look at a window.
   a) Describe the appearance of the glass.

   b) How do you think this type of glass was made?

5. Stand on the trail next to the River House and look down the road toward the river. Historians believe this road was used to roll hogsheads (large wooden barrels) of tobacco down to the river. Why were they taken to the river?

OUTBUILDINGS:

6. Look at the house across the trail from the River House. It was originally a kitchen. Why was the kitchen a separate building?

7. Behind the kitchen are two buildings that served as a smokehouse and a poultry house. Why were these needed on a farm?

8. Walk down the trail to the next house on the left. It was probably built in the 1830s-1850s as a slave house for two families. How is it different from the River House?

9. The inside had just two rooms, one on each side of the chimney. Why do you think the chimney was located in the middle?

10. The next building (now a public rest room) was probably built for newly freed slaves. In about what year do you think this house was built and why?
Clues to the Past Student Worksheet (continued)

11. Many freed slaves became sharecroppers. The house was probably in the middle of a small tract of land for the sharecropper family to farm. What do you think the term “sharecropper” means?

12. The next four buildings on the left were farm buildings—an apple mill, dairy barn, horse barn and corn crib. Plantations were like small towns with everything needed being right on the plantation. What other town-like features might this plantation have had?

MANSION: (Built in 1854)

*13. A line of cedar trees often grows where a man-made fence once existed. Can you think of any reason to explain this? (Hint: Birds eat cedar berries.)

*14. Compare the mansion to the River House. How are they different?

15. Do you think the farm was prosperous in the mid 1800s? Why?

16. Walk around the mansion and note the material each side is made of and the color. What do you see?

*17. Why do you think the front is white? (Hint: It faces the river.)

18. The front of the house appears to be made of large stone blocks. In reality it’s less expensive stucco plastered onto bricks.
   a) Why do you think the plantation owner made the front look like block?
   
   b) Why just the front?

19. Notice the raised, windowed structure on the rooftop. This is a cupola. What purpose do you think it served?

20. Some people (particularly in seafaring towns) call the cupola a “widow’s walk.” Why do you think it received this name?

*21. Look at the display of kitchen equipment inside the kitchen (beside the mansion).
   a) Name 3 kitchen tools on display that are still used today.

   b) Name 3 tools that have been replaced by electric appliances.

*22. Walk to the carriage house and examine the carriages on display.
   a) Which carriage looks the most comfortable?

   b) Which one do you think could travel the fastest? Why?
Clues to the Past - Suggested Answers to Worksheet Questions

1. a) There's a seam in the brick foundation. The brick on the right side looks older than on the left.
   b) Farm was prosperous; family grew.

2. a) All stretchers.
   b) The chimney may have been damaged and repaired at later date.

3. Hold the chimneys upright.

4. a) Wavy.
   b) Hand blown.

5. To load onto ships for transport to England and other far away places. The river was the major method of transportation.

6. Cooking was done in open fireplaces which posed a major fire hazard. With the kitchen in a separate building, the main house was protected. Also the main house would not be overheated in the summer by the heat from the kitchen.

7. Poultry house provided fresh eggs. Meat was preserved by smoking in the smoke house. (There were no grocery stores or convenient refrigeration.)

8. Much smaller, less view of river.

9. Heats both sides of house - separates living quarters.

10. Late 1860s - after Civil War for freed slaves.

11. Farmer shares the crop with land owner.


13. After birds eat berries, seeds pass through digestive tract, and are dropped while birds perch on fence.

14. Mansion larger, brick.

15. Yes - new larger house.

16. Front is white, scribed to look like large blocks; other sides - red brick.

17. House was landmark for river travelers; other sides didn't need to be seen from a distance.

18. a) Stone block was a popular style and/or prestigious (could it have held the paint better than plain brick?)
   b) Harder to maintain than plain brick.

19. Provided good view of river.

20. When the husband traveled by sea, there was a chance that he would never return, and that the wife, who would regularly climb up to the "widows walk" to look for her husband's ship, would become a widow.

21. a & b) Answers will vary.

22. a) Lucy Ludwell's (there are plaques to describe each carriage).
   b) Breaking cart - lightweight, small.
Plantations and Plenty

The prospective planter’s first job was to clear the land of the immense trees dominating the landscape. The lumber from the trees was a primary building material. Clay for bricks, and oyster shells and sand for mortar were also important construction materials. Few essentials for starting a plantation were transported from overseas on the tiny crowded ships—a few hand tools, some livestock for breeding, seed for planting and, perhaps most important, laborers.

The primary laborers fell into two groups. Indentured or bond servants were usually white and worked for a specified period of years as compensation for debts, or as restitution for crimes. Slaves, usually blacks, were owned by the planters, and in most cases had no means or hope of acquiring freedom for themselves or their children. Bonded servants and slaves worked side-by-side in the plantation fields and homes. Most of Virginia's population increase between 1634 and 1674 was due to immigration of bonded servants who had willingly indentured themselves. Much of the development of the Bay region can be credited to those who toiled with little or no compensation.

The growth of plantations, however, was not entirely attributed to cheap labor. Plantations expanded because tobacco farming, which rapidly depletes the soil of nutrients, constantly required new fields of virgin, fertile soil. Today, easily available commercial fertilizers help to maintain a field’s productivity year after year. In colonial times, the custom was to clear new fields when old ones became exhausted. The abandonment of many tobacco farms and fields led to erosion, resulting in siltation of streams and rivers. The concept of natural resources conservation was seldom considered in the “land of plenty.”

Grade Levels: 4 - 11

Objectives
Students investigate the development of plantation economy and lifestyle by:
- researching plantation life;
- communicating information in a creative format;
- comparing past and present roles of the plantation in the economy.

Materials

At school:
- Chesapeake Bay area map
- appropriate resource materials

To take:
- pen, paper and clipboard (optional)

Where

Chippokes Plantation State Park or any Virginia plantation.

When

At the Park: 1 to 2 hours, during regular park hours.

Time of Year: any time of year is suitable, but special arrangements must be made with park staff to open the visitor center between Labor Day and Memorial Day.

Since each plantation occupied large areas of land, towns and cities were slow to be established. Each plantation was virtually self-sufficient and many resembled independent towns with resident blacksmiths, tanners, brick makers and other artisans.

Plantations influenced the region’s moral and political development. Since one requirement for entry into the House of Burgesses...
Plantations and Plenty

was land ownership, many of Virginia's early leaders were planta-
tion owners. This trend continued Throughout the colonial days and
until the end of the Civil War.

Procedure

Before the Trip:
1. Call the park to arrange a field trip date and time.
2. At least two weeks before the field trip, students should locate
Jamestown and Chippokes Plantation State Park (directly across the
James River from Jamestown) on a
map of Virginia or the Chesapeake
Bay region. Discuss what students
would do if they received a land
grant in 1610 for the area that be-
came Chippokes Plantation.
• What do you think the land looked
like at the time?
• What might you have brought with
you from England that would help
you settle the land?
• What might you find on the land
that would be useful?
• What would you need to do in order
to establish a home and farm? What
would you do first? Second? Third?
• How do you think your plantation
would affect the environment? How
important would this be to you?
3. After students have considered
needs in settling the land, explain
that Chippokes was a thriving plan-
tation and that they are going to ex-
amine some of the features that made
it and other plantations successful.
4. Divide the class into five study
groups and assign each group to
one of the following topics. Provide
materials and class time for inde-
pendent research and planning.
• Tobacco: How is it grown? How is
Virginia well-suited to this crop?
Why was it Virginia's cash crop?
• Plantation life: What were typical
activities? Layout and design? Or-
ganization? People?
• Transportation: What types of
vehicles were used in and around
plantations? What was the relation-
ship between a plantation's location
and transportation?
• Virginia economy: How did planta-
tions shape the economy? What role
did tobacco play? What role did plan-
tation owners play in shaping
Virginia's development?
• Role of slaves/bond servants:
Why was this type of labor intro-
duced? How did this labor shape the
development of plantations? How
were slave and bond servants alike?
Different?
5. Sponsor a "Colonial Day."
Each group develops a creative way
of presenting their findings to the
class. Ideas for presentations: simu-
lated television news cast in which
slaves and bond servants are inter-
viewed, a game show in which con-
testants answer questions about
tobacco, or a short skit about life on
a plantation. Encourage students to
create props and wear costumes for
their presentations.

At the Park:
1. Students tour the visitor center
exhibits, watch the ten-minute slide
show on transportation along the
James River, and look for informa-
tion in the exhibits relevant to their
research.
2. Lead the class on a walk along
College Run Trail from the visitor
center to the mansion (1.3 miles).
Stop at several points and talk about
the impact of plantations on
Virginia's growth and economy.
Solicit pertinent information from
the research groups.
• Why was this a good spot for a plan-
tation?
• What factors led to the development
of a few very large plantations?
• Was slave labor necessary for planta-
tions? What other options existed?
• In what ways did large plantation
owners influence Virginia's develop-
ment?
• What role does farming play in
Virginia's economy today?
• In what ways is today's farmer
similar to a plantation owner? In
what ways is he different?
• What attitudes did plantation
owners have about their contribution
to Virginia's economy? Do today's
farmers have the same attitudes?
What is the general public's attitude
towards farmers?
• How did a plantation owner regard
the James River? Do we view the
river the same way today?
(Colonists probably thought of
the river much as we think of our
interstate system.)
• Tobacco has always been a big busi-
ness in Virginia. Do you think it
will always be big business? Why or
why not?
• How did plantations contribute to a
spirit of wastefulness among
colonists? Does this attitude still
eexist today? What evidence do you
have?

Follow-up:
1. Allow each group another day
or two to complete their plans, then
have them make their presentations
to the class.
2. Few old plantations are cur-
rently being farmed. Assign stu-
dents one page essays explaining
their views on why Chippokes
prospered while others failed.
3. Students prepare a list of ques-
tions, then interview a farmer about
his/her role in Virginia's economy
and his/her feelings about people's
attitudes towards farms, farmers,
and the environment. Explain to stu-
dents that an interview is not a
forum for the exchange of view-
points (ie. don't argue with or con-
tradict the interviewee).
4. Students investigate the cur-
rent contribution of tobacco to
Virginia's economy and compare it
to previous times. Discuss students' opinions on tobacco advertising.
"Upon the deck of the Sarah Constant that night Captain Newport unsealed the royal box. With the breaking of the seal-royal and the appointment of the royal council and the laws ordained by the charter and the rules of the London Company, Virginia was born. The Colony was born not at Jamestown May 13th, but at Cape Henry April 26, 1607—the birth not only of this colony but of the United States of America. Measured by any standard, April 26, 1607, is one of the critical days in human history." W.H.T. Squires

This activity provides directions for reenacting and communicating the fascinating history of this very special site.

**Background**

One spring day in 1607, a band of Chesapeake Indians witnessed the arrival of three large strange vessels just off a point of land on the southern side of the mouth of the Chesapeake Bay. As the strangers came ashore, the Indians slipped away unnoticed. That night, the Indians summoned the courage to attack. After a brief skirmish, the strangers fled to their ships and the Indians retreated into the nearby swamp.

The strangers were the first permanent English settlers taking their first steps on what is today, Virginia soil. Despite the attack, a group of the Englishmen explored some eight miles inland the next day. Though they didn’t encounter more Indians, they did find a fire where oysters were being roasted. One of the explorers who tasted the oysters wrote that they were “very large and delicate in taste.”

On the fourth day, the Englishmen erected a wooden cross and

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**Grade Levels: 4 - 9**

**Objectives**

Students will investigate important historic events that occurred at Cape Henry by:
- **using skills in group dynamics and theatrical presentations**;
- **formulating pertinent questions in order to write a “newspaper article”**;
- **stretching their imaginations**.

**Materials**

- copies of the “Background” section (1 per student)
- clipboards, paper & pencils (at least one set per team)
- props and costumes for skits
- cameras (optional)
named the place Cape Henry, in honor of the King’s son. They departed to explore the Bay, eventually establishing a settlement at Jamestown.

Ships continued to arrive at Cape Henry, often stopping to replenish their water supplies with swamp water that was slow to grow stale during long voyages. Few of the new arrivals found the site suitable for settlement, although some stayed in camps near the shore to fish. Eventually, several small plantations were built on nearby high ground. For the most part, though, Cape Henry remained wild and isolated.

It eventually became evident that ships approaching the Bay entrance needed a beacon to steer by, to prevent them from running aground. Thus a group of men stayed on Cape Henry to maintain a massive fire each night, using pine knots from the nearby forest.

Unfortunately, these isolated fire keepers were easy targets for pirates who would overtake them and rebuild the fire some distance down the shore. Ships fooled by the trick beacon would run aground and fall prey to the pirates. The most infamous pirate to prowl Cape Henry was Edward Teach, alias Blackbeard. Eventually Blackbeard was caught and his head was hung from the bow of a British ship. Blackbeard’s legendary treasure is said to still be buried among the dunes of Cape Henry.

As the flow of vessels sailing to and from the Bay increased, a permanent light at the entrance to the Chesapeake Bay became essential. Authorized and funded by this country’s First Congress, the first lighthouse of the United States was completed in 1791 and stood on top of one of the highest dunes at Cape Henry. A second lighthouse was built in 1881 to replace the first one. The original lighthouse is still standing and is open to the public from Memorial Day to Labor Day for a small fee.

The need for an army post to guard the southernmost entrance to the Chesapeake Bay was recognized in the early 1900s. By 1914, Fort Story was developed, and occupied by the army in 1917. Once established, it continued to grow and expand. Today, Fort Story occupies more than 1400 acres and is used for Coast Guard, Navy, and Marine Corps activities, and as a training site for amphibious (land-sea-air) operations.

Cape Henry was owned by the Commonwealth until after the Civil War when it was sold to lumbering companies for $1.00 an acre. Inadequate transportation and an enormous mosquito population, however, prevented the lumber companies from succeeding.

In 1902, a railroad, passing through the northern section of what is now Seashore State Park, was built from Norfolk to the growing resort of Virginia Beach. The railroad brought increasing numbers of vacationers and summer residents. One popular attraction was the immense dunes on which visitors frolicked. Some of the dunes remain within the park boundaries.

As the popularity of Cape Henry increased, local businessmen made plans to develop the area. Some citizens, recognizing the historic and natural values of the land, persuaded the Commonwealth to secure large portions of Cape Henry in the 1930s. During this time, men of the Civilian Conservation Corps, established by President Roosevelt, offset the economic devastation of the Great Depression, came to the newly acquired land and cleared trails, built roads, cabins and a campground. In 1936 the site was opened to the public as Seashore State Park.

Procedure

Before the Trip:
1. Make and distribute a copy of the above “Background” section to each student and explain they are to use the information to stimulate their research efforts and imagination for the following activity.
2. Divide the class into teams of about five students each. Each team will have two responsibilities: a) to develop and perform a 10 to 15 minute skit at the Seashore State Park amphitheater about a historic event from the list below; and b) to become reporters and write an article about a different historic event, based on another team’s skit, their follow-up press conference, and a walking tour of the park to the representative sites of these historic events. The choice of events are:
   • The first landing, from the settlers’ point of view
   • The first landing, from the Native Americans’ point of view
   • Pirate activities (piracy) around Cape Henry
   • Keeping the light: beacons on Cape Henry
   • Lumbering operation attempts

Where

Seashore State Park: one mile walk to representative sites, starting at amphitheater. Use map in park information section.

When

At the Park: Allow 30 minutes per team for skits and “press conferences” and 45 minutes for the walk, daylight hours.

Time of Year: Any time with mild weather.

Resources

Yesteryear

- Railroad construction and early tourist attractions near Cape Henry
- Establishment and construction of Seashore State Park
  3. Allow the teams several class periods to plan their skits (depending on resources available and the students' abilities).
  4. During skit preparation, each team should consider:
     - Each team member's role
     - Presenting important facts
     - Props and costumes
     - Emotions and thoughts of the people actually involved in the events
     - Answering questions about their skit topic during the follow-up press conference
  5. For their role as reporters, each team should consider:
     - Designating responsibility for conducting interviews, writing, editing and preparing graphic materials such as photographs or drawings
     - Preparing a list of questions for the press conference
     - Being alert for points to observe during the walking tour
     - "Who, what, where, when, why, and how?" as basic interview questions
  6. Plan the trip itinerary so that all students know: a) when they will be setting up and performing their skits; b) when and who they will be interviewing; c) when they will be taking their walking tour of the park and which locations are the representative sites for their articles; and d) when and where they will take breaks and eat lunch.

At the Park:
  1. Go to the amphitheater behind the park office. Allow the first team 15 minutes to get set for their performance.
  2. Allow 10 to 15 minutes for the first performance.
  3. After the skit, the characters hold about a 10 minute press conference for the reporters, while the second team prepares for their skit back stage.
  4. Continue the process until all skits and press conferences are completed.
  5. Lead the class on a tour of the representative sites of the historic events in the park. Give students time to take notes for their articles and if desired have the characters pose (in costume) for photographs in the appropriate settings. The sites can all be identified on the park map in this guide and can be reached during a one mile walk beginning at the amphitheater. The sites and their significance are as follows:
     - The beach and dunes directly behind the amphitheater represent the scene of the first landing of permanent English settlers, the area once favored by pirates and many years later, by vacationers.
     - The picnic area is surrounded by woods that were home to the Chesapeake Indians. This was also one of the areas originally developed by the Civilian Conservation Corps.
     - The old railroad bed is located between the cabin road and the paved section of the bike trail.
     - In the cypress swamps behind the visitor center, observe the brown tannic waters favored by seamen for their ships' drinking water; massive cypress trees that attracted lumber interests, and the rugged terrain that thwarted those interests; and part of the unique environment that inspired early conservationists to set this land aside as a park and natural area.
  A side trip, by bus or car, to neighboring Fort Story would give students a view of the Cape Henry lighthouses.

Follow-up:
  1. The teams complete their articles in class. Encourage them to write in an objective journalistic style and to use photographs or other illustrations prepared at the park. Cartoons and editorials would be interesting additions.
  2. Combine the articles into a mini newspaper or magazine, make copies and distribute them to the students.

Variations

1. If students can make an initial planning visit, they may conduct their skits at the representative sites in the park instead of the amphitheater.

2. If field trip time is very limited, students can tour the park, then perform the skits and conduct the press conferences as a follow-up classroom activity.

3. One or more teams prepares a television news show instead of an article, using a camcorder.

Younger students:
Use, find, or draw pictures to go along with the background that zero in on the pirate theme. Incorporate the history with a treasure hunt of clues with each answer making part of a puzzle.

Gifted/Advanced:
Make brochures of the park and its history. Include the pictures taken.
Fragments of the Past in Lee’s Woods

Students study park historical information pertaining to a historical event or character(s), prepare skits and present them at the site of the event along Leesylvania's historical interpretive trail.

Background

The history of Leesylvania is long, by American standards, dating back to the early days of colonization. For thousands of years the wooded ravines and Potomac shoreline attracted Native Americans who harvested the abundant fish, waterfowl and fur-bearing mammals. These and other resources later enticed European explorers and settlers. England encouraged the settlement, and the King granted 50 acres of land to each person transported "into the Kingdom of Virginia." In 1658, Gervais Dobson purchased 2,000 acres, consolidating many of these parcels including the tract which is presently Leesylvania. Henry Corbin bought it next and passed it on to his daughter, Laetitia. In 1674, Laetitia married Richard Lee II, and so began the involvement of a famous Virginia family with this parcel of land on the Potomac.

No one lived on the land until 1753, when Henry Lee II brought his bride, Lucy Grymes, here to live. They named the land Leesylvania, which means "Lee's Woods." The eight children born to Henry and Lucy were to play critical roles in Virginia's future, especially Henry Lee III. Known as "Light-Horse Harry," this "son of Leesylvania" was a hero of the Revolutionary War, leading the soldiers who thus saved George Washington's troops at Valley Forge.

The land at Leesylvania changed hands again in 1825, when it was sold to the Fairfax family. In 1861, the Civil War came to Leesylvania, ironically, through the orders of Robert E. Lee. Light Horse Harry's son, Lee saw the importance of blocking the Potomac River passage into Washington, D.C., to hinder the movements of Union troops and merchant trade in and out of the Capitol. To this end, artillery sites were placed on high bluffs overlooking the river, including Freestone Point at Leesylvania.

A rail line from Washington to Fredericksburg, which bisects the property, was completed in 1872. Tenants cut the timber from the entire estate. Further lumbering operations occurred through the early 1900s.

Grade Levels: 7 - 11

Objectives

Students will investigate the history of Leesylvania by:
- dramatizing historic events;
- selecting appropriate sites;
- evaluating content of presentations for useful information.

Materials

For use at school:
- copies of "Background" or History of Leesylvania (1 per student)
- copies of A Potomac Legacy (1 per 4 students)

To take:
- Skit Summary Sheets (1 per student)
- pencils and clipboards (1 per student)
- props and costumes (optional)
Activity on this tract of land slowed when a private hunting and fishing preserve was established. The Fairfax house was redesigned as a hunting lodge, and wealthy guests stayed there or in private railroad cars. The Fairfax house burned in 1910, leaving only the chimney and stone foundation. After this, the property was unused until the 1950s.

In the 1950s, a corporation with plans to create a major resort bought the property. Among the things completed were a swimming pool and a pier into the Potomac at which was moored a “boatel.” The “boatel” was a floating gambling casino and angry neighbors eventually forced its closure and the subsequent bankruptcy of the resort corporation.

The American-Hawaiian Steamship Company then bought the property. The company’s owner, noted philanthropist Daniel K. Ludwig, was convinced of the value of preserving Leesylvania and sold the property at half its appraised value to the Commonwealth of Virginia. Final papers were signed in 1978, and Leesylvania State Park was born.

Procedure

Before the Trip:
1. Each student reads a copy of the above background information or the History of Leesylvania brochure, available from the park.
2. Contact the park to discuss field trip plans and to request loan-copies (one per four students) of the park publication, A Potomac Legacy: Lee’s Woods Historical Interpretive Trail, and if needed, the History of Leesylvania.
3. Divide the class into teams of 4-5 students each.
4. Assign each team a different passage from A Potomac Legacy to read. Each team then prepares a brief skit related to the historical event or character(s) described in the passage. Each team could also do more detailed research, make costumes and props and rehearse their skits prior to the field trip.
5. Instruct the teams to be sure their skits answer the following questions:
   - Who are the characters?
   - What is their place in Virginia history?
   - What is the time period?
   - What are the political conditions in Virginia at the time?
   - How is the land at Leesylvania being used at the time?
   - What does the particular site look like at the time?
6. Each team studies the map at the front of the brochure to become familiar with the location of their site. (Note: the length of the entire trail, including all loops, is 2 miles. The furthest stop is about 3/4 mile from the parking lot.)

At the Park:
1. Gather the class at the amphitheater as a central location.
2. Each team and an adult leader go to the point on Lee’s Woods Trail that corresponds to the passage for which they will be performing their skit. There they get familiar with the site, rehearse the skit and regroup at the amphitheater within one hour.
3. Proceed with the class to each stop in numerical order along the trail and have each team perform its skit. As an alternative, skits could be performed in the amphitheater.
4. The students watching rank their classmates’ skits on a copy of the accompanying Skit Summary Sheet.
5. When all skits are completed, take a show of hands to determine the team that received the most top scores. The topscoring team could receive as a reward a photograph of themselves posed in some skit action.

Follow-up:
Each student writes a diary entry for one day in the life of a character in their one of the skits.

Where

Leesylvania: Lee’s Woods Trail originating near Freestone Point picnic area.

When

At the Park: Allow 1 hour for on-site preparation, plus about 20 minutes per team for skits, evaluations, and travel between sites; regular park hours.

Time of Year: Any time the weather is pleasant.

Resources

Prince William Historical Commission. 1 County Complex Court, Prince William, VA 22192.
References are also listed in A History of Leesylvania brochure available from the park.

Extensions

1. Students draw a time line mural depicting the history of Leesylvania, also noting interesting historical events other than at this site.

2. Students locate and interview someone who remembers the attempt in the 1950s to develop the site as a resort. Find out what political situation supported this type of venture. (The Potomac River belongs to Maryland, where gambling and liquor by the drink were both legal.) Why did this create a controversy? What brought the plan to a halt in the end?

Variations

Gifted/Advanced:
1. Students research and write about the historical roles of the various Leesylvania owners.

2. Students research the role of the property during the Civil War to draw a map that shows the artillery emplacements along the Potomac and the area they defended. Why were they located in these spots?
## Skit Summary Sheet

<table>
<thead>
<tr>
<th>Stop or Trail Post Number:</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
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<tbody>
<tr>
<td><strong>From the skit did you learn:</strong></td>
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<td>1 Who the main characters were?</td>
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<td>2 Their place in Virginia history?</td>
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<td>3 The time period?</td>
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<td>4 Political conditions in Virginia at that time?</td>
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<tr>
<td>5 How land at Leesylvania was being used?</td>
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<td>6 What site looked like?</td>
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<td><strong>TOTAL SCORE</strong></td>
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</tbody>
</table>

Rank the thoroughness and effectiveness of the performances in answering each question on a scale of 1 to 4, where:

1 = misinformation was provided  
2 = none of the information was provided  
3 = some of the information was provided  
4 = plenty of information was provided
Ever think about building a grist mill? George Washington did and had to take a lot into consideration. In this activity, George approaches the class for help in developing a comprehensive plan for a new grist mill.

**Background**

In 1761, George Washington inherited the title to Mount Vernon with the death of his half-brother's widow. Included in the property was a water mill, or grist mill, which had become decrepit and did not grind corn at a productive rate. At the time, markets were shifting and agricultural crops in northern Virginia were changing. Tobacco crops produced little profit for Mount Vernon. However, Washington, like other farmers of colonial Virginia, found a ready market for wheat.

As the Industrial Revolution developed, the demand for flour increased and merchants in Alexandria and Fredericksburg offered a local market. A mill was convenient for neighboring farmers who could get their wheat and corn ground by paying the miller a "one-eighth toll," or one barrel out of every eight barrels ground.

In 1770, Washington, an enterprising man, began construction of a new mill across the creek (Dogue Run, which is influenced by tides) from the original mill. Power for the mill operation came from water in the main stem of Dogue Run and

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**Grade Levels: 5 - 11**

**Objectives**

Students will investigate factors involved in the construction of an 18th century grist mill by:
- developing group dynamics skills;
- researching literature;
- drawing sketches;
- reading maps;
- writing mill development plans.

**Materials**

- copies of background information and *The Scenario* (1 each per student)
- references for research
- topographic map of rural area adjacent to major Chesapeake Bay tributary
- Chesapeake Bay map copied from front of this guide
- map of northern half of Atlantic Ocean, showing major North American and European ports
- large pieces of plain paper for drawing maps and plans
- rulers, compasses, protractors

**Credits**

from a tributary, Piney Branch Run. At the time, there was a pond uphill from the mill. Water flowing from the pond to the mill could be regulated at the pond.

The new mill operated two pairs of grinding stones. One pair ground wheat into fine flour for export, what Washington called "merchant trade." The other pair ground either wheat or corn for the "country trade." In the 1790s, Washington improved the mill by adding water-operated hoisting machinery, which took the grain from the level of the creek to the top floor.

Washington operated the mill during most of his adult life, including his eight years as the first President of the United States. In 1799, however, he rented it to a nephew, Lawrence Lewis. Later that year, Washington died, leaving the mill to Lewis in his will.

From Lewis' insurance policy on the mill, we know that the property had a nearby distillery for making liquor products from grain. In addition, the complex included a cooper's shop for making barrels to store flour, a stable with stalls for 30 cattle, and pig pens.

Since the water supply of Dogue Run was not constant, the mill seemed to have been able to operate at full capacity only about six months out of the year. Flour was loaded onto Potomac River ships from a wharf on the creek’s waterfront. Today Dogue Run has become so silted that the stream is no longer navigable.

Eventually, the mill passed to Lewis' son, who sold it in 1846. The mill had needed repairs since 1804. Since the mill had been inoperable for many years, the building was allowed to fall, and the stones were later used for other buildings. The present mill is a reconstruction of Washington's mill.

Procedure

Before the Trip:
1. Contact Mason Neck State Park to arrange a tour of the grist mill. (There is a nominal, per-person charge for tours.) Explain to the ranger that the group will be doing this activity and will come with numerous questions.
2. Make copies of the background information and the Scenario for each student.
3. Divide the class into six teams and assign each team the responsibility of preparing one of the six important parts of Washington's new mill plan.
4. Since the parts are all interrelated, be sure the teams collaborate in their planning.
5. Allow class time for students to do literature research, make preliminary plans and sketches, and prepare a list of questions to ask the interpreter after the grist mill tour.

At the Park:
1. Explain to the class that they should view the tour from the perspective of the mill being an example of an 18th century mill after which they can model their plans for George Washington.
2. Take the tour of the mill.
3. After the tour, the students, as a group, ask the interpreter questions to obtain the information they need to complete their plans.
4. Allow the students up to 30 minutes to inspect the mill and grounds on their own, take notes and make sketches that will be useful in their planning.

Follow-up:
1. Allow up to one more week for the students to complete their plans, drawings and maps, and prepare a written explanation of their plans and recommendations.
2. Students present their plans to the teacher (posing as George Washington), the rest of the class, and other invited guests (principal, parents, etc.).
The Scenario

It is 1761 and George Washington has just inherited a large tract of land adjacent to a Chesapeake Bay tributary. Washington contemplates constructing a grist mill on the property but needs to carefully consider several factors before making such a large investment. He approaches your class for advice, knowing the class has the expertise to help him with his plans and decisions. While Washington is away on an important military mission, the class prepares the plans, addressing the following points:

1. There must be a reliable supply of grain. The farmers in the area grow mostly tobacco.
   - How can Washington convince farmers to switch to growing grain?
   - What kind of deal can he offer to ensure that both he and the farmers make a fair profit?
   - How can he ensure there will be a dependable supply of grain for many years? From how far must the grain be transported and by what means?

2. Washington intends to sell the surplus flour to faraway markets in other American colonies and Europe.
   - How will the ships get close to the mill?
   - How will the flour be loaded onto the ships?
   - How will the flour be stored to keep it dry and free of pests during the long journey to other ports?
   - When, during the year, will be the peak milling times? Will this coincide with times when the ships are busy transporting other seasonal cargo? Will there be problems with the weather? If so, how will these problems be solved?
   - What route might the ships take from the mill to the other ports? Draw this route on maps of the Chesapeake Bay and the northern half of the Atlantic.

3. Washington needs to choose the best possible site for the mill on his tract of land.
   - On a topographic map, locate the best place for the mill. Pretend

Washington owns all of the area encompassed by the map, and that any modern facilities shown on the map are either non-existent or in 18th century condition.

   - Where will the water that powers the mill come from?
   - Is the water supply at an elevation well above the mill site so the water can flow over the mill wheel?
   - Is there already a lake nearby? Must a dam be built?
   - How long must the raceway (the structure that channels the water from the water source to the mill) be?
   - Is the mill site accessible to farmers who will bring their wheat by wagon?
   - Is it accessible to merchants who would prefer to transport the flour away by ship?
   - Are there raw materials nearby for the mill construction (i.e. trees for lumber, stone for foundations, clay for bricks)?

4. Washington needs a design for the new mill and asked for a set of plans or a model.
   - What should be the approximate dimensions of the building and the water wheel?
   - What materials should be used for the outside walls, the floors and the

water wheel, and where will the materials come from?
   - Where will the grain be brought in and flour brought out?
   - How will the power be transferred from the water wheel to the mill stones, conveyor systems and other equipment?

5. Washington requested two site plans or maps—one that shows the proposed site as viewed from above (top view) and one from the side. On both drawings show:
   - the position of the mill relative to the water source that powers the mill;
   - the raceway;
   - the wharves;
   - the waterway for ships.

   - On the top view show the roads and other related facilities.
   - On the side view show the changes in elevation from the water source to the mill and docks.

6. Washington also requested ideas for other businesses and facilities that should be near the mill.
   - What other tradesmen should be encouraged to set up shops near the mill to ensure all necessary supplies and services are available for the milling operation?
   - What other businesses should be established to meet the needs of the farmers bringing their grain to the mill and seamen who have come to take it away?

Any topographic map of a rural area adjacent to a major Bay tributary will do. Especially recommended is the Fort Belvoir Quadrangle which contains the grist mill and Mason Neck State Park. For map ordering information, see “Treasured Maps.”

161
Researching the Bay

When scientists do research, they hypothesize, experiment, classify, quantify and perform many other scientific procedures. First, however, they do a literature search to find out what is already known. This activity teaches students some of the skills needed for researching Chesapeake Bay information. Included are suggestions for students to make the research process less taxing, resource lists for students and teachers, and ideas for teachers to increase student success.

Finding Information. Prior to starting the research assignment, the teacher should investigate available sources of information. Discuss with students the various sources of information and encourage all students to utilize at least four or five different sources in preparing their reports. Develop an in-class library of Chesapeake Bay resources. Publications and information sheets can be obtained by writing or calling state and local agencies and conservation groups. Do not assume that all of your students have the necessary skill writing skills or conversational skills to do this without some assistance and instruction. (A Chesapeake Bay resource list and a list of possible sources of information are included.)

Keep Organized. For most students, learning how to do the research is more important than completing the research “product.” A project time log helps students manage their time. (A suggested project log format is included.)

Share the Results. Students will take greater pride in their work if they are given the opportunity to share what they have learned. Have a “Chesapeake Bay Seminar” when students can teach the class (not just read their papers aloud) what they have learned about the Bay.

Grade Levels: 4 - 12

Objectives

Students will investigate sources of accurate, current information about the Chesapeake Bay and will develop skills useful for topic selection and library research by:
- brainstorming topic concept;
- organizing conceptual component;
- using library resources;
- communicating needs via telephone and letter.

Materials

- copies of Finding the Answers, Time Log, and Research Card
  (1 per student)

Credits

Chesapeake Bay Programs and Directions, 1989. Council on the Environment. Richmond, VA.

Where

Class, home, library, community, park resource collections (all parks).

When

2-4 class periods.
Reseaching the Bay

Procedure

Following are four in-class activities that can help make the " ordeal" of researching a paper a little less painful. Included are materials to help students organize their research efforts. Student worksheets Finding the Answers, Time Log, and Research Card provide suggested formats for students to plan research. Any of these forms may be modified as desired.

1. Brainstorming about the components of a concept helps students grasp how a topic is structured and may be divided. To brainstorm a Chesapeake Bay topic list:
   • Write the words "Chesapeake Bay" on the chalkboard. Ask students to list things they know to be part of the Bay. Put at least 25 of these on the board.
   • Some sample contributions might be: fishing, pollution, crabs, acid rain, salt water, sand, tour boats, U.S. Navy, low tide, eelgrass, phytoplankton, pound nets, MARPOL, deadrise, sharks, salt wedge, and tourists.
   • Now make collections of small groups of the terms that have something in common and assign a descriptive label to each, e.g., fishing, sharks, crabs, pound nets (label: living resources); salt water, acid rain, pollution (label: water quality); U.S. Navy, deadrise, tour boats (label: vessels).
   • Map the class concept of the Bay on the board.

Vessels
1. Navy
2. deadrise
3. tour boats

Water Quality
1. salt water
2. acid rain
3. pollution

Living Resources
1. fishing
2. sharks
3. crabs
4. pound nets
5. eelgrass

• The topic areas so identified (vessels, living resources, and water quality in the example) can be used as research topics, and the terms listed under each suggest some specific things to investigate.
• If the topic areas are still too broad (and those in the example given probably are), narrow down the topic by selecting just one of the Bay-related terms and repeat the concept mapping exercise based on that term only. If, for example, "fishing" was selected, the resulting concept map might look something like this:

<table>
<thead>
<tr>
<th>Gear</th>
<th>Laws</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gill nets</td>
<td>1. Marine</td>
</tr>
<tr>
<td>2. fishing rod</td>
<td>Resources</td>
</tr>
<tr>
<td>3. crab pots</td>
<td>Commission</td>
</tr>
<tr>
<td>4. tackle shops</td>
<td>2. limited access</td>
</tr>
<tr>
<td>3. moratorium</td>
<td></td>
</tr>
</tbody>
</table>

Fishing

Sport Fishing
1. spot
2. flounder
3. bluefish
4. fishing boat

The topics "Chesapeake Bay fishing laws," "Chesapeake Bay sport fishing," or "Chesapeake Bay fishing gear" are narrow enough to be easy to research.

2. Information scavenger hunt.
   Announce to the class that they are going on a scavenger hunt... for information. If necessary, make arrangements with the librarian for a short preparatory "using the library" lesson. Take the class to the library and tell them they are to look for interesting facts about the Chesapeake Bay. They will receive one point for each fact discovered and five points for each different resource they use (i.e., magazine, newspaper, books, encyclopedia, atlas, map). The students record each fact and note the source. Allow thirty minutes for the hunt, then assemble the class to share the facts they have found and provide two small prizes: one to the person with the most points; and the other to the person who finds the most interesting fact (determine by class vote). The list of facts can provide good

Information Sources

A variety of curricular materials, workshop opportunities, audio-visual materials, and other resources concerning the Chesapeake Bay are available, many free or at low cost. Chesapeake Bay Toll-Free Information Hotline (800) 662-CRIS.

Chesapeake Bay Resource Directory.
Free Council on the Environment (COE), 202 N. Ninth St., Richmond, VA 23219.

Chesapeake Bay Teaching Materials Lending Library Catalog. Contains over 80 available-to-borrow-by-mail items (printed materials, films, video tapes, computer programs, curriculum guides, charts, maps and posters which deal with the Chesapeake Bay). Some publications are available in quantity classroom sets. See Grant Marine Advisory Services, Virginia Institute of Marine Science (VIMS), Gloucester Point, VA 23062. (804) 642-7171.

The Bay Team. Visits Virginia schools with in-class lessons (K-12), and teacher in-service programs about the Chesapeake Bay at no charge. Contact VIMS listed above; (804) 642-7172.

Coastal Growth, A Delicate Balance (27 minute secondary level video). Explores several current management issues related to the Chesapeake Bay. Cost — $5.00 for postage and handling from 1 Video Productions, Harbour Center, Suite 705, 2 Eaton St., Hampton, VA 23669. (804) 723-4363.

The Chesapeake Bay: It Starts With You! Kit features activities to teach students about important Chesapeake Bay issues. Council on the Environment, 202 N. Ninth St., Richmond, VA 23219.

Landsat Photograph of the Chesapeake Bay. A 25 x 38 inch poster shows incredibly detailed features of the Bay and surrounding area ($19.95 paper, $29.95 laminated). Chesapeake Bay Foundation, 162 Prince George St., Annapolis, MD 21401.

State Parks Reference Collections. Each of the seven parks in the Chesapeake Bay drainage basin maintains a small collection of Bay-related references which may be used on site. Additional information is available through visitor centers, interpretive materials, and programs.
Researching the Bay

topics for further research, could be the source for future scavenger hunts (teacher provides the list of facts, students search for sources) or could be used for a game of “what’s the question?” (teacher supplies the answer, students have to think of a correct question).

3. Reach out and phone someone.
This is a role-playing activity where students practice requesting information over the telephone. Bring in two telephones to be set up on two tables in the front of the room. With the students, develop a list of “things to do and say on the phone.” Include such things as:
- introduce yourself;
- clearly state the type of information you want;
- give your age or grade;
- tell where to send the information;
- indicate when you need the information;
- thank the individual for the assistance.

Ask students to role play the parts of students requesting information. The teacher takes the role of a state agency or industry representative responding to each request. After each role play the class can critique the exchange, pointing out strengths and weaknesses.

4. Write for information. Use the Chesapeake Bay resource list (“Information Sources”) supplied and assign each student an agency or organization. Together, construct a basic letter requesting information about the Bay. Display this letter on the overhead or board. Make changes as necessary until all students are satisfied with the letter. Be sure that it includes the following:
- description of the topic;
- a deadline date by which you need the information;
- identify the kind of information you need;
- your grade level;
- your address (preferably on a self-addressed/stamped envelope);
- a “thank you.”

Each student follows the format of the form letter to request specific information from the assigned agency or organization.

Bay Information

Office of the Secretary of Natural Resources
5th Floor, Ninth St. Office Bldg.
Richmond, VA 23219
(804) 786-0044

Chesapeake Bay Local Assistance Dept.
701 Eighth St. Office Bldg.
Richmond, VA 23219
(804) 225-3440

Council on the Environment
202 N. Ninth St., Suite 900
Richmond, VA 23219
(804) 225-4500

VA Dept. of Agriculture and Consumer Services
Washington Building, Capitol Square
1100 Bank St.
Richmond, VA 23219
(804) 786-2373

VA Dept. of Air Pollution Control
801 Ninth St. Office Bldg.
Richmond, VA 23219
(804) 786-2378

VA Dept. of Conservation and Recreation
203 Governor St., Suite 302
Richmond, VA 23219
(804) 786-2121

VA Dept. of Forestry
Older and McCormick Roads
Natural Resources Bldg.
Box 3758
Charlottesville, VA 22903
(804) 977-6555

VA Dept. of Game and Inland Fisheries
4010 West Broad Street
P.O. Box 11104
Richmond, VA 23230-1104
(804) 367-1100

VA Dept. of Health
James Madison Building
109 Governor St.
Richmond, VA 23219
(804) 786-3561

VA Dept. of Historic Resources
221 Governor St.
Richmond, VA 23219
(804) 786-3143

VA Marine Resources Commission
2600 Washington Ave.
P.O. Box 756
Newport News, VA 23607
(804) 247-2200

Variations

Younger students:
Research assignments for elementary children pose some special problems.
Many students have no helpful resources at home, and their families are unable to provide assistance with community resources. The elementary teacher must ensure that all students have access to research materials appropriate to their abilities. As young children typically have few independent study skills, it is also important that the teacher divide the research project lesson plan into small “bite-sized pieces,” each with specific directions and each focusing on a research skill (e.g., using the index in a reference book or using the author card catalog).

VA Dept. of Mines, Minerals and Energy
2201 W. Broad St.
Richmond, VA 23220
(804) 367-0330
1-800-552-3831 Energy Hotline

VA Outdoors Foundation
221 Governor St.
Richmond, VA 23219
(804) 786-5539

VA Dept. of Waste Management
11th Floor, James Monroe Bldg.
101 N. 14th St.
Richmond, VA 23219
(804) 225-2567
(804) 352-2075

VA State Water Control Board
2111 N. Hamilton St.
P.O. Box 11143
Richmond, VA 23220
(804) 367-0056

Chesapeake Bay Foundation
400 E. Main St., Suite 815
Richmond, VA 23219
(804) 780-1392

The Alliance for the Chesapeake Bay
202 N. Ninth St. Suite 900
Richmond, VA 23219
(804) 225-4355
(804) 225-3982

Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, VA 23062
(804) 642-7172
Finding the Answers

Student Name

My research topic is

Below, I have checked resources for my topic.

<table>
<thead>
<tr>
<th>Plan to Use</th>
<th>Actually Used</th>
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<tr>
<td>Home</td>
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Chesapeake Bay Research Project

Time Log

Name: ________________________________ Grade: ________________

Research Topic: ___________________________________________

<table>
<thead>
<tr>
<th>Due Date</th>
<th>Task</th>
<th>Teacher Check-off</th>
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<tbody>
<tr>
<td></td>
<td>Select topic and have it approved by teacher</td>
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</tr>
<tr>
<td></td>
<td>Determine possible sources of information (at least five)</td>
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<tr>
<td></td>
<td>Conduct research and maintain record on research cards (see below)</td>
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<tr>
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<td>Outline of research report due</td>
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<td>First draft of report due</td>
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<tr>
<td></td>
<td>Final draft of report due</td>
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</tbody>
</table>

Research Card

Name: ________________________________________________

Topic: ______________________________________________

Source: _____________________________________________

Date: ______________________________________________

Important information:

1. ________________________________________________________________________

2. ________________________________________________________________________

3. ________________________________________________________________________

4. ________________________________________________________________________
Mainstream. Science: 6.2, 6.3, 6.14, 6.20, 7.1, 7.2, 7.10, 7.18, 10.1, 10.2, 10.11, 10.14
Now You See Them, Now You Don't. Science: 7.1, 7.2, 7.4, 7.5, 7.16, 7.17, 10.1, 10.2
Picking Up the Past. Science: 4.1, 4.2, 4.12, 5.1, 5.12, 7.1, 7.5, 7.10, 9.9, 9.11
Plantations and Plenty. Social Studies: 4.5, 4.6, 4.7, 4.8, 4.14, 5.7, 5.10, 11.3, 11.8
Researching the Bay. Science: 8.17, 10.3. Social Studies: 7.3, 9.5, 9.11
Sand Shakes & Mud Flakes. Science: 4.1, 4.2, 4.3, 4.6, 4.12, 5.2, 5.12, 5.14, 6.2, 6.3, 6.8, 8.1, 8.2, 8.3, 8.4, 8.12, 9.2, 9.9, 9.22
Small Fry Spies. Science: K.1, K.2, K.3, K.4, K.11, 1.1, 1.3, 1.4, 1.9, 2.1, 2.4
Treasured Maps. Science: 3.3, 3.6, 4.6, 5.4, 6.2, 6.5, 7.1, 9.10. Social Studies: 2.6, 3.6, 4.1, 5.1, 6.5, 7.4, 9.1, 9.2, 9.3, 9.11. Social Studies: 3.4, 6.5, 7.5, 12
Wanted: Dead or Alive. Science: 4.1, 4.2, 4.14, 5.1, 5.4, 6.3, 6.14, 6.16, 7.1, 7.4, 7.5, 7.13, 7.15
Wetland in a Pan. Science: 9.9, 15.1, 18.2, 2.2, 2.5, 2.6, 3.5, 4.2, 4.12, 5.4, 6.2, 6.21, 7.18; 8.1, 9.9
Where has all the Top Soil Gone? Science: 6.1, 6.2, 6.3, 6.20, 6.21, 7.1, 7.2, 7.5, 7.18, 7.19; 8.1, 8.2, 8.3, 8.16, 8.17, 9.1, 9.9
Where the Water Falls. Science: 4.5, 4.12, 6.2, 6.17, 6.20, 6.21, 7.1, 7.19, 9.9, 9.10
Whose Clues? Science: 1.12, 2.5, 2.11, 3.4, 3.14, 3.18, 4.2, 4.3, 4.5, 4.14, 5.16, 6.2, 6.16, 7.1, 7.4, 7.15
Whose Flostsam is This? Science: K.1, K.16.11, 1.1, 1.15, 2.1, 2.13, 3.1, 3.2, 3.4, 4.1, 4.2, 5.1, 5.11, 6.2, 6.20, 6.21, 7.1, 7.5, 7.18, 8.1, 8.16, 8.17, 9.23. Social Studies: 3.3, 3.14, 3.15, 6.3, 6.5, 7.4, 7.5, 8.7, 8.8, 8.9, 8.10, 9.5, 9.6, 9.8, 9.9, 9.11, 11.2, 11.9
Yesteryear. Social Studies: 4.5, 4.7, 4.11, 4.14, 7.1, 7.4, 7.8
You, Too, Can Handle! Science: 3.1, 3.4, 3.18, 4.1, 4.3, 4.14, 5.1, 5.5, 6.2, 6.14, 6.16, 7.1, 7.5, 7.15, 7.16

A Note About Science SOLs...

The Standards of Learning Objectives - Science is the curriculum framework for science instruction in Virginia's public schools. It was developed primarily by committees of elementary, middle and high school teachers, administrators, and university science education specialists. The framework consists of broad program goals and objectives, grade and subject objectives for kindergarten through high school.

The four program goals and the thirteen program objectives describe the role of science education in several dimensions. Not only should the program of instruction be consistent with the nature of the scientific endeavor, it should also recognize the growth characteristics of students, reflect students' developmental characteristics, involve students in solving personal and social problems and relate with the other areas of the curriculum. The grade level objectives define more specifically the concepts, the processes and scientific attitudes which should be the focus of instruction. Most of these objectives are stated broadly, and curriculum developers are encouraged to take these objectives and develop them into their component parts, consistent with the program philosophy.

Instructional strategies and activities which develop the conceptual learning defined by the Standards of Learning Objectives - Science are those which are active, hands-on, minds-on, skill-driven, interesting, useful, nurture the critical habits of mind, and help students comprehend the disciplines. The Virginia science framework gives definition to these goals, and provides a consistent context for all who have a role in science education. —Jim Firebaugh, Science Service, Virginia Department of Education.
biota: the animal and plant life of a region of period. p. 28, 68
biome: an overpopulation of algae in a body of water. p. 50
bog: wetlands in which water is retained by an accumulation of partially decayed organic matter and which are dominated by sphagnum mosses. p. 87
buffer zones: strips of natural plant growth along river and stream banks which help to prevent soil erosion from plowed fields or developed land. p. 39
camouflage: an animal's technique of concealing itself by seeming to be part of the natural background. p. 83, 95, 116
canopy: layer formed by the leaves and branches of the forest's tallest trees. p. 105
carapace: a shield-like covering (or upper shell) on many crustaceans or turtles. p. 113, 122
carnivore: a meat eater. p. 64
cast: forms when dirt or mud fill or harden in a mold, creating a raised impression (similar to the jello in a jello mold). p. 109
castor glands: a scent gland in the beaver. p. 105
climax: the final stage of plant or animal succession; when environmental conditions have been stable long enough for an area to develop a semi-permanent community. For example, rock crumbles, and pioneering plants begin to grow in the sandy soil. As they add mulch and humus, other plants follow—for example, from grasses to shrubs to pine (forest to hardwood). Animal types also follow this pattern of succession. p. 75
climax forest: a final stage of plant succession, with tree species that change very little over time. p. 75
coastal plain: broad low-level plain between a mountain range and a seashore. p. 109, 135
community: a group of plant and animal species living together in a habitat. p. 68
continental shelf: the relatively shallow flat portion of the sea floor extending from the shoreline to the shelf break, where the sea floor abruptly slopes downward. p. 109
crepuscular: animals active in the twilight (dawn or dusk). p. 83
crest: the highest point of a wave. p. 28
critical habitat: habitat crucial to the survival of the species. p. 126, 130
crustacean: an arthropod animal, with jointed feet and mandibles, two pairs of antennae, and a jointed, chitin-encased body. p. 87, 122
currents: a part of a body of water moving in one direction; the swiftest part of any stream. p. 28
cypress swamp: a wooded wetland dominated by cypress trees. p. 79
data base: a complete collection of information on a given topic. p. 143
debis: an accumulation of discarded items; trash. p. 143
decomposer: those organisms (bacteria, fungi) which convert dead organic materials into inorganic materials; a plant or animal that feeds on dead materials and causes its mechanical or chemical breakdown. p. 61
deposition: the laying down of any material. p. 28
detritus: fragments of decaying plant, animal, and other organic material. p. 61, 87, 113
diatoms: minute planktonic unicellular or colonial algae with skeletons containing silica. p. 61
dichotomous key: a guide to identification of plants or animals consisting of
Key Words

a series of pairs of questions or descriptions. p. 135

dinoflagellates: minute phytoplankton which move by means of flagellae (long whiplike appendages). Some dinoflagellates are bioluminescent, others are responsible for red tides. p. 67

diversity: the number of distinct species in a community or ecosystem. p. 45, 72, 126, 133

dredging: deepening a waterway using a machine to remove bottom sediment. p. 135

ecologist: a scientist who studies the interrelations of living things to one another and their environment. p. 113

ecology: the study of the relation of organisms or groups of organisms to each other and to their environment. p. 113

ecosystem: all living things and their environment in an area of any size, with all linked together by energy and nutrient flow. p. 61, 68, 105

ecotone: a transitional area between two communities. p. 68

diagnosis: the diagnosis of an individual's out of a population. p. 113

endangered species: a species which is in danger of extinction throughout all or a significant portion of its range. p. 126

erosion: the removal or wearing away of soil or rock by water, wind, or other forces or processes. p. 28, 37, 39, 41, 45, 83, 87, 139, 151

estuary: a partially enclosed body of water where fresh water and salt water meet. p. 50, 61, 87, 116, 122, 133

extinct: no longer existing. An animal or plant facing extinction is one in danger of vanishing from our world. p. 126

extirpated: to remove or destroy all of a species from a given part of its range. p. 126

erytes: the nests of eagles, usually in the tops of tall (80 ft - 100 ft) trees. p. 130

fall line: the boundary between the piedmont and the coastal plain where waterfalls often occur and where cities (Baltimore, Washington, Fredericksburg, Richmond) are sometimes located. p. 135

fetch: the distance which the wind blows over open water. p. 28

filter feeder: an animal that filters or screens water flowing through or around its body to capture suspended food. p. 61

fledged: young birds which have developed the feathers necessary for flight. p. 130

food chain: the transfer of food energy from one species to another. p. 45

food pyramid: a pyramid representing trends in food consumption, with the lowest level (primary producers) having the greatest total biomass, and the higher consumer levels having successively less total biomass. p. 61

food web: an interlocking pattern of food chains. p. 61, 87

fossil: a remnant or impression of a plant or animal of a past geologic age preserved in the earth's crust. p. 109

freshwater marsh: an area which is dominated by herbaceous plants with roots in soil covered part of the time by fresh water and leaves held above water. p. 87

girdle: to remove the bark of a tree in a ring around the trunk. p. 105

groundwater: water which supplies wells and springs. p. 109

habitat: the place where a plant or animal lives. p. 45, 68, 72, 83, 87, 101, 105, 113, 126, 133

herbaceous: a plant which does not develop woody material and dies back at the end of a growing season. p. 72

hydrozoon: a sessile, polypoid stage of Hydrozoans. p. 95

immigration: movement into a population. p. 113

indicator species: an organism so closely associated with an ecosystem that its presence or absence is indicative of the health of the ecosystem. p. 45, 50

inorganic: matter not originating from living things. p. 50

invertebrate: an animal lacking a backbone and internal skeleton. p. 61, 114

larvae: a young form of an animal which is unlike the adult and must metamorphose before taking on the adult characteristics. p. 45

limnology: the area of science dealing with the study of fresh water aquatic ecology. p. 57

literature search: a thorough exploration of all information published about a given topic. p. 162

MARPOL: an international treaty prohibiting the dumping of plastic in the oceans. p. 143, 162

macroinvertebrate: a large invertebrate such as a crab, clam, or oyster. p. 45

maritime forest: a forest community within range of salt spray. p. 79

megagols: the last larval stage of a crab before metamorphosis into a juvenile. p. 122

mold: an impression of an organism left in mud or other material (similar to a jello mold). p. 109

mort: to shed the old carapace before forming a new one. p. 122

moving tide: a flooding or ebbing tide. p. 122

nictitating membrane: in many vertebrates, a membrane of the eye capable of extending over the eyeball. p. 105

nocturnal: animals active at night. p. 83

nondegradable: incapable of being broken down into simple compounds. p. 143

nonpoint source: a source of water pollution which is not readily identifiable; for example, runoff from farms or dumping from boats. p. 39, 41, 50

nutrients: compounds or elements required by organisms for growth and reproduction. p. 87

nymph: an immature larval stage of some insects. p. 45

omnivore: an animal which eats both plant and animal materials. p. 64

organic: matter originating from living things. p. 41, 50, 87

orientation: determination of direction (east, south, west, north). p. 22

outhouse: buildings separate from but necessary to a main house; for example, a stable, smokehouse, or kitchen. p. 46

pellet: a mass of digested material regurgitated by a carnivorous bird. p. 64

percolate: the flow of ground water due to gravity through the pores in rock or soil. p. 75

perennial: a plant that lives for several years, typically supported by under-
ground rhizomes, tubers, or bulbs. p. 72

permineralization: a fossilization process whereby minerals are deposited in the pore spaces of originally hard animal parts. p. 109

persistent pesticide: a pesticide which does not break down but remains in the environment in a toxic state. p. 130

petrification: a fossilization process whereby inorganic matter dissolved in water completely replaces original organic matter, converting it to a stony substance. p. 109

photodegradable: capable of decomposing when exposed to light. p. 143

phytoplankton: plants (usually microscopic) that float at or near the surface of open water. p. 39, 61

piedmont: lying or formed at the base of a mountain range. p. 109

point source: a source of pollution which is easily identified; for example, a factory or a sewage treatment plant. p. 41, 50

predator: an animal that kills and eats other animals. p. 95, 105, 113, 116, 126

prey: animals that are killed and eaten by other animals. p. 95, 116

primary consumers: herbivores which eat primary producers. p. 61

primary dune: the dune closest to the ocean. p. 81

primary producers: green plants which are able to manufacture food from simple inorganic substances. p. 61

primary succession: the ecological succession of vegetation that occurs in passing from barren earth or water to a climax community. p. 68

quadrat: a sampling plot used for ecological or population studies. p. 72

qualitative: relating to quality or kind. p. 61

quantitative: relating to number or amount. p. 81

raptor: bird of prey; for example, eagle, hawk, and owl. p. 131

regression: retreat of the sea from land areas. p. 109

runoff: water that drains or flows off the surface of the land. p. 28, 37, 39, 41, 87, 93, 139

salt-water intrusion: displacement of fresh surface water or groundwater by salt water due to its greater density. p. 28

salt water marsh: an area dominated by vegetation which is periodically flooded with salt water, due to tidal action. p. 87

salt wedge: a wedge-shaped intrusion of salty ocean water into an estuary or tidal river; it slopes downward in the upstream direction, and salinity increases with depth. p. 28, 122, 162

satellite photography: photography taken from a satellite. p. 22

scat: an animal’s fecal dropping. p. 64

sebaceous gland: a gland associated with a hair follicle which produces sebum (a mixture of fat, cellular debris, and keratin). p. 105

secondary consumers: carnivores which prey upon primary consumers. p. 61

secondary dune: a dune on the landward side of the primary dune. p. 81

secondary succession: succession that begins with a state in which other organisms were already present; for example, abandoned cropland. p. 68

sharecroppers: tenant farmers who work the land of another in exchange for an agreed share of the value of the crop. p. 146

slack tide: the period of reversal between ebb and flood currents; the speed of the current is very weak or zero. p. 122

sponge: any of a phylum (Porifera) of aquatic lower invertebrate animals that are essentially double-walled cell colonies and are permanently attached as adults. p. 127

subcutaneous: under the skin. p. 105

submerged aquatic vegetation (SAV): underwater aquatic rooted plants. p. 61

succession: the orderly, gradual, and continuous change in species composition and community structure over time. p. 72, 75

succulent: having fleshy tissues designed to conserve moisture. p. 81

swamp: a wetland dominated by trees such as cypress or tupelo. p. 87

talons: sharply hooked claws on the foot of a bird of prey. p. 101

territoriality: the instinctive compulsion to gain and defend a fixed and exclusive area maintained by an individual or group. p. 113

tertiary consumers: carnivores which prey upon secondary consumers. p. 61

threatened species: a species which is likely to become endangered. p. 126

tides: the periodic rising and falling of the oceans resulting from lunar and solar forces acting upon the rotating earth. p. 28

toxins: poisons. p. 87

transect: a cross section of an area used as a sample for recording, mapping, or studying vegetation. p. 68, 81

transgression: extension of the sea over land areas. p. 109

triangulation: a method for finding a position by means of bearings from two fixed points a known distance apart. p. 22

tributary: a stream feeding a larger stream or river. p. 22, 28, 39, 45, 87, 93, 109, 135, 139, 159

trough: the lowest point of a wave. p. 28

turbidity: cloudiness in water derived from algae, suspended silt, or other impurities. p. 50

water cycle: the cycle of water from groundwater, to stream, to river, to ocean, to clouds (by evaporation), to rain, and back to groundwater. p. 41

watershed: the drainage area of a stream, river, or estuary. p. 41, 61, 75, 93, 105

wave frequency: the number of waves to pass a point in a unit of time. p. 28

wave height: the vertical distance between the wave trough and the preceding crest. p. 28

wetlands: any land area that tends to be regularly wet or flooded. p. 37, 41, 61, 87, 93, 133

wetland buffer: a wetland which acts to reduce wave force and lessen shoreline erosion. p. 93

woody plants: plants which contain wood fibers and have persistent living parts above ground year round. p. 72

zoa: an early larval stage of crabs and shrimp. p. 122

zooplankton: aquatic animals that drift passively with the currents. p. 61

Portions of this glossary were excerpted with permission from Project WILD's Western Regional Environmental Council.
**QUICK INFORMATION**

- acid rain: 804-786-2378
- adopt-a-spot: 800-KEEP-ITT
- air pollution: 804-786-2378
- aquariums: 804-642-7174
- Bay Team: 804-642-7172
- BMPs: 804-786-2121
- Chesapeake Bay: 800-662-CRIS
- Conservation Course: 703-231-4385
- citizen monitoring: 804-225-4355
- ecology clubs: 804-786-8679
- educational materials: 804-642-7171
- endangered species: 804-786-4554
- energy: 804-367-1310
- environmental SOLs: 804-225-2651
- EPA: 202-382-2090
- ground water: 703-231-8036
- landfills: 804-225-2667
- land use planning: 804-755-2312
- land use zoning: 804-786-4966
- litter: 804-786-8679
- marine debris: 804-851-6734
- marine 4-H: 804-524-5964
- marine resources: 804-247-2200
- maritime history: 804-595-0368
- oil recycling: 800-552-3831
- Project Learning Tree: 804-225-2651
- Project WILD: 804-367-1000
- recycling: 800-KEEP-ITT
- seafoods: 804-642-7169
- septic systems: 703-231-8036
- shoreline erosion: 804-693-7121
- soil erosion: 804-786-2064
- soil testing: 703-961-6705
- State Parks: 804-786-2121
- stream monitoring: 301-528-1818
- trees and water quality: 804-977-6555
- waste management: 800-552-2075
- water conservation: 703-231-8036
- water quality: 804-367-6306
- wetlands: 804-642-7172
- wildlife: 804-367-1000

**CHESAPEAKE BAY INFORMATION HOTLINE**

For one stop information shopping call
800-662-CRIS

- Publications
- Teaching Resources
- State of the Bay
- Databases

Organizations for teachers interested in Virginia's environment

Virginia Environmental Education Association
804-367-1000

Mid-Atlantic Marine Education Association
804-642-7172

Environmental education courses for teachers

Virginia Resource-Use Education Council
703-231-4385
Species List and Distribution by Salinity Zones

This phylogenetic list comprises species covered in *Life in the Chesapeake Bay* (Lipson and Lipson, 1985). Distribution of species in the Bay and its tributaries is shown on the table according to salinity zonation. Assemblages of organisms at parks generally correspond to salinity zonations. Salinity tends to be lower in the spring and higher in the fall. Most parks contain some Zone 1 organisms in freshwater areas.

**Zone 1** - Tidal freshwaters
   Mason Neck, Leesylvania, Caledon

**Zone 2 (upper)** - Brackish waters of 1-10 ppt salinity
   Mason Neck, Leesylvania, Caledon, Westmoreland, York River

**Zone 2 (lower)** - Moderately salty waters of 11-18 ppt salinity
   Westmoreland, York River, Chippokes, Seashore

**Zone 3** - Salty waters of 18-30 ppt salinity
   Seashore

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<th>SPECIES</th>
<th>ZONE 1</th>
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<tr>
<td><strong>PLANTS</strong></td>
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<td>Green Seaweeds — Phylum Chlorophyta</td>
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<td>Green-tufted seaweeds — Cladophora spp.</td>
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<td>Hollow-tubed seaweeds — Enteromorpha spp.</td>
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<td>Sea lettuce — Ulva lactuca</td>
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<td>Brown Seaweeds — Phylum Phaeophyta</td>
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<td>Brown fuzz seaweeds — Ectocarpus spp.</td>
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<td>Red Seaweeds — Phylum Rhodophyta</td>
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Species List reproduced with permission of author.
### Species Distribution

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### Invertebrate Animals

**Sponges — Phylum Porifera**
- Boring sponges — Cliona spp.
- Potato sponges — Cramella spp.
- Sun sponge — Halichondria bowerbanki
- Volcano sponges — Halichondra spp.
- Stinking sponge — Lissodendoryx carolinensis
- Redbeard sponge — Microciona prolifera

**Sea Anemones, Hydroids, Jellyfish, and Corals — Phylum Cnidaria**

**SEA ANEMONES AND CORALS — CLASS ANTHOZOAA**
- Star coral — Astrangia astreiformis
- Sloppy gut anemone — Ceganeopsis americanus
- White anemone — Diadumene leucolena
- Burrowing anemone — Edwardsia elegans
- Green-striped anemone — Haliplanella lyciae
- Whip coral — Leptogorgia virgulata
- Sea onion — Paranthus rapiformis
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<td>Hair — Anguillina palmata</td>
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### Species Distribution

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**SNAILS — CLASS GASTROPODA**

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<td>Flat-browed mud shrimp — <em>Upogebia affinis</em></td>
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**Sea Stars, Sea Cucumbers, and Brittle Stars — Phylum Echinodermata**

- Common sea star — *Asterias forbesii*
- Pale sea cucumber — *Cucumaria pulcherrima*
- White synapta — *Leptosynapta tenuis*
- Burrowing brittle star — *Micropholis atra*
- Common sea cucumber — *Thyone birareus*
- Fossil sand dollar — *Scutella aberti*

**Arrow Worms — Phylum Chaetognatha**

Arrow worms — *Sagitta* spp.

**Acorn Worms — Phylum Hemichordata**

- Acorn Worm — *Saccoglossus kowalevskii*

**Chordates — Phylum Chordata**

**TUNICATES — CLASS ASCIDIACAE**

- Golden star tunicate — *Botryllus schlosseri*
- Sea squirt — *Molgula manhattensis*
- Green beads tunicate — *Perophora viridis*
# Species Distribution

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## VERTEBRATE ANIMALS

### CARTILAGINOUS FISHES — CLASS CHONDRICHTHYES

**Order Squaleiformes**
- Requiem-Sharks — Family Carcharhinidae
  - Bull shark — *Carcharhinus leucas*
  - Sandbar shark — *Carcharhinus plumbeus*
  - Smooth dogfish — *Mustelus canis*
  - Dogfish Sharks — Family Squalidae
  - Spiny dogfish — *Squalus acantias*

**Order Rajiformes**
- Skates — Family Rajidae
  - Clearnose skate — *Raja eglanteria*
- Stingrays — Family Dasyatidae
  - Southern stingray — *Dasyatis americana*
  - Bluntnose stingray — *Dasyatis sayi*
- Eagle Rays — Family Myliobatidae
  - Cowslip ray — *Rhinoptera bonasus*

### BONY FISHES — CLASS OSTEICHTHYES

**Order Acipenseriformes**
- Sturgeons — Family Acipenseridae
  - Shortnose sturgeon — *Acipenser brevirrostrum*
  - Atlantic sturgeon — *Acipenser oxyrhynchus*

**Order Semionotiformes**
- Gars — Family Lepisosteidae
  - Longnose gar — *Lepisosteus osseus*

**Order Anguilliformes**
- Freshwater Eels — Family Anguillidae
  - American eel — *Anguilla rostrata*

**Order Clupeiformes**
- Herrings — Family Clupeidae
  - Blueback herring — *Alosa aestivalis*
  - Hickory shad — *Alosa mediocris*
  - Alewife — *Alosa pseudoharengus*
  - American shad — *Alosa sapidissima*
  - Atlantic menhaden — *Brevoortia tyrannus*
  - Gizzard shad — *Dorosoma cepedianum*
  - Threadfin shad — *Dorosoma petenense*
- Anchovies — Family Engraulidae
  - Bay anchovy — *Anchoa mitchilli*

**Order Salmoniformes**
- Mudminnows — Family Umbridae
  - Eastern mudminnow — *Umbr a pygmaea*
- Pikés — Family Esocidae
  - Redfin pickerel — *Esox americanus*
### Species Distribution

<table>
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### Species Distribution

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**Order Pleuronectiformes**

| Lefteye Flounders — Family Bothidae |        |        |        |
| Summer flounder — *Paralichthys dentatus* |        |        |        |
| Windowpane — *Scophthalmus aquosus*       |        |        |        |
| Righteye Flounders — Family Pleuronectidae |        |        |        |
| Winter flounder — *Pseudopleuronectes americanus* |        |        |        |
| Soles — Family Soleidae                  |        |        |        |
| Hogchoker — *Trinectes maculatus*         |        |        |        |
| Tonguefishes — Family Cynoglossidae      |        |        |        |
| Blackcheek tonguefish — *Symphurus plagiusa* |        |        |        |

**Order Tetraodontiformes**

| Leatherjackets— Family Balistidae |        |        |        |
| Orange filefish — *Aluterus schoepfi* |        |        |        |
| Planehead filefish — *Monacanthus hispidus* |        |        |        |
| Puffers — Family Tetraodontidae     |        |        |        |
| Northern puffer — *Sphoeroides maculatus* |        |        |        |
| Porcupinefishes — Family Diodontidae |        |        |        |
| Striped burrfish — *Chilomycterus schepfi* |        |        |        |
A Chesapeake Bay Primer

Ecosystems

The word "ecology" comes from the Greek language and means "the study of households." We can think of the natural world as divided into a variety of households, each containing a number of living things as well as non-living things, such as soil, water, air, and a variety of chemical elements. This is much like domestic households that contain both people and the things necessary to support their lives. Each natural household is known as an ecosystem, a term that reflects the many activities and interactions that regularly take place between its living members and the chemical and physical features of their environment.

Ecosystems can be as small as a rotting log or as large as an ocean. The Amazon rainforest is an ecosystem, as is Antarctica. It is often convenient to identify small ecosystems that exist within larger ecosystems, such as an ocean tidepool or a forest glade.

The Chesapeake Bay is certainly an ecosystem. Accordingly, an understanding of the Bay involves a close look at the biology of the Bay’s 2,700 species of living things, its geological characteristics, chemical components, and their patterns of interactions. Because we are also a significant part of the Bay ecosystem, our role must also be taken into consideration if we are to gain a complete understanding of the Bay’s ecology.

The Estuary Ecosystem

With few exceptions, brooks and streams join major rivers that eventually reach the ocean. An estuary is a partly enclosed body of water where fresh water from a river meets ocean salt water and the two mix. The Chesapeake Bay is the nation’s largest estuary, receiving salt water from the Atlantic Ocean and fresh water from more than 50 rivers and innumerable smaller tributaries. Because estuaries receive constantly varying amounts of salt water and fresh water from tides and rainfall, they act as large mixing areas. Nutrients vital to plant and animal life drain from the land and reach estuaries where they are used by these living resources. The chemical, physical and biological elements of river and sea unite to create these unique estuarine ecosystems.

Because salt water is heavier than fresh water, estuaries like Chesapeake Bay contain two layers: a saltier layer that lies on the bottom and a fresher water layer above. Mixing occurs where the two layers meet. Further mixing takes place as a result of wind, tides, temperature changes and rainfall.

The waters of the Chesapeake are saltiest near the mouth of the Bay and gradually become fresher northward. The force of the earth’s rotation makes salt water accumulate on the Eastern Shore, so water tends to be saltier on the eastern side of the Bay at any latitude. Overall, however, the proportions of fresh and salt water in the Bay depend largely on the amount of rainfall that flows out of the Chesapeake’s major rivers. During a wet year, the entire Bay will be somewhat fresher than normal, and conversely, a dry year will result in higher-than-average salinities. Salinity is one of the most important physical features in determining what lives in a particular part of the Bay, so plant and animal populations in the Bay differ north to south, west to east, and from year to year. Temperature and bottom sediment also determine the distribution and abundance of organisms.

Estuaries teem with a variety of plant and animal life. The constant movement of the tides sweeps away wastes and circulates nutrients and food, providing a favorable situation for sedentary animals such as oysters and clams. Estuaries are important nursery grounds for fish. Indeed, many kinds of aquatic animals spend some portion of their life cycles in estuaries. The enormous biological productivity of estu-
The Watershed

A thorough examination of Chesapeake Bay ecology includes not only the body of water itself, but also the entire drainage area, referred to as the Bay watershed. The Chesapeake Bay watershed includes all the land from which water drains right into the Bay or into one of its tributaries. Water which falls onto land outside the Chesapeake Bay watershed will drain into some other body of water - Delaware Bay, the Ohio River, the Atlantic Ocean, or any number of streams or lakes.

The Chesapeake Bay watershed is huge. It extends from the south of the Bay in southern Virginia near Norfolk to the headwaters of the Susquehanna River in New York and west to the middle of Pennsylvania. It encompasses 64,000 square miles of land and is the largest watershed on the eastern seaboard of North America.

Why is the size of the Chesapeake's watershed important? Because anything capable of being carried by rainwater, whether it be gasoline, used oil or pesticides, paint, or fertilizer, can eventually enter the Bay. For example, a particularly rainy season in the Bay watershed will result in a greater amount of fresh water coming into the Bay, by way of the many rivers and tributaries. This will decrease the Bay's salinities. A spill of toxic chemicals from a factory can have effects for almost 200 miles. Fertilizers and topsoil from farms can enter rivers during heavy rains, and eventually end up in the Bay. In fact, all of the natural fluctuations in weather, plus the activities of the 13 million people who inhabit the Chesapeake Bay watershed, will have some sort of effect on the Bay's ecology.

Evolution of a Watershed

The Chesapeake Bay is a geological result of the last ice age. As the glacier that covered much of North America melted some fifteen thousand years ago, sea level rose, flooding the lower Susquehanna River basin and creating the Chesapeake Bay. With the exception of the portion that was originally the Susquehanna River channel, the Chesapeake Bay is relatively shallow - the old river bed itself is the current deep bay channel.

The bulk of the watershed was originally forested. Trees play several roles in maintaining a healthy watershed. They buffer heavy rainfall which otherwise pelts the earth, causing soil to wash away. Trees absorb and evaporate large amounts of water during the growing season, thus reducing flood potential. As people moved into the watershed and cleared trees from the land, there has been a substantial increase in soil erosion, flooding, and the delivery of sediment, nutrients, and other materials into the major tributaries of the Bay.

Life in the Chesapeake

Most of the living things in the Chesapeake Bay are much too small to see with the naked eye. Microscopic plants and animals, known as plankton, are perhaps the most important species in the Bay. Without them, no other animals would be able to survive. Why? Because all living animals in an ecosystem need energy in the form of food. Plants and animals continuously circulate energy in a complex network called a food web. Plants capture energy from sunlight and use it to manufacture food in the unique process of photosynthesis. The smallest plants in the Bay, called phytoplankton, float freely near the surface of the water where sunlight is plentiful. Animals called zooplankton, which also drift in the Bay currents, feed on phytoplankton, as do many other invertebrates, including the early stages of mollusks, crabs, and even some fish species. Small animals, in turn, provide food for somewhat larger animals. Animals such as adult striped bass, oysters, and people consume the largest animals in the Bay. Through the food web, all animals in the Bay ecosystem ultimately depend on an abundant supply of phytoplankton, and rooted submerged aquatic vegetation.

Energy in an ecosystem recycles when a plant or animal dies. Various kinds of decomposers, organisms such as bacteria, feed on dead material and animal wastes.
plants capture new energy from the sun and decomposers return nutrients to the ecosystem, organisms in the food web thrive.

It is not unusual for a food web to undergo temporary disruptions such as forest fires, floods, and droughts. Ecosystems are normally able to recover from these disruptions after some time. When man-induced disruptions are added to the ecosystem on top of the stresses that already exist, the ecosystem's ability to bounce back diminishes. Unlike the proverbial camel, whose back will break under a large enough load of straw, stressed ecosystems don't simply collapse. Instead, they gradually degrade, changing in numerous small ways to endure the range of assaults on them. Over a long period an ecosystem loses its original character altogether, and consequently, loses many of the plants and animals that once inhabited it.

Special Problems of the Bay Ecosystem

Habitat

An animal's habitat is the place where it lives, finds food, defends itself from predators, finds a mate and reproduces. Most animals confine their activities to a particular kind of habitat where they are most successful at fulfilling their needs. For example, ospreys live adjacent to the Chesapeake Bay because it offers an adequate food source (fish) and good nesting sites. Likewise, oysters populate areas where there is a suitable flow of oxygen-filled water, an abundant supply of plankton to serve as a food source, and a hard surface to settle on.

Animals differ in their ability to adapt with change. Some species of animals are able to adapt to changes by their habitats or food sources easily. Raccoons, for example, survive equally well eating fish from a river or table scraps from garbage cans. Many animals, however, do not adapt well to change. Degradation of a species' habitat can result in a decrease in the animal's population or extinction of that species in the area.

Many plant and animal species have suffered from habitat destruction in the Chesapeake Bay. The canvasback duck no longer winters on the Bay in its former abundance because its primary food sources, the aquatic plant known as wild celery, has become too scarce to support large flocks. Other species of submerged aquatic vegetation have also declined precipitously over the past 20 years. The canvasbacks that still winter on Chesapeake Bay have resorted to eating small clams. Redhead ducks, on the other hand, have suffered much because they depended on a diet of underwater grasses. Oyster populations are down because of poorly oxygenated water and a lack of clean, hard surfaces on which their young can settle. Areas of the Bay around Baltimore and Norfolk support little or no bottom life. Loss of wetlands and degradation of water quality throughout the Bay have reduced plant and animal diversity and abundance. Each minor change has had its impact; the cumulative effects of these changes has been devastating.

Toxic Materials

A toxic substance is a poison. Almost any substance can be toxic at high enough levels. Toxic materials enter the Bay from a variety of sources, most commonly industrial discharges and sewage outflow. In limited quantities, incoming fresh water and outgoing tides dilute and remove these harmful chemicals. The current rate of toxic input into the Chesapeake Bay, however, far exceeds its ability to eliminate it. As a result, toxic substances collect in the sediments on the Bay's floor and slowly enter the food web.

A classic example of the impact of toxic materials on animals in an ecosystem is the case of DDT, widely used after World War II as an insecticide. When animals contaminated with DDT were eaten by other animals, toxic effects spread far beyond insects. DDT accumulated in the tissues of certain birds, such as the peregrine falcon and bald eagle, causing their eggshells to be...
thin and, consequently, to break in the nest. For several years, few offspring were produced. After DDT was banned from use in the United States in 1972, peregrine falcon, osprey and bald eagle populations have gradually recovered.

Excessive Nutrients

Unlike a toxic chemical that can actually kill plants and animals directly, nutrients alter living populations in the Bay by stimulating algal growth. Plants make their own food from sunlight, carbon dioxide, water and essential nutrients such as nitrogen and phosphorus. When nutrients are absent or low, plant growth is minimal. This is why farmers put fertilizers containing the important nutrients nitrogen, phosphorus, and potassium, on agricultural crops. Use of fertilizers results in larger yields.

Unfortunately, excess nutrients promote the growth of plants in the Bay, too. Algae are microscopic plants that usually occur (as phytoplankton) near the water's surface. Abundant growth of algae can give the water a cloudy green color or can grow as "slime" on rocks or pilings. Fertilizers wash off cropland and residential lawns into the Bay, providing the nutrients enabling algae to reproduce at overwhelming rates. As algae cloud the water, they prevent sunlight from reaching the Bay floor, causing rooted aquatic plants to die. Decomposing algae use up much of the water's oxygen supply, which in turn stresses fish and other animals in the Bay, especially oysters and clams.

Our Role

People affect every aspect of the Bay ecosystem. We alter its chemistry by pouring our wastes into it. We change its geological features by dredging channels, filling wetlands, and speeding shoreline erosion. We harvest its fish, shellfish, and waterfowl in huge quantities. In short, we affect the entire ecosystem every day through countless commercial and recreational activities.

The human population of the Bay watershed continues to grow and is projected to be 15 million by the year 2000. Everyday activities of each of the watershed's inhabitants, such as flushing toilets and fertilizing gardens, combine to place enormous stresses on the Bay. As the chief source of disruption, human activities threaten the Bay's health and future productivity more than any other organism or natural force. Ironically, we are the only creature in the Bay ecosystem that can control the impact we have on the Bay. It is critically important that man act as a responsible steward of the Bay and as advocates for those species of living things that suffer from our careless actions. Only through becoming aware of our dependence on the Bay and vigilant of our responsibility for it will we be able to maintain it in the years ahead.

Each person in the Chesapeake Bay area can help restore the Bay. What about you? You can start by learning more about the Bay's problems and their causes and taking action to change those aspects of your own lifestyle that have adverse effects on the Bay's well-being. Take Pride in Chesapeake Bay - its fish, wildlife, and its future.

Illustrations by A. J. Lipson

U.S. FISH AND WILDLIFE SERVICE

The Chesapeake Bay is the largest estuary in North America. Its waters provide food and habitat for an abundance of fish and wildlife. It serves as a highway for commerce, a playground, a storehouse of food, and a home for the 13 million people who live in its vast watershed. But in recent years the Chesapeake has become less able to support the fish and wildlife it once did. Increasing amounts of excess nutrients, sediment, and toxic substances are causing serious ecological problems in the Bay. Studies show alarming declines in species of fish and wildlife and in the habitat available to them.

The U.S. Fish and Wildlife Service is one of many Federal, State, and local agencies and private organizations engaged in the Chesapeake Bay restoration program to reverse the damage already done, to arrest further degradation and to restore the Bay - as nearly as time, technology and resources allow - to its former productivity.

As one of the primary Federal stewards of the nation's living natural resources, the U.S. Fish and Wildlife Service provides leadership in habitat and wetlands protection, fish and wildlife research, technical assistance, and in the conservation and protection of migratory birds, anadromous fishes, certain marine mammals, and threatened and endangered species. The Service also manages more than 430 Wildlife Refuges and 70 National Fish Hatcheries across the country, including several in the Bay area.

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Page
3 Great blue heron, Ardea herodias
5 Poison ivy, Toxicodendron radicans
6 Lined seahorse, Hippocampus erectus
8 Bald eagle, Haliaeetus leucocephalus
9 Osprey, Pandion haliaetus
Turkey vulture, Cathartes aura
Bald eagle, Haliaeetus leucocephalus
Northern harrier, Circus cyaneus
9 Marsh hibiscus, Hibiscus moscheutos
11 Canvashack, Aythya valisineria (d & s)
Redhead, Aythya americana (d & s)
Lesser scaup, Aythya affinis (d & s)
Mallard, Anas platyrhynchos (d & s)
American wigeon, Anas americana (d & s)
Wood duck, Aix sponsa (d & s)
Behavior silhouettes: Bay ducks diving and taking wing
Behavior silhouettes: Marsh ducks tipping to feed and taking wing
12 Southern leopard frog, Rana sphenoecephala
13 White-tailed deer, Odocoileus virginianus (d & s)
14 Muskrat, Ondatra zibethicus
15 Red-bellied woodpecker, Melanerpes carolinus (d & s)
Downy woodpecker, Picoides pubescens (d & s)
Pileated woodpecker, Dryocopus pileatus (d & s)
17 Common tern, Sterna hirundo
Laughing gull, Larus argentatus
Herring gull, Larus argentatus
Great black-backed gull, Larus marinus
43 Great egret, Casmerodius albus
46 Common skimmer, Libellulidae family
Arrow arum, Pelandra virginica
Water strider, Gerridae family
Whirligig beetles, Gyrinidae family
79 Bald cypress, Taxodium distichum
Bullfrog, Rana catesbeiana
Southern leopard frog, Rana sphenoecephala
80 Bald cypress, Taxodium distichum
Sweetgum, Liquidambar styraciflua
Virginia opossum, Didelphis virginiana
101 Greater yellowlegs, Tringa melanoleuca
Dunlin, Calidris alpina
Least sandpiper, Calidris minuta
Semipalmated sandpiper, Calidris pusilla
105 Beaver, Castor canadensis
113 Illustrations incorrectly acknowledged to Lipson
Marsh periwinkles, Littorina irrorata
Little gray barnacle, Chthamalus fragilis

Page
120 American eel, Anguilla rostrata
Atlantic croaker, Micropogonias undulatus
Chain pickerel, Esox niger
Striped killifish, Fundulus majalis
Atlantic menhaden, Brevoortia tyrannus
Oyster toadfish, Opsanus tau
121 Channel catfish, Ictalurus punctatus
Hogchoker, Trinectes maculatus
Atlantic silverside, Menidia menidia
Northern pipefish, Syngnathus fuscus
White perch, Morone americana
167 Raccoon, Procyon lotor on red maple
169 Silhouette of great blue heron
189 Glossy ibis, Plegadis falcinellus

Cover and Brochure (1st Printing)

Cover: Green treefrog, Hyla cinerea
Southern leopard frog, Rana sphenocephala
Fowler's toad, Bufo woodhousii
Redbelly turtle, Pseudemys rubriventris r.
Bultongue, Sagitaria falcata
Great blue heron, Ardea herodias
Flight silhouette of green-backed heron

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Bultongue, Sagitaria falcata
Great blue heron, Ardea herodias
Flight silhouette of green-backed heron
Green-backed heron, Butorides striatus
Raccoon, Procyon lotor on red maple
Flight silhouette of great blue heron,
Ardea herodias
Northern diamondback terrapin, Malaclemys terrapin t.
Tundra swan, Cygnus columbianus

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