Governor’s Conservation Classroom Challenge

Challenge HS - 1

Title: Create An Elevation Profile of a Common Landform

Grade Level: 9-12 also suitable for some middle school classrooms
Subjects: Science, Math, Language Arts

Abstract:
Coastal and riparian zones are among the most dynamic on Earth. Students investigate relationships between the physical features of a landform and the surrounding environment, while creating a topographic profile. Using simple equipment, students complete an elevation transect of a beach, dune, stream channel or riparian buffer, or any landform with a discernable incline/syncline. At intervals, students collect physical data (temperature, wind speed, light and moisture levels, and soil or substrate composition, as appropriate to the setting.) Students graph elevation data and create a cross-sectional profile. Discussion may center on physical processes like waves and tide levels that shape the shoreline, stream flow that defines a riparian environment, or other physical factors that change with landform elevation.

Objectives:
Students will: practice the Emery method for profiling elevation changes in landforms; collect data in sequence at regular intervals along a transect; make observations and take accurate measurements with simple tools or appropriate technology. They will create annotated cross-sectional profiles of the transect and use their data to infer the relationships between landform elevation and the physical features they recorded Examples include wave/tide extent, temperature, wind speed, sediment type, moisture and light levels.
*See extension for elevation vs. biodiversity study.

Materials:
(See Resource Section for instruction on making equipment, sample data sheets and identification guides)

- Transect line for measuring elevation change – 5 to 10 m length recommended, marked (or knotted) at 1 m intervals (surveyors’ line is recommended, avoid line that stretches)
- Profiling/surveying stadia (aka Emery rods) – instructions for making and using these are available from VIMS Marine Advisory Service Education.
- Clipboards, data collection sheets, pencils – data sheets included in the profiling instructions from VIMS
- Coastal plant and animal identification guides –If including a biodiversity survey as part of the profiling exercise

Safety:
Inherent hazards of the selected study site need to be reviewed in advance with adults and students. Provide safety lines and adequate adult supervision if students are venturing across an active stream bed or working on steep slopes. PFDs are required if a risk of submersion exits. All participants must wear footwear that completely encloses the foot, and plan for adequate drinking water, and protection from sun, biting insects and harmful plants. Teachers should pack a first aid kit appropriate for active outdoor activities and discuss field trip authorization and procedures with school health personnel.

Background:
Additional teacher background for this challenge can be found in the Virginia's Natural Resources Education Guide chapters on *Bay and Coast; Soil*

For elevation profile instructions, including how to make Emery rods, as well as information on how to fit this challenge into a *Meaningful Watershed Education Experience* (MWEE) contact Carol Hopper Brill <chopper@vims.edu> at VIMS Marine Advisory Services

Procedure:
To be most successful, this Conservation Challenge should occur in three phases, preparation, action, and reflection. The introductory notations for each phase parallel the definition of a MWEE.

Preparation Phase: (*Focuses on a question, problem or issue and involves students in related discussions. Includes background research and student or team assignments, as well as management and safety considerations and logistical planning*.)

Based on the class subject matter, curriculum objectives, SOLs to be covered, or environment of interest, the instructor determines an appropriate sampling site (beach/dune, stream or pond bank, forest edge, or other landform) and prepares background for the students. Teachers should consider engaging the students in the decision making on relevant physical measurements to take in concert with the topographic data.

Before attempting the elevation profiling procedures in the field, instructors can have students practice the method while on school grounds. See the Background section for instructions for performing a shoreline profile – this procedure works on any landform. A short series of stairs (3-10 stairs) provides a good practice site so that students can get used to using the profiling stadia/Emery rods, taking data, and calculating change in elevation. Students should also practice their roles on the transect team. With 5-6 students per team: 2 students staff the stadia, up to 2 monitor the stadia levels (or the stadia staffers can do this), 1 monitors the line level, and 1 student reads and records elevation changes.

Additional student(s) may be needed to take other physical measurements or these can be taken by the line level monitor and data recorder. The instructor should also allow students to practice taking other measurements planned for the field investigation.

Action Phase: *(Features one or more outdoor experiences sufficient to conduct the project, make observations and collect data. Students should be actively involved in study or activity design, planning, data collection and/or as safety guidelines permit)*

Students conduct a simple elevation profile of a beach, dune or other coastal ecological feature or habitat. This mapping procedure generates data that students can convert into a graphical representation (in cross-sectional view) of elevation changes across a landscape, highlighting any ecological gradients or microhabitats. An appropriate application is in Earth Science or Ecology class.

For example, a beach profile from the water line to the base of the dune helps reveal physical processes including how wave energy shapes the slope of a beach. Collecting sand samples from along the transect can provide additional data through analysis of grain size and composition.

Comparatively, a profile from open ground into the forest edge may reveal changes in temperature, light levels, wind speed, soil composition and moisture.

Taking measurements such as temperature and wind speed at ground level, as well sediment moisture and composition along the transect can identify environmental parameters of significance to plants and animals. If working in the intertidal zone, conducting transects at low tide vs. high tide can further illustrate changes of ecological significance. Measurements along a transect across a stream bed will reveal water depth, stream bed composition, and differences in stream velocity.

Profiling a dune from its seaward face to the more protected back slope may yield temperature, wind and moisture measurements from the front slope, dune top and back slope. Differences in these environmental parameters may have correlations to distribution patterns of beach and dune plant life.

Similarly, if profiling a riparian buffer from outside the vegetated zone down to the stream bank, temperature, wind, sample sediment type and moisture data can be collected. Vegetation density and diversity may change along the transect. Questions may include which environmental factors might be causing the change in vegetation and which environmental factors are changing because of the vegetation.

Reflection Phase: *(Refocuses on the question, problem, or issue. Includes student analysis of data, evaluation of results, and drawing conclusions. Teacher assesses the activity and student learning.)*

Data collation and analysis: Following the directions for elevation profiling, students calculate the elevation differences at each sampling site and create a table with elevation differences as the dependent variable (Y axis) and the cumulative transect distance as the independent variable (X axis). Students graph the data to create a cross-sectional profile of their study site. Graphing can be done by hand using graph paper, or digitally via Excel on the computer.

Next, students annotate the elevation profile with any measurements of physical factors collected along the transect. Comparing physical factors with elevation, students may draw comparisons between points on the profile or propose hypotheses regarding correlations between the landform profile and changes in the physical factors. They may gather background information from similar studies to support their conclusions.

Finally, students prepare an oral and/or written lab report, illustrated by a poster or power point presentation that outlines their research objectives, methods, data collection and analysis, and delivers their conclusions and suggestions for further research.

Possible Extension:
Biodiversity Survey along the Elevation Transect
Many transect studies are intended to catalog changes in species distributions. As students conduct their elevation transect, they can simultaneously note any changes in species composition. By overlaying species data on the elevation profile, they may recognize natural ecological zones. Although it is especially appropriate for Earth Science or Biology classes in high school, this challenge can be adapted for middle school life science, high school ecology and marine science classes.

For example: In beach and dune profiles, riparian or forest edge profiles, biodiversity patterns may suggest that different plant and animal species have adaptations that allow them to survive in zones where other species do not. Students can conduct additional library research and report on known distributions and adaptations of individual species.

Stewardship:
Students can remove and properly dispose of or recycle any trash items, especially plastics that can be safely bagged and transported from the study site.

Additional Resources:
For guidance on conducting science in outdoor environments, see: Ryken et al 2007. *Field Investigations: Using Outdoor Environments to Foster Student Learning of Scientific Processes* by Assoc. of Fish & Wildlife and Agencies & Pacific Education Institute,
http://www.fishwildlife.org/files/ConEd-2015-Revision-Field_Investigations_.pdf

Texas High School Coastal Monitoring Program, www.beg.utexas.edu/coastal/thscmp/fld_pro.php outlines field procedures and equipment in detail, includes photos of students conducting an Emery profile of a beach and dune.

Resources for the Biodiversity Survey extension activity:
See appropriate chapter in Natural Resources Guide for an introduction to coast, riparian or other environment to be sampled (e.g. Bay and Coast, Forest, Soil. Wildlife).
Project WILD; Science & Civics 2005. A Place for Every Living Thing. VA DGIF, contact: Suzie.Gilley@dgif.virginia.gov. Provides background and instructions for how to conduct a biodiversity survey, including formula for calculating biodiversity index.

LiMPETS, Long-Term Monitoring Program and Experiential Training for Students
http://limpets.org/sandy-beach-monitoring/ and
http://limpets.org/teacher-resources/sandy-beach-monitoring-pilot-curriculum-guide-2010/
This hands-on program was developed to monitor the ocean and coastal ecosystems in CA, but the methods can apply anywhere! Teacher handbook on-line features lists of materials and supplies, illustrated instructions for conducting transects on rocky shores and beaches.

Lippson, A.J. & R.L. Lippson. 2006. Life in the Chesapeake Bay, Third Edition. The John Hopkins University Press. Best single reference on environments and organisms of the Chesapeake Bay.
Selected bibliography, Mid-Atlantic Coastal Ecology & Marine Life – VIMS MAS, contact chopper@vims.edu. A list of recommended references for additional background on the Mid-Atlantic coast, environments and common species.

Life in the Shallows - Chesapeake Bay Program, www.chesapeakebay.net/library
A poster/illustration showing diverse habitats and organisms in shallow coastal waters.
Field Guide to Salt and Brackish Marsh Plants -- VIMS Center for Coastal Resources Management. A color picture guide to common plant species of coastal marshes.
http://ccrm.vims.edu/publications/pubs/8x11brochureannotated2rh.pdf

Native Plants for Beach and Sand Dunes -- VIMS Center for Coastal Resources Management. Color picture guide to common plants of beaches and dunes.
http://ccrm.vims.edu/wetlands/teaching_marsh/wetland_plants/dune_plants.html

Chesapeake Bay field guides – Chesapeake Bay Program, http://www.chesapeakebay.net/fieldguide. Identification guides for common Bay species.

Chesapeake Bay Underwater Grasses – Chesapeake Bay Program. Color guide to common SAV species.
http://www.chesapeakebay.net/library and
www.chesapeakebay.net/documents/cbp_12237.pdf
Bay SAV Identification key – MD Dept. Nat. Resources. Another color guide to SAV species.
www.dnr.state.md.us/bay/sav/key/complete_sav_key.pdf

Dichotomous Key to Invertebrate Phyla &Introduction to Invertebrate Phyla – VIMS MAS, contact chopper@vims.edu. Simple key for determining major phyla of invertebrate organisms found in the Chesapeake and Mid-Atlantic.

Dichotomous Key to Oyster Reef Species – CBNERR-VA, contact: mcguire@vims.edu
Simple key for common species of invertebrates and fishes in shallow Chesapeake waters.
MWEE Conservation Practices & Build Your Own Viewbox. Instructions for making an inexpensive viewbox to use during coastal fieldtrips.

Species Diversity (Biodiversity Index) Calculator (fillable excel file that automatically calculates 2 biodiversity indices). To use when comparing biodiversity counts at different sampling sites.
PDFs available from VIMS Marine Advisory Services (no longer available on their original sites), resources as described above: Life in the Shallows - Chesapeake Bay Program; Guide to Underwater Grasses – Chesapeake Bay Foundation

Teachers take an elevation reading on a dune slope. Two people steady the calibrated stadia poles. Another person monitors the line between them, making sure it is stretched tight and watching the line level. The end on the uphill stadia is adjusted until the line is level. The recorder documents the calibrations on the stadia and records the change in elevation. Photo: C.Hopper Brill.

Teachers here are using stadia made of PVC pipe, with calibration marks made with red vinyl tape and permanent marker. As they adjust the end of the line and record the change in elevation, another teacher takes a GPS reading. Photo: C.Hopper Brill.

Marine Advisory Program
www.vims.edu/adv/

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Basic Elevation Profile Transects

Objective:

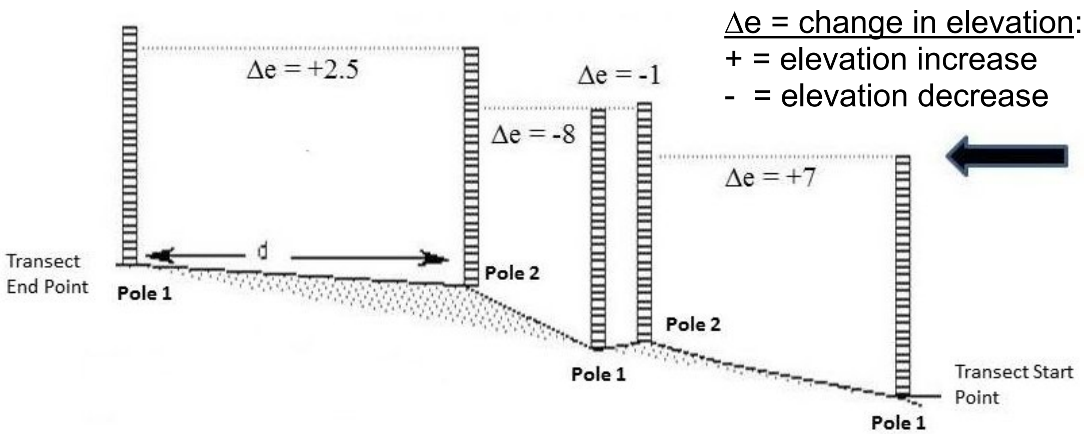
To measure the elevation changes across a landform or habitat edge (ecotone).

Directions: *Using 2 stadia rods and a line, as in a basic Emery Method.*

1. Stretch a transect line from start to end point of your sample site and fix the line at both endpoints. The transect should be perpendicular across the elevation or ecotone (habitat edge) to be sampled. If a GPS is available, record the 2 end points of the transect.
2. Place Pole 1 at one end of the transect. Stretch out the string until it is taut and place Pole 2 along the transect line.
3. Using the levels, ensure the both poles are perfectly straight front to back and side to side.
4. Move the string on Pole 2 up or down until the bubble of the line level is in the center. The line is now level.
5. Note the numerical values on each pole and find the difference between the two numbers - This is the measurement you are looking for! Make sure you use a POSITIVE number if measuring UPSLOPE and NEGATIVE if measuring DOWNSLOPE. *Example: The height of the string on pole #1 is 60 cm. The height of the string on pole #2 is 80 cm. The difference would be +20 cm (80 cm - 60 cm = +20 cm).*
6. Record the data on the data sheet.
7. After recording the data, lift Pole 1 (from your start point) and leapfrog past Pole 2, moving along the transect line.
8. Repeat steps 3-7 until you have reached other end of the transect.
9. Back in the lab, plot the data you gathered. A simple line graph will show your elevation profile where the X-axis is the length of the transect and the Y-axis will be the elevation difference. This yields a cross-sectional elevation map of the transect.
10. Parts of the landform can be labeled on the graph. For example, if the study site is a beach: beach face, beach scarp, berm crest, dune scarp. Consult texts or other reference materials for appropriate terminology.
11. Annotate the cross-section, noting other measurements taken at positions along the transect .

Tips:

- Make as many comments and observations along the transect as possible.
- Take pictures of the transect in both dimensions (sighting along the transect and viewed from the side).
- Try to space your points so that all variations in topography are recorded.
  - Ex. If there is a dip in topography between the transit rods, shorten the distance between them in order to get the data point and therefore providing for a more accurate profile. Be sure to document the appropriate beach face length if you change the dimension!



After: Department of Geological Sciences, Salem State College

Making PVC Transect Stadia for Elevation Profiling

Materials & Supplies:

Two 5-foot lengths of 3/4-inch PVC pipe (1" and 1.5 " PVC pipe can also be used) (<$2 each)
Two 3/4-inch PVC **slip-on** pipe-to-pipe adapter, without threads (<$1 each)
Two PVC 3/4-inch **slip-on** plug, without threads (<$1 each)
Two 3-inch or 4-inch PVC cap fitting or knockout plug (<$1 each) to provide a footing on the sand
Two 1/8-inch diameter x 1/2-inch sheet metal screws
Two washers with 1/8-inch diameter hole
One roll of color vinyl tape or electrician's tape & a fine-tipped permanent marker

Equipment needed: hand drill, hammer, Phillips screwdriver

Assembly Instructions

1. With a 1/8" drill bit, drill holes in the center of the PVC plug & PVC cap fitting.
1. Insert one end of the PVC pipe into the receptacle end of the PVC pipe-to-pipe adapter.
2. Insert the PVC plug into the end of the adapter. Lightly hammer the plug into the adapter & pipe until fully seated. DO NOT use glue; these will fit snugly, but can be hammered apart if repairs need to be made.
3. Attach the PVC cap fitting to the pipe assembly using the washer & metal screw.
4. Use the top of the PVC adapter as "zero" for the height measurements on the stadia, making marks & labeling every 2 cm with an indelible pen.
5. To make the 10 cm increments more visible, wrap colored vinyl tape at 0, 10, 20, 40cm, etc.

Materials:
-2 transit rods
-line
-levels (up to 3)

Resources:
<http://w3.salemstate.edu/~lhanson/gls214/gls214_prof_procedure.html>
<http://www.njmsc.org/Education/Lesson_Plans/Beach_Profiling.htm>
<http://omp.gso.uri.edu/discovery/barrierbeach/bbact.htm>
<http://mciunix.mciu.k12.pa.us/~seastar/beachdir.html> Emery Method of Beach Profiling

Elevation Profile Data Sheet

Date: ____________________ **Recorder:** ____________________

Time: ____________________ **Location:** ____________________

Tide Stage: ____________________

Site #	Distance (m)	Cumulative Distance (m)	Change in Elevation (cm)	Cumulative Change in Elevation (cm)	Observations/Comments
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
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