Activity #1: The Dynamic Beach
Beach Profiling

By Betsy Sheffield, COASTeam Program, College of Charleston, Charleston, SC

Subjects: Science, Math
Skills: Analysis, description, listing, research, small group work
Duration: 2 to 3 hours
Group size: 5-10 students
Setting: Part I: in classroom, Parts II and III: outdoors
Vocabulary: accretion, benchmark, berm, dune, erosion, hurricane, nor'easter, swale, transect
SC Science Standards: Grade 6: IA1a1,2; IA1b1; IA1c1; IA1d1; IA1e1; IA2a,b,f; IA3a; IA6a; IA8a; IC3a. Grade 7: IA1a1,2; IA1b1; IA1c1; IA1d1; IA1e1; IA2a,b,f; IA3a; IA6a; IA8a; III (Ecology – Abiotic) A1a,b,c,d. Grade 8: IA1a1,2; IA1b1; IA1c1; IA1e1; IA2a,b,f; IA3a; IA6; IA8a; IB1a; IB2,3; ID3a.

Objectives

Students will learn:

1) survey techniques and methods;
2) how to measure distances and elevation; and
3) to observe dune and beach environments.

Students survey and record the topography along a segment of the beach.

Background

Barrier islands are changing environments. Wind and waves constantly batter the coastline, depositing and eroding sediment. Severe storms, like **hurricanes** and **nor'easters**, tremendously alter the shape of a beach, often eroding sand from dunes. Winter brings the ocean's fiercest winds, while summer conditions are more mild. The shape of the beach therefore differs with the seasons. This activity will show students how to plot the topography of a local beach. If possible, study the beach over the school year and give your students the opportunity to predict and identify seasonal changes of the beach face.

In South Carolina, the Department of Health and Environmental Control's Office of Ocean and Coastal Resource Management (DHEC - OCRM) is responsible for monitoring the changes of the state's coastline. Twice a year, this office uses points of known elevation, called **benchmarks**, to determine changes in elevation on each of South Carolina's barrier islands. The data are collected by making a **transect**, or line of data collection points, from a benchmark in the island's dunes perpendicular to the ocean surf. Each transect is compared with past transect data and these are used to make conclusions about the general changes of each island. Islands may lose sand due to **erosion**, gain sand (**accretion**), or remain unchanged in various locations along the length of the island.

OCRM's data are gathered using units of feet and inches, the standard for U.S. cartography. If you want your students to survey using metric units, you may convert OCRM's benchmark data into meters and use meters when collecting data on the beach. The conversion factor is 1 foot = 0.3048 meter. (Metric units are included in parentheses.)

Materials:

Part I

- Activity #1 Worksheet 1, pages 7 and 9
- graph paper, page 13

Part III

- one 10 ft (4 meters) section of PVC pipe (referred to as the "long rod")
- one 5 ft (1.5 meters) section of PVC pipe ("short rod")

- thick nylon rope marked off in 1-foot increments, with a knot tied every 15 feet (10 meters)
- lightweight cotton string
- line level (available at hardware stores)
- clipboard with attached pencil (less likely to be lost that way!)
- two or three copies of the Beach Profiling Data Sheet, page 21
- compass (optional)

Procedure

Part I – in the classroom

Before you take your students to the beach, make sure you present the profiling activity to them! In the classroom, familiarize your students with the concept of beach profiling. It is really a simple method, but sometimes difficult to understand at first try. A classroom exercise is included on pages 7 and 9. Have your students go through this in class before attempting to profile in the field. The directions are on the worksheet, and an answer key is provided. Once they are familiar with the concept in the classroom, they will be able to reproduce it in the field.

Secondly, have your students plot this small amount of data on an x, y graph. Plot "actual elevation" on the y-axis and "cumulative distance" on the x-axis. Use the graph paper included on page 13. See Figure 1 for a graph using that data. Your students should plot a line similar in shape to Figures A through E on Worksheet 1.

As an extension, give them data from other benchmarks to plot. Data can be found on the web (see Resource Index). The purpose of these beach profiling activities is to familiarize students with the beach, its shape and the life found on it. As they graph more data, the students will recognize the common shape of the beach, and discover its variations through the seasons.

As an additional extension, have your students construct a profile of the classroom, using data points from chairs and tables in the room. This activity is good for a rainy day, and it will test their understanding of profiling.

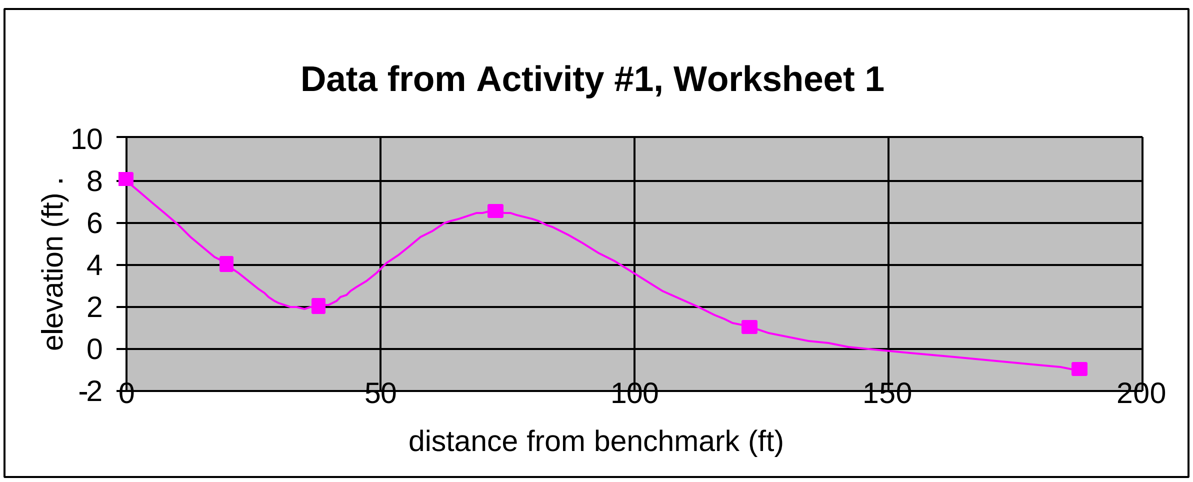


Figure 1-1: Graph generated using data from Activity #1 Worksheet 1.

Part II – preparation

Before the class field trip, choose a location for your study. For more information on locations of benchmarks, see the Benchmark Box, page 5. The best time for surveying is at low tide, when the maximum amount of beach is exposed. Consult a tide chart when planning the field trip.

Part III – in the field, with your students

Begin at your chosen benchmark. Remind your students to be very careful to avoid stepping on plants when performing this beach study.

Step 1: If the benchmark cap is higher than the land surface, measure vertically from the cap down to the land surface to find the actual elevation of the land.

Step 2: Subtract that vertical distance from the benchmark elevation to find the elevation of the land surface (see Figure 2).

Step 3: Enter that number on line A on the BPEW, in the "actual elevation" column.

Step 4: Otherwise, if the benchmark cap is on the land surface, enter the benchmark's elevation in the "actual elevation" column.

The short rod is used as the sighting point and the long rod as the one to which you sight. Both rods should be marked with feet and tenths of feet. You may use meters as your measurement; however, tenths of feet is the increment used by OCRM in their annual beach profiles, and therefore will be easier to compare.

Starting at the benchmark, sight a line directly to the shore. Find a point between the benchmark and the horizon that can be used as a marker to guide the profile transect in a straight line. Or, take a bearing with a compass and follow that bearing to the sea, producing a straight transect.

The person at the short rod sights from the top of that rod to the long rod, which is placed between the short rod and the water. Read the value on the long rod where the horizon appears to intersect the rod. The horizon serves as a level line (see Figure 3, next page). Record the measurement from the long rod on line B in the column marked "reading on long rod."

At times you may find that the view of the ocean is obscured. If the horizon cannot be seen, use a line level to determine differences in elevation. The line level can measure elevation change only between short distances (no more than 10 feet, and less on a windy day). A light cotton string works well. Hold the line at the top of the

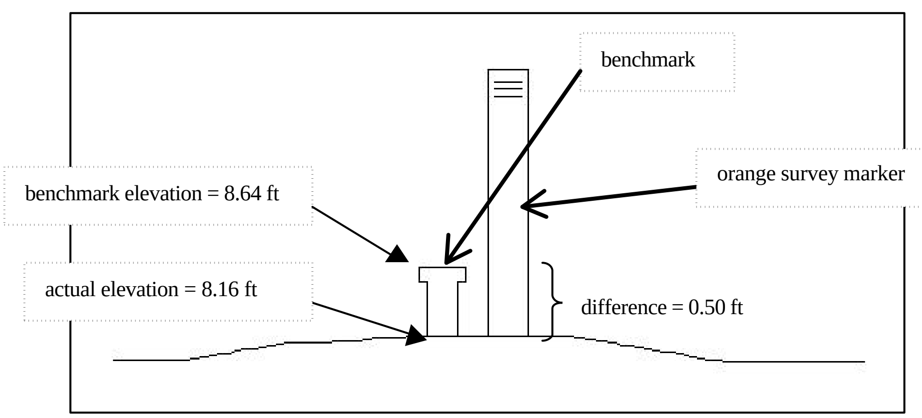


Figure 1-2: Find the vertical difference between the benchmark elevation and the land surface to determine the land surface elevation. In this example, subtracting the vertical difference (0.50 ft) from the benchmark elevation (8.64 ft) results in an actual elevation of 8.16 ft.

short rod and give the other end to the person holding the long rod. Place the line level in the middle of the cotton string; move the line up and down the long rod until the level reads as "level." (See Figure 4 and Figure 5.) Record the number

Figure 1-3: The woman is sighting a line from the short rod to the long rod, directly towards the horizon. The arrow indicates where the man will read the measurement.

measured on the long rod in the data table. For the next measurement, keep the long rod in place and move the short rod up to meet the long rod. Then move the long rod to the next obvious change in elevation, keeping the long rod in line with the benchmark and with the short rod. You may use an incremental distance (such as 15 feet, or 5 meters) and take measurements at that interval, or you may move to the next point

Figure 1-4: Using the line level to measure elevation change when the horizon is not in view.

of significant elevation change (dune or swale or edge of the berm). Measure the distance with the rope that has the foot increments marked. Do not move more than 30 feet (10 m) at one time. Sight again, using the horizon and/or compass to produce a straight line transect.

End the transect when you reach the ocean, or keep on going if you and your students are equipped to enter the water, and are feeling adventurous!

Figure 1-5: The line level is "level" and the string is used to determine the elevation reading on the long rod.

Simultaneous Activities

This activity guide, *The Ever-Changing Beach*, was designed to involve all of your students in some capacity. The following activities provide that opportunity for the students who are not associated with the recording of elevation data in this activity. Have those students assist in surveys of the plants and animals along the profile transect, and by collecting sediment samples. Survey the flora and fauna that are adapted to each location in Activity #2, *You Live Where?* Collect sediment samples on the dunes, swales, high tide line and low tide line, and use a set of sieves to sort them for comparing the grain sizes at the different zones of the beach in *Sifting Sand*. Synthesize all the collected data in *Constructing a Profile of the Beach*

Environment. See the following pages for detailed descriptions of these activities.

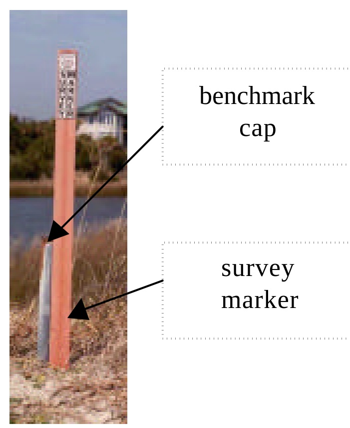
These provide opportunities for all the students in your class to observe the geology and biology of the beach.

Figure 1-6: The rods are spaced at a measured distance.

Benchmark Box

Before you begin, consult OCRM for the location and elevation of the island benchmarks in your area (see Resource Index). They have maps and directions on how to find each benchmark, as well as the elevation of each. Find the benchmark yourself before you take your students to it. Choose the benchmark based on its ease of access, the distance from it to the ocean, and the amount of elevation change. You probably will not want to choose a profile that is longer than 800-1000 feet, particularly if it is a hot day.

You will recognize a benchmark by the thin orange survey marker. Next to the marker is a pipe with a cap at its mouth. The cap is inscribed with a number characteristic to that location. The benchmark elevation provided to you by OCRM is the elevation above approximate sea level of the benchmark cap.



Activity #1 Worksheet 1 Instructions

Part I – In the Classroom

This is a classroom activity to familiarize you with the concept of beach surveying. The charts on the following page are diagrams of dunes. In the field, you will use two rods and the horizon to measure the elevation of the beach at locations spaced apart at a measured distance.

1. Start with Figure A. The short rod is drawn at the starting point, at the benchmark, where the elevation is known (8 feet). The short rod is 5 feet long.
2. The long rod is positioned 20 feet on the ocean side of the starting point.
3. When looking across the top of the short rod toward the long rod, the horizon in the distance crosses the long rod at 9 feet. See diagram.
4. Looking at Figure A, is the new *elevation* greater than or less than that of the starting point? ________
5. Now subtract the reading on the long rod (9 ft) from the height of the short rod (5 ft). It is perfectly fine to get negative numbers because we are looking for *change* in elevation.
6. The answer (-4 ft) is the amount of elevation *change*. The negative number indicates the change is in a downward direction. Place this number in the appropriate box on the chart provided.
7. To find the actual elevation, add the amount of elevation change (either positive or negative) to the previous actual elevation (8 ft). The true elevation at the second point is ____. Does this make sense conceptually? Compare your result to your answer to question 4.
8. Record the horizontal distance (20 ft) and cumulative distance (20 ft) on the chart provided.
9. Go on to Figure B. The short rod is moved to the place where the long rod was in #7. The long rod is shown at the next place of significant elevation change, 18 ft towards the ocean.
10. When reading across the top of the short rod, you read an elevation of 7 feet (where the horizon crosses the long rod).
11. Is the new elevation greater than or less than the previous elevation? ___________
12. Again, subtract to find the amount of elevation change and put it in the correct box on the chart.
13. Find the actual elevation (as in #7, above), record the horizontal distance (18 ft) and the cumulative distance (20 + 18 ft).
14. Go on to Figure C. The short rod is 38 ft from the starting point. Draw the long rod at the next point of elevation change, 35 ft towards the ocean.
15. This time the long rod reading is 0.5 feet. Did we go uphill or downhill from the last point? ________
16. Calculate the elevation change and actual elevation, as well as the horizontal distance between rods and the cumulative distance from starting point.
17. Go to Figure D. Now the short rod is moved to the place that the long rod was in #16, and the long rod is moved 50 ft. The reading on the long rod is 10.5 ft. Calculate the actual elevation, the horizontal and cumulative distances.
18. Go to Figure E. The short rod is moved up to meet the long rod. Draw the long rod 65 ft towards the ocean. The reading on the long rod is 7 ft. Calculate the actual elevation, the horizontal and cumulative distances.
19. Plot your data on the graph paper provided.

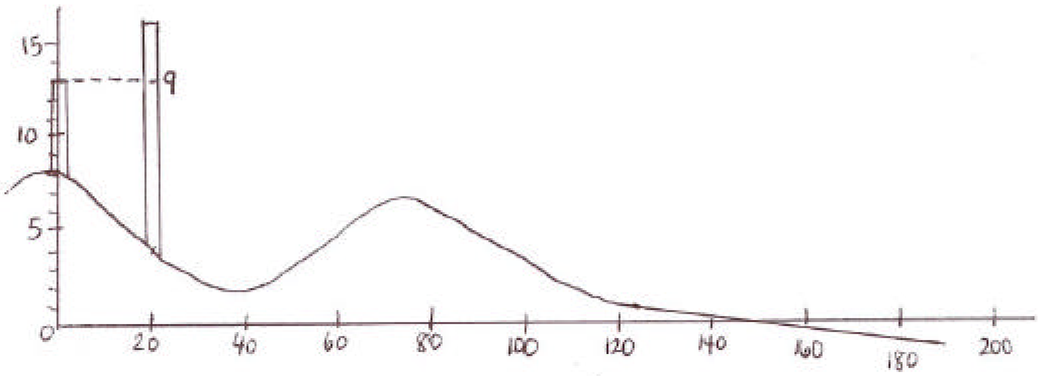
Good job! Let's practice this on the beach!

Activity #1 Worksheet 1

Part I – In the Classroom

Student worksheet

A



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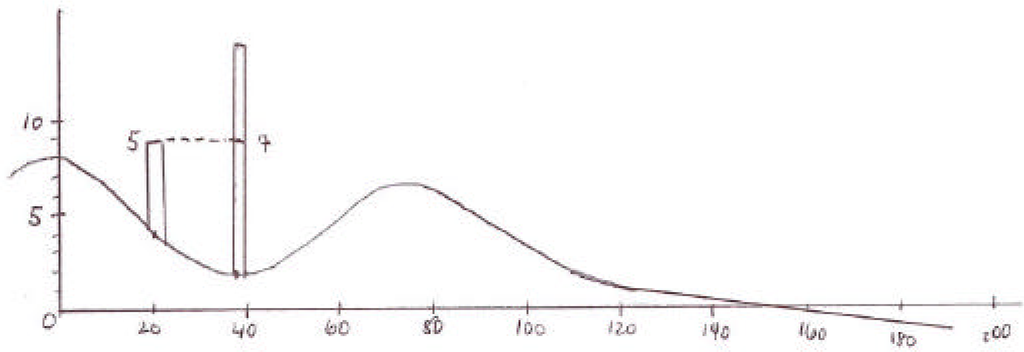

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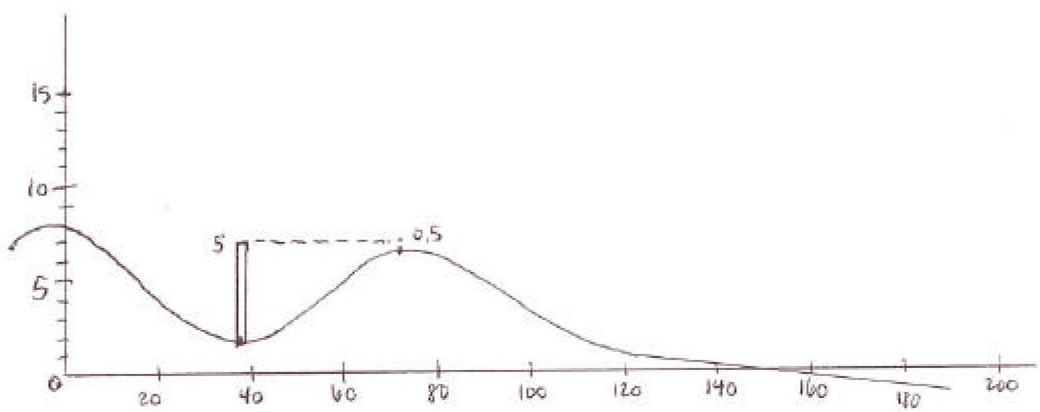


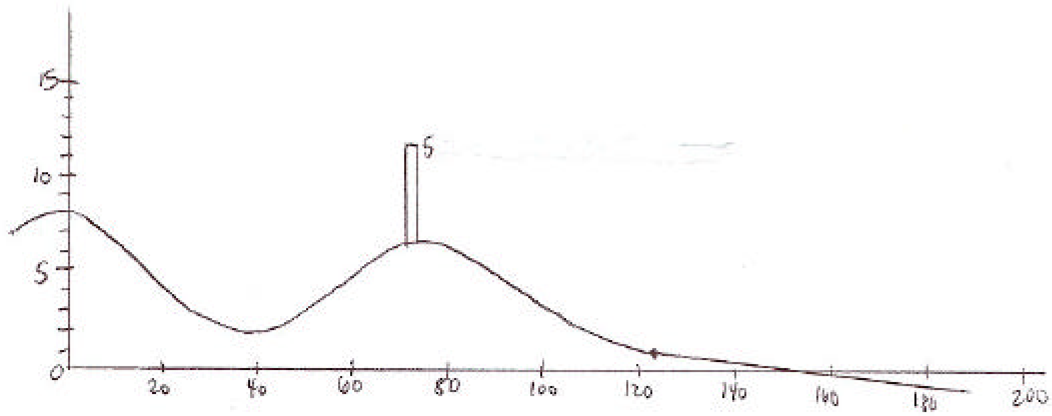
From The Ever-Changing Beach, Third Draft. By Betsy Sheffield, COASTeam Program, Lowcountry Hall of Science and Math, College of Charleston, Charleston, SC 29424

Activity #1 Worksheet 1 (cont'd)

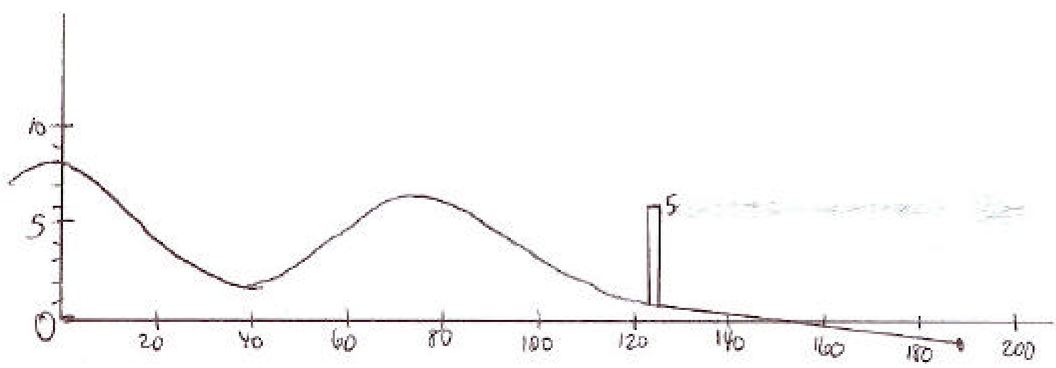
Part I – In the Classroom

Student worksheet

D



E



data points	height of short rod (ft)	-	reading on long rod (ft)	=	elevation change (ft)	actual * elevation (ft)	horizontal distance (ft)	cumulative † distance (ft)
1	5	-		=		8 (at benchmark)	0	0
2	5	-		=			20	
3	5	-		=				
4	5	-		=				
5	5	-		=				
6	5	-		=				188

* Actual elevation is calculated by adding the elevation change (either positive or negative) to the *previous* actual elevation.
† Cumulative distance is calculated by adding the horizontal distance to the *previous* cumulative distance.

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10 Squares to the Inch

Activity #1 Worksheet 1 Instructions

Part I – In the Classroom (teacher's key)

This is a classroom activity to familiarize you with the concept of beach surveying. The charts on the following page are diagrams of dunes. In the field, you will use two rods and the horizon to measure the elevation of the beach at locations spaced apart at a measured distance.

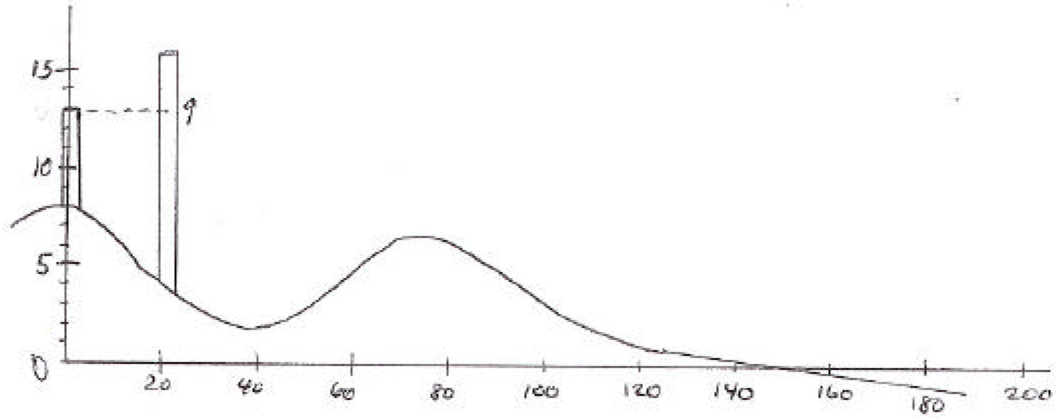
1. Start with Figure A. The short rod is drawn at the starting point, at the benchmark, where the elevation is a known, 8 feet. The short rod is 5 feet long.
2. The long rod is positioned 20 feet on the ocean side of the starting point.
3. When looking across the top of the short rod toward the long rod, the horizon in the distance crosses the long rod at 9 feet. See diagram.
4. Looking at Figure A, is the new *elevation* greater than or less than that of the starting point? **less than**
5. Now subtract the reading on the long rod (9 ft) from the height of the short rod (5 ft). It is perfectly fine to get negative numbers because we are looking for *change* in elevation.
6. The answer (-4 ft) is the amount of elevation *change*. The negative number indicates the change is in a downward direction. Place this number in the appropriate box on the chart.
7. To find the actual elevation, add the amount of elevation change (either positive or negative) to the previous actual elevation (8 ft). The true elevation at the second point is _**4 ft**__. Does this make sense conceptually? Compare your result to your answer to question 4. **[This new point is clearly lower than the starting point. The elevation change of –4 means the second point is 4 feet lower, 8-4=4.]**
8. Record the horizontal distance (20 ft) and cumulative distance (20 ft).
9. Go on to Figure B. The short rod is moved to the place where the long rod was in #7. The long rod is shown at the next place of significant elevation change, 18 ft towards the ocean.
10. When sighting across the top of the short rod, you read an elevation of 7 feet (where the horizon crosses the long rod).
11. Is the new elevation greater than or less than the previous elevation? **less than**
12. Again, subtract to find the amount of elevation change and put it in the correct box on the chart.
13. Find the actual elevation (as in #7, above), and record the horizontal distance (18 ft) and the cumulative distance (20 + 18 ft).
14. Go on to Figure C. The short rod is 38 ft from the starting point. Draw the long rod at the next point of elevation change, 35 ft towards the ocean.
15. This time the long rod reading is 0.5 feet. Did we go uphill or downhill from the last point? **uphill**
16. Calculate the elevation change and actual elevation, as well as the horizontal distance between rods and the cumulative distance from starting point.
17. Go to Figure D. Now the short rod is moved to the place that the long rod was in #16, and the long rod is moved 50 ft. The reading on the long rod is 10.5 ft. Calculate the actual elevation, the horizontal and cumulative distances.
18. Go to Figure E. The short rod is moved up to meet the long rod. Draw the long rod 65 ft towards the ocean. The reading on the long rod is 7 ft. Calculate the actual elevation, the horizontal and cumulative distances.
19. Plot your data on the graph paper provided.

Good job! Let's practice this on the beach!

Activity #1 Worksheet 1

Part I – In the Classroom (teacher's key)

A



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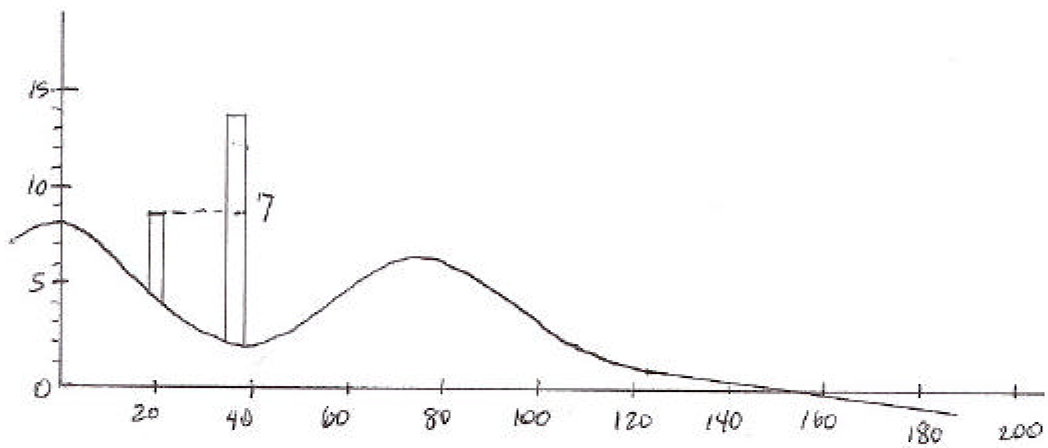

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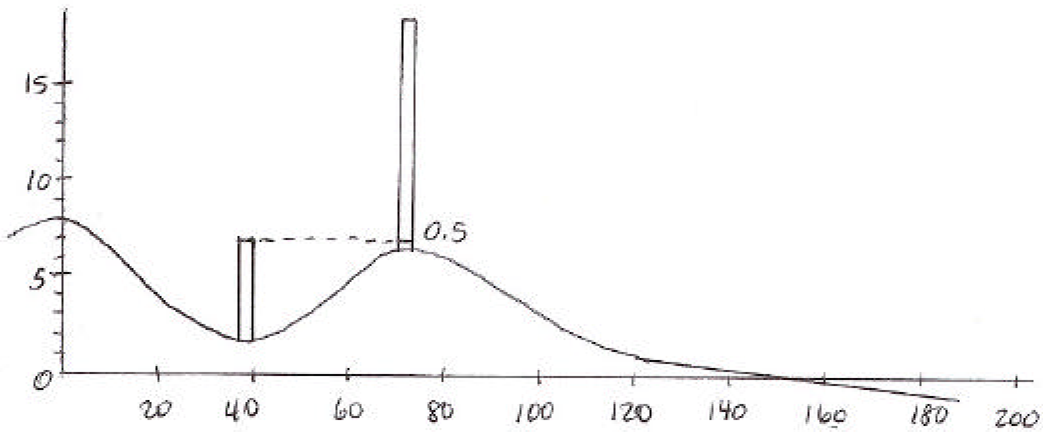
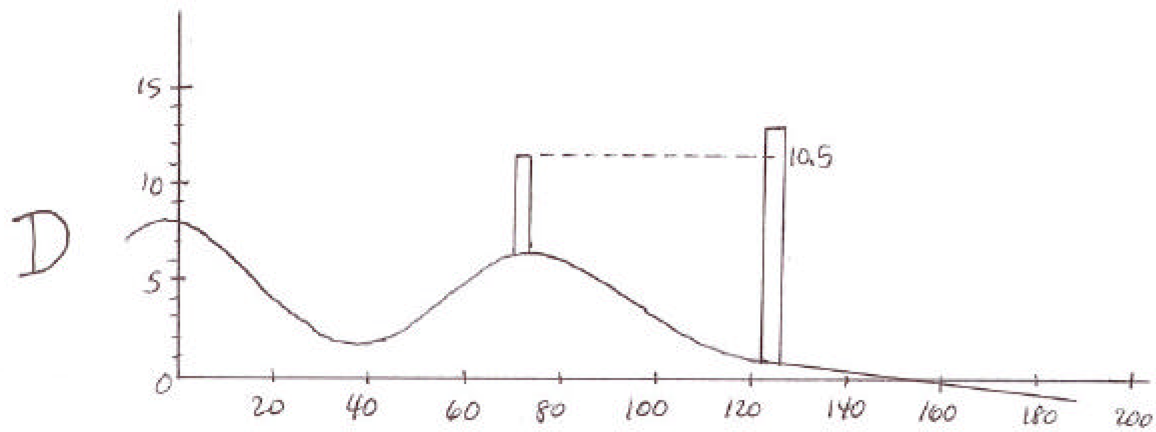
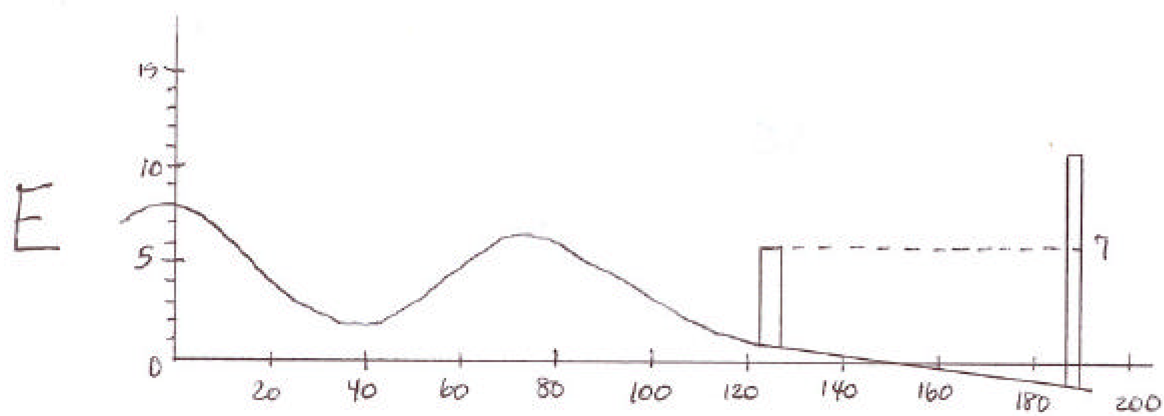


Activity #1 Worksheet 1 (cont'd)

Part I – In the Classroom (teacher's key)





data points	height of short rod (ft)	-	reading on long rod (ft)	=	elevation change (ft)	actual elevation (ft) *	horizontal distance (ft)	cumulative distance (ft) †
1	5	-		=		8 (at benchmark)	0	0
2	5	-	**9**	=	**-4**	**4**	20	**20**
3	5	-	**7**	=	**-2**	**2**	**18**	**38**
4	5	-	**0.5**	=	**4.5**	**6.5**	**35**	**73**
5	5	-	**10.5**	=	**-5.5**	**1**	**50**	**123**
6	5	-	**7**	=	**-2**	**-1**	**65**	188

* Actual elevation is calculated by adding the elevation change (either positive or negative) to the *previous* actual elevation.
† Cumulative distance is calculated by adding the horizontal distance to the *previous* cumulative distance.

Activity #1 Data Sheet 1
Beach Profiling

Location:______________________ Date:______________ Time:_______________
Low tide:______________________ Benchmark elevation:_____________________ Page ___ of ___
Weather conditions:____

data point	height of short rod (ft)	-	reading on long rod (ft)	=	elevation change (ft)	actual elevation (ft) *	horizontal distance between rods (ft)	cumulative distance (ft) †	comments
		-		=		write BM elevation here:	0	0	beginning of transect, at benchmark
		-		=					
		-		=					
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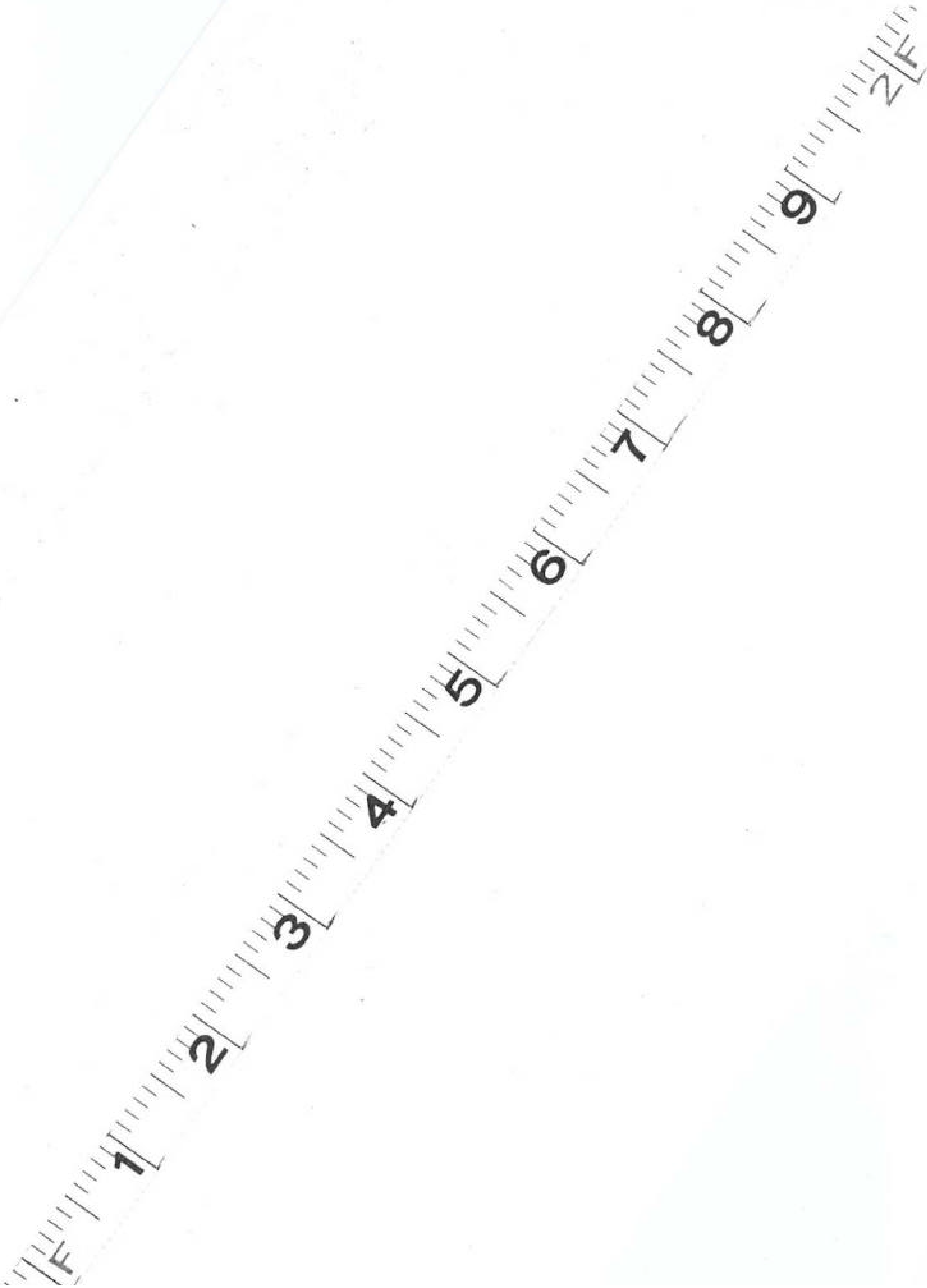
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