CONTENT AND ACTIVITY OVERVIEW

LEVEL I: Understanding Water Quality
Classroom Activities

ACTIVITY 1:
HELLO

Part A: Communication Water Carriers page 4
Summary: Students participate in a game which teaches cooperation and the importance of communication.

Part B: "Hello" Datasets page 6
Summary: Students learn to telecommunicate by submitting and retrieving demographic data. The data is then analyzed and a draft summary created to be sent to the network.

ACTIVITY 2:
ESTUARINE ECOLOGY

Part A: Tide of the Heron page 8
Summary: Students become familiar with estuarine ecology by viewing a video and exploring the connections between known concepts and the estuarine environment.

Part B: Local Communications page 9
Summary: Students discover how abiotic factors influence biotic organisms in the estuary nearest them. Reports are completed on how an abiotic factor effects a selected fish species. Reports are shared with the network.

ACTIVITY 3
CHEMISTRY
WHAT'S IN THE WATER?

Part A: Solubility page 13
Summary: Students observe the variation in solubility of oxygen in water of differing temperature and salinity. They investigate how oxygen is supplied to estuarine waters through abiotic and biotic methods.

**Part B: Relationships**  
Summary: Students predict the relationship of dissolved oxygen (DO), salinity, temperature, and tides (depth). They analyze existing data and compare their results to their predictions.

**ACTIVITY 4  
PHYSICS  
HOW DOES IT FLOW?**

**Part A: Stream Flow Rate and Turbidity**  
Summary: Students determine the relationship between stream flow and turbidity. They discover that stream flow is necessary to transport different substrates; and the interactions between stream flow and varying estuarine conditions.

**Part B: Relationships**  
Summary: Students predict the relationship between air temperature, water temperature, and tide; then analyze a dataset and justify the results.

**ACTIVITY 5  
BIOLOGY  
WHO CAN GROW?**

**Part A: Abiotic factors**  
Summary: Students determine how abiotic variables affect estuarine organisms. They discover the optimum conditions for estuarine primary production, what nutrients limit growth, and the effects of salinity on fish.

**Part B: Relationships**  
Summary: Students predict the relationship between pH and tide over the period of a month and chlorophyll a, water temperature, pH, and salinity over the period of a year. They then analyze a dataset, and compare their findings.
ACTIVITY 6
EARTH SCIENCE
HALF SOIL WILL TRAVEL

Part A: Erosion  page 35
Summary: Students determine the causes and effects of erosion on the estuary. They discover the effect of paving and building on storm water erosion and water quality; the major causes of sediment erosion along a stream bank; and the impact of sediment erosion and transport on aquatic life.

Part B: Relationships  page 38
Summary: Students predict the relationship between storm events and chlorophyll a, analyze a dataset, and compare data summaries to test the validity of their predictions, and revise their predictions.

ACTIVITY 7
SHARE THE DATA

Part A: Local Issues  page 41
Summary: Students create a report that analyzes the process used and the data gathered. They will relate that data to problems that exist in their local watershed. The report will be submitted to the network and their NERRs manager for review.

Part B: Conclusions and Questions  page 42
Summary: Students share what they have learned with their community by creating a presentation for a selected audience.
Level One
ACTIVITY 1

PART A: COMMUNICATION WATER CARRIERS

Activity Objective: Students will learn that a task is easier to accomplish if they work as a team and can communicate effectively.

Estuary-Net Outcome Connection: Students will learn how to play a meaningful role in solving local water quality problems.

Assessment: Have students answer the following types of questions and thought completions in a reflective journal:
- Was the task difficult? Why?
- What kinds of command would have made the task easier?
- I wish we...
- I learned that...

Use the reflective journal to encourage students to think about the task and how well they did it. Have a class discussion around the above questions. Develop a list of indicators of clear, effective communication and good team work. The students should understand that their work, written and oral, will be judged by the standards they set. They should also understand that as they become better at achieving the standard, the standard is raised a little higher. Finally, tie the results of the task into the bigger picture of water quality and communication: How does the game relate to sharing data? How can we increase the quality of communication on our project?

Time Needed: 1 class period (40-50 minutes).

Materials: Paper cups, water, rubber bands (just large enough to fit snugly around the cups), string, strips of cloth for blindfolds.

TEACHER’S NOTE: You need to prepare carriers in advance, one for each 8-10 people. Tie three-foot lengths of string to a rubber band (four for eight people, five for ten). Do not put around cup in advance.
Procedure:

1. Form groups of 8 or 10 students.
2. Each group forms a circle.
3. Everyone picks a partner. Blindfold one partner from each pair.
4. Tell a story about a team of scientists who must carry a valuable water sample back to the lab for analysis. One partner in each pair can not see, and the pairs must be quiet and may only say "yes" or "no". They may not speak to other pairs.
5. Set a paper or styrofoam cup of water on the floor in the center of each group.
6. Hand each blindfolded member the loose end of string tied to a rubber band. Tell groups they must use the carrier to pick up the cup. No touching the cup or rubber bands! Lift the cup off the ground without spilling and move it 20 feet to a second designated spot. When the 4-5 blindfolded partners pull on all strings equally, they can stretch the rubber band large enough to fit over the cup. When they slowly release the strings, the rubber band fits snugly around the cup so it can be lifted. Remind them that only the blindfolded partner may touch the string and that partners may only say "yes" or "no" to their own partner. They have five minutes. Do not tell them how to do the task. If they spill a little, say “Oops! Careful!” but keep going. If the cup falls over, make them start over; or stop and talk, depending on time and frustration levels. When one group succeeds or time runs out, take off the blindfolds and discuss. If time allows, try again, letting pairs freely talk to each other. Another option would be to have all members of the circle able to freely communicate.

Questions:

Was the task difficult? Why?
Which was the clearest way to communicate? Why?
What commands would have made it easier?
How does the game relate to the sharing of data?
How can we increase communication on our project?
How can we work better as a team?

Adapted from Give Water A Hand, National 4-H Council, University of Wisconsin-Extension, Cooperative Extension, Environmental Resources Center, College of Agriculture & Life Science, Madison, WI.
PART B: "HELLO" DATASETS

Activity Objective: Students will become familiar with telecommunication tools and the process of analyzing and summarizing data. Students will learn about others participating in Estuary-Net.

Estuary-Net Outcome Connection: High schools will form a partnership with their local officials, state Coastal Zone Management programs, and National Estuarine Research Reserves to work collaboratively in solving non-point source pollution problems in estuaries and watersheds.

Students will understand the importance of gathering long-term accurate data; will learn how to display the data; and will learn methods of analyzing the data to determine relationships.

Students will understand how to use telecommunications and the benefit of telecommunications networking for collaborative problem-solving.

Assessment: You must be familiar with your spreadsheet software so that you can use it correctly. Students must create a report, save it, send it to the watershed coordinator, and then create their own record in the "Hello" database. Since this is possibly the students first encounter with the software, this should be viewed as a "getting to know you" session. Students may want to take notes about the process. Familiarity and ease of use should come with more practice throughout the project. Discuss the telecommunications process (Was it easy or difficult to use? How will it aid us in our project? What are the different ways we can use the software? etc.) or have students write in a reflective journal about the process.

Analyzing data is also a type of practice session. Using data they are relatively familiar with, students are asked to summarize all the records into one record that represents the class. This should lead to a discussion about what happens to the descriptive value of the data when many records are condensed into one or a few. How does this relate to the water quality project?

Time Needed: 2 class periods (1 computer lab period).

Materials: Computer, telecommunications and spreadsheet software.
Level One

Procedure:
1. Since you will be connecting to the internet weekly, choose a different pair of students each week to submit data or reports.
2. Ask students to subscribe to the listserve (see Telecommunications instructions).
3. Request a list of subscribers. (see Telecommunications instructions).
4. Post a hello message on the listserve. Review subscribers to identify potential collaborators. Send them an e-mail message.
5. Students should then create a spreadsheet with pertinent column headings such as School, address, name, topography favorite natural area near you, community environmental issues, importance of the issue, who is addressing the issue, telecommunications interest, how will the project impact you, latitude, and longitude. Consult your watershed coordinator and review other “Hello’s on the Internet <inlet.geol.sc.edu/estsites.html> for more ideas.
6. After all the students in the class or group have completed their entries on the data table, each student should obtain copies of all entries from students involved in the project.
7. After assessing the compiled data, create a summary about your school. Send the summary and data to your Reserve. Send a message to the listserve identifying your school and announcing your data has been submitted.
8. Discuss what happens to the descriptive value of the data when many records are condensed into one summary report.
9. Download reports from collaborating sites. Review these reports. Compare demographic similarities.
10. Suggest that students identify collaborating sites on the map.
11. Discuss the telecommunications process.
ACTIVITY 2

Estuarine Ecology

PART A: TIDE OF THE HERON

Activity Objective: Students will understand how physical, chemical, and biological variables affect the estuary.

Estuary-Net Outcome Connection: Students will understand water quality and the variables that contribute to water quality.

Students will understand their connection to and the importance of estuaries, and the impact upland activities have on these systems.

Assessment: Teamwork and collaborative understanding can be assessed when students create a report from the information presented in the video about the influences of abiotic and biotic factors on estuarine organisms. After viewing the video, teams work on their presentation, keeping in mind the indicators for good communication that the class developed in Activity 1A. Following the presentations, there is a class discussion about the reports and any information that was missed or incorrect. Individuals can then be assessed as each student is asked to pick one of the two factors about which their team reported and write a brief paper (1-2 pages) for homework, expanding on their team's presentation. They should again keep in mind the indicators of good communication while writing their paper.

Time Needed: 1 class period, plus homework.

Materials: Video, Tide of the Heron, Estuarine Ecology Background, Estuarine Ecology Reference - Abiotic Factors, Biotic Factors (have these sections copied for students).

Procedure:

1. With the students, brainstorm science concepts they have already studied that might apply to an estuarine environment.
Level One

For example:
Chemistry - pH, dissolved oxygen, salinity, nutrients.
Physics - flow, current, circulation, waves, temperature.
Biology - population, food webs, competition, communities,
Earth Science - erosion, sediment source and transport.

2. Divide the class into teams of three students. Ask each team to choose one biotic and one abiotic factor that influence plant and animal organisms in an estuary.
3. Ask each team to keep in mind the chosen biotic and abiotic factor while watching the video.
4. Students will view the video, Tide of the Heron.
5. Each group will create a summary of their findings on chart paper and report orally to the class explaining how their chosen concepts influence plant and animal organisms in an estuary.
6. The teacher will then guide a class discussion to add information about each concept and its influence in an estuary.
7. Ask students to further investigate their selected concept by reading the Estuarine Ecology Background and Estuarine Ecology Reference - Abiotic Factors, Biotic Factors. Have students add any new findings to their chart.

PART B:
LOCAL CONNECTIONS

Activity Objective: Students will learn how an abiotic factor can influence a species of fish that lives in the estuary nearest them.

Estuary-Net Outcome Connection: High schools will form a partnership with their local officials, state Coastal Zone Management programs, and National Estuarine Research Reserves to work collaboratively in solving non-point source pollution problems in estuaries and watersheds. Students will learn how to participate in solving local water quality problems.

Students will understand water quality and the variables that contribute to water quality.
Students will understand their connection to and the importance of estuaries, and the impact upland activities have on these systems.

Students will understand how to use telecommunications and the benefit of telecommunications networking for collaborative problem-solving.

**Assessment:** After Activity 2A, students should have an idea about the influence of abiotic and biotic factors in an estuary. Now the question is "How do abiotic factors influence biotic organisms in the estuary?" A class discussion beginning with prior information can give the teacher insight about how well students understand the factors they have studied so far.

After the class chooses a fish, teams of three select different abiotic factors. They research and write a report about the influence of their abiotic variable on the fish. In addition to being a well written report, their research should also include answers to the following questions:

- What are the benefits of monitoring their abiotic variable when solving pollution problems?
- What state agencies monitor their variable?
- How is their variable monitored?
- What are the values of estuaries for fisheries?

After the reports have been reviewed by the teacher, one team can consolidate them into one report to send to the listserve (this task should be rotated among the teams so that all have practice using the telecommunications software). As reports are posted on the listserve, students analyze the information from other regions, first in teams then as a class, discussing the similarities and differences of the abiotic variables and their effect on plant and animal life in other regions. Each student then writes an analysis (a summary) based on the discussions in class.

**Time Needed:** 2 class periods, plus homework.

**Materials:** Computer, species profiles, NERRS site home pages, Telecommunications Manual

**Procedure:**

1. As homework, ask students to investigate the information about the National Estuarine Research Reserve (NERR) nearest to them (NERR Site Descriptions). Students can also review site home
pages of NERRs in other regions. You or a student may download this information from the web sites or use the hard copy provided by your Reserve. Students should review Estuarine Ecology, and Estuarine Ecology Reference - Abiotic Factors and Biotic Factors sections. Have each student create a venn diagram comparing the estuary depicted in the video, Tide of the Heron, to their regional NERR.

2. Discuss their findings. Create a summary venn diagram to illustrate the class conclusions.

3. Drawing from the conclusions, lead a discussion to summarize what the students have found about how abiotic factors influence organisms in the estuary.

4. The class will choose a fish that is important to the NERR estuary nearest to them. Profiles of the following species can be found in the Species Profiles section: winter flounder, striped bass, alewife, California halibut, Chinook salmon, Atlantic menhaden, Atlantic croaker, mummichog, spotted sea trout, steelhead trout, and brown trout.

5. Divide the class into teams of three students. Ask each team to select a different abiotic variable (ex. temperature, salinity, oxygen) and complete a written report on how that abiotic variable affects the chosen fish species. Abiotic factors affect each other therefore it would beneficial to reference graphing multiple parameters on the website.

6. Students research should also include answers to the following questions:
   - What are the benefits of monitoring the chosen abiotic variable when solving pollution problems?
   - What state agencies monitor the chosen variable?
   - How is it monitored?

7. Reports from each team will be consolidated into one class report. Have students decide an appropriate format for this summary report and volunteer to complete a section of this report. E-mail report to the listserve for review. Requests can also be made on the listserve to other regions for their reports.

8. When reports from collaborating are available, lead a discussion concerning the similarities and differences of the discussed abiotic variables and their effect on plant and animal life at other sites.
ACTIVITY 3
CHEMISTRY

What’s in the Water?

PART A:
SOLUBILITY

Activity Objective: Students will determine the effect of temperature and salinity on dissolved oxygen and on sources of oxygen in the water.

Estuary-Net Outcome Connections: Students will understand water quality and the variables that contribute to water quality.

Students will be able to use the scientific process to test a hypothesis and will understand how science and the process of science contributes to decision-making.

Students will understand how to use telecommunications and the benefit of telecommunications networking for collaborative problem-solving.

Assessment: These outcomes can be assessed through observations during the inquiries and closing discussions. Each inquiry is designed to test a hypothesis about the variable being studied. When students have completed their inquiries, teams of students prepare a presentation about their inquiry. The presentation includes a statement of their hypothesis, a demonstration of the experiment (when possible), the results of their experiment, a conclusion (do the results support the hypothesis?), and implications that the results have on estuarine life.

Students should complete a self-assessment at the conclusion of each inquiry. This assessment can be about how the team interacted, what the students learned about working with others, what the students learned about water quality or estuarine life, or if the students are achieving the objectives. See below for possible forms. Questions at the end of the assessment should change to be consistent with the objective being studied.

Time Needed: 2-3 class periods.

Procedure:

1. Discuss concept of diffusion.
2. Divide students into investigative teams of at least 3 individuals.
3. Assign, or have students select one of the following questions to investigate (all students can work on one question or students can be grouped to answer all questions):
   A. How is oxygen supplied to estuarine waters through abiotic processes?
   B. What are the biotic sources of oxygen to the estuary?
   C. What is the influence of temperature and salinity on dissolved oxygen?
      Identify whether there is a maximum or saturation level for dissolved oxygen.
4. Ask the teams of students to form a hypothesis and test it using the materials provided.
5. Ask the students to demonstrate the experiment they used to test their hypothesis, and present their findings.
6. Identify implications that these findings have on estuarine life.

The following are possible hypotheses and experiments.

POSSIBLE INQUIRY A: How is oxygen supplied to estuarine waters through abiotic processes?

Time needed: 1 class period

Materials: Three 10 gallon aquariums, thermometer, fan, hand mixers

Hypothesis: Dissolved oxygen in water can increase when water mixes with the atmosphere.

Procedure:

1. Fill all aquariums with waters of the same temperature.
2. Take a sample from each and titrate it for dissolved oxygen
   Aquarium #1 sample – leave alone.
   Aquarium #2 sample – blow a fan at high speed at the surface.
   Aquarium #3 sample – use hand mixer to stir.
3. Do each activity for 5 minutes.
4. Retest each for dissolved oxygen.

**POSSIBLE INQUIRY B:** What are the biotic sources of oxygen to the estuary?

**Time Needed:** 2 class periods over a 4-day period.

**Materials:** Diatoms, sun tea jars, thermometer, DO titration kit.

**Hypothesis:** Aquatic plants release oxygen through photosynthesis and increase the level of dissolved oxygen in the water.

**Procedure:**

1. Fill two jars with temperate water - about 21°C.
2. Take a sample from each and titrate for DO. Record.
3. Add diatoms to one jar. Cover both jars. Leave both jars covered in the sun for 48 hours.
4. Take samples from the tops and bottoms of each jar. Be careful not to introduce oxygen by mixing while taking samples.
5. Titrate samples for DO. Record and compare.

**POSSIBLE INQUIRY C:** What is the influence of temperature and salinity on dissolved oxygen? Identify whether there is a maximum or saturation level of dissolved oxygen.

**Time Needed:** 2 class periods.

**Materials:** Six jars with lids, two 1-gallon jugs, plate warmer (not a hot plate), salt, DO titration kit, ice, stirrers, thermometers.

**Hypothesis:** Water of different temperatures and salinities absorb oxygen at different rates and contain different amounts of oxygen when 100% saturated.
Level One

Procedure:

1. Fill two, 1-gallon jugs with 21°C water.
2. Place enough salt in one to make a 35 ppt solution (add 33 grams of salt to a one liter container, then add water to make one liter).
3. Place covers on both jugs and shake jugs until the salt solution is mixed. Be sure both are shaken equally hard and long.
4. Fill one jar with salt water and the other with fresh water. Mark them "cold salt" and "cold fresh". Let them sit ten minutes while you fix the other jars.
5. Fill two more jars with 21°C water, one with fresh and one with salt water. Mark them "warm salt", and "warm fresh" let them sit.
6. Fill the last two jars with 21°C water. Mark them "room fresh" and "room salt".
7. After ten minutes, take a sample of the "cold" jars (the first two) and titrate for dissolved oxygen. Mark the reading on the jar. Place them in the refrigerator.
8. Repeat the procedure with the "warm" jars. Mark them and place them on a plate warmer.
9. Repeat with the "room" jars, leave them out, but not in the sun.
10. Remove cover on all jars overnight. Repeat the titrations during the next class period or class the next day.
11. Shake each jar for five minutes, re-sample shake again, re-sample, keep shaking until the readings remain the same over three samplings. Be sure to uncap and recap jars between each shaking. Note the varying readings for different temperatures and salinities.

PART B:
RELATIONSHIPS

Activity Objective: Students will learn to analyze a dataset to determine the relationship of DO, salinity, temperature, and depth over time and space. They will learn to apply their understanding of this relationship to an estuary, and determine impacts these variables have on organisms there.
Level One

**Estuary-Net Outcome Connection:** Students will understand the importance of gathering long-term accurate data; will learn how to display the data; and will learn methods of analyzing the data to determine relationships.

Students will be able to use the scientific process to test a hypothesis, and will understand how science and the process of science contributes to decision-making.

Students will understand their connection to and the importance of estuaries, and the impact upland activities have on these systems.

Students will understand how to use telecommunications and the benefit of telecommunications networking for collaborative problem solving.

**Assessment:** Assessment can include the students' reports that they send to the listserv. Their ability to submit and analyze data to justify their hypotheses about relationships between water quality variables should demonstrate their further understanding of estuarine ecosystems. Reports sent to the network should used as an additional assessment of student understanding of Activities A. Analysis of reports received from other sites can be in written form or as a class activity. An emphasis is placed on making connections and comparisons with other schools.

At this time, students are refining their use of the data analysis software. Use a self-assessment to determine how well students are achieving this.

**Time Needed:** 2 class periods (1 computer lab).

**Materials:** Computer, spreadsheet software or spreadsheets and graph paper, copy of procedure, datasets.

**Procedure:** (See directions for accessing the NERR System-wide Monitoring Data in Telecommunications Instructions).

1. In small teams, draft a prediction of the relationship between DO, temperature, salinity, and tide (depth).
2. Using the System-wide Monitoring data table of your choice, found at the web site, download the dataset into your data analysis software program <http://inlet.geol.sc.edu/estsites.html>. Graph the
relationship by month, week or day.
   A. DO & temp. & salinity.
   B. Depth & temp. & salinity.
   C. Depth & DO.
3. In small groups discuss the relationship of tides, salinity, depth and
   temperature. Summarize the relationship in a hypothesis.
4. Using another System-wide Monitoring dataset from the same
   location, but at a different time, graph the same relationships as in
   #2.
5. Compare the results. Is the relationship supported by your
   hypothesis? If not refine the results and suggest a rationale for the
   differences.
6. Open another System-wide Monitoring dataset from the same time
   but at a different spot.
7. Graph same relationship as in #3 & #6.
8. Compare results and explain rationale for differences.
9. Compare results with remainder of class. Come to consensus with
   the class on the reasons for these differences.
10. Submit your ideas to the listserve. You may also correspond by e-
    mail to collaborating sites to share your findings.
11. Discuss the implications of your findings on estuarine organisms.
Student Self-Assessment For Level One Activity 3A
What's In The Water

Directions: Place an “X” on the line to represent yourself or your group.

How well my team worked

<table>
<thead>
<tr>
<th>Not well</th>
<th>Very well</th>
</tr>
</thead>
<tbody>
<tr>
<td>(We did not get anything done; we fought about how to do the experiment.)</td>
<td>(We worked quickly and without any problems; we got all the information we needed.)</td>
</tr>
</tbody>
</table>

How well I worked as a team member

<table>
<thead>
<tr>
<th>Not well</th>
<th>Very well</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I was distracted; I did not contribute much; I wandered around the room disturbing other teams.)</td>
<td>(I helped my team throughout the entire experiment, taking various roles when necessary.)</td>
</tr>
</tbody>
</table>

How well I am achieving the objectives

<table>
<thead>
<tr>
<th>Not well</th>
<th>Very well</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I don't understand what the experiment has to do with the objective; I do not understand why we're studying water quality and estuaries.)</td>
<td>(I understand the connections between the experiments and the objectives; I understand why we are studying water quality and estuaries.)</td>
</tr>
</tbody>
</table>

Discuss the effects of salinity and temperature on dissolved oxygen.

Discuss sources of oxygen in the water and how these sources are affected by temperature and salinity.

Discuss the implications these findings have on life in the estuary.
Level One
ACTIVITY 4
Physics

How Does It Flow?

PART A:
STREAM FLOW
AND TURBIDITY

Activity Objective: Students will determine the relationship between stream flow rate and sediment transport.

Estuary-Net Outcome Connection: See Activity 3A.

Assessment: See Activity 3A.

Time Needed: 2-3 class periods.


Procedure:

1. Divide the students into investigative teams of four. Assign or have the students choose one of the following questions: (All students may work on one question or students can be grouped to answer all questions.)
   A. What is the relationship between stream current and a river's capacity to transport various sediment?
   B. What affects the circulation patterns in an estuary during high tide and low tide?
   C. How do varying streamflows into an estuary affect the abiotic conditions?
2. Have the teams of students form a hypothesis and test it using the materials provided.
3. Have teams present their experiment and findings.
4. Discuss the implications these findings have on the health of an estuary. What upstream influences could cause harm to the estuary?
The following are possible hypotheses and experiments.

POSSIBLE INQUIRY A: What is the relationship between stream current and a river's capacity to transport various sediments?

Time Needed: Preparation - 20 minutes, activity - 1 class period.

Materials: Transport model, sand, topsoil, stopwatch, measuring cup, water, scale.

Question A: What is the relationship between stream current and a river’s capacity to transport various sediments?

Hypothesis: The steeper the slope of a water course the faster the current, which increases its ability to carry more, heavier sediment.

Procedure:

1. Divide class into small teams.
2. Provide each team with samples of sand and topsoil.
3. As a class, measure out equal portions of each sediment type. The portions should be fairly small (about 200ml). Weigh the portion.
4. During the experiment, the pipe is raised by moving the dowel to increase the slope and speed of the water.
5. To conduct the experiment, a sample of sediment is placed on the bottom gutter and the top pipe is placed at its lowest level (pipe will almost be horizontal).
6. With the valve closed, fill the liter bottle and reattach the bottle to the pipe. Establish the flow rate of the water when discharged down two different grades of slope. Begin with the pipe at its steepest setting. Turn the valve one and a half turns. Begin timing when the water first flows off the gutter. Stop when it has all flowed off the gutter. This should be recorded as liters/sec. Repeat this process for the lowest grade of slope.
7. Discuss how slope influences current.
8. Reset the pipe to its steepest slope. Place measured amount of sediment on the gutter. Time how long it takes to completely wash
the sediment off the gutter. Repeat with the lowest gradient. Repeat with another sediment type.

9. What influence does slope have on sediment transport?
10. Discuss the implication for a watershed.

POSSIBLE INQUIRY B: What affects the circulation patterns in an estuary during high tide and low tide?

Time Needed: 1-2 class periods.

Materials: Liter bottles, 2 corks, red and blue food coloring, streamflow table.

Hypotheses: Using a streamflow table test the following hypotheses:

1. When a stream widens, the water velocity slows.
2. The water velocity along the stream bank is slower than in the center of the stream.
3. When a stream encounters a rising tide, water velocity is reduced.
4. When two currents of the same density converge, their circulation is diverted laterally.
5. When a stream velocity decreases its ability to transport, sediment decreases and sediment is deposited.

Procedure:

1. Using the streamflow table make a straight channel that widens abruptly about half-way down the table. Pour water down the table at a steady rate. If it is difficult to note any change, try floating a cork in the flowing water. Repeat several times.
2. Record your observations. Repeat the experiment keeping the channel straight but widening it at various points of the stream. Can you make any conclusions based on your observations?
3. Construct a wide, straight channel in the streamflow table. Pour water down the table at a steady rate. Release two corks simultaneously, one at the edge of the channel and one in the middle.
4. Record your observations. Repeat the experiment several times, trying both channel edges. Can you draw any conclusions about the effect of shoreline on stream flow?

5. Construct a straight, fairly narrow channel down the table. Pour red colored water down the stream table at an even rate. From the bottom of the stream table have another student pour blue colored water more slowly into the stream to simulate an in-coming tide.

6. Record your observations. Repeat the experiment several times. Try varying the rate at which the downstream water is poured into the table.

7. Repeat the above dual colored experiment, but this time widen the channel to note what happens to each current as they converge.

8. Based on your results, identify circumstances that slow a stream’s velocity. For each of these instances, use a mixture of suspended sand and water to see the effect of slowing currents on sediment transport.

9. Describe why it would be important to know this information when studying an estuary or identifying a pollution problem.

**POSSIBLE INQUIRY C:** How do various characteristics of a stream interact when they encounter estuarine waters?

**Time Needed:** 1-2 class periods.

**Materials:** Beakers, aquarium, salt, hot plate, food coloring, soils, stirrers, ice, thermometers, stopwatch.

**Hypothesis:** Freshwater will float on top of sea water of the same temperature.

**Procedure:**

1. Fill aquarium with warm seawater, 21°C (add 33 grams of salt to a one liter container, then add water to make one liter).

2. Fill two beakers with 21°C freshwater to simulate spring streamflow. Color the water to make interaction easier to observe.
3. Predict what will happen when the water in the beaker is poured into the aquarium. The freshwater must be placed gently on the salt-water, and not allowed to drop from any height.

4. Practice pouring at a constant rate which can be determined by timing water movement as it flows down an angled board or pipe of determined length. Once a steady rate is achieved, pour the colored water into the aquarium.

5. Note your observations.

6. Add sediment to the second beaker. Stir until it is all suspended. Pour at the same rate. Note your observations.

7. Change the variable of the water - make it warmer, cooler etc. Predict, observe, and explain.

8. Explain why it is important to know this. Discuss what influences upstream would change the variable (i.e. discuss what conditions in the watershed might change the water temperature in the stream).

PART B: RELATIONSHIPS

Activity Objective: Students will learn how to analyze a dataset to look for relationships between air temperature, water temperature, and depth over a tidal cycle. Students will learn to apply their understanding of this relationship to an estuary, and determine the impact these variables have on organisms that live there.

Estuary-Net Outcome Connection: See Activity 3B.

Assessment: See Activity 3B.

Time Needed: 1-2 class periods (1 computer lab).

Materials: Computer, spreadsheet software, copies of procedure, System-wide Monitoring datasets.

Procedure: (See directions for downloading System-wide Monitoring data in Telecommunications Instructions).
Level One

1. Predict what you think the relationship is between air temperature, water temperature and water depth over a tidal cycle.
2. Download a System-wide Monitoring dataset of your choice from the web site.
3. Graph water temperature and depth. Describe the relationship.
4. Graph salinity on each graph. Describe the relationship.
5. Explain why you think the relationship occurs this way during this time of year.
6. Repeat process with another dataset.
7. Compare results and explain possible reasons for differences.
8. Compare results and explain possible reasons for difference.
   Summarize and e-mail a report to watershed coordinator and collaborating schools.
9. When reports are received from collaborating schools, compare the results.
10. Pose questions and comments by e-mail or on listserve if they arise.
Student Self-Assessment for Level One Activity 4A
How Does it Flow?

**Directions:** Place an “X” on the line to represent yourself or your group.

**How well my team worked**

<table>
<thead>
<tr>
<th>Not well</th>
<th>Very well</th>
</tr>
</thead>
<tbody>
<tr>
<td>(We didn't get anything done; we fought about how to do the experiment.)</td>
<td>(We worked quickly and without any problems; we got all the information we needed.)</td>
</tr>
</tbody>
</table>

**How well I worked as a team member**

<table>
<thead>
<tr>
<th>Not well</th>
<th>Very well</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I was distracted; I didn't contribute much; I wandered around the room disturbing other teams.)</td>
<td>(I helped my team throughout the entire experiment, taking various roles when necessary.)</td>
</tr>
</tbody>
</table>

**How well I am achieving the objectives**

<table>
<thead>
<tr>
<th>Not well</th>
<th>Very well</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I don’t understand what the experiment has to do with the objective; I don’t understand why we’re studying water quality and estuaries.)</td>
<td>(I understand the connections between the experiments and the objectives; I understand why we are studying water quality and estuaries.)</td>
</tr>
</tbody>
</table>

Discuss the relationship between stream flow rate and sediment transport.

Discuss the implications of these findings on the health of the estuary.

Comment on the upstream influences that could cause harm to the estuary.
ACTIVITY 5
BIOLOGY

Who Can Grow?

PART A:
ABIOTIC FACTORS

Activity Objective: Students will understand how nutrients, sunlight and salinity might affect organisms that live in an estuary.

Estuary-Net Outcome Connection: See Activity 3A.

Assessment: See Activity 3A.

Time Needed: See inquiries.


Procedure:

1. Divide the class into investigative teams of at least 3 students.
2. Have students choose or assign one of the following questions to each group: (All students can do one question or students may be grouped to answer all questions.)
   A. What are some of the conditions required for optimum rates of primary productivity in an estuary?
   B. Lack of what nutrients can limit the growth of primary producers when other optimum conditions exist?
   C. What are the effects of salinity on freshwater fish and the effects of freshwater on marine fish?
3. Have the teams form a hypothesis and test it using the materials provided.
4. Have each team demonstrate their experiment and present their findings to the rest of the class.
5. Discuss why it is important to know this information when studying the estuary or trying to identify a pollution problem in the watershed.
6. Have the students list upstream influences that might affect some of the factors they have studied.

The following are possible hypotheses and experiments:

POSSIBLE INQUIRY A: What are some of the conditions required for optimum rates of primary productivity in an estuary?

Time Needed: Partial class period over 5 days.

Materials: 6 - 500ml beakers, water, 6 thermometers, green algae (ex. chlorella), nutrient broth, plate warmer, 6 petri dish covers.

Hypothesis: Algae will grow best when sunlight, nutrients and warm water are abundant.

Procedure:

1. Select three variables to test their influence on algal growth: nutrients, sunlight, and water temperature.
2. Set up beakers with conditions that test for only one.

   **Beaker A&B - lack of nutrients** -
   - Beaker A: sun/warm water/nutrients
   - Beaker B: sun/warm water

   **Beaker C&D - lack of sun** -
   - Beaker C: nutrients/warm water/sun
   - Beaker D: nutrients/warm water

   **Beaker E&F - warm water**-
   - Beaker E: nutrients/cooler water/sun
   - Beaker F: nutrients/warm water/sun

Be sure to keep all levels of all variables used consistent between tests (i.e. keep all cold water same temperature; equal amounts of sun; equal amounts of nutrients). Keep all warm water on plate warmers and all cooler water set in pan with cold water and ice. (Large blocks of ice can be made in loaf pans in freezer )

3. Add 5ml of nutrient broth where needed.
4. Place petri dish covers in each beaker as settling plate.
5. Add 1 package of algae.
6. Observe for 3-5 days for algal growth. Record observations.
7. What are the implications for an estuary? What might cause lack of optimum conditions for algae growth? Summarize your findings.

POSSIBLE INQUIRY B: Lack of what nutrients can limit the growth when all other optimum conditions exist?

Time Needed: 1 class period and segments of class period over 5 days, repeat if studying pH.

Material: 4 or 8 - 500ml beakers, distilled water, vinegar, thermometer, green algae (ex. chlorella), LaMotte Plant Nutrition Kit, pH paper, petri dish covers.

Hypothesis: The optimum mix will have mostly macronutrients with some micronutrients. pH will limit growth.

Procedure:

1. Identify variable to test in each beaker: nitrogen and phosphorous.
2. Fill beakers with warm water about 21°C.
3. Predict which nutrient mix is best.
4. Place the following:
   - Beaker #1 - optimum mix of nitrogen, phosphorous and potassium, as recommended in Plant Nutrition Kit manual;
   - Beaker #2 - optimum mix without nitrogen;
   - Beaker #3 - optimum mix without phosphorous;
   - Beaker #4 - optimum mix without potassium;
5. Place petri dish cover in beaker as settling plate.
6. Add 1 package of algae.
7. Observe for 3-5 days for algal growth. Record observations.
8. What are the sources of these nutrients in the estuary?
9. What would limit their accessibility?
10. If time allows, repeat experiment with water with different pH (lower pH to 5 by adding vinegar).
11. Investigate the impact of varying pH on nutrient availability. Predict the results and test the following:
LEVEL ONE

A. optimum nutrient mixture diluted in previous experiment at same pH. (distilled water).
B. optimum nutrient mixture with lower pH (pH 5 made with vinegar and distilled water).

12. What are the implications of this for the estuary? Summarize.

POSSIBLE INQUIRY C: What are the effects of salinity on freshwater fish and the effects of fresh water on marine fish?

Time Needed: 1 class period.

Materials: 8 - 500ml beakers, sea water, fresh water, dialysis tubing, red dye, diagram of fish anatomy, mylar, marking pen.

Hypothesis: The freshwater fish will bloat in salt water and the saltwater fish will dehydrate.

TEACHER'S NOTE: Fish can respond in two ways to changing ionic concentrations in the fluids around them:

1. Osmoconformers: These species such as an oyster, adjust their body fluids to match those of the surrounding liquids.
2. Osmoregulators: These species such as a marine crab maintain or regulate osmotic concentration in spite of external concentration changes.¹
3. Hypertonic: Refers to a solution that contains a higher concentration of solute particles; water moves across a semipermeable membrane into hypertonic solution.
4. Hypotonic: Refers to a solution that contains a lower concentration of solute particles; water moves across a semipermeable membrane out of a hypotonic solution.
6. mOsm: One-thousandth of a 1 molar solution, a millimolar solution.¹

"Marine representatives (vertebrates) fall into two distinct groups: those whose osmotic concentrations are the same as or slightly above sea water (hagfish, elasmobranchs, Latimeria, and crab-eating frog) and those whose osmotic concentrations are about one-third that of sea water (lamprey,
teleosts). The former group has no major problem of water balance if the inside and outside concentrations are equal there is no osmotic flow. In contrast, those that remain distinctly hyposmotic live in constant danger of losing water to the osmotically more concentrated medium. The osmotic problems and the means to solve them thus differ drastically among marine vertebrates. Freshwater vertebrates on the other hand, uniformly have concentrations of about one-quarter that of sea water; thus they are hyperosmotic to the medium."

Relative comparison of osmotic pressure units for various species:

<table>
<thead>
<tr>
<th>Species</th>
<th>Sea Water</th>
<th>Freshwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmon</td>
<td>400mOsm</td>
<td>340mOsm</td>
</tr>
<tr>
<td>Eel</td>
<td>371mOsm</td>
<td>323mOsm</td>
</tr>
<tr>
<td>Ray</td>
<td>1050mOsm</td>
<td></td>
</tr>
<tr>
<td>Hagfish</td>
<td>1152mOsm</td>
<td></td>
</tr>
<tr>
<td>Sea Water</td>
<td>1000mOsm</td>
<td></td>
</tr>
<tr>
<td>Fresh Water</td>
<td>0mOsm</td>
<td></td>
</tr>
</tbody>
</table>

For the purpose of this inquiry, it is suggested that you compare marine and freshwater teleost (bony fish).

As you can see by the chart above, fresh water teleosts (salmon) have an osmotic concentration in the blood roughly of 340 mOsm per liter, which is much higher than the surrounding fresh water. They tend to gain water by osmosis, and must lose as much of this water as possible. These fish gain water and lose salts through the gill membranes. They drink very little water, so no excess water is built up in its fluids.

2 Ibid, page 298

A marine teleost is osmotically more dilute than the sea water around it and they have somewhat higher blood concentrations than fresh water teleosts. They tend to lose water by osmosis and they must try to retain as much water as possible. Some lost water is restored by drinking large amounts of sea water. But as this water contains salt, there is a build up of
salts in the fluids. Excess salt is removed by active transport across the gills.1, 2

Teleosts have a concentration of salt in their blood always less than in the sea, in the neighborhood of 1.4 % NaCl against 3.5 %. The blood of freshwater fishes is more dilute, about 0.6 % NaCl.3


**Procedure:**

1. In a pair of beakers, create the salt concentration of the ocean (add 33 grams of salt to a one liter container, then add water to make one liter).
2. In another pair of beakers, set up a 50/50 mixture of ocean and freshwater.
3. In a third pair of beakers place fresh water.
4. Fill a seventh beaker with a solution to simulate the concentration of ions in the blood of a freshwater fish. Color the liquid red. (60ml of fresh water added to every 40ml of sea water for salmon.)
5. Fill another beaker with a solution to simulate the concentration of ions in the blood of a marine fish (see teacher's note). Color the liquid red.
6. Place a dialysis tube with the freshwater solution in one of each of the three pairs.
7. Place a dialysis tube with the marine fish solution in the other beakers. Mark the level of fluid in the beaker and in the tube.
8. Set aside for 20 minutes and then observe the changes.
9. In the meantime, using the illustration of the organs of a fish and the mylar overlay, mark those organs responsible for exchanges between the surrounding water and the fish. Identify the functions of the organs and their method of keeping osmotic pressure balanced.
PART B: RELATIONSHIPS

Activity Objective: Students will learn to analyze a dataset to look for relationships between pH, tide, chlorophyll a, water temperature, and salinity over time and space. They will learn to apply their understanding of this relationship to an estuary and determine the impact of these variables on organisms that live there.

Estuary-Net Outcome Connection: See Activity 3B.

Assessment: See Activity 3B.

Time Needed: 2 class periods (1 computer lab).

Materials: Computer spreadsheet software, copies of procedure, Wells WET datasets.

Procedure: (See directions for downloading volunteer water quality monitoring data in Telecommunications Manual.)

1. Predict the relationship between chlorophyll a and pH.
2. Download Wells WET data found at the web site, listed under volunteer monitoring data, Maine: Wells NERR.
3. Graph the relationships between pH, chlorophyll a and salinity. Repeat with a different WET dataset - different location or time. Sort data for one site over time or one time over many sites.
4. Compare with your prediction and summarize your findings.
5. Predict the relationship between chlorophyll a (as indicator of primary productivity) water temperature, pH and salinity.
6. Graph the relationship. Compare results with your prediction. Repeat with another sorting of the WET dataset.
7. Summarize your findings in a report and post to the listserve.
8. When regional reports are available, download and compare.
9. Utilize listserve to request reports from other regions, if desired.
10. Pose questions and comments on the listserve.
11. Discuss the implications of your findings on estuarine organisms.
**Student Self-Assessment for Level One Activity 5A
How Does it Flow?**

**Directions:** Place an “X” on the line to represent yourself or your group.

<table>
<thead>
<tr>
<th>How well my team worked</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Not well</td>
<td>Very well</td>
</tr>
<tr>
<td>(We didn't get anything done; we fought about how to do the experiment.)</td>
<td>(We worked quickly and without any problems; we got all the information we needed.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How well I worked as a team member</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Not well</td>
<td>Very well</td>
</tr>
<tr>
<td>(I was distracted; I didn't contribute much; I wandered around the room disturbing other teams.)</td>
<td>(I helped my team throughout the entire experiment, taking various roles when necessary.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How well I am achieving the objectives</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Not well</td>
<td>Very well</td>
</tr>
<tr>
<td>(I don't understand what the experiment has to do with the objective; I don't understand the objectives; I don’t understand why we are studying water quality and estuaries.)</td>
<td>(I understand the connections between the experiments and the objective; I understand why we are studying water quality and estuaries.)</td>
</tr>
</tbody>
</table>

Discuss the relationship between stream flow rate and sediment transport.

Discuss the implications of these findings on the health of the estuary.

Comment on the upstream influences that could cause harm to the estuary.
PART A:
EROSION

Activity Objective: Students will determine the causes and effects of erosion in the estuary.

Estuary-Net Outcome Connection: See Activity 3A.

Assessment: See Activity 3A.

Time Needed: See inquiries.


Procedure:

1. Divide students into inquiry teams of at least three persons. Have each team choose, or assign one of the following questions. (All students can do one question or group the students to complete all questions.)
   A. What is the effect of pavement and buildings on stormwater erosion and water quality?
   B. What are the major causes of sediment erosion along a stream bank, and what are some preventative measures?
   C. When does the greatest amount of erosion occur and what impact does sediment erosion and transport have on aquatic life?

2. Have the teams form a hypothesis and test it using the materials provided. Have each group demonstrate their experiment and explain their findings to illustrate their hypothesis.
The following are possible hypotheses and experiments:

**POSSIBLE INQUIRY A:** What is the effect of pavement and buildings on stormwater erosion and water quality?

**Time Needed:** 1 class period.

**Materials Needed:** Map of building site, rulers, calculators.

**Hypothesis:** Runoff volume increases with the area of impervious surface in a watershed.

**TEACHER’S NOTE:** By determining worst case storm scenarios, students can calculate the amount of drainage flowing from impermeable surfaces. They can design the most appropriate system for disposing of this runoff. They should consider its content, the topography and natural drainage pattern of the land, the proximity to a surface water body, the land cover over which it would travel, the sensitivity of the biotic communities affected in the collecting basin, and the economic reasonableness of the solution.

**Procedure:**

1. To determine runoff of a building site you will need to determine the area of all impervious surfaces - buildings, parking lots, roads. Determine size of building site to be calculated.
2. Determine area (length x width) of each impervious surface and calculate total impervious surface area.
3. Determine percentage of impermeable area (impermeable area divided by whole area).
4. Multiply whole area times rainfall to calculate cubic feet of rain on area.
5. Determine percentage of rainfall on impermeable area by multiplying impermeable % x cubic feet of rain. This is the amount of extra rainfall the permeable areas must absorb or which must be collected by designed drainage systems.
6. What are the implications to surrounding surface waters?

**POSSIBLE INQUIRY B:** What are the major causes of sediment erosion along a stream bank, and what are some preventative measures?
Level One

**Time Needed:** 1 class period.

**Materials:** Stream table, sand, stopwatch, water, calculator, gravel, pebbles.

**Hypothesis:** As stream velocity increases, larger substrate particles can be eroded.

**Procedure:**

1. Have students create a stream in their stream table; leaving the stream bottom substrate and banks as diatomaceous earth.
2. Establish discharge rates for pouring 3 liters of water. Time how long it takes to pour 3 liters of water at a slow flow rate. Convert that to cu ml/sec. Repeat using a fast pace. Convert to cu ml/sec.
3. Predict what will happen when pouring at a slow rate. Pour the 3 liters at a slow rate and record what happens.
4. Predict what will happen and pour at a fast rate. Record results.
5. Determine explanation for differences between predictions and observations.
6. Predict what will happen if stream bottom substrate is changed. Add gravel, pebbles, etc. Pour at slow and fast rates.
7. Predict what will happen if stream bank substrate is changed. Add gravel, pebbles, etc. Pour at slow and fast rates.
8. Discuss differences between predictions and observations. What effect is there on the estuary?

**POSSIBLE INQUIRY C:** When does the greatest amount of erosion occur and what impact does sediment erosion and transport have on aquatic life?

**Time Needed:** 1 computer lab.

**Materials:** Spreadsheet software, computers, brown trout report, dataset (Welflow.dat, provided with curriculum), and copies of procedure.

**Hypothesis:** Brown trout life cycle stages that are most vulnerable to sedimentation (egg, fry) coincide with periods of greatest sedimentation in the watershed.
Procedure: (See Appendix X - Telecommunications Manual.)

1. Read report on Brown Trout, found in US Fish and Wildlife Service Species Profiles Section.
2. Identify the criteria for habitat suitability for the Brown Trout and record time of year and temperature for species spawning, hatching, and fry in a data table.
3. Open data table 6A.
4. Search the table from late summer to fall to identify when spawning migration might begin, 6°C to 7°C; search fall for when spawning occurs, 7°C to 9°C; search for embryo development, 2°C to 13°C; fry emergence, 7°C to 15°C in spring.
5. Search the correlating time periods for flow rates correlate with optimum condition (30.5 cm/s to 75.9 cm/s).
6. Look at flow rates across the entire time period, late summer to early spring. Note if there are periods that exceed optimal flow rates (greater then 79.9 cm/s).
7. Look at total suspended solids (TSS) in the table for these periods.
8. Identify what you think the effect of high levels of suspended solids would be on this species life cycle.
9. What are the sources or reasons for high levels of suspended solids occurring in a river or estuary?

PART B:
RELATIONSHIPS

Activity Objective: Students will learn to analyze a dataset to look for a relationship between storm events, and turbidity. They will learn to apply their understanding of this relationship to an estuary and determine the impact these variables might have on organisms that live there.

Estuary-Net Outcome Connection: See Activity 3B.

Assessment: See Activity 3B.
Level One

**Time Needed:** 1-2 class periods (1 computer lab).

**Materials:** Computer, spreadsheet, software, dataset data table 6B, copies of procedure.

**Procedure:**

1. Predict the relationship between storm events, and turbidity.
2. Open data table 6B.
3. Graph the relationship between turbidity and rainfall.
4. Summarize your findings and submit to the listserve.
5. When collaborating reports are available compare.
6. Pose questions and comments concerning findings on the listserve.
7. Discuss the implications of your findings on organisms in the estuary.
**Student Self-Assessment for Level One Activity 6A**

**Half Soil Will Travel**

**Directions:** Place an "X" on the line to represent yourself or your group.

<table>
<thead>
<tr>
<th>How well my team worked</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Not well</td>
<td>Very well</td>
</tr>
<tr>
<td>(We did not get anything done; we</td>
<td>(We worked quickly and without</td>
</tr>
<tr>
<td>fought about how to do the experiment.)</td>
<td>any problems; we got all the</td>
</tr>
<tr>
<td></td>
<td>information we needed.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How well I worked as a team member</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Not well</td>
<td>Very well</td>
</tr>
<tr>
<td>(I was distracted; I did not contribute much; I wandered</td>
<td>(I helped my team throughout the</td>
</tr>
<tr>
<td>around the room disturbing other teams.)</td>
<td>entire experiment, taking various</td>
</tr>
<tr>
<td></td>
<td>roles when necessary.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How well I am achieving the objectives</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Not well</td>
<td>Very well</td>
</tr>
<tr>
<td>(I do not understand what the experiment has to do with the objective; I don't understand the objectives; I don’t understand why we are studying water quality and estuaries.)</td>
<td>I understand the connections between the experiments and the objective; I understand why we are studying water quality and estuaries.</td>
</tr>
</tbody>
</table>

Discuss possible sources for erosion and the effect on the estuary.

Discuss why this information is important when studying the estuary.

Discuss possible solutions to erosion problems.
ACTIVITY 7

Share The Data

PART A: LOCAL ISSUES

Activity Objective: Students will learn that the data they have gathered is limited, but may indicate potential problems. They will learn that they need assistance from the community in order to begin to address this problem.

Estuary-Net Outcome Connections: High schools will form a partnership with their local officials, state Coastal Zone Management programs, and National Estuarine Research Reserves to work collaboratively with problems in estuaries and watersheds.

Students will learn how to play a meaningful role in solving local water quality problems.

Students will be able to use the scientific process to test a hypothesis and will understand how science and the process of science contributes to decision-making.

Assessment: This entire activity is an assessment of all the information learned through the previous activities. Students are assessed in a number of ways: they brainstorm; they work collaboratively to report about an upland influence on the estuary; telecommunicate their findings; and they create a presentation of their findings for an audience of local officials and other invited guests. Judgments about the reports and presentations should be made using the criteria set at the beginning of the project and any adjustments that have been made to that criteria since that time.

Time Needed: 1-2 class periods.

Materials: Data and reports from existing activities.
Level One

Procedure:

1. Students will be divided into teams of three or four to create a report on the influences that affect the abiotic factors that in turn are influencing the fish identified in Activity 2B.
2. Ask each team to select a different abiotic factor (ex. pH, DO, salinity, turbidity, temperature, depth) on which to report.
3. Each team report should include:
   A. how the abiotic factor affects the fish;
   B. how upland influences affect the abiotic factor and in turn the fish;
   C. what further information is needed to determine what influences exist in the watershed;
   D. what potential watershed problem they would like to study;
   E. what parameters must be monitored to find a potential solution to this problem.
4. Reports from each team should be merged into one report and posted on listserve.
5. Review other reports when they become available. Discuss and compare reports.
6. Students should then come to a regional consensus on the potential watershed problem to be studied and the parameters to be monitored.
7. Not all communities or regions may have a water quality problem present. Identify reasons for monitoring the watershed anyway. Discuss who would benefit from the data collected in this effort. (Data collection contributes to understanding the ecosystem, and data collection contributes to the analysis of long term trends.)

PART B:
CONCLUSIONS AND QUESTIONS

Activity Objective: Students will learn that through a carefully thought out educational activity they can receive the community support needed to continue working on their watershed problem.

Estuary-Net Outcome Connections: High schools will form a partnership with their local officials, state Coastal Zone Management programs, and
Level One

National Estuarine Research Reserves to work collaboratively in solving non-point source pollution problems in estuaries and watersheds.

Students will understand their connection to and the importance of estuaries and the impact upland activities have on these systems.

Assessment: Students understanding of water quality variables, their impact on estuaries and the importance they place on building partnerships can be assessed by observing the presentation they create for the community.

Time Needed: 1 class period, plus homework and presentation.

Materials: All unit materials.

Procedure:

1. Students and teacher will discuss ways that they might share what they have learned with the community and/or a team teacher's classroom. Discuss which community organizations and/or individuals should be contracted.
   Suggestions:
   Display
   Presentation - poster, video or slide show
   Skit
   Song
   Report
2. Students may work in groups or as a class. More than one method of sharing information may be used.
3. Each creation should include an analysis of the data collected, procedures used, and research done. Data from the "Hello" activity may be used and any other data collected in Activity Two or Three. Include, if possible, the research reports completed and any demonstrations the students developed. There should be an emphasis on conclusions reached and questions raised.
4. If continuing on to Level II, it will be very important to form a close relationship with a community organization for support in your efforts. Discuss this with your students prior to their presentation so they can strategize a way to work with the community.