Module 16 Monitoring Beach/Estuary Surface Waters

Introduction

This session will be held at a selected beach or estuary site with local organizers and sponsors. Participants will participate in a two-hour, hands-on session that focuses on the key concepts presented the previous three days. In diverse groups of three to five individuals you will repeat self-selected aspects of the *Streamwalk* activity, share your skills, and learn new skills in this beach or estuary monitoring exercise. In this session groups are asked to use water monitoring equipment and/or testing kits in order to apply what they learned in the *Streamwalk* activity to a different type of waterbody. This is an excellent time to try other types of water monitoring equipment, tests, or protocols that have not yet been practiced.

Please remember the safety considerations already presented and return all equipment in a clean and orderly condition. Groups are encouraged to compare and contrast what they learned in the stream vs. the beach or estuary. Each group should complete selected physical, indicator, and biological monitoring activities and are encouraged to satisfy their curiosity by asking questions and testing ideas about the site that they are assigned.

In this module participants will: *Complete a beach or estuary monitoring activity and compare and contrast their findings with the Streamwalk component of the short-course.*

Second Session — Monitoring Beach/Estuary Surface Waters

Having completed the *Streamwalk*, short-course participants can make a practical application of what they have learned about physical habitat assessment, the 9 water indicators, and/or bio-monitoring activity to a different type of water body.

Sampling and collecting data from a beach or estuary is different from streams, but many of the monitoring skills learned in *Streamwalk* can be used. Since beach and estuary information has not previously been presented in this guide a thumbnail sketch of these important water resources is presented. The purpose is to orient participants to this short-course monitoring experience. Additional study with a local beach or estuary monitoring group, reading, and web searching (see links and references) will be required to gain a full perspective of these resources.

Beaches and their role in surface water quality

Just about everybody enjoys going to the beach! Beaches are an important part of the complex and dynamic coastal watershed. Lake, river, and ocean beaches are America's top vacation choices. We take almost two billion trips to the beach each year and spend billions of dollars in beach communities. Inadequate protection and overuse of beaches can lead to their alteration or destruction. However, some simple actions can be taken to protect these valuable systems. Typically, pollutants washed into rivers, lakes, and streams eventually make their way to recreational beaches.

Local officials collect samples of water at downstream beaches and test them for the presence of contaminants. Monitoring beaches helps every community!

What is a Beach and What Does it Do?

A beach is the sandy, pebbly, or rocky shore of a body of water. The U.S. Environmental Protection Agency (EPA) defines a beach as: "the area of unconsolidated material, such as sand, pebbles, or rocks, that extends landward from the low water line to the place where there is marked change in material or physiographic form, or to the line of permanent vegetation (usually the effective limit of storm waves)."

Beaches vary widely in physical type and characteristics. When most of us think of a beach, we picture sandy ocean beaches with waves crashing, wind blowing, and seagulls flying overhead. But beaches in the United States also include urban seashores, estuarine and lagoonal beaches, and freshwater lakefronts and riverfronts.

Ocean beaches— Ocean beaches vary along our coasts. The Atlantic coast, for example, includes a system of barrier beaches influenced by high-energy wave action. The coastal inlets of Oregon (Coos Bay) and Washington (Puget Sound) are calmer, with less wave action and more submerged vegetation like sea grasses. The Northwest region has some mountainous coastlines and volcanic remnants and is impacted by faults. The plants and animals of each area are different from those of other beaches; the sand texture, color, and consistency even vary.

Urban seashores, freshwater lakefronts, and riverfronts — Since goods were transported via water "highways" before the invention of trains and trucks, many American cities developed along riverfronts, ports, and lakes. Cities like Salem, Newport, Olympia, Wenatchee, Boise, and Lewiston have urban seashores, riverfronts, or lakefronts. These areas provide recreational opportunities for many city dwellers.

Estuarine/lagoonal beaches— Some coastal areas, influenced by river systems, form deltas, bays, and extensive estuarine and lagoonal beaches. An estuary is an area where freshwater empties into and mixes with saltwater. The shorelines within estuaries can be vegetated with many types of plants, including sea grass beds. These areas are important breeding grounds for a variety of fish, shellfish, and shorebirds. The Nisqually National Wildlife Refuge (U.S. Fish & Wildlife Service in Washington), and Tillamook Bay in Oregon are all examples of estuarine systems.

A beach — whether ocean, urban, or estuarine — serves a variety of functions:

- The beach provides a unique habitat for a variety of plants and animals. For example, 75 percent of migratory waterfowl live in or depend on coastal beaches during their life span. Dune vegetation provides nesting areas for several kinds of birds and animals. The types of species found on a beach are determined by the type of beach. Inland beaches of the Snake, Columbia, and Willamette river systems provide protection for wildlife and abundant recreational opportunities for residents. Lakes and reservoir beaches also provide ample fish and

wildlife habitat. In the harsher climate of the Pacific Northwest, coastal beaches are dominated by a few species of hardy grasses and bushes that can withstand strong winds, cold winters, and intense summer sun.

- Stretches of beach along the Washington and Oregon coast provide numerous recreational opportunities for millions of people. Boating, fishing, swimming, walking, beachcombing, bird-watching, and sunbathing are among the numerous activities enjoyed by beachgoers. The aesthetic aspects of a beach system provide additional benefits, even inspiring works of art and literature.
- Beaches provide some protection to residents living near the ocean. They act as a buffer against the high winds and waves of powerful storm systems or turbulent seas.

Monitoring Beaches

The purpose of monitoring is the opportunity for individual beach watchers to learn about local marine ecology and develop a very personal sense of stewardship (by getting on our hands & knees face down in the sand)! There's always something new to learn and by returning to the same beach time after time to record our observations we "tune-in" to this environment in a way that would not otherwise be possible. If we did nothing with the collected data, monitoring programs would *still* be a success for the majority of beach watchers. For those "Beach Watchers" who have gone through a training program and have monitored several times, it is an opportunity to share with people their monitoring experiences and what they have learned about the relationship between marine plants and animals and tide height, substrate, etc. When you visualize a monitoring site you know exactly what is out there and you know exactly how far out to go to find a particular seaweed or animal. You have an intuitive knowledge of your intertidal area.

What is an Estuary?

Unlike many features of the landscape that are easily described, estuaries are transitional zones that encompass a wide variety of environments. Loosely categorized as the zone where fresh and salt water meet and mix, the estuarine environment is a complex blend of continuously changing habitats. To qualify as an estuary, a waterbody must fit the following description:

> *"a semi-enclosed coastal body of water which has free connection with the open sea and within which sea water is measurably diluted with fresh water derived from land drainage." (Pritchard, 1967)*

The estuary itself is a rather well-defined body of water, bounded at its mouth by the ocean and at its head by the upper limit of the tides. It drains a much larger area, however, and pollutant-producing activities near or in tributaries even hundreds of miles away may still adversely affect the estuary's water quality.

While some of the water in an estuary flows from the tributaries that feed it, the remainder moves in from the sea. When fresh and salt water meet, the two do not readily mix. Fresh water flowing in from tributaries is relatively light and overrides the wedge of more dense salt water moving in from the ocean. This density differential often causes layering or stratification of the water, which significantly affects both circulation and the chemical profile of an estuary.

Scientists often classify estuaries into three types according to the particular pattern of water circulation (Figure 16.1.1):

- Highly Stratified Estuary
  The layering between fresh water from the tributaries and salt water from the ocean is most distinct in this type of estuary, although some seawater still mixes with the surface freshwater layer. To compensate for this "loss" of seawater, there is a slow but continual up-estuary movement of the salty water on the bottom.
- Moderately Stratified Estuary
  In this intermediate estuary type, mixing of fresh and salt water occurs at all depths. With this vertical mixing, salinity levels generally increase toward the estuary mouth, although the lower layer is always saltier than the upper layer.
- Vertically Mixed Estuary
  In this type of estuary, powerful mixing by tides tends to eliminate layering altogether. Salinity in these estuaries is a function of the tidal stage. This tidal dominance is usually observed only in very small estuaries.

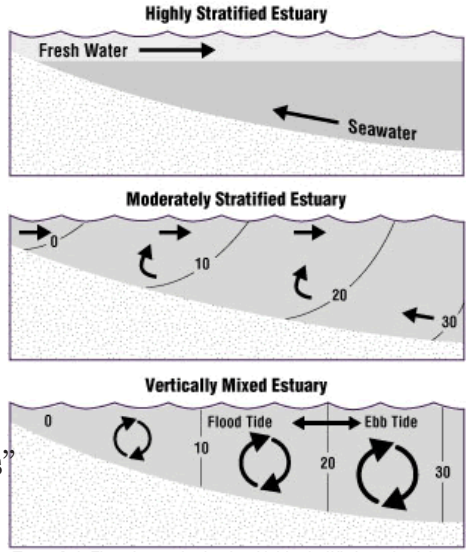


Figure 16.1.1 Three types of estuaries: highly stratified, moderately stratified, and vertically mixed (adapted from Levinton, 1982). Number refer to parts per thousand.

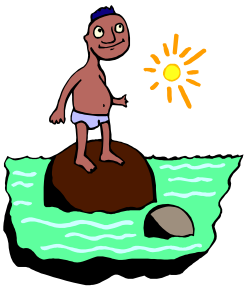
Rivers flow in a single direction, flushing out sediments and pollutants. In estuaries, however, there is a constant balancing act between the up-estuary saltwater movement and down-estuary freshwater flow. Rather than quickly flushing water and pollutants through its system, an estuary often has a lengthy retention period. Consequently,

waterborne pollutants, along with contaminated sediment, may remain in the estuary for a long time, magnifying their potential to adversely affect the estuary's plants and animals. Other factors also play a role in the hydrology of an estuary. Basin shape, mouth width, depth, area, tidal range, surrounding topography, and regional climate combine to make each estuary unique.

To say that estuaries are valuable resources is a gross understatement. They are among the most productive natural environments in the world and among the most sought-after places for people to live. Estuaries support major fisheries, shipping, and tourism. They sustain organisms in many of their life stages, serve as migration routes, and are havens for threatened and endangered species. Associated wetlands filter pollutants, dissipate floodwaters, and prevent land erosion.

Peculiarities of Volunteer Beach and Estuary Monitoring

You may be thinking, "I know how to monitor streams, so I know how to monitor beaches or estuaries." In many respects, you are correct. Basic monitoring techniques are similar for streams, lakes, rivers, beaches, and estuaries. However, beaches and estuaries have several, often unique, properties that must be considered when conducting monitoring efforts. As one volunteer leader wrote, "Estuary monitoring can be characterized as a mixture of river and lake monitoring techniques–liberally salted." (Green, 1998). Two main influences that make beach and estuary monitoring unique are tides and salinity. Volunteers are strongly recommended to learn proper techniques for monitoring in a beach or estuarine environment.



Tides & Estuaries

Estuaries differ from streams and lakes in several respects. First and foremost, they are subject to tides and the accompanying mixing of salt and fresh water. Any successful estuary monitoring program must take into account the tidal stage when scheduling training sessions and sampling times. Tidal stages can mean the difference between using a boat and trudging across mudflats to get to a sampling spot.

The fact that high tide occurs at different times in different parts of the estuary complicates scheduling. Some monitoring groups schedule sample collection for low and high tides at each station on each monitoring date — which translates into different sampling times for each location!

Estuaries are complex, with a wide variety of environments that are constantly changing. When the tide is rising, incoming salt water does not mix uniformly with fresh water. Fresh water is lighter (less dense) than salt water and tends to stay nearer the surface. The result is layering, or **stratification**, which may necessitate sampling at several depths — particularly for dissolved oxygen, nutrients, plankton, and salinity. On the other hand, tides of sufficient magnitude are effective mixers of estuarine waters and may break down stratification.

Tide charts are readily available and should be a standard part of any program coordinator's tool kit. Programs studying highly stratified estuaries or estuaries with tidal ranges over a few feet may want to measure tidal stage. Even if tidal stage data are not included at the beginning of the sampling effort, the National Oceanic and Atmospheric Administration (NOAA) publishes tide tables for most of the U.S. This information can be obtained and applied after the fact, if the monitoring station is reasonably close to one of the published tide table sites.

Salinity and Estuaries

Salinity, the concentration of salts in water, isn't usually monitored in streams, rivers, or lakes, unless there is a connection with salt water or concerns about excessive road salting. Salinity changes with the tides and the amount of fresh water flowing into the estuary. It is often the major determinant of what lives where.

Salinity is often a factor in monitoring many key water quality variables. For example:

- To properly calibrate most dissolved oxygen meters, knowledge of salinity concentration is necessary.
- If you are interested in converting the dissolved oxygen concentration to **percent saturation** (the amount of oxygen in the water compared to the maximum it could hold at that temperature), you must take salinity into account. As salinity increases, the amount of oxygen that the water can hold decreases.
- If you use a meter to measure pH, the techniques are the same whether you are testing salt or fresh water. However, if you use a colorimeter, you must use a correction factor (available from the manufacturer) to compensate for the effects of salinity.
- Although **macroinvertebrates** (e.g., insects, worms, shellfish, and other animals that lack a spinal column) live in estuaries, using them as indicators of ecosystem health is more problematic than in streams. Estuaries support different invertebrate communities than freshwater systems, and many of the key freshwater indicators are not present in estuaries. In addition, collection is more difficult, given the tidal fluctuations and the muddy bottom. Finally, data analysis tools for relating macroinvertebrate communities to ecosystem health have not been as well developed for estuaries as for streams.

Beaches are the sandy, pebbly, or rocky shore of a body of water. Estuaries have inlets and outlets, they store water for the purposes of economic development (shipping, fishing, recreation, tourism, etc.) culture (traditions, survival, ceremony), watershed protection, water filtration, to reduce flooding, for fish and wildlife habitat, and nursery protection and/or production.

In thinking about monitoring skills that have been learned, short-course participants are asked to synthesis this information and apply it to a new circumstance.

The following questions can stimulate reflection and discussion with task group members:

- What is similar and what is different about this physical habitat surrounding this beach/estuary to the stream we looked at?
- Where should sampling take place on this type of beach/estuary? Should random transects be made and how do we go about monitoring?
- Which of the 9 indicators (temperature, dissolved oxygen [DO], pH, BOD, fecal coliform, phosphates, nitrates, turbidity, and total solids) is most important for this beach/estuary.
- How should this beach/estuary be measured? How about the sediments?
- What natural and human impacts (wave action, debris from water craft, storm events, sediment accumulation from upstream human activities, etc.) must be considered in monitoring this beach/estuary?
- What types of insects, wildlife, or other biota would you expect to find in this beach/estuary as compared to a stream…what can they tell us about water quality that is different from streams?

The activities surrounding beach/estuary and this one short-course measurement provides only limited information — only a guess can be made about what is happening the rest of the time. Regular sampling and collecting of data will provide information that can help document changes in beaches and estuaries. The most obvious change in water quality are:

- changes in salinity of the water,
- changes in the abundance of biota,
- production and protection of fish, wildlife, and aquatic plants, and
- the seasonal and cycles of tides, storm events, and other weather related conditions.

As a volunteer monitor you can collect information according to established protocols that will help address beach/estuary issues.

Take a look at the Streamwalk and PondWatch data sheets that are presented on pages 158-170. Does this fit the beach/estuary that you are monitoring? What protocols might you add to these sheets and why? Check out some of the web sites to see what experts include in a beachwatch or estuary monitoring program. For the purposes of this short-course, participants are monitoring from the edge of a beach/estuary, or from a dock or bridge. If an actual monitoring effort were planned other materials would be required. For example:

- Watercraft
- Personal flotation devices for each person on board.
- First aid kit.
- Other equipment that may be required by state and local watercraft laws.

Beaches/estuaries selected for demonstration monitoring were chosen because of their accessibility and convenience to your training site. Not all beaches or estuaries, even in your region, will look like this one. Use caution in directly applying all things you learn at this site to other waterbodies in your own area. Circumstances surrounding each beach/estuary are unique and should be approached as such.

When you are monitoring take in the entire picture of your site. Some groups so focus on the **doing** part of this activity that the **being** part of the shared learning experience gets lost in the shuffle. When we are relating beach/estuary water quality to our environment each monitor will have an individual perspective, collectively the group's perspective will more likely come closer to the actual circumstances that surround the beach/estuary being studied.

Volunteer monitoring of estuaries has grown significantly from the early programs that monitored only a few simple parameters. As these monitoring programs have developed, so has the interest of the Environmental Protection Agency (EPA), which has supported volunteer monitoring since 1987. The EPA sponsors national symposia on volunteer monitoring, publishes a newsletter for volunteers, has developed guidance manuals and a directory of volunteer organizations, and provides technical support to volunteer programs. Through these efforts, the EPA hopes to foster the interest and support of state and other agencies in these programs.

This short-course activity can be concluded with a discussion of beach/estuary monitoring programs in your area. These may be conducted by schools, public interest groups, private organizations, or public agencies. Short-course participants are encouraged to continue their training by exploring these opportunities.

Discussion Points

- What new vocabulary terms were introduced in the beach/estuary session when compared to the *Streamwalk* session?
- Which indicators of water quality were used in your study of this beach/estuary? What did you find out and where did you sample?
- What is the purpose of this beach/estuary and what evidence did you find to support or refute this information?
- Did your task group pick up garbage or waste when you did the physical assessment of the beach/ estuary? Why or why not?

Major Points to Remember

- Be safe in your monitoring effort.
- Do the physical habitat assessment first, then do the surface water indicator testing that seems appropriate, and complete the beach/estuary study with a biomonitoring activity.
- Clean up your messes and return all equipment and resources. Remember to "Leave no trace!"

Journal and Evaluation

When you get home pull out your journal and review the notes you took. Think about what you have learned and how you will apply it. On the back of the last page make out a time line or calendar to reach your goals. This will take the issues you have studied to action for yourself, your family, and your community. If you have not already done so, use the journal to complete your post-test and return it to short-course organizers.

Additional Activities

There are two publications that can be helpful in understanding concepts presented in this module. *Where Rivers Meet the Sea: A Guide to Washington Estuaries Poster* http://www.ecy.wa.gov/programs/sea/pubs/98104/98104.pdf and *Before You go to the Beach* (Guide) http://www.epa.gov/ost/beaches/BeachBro.pdf. Both provide insights and conditions of beaches and estuaries that increase understanding of the circumstances that surround our region's beaches and estuaries.

Links and References

Beachwatchers Web Site. http://www.island.wsu.edu/bw.

Beachwatch Web Site. http://www.epa.gov/ost/beaches.

Green, L (1998) Let Us Go Down to the Sea–How Monitoring Changes from River to Estuary. *The Volunteer Monitor* 10(2): 1-3.

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Mitchell, M. and W. Stapp (2000) Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools, 12th Edition, Kendall/Hunt Publishing Co. Debuque, Iowa.

Pacific Northwest Coastal Ecosystems Regional Study (2000). http://www.pncers.org/.

Pritchard, D.W. (1967) What Is an Estuary: A Physical Viewpoint In: *Estuaries*. G.H. Lauff (ed.) American Association for the Advancement of Science. Publication No. 83. Washington, DC. 757 pp.

Project WET Curriculum and Activity Guide (1995) Western Regional Environmental Education Council, 4014 Chatham Lane, Houston, TX 77027.

Shorelands and Wetlands Web Site (2000). Washington Department of Ecology. http://www.ecy.wa.gov/programs/sea/shorelan.html.

Volunteer Estuaries Monitoring: A Methods Manual (2000). Environmental Protection Agency. http://www.epa.gov/owow/estuaries/monitor/.

Volunteer Stream Monitoring: A Methods Manual, United States Environmental Protection Agency, EPA 841-B-97-003, November 1997, Office of Water, 4503F, Washington D.C. http://www.epa.gov/owow/monitoring/volunteer/stream/.

Washington State NatureMapping: Estuaries. http://www.fish.washington.edu/naturemapping/water/1fldestu.html.

Water Quality Programs Web Site (2000). Washington Department of Ecology. http://www.ecy.wa.gov/programs/wq/wqhome.html.

Short-course Presenters

The second portion of the field day is designed to amplify the "discovery learning" experience of short-course participants. Short-course developers found it helpful to check out the site before the start of the short-course. Such places as the outlet of the stream being studied into a lake, a coastal stream as it flows into the ocean, and a National Wildlife Refuge were selected in the pilot. Collecting water samples on-site ahead of time, noting vegetation types, and understanding present use (shellfish industry, recreation, tribal salmon production, etc.) also helped in facilitating the actual field day. The teaching site should have easy access for the type of learners in your group, preferably a rest area nearby and have all safety issues identified and hazards noted or flagged before tasks groups continue their studies.

This portion of the short-course should be profoundly informal and all participants urged to explore the beaches/estuaries based upon what they have already learned. In most cases, demonstrations of equipment and tests for beaches/estuaries can be accommodated in response to questions from participants. Organizers should have a selection of testing equipment that task groups can use. In addition they must be willing and able to demonstrate how to use it.

During the pilot, beaches/estuaries were walked on or near and physical assessments were made. Participants noted the similarities and differences between beaches/estuaries and streams. Estuaries were monitored at docks, on shorelines and from bridges. During the short-course pilot, water trunks from the WSU Howard Hughes Loan program were opened and groups or individuals conducted tests on questions that they were interested in addressing. Similarly biomonitoring can take place based on observations and questions that emerge in each task group.

When groups have completed the physical beach/estuary assessment, they then can request equipment to measure surface water indicators or bio-monitor the site. When their curiosity is satisfied, send them home with a thanks and a smile! Most task groups complete the beaches/estuaries monitoring activity in just under two hours.