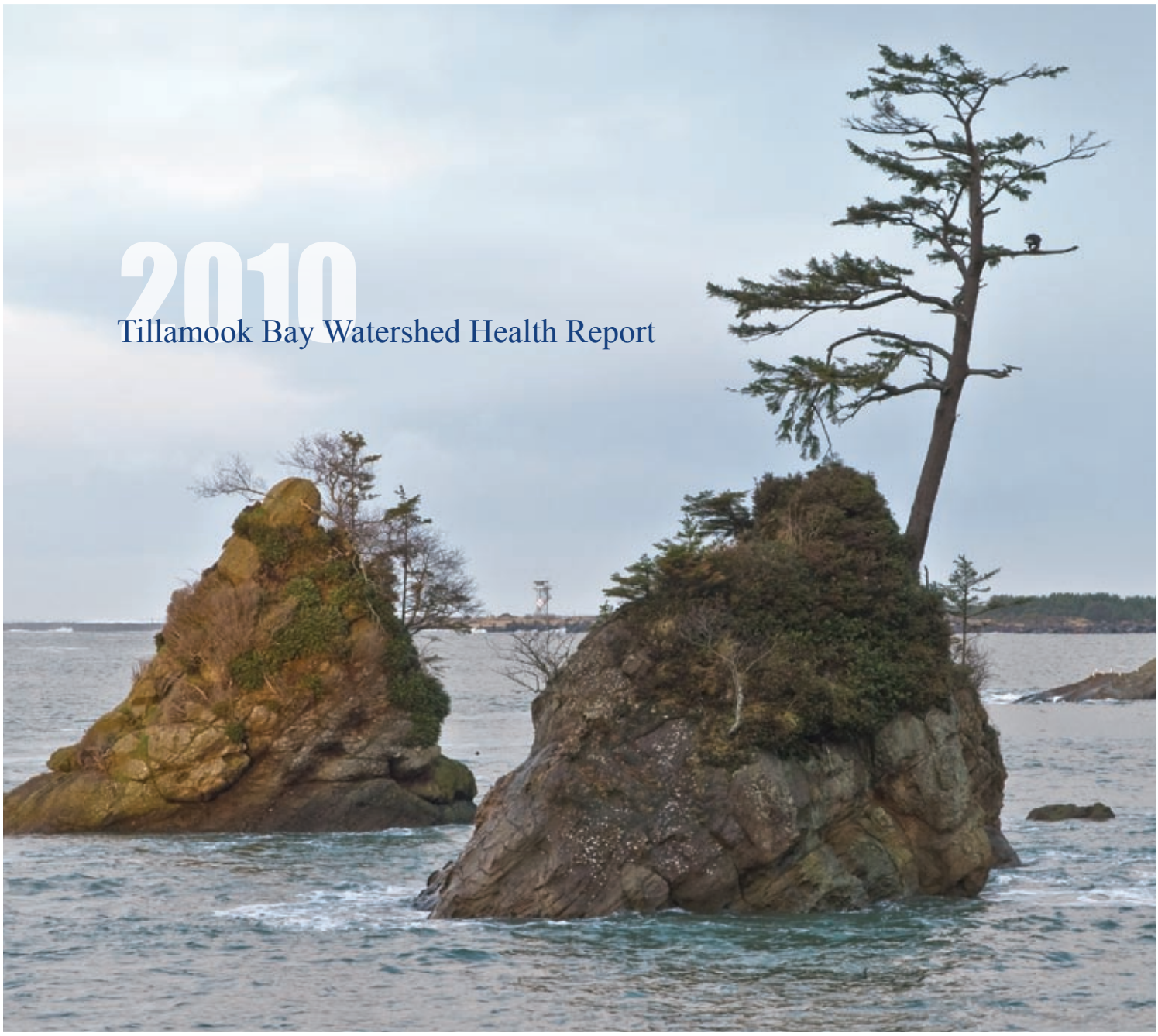
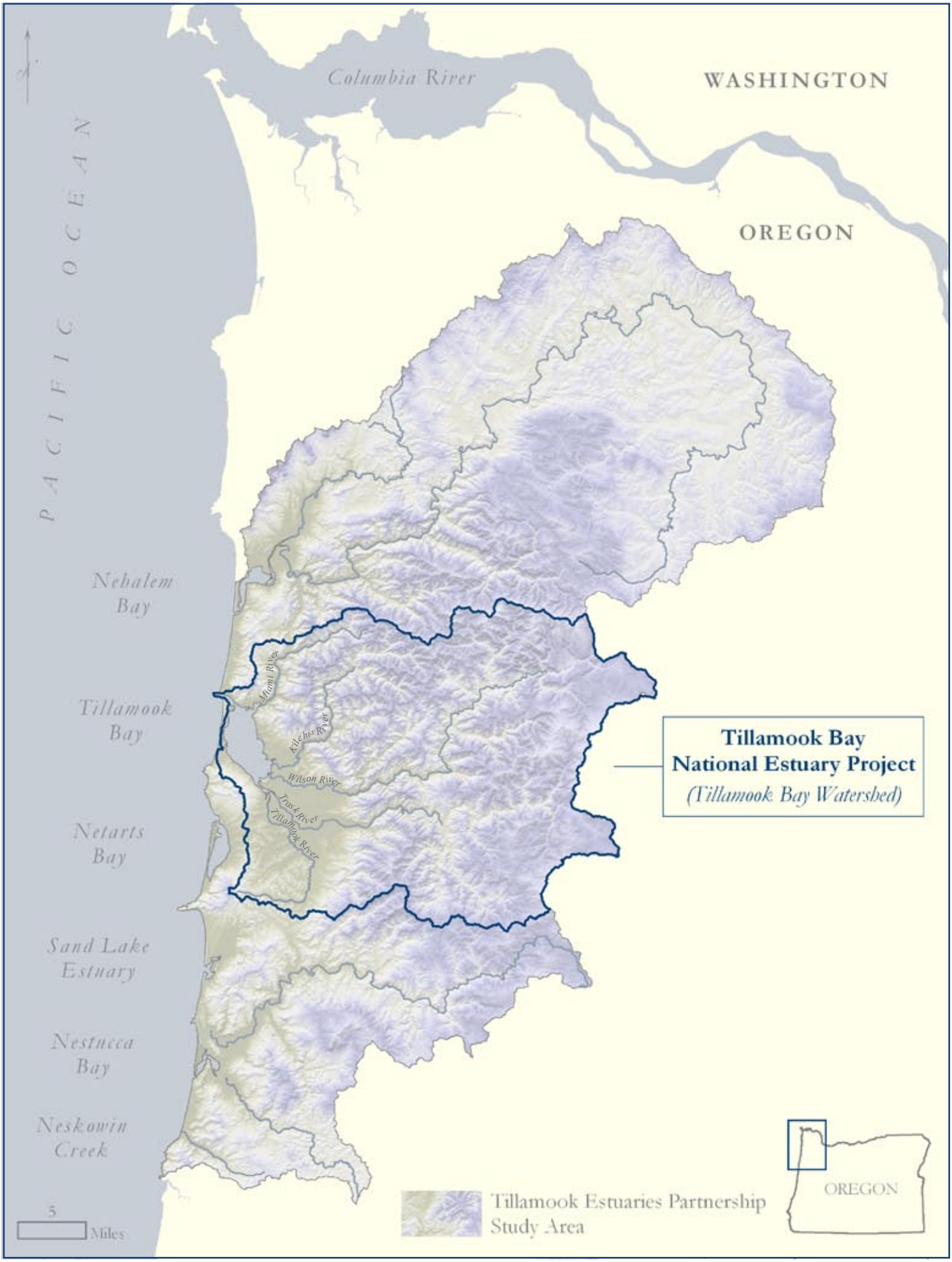


2010
Tillamook Bay Watershed Health Report

Tillamook Estuaries Partnership

A National Estuary Project


Columbia River
WASHINGTON
OREGON
PACIFIC OCEAN
Nehalem Bay
Tillamook Bay
Netarts Bay
Sand Lake Estuary
Nestucca Bay
Neskowin Creek
Miami River
Kilchis River
Wilson River
Trask River
Tillamook River
Tillamook Bay National Estuary Project
(Tillamook Bay Watershed)
Tillamook Estuaries Partnership Study Area
OREGON
5
Miles

Tillamook Estuaries Partnership

Vision

In the coming years, we will hold fast to a vision for the Tillamook Estuaries Partnership:

We will strengthen our foundation of partnerships, deep relationships that are grounded in our mission and sustain our vitality. We will reach out, engage, and learn with and from new partners.

We will always be a vibrant growing environmental organization. We will maintain and focus on our mission: to conserve and enhance the estuaries and watersheds in Tillamook County.

We will be a leader in stewardship. Through our programs: water quality monitoring, habitat restoration, and education, we will measure and share with the public the improvements we help make throughout the many watersheds.

We will notice, identify, and respond to community needs where those needs relate to the environment we cherish and seek to protect. We will always seek to know and understand the social, cultural, and economic links to our natural resources.

Our belief in the intrinsic value of nature will ground our actions, as we:

- Provide environmental leadership
- Protect and conserve the natural resources in Tillamook County
- Carry out the goals set forth in our guiding document, the Comprehensive Conservation and Management Plan
- Actively participate in our community and be a responsive neighbor
- Create an internal work environment and organizational structure that is a model for our industry
- Sustain our programs through diversified funding
- Support our partners
- Follow the principles that we expound
- Develop opportunities for open discussions on natural resource topics that are at the core of our community
- Honor the values of good stewardship and environmental ethos
- Adapt our strategies to the changing needs of our natural environment
- Empower the community through education
- Continually assess our organizational capacity

As the TEP evolves, we stand committed to the partnerships that laid our foundation and to the partnerships that have yet to be recognized.

We are the Tillamook Estuaries Partnership.

Tillamook Bay: Balancing Our Vital Resource

With over 597 square miles of rivers and creeks and a bay totaling 13 square miles, there are plenty of challenges and opportunities in the Tillamook Bay Watershed (Watershed). With diverse ownerships and multiple uses throughout the Watershed, balance is the key word.

Nominated for the US Environmental Protection Agency's (EPA) National Estuary Program (NEP) by Governor Barbara Roberts, she characterized the Tillamook Bay as "representative of the bays along the Pacific Northwest coast because it provided a vital resource to the local and regional economies and supported diverse aquatic resources including anadromous fish, shellfish and waterfowl". Perhaps more importantly, the citizens in the Tillamook Bay Watershed were recognized as a community that works together to address its problems. The NEP was established by Congress in 1987 to improve the quality of estuaries of national importance. With the designation of Tillamook Bay as a "Bay of National Significance" in 1994, the Tillamook Estuaries Partnership (TEP - also known as the Tillamook Bay National Estuary Project) was created to carry out the goals of the NEP throughout the Tillamook Bay watershed. In 2002, the TEP expanded its mission to include the conservation and restoration of all of Tillamook County's estuaries and watersheds.

Mandated to create a plan for the Bay that balanced maintaining and improving water quality and living resources with Tillamook County's economically important industries, a committed group of stakeholders at the local, state, and federal level, developed the Comprehensive Conservation and Management Plan (CCMP). The CCMP highlights the major areas of concern and identifies 63 action items to address those concerns. Utilized as a "living document", concerted efforts by TEP and our partners are certainly moving the goals outlined in the CCMP forward. In concert with our partners and funders, we implement habitat restoration projects and water quality monitoring programs, and provide technical assistance and funding. As a non-partisan entity, we bring diverse perspectives to the table to discuss issues of concern as they relate to the Bay.

At every level of effort in the Watershed, there is a need for balance. As the TEP, we are invested in Tillamook County and giving all of its stakeholders an opportunity to participate in the activities we carry out. Balancing social, economic, and environmental needs is critical when addressing issues such as flooding, wetland restoration, salmon recovery, climate change impacts, water quality, and education.

Tillamook Bay faces many challenges from multiple uses. Increasing development and changing landscapes continue to place pressure on the Tillamook Bay Watershed. With a diverse portfolio of partners, together we are able to complete significantly more projects with fewer resources. Working with private landowners, nearly 200 miles of streambank have been planted with native conifers and understory, fish passage has been improved, and wetland restoration projects are planned for implementation. Through education and Best Management Practices, we are seeing improvements in bacteria concentrations in some waterbodies. Without landowner support, restoration in some of the most critical areas would not be possible. Strong relationships with landowners are a cornerstone of our success.

As we look to future goals and objectives of restoration and conservation, we renew our pledge to coordinate resources, strengthen partnerships and dedicate our resolve to protect and enhance Tillamook Bay's natural resources and those of all of the bays and watersheds in Tillamook County.

What is the State of the Tillamook Bay Watershed?

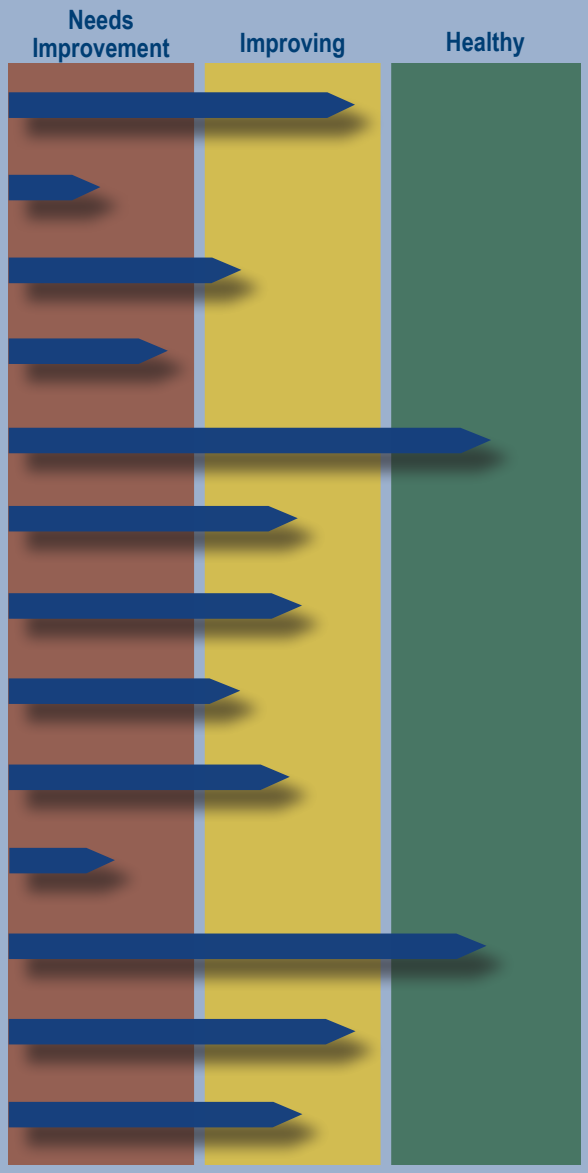
Throughout the following pages, you will read about the efforts of TEP and many of its partners to improve water quality, restore habitat, and encourage citizen involvement. While painting a picture for you of the Tillamook Bay, we want to draw your attention to the many efforts underway to improve its health.

The ratings below are specific to the Tillamook Bay Watershed and are intended as a baseline against which individuals, local, state, and federal entities can measure success.

We are proud of the partnerships that we have and are always looking for new partnerships to further our mission of restoring and conserving the Watershed. We also want to emphasize that although this document is specific to Tillamook Bay Watershed, TEP and our partners are implementing similar conservation and restoration actions in all of Tillamook County's estuaries and watersheds. TEP commits to achieving a "healthy" rating for the Bay in every category. A healthy Tillamook Bay supports our natural resources, our community, and our economy – this is the balance we strive to achieve.

Tillamook Bay Watershed Health Report

Needs Improvement - either not much work has been done or progress is slow
Improving - documentable evidence supports improvements are being made
Healthy - signs of healthy influences are obvious



Contents

Is Water Quality in the Tillamook Bay Watershed Improving?

During development of the CCMP, the stakeholders determined that four types of pollution were of primary concern in the Tillamook Bay Watershed: bacteria, dissolved oxygen, sediment, and temperature. The Oregon Department of Environmental Quality (DEQ) also identified toxics (an overarching category that includes numerous toxic substances such as heavy metals, chemicals and other toxic substances) as another pollutant type that might be of concern in the Tillamook Bay Watershed. In the following sections, we discuss why the five pollutants identified above are a concern, present information on current pollutant levels, briefly discuss what is being done in response to these pollutants, and evaluate trends in pollutant levels where sufficient information is available for trend analyses.

Roger Ross Photography

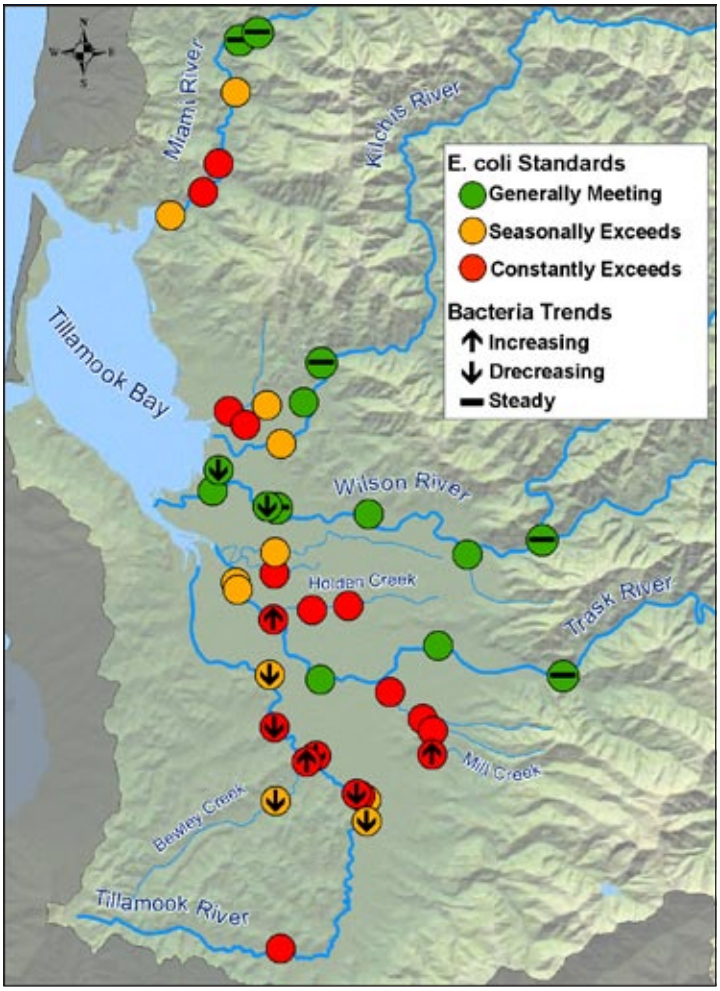
Why are Bacteria in Surface Waters a Concern to People?

Diseases can be spread directly to humans through contact with polluted water or from food products, such as shellfish, that are exposed to polluted waters. Levels of fecal bacteria (bacteria that occur in the guts of warm-blooded animals and humans) in water are used as an indicator of potential for spread of water-borne diseases. The State of Oregon measures concentrations of fecal coliform to determine if shellfish are safe to eat. Concentrations of the fecal bacteria *Escherichia coli* (*E.coli*) are measured to determine if surface waters are safe for recreational contact such as swimming, boating, and fishing. *E. coli* bacteria are a subset of the large fecal coliform bacteria group. The shellfish standards for waters in the Bay are monitored by Oregon Department of Agriculture (ODA) and will be discussed in the Bay Toxics section of this report.

Since the beginning of TEP's monitoring program in 1997, volunteers have collected15,000 water samples from 43 locations in the five major river systems in the Tillamook Bay Watershed. Samples are analyzed for *E. coli* bacteria at the TEP laboratory. In 1998, DEQ determined that the lower reaches of the Miami, Kilchis, Wilson, Trask, and Tillamook rivers were water quality limited for bacteria. TEP data were included in the data set that DEQ used to make this determination. Through a partnership with DEQ, *E. coli* data from 1997 through 2008 were analyzed to determine if waters were meeting the State water quality standard for recreational use and if *E. coli* levels were changing over time.

Are surface waters meeting State bacteria standards for recreational use and where have Escherichia coli (E. coli) concentrations increased or decreased over time?

Bacteria (*E. coli*) levels: Improving



Tillamook Bay Watershed bacteria monitoring sites. Color indicates relationship to Oregon State standards and arrows/bars indicate increasing, decreasing, or static trends.

The Wilson River has been meeting standards for recreational use since approximately 2005. We credit this success to the application of several Best Management Practices (BMPs) implemented by TEP and its partners. Some of the BMPs implemented include, but are not limited to, riparian habitat enhancement, livestock exclusion, wet and dry manure storage, off-channel livestock watering stations, and buried manure mainlines. Partners in these efforts are highlighted in the *Partners* section of this document.

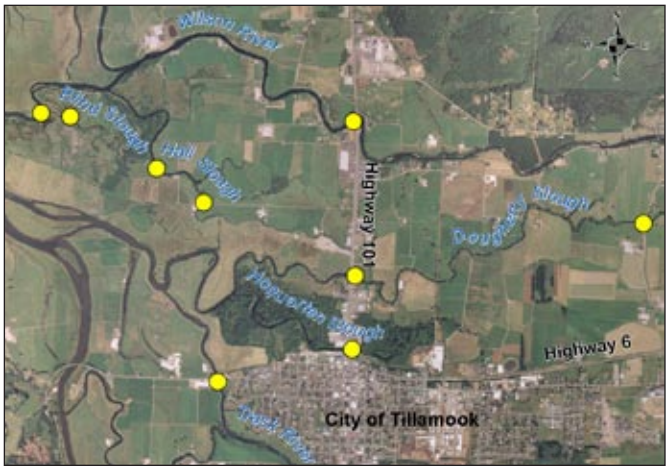
Progress also has been made in the Tillamook River Watershed, where our analysis indicates decreasing *E. coli* levels at a majority of sampling stations. Although progress is being made, this watershed has some of the highest *E. coli* levels in the region and continues to consistently violate standards for recreational contact.

Our results also indicate increasing *E. coli* levels at sites on Mill Creek, lower Bewley Creek, and lower Holden Creek. TEP and partners must focus restoration efforts, similar to those described for the Wilson River, at these locations to reverse these increasing trends.

E. coli contamination can be attributed to several different sources. To determine the sources of *E. coli* affecting the Tillamook Bay Watershed, TEP contributed water samples to an Oregon State University-led bacteria DNA marker study.[1] Researchers sought to identify bacteria sources by detecting host-specific genetic marker sequences. This study identified bacteria from both human and ruminant sources (ruminants are animals that have stomachs divided into four compartments, such as elk and cattle). Results indicated widespread contamination from ruminant sources and contamination from human sources in specific portions of Holden Creek and the Trask, Miami, and Tillamook rivers. The report concluded that "a watershed manager's best strategy for decreasing indicators of fecal pollution in this watershed is to mitigate runoff from ruminant sources".

[1] *Shanks, O. C., C. Nietch, M. T. Simonich, M. Younger, D. Reynolds, and K. G. Field. 2006. Basin-wide analysis of the dynamics of fecal contamination and fecal source identification in Tillamook Bay, Oregon. Appl. Environ. Microbiol. 72: 5537-5546.*

How Do Dissolved Oxygen Levels Affect Aquatic Life in the Sloughs of Tillamook Bay?



TEP's DO monitoring sites.

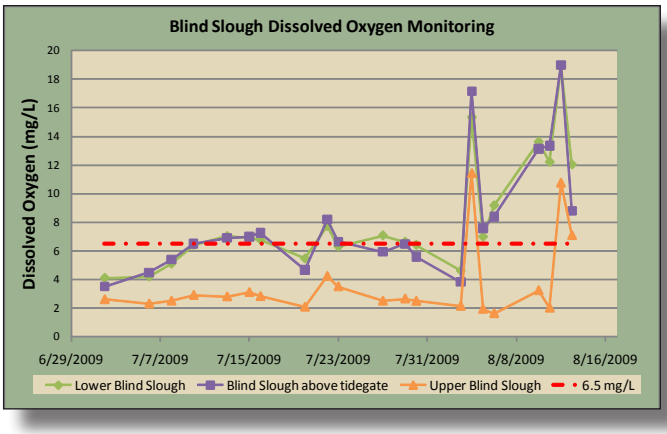
Fish and other aquatic organisms rely on oxygen dissolved in water to sustain life. At low dissolved oxygen (DO) levels, aquatic organisms can be impaired or die (this level differs for different organisms). The DEQ water quality standard for DO in estuaries (6.5 mg/L) is based on the minimum level required to support aquatic life (particularly juvenile salmon). DO levels are affected by temperature, algae growth, nutrients, flow, and other factors.

DEQ has designated Dougherty, Hoquarton, Hall, and Hathaway sloughs as water quality limited for DO. As a result, TEP and DEQ initiated a project to collect DO data in these sloughs to understand what drives DO levels in these waters. Data has also been collected from Blind Slough and the lower Wilson and Miami rivers to establish baseline conditions prior to the implementation of planned restoration projects as part of the Wilson-Trask Wetlands Project and Miami Wetlands Enhancement Project, respectively (see Habitat section).

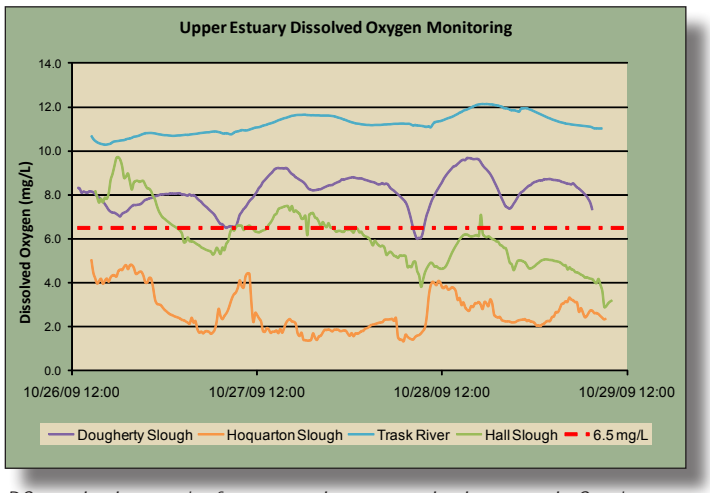
Are dissolved oxygen concentrations in the sloughs suitable for juvenile salmon?

Dissolved oxygen concentrations: Needs Improvement

Results of the data collection noted above indicate that DO in Tillamook Bay sloughs regularly drops below 6.5 mg/L (the minimum required level for salmon use) during spring, summer, and fall. Hoquarton and Hall sloughs are most frequently impaired. In contrast, the lower Trask River (near the confluence of the Hoquarton and Dougherty sloughs) maintains adequate DO levels. Baseline monitoring at the Wilson-Trask and Miami Wetlands project sites also has revealed DO levels well below the 6.5 mg/L minimum. These sloughs and wetlands are areas of transition from fresh to salt water in the Watershed and provide important habitats for juvenile salmon. A majority of this transitional habitat in Tillamook Bay has been altered by land use practices, such as dredging and the installation of dikes and tide gates. The remaining sloughs and wetlands in Tillamook Bay still have potential to provide transitional habitat for juvenile salmon, but low DO levels may limit this potential. At this time, there has been insufficient data collected to evaluate trends in DO levels in these remaining sloughs and wetlands. TEP will continue to monitor DO in these areas.



DO monitoring results for Blind Slough, collected by the Oregon Youth Conservation Corp team. Red dashed line indicates State DO standard.



DO monitoring results from a continuous monitoring event in October, 2009. Red dashed line indicates State DO standard.

What is Sedimentation and Why is a Proper Balance Important?

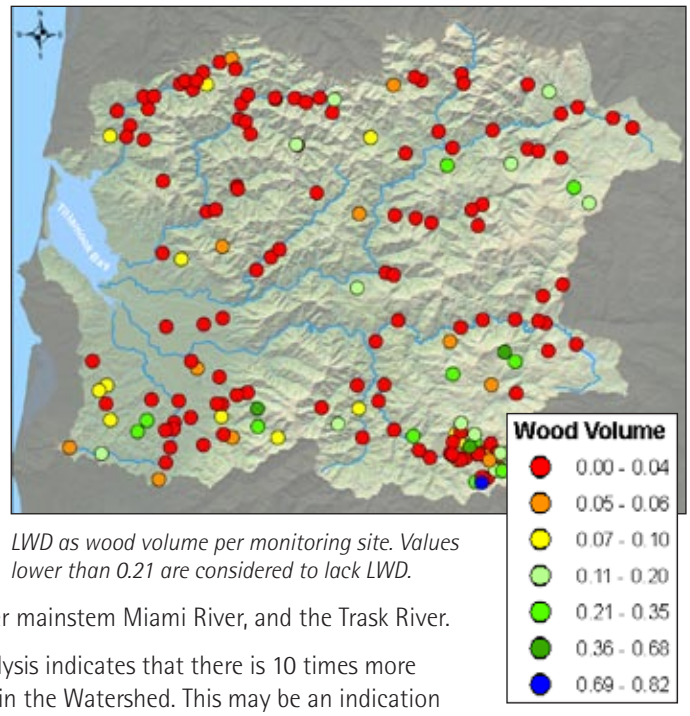
Illustration by East Elementary 'Salmon Life Cycle Study' - 2010

Sedimentation is the process of particles settling out of the water column and depositing on a streambed or estuary floor. This is a natural process. In a healthy system, a balance between sediment deposition and sediment flushing is maintained. Several factors contribute to sediment transport and deposition in coastal streams. These include stream slope, amount of large woody debris (LWD), stream width, bank stability, and upland and streamside landscape alterations. If the balance is disrupted, however, excess deposition of fine sediments can occur and adversely affect salmon egg and fry survival, spawning habitat quality, and other aquatic life such as insect larvae.

What is the current condition of sedimentation in the Watershed?

Sedimentation in the Watershed: Improving

In 2006, TEP initiated a three year study to characterize sediment in the watershed[2] to determine if there is a balance between sediment deposition and sediment flushing. The study included measurements of physical parameters of the streams following a component of the physical habitat section of EPA's Environmental Monitoring and Assessment Program (EMAP).[3] Stream characteristics measured included slope, bankfull height and width, and channel depth. In addition, the project included a tally of LWD and a modified pebble count at each site. Data from this study were analyzed for the entire Tillamook Bay Watershed and for individual river watersheds (i.e., Wilson River Watershed). Many sediment reports in the past identified excess fine sediment accumulation as a problem in the Bay. However, this study revealed that mainstem river aquatic habitats in the Tillamook Bay Watershed suffer more from excess scour and lack of LWD than excess fine sediment deposition. Scour indicates that the average stream bed particle size is larger than expected given the physical characteristics of the streams. This appears to be due, in part, to lack of LWD to retain stream gravels. The study did identify areas with high amounts of fine sediments when the river systems were analyzed individually. These areas include the mainstem Tillamook River, lower mainstem Miami River, and the Trask River.



LWD as wood volume per monitoring site. Values lower than 0.21 are considered to lack LWD.

The study also compared 1st and 2nd order streams in the Watershed. This analysis indicates that there is 10 times more LWD in smaller 1st order streams as compared to the larger 2nd order streams in the Watershed. This may be an indication that natural ecosystem repair is occurring and that the LWD will eventually make its way into larger streams lower in the system. The study also concluded that "without large key pieces of wood in the mainstem to hold the upstream wood, the potential benefits of improved habitat from the delivery of upstream wood to downstream reaches will be reduced." TEP believes that due to this discovery, LWD placement projects in mainstem rivers will be a key component to improving sediment water quality in the Tillamook Bay Watershed.

In addition to improving sediment conditions, LWD projects will provide benefits to Coho. Habitat complexity has been identified as a limiting factor for coastal Coho salmon survival and LWD contributes to habitat complexity in several ways. It provides cover from predators, creates side channels that are refuges during high flow events, forms pools that have cool temperatures and can persist during low flow periods, and is a barrier to sediment movement that allows for proper sorting of sediments, such as spawning gravels. The study concludes that the average particle size is increasing and there is a documented lack of LWD throughout the system. The Tillamook Bay Watershed sediment equilibrium appears to be out of balance.

[2] *Mico, C. and L. Mico 2009. Tillamook Bay Watershed Sediment and Physical Habitat Assessment. Technical Report Prepared for the Tillamook Estuaries Partnership.*

[3] *Peck, D.V., A.T. Herlihy, B.H. Hill, R.M. Hughes, P.R. Kaufmann, D. Klemm, J.M. Lazorchak, F.H. McCormick, S.A. Peterson, P.L. Ringold, T. Magee, and M. Cappaert Environmental Monitoring and Assessment Program - Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams. U.S. Environmental Protection Agency, Washington, DC, EPA/620/R-06/033, 2006*

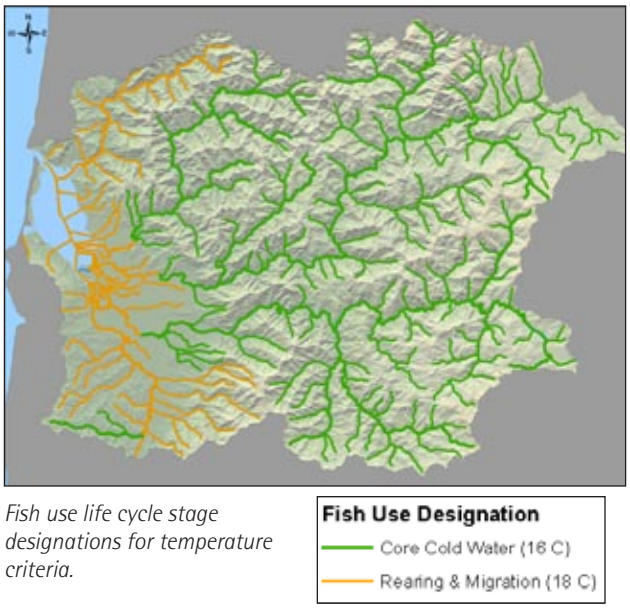
Why is it Important to Have Cold Water in Rivers?

Salmon and other aquatic life in Pacific Northwest streams evolved in cold waters, so stream temperature is a critical factor in maintaining and restoring healthy salmon populations throughout the Tillamook Bay Watershed. Stream temperature is influenced by many factors including, but not limited to, stream shade, ambient air temperatures, water withdrawals, groundwater inflows, and water volume and flow.

DEQ has established maximum allowable water temperatures for each salmon lifecycle stage: spawning, rearing, and migration. The standards are designed to limit exposure to temperatures that cause sublethal effects which reduce these fishes ability to grow, reproduce, and survive. Sublethal effects include increases in disease, inability to spawn, reduced egg survival, reduced juvenile growth and survival, increased competition for habitat and food, and inability to compete with species that are better adapted to higher temperatures (often introduced species). Seven-day average maximum temperatures are used when testing for these standards. DEQ temperature standards are:

- a stream identified as having salmon and trout rearing and migration may not exceed 18 °C,
- a stream identified as having core cold water habitat use may not exceed 16.0 °C, and
- a stream identified as having salmon and steelhead spawning occurring may not exceed 13.0 °C.

TEP has deployed continuous temperature monitoring devices in stream reaches designated as water quality limited for temperature to determine if streams in the Tillamook Bay Watershed are in compliance with State standards. These devices collect hourly temperature readings and are deployed during summer months to capture maximum annual temperatures. Maximum daily and seven-day average temperatures are calculated from these hourly temperature data.

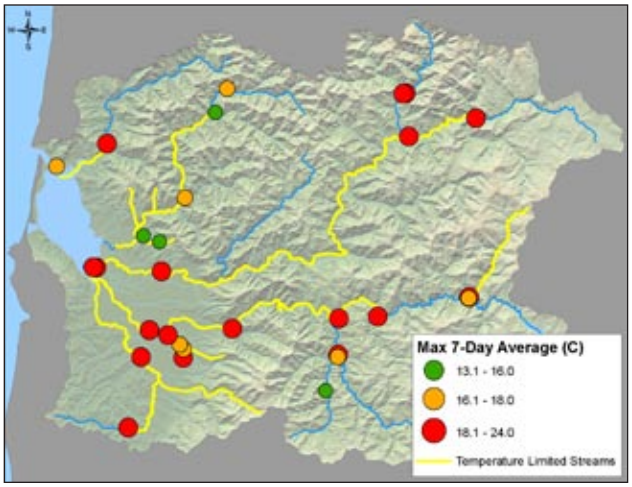


Fish use life cycle stage designations for temperature criteria.

Are maximum yearly surface water temperatures at levels that support salmon life cycle requirements?

Stream temperatures: Needs Improvement

The adjacent map illustrates TEP's stream temperature monitoring data. TEP has monitored stream temperatures in the Tillamook Bay Watershed for a short time. Our data with respect to this question is limited and should be viewed with this fact in mind. Small datasets may not reflect an entire stream temperature profile. Because stream temperature is greatly influenced by annual weather fluctuations, extreme high or low air temperatures, drought and other events can influence stream temperature to such an extent that samples taken during these periods may not be indicative of typical stream conditions. Long-term datasets are needed to truly understand stream temperatures and to evaluate trends. However, TEP's data show that during the period of time measured, the temperature standards are not being met at many of the monitoring locations. TEP has implemented many projects that target riparian restoration to help limit stream temperatures. These projects are described in the Habitat Restoration section of this document.

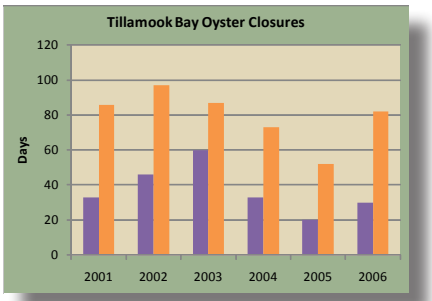


TEP temperature monitoring sites. Color indicates maximum value of the 7-day average temperature reading.

Why Should You be Concerned About Pollutant Levels in Clams?

Clams are particularly susceptible to pollution in sediments and the water column. As clams feed, they filter several liters of water every hour. As a result, small concentrations of pollutants in the water column and attached to suspended sediments can become concentrated in clam tissues. Low or acceptable levels of pollution in the water can lead to dangerous pollutant levels in clam and other creature's tissues. This process is known as bioaccumulation. People who eat even a small amount of shellfish with high pollutant concentrations can be affected. This process is also true for harmful bacteria. Low concentrations of fecal coliform bacteria in the water can become concentrated in shellfish tissues, making them unsafe to eat. This is especially true for oysters which are often eaten raw.

ODA monitors fecal coliform levels in Tillamook Bay and regulates oyster harvest based on the results. As noted in the bacteria section of this document, several sources of bacteria are present in the Tillamook Bay Watershed. As a result, oyster harvests are regularly closed due to unsafe fecal coliform levels in the Bay. TEP hopes efforts to control *E. coli* bacteria concentrations in the upper watershed will lead to fewer closures for oyster harvests in the Bay and reduce potential for bacterial contamination of shellfish in the Bay (*E. coli* bacteria being a subset of the large fecal coliform bacteria group).



ODA graph depicting days Tillamook Bay has been closed. Purple bar is west bay and orange is main bay.

Development of industry, agriculture, and urban areas in the Tillamook Bay Watershed has led to an increased potential for bacteria and other pollutants to affect shellfish. In 1999, the EPA Coastal Environmental Monitoring & Assessment Program (CEMAP) sampled fish tissue and sediments from approximately 35 sites in Tillamook Bay. Preliminary results of this study indicated that there is potential for elevated levels of toxic pollutants in fish tissues. Non-game fish, those not generally consumed by people, were sampled in this effort. As as result, the study did not draw a direct link to people. However, it did suggest potential for other aquatic life such as shellfish to also have elevated toxic pollutant levels in their tissues. People do eat shellfish from the Bay and if shellfish were found to have similar levels of toxic pollutants as the fishes sampled, then people that eat shellfish from the Bay could be affected. To address this concern, TEP partnered with DEQ, Oregon Department Fish and Wildlife (ODFW), and Oregon Department of Human Services (DHS) to further investigate toxics in Tillamook Bay by sampling shellfish (clam) tissue.

Do clams in the Bay contain levels of toxic pollution that could be harmful to humans if consumed?

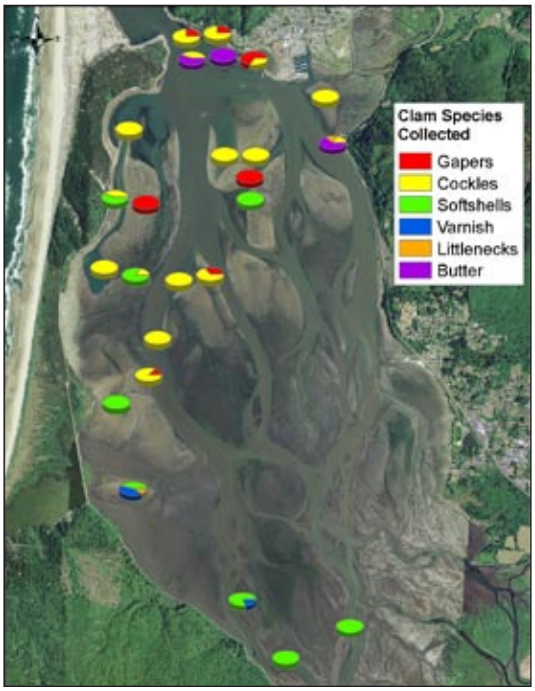
Bay toxins in clams: Healthy

Personnel from ODFW, TEP, and DEQ collected clam tissues and sediments from 25 locations in Tillamook Bay and three locations in Netarts Bay. Netarts Bay has not been as widely affected by human activity as Tillamook Bay and, therefore, samples from there could be used to establish naturally occurring levels of contaminants if problems were identified in Tillamook Bay. Sample areas proved to contain abundant amounts of clams, and several large specimens were collected including Gaper, Littlenecks, Butter, Soft-shell, and Cockle clams.

Tillamook Bay clams: Gaper, Cockles, Littlenecks, and Butter clams.

Clam tissues were analyzed for the following bioaccumulating pollutants: metals, PCB (polychlorinated biphenyls), PAHs (polycyclic aromatic hydrocarbons), chlorinated pesticides, and dioxins. The sediment samples were not analyzed initially, but were held for later analysis if results from tissue sample warranted additional investigation.

The most frequently detected metals in clam tissues were aluminum, arsenic, chromium, iron, and nickel. Dioxins were detected in only one sample. PCBs, PAHs, chlorinated pesticides, and mercury were not detected in any of the samples. These results were provided to DHS to determine if the levels detected could pose a risk to human health and if limits should be placed on the amount of clams people consume from the Bay. The Environmental Toxicology Section of the Office of Environmental Public Health, DHS, conducted a screening value risk assessment for the contaminants sampled in Tillamook Estuary shellfish. Based on a screening value risk assessment, DHS determined consumption of Tillamook Bay clams does not pose an undue threat to humans.



Tillamook Bay shellfish sampling sites.

Is Habitat in the Tillamook Bay Watershed Improving?

Initially, you need to identify what habitat types are found in the Watershed, if they are being impacted, and what is being done to restore them. Habitat is the natural environment where a plant or animal lives. There are four major types present in the Tillamook Bay Watershed: estuarine, lowland floodplain, upland forest and riparian.

Estuarine habitat

One of the most complex ecosystems on the earth, estuaries are important in the life cycle of many fish and wildlife species. The Bay's tidal channels and sloughs, intertidal sand and mud flats, eelgrass beds, and tidal marshes provide structural complexity and a rich source of food upon which salmon and other species depend.

Lowland floodplain habitat

Historically, low-lying areas in the Watershed were rich alluvial plains subject to regular winter flooding and vegetated with a mosaic of forests, shrublands, and open grasslands. Forests supply organic matter and insects to support aquatic food webs and are a source for large wood that promotes channel complexity. The long term presence of in-stream wood is essential to creating and sustaining complex wetland habitats. Low velocity off-channel areas, like alcoves, off-channel sloughs, oxbows, and connected wetlands offer ample habitat for rearing salmonids. Wetlands provide areas for flood storage, filter run-off, and buffer against effects of climate change such as sea level rise.

Upland forest habitat

Tillamook County's forestlands have provided timber for the wood products industries since the 1880s. The earliest European-American settlers considered the extensive stands of timber a hindrance to farming, but by 1894 the timber trade was the County's most important industry. Home of the headwaters of the five rivers and tributaries, upland forestlands play a vital role in water quality.

Riparian (streamside) habitat

Healthy riparian areas provide many benefits. Besides providing shade to limit temperatures, they stabilize stream banks, filter sediments and pollutants, improve habitat and wildlife corridors, and increase large wood recruitment to streams.

Why is Habitat Complexity and Quality Important?

The Tillamook Bay Watershed supports a variety of plants and wildlife, including five species of anadromous fishes: Coho, Chinook, and Chum salmon, and Steelhead and Cutthroat trout. These salmonids are integral to the economy, ecology, and culture of the Pacific Northwest. However, loss and degradation of important freshwater and estuarine habitats from historical and current forest, agricultural, urban, and rural land uses have adversely affected these species.

Fish and shellfish were historically plentiful in Tillamook Bay and supported a vibrant commercial fishing industry through much of the 1900's, some of which remains. The Bay has long been a major clam, oyster, and Dungeness crab producer. Although commercial oysters are not native, they were introduced in 1928 and conditions here are very favorable for their production.

Often considered one of Oregon's cornerstone species, Oregon Coast Coho salmon were first listed as Threatened under the Endangered Species Act (ESA) in 1998. In 2006, ODFW's Oregon Coastal Coho Assessment identified habitat complexity and degraded water quality as the two risk factors that most limit Coho populations in the Tillamook Bay. Habitat complexity, providing favorable refuge for good over-winter survival, is important for Coho, which spend their first year in freshwater before migrating to the estuary. Other factors potentially limiting Coho and other salmonids are wetland loss, degraded water quality, over-harvest, hatchery practices, fish passage barriers , poor ocean conditions, and predation. Many of these factors have reduced the quality of habitats in the Watershed for juvenile salmonids and other estuarine organisms.

What is Impacting the Bay's Habitats?

Dredging, large wood removal, sedimentation, diking, the breach of Bayocean Spit in 1952, and other factors have resulted in changes to the bathymetry of Tillamook Bay and reduced its structural complexity.

Approximately 85% of Tillamook Bay's tidal wetlands have been destroyed or altered and the quality of much of what remains is poor. Activities like diking, channel filling, levee and ditch construction, along with poorly designed tide gates and culverts, limit connectivity between aquatic habitats and adjacent wetlands and floodplains, as well as impact fish

passage. TEP has documented that dissolved oxygen in these sloughs often falls below State standards during the spring, summer, and fall. Water quality behind tide gates and cut-off sloughs suffers due to long retention times and limited tidal exchange further impacting salmonid populations.

Streams have been channelized, riprapped, and mined for gravel. Where livestock have access to streams, banks crumble and vegetation is trampled contributing to bacterial and sediment pollution in streams and the Bay.

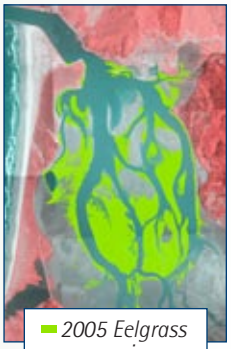
The Tillamook Burn, a series of forest fires from 1933–1951, profoundly affected the use of forestlands in the region. The fires destroyed about 200,000 acres of the old-growth forest and burned some areas repeatedly. Extensive road building was initiated for salvage logging, fire protection, and replanting efforts. The Burn contributed to high sediment loads during the mid 1900's. Salvage logging, which ended in 1959, left a legacy of poor-quality logging roads and skid trails, which may contribute to changes in landslide frequency and composition. Many of these roads have poorly designed culverts and road crossings, creating problems for fish passage, road failures, and sediment loads.

Historical unregulated timber harvest and clearing for agriculture, urban, and rural development has decreased the amount of large trees within riparian areas. These trees provide the foundation for shade and LWD in streams. Adequate levels of LWD are an important component of healthy salmonid habitat. Resource managers and other scientists acknowledge that the amount and distribution of LWD has been greatly reduced from historic levels. Settlers typically removed riparian trees to expedite log drives and cleared logjams with the intent to reduce flooding and improve navigation. Splash damming was once a common practice to move logs downstream, but this technique damaged instream and riparian habitats. Prior to the early 1980s, there was an effort to clear wood from stream channels to promote fish passage. It is now recognized that all of these activities caused changes in the hydrograph, sediment routing and deposition, and channel complexity.

Since the CCMP was completed in 1999, many of the practices that contributed to declining habitats have been modified or eliminated and dedicated organizations and individuals have supplied significant resources and implemented strategies for habitat restoration to recover these habitats. Nonetheless, the Watershed retains a legacy from historic practices that continue to cause adverse affects. Salmon and other species still face threats. Therefore, preserving and enhancing the habitats that support their diverse life histories is essential to their sustainability.

Eelgrass: An Indicator of a Healthy Estuary

An often overlooked habitat important to salmon and other vertebrate and invertebrate life histories is estuarine eelgrass beds. Eelgrass is a submerged aquatic plant that grows in estuaries and shallow bays. Two species of this flowering perennial occur in Tillamook Bay, *Zostera marina* (native) and *Zostera japonica* (introduced). Eelgrass is sensitive to disturbance and changes in water quality and is considered an indicator species for estuarine health. Monitoring changes in its abundance and distribution provides important clues about environmental stressors. Mapping efforts in the 1970's, 1995, 2005 and subsequent qualitative comparisons between the studies found that, although distribution apparently changed considerably, the presence in some areas had remained constant. TEP partnered with EPA in 2005 to employ remote sensing and field study to assess eelgrass in the Bay. The study documented that *Z. marina* beds were predominantly in the lower (oceanic) portion of the Bay, covering approximately 9% of the Bay. *Z. japonica* remained most common in the upper (riverine) portion of the Bay, occupying approximately 3% of the Bay. Care must be taken when comparing this study to the 1995 study, as very different techniques were used. However, these data suggest that eelgrass coverage remained fairly stable and the two species remained similarly segregated over the period between the studies.[4] [5]



2005 Eelgrass presence in Tillamook Bay

[4] *Earth Design Consultants, Inc. 1996. Determining Abundance and Distribution of Eelgrass (Zostera spp.) in Tillamook Bay Estuary, Oregon Using Multispectral Airborne Imagery. Earth Design Consultants, Inc., Corvallis, Oregon.*

[5] *Lee II, H. and C.A. Brown, (eds.) 2009. Classification of Regional Patterns of Environmental Drivers and Benthic Habitats in Pacific Northwest Estuaries. U.S. EPA, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Western Ecology Division. EPA/600/R-09/140.*

What are the Ecological Impacts of Lost and Degraded Habitats?

Human and natural disturbances in both terrestrial and aquatic environments can simplify or modify plant communities, exacerbate flooding, pollute waterways, increase non-native species distribution and abundance, and imperil native species. Individual disturbances typically affect a distinct area, but multiple disturbances often act synergistically to affect the function of entire watersheds or ecosystems. In TEP's study area, modifications to the environment have had many effects including reduced viability and productivity of salmonid populations. Notable changes to salmonid habitats include: altered instream complexity, limited availability of forage, increased turbidity, reduced cover from predation, and reduced off-channel refuge and rearing habitat. Healthy salmon and eelgrass populations are indicators of a properly functioning watershed. A healthy watershed supports natural hydrological functions and robust populations of native flora and fauna, as well as recreational and economic benefits for humans.

Snowy Plover
Doug Backlund

Endangered Species Act Listing

Native Species	*Federal Status*
FISH	
Coho Salmon (Oregon Coast)	Threatened
BIRDS	
Marbled Murrelet	Threatened
Northern Spotted Owl	Threatened
Western Snowy (Coastal) Plover	Threatened
INVERTEBRATES	
Oregon Silverspot Butterfly	Threatened
PLANTS	
Nelson's Checker-Mallow	Threatened

Non-Native & Invasive Species	Presence
FISH	
Asian Carp	No
Northern Snakehead	No
BIRDS	
Barred Owl	Yes
European Starling	Yes
House Sparrow	Yes
MAMMALS	
Nutria	Yes
Opossum	Yes
REPTILES & AMPHIBIANS	
American Bullfrog	No
Common Snapping Turtle	No
Red-eared Slider	No
INVERTEBRATES	
Chinese Mitten Crab	No
New Zealand Mud Snail	Yes
Quagga Mussel	Unknown
Rusty Crayfish	No
Red Swamp Crayfish	No
Zebra Mussel	Unknown
PLANTS	
Bull Thistle	Yes
Canada Thistle	Yes
Chordgrass, English, smooth	Unknown
Eurasion Watermilfoil	Yes
False Brome	Yes
Garlic Mustard	Unknown
Giant Hogweed	Unknown
Gorse	Yes
Hydrilla	Unknown
Knotweed	Yes
Lesser Celandine	Yes
Parrotfeather	Yes
Policeman's Helmut	Yes
Purple Loosestrife	Yes
Reedcanary Grass	Yes
Shining Geranium	Unknown
Spartina	No
Spurge Laurel	Unknown
Tansy Ragwort	Yes
Yellow Flag Iris	Yes

Species marked 'No' or 'Unknown' presence have potential to invade and threaten native species.

What is Being Done to Address These Impacts?

The CCMP charges TEP and watershed partners with:

- Enhancing the health of salmon, shellfish, and other aquatic species populations; and
- Assessing, protecting, and enhancing riparian, instream, wetland, and estuarine and tidal habitats.

TEP and partners employ a variety of protection and enhancement projects to address these issues. The following sections summarize project implementation results, highlight key projects, and provide the status of native salmonid and shellfish populations.

What is the status of native fish and shellfish populations?

Native fish and shellfish populations: Improving

Although fish and shellfish populations have been generally declining since European settlement, short term improvements for some species are contributing to population recovery.

Fish

The 2005 ODFW Native Fish Status Report (NFSR) describes the status of native Oregon fishes based on criteria defined in Oregon's Native Fish Conservation Policy (NFCP). The NFCP serves as ODFW's basis for managing hatcheries, fisheries, habitats, predators, competitors, and pathogens in balance with sustainable natural fish production. The NFSR describes the status of stocks by population and by the Species Management Unit to which they belong. In spite of the State status shown for Coho, the ESA provides the overarching management framework.

ODFW Native Fish Status Report

Species	Risk to Tillamook Bay Populations	Risk by Species Management Unit
Fall Chinook	Not at Risk	Not at Risk
Spring Chinook	At Risk	At Risk
Coho	Not at Risk	Not at Risk
Chum	Not at Risk	At Risk
Winter Steelhead	Potentially at Risk	Potentially at Risk
Sea-run Cutthroat	Not at Risk	Not at Risk

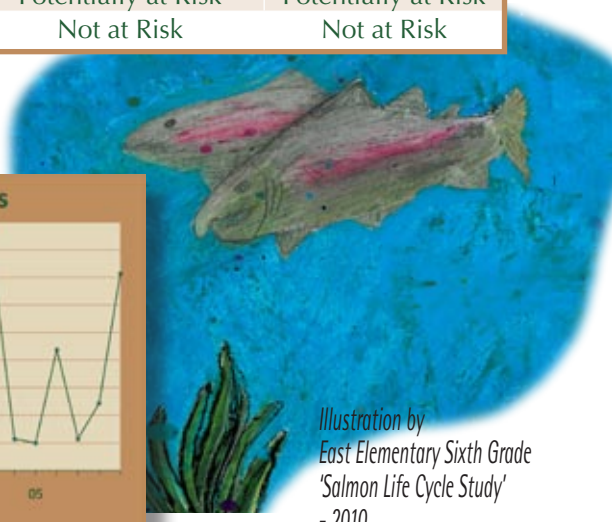
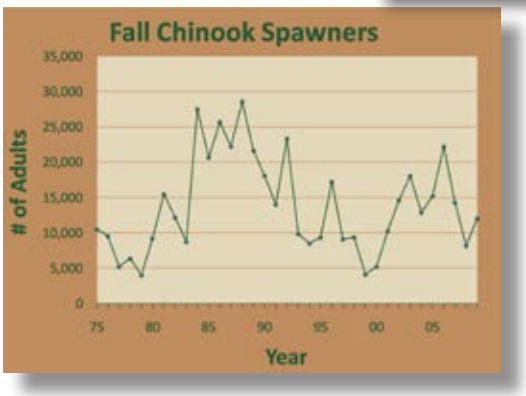
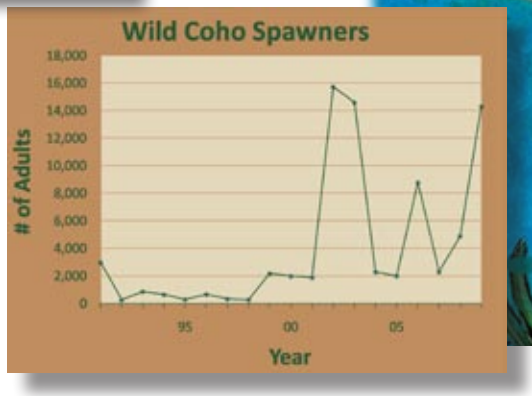
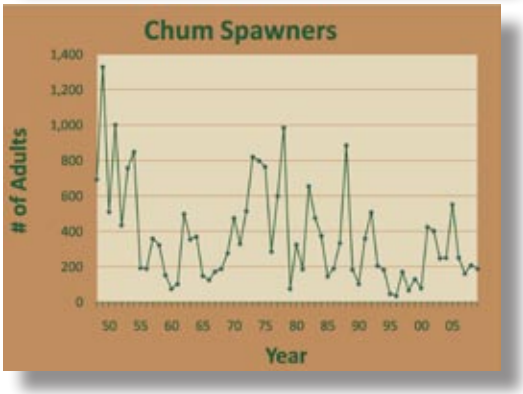


Illustration by East Elementary Sixth Grade 'Salmon Life Cycle Study' - 2010

Population Trends



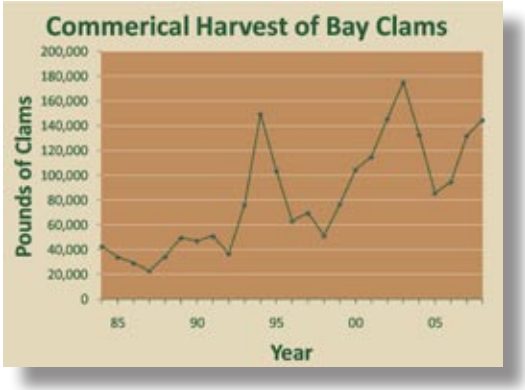




Shellfish

Tillamook Bay has the highest commercial landings and estimated recreational harvest of bay clams in Oregon. Cockles are the most important clam species for both the commercial and recreational bay clam fishery with annual commercial landings of 121,846 pounds (2008) and an estimated recreational catch of 77,700 pounds (March-September 2008).[6] ODFW's Shellfish and Estuarine Assessment of Coastal Oregon (SEACOR) group will be conducting shellfish population monitoring surveys in Tillamook starting April 2010 and continuing into 2011. SEACOR will record where recreationally important bay clams are found in the Bay, estimate their abundance and biomass, and determine estuarine habitat associations for each species. SEACOR is currently focused on the four commonly harvested species: the Gaper clam, Butter clam, Cockle, and Littleneck clam. However, there are several other clam species found within the Bay (i.e., Soft shells, Bentnose, etc.) that also may be quantified.

Although Dungeness crab is a commercially and recreationally important species, little population monitoring within Tillamook Bay has been completed. The Oregon Recreational Bay Crab Survey estimates 31,500 pounds were harvested from Tillamook Bay in 2008.[6] Approximately 1,040,000 pounds of ocean-caught crab were landed at the Port of Garibaldi in 2009.



[6] *Oregon Department of Fish and Wildlife, Marine Resources Program, Newport, Oregon. http://www.dfw.state.or.us/MRP/publications/Ainsworth_Vance_Rec_catch_effort.pdf, accessed on 03/08/2010*

How has instream habitat been improved?

Instream habitat: Improving

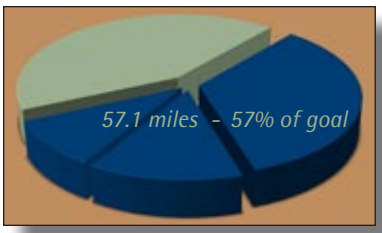
Instream habitats in the basin have been improved through the implementation of a variety of projects such as culvert replacements, large wood placements, and road decommissioning. These projects aim to restore natural stream processes such as floodplain connectivity, sediment routing and retention, fish and wildlife passage, and channel avulsion.

Placing large wood in stream channels and floodplains increases habitat complexity. It improves retention of spawning gravels and organic debris and provides cover that reduces salmon predation and the potential for juveniles to be flushed downstream during flood events. Programs such as TEP's Backyard Planting Program establish diverse riparian areas to support long-term large wood recruitment and limit stream temperatures.

Removing culverts, often associated with road decommissioning, or replacing culverts with bridges or open bottom culverts, expand access to habitats for both fish and wildlife.

Decommissioning low priority or problem forest roads typically involves removal of drainage structures, decompacting road bed soils, restricting vehicle access, and planting native vegetation.

Over the last eight years, TEP and its partners have improved instream conditions along 57 miles of stream.



CCMP Goal = 100 instream miles
9.6 miles road decomission
13.3 miles large wood
34.2 miles fish passage

The Ideal Instream Project

With a partnership unique for its time and extraordinary benefits yet to be discovered, the 2005 Cruiser Creek project may be a truly perfect instream project. Cruiser Creek, in the upper Trask River watershed, straddles ODF and BLM lands. With fish passage, salmon habitat, and riparian enhancement goals in mind, TEP, ODF, BLM, and six other partners replaced barrier culverts, placed large wood jams in the streams, decommissioned forest roads, and under-planted alder-dominated riparian areas with conifers for only $190,000.

Coho spend a year in freshwater before migrating to the estuary as smolts. Post-project monitoring in Cruiser Creek found that juvenile Coho salmon over-winter retention increased from 5% to an average of 15.5% for three consecutive years, while rates remained stable in nearby untreated reaches. The project's success led to the completion of a complementary second phase of wood placement on Elkhorn Creek in 2008. Cruiser Creek is a tributary of Elkhorn Creek.

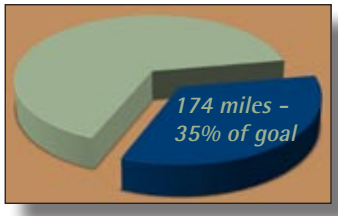
*Two years after project completion in Elkhorn, over-winter retention rates have **improved from 6.3% pre-project to 38.2%.** The structures have unequivocally succeeded in creating vast surface areas of highly complex, low velocity habitat that is stable and present at variable winter flows. In short, the project has created exceptional over-winter habitat. Steve Trask of Bio-Surveys, LLC., conducted the monitoring and noted that "these rates document the most radical recovery of production potential we have witnessed in 30 years of coastal stream monitoring".*[7]

[7] *Trask, S. 2010. Elkhorn and Cruiser Creek Project Effectiveness Monitoring Report 2010. Bio-Surveys, LLC. Alsea, Oregon.*

Has riparian habitat enhancement increased?

Riparian habitat: Improving

Since 2001, TEP and partners have enhanced nearly 200 riparian miles in the Tillamook Bay Watershed. These projects typically include mechanical removal of invasive and non-native vegetation, planting diverse native plant communities, and construction of off-channel watering stations and livestock exclusion fences. TEP's Backyard Planting Program, a voluntary assistance program to private landowners, implements many of these projects annually free of charge.



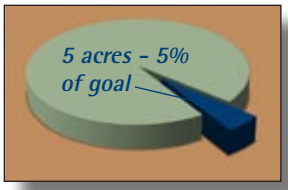
CCMP Goal = 500 riparian miles

Knotweeds are aggressive, fast-growing invasive perennials introduced in the late 1800's. They thrive in a variety of habitats and out-compete native species, often dominating aquatic, riparian, forest, and upland areas. The resultant homogeneous stands have low species diversity and decrease bank stability, wood recruitment, shading, and nutrient inputs to soils and streams. Because knotweeds can easily spread by small root fragments, they dominate over 80 miles of Tillamook Bay's waterways.

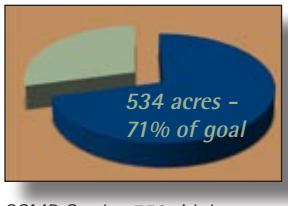
Are tidal and freshwater wetlands being protected and/or restored?

Tidal wetland protection/restoration: Improving

Freshwater wetland protection/restoration: Needs Improvement



CCMP Goal = 100 freshwater acres



CCMP Goal = 750 tidal acres

Numerous studies and planning efforts have identified Tillamook Bay as a high priority area for wetland conservation and restoration. Tidal and freshwater wetlands are essential to the survival of wetland-dependent species, protection of water quality, and buffering potential effects of climate change. A Tillamook Bay Estuary Assessment planned for 2011 will provide support for strategic restoration efforts along the Bay.

In recent years, TEP and partners have been successful in acquiring and protecting wetlands, including 375 acres at the mouth of the Wilson and Trask Rivers. Planning for restoration of these acquired wetlands and others (see below), is ongoing.

The Miami Wetlands

TEP initiated the 58-acre Miami Wetlands Enhancement Project in 2004. Although a seemingly straightforward project at its conception, it has grown to potentially surpass the ecological benefits and design scope originally envisioned. Project implementation begins in 2010 and aims to restore and permanently protect important wetlands at the mouth of the Miami River.

Like the four other watersheds that feed Tillamook Bay, diking, draining, and other human activities have adversely affected much of the original palustrine emergent, scrub-shrub, and forested wetlands in the Miami River watershed. Within the project site, the 44 acres of remnant palustrine wetlands have also been affected by the introduction of non-native plant species and construction of the railroad and highway across the mouth of the Miami. In addition to reduced habitat quality and quantity, the lower Miami River is water quality limited for temperature and bacteria.

Habitat simplification and degraded water quality likely limit productivity of Miami River salmon, especially Chum and Chinook which spend a substantial portion of their juvenile life-stage in the estuary. The Miami is one of only three watersheds that support these species in the Tillamook Bay basin.

Adjacent to Highway 101, this high-visibility project is the only opportunity in the 23,000-acre Miami basin to protect and restore historical tidal spruce swamp at the tidal-freshwater interface, a rare and critical habitat for out-migrating salmon smolts. The project also blends the needs and desires of a diverse group of partners and landowners and provides public education and monitoring opportunities. Enhancing and protecting the wetlands at the mouth of the Miami River is vitally important to sustaining salmon populations in the Miami River basin.

The project strives to eliminate as many human alterations as possible and allow natural forces to restore wetland functions. These natural forces (tidal flows, riverine flooding, sediment deposition, etc.) are necessary for the return of historic wetland function over time.[8] The design restores tidal spruce swamp communities by increasing the quantity and quality of freshwater and tidal channels and enhancing the remnant historical character of the site's vegetation. Activities will include ditch filling, stream re-meandering, tidal channel excavation, large wood placement in the channels and floodplains, non-native plant removal, and native plant establishment. The project also relocates an overhead utility system to an underground system to allow for the restoration to occur. Partners also are pursuing options for permanent protection of the project area.


Don Best/Best Impression Picture Co.

[8] *Brophy, L.S. (Green Point Consulting), and K. So. 2005. Tidal Wetland Prioritization for the Nehalem River Estuary. Prepared for U.S. Fish and Wildlife Service, Oregon Coastal Program, Newport Field Office. Available online at www.GreenPointConsulting.com/reports.html.*

Photo by Roger Ross Photography

Wilson-Trask Wetlands

The Oregon Watershed Enhancement Board (OWEB) partnered with Oregon Wetlands Joint Venture, Ducks Unlimited, and ODFW to develop a project aimed at the protection and restoration of coastal wetland habitats in Tillamook Bay. They identified willing property owners and received acquisition funds from OWEB, U. S. Fish and Wildlife Service, and the National Oceanic and Atmospheric Administration (NOAA).

TEP was tasked to administer the grant funds and manage the acquisition process. The Trust for Public Lands successfully negotiated purchase agreements for three contiguous parcels near the mouth of the Wilson and Trask rivers with outstanding restoration potential. Tillamook County requested that partners work with the community to develop a management plan that could be supported by the broad range of interests involved. In 2002, Tillamook County adopted the Tillamook Bay Wetlands Management Plan and accepted title to the 375 acres of wetlands, locally known as the 'Wilson-Trask Wetlands'.

Decades of floods throughout Tillamook County have caused significant property damages. In 2006, state, county, and city representatives sent Governor Ted Kulongoski a letter requesting that Tillamook flood mitigation efforts be designated an Oregon Solutions Project. The Oregon Solutions process provides a framework for public and private sectors to collaborate in addressing community needs. A project assessment was conducted, followed by the Governor's official designation in April 2007.[9]

The newly assembled Oregon Solutions Project Team prioritized a list of projects, two of which have been combined and labeled 'Project Exodus'. The main focus of Project Exodus is enhancement of the Wilson-Trask Wetlands. As a project chosen for its significant flood reduction benefits, the ecosystem benefits are equally impressive. A dike surrounds the property and isolates it from the Bay and tidal inundation. An extensive planning effort is underway to remove the dike and return the wetland to a natural, tidally-influenced state

The Wilson-Trask Wetland properties are open to the public (foot traffic only).

that supports high salt marsh, brackish marsh, and forest wetland habitats. Construction of a new levee will protect adjacent lands from tidal inundation. Inclusion of an additional 106 acres at the mouths of Hoquarton and Dougherty sloughs magnifies the ecological and flood reduction benefits gained from removing or setting back the existing levees on the Wilson-Trask property. The restoration of tidal wetlands creates a buffer from the effects of weather and climate change creating resilient communities. This proposed project will be the largest wetland restoration project in Oregon.

As previously discussed in the habitat enhancement and water quality sections of this report, human alterations have impacted approximately 85% of Tillamook Bay's tidal wetlands. These wetlands once supported a productive food web, high species diversity, floodwater retention, run-off filtering, and climate change buffering. The enhancement and permanent protection of large contiguous wetlands like the Wilson-Trask and Miami are vital to sustaining the ecological health of Tillamook Bay.

Effectiveness Monitoring

The TEP is developing a Project Effectiveness Monitoring Program in 2010. Project-scale effectiveness monitoring measures environmental parameters to determine if habitat enhancement actions result in desired changes in habitat conditions. This evaluation process requires both pre- and post-project data collection and will allow us to assess and compare habitat enhancement projects we undertake. TEP will use monitoring protocols that are consistent with other effectiveness monitoring efforts in our region. This will decrease the time and effort needed to develop our program and increase its utility beyond our organization by allowing for comparison among projects in a broader regional context. Effectiveness monitoring will be incorporated into all of our future habitat enhancement projects.

Tillamook Oregon Solutions Project Project Team

Oregon State Senator Betsy Johnson
Tillamook County Commissioner Mark Labhart
Oregon State Representative Deborah Boone
Tillamook County Management Analyst, Paul Levesque
Tillamook Bay Habitat and Estuary Improvement District
Oregon Watershed Enhancement Board
Farming Community
City of Tillamook
Oregon Farm Bureau
Tillamook Estuaries Partnership
U.S. Army Corps of Engineers
Tillamook County Soil Water & Conservation District
Tillamook Bay Community College
Governor's Economic Revitalization Team
Oregon Economic and Community Development Dept.
Tillamook County General Hospital
Oregon Department of Forestry, Tillamook District
Downtown Businesses
ODFW, North Coast Watershed District
Tillamook County Emergency Management
Oregon Department of Transportation
Oregon Department of Environmental Quality
Local Fishing Guide
Port of Tillamook Bay
Tillamook County Creamery Association
Trust for Public Land
NOAA's National Marine Fisheries
Oregon Department of State Lands
U.S. Fish and Wildlife Service
Oregon Department of Land Conservation and Development

Congressional representation:
Senator Ron Wyden's Office
Senator Jeff Merkley's Office
Congressman Kurt Schrader's Office

Project Manager: Dick Townsend

[9] *Northwest Hydraulic Consultants, Seattle, Washington and HBH Consulting Engineers, Sherwood, Oregon. October 2009. Project Exodus Draft Final Report.*

Partners: Working with organizations to improve

the State of Tillamook Bay

The following brings focus to a few of the many projects that have been or are being undertaken in our Watershed:

Water Pollution Reduction

The **City of Tillamook** removed soils contaminated with petrochemicals from an industrial site along Highway 101. The City also has completed a new wastewater treatment plant and is working on improvements to its stormwater management system. The City of Tillamook and the **Tillamook Bay Habitat and Estuary Improvement District** have worked with multiple partners to mitigate the effects of flooding across north Highway 101 and reduce water quality impacts during flood events.

The **Oregon Department of Forestry, Oregon Department of Fish & Wildlife, Tillamook Bay Watershed Council,** and **Green Diamond Resource Company** all participated in forest road closure and rehabilitation projects over the past decade. Forest roads can be a source of sediment discharges into streams and rivers that feed Tillamook Bay. Selectively closing and rehabilitating road segments reduces potential for sediments and other pollutants to enter waterways.

The **City of Bay City** constructed a bio-swale along a portion of Main Street to reduce the potential for stormwater-borne pollutants to enter Patterson Creek.

Riparian Plantings and Livestock Management

The **Tillamook Bay Watershed Council, Oregon Department of Agriculture, Oregon Department of Environmental Quality, Oregon Department of Fish & Wildlife, Oregon State University Extension, Oregon Watershed Enhancement Board, Tillamook Native Plant Cooperative, Tillamook County Creamery Association, Tillamook County Soil & Water Conservation District,** and several **Private Landowners** have planted native riparian vegetation, controlled invasive plants (such as blackberry), and installed livestock exclusion fences and off-channel livestock watering stations on numerous properties.

The **U.S. Natural Resources Conservation Service** has worked with numerous **Private Dairy Owners** to develop Comprehensive Nutrient Management Plans. These plans include BMPs to reduce negative impacts to water quality.

Fish Passage

Stimson Lumber Company and **Oregon Department of Forestry** removed or replaced numerous undersized culverts on their properties.

The **Oregon Department of Transportation** replaced an undersized culvert with a bridge and re-aligned the stream channel on Fall Creek at its confluence with the Wilson River.

The **Oregon Department of Fish & Wildlife,** in conjunction with the **Association of Northwest Steelheaders** removed a water diversion dam from Blue Bus Creek, a tributary of the East Fork Trask River.

The **Tillamook Bay Watershed Council** has worked with several partners to replace problem culverts throughout the Watershed.

Large Wood Placement

The **Oregon Department of Forestry** has completed several projects that placed large wood in channels and has supplied trees and logs for use on projects completed by others.

The **Tillamook Bay Watershed Council** has partnered extensively in completing several large wood projects in the Wilson, Trask, and Tillamook river watersheds.

The **Oregon Department of Fish & Wildlife** has led several large wood projects and provided technical assistance for many more.

Monitoring

The **Oregon Department of Forestry** and **Oregon Department of Fish & Wildlife** regularly survey streams to evaluate fish distribution and inform management planning efforts. They also monitor juvenile and adult salmon populations through weirs and smolt traps in the Trask and Wilson watersheds, and spawning and juvenile snorkel surveys throughout the Watershed.

Additionally, the **Oregon Department of Fish & Wildlife** inventories physical stream attributes through their Aquatic Inventory Project.

Assessments

The **Tillamook Bay Watershed Council** completed a limiting factors analysis to evaluate salmon habitat conditions and guide efforts to enhance streamside and in-stream habitat conditions.

Principle Funders

Several entities have contributed substantial funding for conservation projects that TEP and our partners have completed in the Tillamook Bay Watershed.

The **U.S. Environmental Protection Agency** is a primary funder of the TEP, through its National Estuary Program, and supports restoration efforts throughout the Watershed.

The **Oregon Watershed Enhancement Board** has funded numerous projects completed in the Watershed. OWEB is funded primarily through Oregon Lottery revenues, Salmon license plate revenues, and federal Pacific Coast Salmon Recovery Funds.

The **U.S. Fish & Wildlife Service** has contributed to several conservation projects in our area through its Partners for Fish and Wildlife and Coastal programs.

The **National Oceanic & Atmospheric Administration** and **National Fish and Wildlife Foundation** programs have funded several partner projects throughout the Watershed.

The **Oregon Department of Environmental Quality's** 319 Program has funded our Backyard Planting Program and the Children's Clean Water Festival, and provides funds to support TEP's monitoring efforts and Monitoring Coordinator position.

The **U.S. Bureau of Land Management** has funded several large-scale habitat enhancement projects such as Cruiser Creek and Elkhorn Creek that included large wood placement and riparian plantings.

Photos: Don Best/Best Impression Picture Co., Roger Ross Photography, and the U.S. Bureau of Land Management

Why is it Important to Foster Citizen Involvement?

Environmental awareness within the community, and sound environmental decision-making by stakeholders, depends upon focused education programs and citizen involvement. Research shows that satisfaction goes up when citizens feel they can influence decisions. Community participation results in a sense of pride and ownership in something they have helped create. Many issues of concern will only be resolved if citizens and decision makers are engaged and contribute their knowledge and resources. Collaborative solutions lead to long-term sustainable results.

Education also plays a role in sustainable environmental results. Individuals and groups make informed decisions based on expanded knowledge and perspectives. Sometimes traditional instruction, such as lecturing, is the most practical approach to covering broad content. But when students or citizens learn through a problem or project-based approach, a key strategy in environment-based education, they gain a better understanding of what they learn, retain it longer, and take charge of their own learning. Using outdoor settings like wetlands, streams, or forests can infuse a sense of richness and relevance into traditional school curriculum.

TEP, watershed councils, school districts, and local, state and federal agencies have made concerted efforts to work collaboratively towards achieving the CCMP goals of improving and strengthening community and K-12 environmental education and raising awareness of natural resource issues in all Tillamook County watersheds.

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Are K-12 environmental education opportunities available to students in Tillamook County?

K-12 environmental education: Improving

The breadth and depth of environmental education opportunities available in Tillamook County schools is impressive. Each of the three school districts utilize different practices to ensure state science benchmarks are being reached. Methods range from a district wide approach to focusing on individual classroom and teacher requirements. Limited budgets and staff impact the amount of opportunities available, especially when moving instruction out of the classroom and into the field.

Science-based inquiry and research are hallmarks for activities included in Tillamook County's K-12 environmental education efforts. At the elementary school level, students are learning the importance of riparian areas by participating in invasive species removal and native plant propagation or using Global Positioning System (GPS) units to map soil types and plant species in a wetland. Middle school classes are raising salmon in the classroom to engage students in stewardship through increased awareness of the unique salmon life cycle and habitat requirements. At the senior high level, students are monitoring water quality and characterizing channel cross-sections on the Wilson-Trask wetlands and other project sites. Information gathered at these sites is being used to develop baseline data that will help evaluate project success and inform future restoration efforts beyond the classroom.

These are just a few examples of learning experiences available for K-12 students. Soils, natural history, aquatic invertebrates, and rocky intertidal zones are other topics that are woven into classroom curricula and add to the growing environmental awareness of Tillamook County students. Organizations such as TEP, OSU Extension, watershed councils, land trusts, KELP (Kiwanda Educational Learning Program), and Tillamook County Outdoor School, offer place-based scientific exploration encounters for local students that supplement school district efforts. Challenges to strengthening natural resource instruction in Tillamook County include funding for transportation, classroom resources and teacher training, and increasing opportunities for participation in community supported restoration efforts. TEP recognizes a need for a comprehensive assessment of environmental education and public outreach activities in Tillamook County and will pursue development of a strategic plan for its Education Program. This plan will guide TEP and partners in determining the best approaches to increase and strengthen natural resource education in Tillamook County.

Education Kits

To encourage environmental awareness, TEP and partners developed curriculum kits for use by teachers in their classrooms. These kits are inspired by CCMP priority actions, such as water quality, riparian restoration, and wetlands preservation.

Roger Ross Photography

Environmental Awareness: *"To be aware of the fragility of the environment and of the interdependence between the environment and mankind"* - American Heritage Dictionary

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A Sense of Place

Two of TEP's flagship environmental education events are the Down by the Riverside and Children's Clean Water Festival. These events provide opportunities for "hands-on" natural resources education activities for 3rd and 4th grade students, respectively. These events help students gain a sense of place about the environment they live in while complementing existing school curriculum. Prior to each event, TEP staff works with participating teachers, administrators, and presenters to develop and coordinate curricula and conduct in-class environmental education sessions.

At Down by the Riverside, students participate in watershed restoration and enhancement activities including invasive species control, trail maintenance, garbage clean up, and riparian restoration plantings. The Children's Clean Water Festival attracts environmental educators from established institutions such as Oregon Museum of Science and Industry, Jackson Bottom Wetlands Preserve, and Hatfield Marine Science Center, offering Tillamook County students access to nationally and regionally recognized leaders in their respective fields of study. Topics such as macro-invertebrates, water quality, the water cycle, salmon, riparian areas, invasive species, and stewardship are presented in exciting hands-on workshops. Volunteers help shepherd classes to each activity and discover the wonders of our watersheds along with the students.

Is awareness of natural resource issues and citizen involvement promoted in Tillamook County?

Citizen involvement/Natural resource awareness: Improving

Citizens of Tillamook County have many opportunities to raise their awareness of natural resource issues. One tangible way is to join a local watershed council. Watershed councils are locally organized, voluntary, non-regulatory groups established to improve the conditions of watersheds in their area. Councils represent the varied interests in the basin and are balanced in their makeup. Council members collaborate to identify issues, promote cooperative solutions, focus resources, agree on goals for enhancement, and foster communication throughout the watershed. Tillamook County is fortunate to have four active watershed councils: Tillamook Bay, Lower Nehalem, Upper Nehalem, and Nestucca/Neskowin - Sand Lake.

Lower Nehalem Community Trust (LNCT), Tillamook SWCD, and OSU Extension also provide opportunities for citizen involvement. The LNCT began as a community initiative to preserve one specific piece of property and expanded its mission to include volunteer monitoring, workshops on natural resources issues, K-12 education, and a community garden. Working with agricultural landowners, Tillamook SWCD promotes conservation practices that reduce soil erosion and improve water quality. SWCD has been designated by the County as the primary agent for noxious weed control and encourages citizen involvement in controlling weeds before they gain a foothold. OSU Extension hosts classes on landscaping with native plants, early detection of invasive species, and low impact development. A future goal for OSU Extension is the creation of a Master Naturalist Program. This program would foster citizen advocates for natural resource issues and generate a pool of volunteers for environmental data collection efforts.

Funding, adequate staffing levels, and the need for a consistent message across diverse entities are limitations to increasing awareness and promoting citizen involvement. Together, TEP and partners can mitigate these obstacles and determine the best approaches for engaging the community in collaborative solutions. TEP strives to involve citizens in the work of implementing the CCMP whenever possible. Furthering citizen stewardship through its programs such as the Volunteer Water Quality Program, Hoquarton Interpretive Trail, Tillamook County Water Trail, and the Speaker Series encourages active participation by individuals in achieving research, restoration, and preservation goals.

Tillamook County Water Trail (TCWT)

Increased use of the area's abundant rivers, sloughs, and bays were the impetus for this multi-phase, community driven project. Citizens, local agencies, and recreational enthusiasts, all seeking a common source of information about the area's waterways, came together to develop what is known as the Tillamook County Water Trail (TCWT). TEP has been working with these partners, for the past five years, designing a water trail system that will eventually encompass each of the County's five estuaries detailed in waterproof, full-color guidebooks. This series of guidebooks will serve as a tool to explain sensitive environmental issues of the watersheds, provide safety information, depict the location of public access, offer suggested paddle trips and describe amenities. The first in the series, the Nehalem Water Trail guidebook was published in 2007. The Tillamook Bay Water Trail guidebook is scheduled for release in June 2010.

The TCWT attracts a broad range of individuals, each adding unique perspectives and ideas that enhance the project. Groups from around the state have hosted excursions introducing non-motorized boaters to our local waterways and their unique ecosystems. Paddle clean-ups, educational tours, and water quality and invasive species monitoring have also been undertaken by users of the TCWT. Utilizing targeted outreach in regional newspaper articles, internet, and personal presentations, the TCWT has proven to be a catalyst for increased interest in paddling throughout Tillamook County. The project has moved beyond its original vision to become a valuable tool not only for recreationalists, but for individuals interested in sustaining this region's vital natural resources.

Volunteers: Working with people to improve
the State of Tillamook Bay

The following brings focus to a few of the many ways citizens are involved in the restoration of our Watershed:

Water Quality Monitors

Volunteers have been braving wind, rain, sleet, and occasional sun since 1995 to collect water samples from all five of the major rivers entering Tillamook Bay. These hardy individuals are the critical component to the success of TEP's water quality program. Samples are transported to TEP's laboratory and analyzed for bacteria (*E.coli*) concentrations. The primary intent of this monitoring effort is to understand the status of the five rivers and their tributaries in relation to the State bacteria water quality standard. This information was used in part for the development of the State bacteria standards for Tillamook Bay. The data is currently used to prioritize areas on which to focus improvement efforts.

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Hoquarton Interpretive Trail (HIT)

Margaret Mead famously said, "Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has". This quote certainly applies to the HIT committee. Diligently working for over a decade, their dream of converting a neglected, former industrial site along Hoquarton Slough into a vibrant, natural interpretive trail was realized in 2010. Now native vegetation, including Sitka spruce and hemlock, form the basis of a healthy riparian area, migratory birds crowd nearby trees, and local residents and visitors stroll past verdant meadows free of invasive species. This four acre oasis in downtown Tillamook is a true testament to citizen stewardship.

Tillamook Native Plant Cooperative (TNPC)

Watershed assessments have recommended riparian restoration for 400+ miles of stream in Tillamook County. This daunting task prompted watershed councils, TEP, BLM, SWCD, and the Oregon Youth Authority to join forces and establish the TNPC. They recognized that a primary challenge of implementing riparian enhancement projects was securing a low-cost supply of locally-adapted, native plant materials. By collecting and growing native seeds and cuttings, volunteers propagate about 60,000 trees and shrubs annually. Since its inception in 2002, the TNPC partners have provided plant materials used for riparian enhancement projects along more than 200 miles of stream.

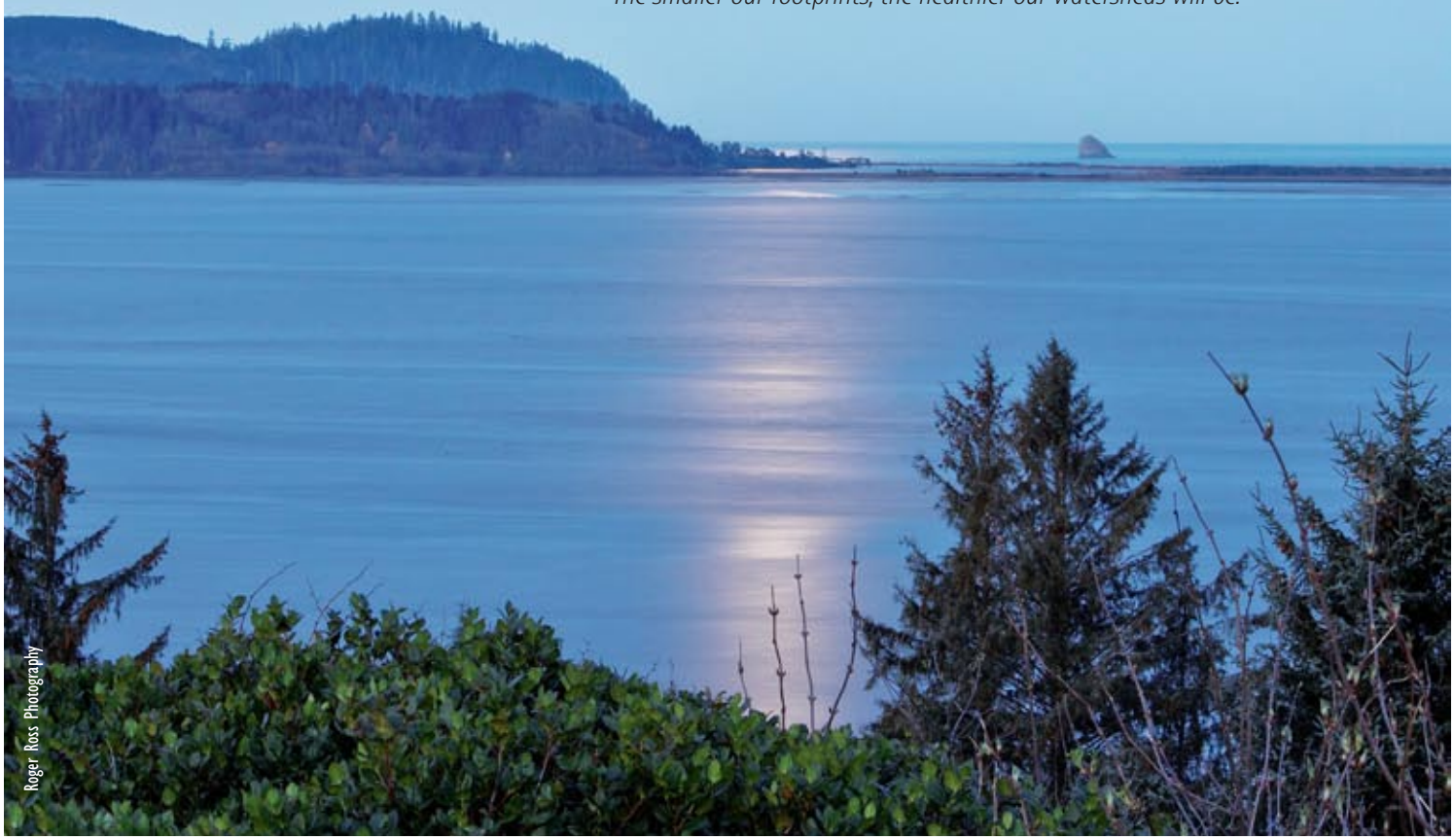
Achieving Balance and Moving Forward

It is easy to see that a lot of work has been done in the Tillamook Bay Watershed... and that a lot more needs to be done. The estuary is a complex and diverse ecosystem, and so are the solutions to achieving a healthy bay. The need for balance continues to be a driving force as the landscape changes and multiple human uses continue to affect the Bay and its watershed. TEP and partners have planted trees along more than 200 miles of stream bank, eliminated fish passage barriers, and used large wood to create complex stream channel habitats for salmon and other fish species. These restoration activities, along with Best Management Practices and education, are influencing water quality trends and resulting in quantifiable improvements in some of our largest rivers. Without partnerships, these successes would not be possible.

As we move forward, expect to see more organizations join together to coordinate resources and strengthen partnerships. While planning and implementation for water quality and habitat restoration projects are on-going, new projects are surfacing. Monitoring the effectiveness of restoration projects will be increasingly important to assess the success of these projects, develop and refine techniques, and document short and long term habitat changes. To that end, TEP is developing the Effectiveness Monitoring Program described earlier. We are also aware that as more development takes place and land uses continue to diversify, it is important to understand the dynamics of how people are affecting water quality. Working with multiple partners, TEP will implement a number of research projects to determine how a growing population is influencing water quality in the basin. Anticipated impacts from climate change will continue to guide restoration and conservation efforts. Understanding the vital role that estuaries and wetlands play in creating a more resilient community will help us plan projects that reduce the negative environmental, social and economic effects associated with climate change.

TEP and our partners are committed to restoring healthy and functioning natural systems throughout not only the Tillamook Bay Watershed but all of Tillamook County's bays and watersheds. To make this happen, we all need your help. There are many ways you can support restoration and conservation efforts in your watershed: volunteer with TEP or your local watershed council; use native vegetation in your landscaping and curb the use of chemical fertilizers and pesticides; maintain your septic systems; plant riparian buffers along your riverbank; appreciate the beauty of the county; and as always reduce, reuse, and recycle.

The smaller our footprints, the healthier our watersheds will be.



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GLOSSARY

Alluvial Soils – Soils composed of sediment transported and deposited by flowing stream water.

Anadromous – Fish that typically are born in freshwater streams, mature in the sea, and return to streams to spawn.

Bankfull Depth and Width - The average depth and width of a stream measured at bankfull discharge. Bankfull discharge is the dominant channel forming flow with a typical recurrence interval of one to two years.

Bathymetry – The information derived from measurement of water depth at various places in a body of water; similar to topography for terrestrial areas.

Decommission – To physically alter unused and abandoned roads in an attempt to restore the area to its natural state. Usually includes removing culverts and bridges, breaking up the road surface, and encouraging re-vegetation of the road surface.

Dissolved Oxygen – The amount of gaseous oxygen dissolved in water; measured in milligrams/Liter. Adequate dissolved oxygen is necessary for good water quality.

Estuary – A coastal water body where fresh water from a river or stream mixes with salt water from the sea.

Food web – A complex system of energy and food transfer between organisms in an ecosystem.

Intertidal – Occurring between mean high and low water levels. In Tillamook Bay, intertidal areas are fully or partially exposed twice daily during low tides.

Over-Winter Retention – The percentage of summer rearing salmonid parr remaining in a stream segment after being exposed to a full winter's flow regimes and just prior to smolting.

Palustrine - Inland, nontidal wetlands characterized by the presence of trees, shrubs, and emergent vegetation (vegetation rooted below water but grows above the surface). Palustrine wetlands range from permanently saturated or flooded land (e.g., marshes, swamps, and lake shores) to land that is wet only seasonally (e.g., vernal pools).

Riparian – Pertaining to the area adjacent to a stream or river.

Salmonid – Fishes belonging to the family Salmonidae, which includes salmon, trout, char, and whitefish.

Sediment – Soil, rock, or organic particles transported and deposited by rivers and streams.

Slough – A side channel or inlet; a sluggish channel or small backwater. In our area these are former river channels which now receive mostly tidal water.

Smolt - The salmonid life-cycle stage when juvenile salmon undergo the physiological adaptation from freshwater to saltwater during ocean migration.

Stream Order – The numbering of streams in a network. The most widely used system was developed by Strahler in 1952. This system classes all unbranched streams as first order streams. When two first order streams meet, the resulting channel is a second order stream, and so on.

Turbidity – The cloudiness or haziness of a fluid caused by individual particles suspended in the fluid, similar to smoke in air. Turbidity is one of the basic tests of water quality.

Watershed – The entire surface drainage area that contributes water to a lake, river, or estuary.

Wetland - An area that is influenced by surface and subsurface water for at least part of the year, and has characteristic soils and vegetation.

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For more information about the National Estuary Program visit: www.epa.gov/nep

We regret any errors or omissions; please notify us: 503-322-2222 or info@tbnep.org

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The Tillamook Estuaries Partnership is dedicated to the conservation and restoration of the five Tillamook County estuaries and their watersheds

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