

# TILLAMOOK ESTUARIES PARTNERSHIP

## State of the Bays 2015: Executive Summary



**Tillamook Estuaries Partnership**  
*A National Estuary Project*



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

We are the Tillamook Estuaries Partnership.

## Expanding Horizons

Five estuaries, seven major rivers, and streams and creeks too numerous to count...this is the study area of the Tillamook Estuaries Partnership. Each watershed is special in its own way. Yet, many of the challenges and opportunities are the same. With diverse ownerships and multiple uses throughout the Watersheds, finding balance is more important than ever.

TEP's history is over 20 years long, beginning with the nomination to 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, Tillamook County was recognized as a community that works together to address its problems. With the designation of Tillamook Bay as a "Bay of National Significance" in 1994, the Tillamook Estuaries Partnership (also known as the Tillamook Bay National Estuary Project) was created to carry out the goals of the NEP. In 2002, the TEP expanded its mission and study area to include the conservation and restoration of all of Tillamook County's estuaries and their watersheds.

Charged with creating a plan for Tillamook 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). Completed in 1999, the CCMP identifies 63 action items to address those concerns. Over time, many of those actions have been applied to all of the bays and watersheds in the County. This will be reflected in the update of the CCMP to be completed in 2016. With our partners, we implement habitat restoration projects, water quality monitoring programs, environmental education, and provide technical assistance and funding. A non-partisan entity, we bring diverse perspectives to the table to discuss issues of concern as they relate to the natural resources of the County.

Partnerships are critical to balancing social, economic, and environmental needs when addressing issues such as flooding, wetland restoration, salmon recovery, climate change impacts, water quality, and education. As you read through the Executive Summary, you will see that it is broken out by program area. However, it is important to understand that while water quality monitoring, habitat restoration, and education, may be broken out separately to highlight the challenges and successes, they are also intertwined in the same way as the issues we are tackling are.

Increasing development and changing landscapes continue to pressure and influence our estuaries and watersheds. With a wide array of partners, we are working together to complete significantly more projects with fewer resources. Working with private landowners, streambanks have been planted with native conifers and understory vegetation, fish passage has been enhanced, and restored wetlands will provide critical habitat to fish and wildlife. Through stewardship and Best Management Practices, we are seeing improvements in many waterbodies for bacteria concentrations. Without landowner support and voluntary participation, 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 the natural resources of all of the bays and watersheds in Tillamook County.



## The State of Five Bays and their Watersheds

The State of the Bays Report highlights the efforts of TEP and its partners to improve water quality, restore habitat, encourage environmental literacy, and foster citizen involvement and stewardship throughout TEP's study area. This is the first time that TEP has produced a document that covers the watershed health of all of the estuaries in our study area. Because of the scope and sheer amount of information, we have separated the State of the Bays 2015 Health Report into two parts: the Executive Summary (this document) and the State of the Bays 2015 Health Report.

This Executive Summary provides a general overview and assessment of the estuaries and watersheds within the TEP study area. The State of the Bays 2015 Health Report offers much greater detail on the projects and efforts throughout the study area. This document can be found online at [www.tbnep.org](http://www.tbnep.org) or a copy can be supplied on request.

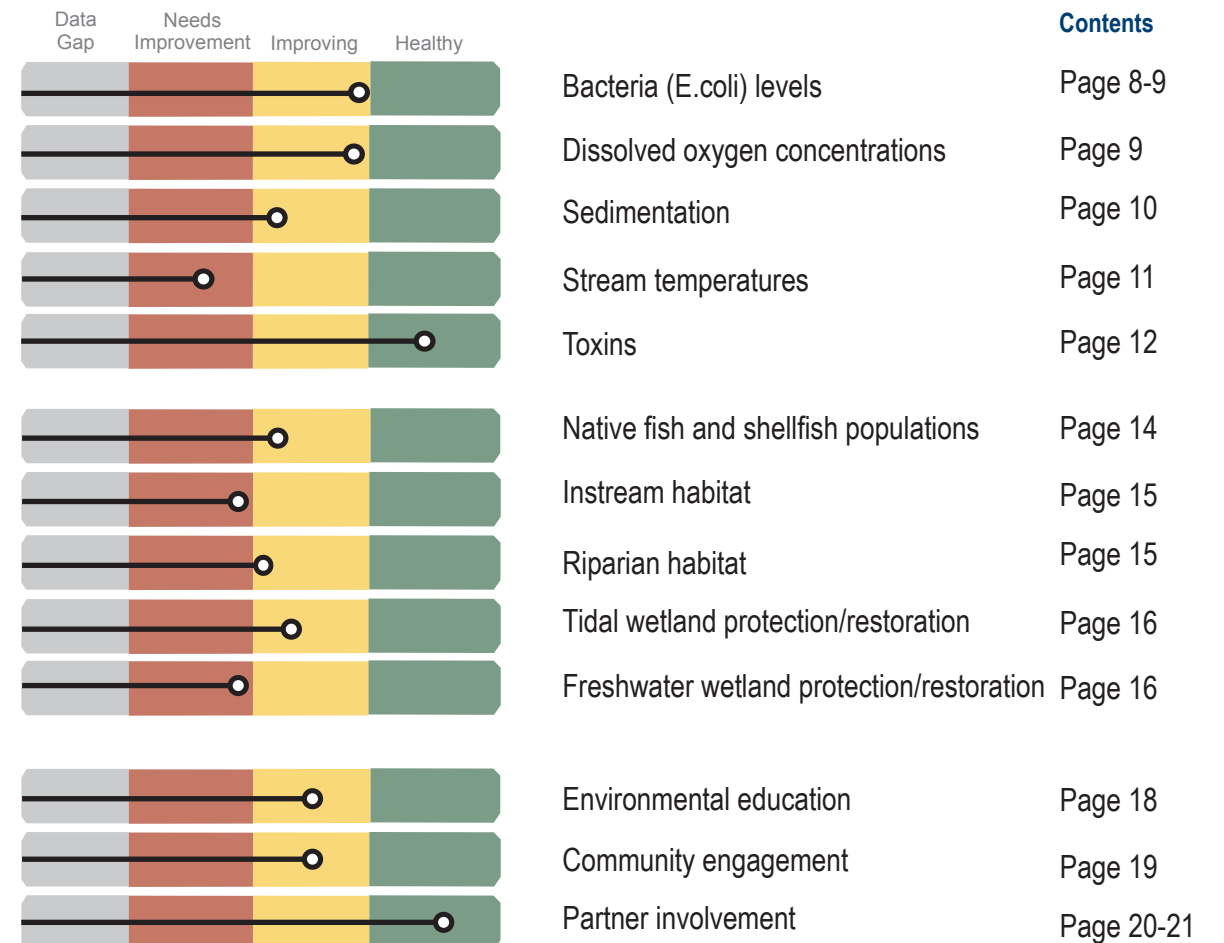
The State of the Bays 2015 Report Card, below, reflects the overall rating of the entire study area per category. The ratings are a snapshot in time covering the past five years. Ratings for individual watersheds, where applicable, are called out within narrative sections of the Executive Summary.

TEP commits to achieving a "healthy" rating in every category throughout the study area and building new partnerships and enhancing our existing partnership. With 77% of the categories showing overall "improving" or "healthy" trends, we are moving in the right direction.

Healthy estuaries and watersheds support our community, our economy, and our ecosystem. This is the balance we strive to achieve as we further our mission of restoring and conserving all of Tillamook County's estuaries and watersheds.

# Report Card

## State of the Bays 2015 Report Card TEP Study Area





# State of the Bays

## Study Area

When the National Estuary Program first came to Tillamook County, it was centered on Tillamook Bay. Designated as "a Bay of National Significance", all efforts were directed towards developing 63 actions that addressed the four priority problems in Tillamook Bay: key habitat, water quality, erosion and sedimentation, and flooding. In 2002, TEP transformed into a non-profit organization and took this opportunity to look at the broader landscape and expand its mission and study area to include all of the estuaries and watersheds in Tillamook County. With a myriad of partners already focusing energy in these other watersheds, TEP hoped to provide support to those entities in the form of added capacity, technical assistance, water quality monitoring and increased leveraging opportunities culminating in a stronger network of resources for restoration activities. Although work has been underway since 2002, this is TEP's first opportunity to share results covering the larger geographic range. Upcoming updates to our CCMP will also reflect the expanded mission. Linked by proximity, each estuary shares similar challenges and opportunities but retains their unique character because of the communities that surround and nourish them.

## Tillamook Bay & Watershed

Nestled between rugged mountains and the Pacific Ocean with over 597 square miles of rivers and creeks and a bay totaling 13 square miles, Tillamook Bay is Oregon's second-largest bay and one of its most prized resources. The bay supports a thriving oyster industry and some of the best runs of salmon and steelhead on the West Coast. In addition, broad fertile floodplains play host to rich dairy lands which produce world-class cheese. A healthy and functioning Tillamook Bay is essential to not only honor our cultural landscape and crucial natural resources, but to the overall vitality of its surrounding communities. TEP, along with many partners, are dedicated to further understanding the mechanisms at work and finding practical solutions to ensure the long-term sustainability of this "Bay of National Significance".

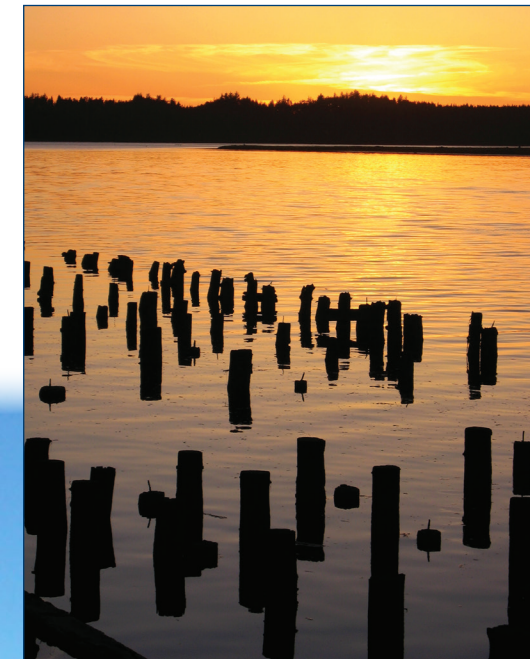


Above: Three Graces at Tillamook Bay. Right: Aerial photo of Tillamook Bay at low tide, 2014.



## Nehalem Bay & Watershed

Stretching for 118 miles with a watershed of 855 square miles, the Nehalem River is Oregon's largest stream contained entirely within the coast range. Along its journey, the Nehalem River flows through dense forests, then quietly meanders by green pastures and small towns before entering Nehalem Bay. Around the turn of the 20th century, the margins of the bay were abuzz with a bustling community of several thousand residents centered on agricultural products, logging, and a plentiful salmon fishery. Today, the area has a more quiet appeal, while still maintaining its charm of old. Tourism is an increasing focus of the local communities, as evidenced by the expansive Nehalem Bay State Park. Work to restore and conserve ecological functions throughout the watershed is buoyed by the active efforts of partners in the upper Nehalem River, lower Nehalem River, and Nehalem Bay.



Above: Aerial photo of Nehalem Bay at low tide, 2014. Left: Sunset Nehalem Bay. Below: City of Nehalem from the Tillamook County Water Trail perspective.





### Netarts Bay & Watershed

Netarts Bay boasts a predominately pristine estuarine environment compared to its sister bays in Tillamook County. This is due to the relatively light influence of development along its shores and throughout its watershed. Rather than being fed by larger rivers, Netarts Bay is fed by 16 smaller direct-to-bay creeks. The bay is approximately 2,325 acres, 812 of which are permanently submerged. In spite of its size, Netarts Bay is a highly dynamic system that influences coastal erosion throughout its littoral cell. In addition to the many recreational opportunities, Netarts is home to robust commercial oyster operations and an emerging premium sea salt industry. Netarts Bay is a pilot site for a project focused on restoring the Pacific Northwest's native Olympia Oyster within its historical distribution. Because of Netart's relatively unaltered natural state, it is often used as a reference site to compare the water and habitat quality of other estuaries.

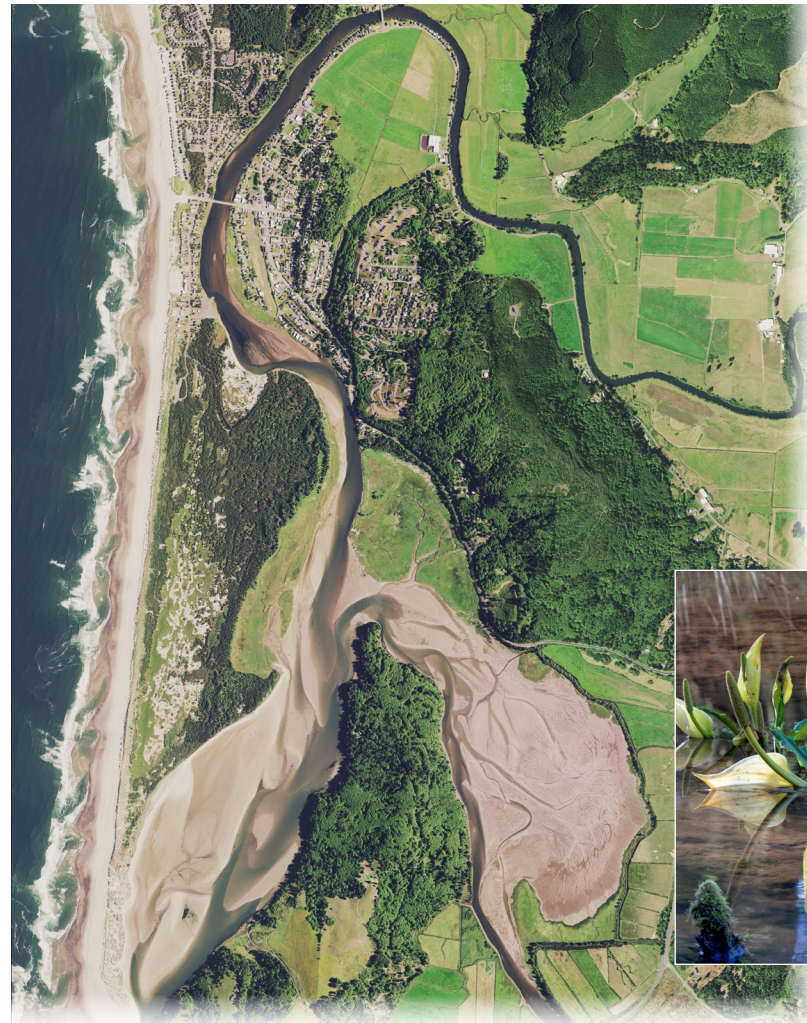


Photo courtesy Jim Young

Above left: Aerial photo of Netarts Bay at low tide, 2014  
 Above right: Juvenile Red-necked Phalarope at Netarts Bay  
 Below: Sunset at Netarts Bay



Photo courtesy Mark Mertens



### Nestucca Bay & Watershed

Nestucca Bay is formed by the confluence of the 57-mile Nestucca River and the 20-mile Little Nestucca River where they meet the Pacific Ocean near Pacific City. Nestucca Bay is a 1,000 acre bar-built estuary. Seasonally, a variably sized sand bar (spit) forms from the interaction of currents from the ocean and freshwater rivers and separates the bay and the ocean. Part of the bay is contained within the Nestucca Bay National Wildlife Refuge. Like many of the estuaries in TEP's study area, Nestucca Bay is a valuable natural resource supporting an economy dependent on fishing, forestry, tourism, and agriculture. The fishing culture of the Nestucca is highlighted by the century-old beach-launched dory fishery at Cape Kiwanda. Partners in the watershed are working diligently to improve water quality, fish passage, and salmonid habitat in the watershed and bay.



### Sand Lake & Watershed

The Sand Lake Estuary is a beautiful, nearly untouched estuarine ecosystem. It is only one of five estuaries on the Oregon Coast designated as a "natural estuary." Similar to Netarts, there is relatively minimal freshwater influence from its watershed and it is dominated by tidal influence. The surface area of Sand Lake is roughly 1,258 acres and has Oregon's second smallest watershed area of its 22 "major" estuaries at only 17 miles. Much of the land encompassed by the estuary is estuarine marsh which is exposed by tides daily. Because of this, Sand Lake is home to many unique tidal wetland plant species. Thousands of visitors each year enjoy the adjacent Sand Lake Recreation area, the Clay Myers State Natural Area, and one of Oregon State Parks newest acquisition's, the Sand Lake spit.

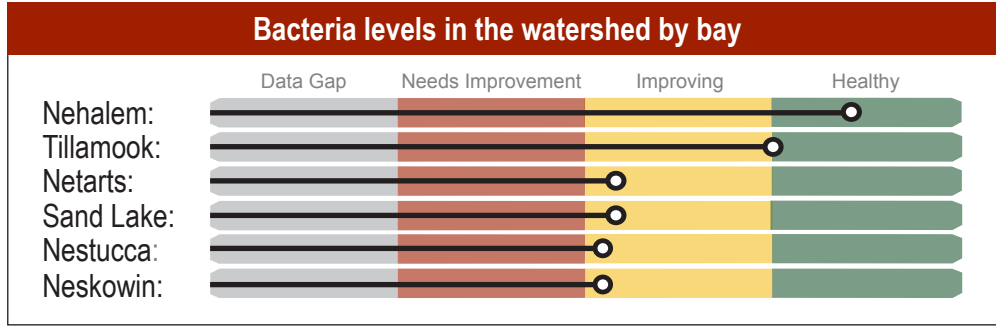


Top: Aerial photo of Nestucca Bay at low tide, 2014. Above left: Skunk Cabbage Above right: Nestucca Bay Bottom left: Sand Lake Estuary Bottom right: Aerial photo of Sand Lake Estuary at low tide, 2014.





# Water Quality

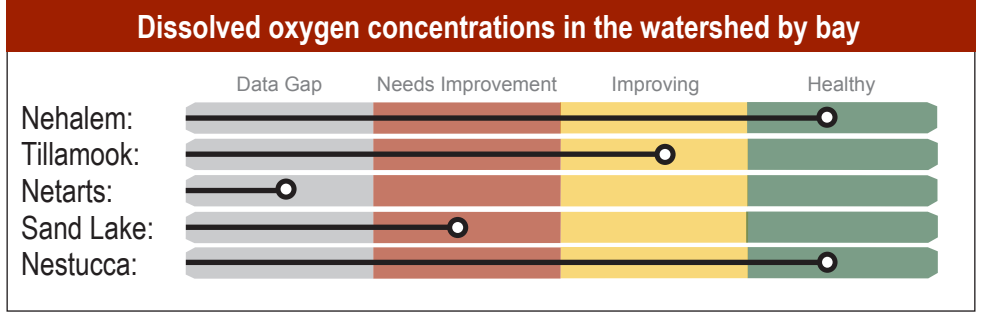


TEP works with the Oregon Department of Environmental Quality (DEQ) to determine how current bacteria levels compare to State standards. Another query answered through the VWQMP is whether bacteria levels are improving or getting worse over time. Individual sampling results are documented on TEP's website in a "real-time" interactive map.

### Bacteria Research and Demonstration Projects

Tillamook Bay was chosen as a Demonstration Project for EPA's national effort to develop a standard method for analyzing bacteria DNA. VWQMP volunteers collected additional water samples from the Tillamook, Trask, and Kilchis Rivers for one year. From these samples, EPA will determine potential sources of bacteria contribution from three categories: cattle, humans, and bird species. Once this data becomes available, TEP and partners will be able to use it to target the appropriate sources in future restoration and outreach efforts.

The second project is complementary to EPA's microbial source tracking. TEP joined with OSU, DEQ, and ODA to better understand how general farm practices affect water quality, specifically *E. coli* bacteria, in the Tillamook River Watershed. To address this question, the project focuses on three efforts: establishing a water quality monitoring network, working with farms to track farm practices, and developing management practices that produce improvement in water quality. TEP is working with its partners to develop the monitoring network. The water quality monitoring network takes advantage of established bacteria monitoring techniques including bacterial DNA analysis performed by OSU and new equipment developed by ZAPs Technologies. The ZAPs LiquiD Station is unique in that it uses an optical signature to determine a water column *E. coli* concentration in a few seconds compared to the standard method that requires 18 hours to produce a result. Partnerships with the agricultural community in these projects are critical to increase our understanding of impacts on water quality.

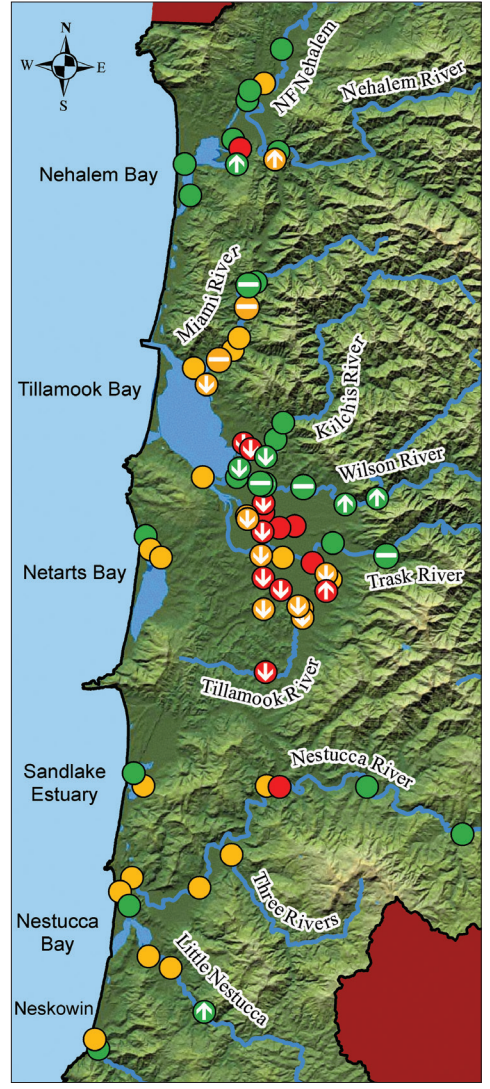


### Why are bacteria in surface waters a concern to people?

Disease can be spread through contact with polluted water or from food products such as shellfish 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 several different fecal bacteria depending on location and use. *Escherichia coli* (*E. coli*) is measured in freshwater and *Enterococcus spp.* in saltwater, for recreational contact such as swimming, boating and fishing and fecal coliform bacteria to determine if commercial shellfish harvest can occur. The shellfish standards for waters in the bay are monitored by Oregon Department of Agriculture (ODA). ODA is currently developing a pilot program for monitoring existing oyster growing areas to achieve a greater precision in closure and opening thresholds.

### Are surface waters meeting State bacteria standards for recreational use and where have bacteria concentrations increased or decreased over time?

In 1997, TEP began the Volunteer Water Quality Monitoring Program (VWQMP) to evaluate bacteria levels in the rivers and streams entering into Tillamook Bay. With a committed volunteer base, TEP expanded the program to include many waterways and all five estuaries in TEP's study areas. TEP tests for *E. coli* in freshwater and *Enterococcus spp.* in estuaries.



Right: The map shows the VWQMP locations in Tillamook County. The colors indicate how the sites compare to the state recreational use standards. Green indicates a site generally meets the standard, orange that there are intermittent elevated levels, and red that the site is regularly above the standard. The symbols indicate if a trend is present. Up arrow = bacteria pollution is increasing, down arrow = bacteria pollution is decreasing, and a dash means that a trend is present but is changing very slowly.

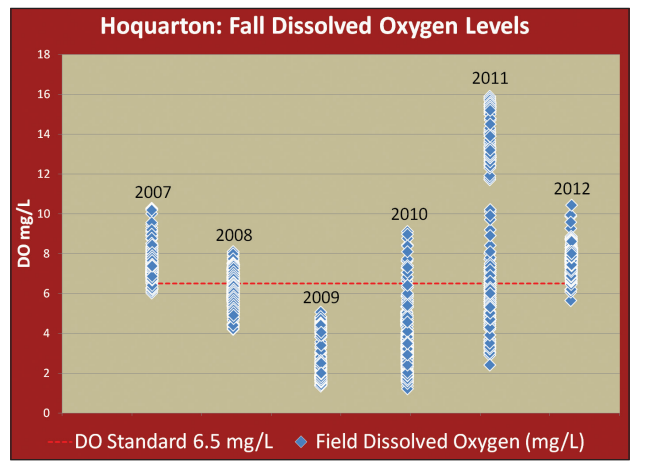
### How do dissolved oxygen levels affect aquatic life in Tillamook County's rivers and sloughs?

Dissolved oxygen (DO) is an important component of estuary and freshwater in-water habitats. In simple terms, DO is the amount of oxygen available in the water column to be used by aquatic life such as salmon. There are several rivers in TEP's study area that have been identified by the State as having low DO levels that will not fully support aquatic life at different stages and locations, particularly juvenile salmon.

### Are dissolved oxygen concentrations in sloughs and rivers suitable for juvenile salmon?

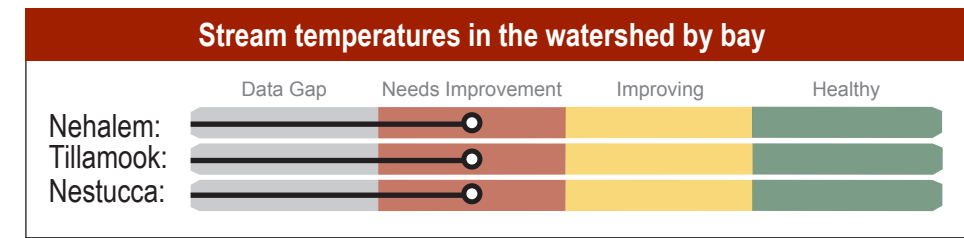
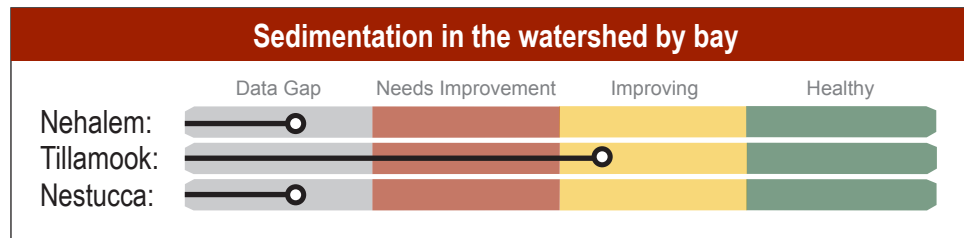
In partnership with DEQ, TEP monitors DO levels in the sloughs, rivers, and streams throughout the study area identified as having low levels of dissolved oxygen. DO levels change frequently and to capture the variation, TEP measures DO levels every 15 minutes for several days at a time. This type of information is collected three times a year in the spring, summer, and fall, when DO levels are typically at their lowest.

Through this monitoring effort, TEP identified times of year and locations where DO levels drop below the recommended level of 6.5 mg/L (estuary standard) for aquatic life in the sloughs of Tillamook



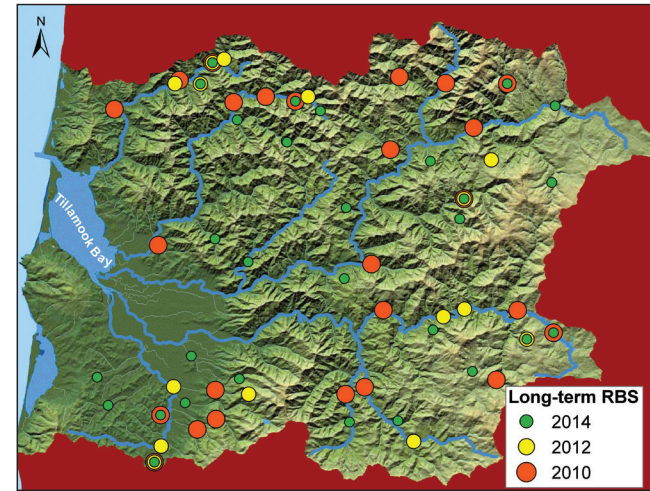
Above: DO levels for a Tillamook Bay slough indicate improvements since 2009.

Bay. The DO data from the Nehalem and Nestucca rivers indicate that, in general, the standards are being met. In addition, DO monitoring by the USGS in the Wilson and Trask has shown that these rivers are meeting the summer rearing and migration standard of 8 mg/L (freshwater standard).



### What is sedimentation and why is a proper balance important?

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



### Research Projects

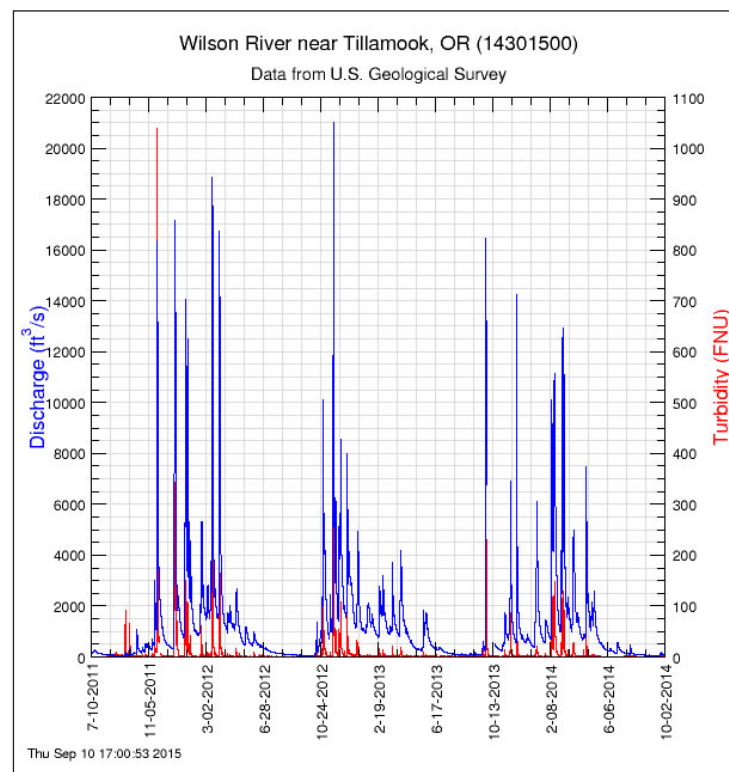
In 2009, through a contractor, TEP developed and initiated a study to characterize sediment in the Tillamook Bay watershed using a technique based on an EPA method termed Relative Bed Stability (RBS). This study resulted in conclusions about the transport of sediment within the watershed and is available on TEP's website. Long term data continues to be collected for 30 sites in the watershed every two years beginning in 2010 via a partnership with DEQ. TEP is working on acquiring resources to analyze the data to determine if trends are present and what efforts are needed to address negative impacts from sedimentation.

Left: Tillamook Bay Watershed with long-term RBS monitoring sites color coded by year. Some sites are revisited every two years. This provides information on short-term and long-term changes in sediment conditions.

Building on results of its initial RBS sediment study, TEP aligned with USGS and Tillamook County to investigate fine sediment loads produced in the Wilson and Trask rivers. The USGS led this effort to correlate turbidity and stream flows and estimate annual sediment loads to Tillamook Bay. They also included route and storm-related suspended-sediment samples. In addition, water temperature, specific conductance, and dissolved oxygen data were collected and are available on the USGS gauges website.

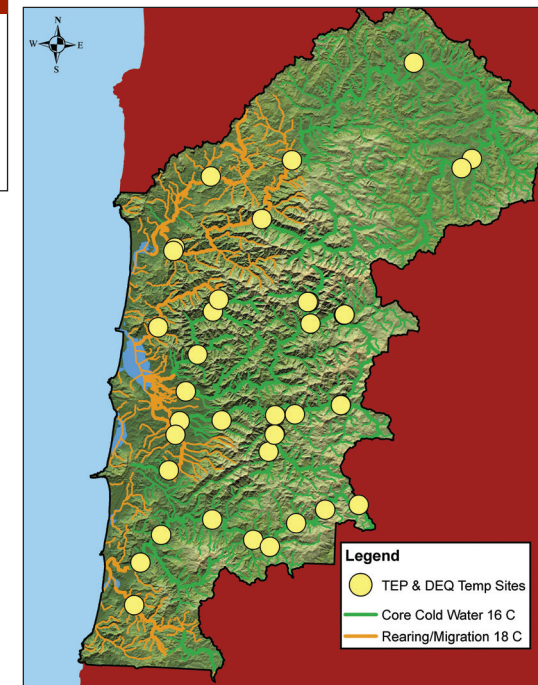
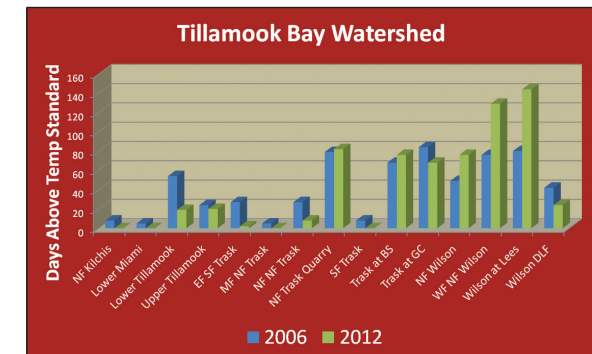
USGS finished the project in summer of 2015 and issued a report entitled *Water-Quality Conditions and Suspended-Sediment Transport in the Wilson and Trask Rivers, Oregon*. It summarizes the project and describes the methods used to construct the regression models and quantify the real-time suspended-sediment concentrations and loads and yields from each of the watersheds. It is available online at: <http://pubs.er.usgs.gov/>

Right: Example of flow and turbidity data collected as part of the study and available on USGS gage website. High turbidity levels usually correspond to high flow events.



### Why is it important to have cold water in our 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. Stream temperature is influenced by several factors including, but not limited to stream shade, ambient air temperatures, water withdrawals, groundwater inflows and flow. The State has established maximum allowable water temperatures for each salmon lifecycle stage: spawning, rearing and migration. The standards are based on maximum temperatures that will not limit salmon's ability to grow, reproduce and survive and are different depending on location and habitat provided by the waterbody.

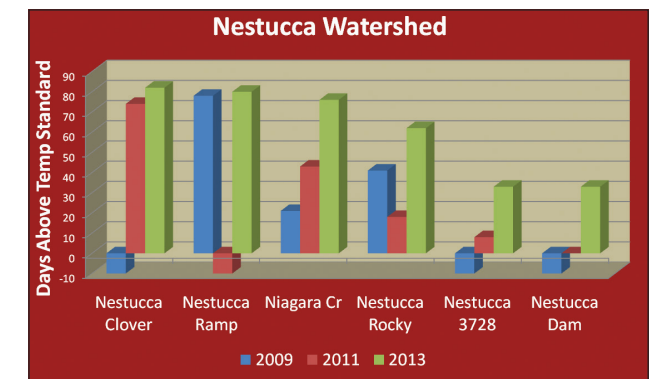
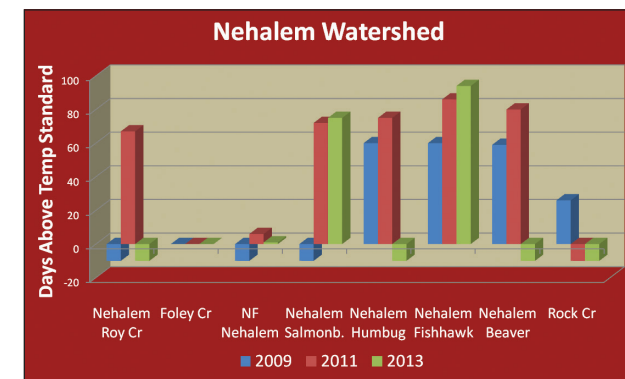


Left: Number of days each monitoring location was greater than the 7-day maximum average. Temperature data is typically collected from May to September to capture the most critical time of year. Above: Core Cold Water streams which have the 16° C target versus the Rearing and Migration streams that have the 18° C target. The yellow circles are the TEP and DEQ temperature monitoring sites.

### Are maximum yearly surface water temperatures at levels that support salmon lifecycle requirements?

TEP collects temperature data and in the Tillamook, Nestucca and Nehalem watersheds. The State temperature standard, called the "seven day moving average", has different temperature targets depending on fish use and habitat type. The majority of TEP's study area is designated Core Cold Water by the State with temperature target no greater than 16 degrees Celsius. Other rivers and streams are identified for rearing and migration and have a target no greater than 18 degrees Celsius.

Many of the included waterways are not meeting the temperature standards for a portion of the summertime periods. Through this long-term monitoring effort, TEP compares number of days each site is above the temperature target and compare these same sites from year to year.



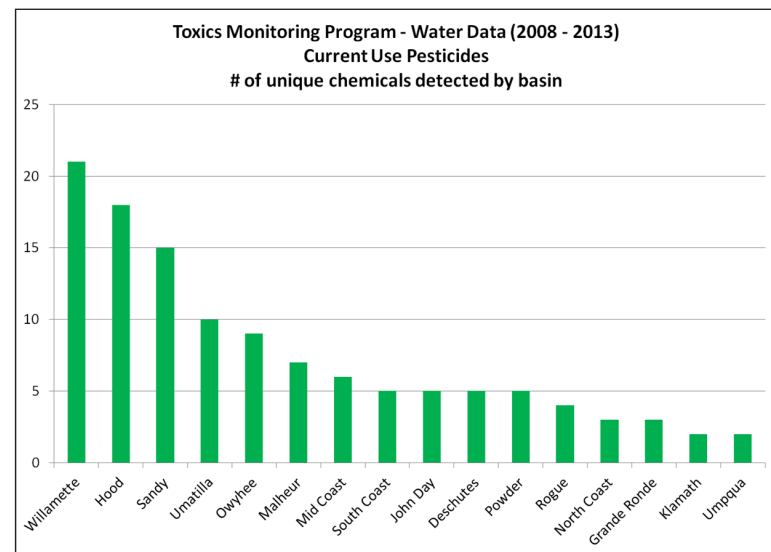
Above: These bars indicate the number of days that temperatures were above the standard for the years indicated. Bars showing a negative value indicate that the monitoring equipment was lost or damaged and no data was collected. This is different than a flat square (Foley Creek or Nestucca Dam) which represent a time when the temperature standard was not exceeded.



Above: TEP staff deploying POCIS device in the upper reaches of Fawcett Creek, one of Tillamook's drinking water source streams.

TEP joined DEQ during the 2013 portion of their state-wide monitoring effort. TEP focused on monitoring drinking water source streams (DWSS) and current-use pesticides. The monitoring strategy included sampling during the spring and fall when most pesticide applications take place.

This study detected five current-use pesticides: atrazine, desethylatrazine, sulfometuron-methyl, glyphosate, and aminomethylphosphonic acid (AMPA). N,N-diethyl-meta-toluamide (DEET), a common insect repellent, also was identified. TEP and DEQ consulted the Oregon Health Authority (OHA) to evaluate risks. OHA provided a report of the data and associated toxicological



Above: This chart shows the numbers of individual current use pesticides that DEQ detected in various regions of Oregon. The North Coast and TEP's study area have some of the least numbers of pesticides detected.

## Toxics Monitoring in the North Coast

### What is meant by toxic compounds and why are they a concern?

As society evolves, new products we use in everyday life – pharmaceuticals, personal care products, flame retardants, and pesticides – are finding their way into our waterways. These compounds can have unintended effects on human health and aquatic life. Small concentrations of pollutants in the water column or in sediments can become concentrated in tissues over time. This process is known as bioaccumulation. It is important to collect information on potentially new and emerging pollutants in our waters before unfavorable effects are evident.

### What toxic compounds are present in our surface water and surface drinking water sources?

DEQ leads a State-wide Toxics Monitoring program focused on rivers and streams which includes sediment and fish tissues at coastal locations. The program looks for several toxic compounds including: pharmaceuticals, personal care products, flame retardants, and pesticides. In 2015, this study discovered elevated levels of arsenic in soft shell clams in estuaries along the entire Oregon Coast. Arsenic occurs naturally at high levels in Oregon soils and erosion of these soils contributes to the high levels found in the shellfish. This finding led the Oregon Health Authority (OHA) to issue an advisory for consuming soft shell clams and recommendation for lowering arsenic levels in the clams by specific preparation techniques. The details of the advisory can be found on the following OHA website: <http://public.health.oregon.gov>



Above: Bottles used to collect water column samples for pesticide testing at Jetty Creek.

information to municipalities included in the effort. The agencies concluded these pesticides were measured at concentrations tens to thousands of times below human health benchmark concentrations (where benchmarks are established). In addition, samples were collected in source waters, prior to drinking water treatment, in the case of drinking water source streams. According to OHA and DEQ **none of the pesticides detected were at concentrations that posed a threat to human health.** TEP acknowledges that there are limitations with any monitoring effort. If you are interested in obtaining a copy of the data from this study please visit the TEP website.

## Ocean Radiation Monitoring

### Can the Fukushima accident provide a better understanding of ocean currents?

After the 2011 tsunami, the Fukushima Dai-ichi nuclear power plant in Japan grabbed the public's attention in Tillamook County. Radiation from the facility had entered the ocean and there was concern that it could have an impact on West Coast ecosystems. Scientists tracking radiation predict that levels will increase but will remain at concentrations that do not pose a threat to human health or aquatic life. TEP assists Woods Hole Oceanographic Institute (WHOI) scientists with data collection to verify predictions and add to a better understanding of ocean water circulation.

### What is the concentration of cesium off the coast of northern Oregon?

TEP contributes to WHOI's program: *How Radioactive is Our Ocean*. The program tracks the spread of radioactive isotopes. TEP funded analysis for six water samples collected in the ocean at Cape Kiwanda, Pacific City. WHOI analyzes samples for Fukushima-specific radionuclide cesium-134 and a legacy radionuclide cesium-137. Cesium-137 has a longer half-life than cesium-134 and therefore is an indicator of other past activities such as nuclear testing in the ocean in the 1950's.

TEP collected a total of three samples and results have been non-detect or no cesium-134 measured above 0.2 Bq/m<sup>3</sup> of water. On the broader scale of the effort, WHOI has found its first evidence of Fukushima radioactivity along the West Coast from a sample collected in British Columbia in April 2015. As predicted, levels of cesium remain at concentrations which do not pose a threat. For more information please visit: [www.who.edu/cmer](http://www.who.edu/cmer)



Above: TEP staff preparing to collect ocean water at Cape Kiwanda to have WHOI look for cesium 134, June 2014. Below: WHOI ocean water sampling equipment on the beach at Cape Kiwanda, December 2014.



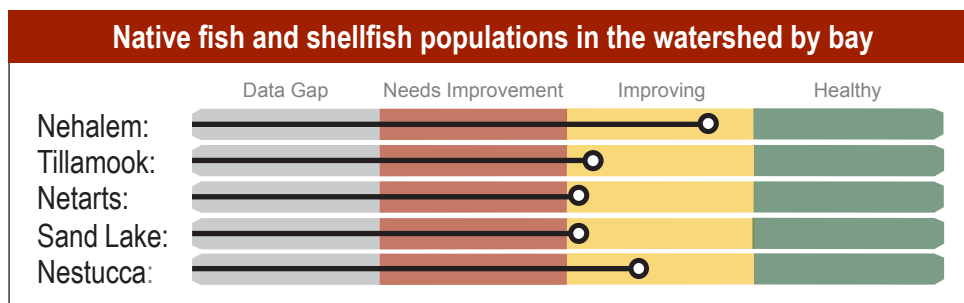




# Habitat Restoration

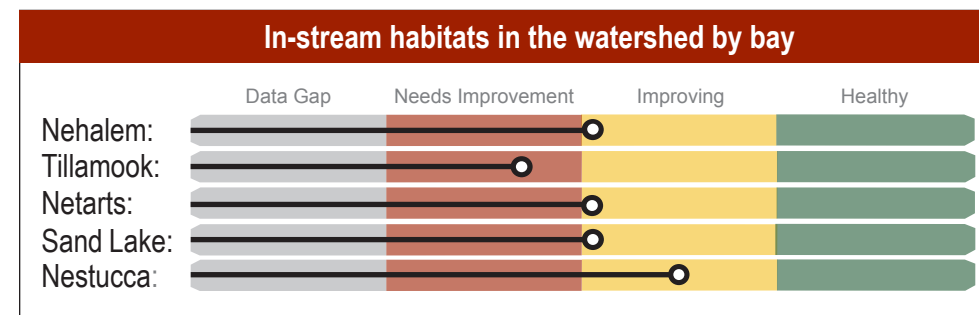
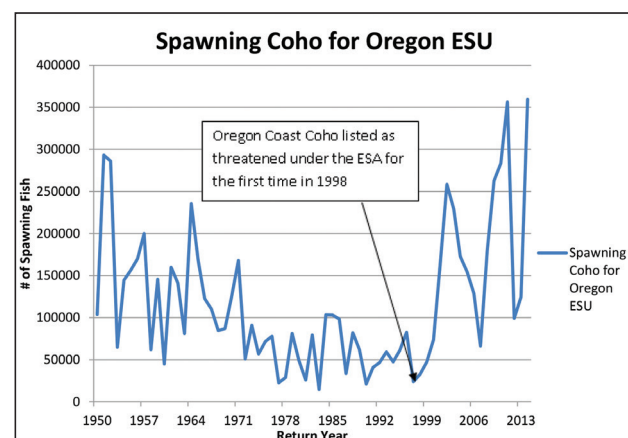
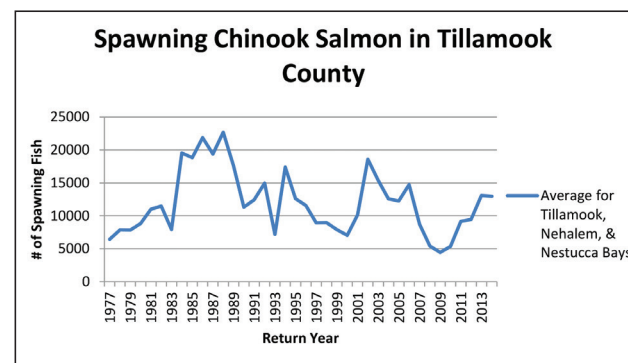
## The Importance of Quality Habitat

Having a diverse array of healthy, high quality habitats in an ecosystem is essential to support the natural resources we depend on. TEP and its partners recognize the importance of natural resources to Tillamook County's economy, culture, and quality of life. Without clean water, productive habitats, and an engaged citizenry, Tillamook County wouldn't be the special place it is today. TEP and its partners strive to identify, prioritize, conserve, and enhance or restore vital areas of our watersheds in an effort to ensure the livelihood of the many species we depend on, our natural economy, and our culture well into the future.



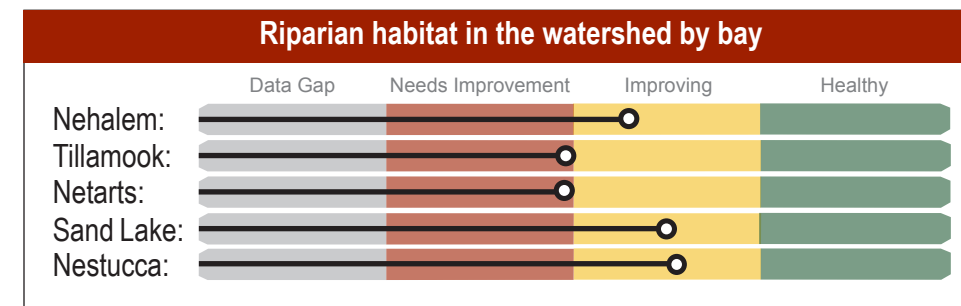
The Pacific Northwest is well known for its robust populations of fish and shellfish, and people living in the region have depended on these resources for centuries. These resources have not only provided sustenance, but have sculpted the cultural identity of our area. The estuaries and watersheds of Tillamook County remain some of the Pacific Northwest's best areas for producing these valuable resources, but over the last century local declines in the abundance of these species have been notable, with only a fraction of some populations still remaining. Available data points to historical over harvest and the loss of stream, estuary and ocean habitats as the primary causes of these declines. Furthermore, as a result of our limited understanding of aquatic biology and the many life history strategies these organisms employ, the effects of our actions went unrecognized for some time. Meaningful restoration of these populations depends on a comprehensive understanding of many complex physical and biological factors, and a concerted effort by all to put what we've learned into action. The Oregon Plan for Salmon and Watersheds, the Oregon Conservation Strategy, and TEP's Tillamook Bay Comprehensive Conservation & Management Plan, to name a few, contain frameworks for how stakeholders should assess, monitor, and restore populations in Oregon and organizations like TEP are banding together with hosts of partners to put them into action.

Left: Graphs depicting population estimates for some of our most cherished salmonid species. In them, one can see the historical population declines, but also the positive rebounds that are possible when corrective action is taken.



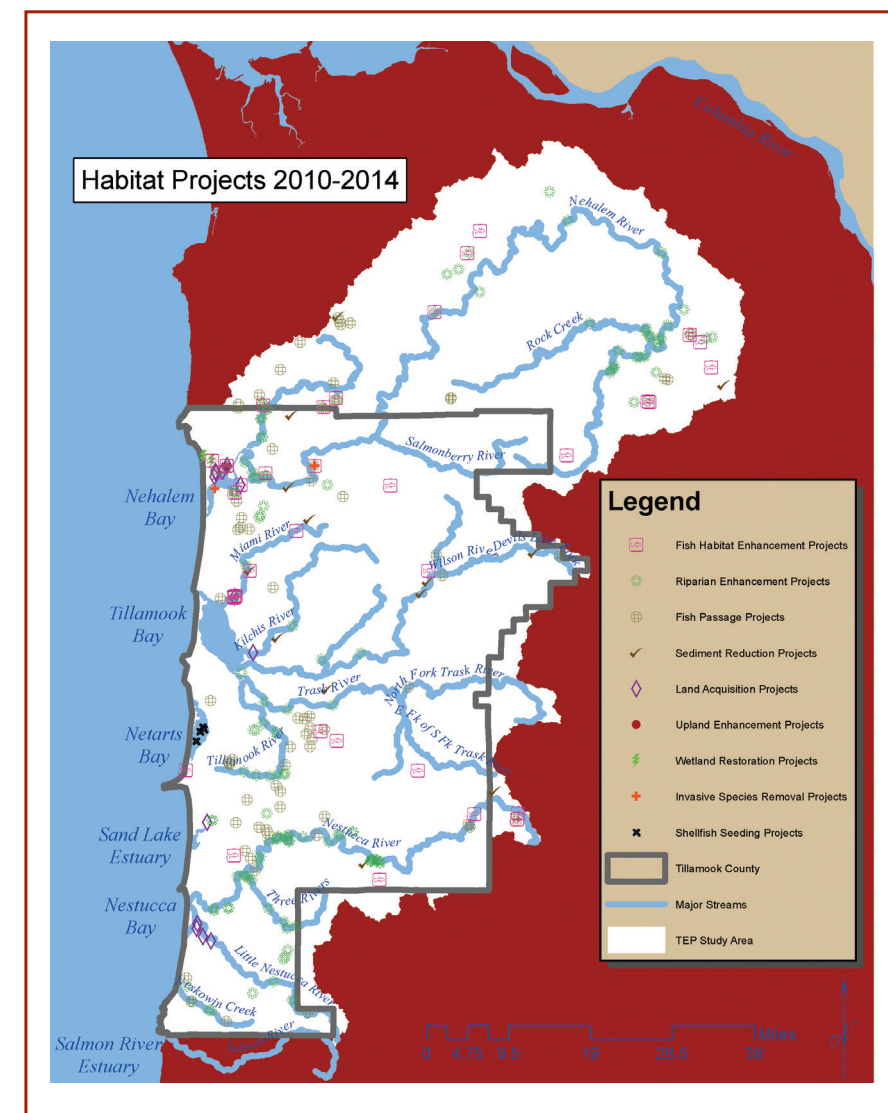
Streams are essentially the veins of life's existence—supplying water from upslope areas to the lowlands and estuaries. In addition to transporting water, streams also move sediments and organic materials, and provide migratory routes for aquatic and terrestrial wildlife. Over the last two centuries, land use practices have impacted Tillamook County stream conditions by altering and simplifying stream channels, reducing the the diversity

of vegetation and function of some riparian areas, and disconnecting floodplains. TEP and its partners are utilizing a suite of restorative actions including passage improvement, large wood placement, streamside planting, removal of manmade barriers, and key conservation acquisition to address these issues. Such efforts result in clean cold water, complex stream habitats, and well-connected stream networks.

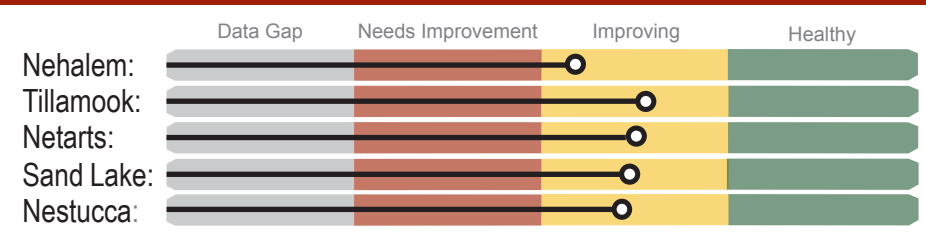


Riparian communities are lush areas of vegetation that occur adjacent to waterways and other areas with greater amounts of available water. These communities typically include species found in adjacent uplands (individual plants often reach larger sizes and grow in denser associations), but they also often include species that don't occur in upland communities. Riparian areas provide numerous ecological benefits to the waterways they surround: they supply shade that regulates water temperatures, organic inputs that support the food chain, large woody debris that maintains stream complexity, roots that stabilize banks and reduce erosion, and above ground structure that filters pollutants from overland inputs. These features protect and enhance in-stream flows and the groundwater system. Like many other habitat types, riparian areas have been impacted by multiple land uses that resulted in the loss of vegetation, an increase in invasive species, increased erosion and subsequent sedimentation, increased water temperatures, and lack of stream complexity. Without the nurturing and buffering effects of riparian communities, adjacent streams and the organisms that call them home quickly degrade. To protect and restore healthy riparian areas, TEP and partners are replanting native vegetation, removing invasive species, stabilizing banks, and acquiring conservation lands and easements.

Above: TEP and partner-led habitat restoration projects in TEP's study area 2010-2014



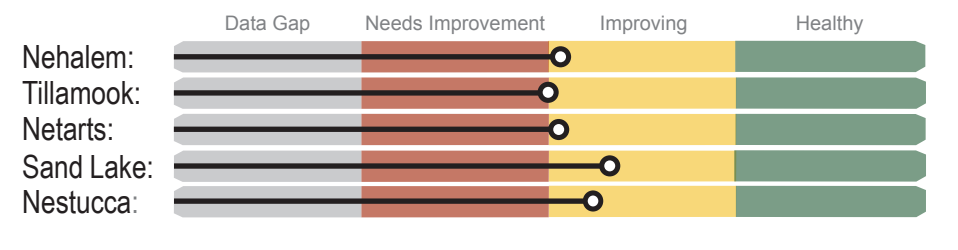
### Tidal wetland protection/restoration in the watershed by bay



As some of the richest and most complex ecosystems on earth, estuaries are important in the life cycle of many fish and wildlife species. Tidal channels and sloughs, intertidal sand and mudflats, eelgrass beds, and tidal wetlands provide structural complexity and abundant food upon which salmon and other species depend. Over the years, there have been many human impacts to the estuaries of Tillamook County including dredging, large

wood removal, sedimentation, dike building, channelization, and other forms of modification. This has resulted in a reduction in ecological services provided by estuaries including flood control and salmon rearing habitat. Since the 1850's, more than 70% of Tillamook's tidal wetlands have been lost or degraded (Tidal Wetlands Prioritization for the Tillamook Bay Estuary 2012). TEP and its many partners strive to address these challenges by conserving intact wetland tracts, removing or improving tide gates, removing invasive species, and reestablishing native tidal wetland plant communities. While increasingly challenging, these efforts represent the single biggest impact available in the goal of restoring the health of our estuarine watersheds.

### Freshwater wetland protection/restoration in the watershed by bay



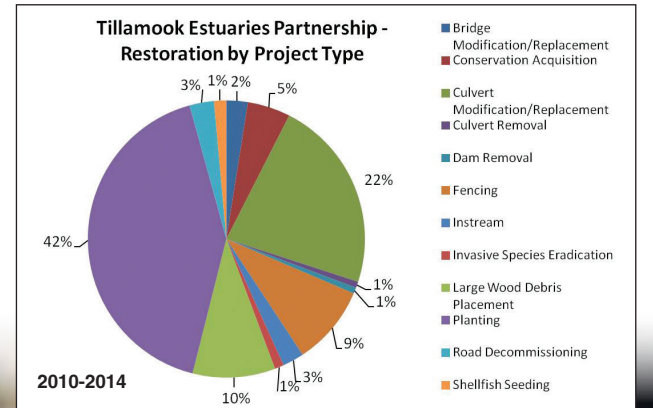
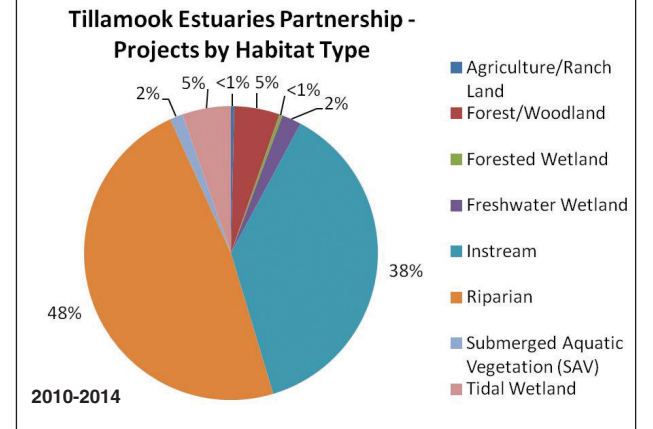
Freshwater wetlands are habitats where fresh water is present at or near the surface of the land for a majority of the growing season. Because of the stress caused by frequent flooding, wetland plants and animals have evolved specialized adaptations enabling them to survive - many wetland plant and animal species are found only in wetland habitats. Wetlands provide a vast number of critical functions that humans depend on. They act as sponges - accepting flood waters, holding them, and redistributing them slowly - helping to provide flood mitigation. Wetlands also intercept, store and break down pollutants, which protects downstream areas (including drinking water diversions). Furthermore, wetlands provide protection to young salmonids and other aquatic organisms that we depend on for food. Historically, we were unaware of the important ecological services wetlands provided and converted or altered many of Tillamook County's wetlands by draining, diking, and filling. TEP and its partners are working to reverse this trend by protecting intact wetlands, restoring wetland hydrology, reconnecting floodplains, removing exotic species, and replanting native plants.



Right: Backyard planting crew member planting native sedge.

### A Legacy We Can Depend On

Through our conscious actions to restore and protect our vital habitats, we are ensuring a sustainable legacy we can depend on today and pass on to those we love tomorrow. Nature provides sustenance, and a basis for our economy, but just as important, it provides a cultural identity, peace of mind, and a direction we can believe in. To learn more about TEP and its partner's efforts to improve the state of our bays and watersheds over the last five years including program specifics, project examples, interesting research, and much much more, please view a copy of our full-length State of the Bays 2015 Health Report on TEP's website.



### Northwest Oregon Restoration Partnership A Model for Successful Watershed Restoration

TEP manages the Northwest Oregon Restoration Partnership (NORP) under its umbrella of programs. NORP is a cooperative effort, consisting of 30 members, who promote healthy forest and riparian ecosystems by growing native plants for habitat restoration. NORP specializes in native plants grown from local seed and cuttings to develop genetically adapted plant material accustomed to the climates of the coast. Plants are grown in containers for two-to-three years to create large planting stock able to revegetate disturbed areas and outcompete invasive plants. NORP's primary facility, sited at Camp Tillamook, includes a commercial-sized greenhouse, shade-house, and a container nursery. Annually, NORP strives to provide plant material to restore native vegetation along 20 miles of streams and on 200 acres of land. In 2014 alone, partners utilized 81,755 plants on 23 miles of streams and 452 acres of wetland and upland habitat. Over 1,900 landowners have benefitted from this program.

### Backyard Planting Program

In 2003, TEP initiated a cost-free voluntary program called the Backyard Planting Program (BYPP). With significant benefits to water quality and habitat in mind and the opportunity to tie into partner efforts throughout the study area, TEP provides education and assistance to landowners interested in restoring the streambanks along their properties. BYPP provides willing landowners with a site-specific planting plan, invasive species removal, native trees and shrubs, and three years of site maintenance and monitoring to ensure project success. TEP partners with the Tillamook County SWCD to provide livestock fencing and off-stream watering devices. Since inception, 116 landowners have participated making possible the restoration of 200 acres comprising 42 stream miles of riparian habitat. BYPP efforts on these properties included the planting a diversity of 51,025 native trees and 12,613 native shrubs.





# Education & Community Engagement

## Environmental Education

Settled within a temperate rain forest, harboring five estuaries, flowing rivers and streams, and lying next to the Pacific Ocean, TEP's study area beckons to be an extension of the classroom. Nature can be the most obvious or most subtle teacher and TEP appreciates the educational opportunities that exist outside its door. Over the past two years, TEP has been engaging with local environmental educators to assess their needs and see where TEP can complement their efforts. As we move into the next five years, TEP and its many partners are working to provide environmental education and community engagement that empower all of us to reach our goal of a healthy and sustainable environment.

## Getting Kids Outdoors Where Learning Comes Natural

Memories of being in elementary school can bring reflection of counting the minutes until you and your friends could meet up outdoors to begin the day's undiscovered adventures. In an attempt to recreate this excitement, TEP annually sponsors the Children's Clean Water Festival (CCWF) and Down by the Riverside (DBR) education events. Every third and fourth grader within Tillamook County are invited to these outdoor education events to explore topics such as the life cycle of the salmon, macro-invertebrates, art within science, trail restoration, how water quality affects us, carbon footprint reduction, healthy riparian areas, and many more. Hosted by TEP, in partnership with the Oregon DEQ, sessions are led by environmental educators and partners from throughout the North Coast.

## Children's Clean Water Festival and Down by the Riverside

In the 14 years of TEP's CCWF and DBR programs, approximately 7,750 Tillamook County grade school children and over 1,200 volunteers have joined in the "learn by doing" activities. These events occur outdoors along local rivers, sloughs, or near the forest, and help students get out into the world to see, to touch, to hear, and smell all that is around them. By giving students a chance to build sense of place and increase environmental literacy, TEP and partners hope to lay a foundation for a stewardship ethic. Designed to complement the new Oregon Science Standards, the CCWF and DBR provide a unique opportunity for local grade schools to participate in field based environmental education that is not always possible in the individual classroom setting. TEP has been an active partner in the Oregon Coast STEM Hub and the Oregon Environmental Literacy Program Council expanding partnerships and building capacity for our partners in education, both formal and informal.

## Outdoor Education Kits

To augment classroom teacher's efforts to increase environmental literacy TEP offers eleven outdoor education kits. These kits include curricula touching on water quality, community awareness, watershed processes, exploring estuaries, wetland functions, macroinvertebrate communities, animal tracking, intertidal life, bird species of the estuary, and local geology. They contain numerous hands-on activities and are stocked with associated props and field equipment and can be checked out at no cost.



## Community Engagement

It is the goal of the TEP to develop Life Long Learners, people that continue to grow and develop beyond school years. The core education model is no different for adults. TEP approaches this goal in two ways: 1) through community forums and workshops and 2) getting adults outside and having fun. Both lead to learning and developing a greater sense of stewardship and connection to nature.

## Tillamook County Water Trail

Don't just look at nature, immerse yourself in it! That in a nutshell, is the nexus of the Tillamook County Water Trail (TCWT). A network of water trails flowing through the quiet bays, and roaring rivers of the county, the TCWT focuses its efforts on non-motorized watercraft. Guidebooks, with inset maps, are available detailing all local estuaries. Colorful and captivating, the guidebooks convey valuable information on water-safety, appropriate access points, cultural history, stewardship, etiquette and inspire all who paddle the waterways to become more aware of their natural surroundings. The TCWT is designated as a National Recreation Trail by the U.S. Department of the Interior. TEP's TCWT is a true success story, empowering people to live, learn, and experience their environment on their own terms, at their own pace.



## Education through Recreation

Out of the TCWT blossomed TEP's "Education through Recreation" program centered on getting everyone outdoors and recreating while they learn. Activities such as hiking, biking, and kayaking are not only healthy forms of exercise; they are a great platform for learning about the environment. Each summer, TEP and its partners offer opportunities enticing residents and visitors to experience new things. Offerings include kayaking your local estuary, interpretive hikes focusing on local natural history topics, and wildlife viewing and photography. Future aspirations of terrestrial trails to mimic the success of the TCWT have been set in motion by the development the Northwest Coast Trails Coalition - Tillamook. This coalition is working close with all regional land managers to discover the possibilities of education, recreation, sustainability, and stewardship as one rambles down the road.

## Engage and Go

TEP strives to be a familiar face at popular Tillamook County public events supporting our community and partners. It is an opportunity for TEP to form lasting relationships that help promote our important message that healthy estuaries and watersheds make for happy, healthy people. Some of the many events that TEP attends include the Tillamook County Fair, Garibaldi Days, and Local Farmer's Markets where TEP staff engages the public through interpretive displays and materials, fun hands-on activities, and conversation. The connection is solidified between restoration and recreation and fun is had by all.

Left: 3<sup>rd</sup> grade students learn outdoors at Down by the Riverside. Above: Tillamook County Water Trail, Education through Recreation. Below: Riparian art fish prints, Children's Clean Water Festival





# Partners

## Why Partnerships are Important

Partnerships provide the capacity to achieve what may not otherwise be possible. A partnership is created by individuals believing they can better attain their goals by working together. Working in concert, organizations and stakeholders can deliver better outcomes for the communities they operate in.

TEP has been fortunate to work with many partners and we thank all of them for their time, efforts, and talents. This extensive list, covering the last 20 years, is inevitably incomplete and we regret any omissions.

- U.S. Environmental Protection Agency
- AAUW – Tillamook Branch
- Alderbrook Golf Course
- Ancient Mariner Guide Service
- Anderson's Outdoors
- Andy Schneider Guide Service
- Angler Innovations
- Art Higashi
- Asperdt and Associates
- Association of National Estuary Programs
- Association of Northwest Steelheaders
- Averill Landscaping Materials
- Bay City Arts Center
- BC Angling
- Best Impression Picture Company
- Blue Heron French Cheese Co.
- Bob Rees – Northwest Guides Service
- Brandon McGavran Guide Service
- CART'm
- Central Coast Land Trust
- Charter Communications
- City of Bay City
- City of Garibaldi
- City of Manzanita
- City of Nehalem
- City of Rockaway Beach
- City of Tillamook
- City of Wheeler
- Clatsop-Nehalem Confederated Tribes
- Columbia River Estuary Study Task Force
- Columbia River Maritime Museum
- Confederated Tribes of Siletz Indians
- Cory Anderson Guide Service
- Crimsontrace
- Curt Hedges' Guide Service



- Dane Crossley Guide Service
- David Johnson Fishing
- Department of Land Conservation and Development
- Dick's Sporting Goods
- Economic Development Council Of Tillamook County
- Ecotrust
- Fire Mountain School
- Fishermans Marine and Outdoor
- FLIR Systems
- Food Roots
- Four Rivers Guide Service
- Garibaldi Inn and Suites
- Garibaldi Marina
- Garibaldi Maritime Museum
- Greg Hublou Bayridge Properties
- Hampton Industries
- Hatfield Marine Science Center
- Haystack Rock Awareness Program
- Hebo Stewardship Group
- Ifish.com
- Jackson Bottoms Wetland Preserve
- Kayak Tillamook
- Kershaw Knives
- KTIL/KDEP
- Lamiglas Rods
- Leatherman
- Longview Timber
- Lower Columbia Canoe Club
- Lower Columbia Estuary Partnership
- Lower Nehalem Community Trust
- Lower Nehalem Watershed Council
- Manzanita Golf Course
- Mick's Styx
- Moore Northwest Images

- National Endowment for the Arts
- National Fish and Wildlife Foundation
- National Marine Fisheries Service
- National Oceanic and Atmospheric Administration
- National Park Service
- Neahkahnie School District
- Necanicum Watershed Council
- Neskowin Valley School
- Nestucca Adventures
- Nestucca Anglers
- Nestucca Connections
- Nestucca School District
- Nestucca, Neskowin & Sandlake Watershed Council
- North Coast Land Conservancy
- NW Weed Management Partnership
- Northwest Hardwoods
- Ocean Breeze Baptist School
- Oregon Arts Commission
- Oregon Coast Aquarium
- Oregon Community Foundation
- Oregon Department of Agriculture
- Oregon Department of Environmental Quality
- Oregon Department of Fish and Wildlife
- Oregon Department of Forestry
- Oregon Department of Geology and Mineral Industries
- Oregon Department of State Lands
- Oregon Department of Transportation
- Oregon Farm Bureau
- Oregon Forestry Resource Industries Council
- Oregon Governor's Office
- Oregon Museum of Science and Industry
- Oregon Ocean Paddling Society
- Oregon Parks and Recreation Department
- Oregon Shores Conservation Coalition
- Oregon State Marine Board
- Oregon State University Extension
- Oregon Watershed Enhancement Board
- Oregon Youth Authority
- OSU Extension Service
- OSU Open Campus
- OSU Sea Grant
- Pacific Christian School
- Pacific City – Nestucca Valley Chamber of Commerce
- Pacific Coast Joint Venture
- Pacific Seafood
- Pat Abel's Guide Service
- Pelican Pub
- Port of Garibaldi
- Port of Nehalem
- Port of Tillamook
- REI
- Rob Russell Guide Service
- Roger Goodwin Guide Service
- Roger Ross Photography
- Rosenberg Builder's Supply
- Russ Morrow's Sportfishing Guide Service
- Safeway
- Salmon-Drift Creek Watersheds Council



- Salty Dog Foundation
- Samuel Johnson Foundation
- Sand Dune Pub
- Sierra Club Outings
- Siggi G Charters
- SOLVE
- STEM Hub
- Stimson Lumber
- TCCA
- Ted Teufel Guide Service
- The Nature Conservancy
- Tillamook Adventist Academy
- Tillamook Air Museum
- Tillamook Anglers
- Tillamook Bait
- Tillamook Bay Community College
- Tillamook Bay Watershed Council
- Tillamook Chamber of Commerce
- Tillamook Connections
- Tillamook County
- Tillamook County Creamery Association
- Tillamook County Fair
- Tillamook County Library
- Tillamook County General Hospital
- Tillamook County Pioneer Museum
- Tillamook Headlight Herald
- Tillamook County Public Works Department
- Tillamook County Soil and Water Conservation District
- Tillamook County Solid Waste Department
- Tillamook Cow
- Tillamook Farm Bureau
- Tillamook Farmer's Market
- Tillamook Forest Center
- Tillamook Habitat and Estuary Improvement District
- Tillamook People Utility District
- Tillamook School District
- TLC Federal Credit Union
- Twin Rocks Friends Camp
- U.S. Bureau of Land Management
- U.S. Forest Service
- U.S. Geological Service
- U.S. National Park Service
- U.S. Natural Resource Conservation Service
- University of Oregon
- Unfurl
- Upper Nehalem Watershed Council
- US Army Corps of Engineer
- US Fish and Wildlife Service
- WEBS
- Werner Meats
- Wetlands Joint Venture
- Whiskey Creek Shellfish Hatchery
- Wild Salmon Center
- Wildlife Rehab Center of the North Coast
- Winters Guide Service
- Yakima Bait
- Tillamook County Pioneer
- Numerous Dedicated Landowners and Citizens



## Adapting to Change

### An Eye Towards Climate Change

Climate change in the Pacific Northwest is a complicated topic. Keeping an eye on climate predictions and the changes that might occur is becoming a key consideration in conservation and restoration activities. Organizations such as TEP are looking to create and protect existing habitats that exhibit qualities that are resilient and adaptable in the face of change such as intact habitat types, habitat diversity, species diversity, and adequate habitat connectivity.

Over the next 100 years, Tillamook County's weather is predicted to be warmer and wetter, and have more condensed winters with longer and drier summers. Sea level rise estimates for the year 2100 range from 2.6ft – 6.6ft taking into account melting ice sheets, thermal expansion of the oceans, and ice dynamics. As carbon dioxide concentrations increase in the atmosphere, the ocean will begin absorbing higher rates of carbon dioxide and become more acidic.

Estuaries in TEP's study area have not been immune to the influence of climate change. In 2007, the Whiskey Creek Shellfish Hatchery, located adjacent to Netarts Bay, noticed a dramatically increased rate of mortality in their oyster seed stock. Whiskey Creek, in cooperation with OSU researchers, launched a comprehensive water quality monitoring program that uncovered the cause—the acidity of the incoming seawater affected the concentration of aragonite, crucial for shell production in the young oysters.

Armed with this knowledge, the oyster growers were able to combat the aragonite deficiency with the addition of sodium carbonate (also known as washing soda), which showed immediate positive results on the survivability of the young oysters. While the study focused on the effects of ocean acidification on shellfish, it also verified that changing climate conditions are real and can have significant economic and environmental repercussions. Recent events highlight scientific reason for concern: 2015 appears to be on track to break the record for the warmest year ever recorded globally; off the Pacific Northwest Coast, large concentrations of warm seawater are affecting ocean food chains and valuable fisheries; and water temperatures in our coastal streams are rising to levels known to be lethal to salmon. Regardless of their cause, these events should be used as a platform to focus research and enlighten further dialogue.

While many climate change scenarios have been hypothesized and uncertainty accompanies them all, it is important that we factor these scenarios into our plans with the cautionary principal in mind. To learn more about climate change and Tillamook County visit the TEP website to read the 2013 report prepared by the Oregon Climate Change Research Institute. For more on the effects of climate change on shellfish growers and what is being done to adapt, see the Journal of Oceanography article here: [www.tos.org/oceanography](http://www.tos.org/oceanography)



## Local Economy

### Healthy Watersheds & Estuaries = Healthy Economy

Healthy estuaries and watersheds provide many ecological benefits – clean water and habitat for fish and wildlife. But healthy and functioning watersheds and estuaries also have direct social and economic benefits – resiliency against storm damage and flooding, robust sports and commercial fisheries (including oysters and crabs), a vast array of recreational opportunities, and jobs. Projects taken on by TEP and our partners ensure that our estuaries and watersheds will remain prosperous well into the future and support a "restoration economy" for vendors and contractors. Between 2011 and 2014, TEP secured over \$5,600,000 in grants and donations from federal, state and local entities, private foundations, and individuals. Eighty-four percent of those dollars went into projects supporting habitat restoration, research and monitoring, and education and outreach. Looking at the local impacts of these dollars, the accompanying table provides an example of one of our primary grant sources, a Section 320 grant from EPA, and its economic impacts. Take this example and apply it to all of the work being done throughout our watersheds, by so many partners, and it highlights restoration providing yet one more way for our local economy to become more diverse and resilient.

### Section 320 EPA Grant and the Economic Benefits Provided to Tillamook County 2011-2014

Local Grants and Partner Support  
\$95,300

Local Contractors – Services  
\$426,900

Local Retailers – Supplies  
\$60,700

Salaries – Family Wage Positions  
\$875,200

Total Contribution to Local Economy  
\$1,458,100



**Balance.** It is a simple word full of complexities. TEP and its partners work hard to balance the many needs in our community – cultural, social, economic, and environmental. All of these are what make TEP's study area so unique and wonderful. However, there is still a lot of work that needs to be done. Our estuaries are complex and diverse ecosystems as are the solutions to achieving a "healthy" rating in each of them.

The need for balance continues to be a driving force as the landscape changes and multiple land uses continue to affect the estuaries and watersheds. As we move forward, expect to see more organizations join together to coordinate resources, strengthen partnerships, and ensure that diverse perspectives and needs are considered in implementation.

Over the past five years, TEP has expanded its efforts in water quality monitoring, habitat restoration, and outreach. TEP is investing resources in its role in environmental education to provide additional support to educators, formal and informal, and to connect students of all ages to outdoors through fun and interactive experiences. And, TEP is looking for ways to grow and enhance capacity throughout its study area to achieve the goals laid out in the CCMP.

However, this isn't just about TEP. Without the dedicated and passionate partners and volunteers that work throughout the study area, the state of our bays would be precarious. Without the many landowners who are committed to improving their part of the landscape, most of the successes wouldn't be possible. This is truly a partnership at the highest level and it only works when we are all working together.

This Executive Summary is but a snapshot of the efforts that have gone on over the past five years. For a much more comprehensive overview, visit the TEP website to read the State of the Bays 2015 Health Report. It paints an amazing picture of the foundation that has been laid for the next five years.

TEP and our partners are committed to restoring healthy and functioning natural systems throughout Tillamook County's estuaries 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; donate; use native vegetation in your landscaping and reduce 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.

*"Humankind has not woven the web of life. We are but one thread within it.  
Whatever we do to the web, we do to ourselves.  
All things are bound together ... all things connect."*

*—Chief Seattle*

## GLOSSARY

**Aquatic** – an aquatic plant or animal, of or relating to water

**Bioaccumulation** – refers to the accumulation of substances, such as pesticides, or other chemicals in an organism

**Climate change** – a change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels

**Diversity** – a range of different things (i.e. habitats, organisms)

**Ecological services** – an ecosystem service is any positive benefit that wildlife or ecosystems provides to people. The benefits can be direct or indirect – small or large

**Ecosystem** – a biological community of interacting organisms and their physical environment

**Environmental literacy** – the capacity of an individual to understand complex environmental issues and how people and societies relate to each other and to natural systems, and how they might do so sustainably.

**Estuary** – the tidal mouth of a river(s), where the ocean tides meet the stream

**Hydrology** – the branch of science concerned with the properties of the earth's water, especially its movement in relation to land

**Intertidal** – denoting the area of a shoreline that is covered at high tide and uncovered at low tide

**Invasive species** – are plants, animals, or pathogens that are non-native (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause harm

**Large woody debris** – logs, sticks, branches, and other wood that falls into streams and rivers. This debris can influence the flow and the shape of the stream channel, and is important in salmon habitat providing cover from stream flows and predators

**Life history** – refers to the timing of key events in an organism's lifetime, as shaped by natural and/or sexual selection

**Microbial** – of, or related to microorganisms (organisms not visible to the naked eye)

**Natural resources** – materials or substances such as minerals, forests, water, and fertile land that occur in nature and can be used for economic gain

**Rearing** – development process of an organism being brought up and cared for until they are fully grown, especially in a particular manner or place (i.e. Coho Salmon frequently rear in tidal wetland channels)

**Regression model** – technique for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables

**Restoration** – action of returning a habitat, community, or species to a former place or condition

**Riparian communities** – a community characterized by the availability of water often situated on the banks of a river, lake, or wetland

**Sedimentation** – the tendency for particles in suspension to settle out of fluid and come to rest in a specific place such as a barrier, river bed, or lake bed

**Water diversion** – a structure utilizing instream barriers such as dams, weirs, culverts, canals, and pipes to divert water to or from a source

## Acknowledgements:

### Tillamook Estuaries Partnership

*A National Estuary Project*



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York Johnson, Monitoring Coordinator

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*Thanks to our partners for all of their work in the watersheds of Tillamook County.*

For the full version of this document, visit our website: [www.tbnep.org](http://www.tbnep.org)

Produced by TEP staff with support from the board and partners.

Cover photo: Roger Ross Photography

Photos: Best Impressions Picture Co., Roger Ross Photography, or Tillamook Estuaries Partnership, unless otherwise noted.

This document made possible by a Section 320 Grant from EPA.

For more information about the National Estuary Program visit: [www.epa.gov/nep](http://www.epa.gov/nep)

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

The Tillamook Estuaries Partnership is dedicated to the conservation and restoration of Tillamook County's estuaries and watersheds in their entirety.

### Tillamook Estuaries Partnership

613 Commercial Street  
PO Box 493

Garibaldi, Oregon 97118

503-322-2222 • fax 503-322-2261

[www.tbnep.org](http://www.tbnep.org)

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**Tillamook Estuaries Partnership**  
613 Commercial Street  
PO Box 493  
Garibaldi, Oregon 97118  
503-322-2222 • fax 503-322-2261  
[www.tbnep.org](http://www.tbnep.org)

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