TILLAMOOK ESTUARIES PARTNERSHIP

State of the Bays 2015: Health Report

Tillamook Estuaries Partnership

A National Estuary Project

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Foreword: 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 land 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, 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. As 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.

The issues facing our estuaries and watersheds are complex . Partnerships are critical to balancing social, economic, and environmental needs when addressing concerns such as flooding, wetland restoration, salmon recovery, climate change impacts, water quality, and education. These challenges need to be dealt with looking at the whole watershed and assessing the needs within it. This requires partners and stakeholders sitting at the table, identifying common goals and the strategies needed to achieve those goals.

As you read through this document, 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 as intertwined as the issues we are tackling.

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.

Figure 1: TEP Study Area

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 made.

We are the Tillamook Estuaries Partnership.

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Scenic Snapshots of our Bays and their Watersheds

TEP 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 retain their unique character because of the communities that surround and nourish them.

Figure 2: TEP Study Area

Tillamook Bay & Watershed

Figure 3: Tillamook Bay Photo

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"..

Nehalem Bay & Watershed

Figure 4: Nehalem Bay Photo

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.

Nestucca Bay & Watershed

Figure 5: Nestucca Bay Photo

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.

Netarts Bay & Watershed

Figure 6: Netarts Bay Photo

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.

Sand Lake & Watershed

Figure 7: Sand Lake Photo

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 square 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..

The State of Five Bays & Their Watersheds: A Report Card

This 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 and the State of the Bays 2015 Health Report (this document). This Health Report offers greater detail on specific projects and efforts throughout the study area while the State of the Bays 2015 Executive Summary provides a general overview and assessment of the estuaries and watersheds within the TEP study area. The Executive Summary document can be found online at 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. 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.

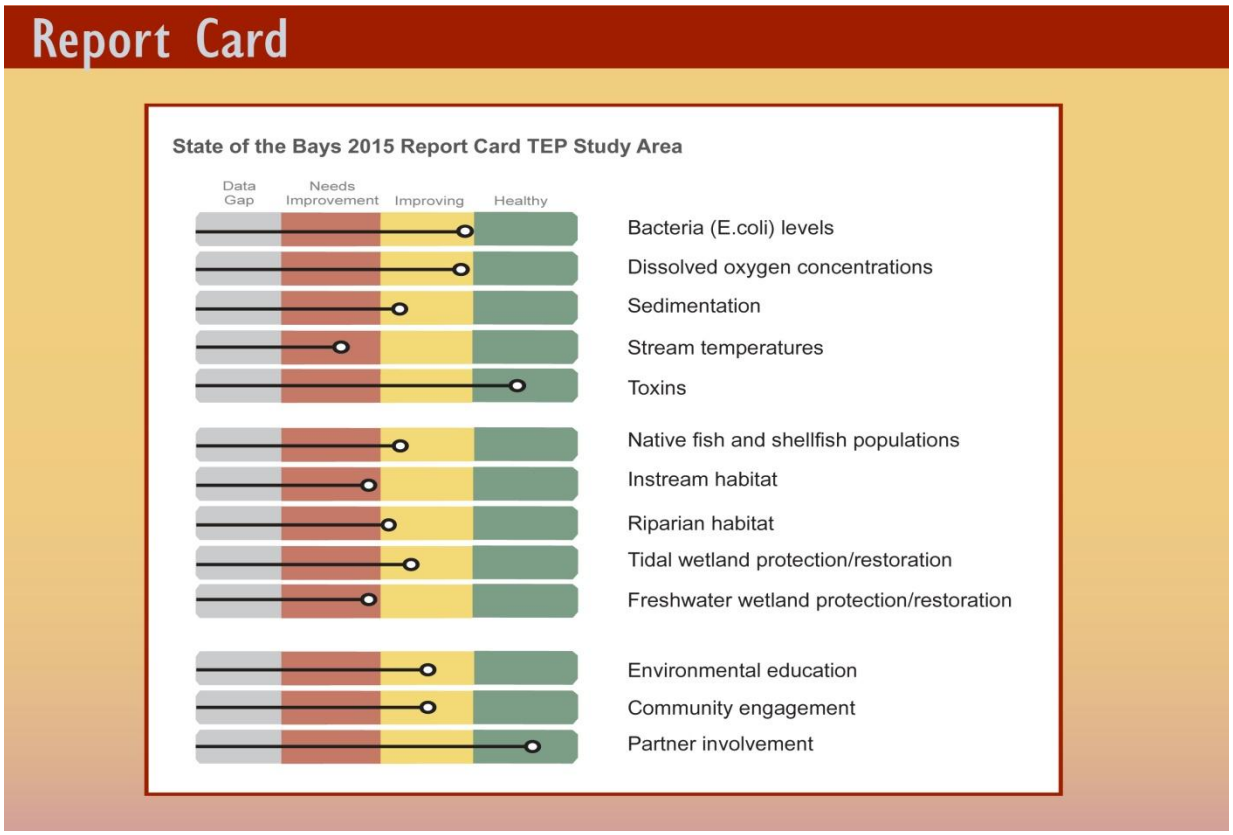
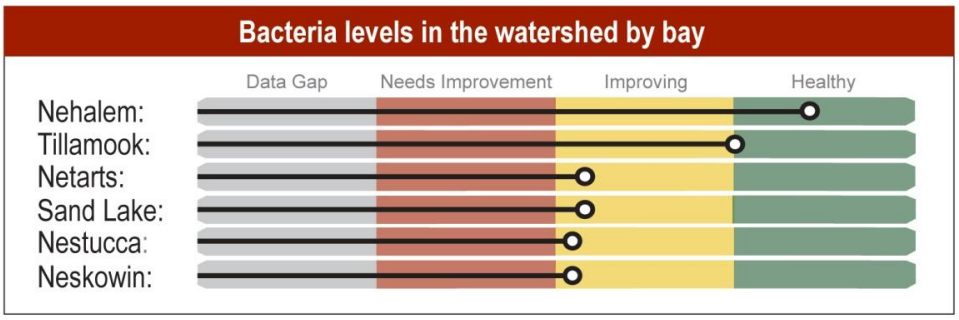


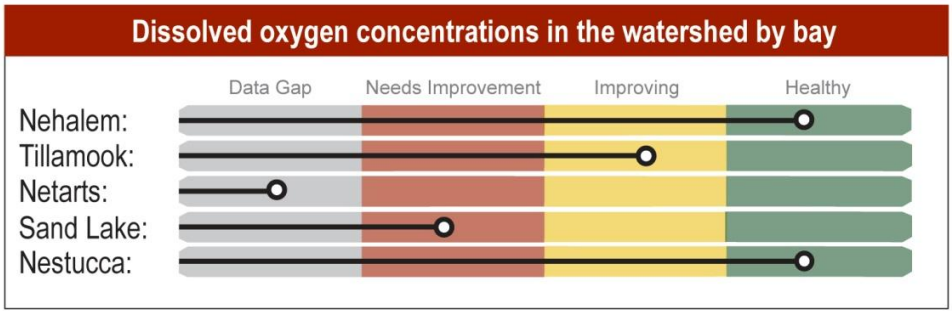
Figure 8: Report Card, TEP Study Area

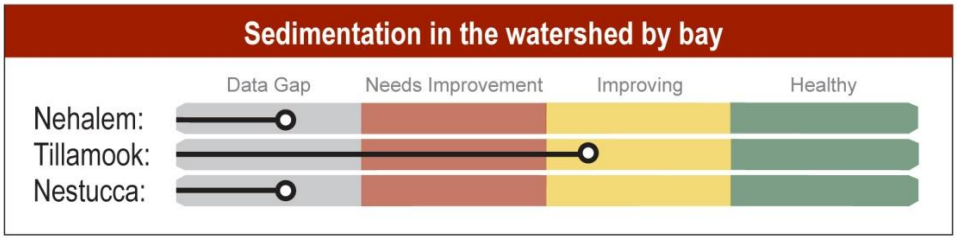
Detailed Report Cards by Estuary

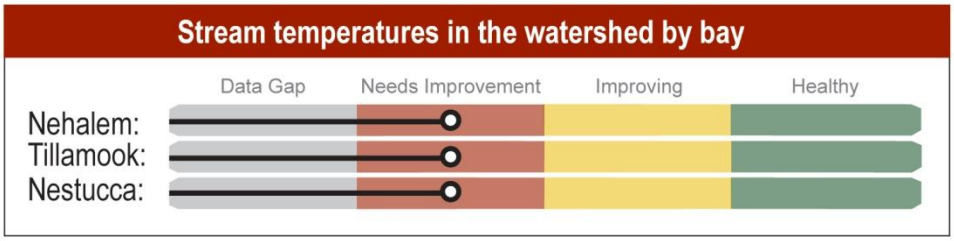
Below you will find expanded report cards detailing the same study area wide criteria by individual estuary. Report cards for environmental education, community engagement, and partner involvement are not included below because the ratings for those are done on a study area basis only.

Water Quality Report Cards

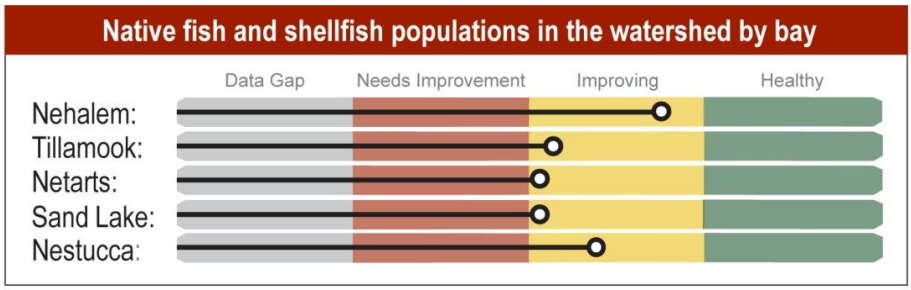


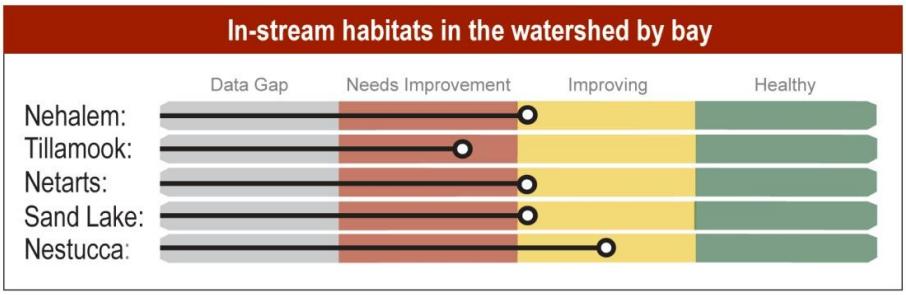


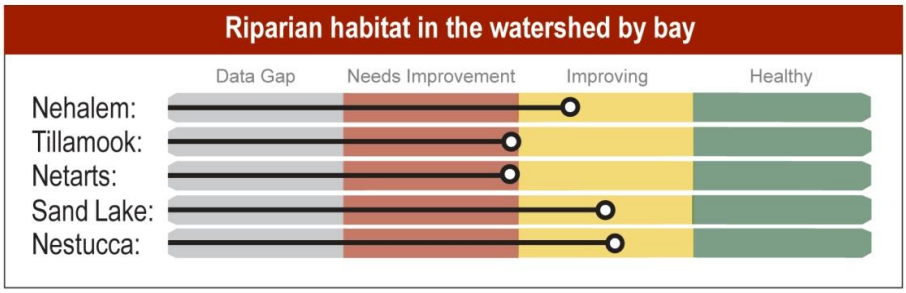


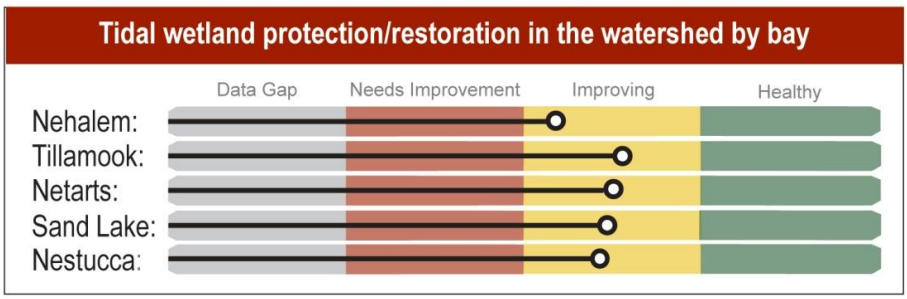


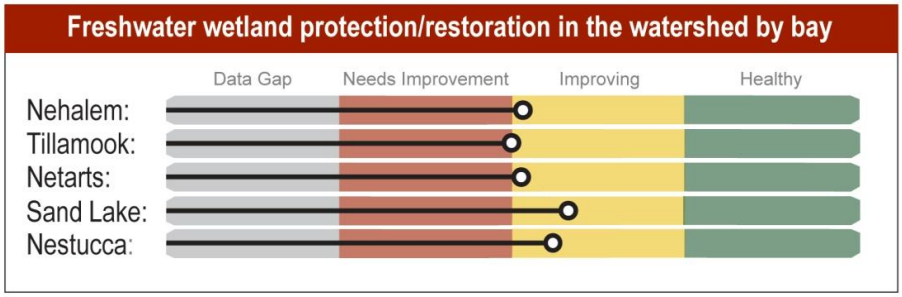
Habitat Report Cards











State of the Bays: Water Quality

The Importance of Clean Water

Clean water is important for people and wildlife. People, especially on the north coast of Oregon rely on clean water as a drinking water source, taking much of their drinking water from surface water sources such as streams and rivers. Clean water also provides people with a place to fish, swim, and play. It can also provide food such as cultivated oysters or wild caught fish. Salmon and other aquatic life need good habitats to thrive and reproduce. In the Pacific Northwest, a component of this aquatic habitat is clean, clear, cold water. To determine whether water is clean, it is necessary to we had to establish what type of use we are trying to protect and what specific water pollutants may limit that use. During development of TEP's CCMP, local stakeholders determined that four types of pollution are 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, pesticides and other toxic substances) as another pollutant type that might be of concern in the north coast of Oregon, including TEP's study area. These pollutants and their impacts on water quality are discussed in greater detail below

Bacteria

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, which have been 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 the fecal bacteria *Escherichia coli* (*E. coli*) in freshwater and *Enterococcus spp.* in saltwater to determine if surface waters are safe for recreational contact such as swimming, boating and fishing. The State measures fecal coliform bacteria concentration to determine if commercial shellfish harvest can occur. *E. coli* and *Enterocuccus spp*. 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).

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. The program expanded to include most of the major rivers and streams and all five estuaries. Dedicated volunteers sample sites twice a month all year long in rain or shine. The results of TEP's testing are compared to the State of Oregon water quality standards associated with bacteria for recreational use. Recreational

use includes fishing, boating and swimming. If bacteria levels are too high, people have an increased risk of becoming sick from pathogens associated with fecal bacteria.

TEP works with the Oregon Department of Environmental Quality (DEQ) to determine how current bacteria levels compare to the State standards. Another question that TEP answers through the VWQMP is whether bacteria levels are improving or getting worse over time. TEP works with DEQ to determine if statistically significant changes in bacteria levels are present. TEP also posts individual sampling results on its website in an interactive map as soon as the information is available. To view the latest bacteria results, go to: http://www.tbnep.org/map.php

Based upon State standards and the VWQMP, TEP tracks changes in bacterial concentration over time. In general, the Wilson, Kilchis, and Nehalem rivers have been meeting recreational standards since 2005, 2009, and 2010 respectively. The Tillamook River, while not meeting standards, continues to improve at all monitoring locations. Mill Creek is not meeting standards and bacteria levels are increasing. Hoquarton, Dougherty, and Gallagher Sloughs all have bacteria levels that are higher than the recreational use standards. In addition, some of the smaller tributaries to the Nehalem river have level of bacteria above the standard.

The Nestucca River watershed was added in 2012. As a result, there is less data available making it challenging to establish any trends. Generally, the lower reaches of the Nestucca River and the

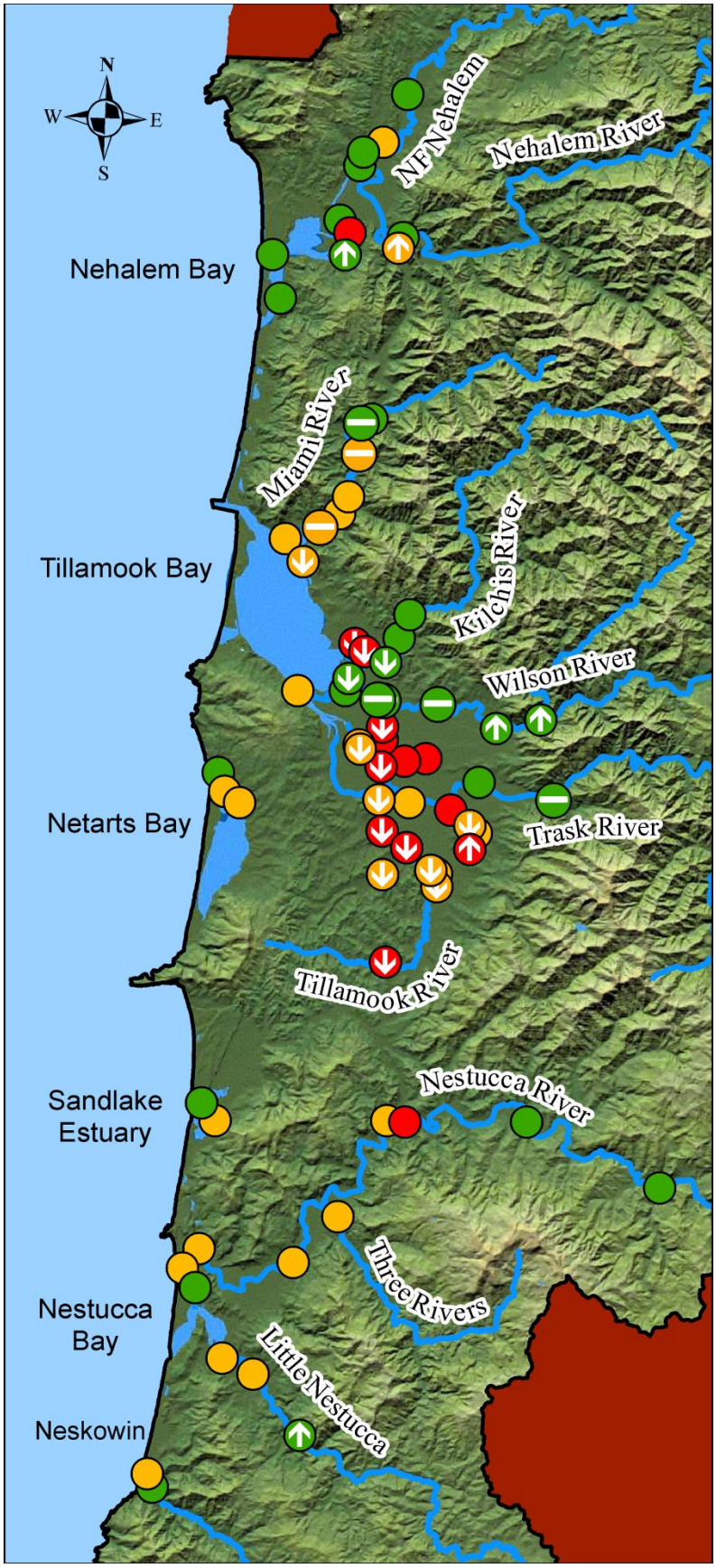


Figure 9: VWQMP monitoring locations with trends

Little Nestucca River are not meeting the recreational use standard. However, further upstream monitoring sites are meeting standards. A slight trend is present at the uppermost site in the watershed on the Little Nestucca River. Although the site currently meets recreational standards, it does show increasing bacteria concentrations.

TEP also monitors bacteria levels within the five estuaries of our study area. The State of Oregon recreational use standard for estuaries is based on *Enterococcus spp.* bacteria. Nehalem Bay is the only estuary currently meeting the State standard at all monitoring locations. Tillamook Bay is not meeting standards at any of the three monitoring locations but does show improvement at one location. The bacteria levels at the other estuaries are generally meeting standards at sites closest to the mouth of the estuaries, but not higher up in the estuaries.

While monitoring shows that improvements are being made in many of the watersheds as it relates to the State's recreational standards for bacteria, there are opportunities for improvement. Using VWQMP results, TEP identifies and prioritizes degraded areas and works with partners to target lowering bacteria levels in waterways that are not meeting standards.

Many programs target reducing bacteria levels in TEP's study area. The Backyard Planting Program is a TEP effort to augment riparian areas through voluntary landowner participation on residential and agricultural land and often partners with Tillamook SWCD who provides fencing on agricultural lands to limit livestock access to streams and rivers. Tillamook SWCD and Watershed Councils facilitate outreach to increase participation in BYPP. The Watershed Councils also implement their own riparian restoration projects within their service areas. The Oregon Department of Agriculture (ODA) Confined Animal feeding Operation (CAFO) and Water Quality programs also use the results of this data to guide their activities on the ground.

Bacteria Research and Demonstration Projects

Tillamook Bay Estuary Water Quality Improvement, Evaluation of Best Management Practices, and Identification of Pollution Sources Using Innovative Microbial Source Tracking Analyses

The VWQMP allows comparison of bacteria levels in rivers and bays to the State of Oregon Standards and detects changing levels over time. However, this does not permit TEP or partners to identify the possible sources of bacteria in a meaningful way. In 2001, TEP partnered with Oregon State University (OSU) to perform a bacteria DNA study to better understand which sources of bacteria were affecting water quality. The study entitled "Basin-Wide Analysis of the Dynamics of Fecal Contamination and Fecal Source Identification in Tillamook Bay, Oregon" was useful for planning appropriate restoration and outreach efforts (Shanks et al. 2006). But, with advancing methodologies and technologies, efforts to improve upon results became important. In 2012, TEP joined with EPA on a national endeavor to develop a standard method for analyzing bacteria DNA. Tillamook Bay was selected as a Demonstration Project for the larger EPA effort. VWQMP volunteers collect additional samples for EPA from the Tillamook, Trask, and Kilchis Rivers. Over the next six months to a year, 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 use this information to target the appropriate contributing sources in future restoration and outreach work.

Reducing Bacterial Contamination in the Tillamook Estuary through Performance-Based Incentives

TEP, with assistance from partners like EPA and OSU, uses bacteria DNA analysis to identify possible sources of bacteria. In a project that is complementary to EPA's microbial source tracking, TEP has partnered with OSU, DEQ, ODA, and a private landowner to try 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 when a farm is contributing to bacteria levels above standards.

TEP is developing a water quality monitoring network that 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. The LiquID Station transfers the data it collects to a website and results are available to researchers in real time. The project established the first of three LiquID Stations in the lower Tillamook River which collects E. coli concentration every two minutes. The goal of the first station is to allow partners and local farms to become comfortable with the data being produced and to begin to determine how land management in the Tillamook River watershed may affect bacteria concentrations in the river. TEP collects water samples from this location to have OSU analyze the sample for specific bacterial DNA. This allows researchers to establish the source of bacteria and determine if local livestock are contributing to high bacteria concentrations measured in the river.

Future efforts include recruiting interested landowners and collaborating on the development of best management practices to adjust activities as necessary on participating farms to decrease livestock bacteria concentrations collected through the real-time monitoring network in the river. Results may give farms, agencies, and other organization insight into how farm practices contribute to water quality in adjacent streams. Partnerships with the agricultural community in these projects are critical to increase our understanding of sources and impacts of bacteria on water quality.

Shellfish

TEP and its partners are working to lower bacteria concentrations throughout the TEP study area to meet the State's recreational use standard for *E. coli* bacteria. Tillamook and Netarts bays have a significant commercial shellfish industry and good water quality is a vital component for their success and for human health, as raw oysters are a sought-after delicacy. In addition to the

recreational standards, the State established a bacteria water quality standard for shellfish-producing estuaries and it's measured in fecal coliform bacteria. If bacteria levels are higher than the standard, commercial shellfish harvesting in the bays is closed. Analyzing water samples for fecal coliform bacteria is more complex than *E. coli* bacteria and TEP does not have the ability to perform this type of monitoring. TEP works with ODA's shellfish program to assist with monitoring when possible to better characterize fecal coliform levels in Tillamook Bay. In addition, TEP does monitor the bays for *Enterococcus spp.* bacteria. *Enterococcus spp.* is the bacteria use to compare to the State's recreational use standard in estuary waters. TEP believes that improvements made in the rivers and streams that enter the bays will likely have a similar positive effect on water quality in the bays.

Oregon Shellfish Initiative – Tillamook Bay Case Study

ODA is currently developing a pilot program for monitoring existing oyster growing areas to achieve a greater precision in closure and opening thresholds. Commercial shellfish growing areas are managed on predictable pollution conditions using proxies for water pollution. These proxies are either river height, rainfall or both. When a threshold river height or rainfall is reached, a particular part of a bay is closed for harvest for a particular period of time. Thresholds have been established and refined over time using water quality data collected in the bay and comparing these to the pollution proxies. These thresholds are written in as conditions in the Tillamook Bay Commercial Shellfish Management Plan. The Tillamook Pilot Project seeks to perform additional water sampling to test whether the existing Management Plan can be adjusted to result in fewer closure days for the industry.

Increased sampling will be focused on the possibility of creating a new management area in the center of the bay. The goal of the increased sampling will be to explore the opportunity to establish a less conservative condition for growing areas north of this boundary. For example, rather than the existing 7' Wilson River height closure threshold, this new area may not need to close until the Wilson River exceeds 8' or even higher. The Wilson River height is used because the USGS has a gauge station on this river which ODA staff can monitor on an hourly basis. Increased testing will validate this theory.

A second facet of the Pilot Project will be to test whether the lengths of closures can be shortened under certain conditions based upon the information gathered through this pilot program. Although the reasons can be complicated, a review of closures for Upper Tillamook Bay, since 2010, revealed that 80% of the closures ran for longer than the minimum five-day closure period. Since the majority of closures extend beyond the minimum five days, opportunities to reduce this percentage would result in many more harvest days to industry. As an example from 2014, Upper Bay was closed 14 times for a total of 113 days. If each of these closures were only 5 days long, the number of days closed would have been 70 days.

Dissolved Oxygen

How Do Dissolved Oxygen Levels Affect Aquatic Life in Tillamook County's Rivers and Sloughs?

Dissolved oxygen (DO) is an important component to estuary and freshwater in-water habitats. In simple terms, DO is the amount of oxygen available (and hence available to sustain aquatic life) in the water column of a lake, river, or stream. 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 life stages and locations, particularly juvenile salmon. There are also several sloughs around Tillamook Bay that have DO levels that do not support juvenile salmon use in the warmer periods of the year. Rivers provide rearing habitat for juvenile salmon and sloughs provide habitat for the juvenile salmon as they are transitioning from freshwater to salt water. DO levels are affected by many factor including temperature, algae growth, and nutrients.

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

In partnership with DEQ, TEP monitors DO levels in the Tillamook Bay sloughs, and other rivers, and streams throughout the study area identified as having low levels of dissolved oxygen. DO levels change frequently throughout any given day, and to capture this daily variation, TEP measures DO levels every 15 minutes for 24 to 96 hours 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 Bay. The frequency and duration of these low levels change depending on many factors including weather conditions as well as land management activities. 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 Rivers has shown that these rivers are also meeting the summer rearing and migration standard of 8 mg/L (freshwater standard).

TEP collected DO data in Tillamook Bay in 2011 and 2012. Results indicate that ocean conditions have a significant influence on DO in the Bay. This influence decreases in the upper portions of the bay. Unlike temperature and bacteria, DEQ has not developed a Total Maximum Daily Load (TMDL) for dissolved oxygen on the north coast. TEP works closely with DEQ so that all data collected by TEP will be available for developing TMDL for DO impaired rivers, streams, and sloughs in Tillamook County.

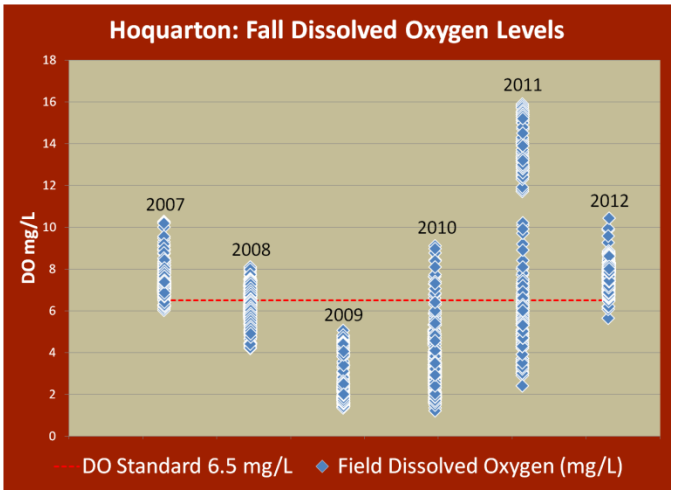


Figure 10: DO levels for a Tillamook Bay slough indicate improvements since 2009

Sediment

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 stream bed or in an estuary. This is a natural process and a balance between sediment deposition and sediment flushing is maintained in a health system. Excess deposition of fine sediments or an imbalance in a system 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 large woody debris (LWD), stream width, bank stability, and upland and streamside land uses.

Sediment Monitoring Projects

Relative Bed Stability Long-Term Monitoring

TEP, in its CCMP, identified excess sediment as a water quality concern in the Tillamook Bay watershed and a likely concern in the Nehalem River Watershed. The State identified excess sediment as a concern in the upper Nestucca watershed. From 2007 through 2009, TEP contracted with Demeter Design to initiate 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 many conclusions about the transport of sediment within the watershed. (Mico, C and L. Mico 2009) This initial effort produced a single snapshot in time and did not document how the watershed might change. A long-term monitoring strategy, developed by TEP and DEQ, includes the collection of sediment and other data using the RBS technique. Since the original study was completed, partners have collected monitoring data for 30 sites in the watershed every two years. Through the partnership with DEQ, this data continues to be collected on the schedule established in the original study with the next collection event taking place in the summer of 2016. TEP is working on acquiring resources to analyze the data to determine if trends are present in the watershed and what efforts might be needed to address negative impacts from sedimentation to the watershed.

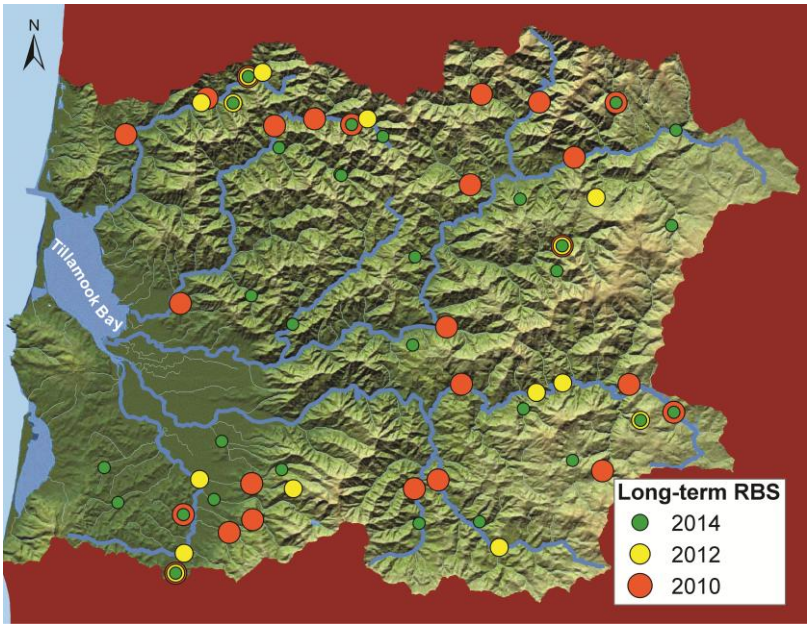


Figure 11: Long term RBS monitoring sites

Tillamook Suspended Sediment Discharge Study

TEP built on the results of its initial RBS sediment study and partnered with USGS and

Tillamook County to investigate fine sediment loads produced in the Wilson and Trask rivers. The USGS led this effort with the goal to correlate turbidity and stream flows to estimate an annual sediment load to Tillamook Bay from its two largest rivers.

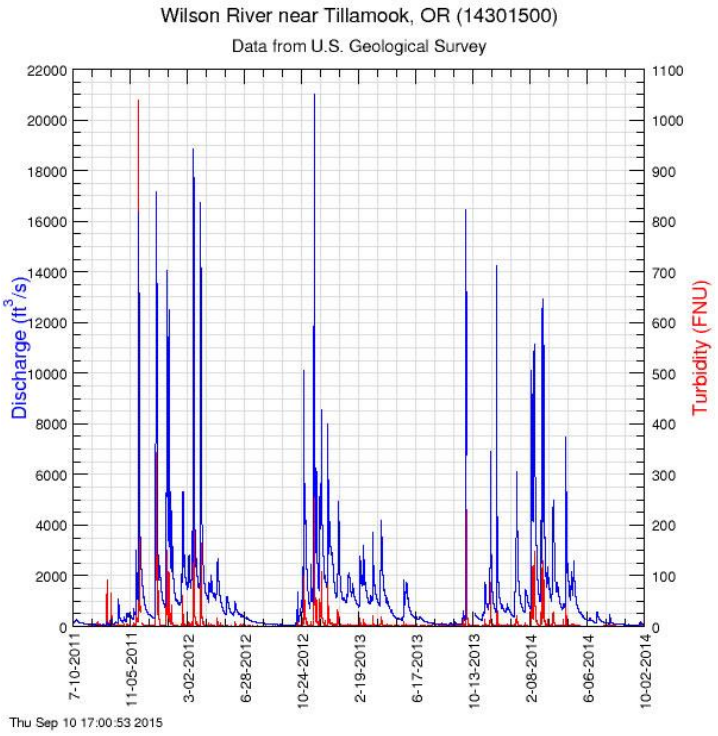


Figure 12: Example of flow and turbidity data from USGS gauge

The USGS installed and operated a turbidity and suspended-sediment monitoring network at the Wilson and Trask River gages. Routine and storm-related samples for suspended-sediment concentration were collected. In addition, water temperature, specific conductance, and dissolved oxygen data were gathered with separate sensors to give a general sense of water quality at the sites. All water quality parameters were available in real-time on the USGS gages website for three years. The dissolved oxygen data was collected at both stations for only the months of June through October; the other data was collected year-round. The USGS used the data to feed into a regression model that uses the continuous in-stream turbidity data and point in time suspended-sediment concentrations (SSC) data to estimate continuous SSC based on flow.

USGS completed the project in summer of 2015 and summarized the project in a report entitled Water-Quality Conditions and Suspended-Sediment Transport in the Wilson and Trask Rivers, Oregon. The report 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. TEP and other resource managers can use this information in determining to what degree each system is most affecting the Bay through sediment delivery. It allows resource manager to prioritize and target restorations tasks, such as large wood placement and riparian restoration projects, in the watersheds if excess sediment is reaching the Bay.

Long-Term Temperature Monitoring

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 throughout Oregon. Stream temperature is influenced by shade, ambient air temperatures, water withdrawals, groundwater inflows, and water volume 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. When temperatures exceed the standards, salmon experience an increased susceptibility to 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 daily temperatures are calculated and used when testing for these standards.

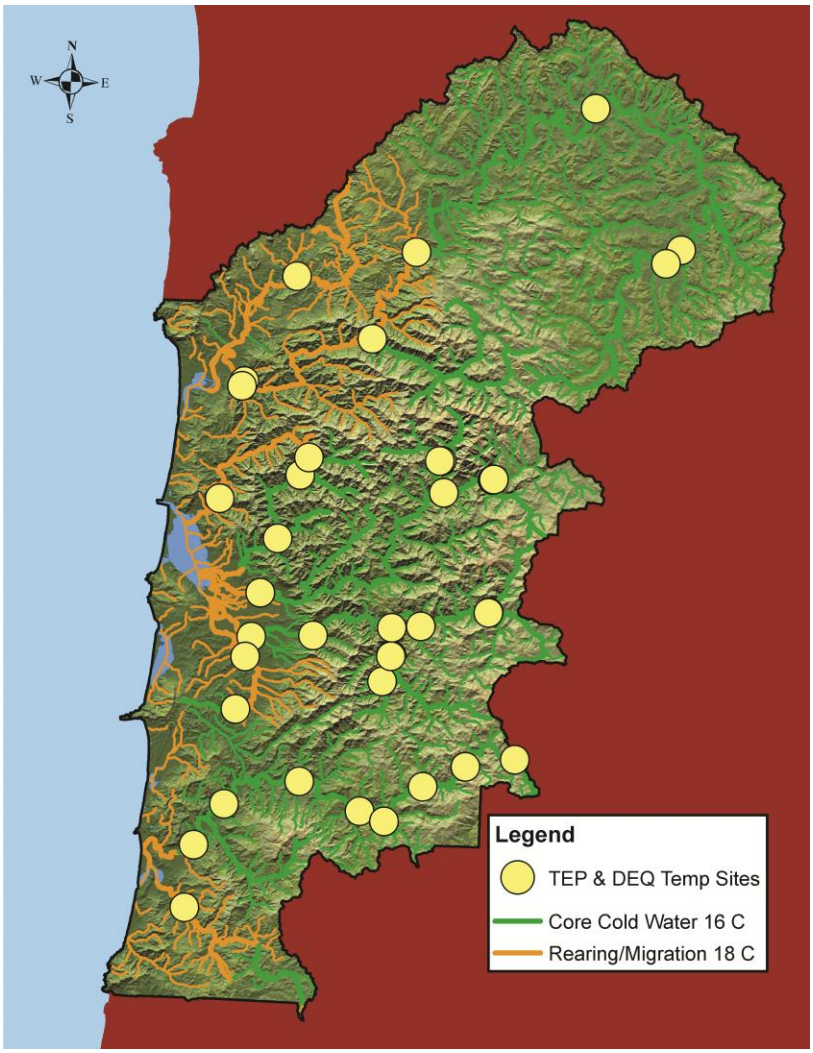


Figure 13: TEP/DEQ Temperature monitoring sites including core cold water streams (16 C) & rearing and migration streams (18 C)

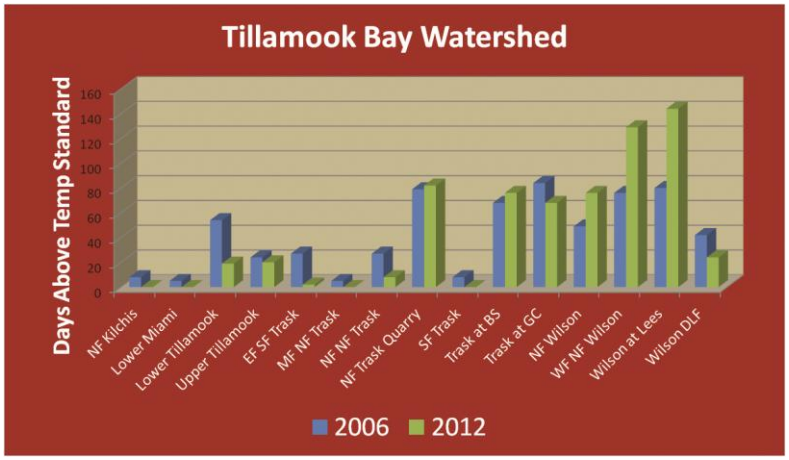
Are maximum yearly surface water temperatures at levels that support salmon lifecycle requirements?

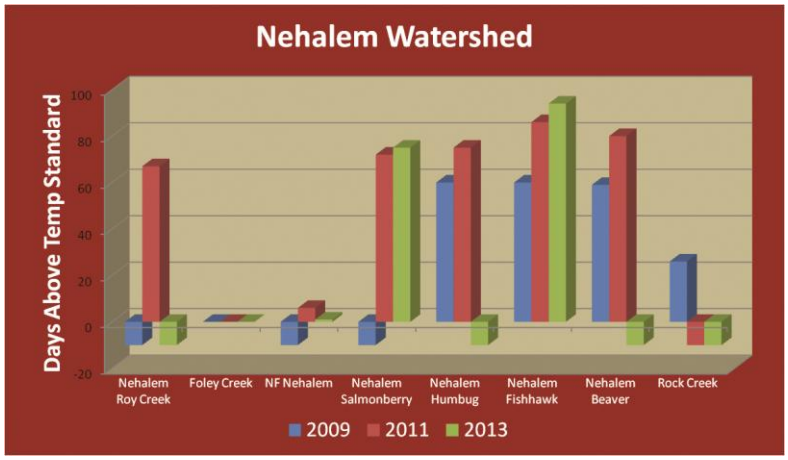
TEP assists DEQ with stream temperature monitoring in the Tillamook, Nestucca and Nehalem watersheds. Temperature data is collected from Nehalem and Nestucca watersheds in odd years and in the Tillamook Bay Watershed on even years. A large amount of data is required to establish temperature changes over time and to account for seasonal or long-term weather patterns. TEP's annual temperature monitoring program captures hourly temperature readings from May through September to record both daily high temperatures as well as the highest summertime temperatures. TEP looks to partners to provide additional temperature data. The Upper Nehalem Watershed Council in cooperation with the Vernonia School District has been providing valuable temperature data on the upper Nehalem Watershed.

TEP compiles the hourly temperature readings and calculates the daily high temperature, then averages the daily highs over a seven-day period. This information is compared to the State temperature standards to determine if the rivers and streams are providing salmon and other aquatic life with cool water temperatures. The State standard, called the "Seven-Day Average Maximum Temperature", 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 and, therefore, the temperature target for these streams is a maximum seven-day average no greater than 16 degrees Celsius. Other rivers and streams are identified for rearing and migration and have a maximum seven-day average of no greater than 18 degree Celsius.

Many of the streams are not meeting the temperature standards for a portion of the summertime periods. Through this long-term monitoring effort, TEP is able to compare number of days each site is above the temperature target and compare these same sites from year to year. Data from 2006 through 2013 was included in this summary. The loss of forested riparian areas, simplified stream channels, and loss of connectivity to riparian wetlands affect temperature in the streams. Over time, the habitat restoration activities, identified later in this document, will result in cooler temperatures as well as improved habitat.





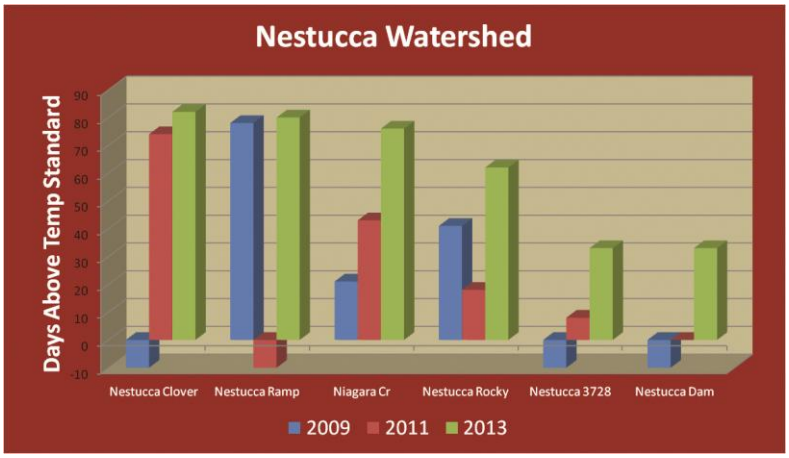


Figure 14: Temperature standard exceedances by year for Tillamook, Nestucca, and Nehalem Bays

Toxics Monitoring in the North Coast

What is meant by toxic compounds and why is it a concern?

As society advances, new products are finding their way into our rivers and streams. Some examples are pharmaceuticals that are not disposed of properly, personal care products, flame retardants, and pesticides. These compounds can have unintended effects on human health and aquatic life. People rely on streams for drinking water and water is critical for aquatic life. Small concentrations of pollutants in the water column or in sediments can become concentrated in tissues over a long time of continued exposure. This process is known as bioaccumulation. It is important to collect

information on potentially new and emerging pollutants is our waters before unfavorable effect begin.

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

In 2008, DEQ began a State-wide Toxics Monitoring program focused on rivers and streams including sediment and fish tissues at appropriate locations. The program gathered samples in a various areas of the state every year until the entire state was covered. The State Toxics program looked for several toxic compounds including: pharmaceuticals, personal care products, flame retardants, pesticides and many other pollutants. The project provides baseline information on concentration of the identified pollutants in the environment. One result of the study was the discovery of 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. The results were shared with other State agencies and led the Oregon Health Authority (OHA) to issue an advisory for consuming soft shell clams and recommendation 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/HealthyEnvironments/Recreation/FishConsumption/Pages/fishadvisories.aspx

More information on the results of the State-wide Toxics Monitoring program can be found at the follow website: http://www.deq.state.or.us/lab/wqm/toxics.htm

TEP was interested in gathering more data on toxic pollution and partnered with DEQ during their 2013 component of their state-wide monitoring effort. TEP focused on monitoring drinking water source streams (DWSS) and current-use pesticides. A majority of the North Coast drinking water is supplied from surface water streams and many drinking water plants have minimal treatment processes. Watersheds that supply surface drinking water are susceptible to pollution from urban, forest, and agricultural pollutants. TEP chose to include drinking water source stream because of the connection to human health and the limited treatment in these small systems. TEP also chose to limit its analysis to current-use forestry pesticides because of the cost for additional parameters and forestry is the major land use in the DWSS.

To increase the sample collection period, TEP decided to include Polar Organic Chemical Integrative Samplers (POCIS) as well as water

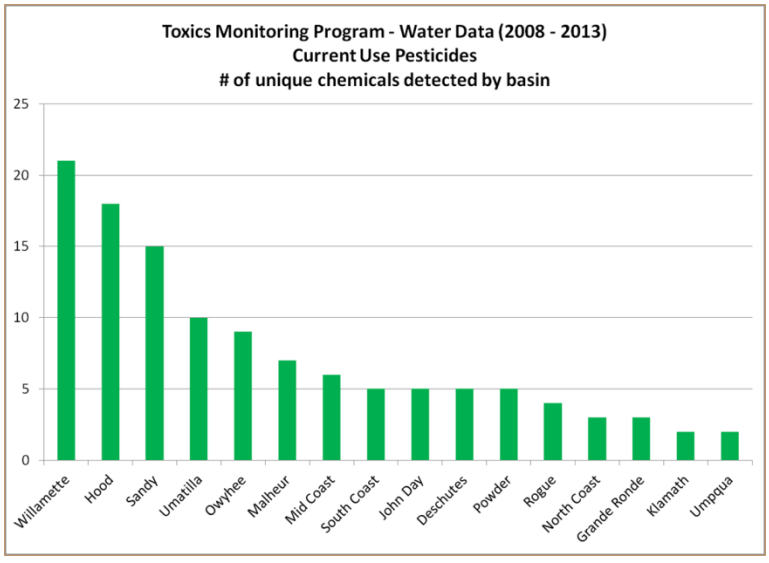


Figure 15: This chart shows the number of individual pesticides detected by region in DEQ study

column samples in their effort. POCIS has a membrane that collects dissolved pollutants as water flows through it. The advantage of POCIS is that it can be deployed for 28 days at a time and therefore have a greater likelihood of capturing a spray event. A drawback of POCIS is it provides only a presence or absence result and not a pollutant concentration.

TEP identified six drinking water source streams and five other streams to include in the monitoring effort. At three of the DWSS sites, an additional upstream sample location was included to better understanding of how pollutants might be diluted or travel within the watershed. The sampling locations and DWSSs are listed in the table below.

Table 1: TEP POCIS Sites

TEP POCIS Sites		
Stream	Drinking Water Source	Station Name
Beaver Creek	Yes	Beaver Creek at Beaver
Fawcett Creek	Yes	Fawcett Creek at Fawcett Creek Farm
Fawcett Creek	Yes	Fawcett Creek at River Mile (RM) 3.3
Hawk Creek	Yes	Hawk Creek RM 0.8
Jetty Creek	Yes	Jetty Creek RM 0.4
Killam Creek	Yes	Killam CR above city diversion
Killam Creek	Yes	Killam Creek RM 2.6
Rock Creek	Yes	Rock Creek at RM 0.8
Rock Creek	Yes	Rock Creek at Keasy Rd (RM 11)
Nestucca River	No	Nestucca River at first bridge ramp (upstream of Beaver)
NF Nehalem River	No	North Fork Nehalem River at Highway 53
SF Trask River	No	South Fork Trask River downstream of Edwards Creek

Tillamook River	No	Tillamook River at Bewley Creek Road
Wilson River	No	Wilson River at Hwy 6 (Lee's Camp)

TEP's monitoring strategy was to sample at the time of year when the most pesticide applications were likely to take place, during the spring and fall. TEP decided to include a water column sample at the beginning and end of each POCIS deployment. This allows for some data that includes concentration values in addition to the 28 day presence/absence POCIS results. There was an adjustment made to the Jetty Creek deployment to coincide with a notice of spraying and in-water construction activities.

The results of TEP's monitoring work found five current-use pesticides: atrazine, desethylatrazine, sulfometuron-methyl, glyphosate, and aminomethylphosphonic acid (AMPA). N,N-diethyl-meta-toluamide (DEET), a common insect repellant, was also detected. TEP, along with DEQ, consulted with other agencies, including the Oregon Health Authority, to evaluate risks and provided a report of the data and associated toxicological information to municipalities and the public. The agencies concluded that these pesticides were measured at concentrations tens to thousands of times below human health benchmark concentrations (where the 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 these studies are not all encompassing and there are always limitations with any monitoring effort. If you are interested in obtaining a copy of the data from this study please visit our website: http://www.tbnep.org/

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 entered the ocean and there was concern that it could have an impact on West Coast ecosystems. Scientists tracking radiation from the incident predict that radiation 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 Institution (WHOI) scientists with data collection to verify predictions and add to understanding of ocean water circulation in the northern Pacific Ocean.

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

In TEP 2014 began participating in the WHOI Center for Marine and Environmental Radiation (CMER) project: "How Radioactive Is Our Ocean?" The program tracks the spread of radioactive isotopes released from Fukushima and relies on crowd source funding to support the scientific

monitoring. TEP funded analysis for a total of six water samples to be collected every six months. Depending on the results of initial samples gathered in the ocean at Cape Kiwanda, a second location may be included at Memaloose Point in Tillamook Bay. The samples are shipped to WHOI for analysis of 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 or accidents like the Chernobyl power plant in Russia. If, at some point during TEP's sampling, results of ocean water collected at Cape Kiwanda, show cesium-134 is present, the remaining samples will be collected at the Tillamook Bay site. The purpose of changing the sample locations will be to determine how the estuary radiation levels compare to that of the ocean levels.

TEP has collected a total of three samples to date, all from the ocean at Cape Kiwanda. Results from all samples have been non-detect or no cesium-134 measured above 0.2 Bq/m^3 of water. The samples were collected in June and December of 2014 and July 2015. On the broader scale, CMER found its first evidence of Fukushima radioactivity along the West Coast from a sample in British Columbia in April 2015. As predicted, levels of cesium remain at concentrations which do not pose a threat to human health or aquatic life. This effort is also providing great insight into ocean currents and circulation. For more information on WHOI and CMER effort please visit their website: www.whoi.edu/cmer.

State of the Bays 2015: Habitat

The Importance of Quality Habitat

Having a diverse array of healthy, high-quality habitats in an ecosystem is essential for our livelihoods and quality of life. TEP and its partners recognize the immense importance of natural resources to our local economy and its culture. Without clean water, productive habitat, and a knowledgeable citizenry, Tillamook County wouldn't be the special place it is today. Over the past five years, TEP and its partners strived to identify, prioritize, conserve, and enhance or restore vital areas of our watersheds in an effort to ensure their sustainability well into the future.

Ecological Community Descriptions

What's the difference between a bay and an estuary, and what makes them valuable?

The answer to this question is nothing really. These words are synonymous and are often used interchangeably. As some of the richest and most complex ecosystems on earth, estuaries are important in the life cycle of many fish and wildlife species, many of which form the backbone of our fishing industry. Tidal channels and sloughs, intertidal sand and mudflats, eelgrass beds, and tidal marshes 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, diking, 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 (Brophy et al., 2012). TEP and its many partners strive to address these challenges by conserving intact wetland tracts, removing or improving tidegates, removing invasive species, and re-establishing native tidal wetland plant communities. While increasingly challenging, these efforts represent the single biggest impact in the goal of restoring the health of our estuarine watersheds.

What functions do wetlands play?

Wetlands are habitats that are greatly influenced by the presence of water at or near the surface of the soil. Due to this frequently saturated condition, the plants and animals that inhabit wetlands are highly specialized and in many cases don't occur anywhere else. Historically, we were unaware of the important ecological services wetlands provided and converted or altered many of Tillamook County's wetlands. As our knowledge of how ecosystems function increases, we realize the critical services that wetlands provide and that humans depend upon. Wetlands act as nature's sponge accepting flood waters, holding them, and redistributing them slowly helping to provide flood mitigation. Wetlands also act as nature's filter by intercepting pollutants, storing them, and

breaking them down over time, which protects downstream areas (including drinking water diversions.) Wetlands are biological nurseries that provide protection to young salmonids and other aquatic organisms. Realizing the critical role wetlands play in our daily lives, TEP and its many partners are dedicated to their conservation and restoration, not just for the ecological benefits but for social and economic stability as well. It is important to consider all of the values of land being restored and look for opportunities to combine restoration activities with working lands.

What values do floodplains provide?

Traditionally, low lying areas of watersheds on the valley floors were rich in alluvial material deposited annually during winter river flooding. These nutrient rich floodplains were vegetated with a mosaic of forests, shrub lands, wetlands, and open grasslands. Although characterized by intermittent flooding, lowland floodplains were among the richest of terrestrial ecosystems and readily supported Native Americans and early settlers of the region.

As the population of Tillamook County expanded, fertile lowland not subject to regular flooding was in high demand. Levees and dikes were constructed and streams channelized to limit inundation of the valley floor. While modifications enabled expansion of development, they disconnected lowland floodplains from the riverine processes that maintained their productivity. Without the flooding and subsequent deposition of new silt, nutrients, organic matter, and topsoil can be lost, leading to poorer soils and land subsidence. While nutrients can be added through application of manure and fertilizers, these can potentially degrade water quality if not managed properly, and do little to alleviate subsidence. To restore the nexus between riverine processes and terrestrial ecosystems, TEP and its partners focus on ways to engage landowners to develop solutions preserving high quality farm land and residential areas while allowing for important natural processes to take place.

What does a healthy forest look like?

Tillamook County is known for its productive rainforests. Forestlands have supported our local economy and supplied the wood products industry since the 1880's. In addition to their economic value, upland forests offer numerous irreplaceable ecological functions crucial for our watersheds. Healthy forests stabilize steep slopes, help filter and slow run off, provide inputs of large wood and other organic material, sequester carbon, produce oxygen, and afford habitat for numerous plant and animal species.

Coastal rainforests of Tillamook County have been altered significantly since first encountered by early European explorers. Across the State of Oregon, less than 2% of the coastal rainforests remain unaltered. In what is now known as the Tillamook State Forest, over an 18-year period, a series of devastating fires called the "Tillamook Burn" scorched approximately 355,000 acres of forest. Legacy logging practices resulted in increased flooding, decreased water quality, increased sedimentation rates, organic inputs, amplified carbon levels, and loss of species. These effects continue to be felt today. Management strategies regulating both public and private timber lands attempt to mitigate the effects of these past practices and minimize impacts from current practices.

TEP and its partners, aware of the importance of forest products, engage stakeholders to strike the right balance between resource utilization and sustainable and diverse forest and stream ecosystems.

What is riparian habitat?

Riparian communities are vegetation assemblages that occur adjacent to waterways. This close association allows riparian plant groupings to grow larger and more lush than their counterparts farther away from water. Riparian plants surrounding the coldwater streams influence in-water physical and biological processes by providing shade to regulate 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. Without the nurturing and buffering effects of riparian areas, streams and the organisms that call them home quickly degrade.

As with other habitat types, riparian areas have also been impacted by multiple types of land uses. Historically, banks of along many of our waterways were cleared of vegetation with various development goals in mind. These changes have impacted the quality of in-stream conditions and the habitat value of riparian forests. TEP and its partners are engaging landowners on the importance of riparian ecosystems with the goal of cleaner water, reduced erosion, healthy fisheries, and improved wildlife habitat conditions, resulting in many miles of riparian community restoration and enhancement.

Rivers provide more than just water

Rivers and streams are the veins of life's existence - supplying water from upslope areas to the lowlands and estuaries. In addition to transporting water, streams move sediment and organic materials, and offer a migratory route for aquatic and terrestrial wildlife. Healthy streams contain cold water, spawning gravels, and cover from predators for the many aquatic species that call them home, and they also provide clean drinking water to the residents of Tillamook County. To ensure the health of all of our community types and the species that depend on them, it is important to focus on water resources.

While Tillamook County is blessed with abundant stream networks, many of them have been altered by dredging, large wood removal, stream cleaning, diking, channelization and other land-use practices. This has led to increased instances of degraded water quality, as well as physical and biological simplification. With the goal of protecting municipal water supplies and important aquatic organisms, TEP and its partners focus on restoration efforts that address clean cold water, stream habitat complexity, and connectivity within stream networks.

Habitat Enhancement: Types of Restoration Activities

TEP and its partners focus on habitat improvements that benefit ecosystems and, in turn, benefit the residents of Tillamook County. A diverse portfolio of projects has been implemented to

improve habitat quality and better sustain the fish and wildlife populations that depend on these habitats. Types of restoration projects are described below.

What is fish passage, and what can we do about it?

In order for aquatic organisms to flourish, access to the various environments that support the different stages in their life cycle must be maintained. Many organisms are not community specific throughout their lives and use a multitude of locales for migrating, food, rearing, and breeding as they develop from juveniles to adults. If these habitats are not available or not connected to each other, the species can decline rapidly. Roadways for human transportation can compromise connectivity when passage under or around them are insufficient, often necessitating an improved culvert or bridge for aquatic species to safely pass under the road. Now armed with a better understanding of these habitat requirements and the observed decline of many aquatic organisms, a more strategic approach to removing these passage barriers has begun. TEP and partners are engaged in an ongoing watershed scale effort to identify and prioritize passage barrier culverts throughout our study area. Based in part on these efforts, crossings are now being replaced taking into account the physical characteristics of the water bodies they are associated with and the biological requirements of the species present. While the effort is often cost intensive, it has resulted in the utilization of many formerly inaccessible habitats which has helped species rebound, while also making the roads safer for us to use.

Why would we want to put large wood in streams?

Complex, high-quality stream habitats are dependent on physical and organic inputs from both within and outside of the stream, none of which has a more profound impact on the character of stream habitat than large woody debris. Large woody debris consists of fallen trees that enter the stream via old age, blow down, forest fires, and landslide. Once in the stream, the wood alters flow and creates pools, gravel deposits and other stream features above and below the structure. Such features provide critical habitat that organisms' such as salmon, depend on throughout their life cycle.

When European inhabitants colonized the area they were amazed by the volume of downed wood found in most streams. Unaware of the ecological benefits and desiring easy access to the waterways for transportation, navigation, and "better fish passage," large wood was removed by using machinery and even dynamite. The effects of these activities impacted the streams—altering sediment transport, flow complexity, and variation in channel morphology drastically simplifying the habitat.

As stream dynamics and species requirements are better understood, the impact of the loss of large wood and the need for its replenishment is elevated as an area of focus for restoration efforts. Yet because of historic alterations to the forests ecosystems, much of the wood that would naturally enter the stream is no longer available. To re-establish healthy stream complexity, TEP and partners are harvesting trees to place in the streams and re-vegetating riparian areas to replenish natural sources of wood in the future.

Why is intact riparian vegetation important, and what can we do to enhance it?

Due to the over-simplification and removal of riparian areas, and the subsequent decline in the quality of stream health, work is underway to restore streamside riparian communities and reestablish lost function. Intact riparian communities help shade the water, filter pollutants, and stabilize stream banks. Successful riparian restoration requires willing landowners, planting high quality locally adapted plant materials, and establishing adequate buffers. Riparian restoration represents one of our best tools to address issues of water quality and productive stream habitat, and recovery is evident in sites where projects have been undertaken.

Why are we concerned about invasive species?

Invasive species are plants and animals that are not indigenous to an area and tend to rapidly spread and out-compete native species. Their presence can cause severe environmental, economic and social damage and have dramatic effects on native species through direct competition and altering baseline ecosystem conditions and processes. The mechanisms of exotic species introduction onto the landscape have occurred both intentionally or accidentally with every species having a unique story. Introductions for food, forage, aesthetic value, and functional value have been many, while other species have simply hitched a ride by ship, plane, or automobile with transporters unaware of their presence. Some examples of invasive species in TEP's study area include: reed canary grass (*Phalaris arundinacea*), Scotch broom (*Cytisus scoparius*), parrot's feather (*Myriophyllum aquaticum*), Japanese knotweed (*Fallopia japonica*), barred owl (*Strix varia*), nutria (*Myocastor coypus*), and the New Zealand mud snail (*Potamopyrgus antipodarum*).

A large component of TEP and its partners' restoration efforts include invasive species control as a significant portion of project implementation. While in many cases it may not be feasible to expect total eradication of an individual invasive species range-wide, experience has shown that given proper understanding of the species' mechanisms for spreading, a focused plan of a attack in a defined area, a well chosen method of eradication, and a persistent and comprehensive effort can rid high priority areas of unwanted invaders. Once eradicated, if proper care is taken to reestablish native populations, restore natural ecological processes, and prevent reintroduction, success can be long term.

Can setting aside land to allow nature to simply do its thing make a difference?

Often times the best form of restoration is conservation. Willing landowners who are interested in conserving the natural resource values of their land often donate or sell their land to land trusts. Another option available to property owners is a conservation easement which allows the owner to continue to own the land while permanently protecting the habitats of concern. By identifying intact, diverse, productive, and resilient community types on the landscape and protecting them in perpetuity, we can make a lasting contribution to the future of all of our local ecosystems. This is because high-value natural areas that are managed for conservation provide a safe haven for numerous species, and allow ecosystem processes to occur free of alteration. When this occurs, ecosystems flourish and their benefits extend beyond the boundaries of the communities protected.

Restoration and conservation should not be exclusive of working lands. It is important to consider all of the values of land that is being contemplated for conservation and look for opportunities to combine restoration activities with working lands. Collaborating with diverse stakeholders, TEP and its partners can accomplish our goal of protecting the most critical habitats and species in our area in concert with the community's economic and social needs. Functioning ecosystems benefit all.

Habitat Restoration and Conservation Snapshot: 2010-2014

The enormous amount of restoration and conservation that has taken place in TEP's study area in the past five years could not be accomplished by one organization. As the name implies, the Tillamook Estuaries Partnership is just that, a partnership. There is not a single project that takes place in our study area that doesn't include a number of partners. It is this collective, collaborative, and concerted effort amongst all of our local partners that get things done. TEP is proud to share all of the restoration and conservation efforts below on behalf of our partners.

Cumulative efforts by TEP and its' partners 2010-2014

Table 2: Restoration Projects by Bay/Watershed

Restoration Projects by Bay/Watershed 2010-2014			
Bay/Watershed	**# of Projects**	**Acres Treated**	**Miles Treated**
Nehalem Bay	124	630.1	67.3
Nestucca Bay	83	453.3	41.2
Netarts Bay	6	22.5	3.3
Sand Lake	3	169.5	1
Tillamook Bay	62	254.8	38.3

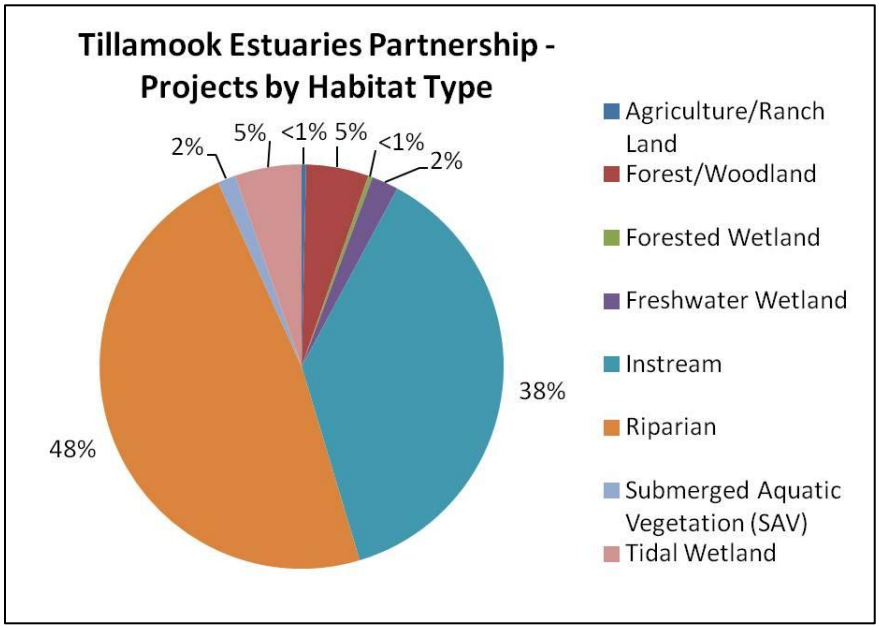


Figure 16: Restoration projects completed by TEP & partners by habitat type 2010-2014

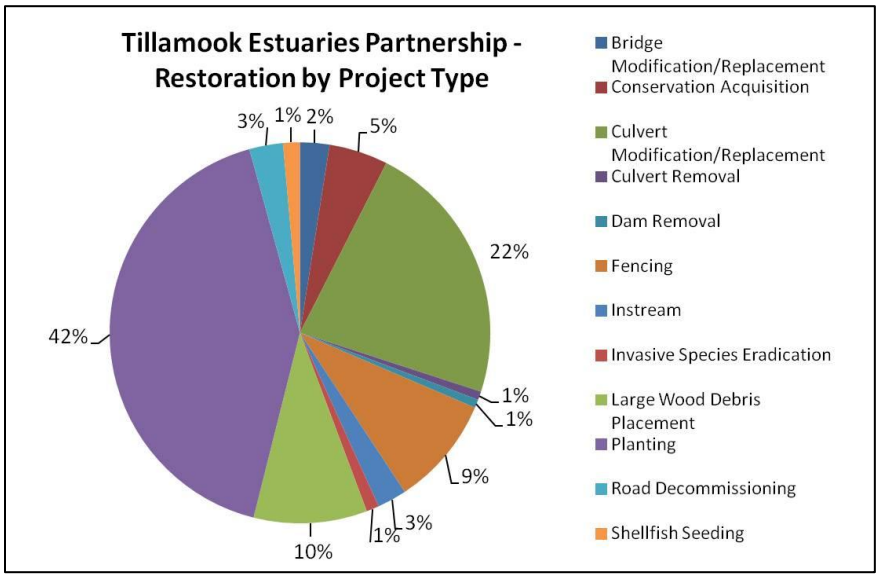


Figure 17: Restoration projects completed by TEP and partners by project type 2010-2014

Instream restoration accomplishments in the study area by TEP and its' partners

Figure 18: Instream restoration accomplishments

Table 3: Instream restoration accomplishments

Instream Restoration Accomplishments by Partner 2010-2014				
Lead Partner	**Fish Passage (Projects/Mi.)**	**Instream Modification (Mi.)**	**Large Wood Placement (Mi.)**	**Road Improvement/Decommissioning (Mi.)**
Bureau of Land Management	3/5.8		5.3	
City of Garibaldi	1/0.2			
Ecotrust	1/1.5			
Longview Timber	12/5.4			
Lower Nehalem Watershed Council	5/6.2	11.2	6.9	
Nestucca, Neskowin, & Sand Lake Watersheds Council	4/6.6	2	1	
Oregon Department of Forestry	7/3.3		0.6	
Oregon Department of Transportation	1/0.03			
Private Industrial Forest	18/18.2			
Tillamook Bay Watershed Council	4/6.1		6	2.9
Tillamook County Public Works	3/8.7			
Tillamook Estuaries Partnership	2/2.3	48.9 *		
U.S. Forest Service	7/3.5		4	
Upper Nehalem Watershed Council	5/18.6		14.2	
Weyerhaeuser	1/0.6			
* Includes 44 acres of tidal wetland channel modification				

Riparian restoration accomplishments in the study area by TEP and its' partners

Figure 19: Riparian restoration accomplishments

Table 4: Riparian Restoration accomplishments

Riparian Restoration Accomplishments by Partner 2010-2014		
Lead Partner	**Livestock Exclusion Fencing (Mi.)**	**Planting (Acres)**
Bureau of Land Management	0.5	3.5
Lower Nehalem Community Trust		1.5
Lower Nehalem Watershed Council		67.9
Nestucca, Neskowin, & Sand Lake Watersheds Council		54.3
Tillamook County Soil & Water Conservation District	10.3	2.6
Tillamook Estuaries Partnership		58.5
U.S. Forest Service		10
Upper Nehalem Watershed Council	11.4	349

Freshwater Wetland Restoration Accomplishments in the Study Area by TEP and Its' Partners

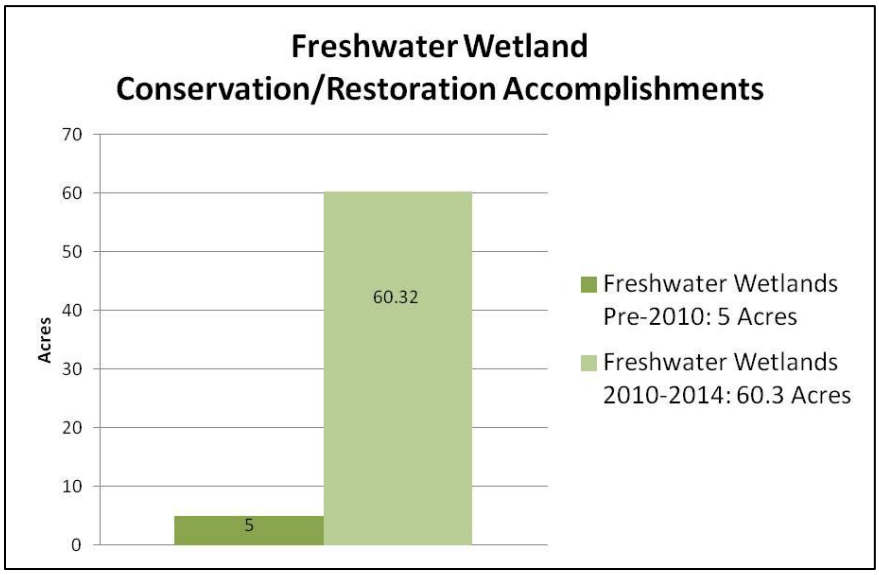


Figure 20: Freshwater wetland accomplishments

Table 5: Freshwater wetland accomplishments

Freshwater Wetland Restoration Accomplishments by Partner 2010-2014			
Lead Partner	**Planting (Ac.)**	**Conservation Acquisition (Ac.)**	**Invasive Species Control (Ac.)**
Lower Nehalem Community Trust	15.4	33.4	1.3
Lower Nehalem Watershed Council	10.2		

Tidal Wetland Restoration Accomplishments in the Study Area by TEP and Its' Partners

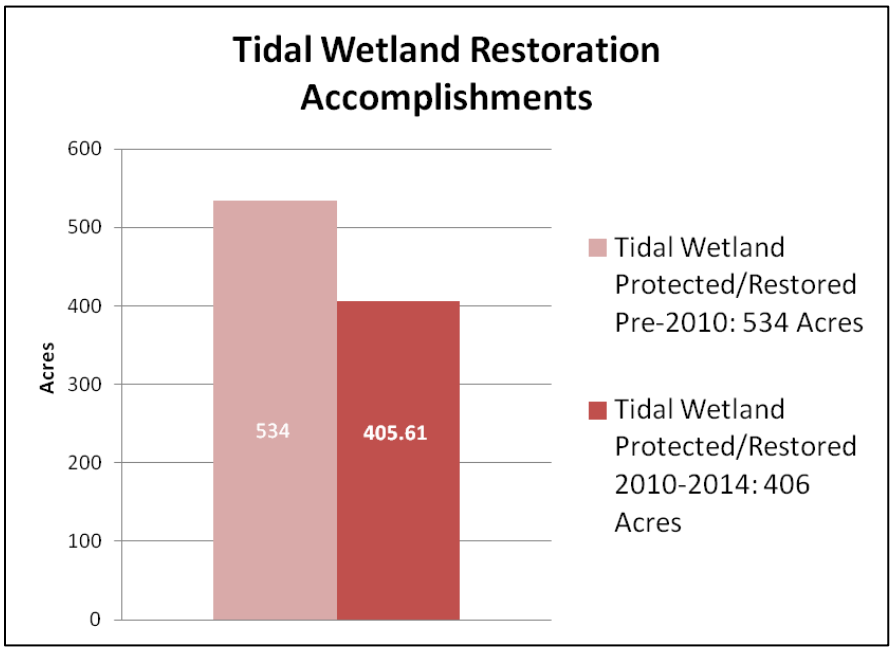


Figure 21: Tidal wetland accomplishments

Table 6: Tidal wetland accomplishments

Tidal Wetland Restoration Accomplishments by Partner 2010-2014				
Lead Partner	**Conservation Acquisition (Ac.)**	**Planting (Ac.)**	**Invasive Species (Ac.)**	**Fencing (Mi.)**
Lower Nehalem Community Trust	2.9	36.2		
North Coast Land Conservancy	167		24	
The Nature Conservancy	39	39		
Tillamook Estuaries Partnership		22.10		
Tillamook County Soil & Water Conservation District				0.6
U.S. Fish & Wildlife Service	107.8			

Habitat Restoration and Conservation: Project Focus

TEP and partners have undertaken numerous projects in the past five years to improve the health of Tillamook County's estuaries and watersheds. They include habitat restoration, in-stream enhancement, fish passage improvements, and conservation property acquisition. Below you will find specific project examples and highlights.

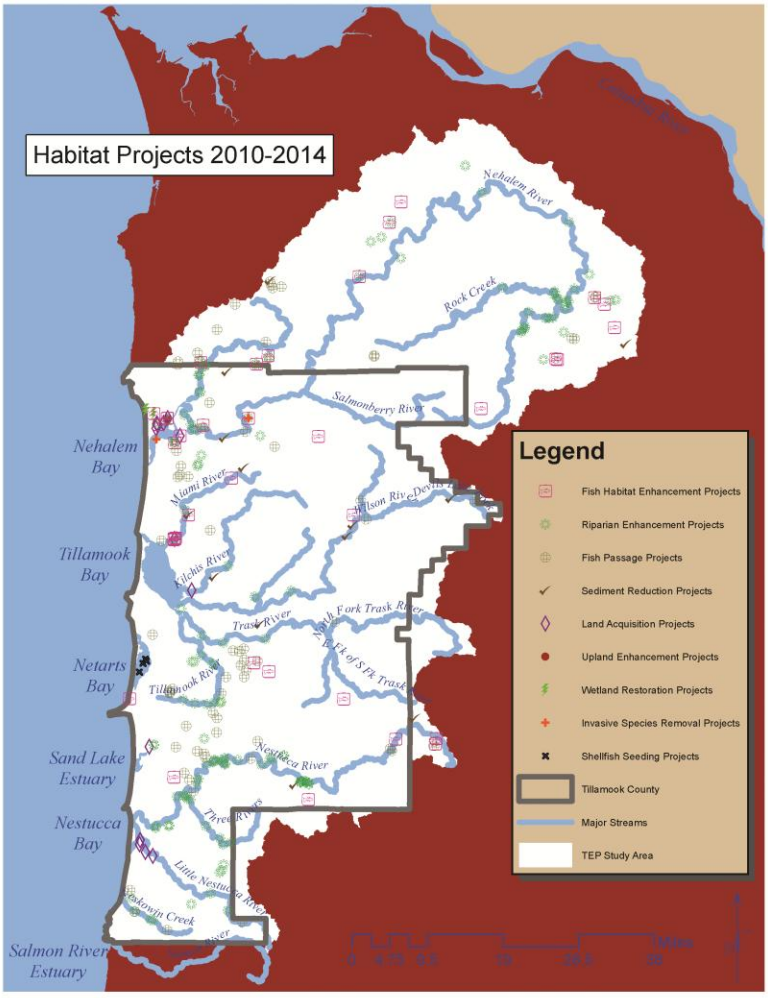


Figure 22: Map of habitat restoration projects 2010-2014

Miami Tidal Wetlands Restoration

Diking, draining, and other human activities have shaped Tillamook County's tidal wetlands. An estimated 85% of Tillamook Bay salt marsh wetlands have been altered. In 2004, TEP was presented with an opportunity to address these critical habitat losses when approached by a private landowner who was interested in restoring their land. What evolved was the 58-acre Miami Wetlands Enhancement Project, a rare opportunity to enhance tidal/freshwater wetlands at the nexus of the Miami River and Tillamook Bay. Completed in 2013 by the efforts of an astounding group of 26 partners, the project eliminated alterations and allowed natural forces to restore long term wetland function. Enhancements included ditch filling, stream re-meandering, tidal channel excavation, large wood placement in the channels and floodplain, non-native plant removal, native plant establishment, and overhead utility system removal. TEP continues to monitor the sites to document the project's effectiveness over the long term. A substantial portion of the project area has been acquired by The Nature Conservancy and the remainder has been placed under a conservation easement, assuring that this site will remain a conservation site in perpetuity.

Jackson Creek Restoration

Jackson Creek, a small, direct-to-ocean tributary in Cape Lookout State Park was impacted by a project started in 1950 that diverted flows from its historical ocean-going channel into Netarts Bay. In addition, a concrete-reinforced ford crossing in the ocean-going channel hindered fish passage and affected the channel. OPRD partnered with TEP to implement restoration actions at this site. This project filled the diversion channel to restore historical banks, reconnect the floodplain and return full flow to the ocean-going channel. The ford crossing and a wooden pedestrian bridge were also removed. The channel in this area was reconstructed to provide unimpeded fish passage and improve in-stream conditions and a new bridge was installed. To facilitate implementation, the park's water treatment system intake was upgraded

Fan Creek Culvert Replacement

This project replaced two passage barrier culverts on Fan Creek, a tributary in the upper Nestucca River watershed. Together, these culverts hampered passage to approximately 1.2 miles of spawning and rearing habitat and impaired stream habitats and functions. BLM partnered with TEP to implement this project. The new culverts, designed to pass 100-year flood waters and associated bed load and to meet fish passage requirements, are open-bottomed structures and included constructed stream beds that simulate the natural substrate.

Fawcett Creek Fish Passage & Screening

Fawcett Creek is an eastern tributary to the Tillamook River, which drains into the Tillamook Bay. Two miles upstream of Fawcett Creek's confluence, the City of Tillamook operates a surface water diversion as a primary source for its municipal water supply. The diversion dam at this location blocked fish passage to important habitats and the lack of a screened diversion allowed juvenile fish to become trapped in the settling pond. Additionally, the stream channel was modified and lined with concrete walls which constrained the stream and increased flooding and damage to structures and the pond. In 2012, Tillamook Bay Watershed Council and the City of Tillamook with management assistance from TEP replaced the former diversion, replacing the system with a full-spanning concrete structure and a 24 ft. long fish ladder. The diversion structure is specifically designed to widen the stream channel and alleviate flooding problems. The ladder allows adult and juvenile salmon passage to upstream habitats. A new screened intake ensures sufficient water is supplied to the upgraded settling pond, and that no fish become trapped in the City's water system.

Pebble Creek Restoration – Upper Nehalem Watershed Council (UNWC)

The Upper Nehalem Watershed Council partnered with Weyerhaeuser Company, ODFW, USFWS, BLM and NORP to implement a multiple component restoration project to address identified factors limiting salmonid production in the Pebble Creek sub-basin of the Nehalem River. Activities included salmon passage, in-stream habitat enhancement, riparian planting, and road decommissioning. In total, this restoration effort placed more than 1,000 pieces of large woody

debris over approximately 6 miles of stream, restored salmonid access to approximately 17 miles of stream by addressing five problem culverts, planted 15.2 acres of riparian vegetation, decommissioned 0.45 miles of road, and realigned another 500 feet of road. Large watershed scale efforts like this go a very long way towards preserving the future of our salmon populations.

Backyard Planting Program

Riparian vegetation adjacent to streams provides numerous ecological benefits that maintain high quality habitat for aquatic and terrestrial organisms. Benefits include shade that maintains cool water temperature, bank stabilization by extensive root systems, pollutant filtration, and organic inputs which drive the aquatic food web. Over the past century, development has resulted in the loss of riparian vegetation. In many cases, to restore riparian zones it is necessary to reach out to private landowners and work with them re-establish vegetation on their banks.

Addressing the need to engage landowners to support the effort, TEP developed a voluntary assistance program called *The Backyard Planting Program* (BYPP). BYPP provides willing landowners with a site-specific planting plan, invasive species removal, native trees and shrubs, a planting crew, and three years of site maintenance to ensure project success. This program, in conjunction with the Tillamook County Soil and Water Conservation District, also provides livestock fencing, off-stream watering devices. All of these activities are provided at no cost to the landowner. BYPP is actively pursuing restoration opportunities throughout Tillamook County, and has implemented projects in nine major watersheds. In addition many other partners such as the Nestucca, Neskowin, & Sandlake Watersheds Council maintain similar programs that have made significant progress towards restoring our riparian communities.

2015 marked BYPP's 11th year. During that time, 116 landowners supported the riparian rehabilitation effort making possible the restoration of 200 acres comprising 42 stream miles of riparian habitat. Of the 116 landowners who participated, 48 were agricultural and 68 were rural-residential landowners. BYPP's efforts on these properties included the planting of 51,025 native trees and 12,613 native shrubs representing a variety of different species. Average plant survival over the 11 year period was 63%, and 92% over the past 5 years.

Northwest Oregon Restoration Partnership – A Model of 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.

Restoration on Private Forest Lands – Stimson Lumber Company

Stimson Lumber Company is a large private timber land holder in Tillamook County. While logging and the production of high quality wood products is their focus, they are simultaneously dedicated to the long term protection of watershed ecosystems. Stimson voluntarily exceeds Oregon's Forest Practice Act standards, and its operation is certified sustainable by the Sustainable Forestry Initiative (SFI). Stimson accomplishes these goals by supporting in-stream restoration activities through the donation of logs for large wood placement and seedlings for riparian plantings. In addition, Stimson always maintains the highest level of quality on their forest roads providing adequate fish passage and flow volume at crossings. In Stimson's most recent restoration effort on Killam Creek, in the Tillamook River Basin, they donated 111 logs equaling 90,000 board feet with an approximate value of $19,000.00. Given that one of the most difficult challenges to accomplishing restoration is access and the willingness of private landowners, Stimson's dedication to the environment and partnership in watershed restoration is valuable.

Restoration of State Forest Lands – Oregon Department of Forestry (ODF)

The Oregon Department of Forestry manages Oregon's state forests in the interest of Oregon citizens. Part of this mission includes ecological stewardship of the forests in the form of active habitat restoration and enhancement activities. ODF's forest ecologists are always on the lookout for ways to improve the ecological conditions of the forests and streams by prioritizing, planning, and executing projects addressing roads, fish passage barriers, instream habitat quality, and riparian communities. To coordinate efforts, utilize available resources, and reduce costs, ODF frequently plans habitat enhancement and restoration activities in conjunction with timber sales on state forests lands. From 2010-2014 the Oregon Watershed Enhancement Board's Online Restoration Inventory reports the following restoration and enhancement activities accomplished by ODF in the Tillamook District: four instream large wood placements, six fish barrier enhancements/removals opening up 3.69 miles of stream, 179 logs donated for instream placement, one type-N stream crossing enhancement/removal, and 5.61 miles of forest road decommissioned. These projects included $159,550 ODF dollars towards the project work accomplished. It is important to note that this data only represents a small fraction of the restoration and enhancement work accomplished by ODF since 1995, as a large majority of high priority activities were accomplished prior to 2010. In addition numbers for 2010-14 may exclude unreported project data.

Southern Flow Corridor, Wilson-Trask Wetlands – County of Tillamook

Conservation and restoration of tidal wetland habitats represents one of the most important opportunities available in the quest to ensure ecosystem health and reduce the effects of flooding in the Tillamook Bay Basin. The Southern Flow Corridor Project is an important step in the right

direction for the health of Tillamook Bay. In 2002, following years of tireless effort by a group of inspired partners, Tillamook County accepted title to the 377 acres locally known as the Wilson-Trask Wetlands. Since that time the County and its many partners developed a plan to remove man-made structures and reconnect historical tidal channels that will have substantial flood reduction benefits for the City of Tillamook and its residents. Additionally, the plan will reconnect acres of former tidal wetland habitats benefiting numerous sensitive species within these communities. Construction is planned for 2016 and the County has unveiled 65% design plans for the project. Project history, design plans, and other details may be reviewed at: http://tillamookoregonsolutions.com/

Two Rivers Peninsula, Nestucca National Wildlife Refuge – U.S. Fish & Wildlife Service

The Nature Conservancy in Oregon and the Pacific Region of the U.S. Fish & Wildlife Service reached an agreement in September 2013, with the Jesuit Novitiate in Sheridan, OR, to purchase the 102.53-acre Jesuit property located on Cannery Hill overlooking Nestucca Bay. An adjacent 90- acre parcel was purchased in May of 2013. These properties, renamed the Two Rivers Peninsula, have been combined with the 1,202-acre Nestucca Bay National Wildlife Refuge to protect habitat for declining dusky Canada goose and endangered Aleutian cackling goose populations. The Two Rivers Peninsula includes a variety of habitat types, including upland coastal prairie, tidal marshes and mudflats, freshwater ponds and forested wetlands. The prairie is home to the Oregon Silverspot butterfly, which the federal government classifies as a threatened species. The new addition to the refuge will be open to the public as soon as proper arrangements can be made.

Beltz Farm – Oregon Parks & Recreation Department

In 2014, the Oregon Parks & Recreation Department added a 357-acre piece of critical coastal habitats along the Sand Lake Estuary to its parks system. The Beltz Farm property is named for the family that formerly owned the land. The property was purchased by the Portland- based conservation group, Ecotrust, with long-term preservation in mind and was in turn sold to the state. The property includes one mile of coastline with forests, prairies, dunes, and fresh and tidal marshes. Because the land was in private ownership for many years and was not overly altered. it represents one of the most pristine intact coastal ecosystems on the North Coast. As soon as a State Parks management plan is completed, public access to the natural site will be available.

Sand Lake Conservation Acquisitions – North Coast Land Conservancy (NCLC)

In 2014, the NCLC made tremendous strides towards preserving the Sand Lake ecosystem, one of the North Coast's most unique estuary systems. In May of 2014, NCLC acquired 167- acres in the northeastern portion of the estuary; an area characterized by intertidal salt marsh, tidal channels, and forested wetlands. These areas connect to a number of stream systems, including 1.5 miles of Sand Creek, which provides a migratory pathway for spawning adult salmon and steelhead and rearing habitat for juveniles. Later, in October of 2014, NCLC added the 48-acre Bradley Bog to their Sand Lake Reserve System. The Bradley Bog is botanically diverse and contains the northernmost

population of California Pitcher Plant (*Darlingtonia californica*) along and many other sensitive species of wetland plant. The NCLC's efforts in the Sand Lake Estuary are a prime example of how well prioritized conservation through land acquisition can preserve regional biodiversity for future generations.

Neskowin Waterwood Conservation Easement - North Coast Land Conservancy (NCLC)

Located in the Nestucca River valley, and adjoining almost 700-acres of Siuslaw National Forest lands, Waterwood is primarily a second-growth forest dominated by Sitka spruce trees, with healthy populations of western hemlock and red alder. Three major perennial streams run through the property, one of which hosts a run of winter steelhead. Waterwood was generously donated by a Neskowin couple who value Tillamook County's natural heritage. In a conservation easement, the property owner retains ownership of the land, but either donates or sells the development rights for the land to a conservation organization like NCLC. A conservation easement is attached to the deed of the property so that even if ownership is transferred, the easement on the property remains in place, in effect protecting the land in perpetuity.

Conservation Activities – Lower Nehalem Community Trust (LNCT)

The Lower Nehalem Community Trust is dedicated to community, conservation, and education through the restoration of crucial natural areas, uniting caring people, and protecting scenic vistas and sparkling waterways. In the past five years the LNCT has accomplished the following highlights in addition to their everyday activities of land stewardship and community engagement:

The Sitka Wetlands (2011, 2015): OWEB provided acquisition funding for the purchase of 19-acres of critical wetland habitat in 2010. This protected and ensured ecological connectivity of high-value wetlands on the northern perimeter of Nehalem Bay. A nearby property of about five acres was purchased by LNCT in 2015. Together, this 24-acre conservation property contains tidally influenced freshwater forested and shrub-scrub wetlands, a small amount of intertidal salt marsh, and approximately three acres of uplands.

Zimmerman Marsh (2012): Located in Wheeler, Zimmerman Marsh was purchased by LNCT in 2012 with grants and donations from the local community. The habitats present on this property include a slough sedge wetland, an estuarine wet meadow, a small but highly disturbed area dominated by Eurasian blackberry, and a riparian area surrounding Zimmerman Creek.

Vosburg Creek Conservation Complex (2014): The original eight acres of intact-forested riparian habitat was donated to the Trust in 2005. This parcel is characterized by a mix of alder and conifer trees and associated understory native plant community. Vosburg Creek, which runs through the entirety of the property, provides spawning and rearing habitat for coho salmon. Site elevation ranges from sea level, where the creek flows into Nehalem Bay, to 560' at the southern boundary of the property. The property contains approximately two acres of wetlands. Three new lots totaling about seven acres were added to the footprint of the Vosburg conservation area in 2015. The largest lot, approximately five acres, contains wooded upland habitats dominated by alder,

hemlock, and associated understory species. This property contains two small tributaries of Vosburg creek.

Sorrell Woods (2014): 4.8-acres of key habitat adjacent to LNCT's 54-acre Alder Creek Farm Conservation Area were donated to the Trust in 2014. This property contains second and third growth upland habitat with a mixture of conifer and deciduous trees. A large number of western red cedar can be found throughout the property. Two small wetland areas are present on the property. This property contains approximately 800 feet of creek frontage along one side of Alder Creek.

Elk Meadows Park (2013): LNCT helped to facilitate the creation of a nature park with the city of Manzanita. Partners included in this project were the City of Manzanita and the Oregon Parks and Recreation Department (OPRD). A grant from OPRD provided funding for the purchase of the otherwise developable property and LNCT donated four acres of adjacent land as match and to increase the footprint of the park. This nine acre natural park will have a series of walking trails, benches, natural play areas, and eventually some informational signage.

Kilchis Preserve Acquisition and Restoration – The Nature Conservancy (TNC)

The Nature Conservancy (TNC) has recently completed the initial construction phase for restoration of tidal wetlands on their Kilchis Estuary Preserve in Tillamook Bay. The 66-acre Preserve has been the focus for restoration efforts since 2010 when TNC acquired the site. Tidal wetland habitats along the lower reaches of the river are critical to salmon species, especially chum salmon and the threatened Oregon Coast coho salmon.

The Nature Conservancy's restoration plan for the Kilchis Estuary Preserve involved removing dikes to reconnect the floodplain with the river, creating tidal channels that will provide off-channel rearing habitat for salmonids and planting native species to restore spruce swamp wetlands. Restoration of Stasek Slough was a key piece of the project in bringing tidal waters back to the wetlands and creating nearly 9000' of off-channel habitat. The project will also expand the Bay's capacity to absorb floodwaters as it restores the vitality and functionality wetland ecosystems the watershed. Now that the construction phase is finished, replanting with native species will be the focus of the project for the next four years.

Salmon Super Highway

The Tillamook-Nestucca Salmon Super Highway Project aims to replace 93 barrier culverts and restore 180 miles of unimpeded access for salmon, steelhead, and other aquatic organisms within 10 years. Using a strategic, scaled approach to maximize benefits and minimize costs, this unique community partnership will deliver a portfolio of road-stream crossing replacements projects to accomplish this ambitious goal. Their completion will reconnect historical habitats, reduce chronic flooding, improve recreation opportunities, improve public safety and stimulate the local economy— both now and for the future. To learn more and find out how you can help visit: *http://www.salmonsuperhwy.com/*

Tillamook County Partnership for Regional Invasive Species Management (T.C. PRISM)

The T.C. PRISM is a diverse group of partner organizations that work together to identify, prioritize, and rapidly respond to invasive species concerns that threaten healthy ecosystems, forestry operations, and agricultural production areas. T.C. PRISM is led by TEP and currently has 19 active partners made up of federal, state, and local agencies and a variety of industry and non-profit organizations. Without the collaboration, cooperation, and monetary investment provided by the partnership it would be very difficult to make positive progress due to the persistent, wide spread, multi-species challenges that invasive species present. In addition to invasive species control the partnership is also dedicated to educating the public about the threat of invasive species and how we can all make a difference starting in our own backyard. Currently Tillamook County Soil & Water Conservation District in conjunction with T.C. PRISM is mapping and prioritizing riparian invaders in the Nestucca Watershed. This effort is part of a larger effort initiated by BLM and will include a substantial public outreach component. Once invasive populations are mapped and prioritized, the hard work of eradicating these populations will begin. Mapping and prioritization ensure that nothing is missed, decisive targeted actions are taken, and supports the acquisition of funding to get the job done.

State of the Salmon Fisheries

The salmon species of the Pacific Northwest are legendary, and have sustained humans residing in the area for millennia. Historically, populations of salmon species returning to Tillamook County watersheds were plentiful, and the harvests so robust a sense of inexhaustibility dominated. Things changed in the first half of the 20th century when most populations began to show a rapid decline due to harvest practices and the loss of stream, estuary, and ocean habitats. Furthermore, as a result of limited understanding of salmon biology and life history strategies, many of the effects of these actions went unrecognized. Today, while salmon populations still face challenges, our understanding of these resilient creatures has improved and our efforts to protect and restore their habitats have expanded. Meaningful restoration of salmon populations depends on a comprehensive understanding of many complex physical and biological factors, and a concerted effort by all of us to make it happen. The Oregon Plan for Salmon and Watersheds contains a framework for how stakeholders should assess, monitor, and restore salmonid populations in Oregon.

A number of coordinated monitoring programs are giving those involved in restoring salmon populations more of the information they need to be effective. Graphs below depict estimated escapement to spawning grounds for the threatened Oregon Coast Coho and coastal Chinook salmon. The graphs average data from the Tillamook, Nestucca, and Nehalem watersheds. It is important to note that the data presented is only an estimate based on extrapolation of direct field measurements. The data is included to provide an idea of how variable salmon returns are in relation to habitat conditions in rivers, estuaries, and the ocean, also our impacts to the species via harvest. This data is unpublished and is for general reference only. For more information please contact your local ODFW office.

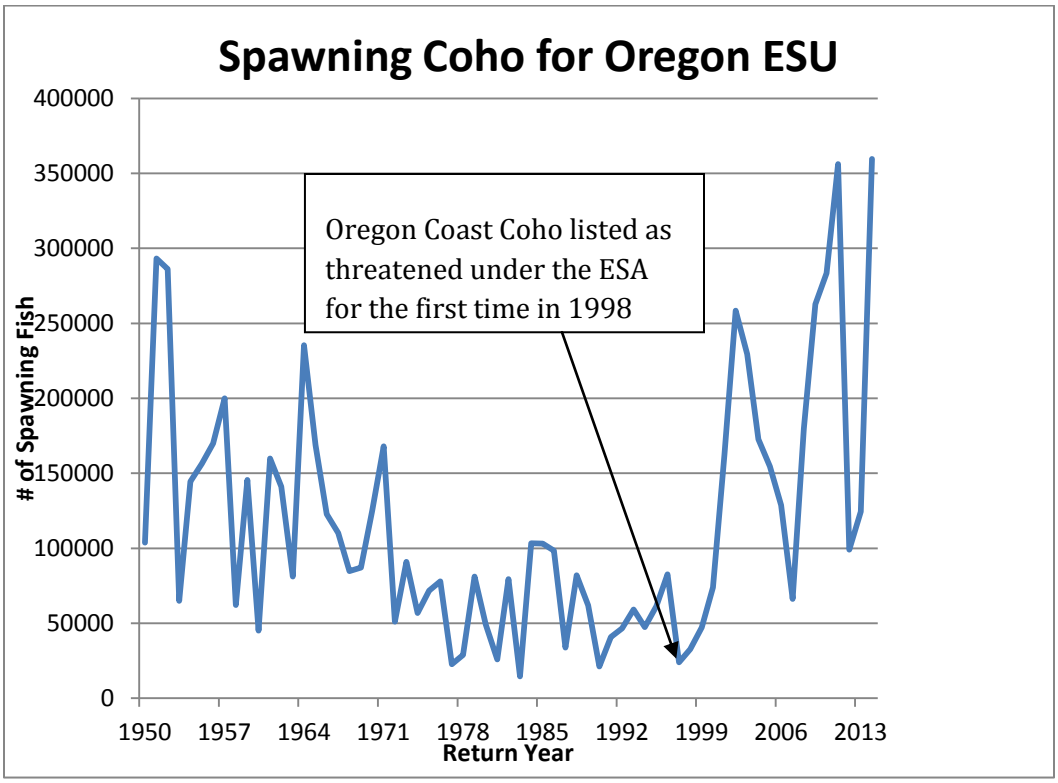


Figure 23: Oregon Coast Coho Escapement

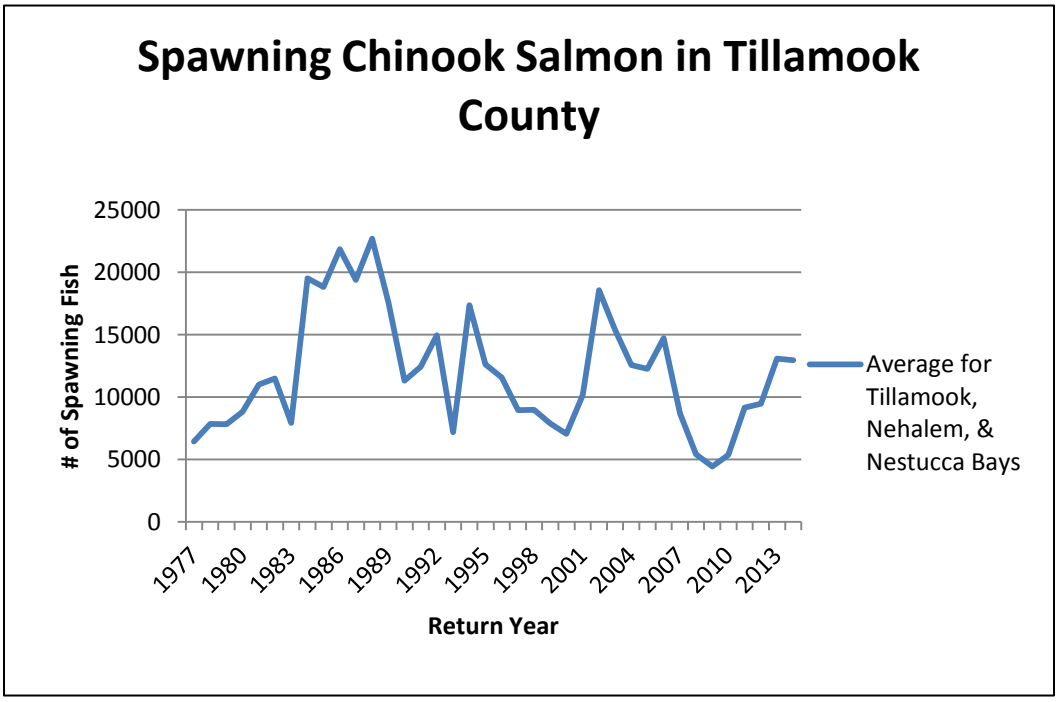


Figure 24: Chinook Escapement for Tillamook County

Oregon Department of Fish & Wildlife Monitoring Studies

Based on the Oregon Plan for Salmon and Watersheds Monitoring Plan, the ODFW developed a comprehensive monitoring approach to further understand all aspects of Oregon's salmonid populations including juvenile life stages, adult life stages, survival rates from juvenile to adult, and habitat quality parameters. The juvenile and adult monitoring projects are linked through the use of the same Environmental Mapping & Assessment Program (EMAP) site selection and rotating panel sample design in order to promote sampling efficiencies and allow for integration of data and analysis. Understanding the salmon life cycle and the various complex habitats they depend on, will ensure high quality restoration of the resource and smart management decisions into the future. The various ODFW monitoring programs are described in the following paragraphs.

Western Oregon Rearing Program Surveys (WORP)

Western Oregon Raering Programs Surveys (WORP) was established to understand the distribution, abundance, and habitat requirements of juvenile life stages of threatened coho salmon populations. This is accomplished by annual summer surveys to monitor juvenile coho salmon in Oregon coastal streams. The objectives of these surveys are to: 1) monitor trends in the abundance and distribution of juvenile coho in each of five coastal coho Gene Conservation Areas (GCAs); and 2) provide information needed to investigate the relationships between freshwater habitat characteristics, adult spawner abundance and juvenile recruitment.

The study designed a monitoring system which produces estimates that statistically represent each area. In order to keep costs reasonable and avoid bias ODFW collects representative samples from randomly selected sites. Sample measurements, such as the number of coho juveniles at each selected reach, are used to make inferences about the resource as a whole. Sampling is done by a two-person snorkel crew that counts the number of juvenile coho at each of the sample reaches. Detailed data and reports for this ongoing project may be viewed at: https://nrimp.dfw.state.or.us/crl/default.aspx?pn=WORP

Oregon Adult Salmonid Inventory and Sampling (OASIS)

The overall objective of the OASIS project is to monitor status and trends of naturally produced Oregon coastal and Lower Columbia salmonid stocks. The project has four main target species: Chinook, chum, coho, and steelhead. Although not a main target species, information is also collected on spawning Pacific Lamprey. Key metrics include: abundance, spatial distribution, temporal distribution, and proportion of hatchery fish in the naturally spawning population. Spawning ground surveys are conducted from October through January (Chinook, chum and coho) and from February through May (steelhead and lamprey). Surveys are conducted at least once every 10 days (Chinook, chum and coho) and once every 14 days (steelhead and lamprey). Survey sites are either "Standard" surveys or EMAP surveys. Standard survey sites were specifically selected, many in the 1950's, for ease of access and historically high numbers of spawning salmon. The EMAP survey sites are based on a spatially-balanced random selection process, and incorporate a rotating panel design to create a 27 year survey plan. Surveyors either walk upstream or boat

downstream, depending of the size of the stream being surveyed. The surveyors count redds, live and dead fish (by species), and sample carcasses for gender, length, scales, fin clips and tags.

Program objectives vary by species, but include: estimate annual spawner abundance for each population/complex, evaluate straying and natural spawning by hatchery fish, monitor and assess abundance trends, and determine spawner age composition and life history (fish scales). Additional objectives of this program include, mapping the spatial and temporal distribution of spawners, as need and as opportunity allows research and development of methodologies.

Populations being assessed in TEP's study area include the Nehalem, Tillamook, and the Nestucca watersheds with exact monitoring locations varying by species. Detailed data and reports for this ongoing project may be viewed at http://oregonstate.edu/dept/ODFW/spawn/index.htm

Life Cycle Monitoring Program (NF Nehalem and EF Trask)

ODFW monitors survival and migration of salmonids in select coastal basins. The primary objectives of the salmonid Life-Cycle Monitoring (LCM) project are to estimate abundance of adults and downstream migrating juveniles and estimate marine and freshwater survival rates for coho salmon. The LCM Project also calculates the coho salmon marine survival prediction for fisheries management and has evaluated the effects of habitat modification on salmonids. In Tillamook County, the LCM project has two sites located on the North Fork Nehalem River and the East Fork Trask River. The NF Nehalem site is unique among the Life Cycle Monitoring sites in having a coho and steelhead hatchery located nearby. This provides an opportunity to further investigate the distribution and possible effects of hatchery fish within and between basins.

To review the most current findings visit: https://nrimp.dfw.state.or.us/CRL/default.aspx?p=430

Coastal Chinook Research and Monitoring Program (CCRMP)

The Coastal Chinook Research and Monitoring Program (CCRMP) conducts research on populations of Chinook salmon on Oregon's coast with a focus on north migrating populations important to Oregon's participation in the Pacific Salmon Treaty. CCRMP generates robust adult population estimates for specific basins, estimates harvest of returning adults, and determines appropriate methods and tools to monitor Chinook populations in a cost effective and accurate way. In TEP's study area, CCRMP currently works in the Salmon, Nestucca, Nehalem and Tillamook watersheds.

The overall goal of this project is to improve our ability to estimate adult Chinook salmon spawners from year to year and understand the contribution of Oregon's stocks to the northern ocean and Oregon fisheries. For more information visit:
https://nrimp.dfw.state.or.us/crl/default.aspx?pn=CCRMP

Aquatic Habitat Inventories (AQI)

The Aquatic Inventories project (AQI) is a statewide freshwater and estuarine research program. The project assesses aquatic habitats, conducts fish presence/absence surveys, monitors fish

populations, establishes salmonid watershed prioritization, monitors habitat restoration projects, and reconstructs historical salmonid life histories. This information is used to provide basic information for biologists and land managers, to establish monitoring programs, and to direct or focus habitat restoration efforts.

The AQI provides an important contextual framework to evaluate results from the previously described biological research efforts. This methodology was designed to be compatible with other stream habitat inventory and classification systems. The process of conducting a stream survey involves collection of general information from maps and other sources and the direct observation of stream characteristics in the field. This information is both collected and analyzed based on a hierarchical system of regions, basins, streams, reaches, and habitat units. Supervisors are responsible for collecting the general information on regions and basins and for directing the activities of the survey crews. Survey teams collect field data based on stream, reach, and channel unit characteristics. Region and basin data primarily come from ODFW-EPA region and sub-region classifications, also from map analysis. For more information on this program see: http://oregonstate.edu/dept/ODFW/freshwater/inventory/index.htm

Habitat Assessment & Monitoring

Miami Wetlands Monitoring Discussion

Construction efforts for the Miami Wetlands Enhancement Project were completed during summer 2010–11 and native plant enhancement planting and maintenance activities have continued annually through 2015. TEP collected data on a variety of biological and physical attributes at the site before construction efforts began and continues to monitor these attributes to evaluate the efficacy of the project and inform future tidal wetland restoration efforts. Physical attributes monitored at the site include water levels, water quality (temperature, salinity and dissolved oxygen), channel morphology and soil qualities (organic matter and salinity). Biological attributes include vegetation structure and composition, and fish and wildlife resources.

Before the Miami Wetlands Restoration project began, the site was highly modified from historical conditions. It once was a tidally-connected, spruce-dominated wetland with a network of natural channels. Through human manipulation, it became a densely vegetated herbaceous wetland dominated by non-native, Reed canary grass with a muted tidal signature and a reduced and highly modified channel system constructed primarily to drain the site. In addition, baseline site characterization data indicates that, pre-construction, the site was primarily a precipitation-driven, fresh water wetland with limited salt water intrusion.

The goal of the restoration project is to restore the site to a semblance of its former self, with increased woody cover, native-dominated vegetation communities, and more natural and well-connected hydrological conditions. Some aspects of the site were immediately altered as a result of the project and resulted in very pronounced changes to the site, but other aspects will change more gradually and long-term monitoring will be required to fully understand and demonstrate these changes. For example, channel construction resulted in dramatic and immediate visual and physical

changes to the site, but long-term monitoring will be needed to fully understand how the modified channels change over time and influence hydrological conditions. Similarly, although a considerable amount of plant material has been added to the site, only after this material has had an opportunity to grow and reproduce will we be able to understand how vegetation community distribution, composition and structure has responded to project activities.

Culvert Assessment and Prioritization Plan for Fish Passage in the Tillamook Bay Watershed

Six student interns under the direction of TEP's Project Manager completed field surveys of nearly 900 road-stream crossings throughout the Tillamook Bay Watershed that were identified using a computer-assisted analysis. Through this effort, 215 culverts within the watershed with potential to affect fish passage were indentified. Detailed information was gathered on these culverts and then they were prioritized for replacement based primarily on the degree to which they impaired fish passage and the quantity and quality of upstream habitats. This project was completed to facilitate a strategic approach to passage barrier culvert replacement; improve inter-organizational, long range planning efforts; and allow for more efficient use of funds and other resources.

TEP's efforts are paying off. Some culverts identified and prioritized in this study have already been replaced by our partners and several additional replacement projects are in various stages of development at this time. TEP and its' partners are working to complete similar assessments for all of the watersheds in our study area including an assessment and prioritization of crossings in the Nehalem Basin being carried out by the Lower Nehalem watershed Council.

Tidal Wetland Prioritization for the Tillamook Bay Estuary

TEP contracted with Green Point Consulting (GPC) to identify, characterize, and assess tidal wetlands in the Tillamook Bay Watershed, and prioritize these sites for restoration and conservation. This endeavor facilitates a strategic approach to protecting, restoring/enhancing, and managing tidal wetlands in the estuary; provides for more efficient use of funds and other resources; and allows TEP and our partners to focus conservation action towards areas and activities that will provide the most benefit for wildlife and their habitats.

Effectiveness Monitoring Program: Plan and Protocols

TEP developed 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 allows assessment and comparison of habitat enhancement projects. TEP uses monitoring protocols that are consistent with other effectiveness monitoring efforts in the region. This decreases the time and effort needed to develop our program and increases its utility beyond our organization by allowing for comparison among projects in a broader regional context. TEP's effectiveness monitoring plan and associated protocols are on the TEP website and may be viewed there. It is TEP's goal for effectiveness monitoring to be incorporated into future habitat enhancement projects.

State of the Bays: Education

Tillamook County's natural environment and the cultural heritage of its inhabitants are nearly indistinguishable, having shaped and nourished one another for centuries. The continual health and bounty provided by this relationship hinges upon the knowledge, passion, and commitment of those closest to it. While it is true that knowledge is power, it is also the catalyst by which respect, inspiration, and positive action are realized. It is us, the residents and visitors, who arethe stewards of Tillamook County's environment. Understanding this, TEP and its many partners have laid a foundation of education, outreach, and community engagement that will empower all of us to reach our goal of a healthy and sustainable environment for generations to come.

Settled within a temperate rain forest, harboring five estuaries, flowing rivers and streams and lying next to the Pacific Ocean, TEP's work study area beckons to be an extension of the classroom for all. Nature can be the most obvious or most subtle teacher and TEP appreciates the educational opportunities that lie outside its door. It is everywhere with national movements such as the Obama Administration's '*Every Kid in the Park'*, Richard Louv's (Author, "*Last Child in the Woods: Saving our Children from Nature-Deficit Disorder*") Children & Nature Network, and Green Schoolyards popping up all over.

Recognizing these movements to get people outside and engaged with nature, the time is ripe for the development of TEP's Education program. At a state and local level, TEP is active in programs such as STEM, (integrated science, technology, engineering, and math education); Oregon Environmental Literacy Plan: *Toward a Sustainable Future,* the result of *No Child Left Inside Act – 2009,* intended to address the need for improved environmental literacy among the young people of Oregon; and has embraced the New Oregon Science Standards and Common Core Curriculum. Additionally, TEP partners with the three Tillamook County school districts, the Tillamook Pioneer Museum, and other field educators to create a robust outdoor experience for all learners.

Getting Kids Outdoors Where Learning Comes Natural

TEP and its partners inspire local youth through a range of programs that aim not just to educate, but immerse them in the wonders of nature and the lasting benefits of a healthy environment. In many cases this means doing our best to get kids out of their classrooms and into the world to see, touch, hear, and smell all that is around them. By making experiences fun and interactive, learning becomes effortless.

Children's Clean Water Festival and Down by the Riverside

Memories of being in the 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 is 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 the TEP, in partnership with the Oregon Department of Environmental Quality, sessions are led by environmental educators and partners from throughout the North Coast.

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. By giving students a chance to build sense of place and increasing their 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 Education Kits

To augment classroom teacher's efforts to increase environmental literacy, TEP offers eleven outdoor education kits. These kits include curricula relative to 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.

Tech-Trek (STEM Camp)

Tech-Trek Camp is a region-wide camp for 8th grade young women. Participants attend courses in one of three tracts (science, technology/engineering, and math). Field experiences include multiple interactive presentations ranging from exploring the Kilchis Point Preserve to astronomy. All components increase their knowledge of STEM and promote young women in those fields. The classes and presentations highlight the many different career paths an individual can take and how fundamental the STEM fields are to those paths. TEP joins with American Association of University Women–Tillamook, Oregon State University Open Campus, and Tillamook Bay Community College, in providing this exceptional week long experience.

Integration with National and State Initiatives

Science Technology Engineering & Math Program (STEM)

The STEM program promotes integrated science, technology, engineering and math education and serves coastal teachers, students and communities. The Oregon coastal region is one of six Regional STEM Hubs funded in 2014-2015 by the Oregon Department of Education. STEM represents:

"An approach to teaching and lifelong learning that emphasizes the natural interconnectedness of the four separate STEM disciplines. The connections are made explicit through collaboration between educators resulting in real and appropriate context built into instruction, curriculum, and

assessment. The common element of problem solving is emphasized across all STEM disciplines allowing students to discover, explore and apply critical thinking skills as they learn."

–Oregon Department of Education

Oregon Coast STEM Hub utilizes contextual, Problem Based Learning (PBL) to enhance teaching and promote higher achievement among students from our rural communities. Tillamook County School Districts reaches its rural populations through programs focused on natural resource assessment and management. To accomplish this, the local community and its natural environment are utilized as classroom annex and community partnerships form the backbone of the effort. The primary goal is to provide an opportunity to connect youth with nature and provide tangible real world career experiences to prepare them for their future. TEP plays an active role in the Oregon Coast Stem Hub as a voting member of its steering committee.

Oregon Environmental Literacy Plan

Oregon enacted the *No Child Left Inside A*ct to address the need for improved environmental literacy. The act required the creation of an Environmental Literacy Task Force who was charged to work with the Oregon Board of Education to develop an Oregon Environmental Literacy Plan that would lay out a course of action to improve environmental literacy among Oregon's youth. The plan defines Environmental Literacy as:

"An individual's understanding, skills and motivation to make responsible decisions that consider his or her relationships to natural systems, communities and future generations".

The Environmental Literacy Plan's framework stresses integration of environmental education at all grade levels, consistent high level educational content, comprehensive training for instructors, higher education standards for achievement, and frequent access to the outdoor classroom. Abundant professional development opportunities are stressed for both formal and non-formal educators. TEP and partners work diligently to encourage local schools in our study area to adopt the policies laid out in Oregon's Environmental Literacy Plan. Additionally, TEP has a seat at the table as a member of the Oregon Environmental Program Council and acts as a liaison for local interests.

New Oregon Science Standards

The Oregon State Board of Education adopted the Next Generation Science Standards (NGSS) as the new Oregon 2014 Science Standards. The new science standards will be phased in so that school districts can make the necessary changes to local curriculum, and provide training for instructors and administrators. In addition, prior to initiating student assessments, students will be given an opportunity to learn the new content, practices, and cross-cutting concepts adopted by the standards. Since the release of the Next Generation Science Standards, TEP and its partners have been working to transition the content of education programs and the knowledge base of our staff and volunteers leading the programs to meet these new higher level standards. Successfully enacting these standards will certainly give the young people of Tillamook a competitive advantage

moving forward in their lives, and will bolster TEP's efforts to improve the environmental literacy of our children.

Community Engagement

It is the goal of the TEP to develop "life-long learners" (people who continue to grow and develop beyond school years). The concept is really no different for the adults—gets them outside where they have fun and learn, and a sense of stewardship follows.

Tillamook County Water Trail

Don't just look at nature, immerse yourself in it! That in a nutshell, is the beginnings of the Tillamook County Water Trail (TCWT). In 2004, a committee of visionary people convened to develop a system of trails that was the first of its kind in Tillamook County. This committee envisioned a system of water trails flowing through the quiet bays, and roaring rivers of the county that would bring its residents closer than ever before to their surroundings. The TCWT focused its efforts on non-motorized watercraft, affording nearly everyone in the community the opportunity for exploration. Guidebooks, with inset maps, were produced detailing all local estuaries. Colorful and captivating, these guidebooks impart valuable information on safety, appropriate access points, cultural history, stewardship, etiquette and inspire all who paddle the waterways to become more aware of their natural surroundings. As of 2015, all four guide books were completed, widely distributed, and publically acclaimed, culminating in the TCWT being recognized as a National Recreation Trail by the U.S. Department of the Interior. TEP's TCWT is a true success empowering people to live, learn, and experience their environment on their own terms, at their own pace.

Education through Recreation

Out of the Tillamook County Water Trail blossomed *Education through Recreation program*. There is no better place to learn about the environment than experiencing it and having fun. TEP's *Education through Recreation* program focuses on getting everyone outdoors and recreating while they learn. Activities such as hiking, biking, and kayaking are not only a great platform for learning about environment, they are healthy forms of exercise which allow participants to get outside, and feel good about themselves in doing so. Each summer, TEP and its partners offer opportunities encouraging residents and visitors to experience new things. Offerings include kayaking in 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.

TEP Speaker Series

TEP's Speaker Series facilitates public discussion about natural resource issues so residents feel informed and recognize the perspectives and concerns of their neighbors. Topics focus on relevant CCMP related issues such as climate change and water quality. By inviting experts on issues to engage the public, TEP fosters community dialogue about natural resource management. In addition to hosting events within the community, TEP plans to broaden its outreach to user groups across the state. The significance of the NEP designation for Tillamook Bay has regional relevance.

Engage and Go

TEP strives to be a familiar face at popular Tillamook County public events. It is an opportunity for TEP to form lasting relationships in our community 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. Each year, TEP pulls out all the stops for our premier community soiree, Bounty on the Bay. The action packed weekend includes a fishing tournament, silent auction and fantastic food. Fishermen come from far and wide to try and land the elusive salmon and learn a little something along the way. The connection is solidified between restoration and recreation and fun is had by all.

Volunteers – TEP's Environmental Heroes

Volunteers are a vital component in achieving successful CCMP implementation. Without them, TEP would not exist. Volunteers led the charge for our nomination to the National Estuary Program and facilitated creation of our Comprehensive Conservation and Management Plan. They still play a big role in our operations. On average, annually we engage over 150 volunteers totaling in excess of 2,000 hours of volunteer time which equals a value greater than $42,000. These volunteers form the backbone of many TEP programs – potting NORP plants, collecting water samples, and leading education activities. Our all volunteer Board of Directors enable the organization to remain sustainable and be a leader in the restoration arena for Tillamook County. Volunteers are our biggest advocates and spokespeople in the community and we appreciate their contributions enormously.

State of the Bays: Adapting to a Changing Climate

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. In order to ensure our vital natural resources well into the future it is paramount that we protect and restore the resiliency of ecosystems to withstand and adapt to change.

Tillamook County is a coastal-dominated climate and stands to experience some substantial changes under most climate change models. Generally speaking, we can expect warmer, wetter, and more condensed winters, with longer and drier summers. Additionally 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. If these changes do play out as predicted, we will likely see equilibrium shifts in our estuaries, rivers, and forests that will last centuries.

Estuaries are likely to become more saline and brackish as ocean water becomes more of a dominant force. Higher seawater levels will impact productive mudflats and tidal wetlands especially where development has consumed surrounding lowlands. In areas where surrounding lowlands still exist, a transgression of habitats will occur with mudflats and tidal wetlands spreading outward to higher elevations. As the ocean becomes more acidic, so will our estuaries, potentially limiting the primary productivity of the ecosystem and in turn affecting fish and wildlife. Shellfish populations that rely on calcium carbonate shell structures will be affected by elevated acidity. Coastal rivers are expected to experience significantly warmer average water temperatures, which is incompatible with cold water inhabiting fish species like salmon. In the winter, larger rain events are anticipated over shorter periods of time causing amplified bed scour and bank erosion as well as downstream flooding. In the longer summers, stream flows are projected to run lower and warmer making survival of sensitive species difficult. While it is predicted that forest stands have the potential to expand, stresses such as increased pest infestation, invasive species, and larger and more devastating wildfires may work against them.

Given these predictions, 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. Some of these qualities include intact habitat types, species diversity, and adequate habitat connectivity. Intact ecosystems allow expansion and contraction along their edges with changing climate conditions and resource availability. Species diversity ensures community resilience by having species with different functional traits and strengths work together to retain vital ecosystem processes; as some species become stressed and decline, others can fill crucial roles that provide for the whole. Habitat connectivity allows organisms the ability to adjust their geographic position as environmental conditions change, and provides a source of new organisms to colonize an ecosystem from outside the system. For example, in an area where climate warms, organisms preferring cooler conditions may move north or up slope if adequate habitat corridors are available.

Healthy debate is crucial for progress and leads to stronger decision-making. It is important that we factor climate change into our plans with that cautionary principal in mind. Recent events highlight sound 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. These harbingers should be used as a platform to focus research and inform further discussion. To learn more about climate change and Tillamook County, visit http://www.tbnep.org/reports-and-publications.php to read the 2013 report prepared by the Oregon Climate Change Research Institute.

Climate Change Case Study: Impacts of Coastal Acidification on the Pacific Northwest Shellfish Industry

The ocean is the world's single biggest depository for atmospheric carbon dioxide. As excess amounts of fossil fuel emissions are introduced into the atmosphere, oceans continue to become more acidic. Increased ocean acidifications along with other biochemical changes are likely to undermine the function of marine ecosystems and the species they support.

Estuaries in TEP's study area have not been immune to the influence of climate change. Tillamook County is Oregon's leading producer of farmed shellfish. In 2007, the Whiskey Creek Shellfish Hatchery, located adjacent to Netarts Bay, noticed a dramatically increased rate of mortality in their oyster seed stock. What was originally thought to be a bacteria-related issue transitioned into an investigation into the effects of ocean water chemistry on the oyster larvae. Whiskey Creek, in cooperation with Oregon State University researchers, launched a comprehensive water quality monitoring program focused on determining the problem. They discovered that the acidity of the incoming seawater was impacting the development of young oyster seedlings in the first 24 hours following fertilization. This is because acidity in the seawater affected the concentration of aragonite, a crucial carbon based molecule found in seawater that is necessary for shell production in the young oysters. Acidic water destabilizes these carbon base molecules causing them to break apart.

To address this concern, the oyster growers began buffering against 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. Local oyster growers were the catalyst to further understand the relationship between climate change and our coastal ecosystem. While much was learned about the effects of ocean acidification on shellfish, this study also verified that the changing climate conditions are real and can have significant economic and environmental repercussions. To review the complete article on the study in the *Journal of Oceanography* visit: http://www.tos.org/oceanography/archive/28-2_barton.html

State of the Bays: 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 sport and commercial fisheries (including oysters and crabs), a vast array of recreational opportunities, and jobs. In ODFW's 2008 "Fishing, Hunting, Wildlife Viewing, and Shellfishing In Oregon", the importance of natural resources as an economic driver was highlighted. Across the State of Oregon, 2.8 million Oregon residents and non-residents fished, harvested shellfish, hunted, and participated in outdoor recreation associated with wildlife viewing. The total expenditures across the state associated with these activities totaled $2.5 billion. In the North Coast (Tillamook and Clatsop Counties), total expenditures totaled ~$147 million. It's also important to note that while these numbers are impressive they do not reflect the additional economic impact of the thousands of people who visit the area simply to enjoy sitting on the beach or to take a stroll along a trail. The economic value of healthy functioning ecosystems is significant in our study area and can't be overstated

Projects taken on by TEP and our partners ensure that our estuaries and watersheds will remain prosperous well into the future and support a recreation economy and a "restoration economy" for vendors, contractors, and local businesses. Between 2011 and 2014, TEP secured over $5.6 million in grants and donations from federal, state and local entities, private foundations, and individuals. 100 percent of those dollars went back into the region through habitat restoration, research and monitoring, education and outreach, and payroll.

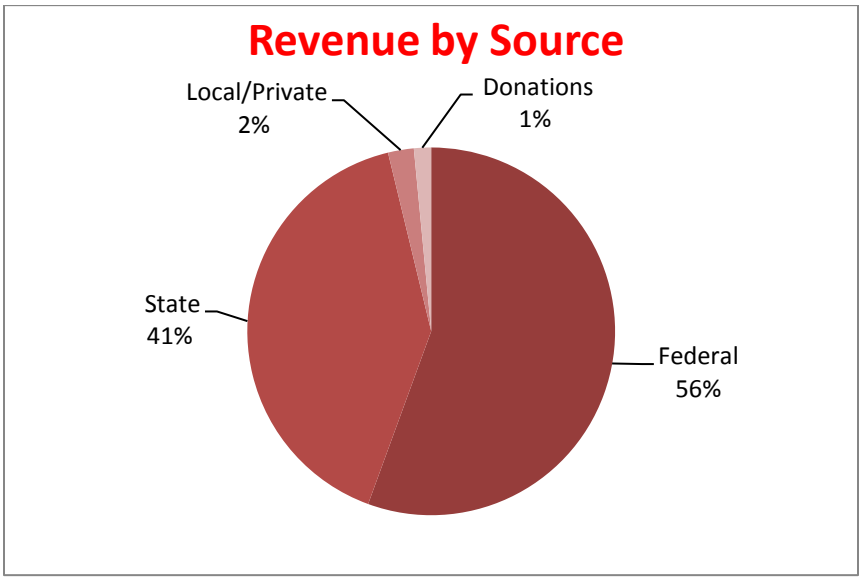


Figure 25: Example of TEP revenue by source 2010-2014

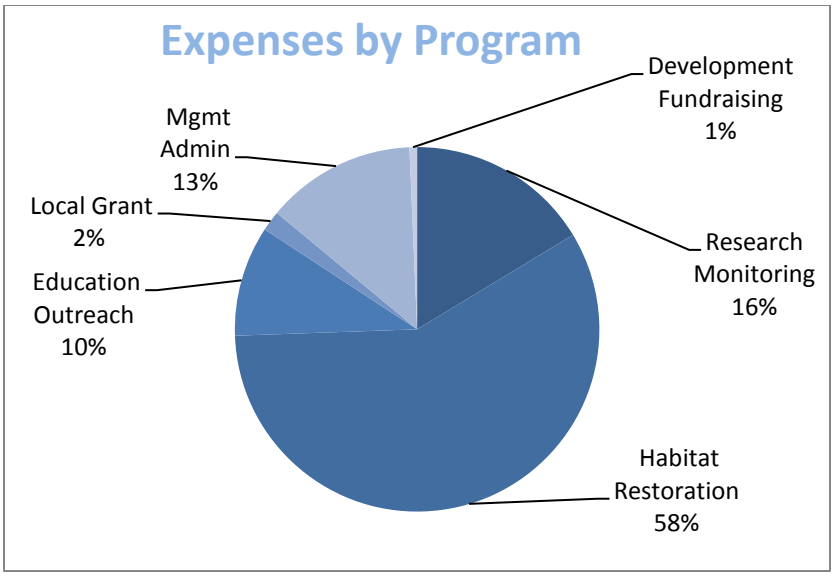


Figure 26: Example of TEP expenses by program 2010-2014

Table 7: Table of funding partners

US Environmental Protection Agency	Institute for Applied Ecology
US Bureau of Land Management	Tillamook County
Ducks Unlimited	City of Bay City
Ecotrust	City of Tillamook
Wild Salmon Center	Oregon Community Foundation
National Fish and Wildlife Foundation	City of Tillamook
Oregon State Parks and Recreation Department	The Nature Conservancy
Oregon Watershed Enhancement Board	Spirit Mountain Foundation
US Fish and Wildlife Service	Meyer Memorial Foundation
Oregon Department of Environmental Quality	Whole Watershed Restoration Initiative
Oregon Department of Agriculture	U.S. Fish & Wildlife Service
Fibre/TLC Federal Credit Union	Oregon Department of Forestry
Fish America Foundation	Oregon Department of Fish & Wildlife
Oregon Department of Forestry	Norcross Wildlife Foundation
Hebo Stewardship Group	Jubitz Foundation
Oregon State University	Oregon Community Foundation
US Geological Survey	Samuel S Johnson Foundation

Looking at the local impacts of these dollars, the table below 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. More economic impact information can be found on TEP's website under Financial Reports.

Table 8: Economic Benefits Provided to Local Economy

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

State of the Bays: A Partnership Focus

Why Partnerships are Important

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

TEP has been fortunate to work with many partners – we thank all of them for their time, efforts and talents. This list, though extensive, 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 (CREST)
- Columbia River Maritime Museum
- Confederated Tribes of Siletz Indians
- Cory Anderson Guide Service
- Crimsontrace
- Curt Hedges' Guide Service
- Dan Crossely 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
- McMenamins
- Mick's Styx
- Moore Northwest Images
- National Endowment for the Art
- 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
- Northwest Hardwoods
- NW Weed Management Partnership
- Ocean Breeze Baptist School
- Ocean Inn Motel
- 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-Tillamook
- 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
- Unfurl
- 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
- Upper Nehalem Watershed Council
- U.S. Army Corps of Engineer
- U.S. Fish and Wildlife Service
- WEBS
- Werner Meats
- Wetlands Joint Venture
- Weyerhaeuser
- 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 Citizen

Thank You!!!

Closing Statement: "Balance"

It is a simple word full of complexities. TEP and our 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 work that needs to be done. Our estuaries are complex and diverse ecosystems as are the solutions to achieving a "healthy" ratings 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 5 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 the 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 report describes our activities over the last five years in great detail. If you would prefer a brief snapshot of the efforts that have gone on over the past 5 years visit www.tbnep.org to read the State of the Bays 2015 – Executive Summary. It paints a colorful picture of the past 5 years utilizing many inspiring photos and descriptive graphics.

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

Appendix

Glossary of Key Terms

Adaptive management - a systematic approach for improving resource management by learning from management outcomes

Anthropogenic - of, relating to, or resulting from the influence of human beings on nature

Aquaculture - the rearing of aquatic animals or the cultivation of aquatic plants for food

Bed scour - is the removal of granular bed material by hydrodynamic forces

Best Management Practice - Methods or techniques found to be the most effective and practical means in achieving an objective

Biological processes - a process occurring in or by living organisms in an ecosystem

Brackish - water that has more salinity than fresh water, but not as much as seawater. It may result from the mixing of seawater with fresh river water, as in estuaries.

Carbon sequestration - a natural or artificial process by which carbon dioxide is removed from the atmosphere and held in solid or liquid form.

Channel morphology - dimensions of a stream channel (width, depth, and meander wavelength and gradient) as controlled by instream structure and flow characteristics

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

Computer-assisted analysis – a form of scientific analysis aided by the computational abilities of computer systems (i.e. climate change computer modeling)

Confluence - the flowing together of two or more streams or rivers

Connectivity - the state or extent of being connected or interconnected (i.e. habitat connectivity between river and upland forests)

Conservation acquisition – purchase of lands or legal rights with the expressed intent of conserving land and water with high conservation value

Cross-cutting concepts – are concepts that bridge disciplinary boundaries, uniting core ideas throughout the fields of science and engineering

Drainage area - A drainage basin or catchment basin is an extent or an area of land where surface water from rain, melting snow, or ice converges to a single point at a lower elevation, usually the

exit of the basin, where the waters join another waterbody, such as a river, lake, reservoir, estuary, wetland, sea, or ocean.

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 complexity - The Complexity of Ecosystem Interactions related to the diversity of organisms, physical characteristics, and ecosystem functions paramount to the stability of an ecosystem

Ecosystem process - The physical, chemical and biological actions or events that link organisms and their environment (i.e. decomposition, production [of plant matter], nutrient cycling, and fluxes of nutrients and energy)

Effectiveness monitoring – monitoring that is designed to determine if a restoration project is effective at meeting its biological and ecological objectives

Environmental standard - is a policy guideline that regulates the effect of human activity upon the environment. Standards may specify a desired state (e.g. lake pH should be between 6.5 and 7.5) or limit alterations (e.g. no more than 50% of natural forest may be damaged).

Environmental assessment – an investigation into some aspect(s) of the physical and/or biological environment (i.e. watershed assessment)

Environmental awareness - understanding the fragility of our environment, our impact on it, our role within in it, and the importance of its protection

Environmental curriculum – educational materials aimed at teaching complex *environmental* issues and raising environmental literacy and awareness

Environmental Literacy - is 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 meets the stream

Fish escapement - That portion of an anadromous fish population that escapes the commercial and recreational fisheries and reaches the freshwater spawning grounds

Floodplain – the area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge.

Functional traits - are morphological, biochemical, physiological, structural, phenological, or behavioral characteristics that are expressed in phenotypes of individual organisms and are considered relevant to the response of such organisms to the environment and/or their effects on ecosystem properties (Violle et al. 2007)

Habitat mosaic - An area or site comprised of multiple habitat types

Habitat transgression – the act of a habitat type moving from one position to another based on changing environmental conditions

Hatchery fish – a fish that is hatched and reared in a hatchery setting before being released into the natural environment

Hydro-modification - the alteration of the natural flow of water through a landscape, and often takes the form of channel modification or channelization.
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 - are the 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 cycle - the series of changes in the life of an organism, including reproduction

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

Macroinvertebrates - organisms that are large (macro) enough to be seen with the naked eye and lack a backbone (invertebrate)

Migratory route - the geographic *route* along which a particular species of animal customarily migrate

Mudflats - also known as tidal flats, are coastal wetlands that form when mud is deposited by tides or rivers. They are found in sheltered areas such as bays, bayous, lagoons, and estuaries.

Native – an organism of indigenous origin or growth. (i.e."these plants are native to North America")

Natural capital - can be defined as the world's stocks of natural assets which include geology, soil, air, water, and all living things. It is from this Natural Capital that humans derive a wide range of services

Natural filtration – the natural filtration of pollutants from water and air by plants, soils, and within the water column via chemical, biological and physical processes that occur naturally

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

Non-indigenous - are plants, animals, or pathogens that are non-native (or alien) to the ecosystem

Non-point source pollution - *Non-point* source (NPS) *pollution* refers to both water and air *pollution* from *diffuse sources*

Physical processes - Physical processes shape features on Earth's surface (i.e. climate, wind, precipitation)

Primary productivity - is the process and rate at which energy is converted by photosynthetic and chemosynthetic autotrophic organisms to organic substances which form the base of the global food chain (i.e. plants creating energy via sunlight, water, and carbondioxide)

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

Renewable resource - an organic natural *resource* which can be replenished, either through biological reproduction or other naturally recurring processes

Restoration - the action of returning a habitat, community, or species to a former place or condition

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

Riverine - Located in, adjacent to, or inhabiting the banks of a river

Saline - containing or saturated with salt

Salmonid - a fish of the salmon family (Salmonidae)

Sediment transport - is the movement of solid particles (sediment), typically due to a combination of gravity acting on the sediment, and/or the movement of the fluid in which the sediment is entrained

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

Specific conductance - is a measure of how well water can conduct an electrical current

Sustainability - is the capacity to endure; it is how biological systems remain diverse and productive indefinitely

Temporal - of or relating to time

Terrestrial - of, on, or relating to the earth

Tidal marsh - a type of *marsh* that is found along coasts and estuaries of which the flooding characteristics are determined by the *tidal* movement of the adjacent estuary, sea or ocean

Total Maximum Daily Load (TMDL) - is a regulatory term in the U.S. Clean Water Act, describing a value of the maximum amount of a pollutant that a body of water can receive while still meeting water quality standards

Turbidity - is the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in air

Urbanization – is the transition of an area from rural to more densely populated and urban

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

Water quality - refers to the chemical, physical, biological, and radiological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose

Watershed - the area of land where all of the water that is under it or drains off of it goes into the same place

Wetland - Anarea that is saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem

Wildlife corridor - is an area of habitat connecting wildlife populations separated by human activities or structures (such as roads, development, or logging)

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